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JOURNAL PAPER INSTRUCTIONS TO AUTHORS

General

The paper should be valuable and should not have been published or submitted for publication in any other Journals. The text should be complete with abstract, introduction, material and methods, results, discussion and reference. The text must not exceed 15 pages for sciences papers and 25 for the humanities

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Include page numbers. The page numbers should be placed in the lower right hand corner.

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The paper title must be capitalized, bold, centered, 11 pt., and spaced after 18 pt. Main titles and abstract title should be capitalized 9 pt., aligned left, bold, spaced before 12 pt., and after 6 pt., and numbered as (1., 2.,3.). Principle subtitles must be written in 10 pt, bold, aligned left.

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ALI MUHAMMED[1], JALAL AMEEN [2] and DLOVAN ASSAD [2]

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Table (1): The effect of pepper shoot & root aqueous extract on the growth of different other plants:

Shoot Extract						Root Extract				
Plant type	Conc. %	Root length (cm)	Shoot length (cm)	Intact plant length (cm)	Inhibition %	Conc. %	Root length (cm)	Shoot length (cm)	Intact plant length (cm)	Inhibition %
Okra	0	*25.7 a**	27.8 a	53.5a	-	0	25.7a	27.8a	53.5a	-
	5	25.00a	26.77a	51.77a	3.23	1	24.50a	27.00a	51.50a	3.73
	10	24.50a	25.95a	50.45a	5.70	2	23.87a	25.65a	49.52a	7.43
Sorghum	0	21.6a	27.2a	48.8a	-	0	21.7a	27.2a	48.9a	-
	5	13.00b	17.25b	30.25b	38.03	1	9.8b	25.5ab	35.3b	27.6
	10	6.00c	5.50c	11.50c	76.44	2	9.4b	22.6b	31.9 b	34.6

Figure (1): xxxxxxxxxxxxx

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- Healey, M., Foote, K., and Hay, I. (2000). Developing the International Network for Learning and Teaching (INLT) *Geography in Higher Education. In: International Geographical Union Commission on Geographical Education* (Eds.). Geographical Education at the Cross-roads: Directions for the Next Millennium, Proceedings of the Kyongju Symposium (pp. 203-207), Korea.

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CONTENTS

DNA ISOLATION FROM FORMALIN-FIXED PARAFFIN-EMBEDDED TISSUE FOR THE DETECTION OF *K-RAS*MUTATIONS IN PANCREATIC CANCER

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(Received: October 11, 2012; Accepted for publication: April 4, 2013)

ABSTRACT

This study conduct toassess the detection of K-ras gene mutation at codon 12, to estimate the percentage of K-ras gene mutation and pancreatic cancer. A total of 30 paraffin blocks containing pancreatic cancer tissue were obtained from archive of central laboratory in Duhok government, 50-µm sections was cut from each paraffin-embedded tissues block for DNA extraction and then DNA samples were quantities by spectrophotometry. K-*ras* exons 12 was amplified by Real time-PCR from 50 µg of DNA using detection of K-ras gene mutation (QIAGENE, Germany) according to manufactures protocol. It was found that 19 patients (63.3 %) showed positivity for K-ras mutation test and 11 patients (36.7%) showed negativity with K-ras mutation. In conclusion, the method that demonstrated in this report provides a simple and fast way to identify K-ras mutation for the purpose of clinical evaluation in human pancreatic cancer. Further studies concerning oncogenes, including rasgenes, are warranted to elucidate molecular pathogenic mechanisms of Pancreatic cancer.

KEY WORDS: K-ras gene, RT-PCR and Pancreatic cancer

INTRODUCTION

The development of PCR-based techniques for detection of K-*ras* mutations has allowed its use in the clinical setting. Data suggest that a combination of cytological examination and K-*ras* mutation detection in cellular material may improve diagnostic accuracy (Tada *et al.*, 1991). However, K-*ras* mutations have been detected not only in intraductal carcinomasbut also in pancreatic mucinous cell hyperplasia and chronic pancreatitis (Van Es *et al.*, 1995), a finding that may limit its value in pancreatic cancer diagnosis.

Pancreatic cancer arise in the retroperitoneal region, this fact makes it very difficult to be detect by simple imaging in the early stage, so once diagnosed it is in the advanced stage in most cases, with a 5-year survival rate of less than 5%. With extensive research into the molecular biology of pancreatic cancer, the K-ras gene has been found to be related to the development of pancreatic cancer (Haller, 2002). K-ras also known as V-Ki-ras2 Kirsten rat sarcoma viral oncogene homolog and K-ras, is a protein that in humans is encoded by the *K-ras*gene (McGrrath *et al.*, 1983 and Popescu *et al.*,1985). Like other members of the Ras family, the K-ras protein is a GTPase and is an early player in many signal transduction pathways. The protein product of the normal K-ras gene performs an essential function in normal tissue signaling, and the mutation of a K-ras gene is an essential step in the development of many cancers (Kranenburg, 2005). After the advances in molecular biological technology, point mutation at codon 12 of K-*ras* oncogene has been found in 75–100% of pancreatic cancer tissues , and this information has been recognized as a new promising approach to the diagnosis of pancreatic cancer(Lohr *et al.*, 2001and Ferrari *et al.*, 1994).

The aims of this study are to isolate the genomic DNA from Fixed Paraffin-Embedded Tissue (FPET)in patients with pancreatic cancer. Then estimate the percentage between K-ras gene mutation and pancreatic cancer.

Materials and Methods

A total of 30paraffin blocks containing pancreatic cancer tissue were obtained from archive of central laboratory, Department of Histopathology which diagnosed between May 2006 to August 2011. An appropriate paraffin block containing tumor tissue were selected for analysis after reviewing the hematoxilin-eosin

(H&E) stained slides by specialists in pathology. The mean age of patients with pancreatic cancer in this study was 58.1 years ranging from 42-75 years (17 men and 13 women).

Fifty-µm sections were cut from each paraffin-embedded tissues block for DNA extraction.DNA was extract as previously describe(Shi *et al*, 2004; Amado *et al*, 2008)and then DNA samples were quantities by spectrophotometry and stored at –20°C.K-*ras*exons 12 was amplified by Real time-PCR from 5 µg of DNAase previously described using detection of K-ras gene mutation (QIAGENE, Germany) according to manufactures protocol.-specific primers at exon 12.

RESULT

The ductal adenocarcinoma was the commonest type about 88 % followed by acinar carcinoma and undifferentiated carcinoma 12 % for both. The analyses of K-ras gene mutation found that 19 patients (63.3 %) showed positivity for K-ras mutation and 11 patients (36.7%) showed negativity with K-ras mutation (Figure 1). The relation with the degree of differentiation is shown in (table1). The method is highly specific for mutant K-ras and no false positive signals due to break through of mutant specific primers have been detected.

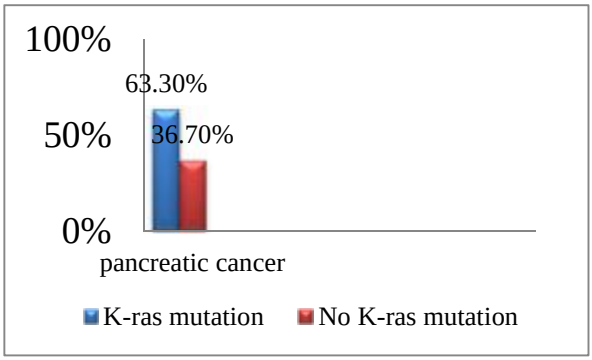

Fig. (1) represents the percent of K-ras gene mutation among patients with pancreatic cancer

Table (1): The relation of K-ras gene mutation with the degree of differentiation of the pancreatic cancer

Degree of differentiation	K-ras gene mutation				Total	%
	Positive	%	Negative	%		
Well	7	23.3	3	10	10	33.3
Moderately	10	33.3	4	13.4	14	46.7
Poor	2	6.7	3	10	5	16.7
Undifferentiated	0	0	1	3.3	1	3.3
Total	19	63.3	11	36.7	30	100

DISCUSSION

The early diagnosis of pancreatic cancer has long been a hot topic worldwide. Early stage diagnosis and resection of pancreatic cancer are essential to the improvement of patients with pancreatic cancer. Researchers begin to investigate the correlation between gene and carcinoma for the diagnosis and screening of tumor (Wilentz *et al*, 1999). Mutations result in trapping the gene product in an activated state and thus leading to uncontrolled cell growth. Some data have raised the possibility of tumor suppressor properties of K-ras (Zhang *et al*, 2001) Mutation status of RAS in the tumor has important clinical implications as it may affect the response to treatment and has treatment-independent prognostic value (Karapetis *et al*, 2008, Schubbert *et al*, 2007, Amado *et al*, 2008, Friday and Adjei, 2005 and Castagnola and Giaretti, 2005). Therefore, mutation detection of RAS is of clinical importance in cancer

prognosis and treatment. Tumors of the pancreas are highly malignant and characterized by poor prognosis. These tumors, although they are not very frequent, harbor mutation in the ras family genes at the highest frequency as compared with all other human tumors. It has been reported that 90% of the pancreatic adenocarcinoma harbor a K-ras mutation (Smit *et al* 1988, Ferrari *et al,* 1994, Kawesha *et al,* 2000). It is of specific interest that all mutations have been detected in K-ras and the majority affecting codon 12. This finding indicates specificity in K-ras proto-oncogene in the development of pancreatic cancer (Lemoin *et al,* 1992). The strong association of K-ras codon 12 point mutation with the development of pancreatic cancer led several investigators to explore a possible clinical significance of this finding for diagnosis of the disease. In the present study the K-ras gene mutations were positive in 63.3 % of the patients, which was slightly lower than the previous studies. The results were in agreement with other studies regarding the type and degree of cancer differentiation and also the ratio of male to female pancreatic cancer incidence(NCIN, 2008). The mean age of patients in this study was 58.1 years ranging from 42-75 years, this was lower than the age range of mostother literatures, where nearly 90% of pancreatic cancer patients are older than 55 years with average age at the time of diagnosis is 72(Anderson, K *et al*, 2006, Winter *et al*, 2006). (Tado *et al,* 1993) detected K-ras codon 12 point mutation in the pancreatic juice of all cases tested. In addition, (Kondo *et al,* 1994) detected mutation at codon 12 in the pancreatic juice of patients with pancreatic cancer, all negative by cytodiagnosis, and proposed that the detection of K-ras codon 12 point mutation may be a valuable diagnostic modality for pancreatic carcinoma. A tumor suppressor function of K-ras might also exist in the pancreas based on the study of pancreatic cancer cell lines (ASPC-1, CAPAN-1, MIA-PaCa) with loss or underexpres-sion of wild-type K- ras. (Caldas and Kern, 1995) These functions are thought to be produced by the interaction of K- ras with proteins involved in cell cycle arrest and apoptosis (Vos *et al,* 2003). The overall frequency of K-ras mutations found in pancreatic cancer aspirates was 76.7 %, confirming the widely acknowledged significant incidence.

The frequencies reported in literature were mostly within a range from 75 to 100 %, with frequency between 61 % and 80 % in pancreatic juice (Costentin *et al,* 2002 and Queneau *et al,* 2001), 70 - 73 % in pancreatic duct brushings (Liu *et al,* 2003). In contrast to the tumor targeting approach, mutation detection sensitivity is the most important factor for applying the molecular marker screening in pancreatic cancer diagnostic screening. The issue of mutations detection sensitivity is the key in finding small populations of mutated cells in an excess of normal cells (Li-Sucholeiki *et al,* 2000).

CONCLUSION

In conclusion, the method that it demonstrated in this report provides a simple and fast way to identify K-ras mutation for the purpose of clinical evaluation in human pancreatic cancer. Further studies concerning oncogenes, including ras genes are warranted to elucidate molecular pathogenic mechanisms of pancreatic cancer.

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جوداكرناگەردێن ترشێ ناڤكی ژ شانەیێندناڤشەمایاپارافینێداهاتینەجێگیركرن و هەلگرتنكو ژ وان كەسانهاتینەوەرگرتنیێن توشی نەخوشیاپەنجەشێرا پەنكریاسێبووین ژ پێخەمەتدیاركرناكەشەفریتاجینیK-ras

پوختە

ئەڤڤەكولینەهاتیەئەنجامدان ژ پێخەمەتهەلسەنگاندنابهایێدیاركرنێ ژ بو دیاركرن و دەستنیشانكرناكەشەفریتاجینی ل دەڤكودونێژمارە 12. هەردیسانبۆهەلسەنگاندنارێژاسەدی ل دەمێ دیتنا ڤێجینێ و نەخوشیاپەنجەشێراپەنكریاسێ. بۆڤێمەرەمێ 30 نموونە ژ شانەیێن وان كەسێنئەڤنەخوشیە ل دەڤهەیێكودناڤشەمایاپارافینێداهاتبونەهەلگرتن و جێگیكرن ژ تاقیگەهاناڤەندی\بەشێنەخوشیێنشانەیی ل باژێرێدهوكێهاتبوونەوەرگرتن، پشتێئەنجامداناڤەكولینێ و رێكێنپێدڤێبۆجوداكرناگەردێن ترشێ ناڤكێدناڤ وان شانەیاندا، ل دویڤداتاقیكرنەكاتایەتهاتەئەنجامدانبۆدیاركرنا بوونا ڤێكەشەفریتێئەوژی ب هاریكاریاكارلێكازنجیرەیییێنپەلمەركرنێRT-PCR، د دوماهیێدیاربووكوئەنجامێن 19 نموونەیان ژ شانەیێنكەسێنتووشبووی ب نەخوشیاپەنجەشێراپەنكریاسێدپوزەتیڤبوونلدویفكەشەفریتاجینێكورێژا وان دبیتە 63.3٪ ، دهەماندەمدائەنجامێن 11 نموونەیانئانكو ب رێژا 36.7٪ د نێگەتیڤبوون.لدوماهیێ هوسا دیاربووكوئەڤڤەكولینەشیایەرێكەكا ب سانەهی و بلەزبۆدیاركرناكەشەفریتاجینێپەیدابكەت ژ بو مەرەمێن هەلسەنگاندانا كلینیكی یا نەخوشیاپەنجەشێراپەنكریاسێ. ئەنجامێنڤێڤەكولینێرێخوشكەرنبۆئەنجامداناڤەكولینێ، زێدەترەدەربارەی جینێن پەنجەشێرێ ژ پێخەمەتپەتررووهنكرنائامراز و رێكێننەخوشیییێنگە ردی بۆنەخوشیا پەنجەشێراپەنكریاسێ.

عزل جزيئات الحامض النووي من الانسجة المثبتة والمطمورة في شمع البارفينللاشخاص المصابين بسرطان البنكرياس للكشف عن الطفرة الجينية k-ras

الخلاصة

اجريت هذه الدراسةلتحديد الطفرة الجينية k-rasعند كودون 12 ، لتقدير النسبة المئوية بين تواجد هذا الجين وسرطان البنكرياس. حيث تم الحصول على 30 عينة من الانسجة المثبتة في شمع البارافين والحاوية على انسجة الاشخاص المصابين بسرطان البنكريس من المختبر المركزي الحكومي قسم الامراض النسيجية في مدينة دهوك ، وبعد القيام بالخطوات اللازمة لعزل جزيئات الحامض النووي من تلك الانسجة فقد تم اجراء الاختبار الخاص للكشف عن تلك الطفرة باستخدام طريقة تفاعل البلمرة (RT-PCR) وجد بان 19 عينة للاشخاص المصابين بسرطان البنكرياس كانت ايجابية للطفرة الجينية اي بنسبة (63.3%) في حين ان 11 عينة اي بنسبة (36.7%)كانت سلبية للاختبار البامرة (RCR). ان الدراسة الحالية تعد وسيلة بسيطة وسريعة لتحديد طفرة K-ras لغرض التقييم السريري في سرطان البنكرياس. وهناك مايبرر اجراء المزيد من الدراسات بشان الجينات المسرطنة لتوضيح اليات الامراض الجزئيي للسرطان البنكرياس.

PERSONALIZATION USING WEB RECOMMENDATIONS BASED ON ELMAN ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

Nowadays Web users are facing the problems of information overload and drowning due to the significant and rapid growth in the amount of information and the number of users. As a result, how to provide Web users with more exactly needed information is becoming a critical issue in Web applications. In this work, our aim is to address the improving of the performance of Web personalization through developing and employing Web recommendation based On Elman Artificial Neural Network. The experimental results show the success of the recommendation in the prediction of the best link to the user based on the new profile. This is developed based on the data in the user clicks for previous use in the past.

KEYWORD: Personalization, Elman Artificial Neural Networks

1. INTRODUCTION

The Web information age has brought a dramatic increase in the sheer amount of information (Web content), the access to this information (Web usage), as well as the intricate complexities governing the relationships within this information (Web structure). One of the most promising and potent remedies against this plague comes in the form of personalization. Personalization aims at customizing the interactions on a website depending on the user's explicit and/or implicit interests and desires [9, 13].

Personalized search has gained great popularity to improve search effectiveness in recent years. The objective of personalized search is to provide users with information tailored to their individual contexts. [8]

The move from traditional physical stores of products or information (such as grocery stores or libraries) to virtual stores of products or information (such as e-commerce sites and digital libraries) has practically eliminated physical constraints traditionally limiting the number and variety of products in a typical inventory. Unfortunately, the move from the physical to the virtual space has severely limited the traditional three dimensional layout of products for which access is further facilitated thanks to the sales representative or librarian who *know* their *products and* their *customers*. As a result, the customers are drowned by the huge number of options, most of which they may never even get to know.

Hence, in both the e-commerce sector and digital libraries, Web personalization has become more necessary than an option. Personalization can be used to achieve several goals, ranging from increasing customer loyalty on e-commerce sites to enabling better search. [9, 13]

The objective of web personalization is to give users a website they want or need, and thus knowing the needs of users is an important task for content recommendation in web personalization. In this article, we propose a hybrid approach for this task. This paper describes a collaborative user profiling and adaptive interface method embedded within website. The system combines VB.NET, ASP.NET and Artificial Neural Network (ANN) technologies to produce web pages with dynamic content that recommend the next best links for a customer based on the interactions of prior customers. Tests on human subjects show that the effectiveness of the system appear when compared to a base-line system that randomly recommends best links. Even the users who were not informed of the purpose of the recommendation links can observe the advantage of the system.

2. PERSONALIZATION

Personalization involves a process of gathering user-information during interaction with the user, which is then used to deliver appropriate content and services, tailor-made to the user's needs [4, 5]. The aim is to improve the user's experience of a service.

Web Personalization aim's at [9]:

- Converting browsers into buyers.
- Improving web site design and usability
- Improving customer retention and loyalty.
- Increasing cross-sell by recommending items related to the ones being considered.
- Helping visitors to quickly find relevant information on a website.
- Making results of information retrieval /search more aware of the context and user interests.

2.1 MODES OF PERSONALIZATION

Personalization falls into four basic categories, ordered from the simplest to the most advanced:

- **Memorization**: In this simplest and most widespread form of personalization, user information such as name and browsing history is stored (e.g. using cookies), to be later used to recognize and greet the returning user. It is usually implemented on the Web server. This mode depends more on Web technology than on any kind of adaptive or intelligent learning. It can also put in danger user privacy [9], these modes of personalization are used as first part in proposed system, see figure (1-a).
- **Customization:** This form of personalization takes as input a user's preferences from registration forms in order to customize the content and structure of a web page. This process tends to be static and manual or at best semi-automatic. It is usually implemented on the Web server. Typical examples include personalized web portals such as My Yahoo! [9]. Customization is used as a second part of proposed system see figure (1-b).

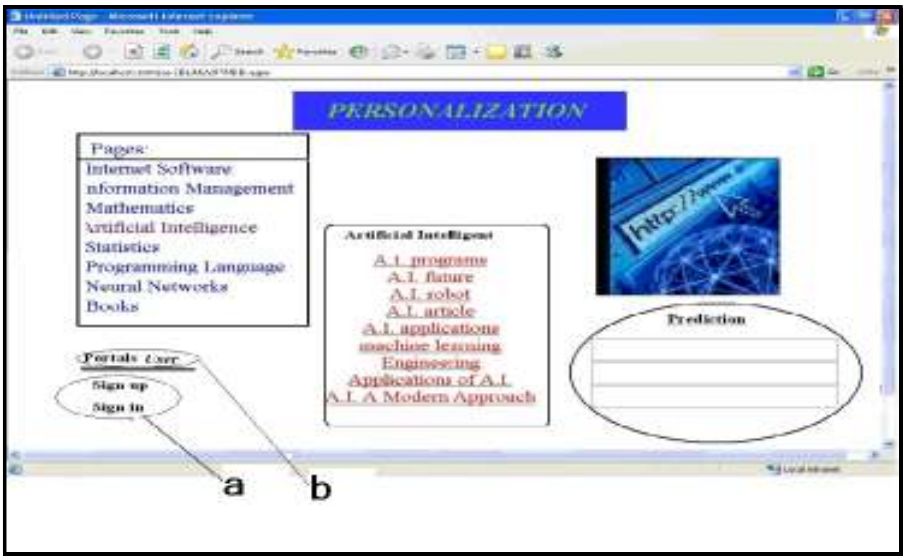

Fig. (1): Memorization and Customization

- **Guidance or Recommender Systems:** A guidance based system tries automatically to recommend hyperlinks that are deemed to be relevant to the user's interests, in order to facilitate access to the needed information on a large website. It is usually implemented on the Web server, and relies on data that reflects the user's interest implicitly (browsing history as recorded in Web server logs) or explicitly (user profile as entered through a registration form or questionnaire). [9], this mode is used in third part of proposed system (using Elman Artificial neural network).
- **Task Performance Support:** In these client-side personalization systems, a personal assistant executes actions on behalf of the user, in order to facilitate access to relevant information. This approach requires heavy involvement on the part of the user, including access, installation, and maintenance of the personal assistant software. It also has very limited scope in the sense that it cannot use information about other users with similar interests. In the following, we concentrate on the third mode of personalization, namely, automatic Web personalization based on recommender systems, because they demand a minimum or no explicit input from the user. Also, since they are implemented on the server side, they benefit from a global view of all users' activities and interests in order to provide an intelligent (learns user profiles automatically),

and yet transparent (requiring very little or no explicit input from the user) Web personalization experience.[9]

Three different approaches can be identified for the acquisition of information about the users of Web applications, see figure (2). [7]

2.2 COLLECTION OF WEB DATA

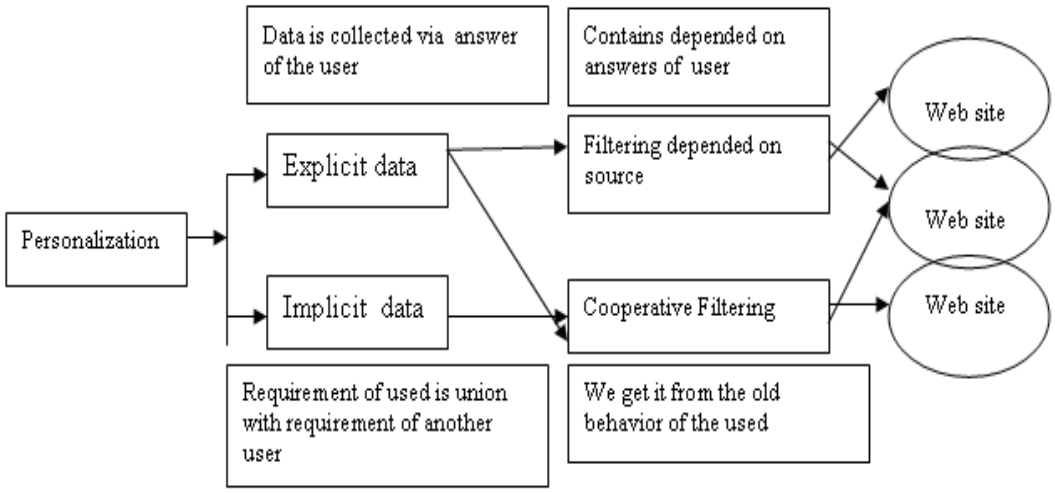

Fig. (2): Collection of Web Data

- **Explicit acquisition**: The easiest way to acquire data about users is to ask them directly. The advantages of explicit acquisition are the possibility to collect detailed information about users (e.g., their age, gender, job etc) and to ascertain their interests in a given domain (e.g., musical preferences). On the negative side, since data are inserted directly by the user, there is no possibility to verify their correctness. Besides casual errors, privacy concerns and the fear of being exposed to undesired marketing actions are common reasons for the occurrence of false data in the explicit acquisition process.
- **Implicit acquisition:** An alternative data source about users is their navigation behavior within Web applications. By studying the sequence of pages visited by users (known as click stream) it is possible to discover what sections of a Web site the user is particularly interested in. The advantages of this approach are the simplicity in the acquisition of data. The main disadvantage is that the information content of clicks stream is quite poor. Consequently user profile analysis becomes more complex because algorithms work on very raw information. Moreover the amount of data to store and analyze is normally very large.
- **Third part acquisition:** Another way to obtain data about users is to acquire information from other data sources like company databases, third party archives and so on. In this case, the user has no direct role in the acquisition of information, because the supply of users' data occurs in a different moment with respect to their acquisition.

3. RECOMMENDATION TECHNIQUES

Recommendation techniques have a number of possible classifications. Our interest in this discussion is the sources of data on which recommendation is based and the use to which that data is put.

Specifically, recommender systems have:

- Background data, the information that the system has before the recommendation process begins.
- Input data, the information that user must communicate to the system in order to generate a recommendation.
- Algorithm that combines background and input data to arrive at its suggestions.

On this basis, we can distinguish five different recommendation techniques as shown in Table 1. Assume that **I** is the set of items over which recommendations might be made, **U** is the set of users whose preferences are known, **u** is the user for whom recommendations need to

be generated, and **i** is some item for which we would like to predict **u**'s preference.[2]

3.1 Collaborative Filtering

These techniques, are very popular for defining personalization Web application (for instance they are used in www.amazon.com, [5,10]. Collaborative recommendation is probably the most familiar, most widely implemented and most mature of the technologies. Collaborative recommender systems aggregate ratings or recommendations of objects, recognize commonalities between users on the basis of their ratings, and generate new recommendations based on inter-user comparisons. A typical user profile in a collaborative system consists of a vector of items and their ratings, continuously augmented as the user interacts with the system over time. Some systems use time-based discounting of ratings to account for drift in user interests. In some cases, ratings may be binary (like/dislike) or real-valued indicating degree of preference. Some of the most important systems using this technique are Group Lens / Net Perceptions, Ringo/Firefly, Tapestry and Recommender. These systems can be either memory-based, comparing users against each other directly using correlation or other measures, or model-based, in which a model is derived from the historical rating data and used to make predictions. Model-based recommenders have used a variety of learning techniques including neural networks, latent semantic indexing, and Bayesian networks. The greatest strength of colla-borative techniques is that they are completely independent of any machine-readable representation of the objects being recommended, and work well for complex objects such as music and movies where variations in taste are responsible for much of the variation in preferences. This is called "people-to-people correlation. [2]

3.2 Content-Based

This system recommends items deemed to be similar to the items that the user liked in the past. Item similarity is typically based on domain specific item attributes (such as author and subject for book items). This approach has the advantage of easily including new items in the recommendation process, since there is no need for any previous implicit or explicit user rating or purchase data to make recommendations. [9]

3.3 Demographic

Demographic recommender systems aim to categorizing the user based on personal attributes and making recommendations based on demographic classes. An early example of this kind of system is Grundy that recommended books based on personal information gathered through an interactive dialogue. The users' responses are matched against a library of manually assembled user stereotypes. Some more recent recommender systems have also taken this approach, for example, using demographic groups from marketing research to suggest a range of products and services. A short survey is used to gather the data for user categorization. In other systems, machine learning is used to arrive at a classifier based on demographic data. The representation of demographic information in a user model can vary greatly.

Table (1): Recommendation Techniques

Technique	Background	Input	Process
Collaborative	Ratings from **U** of items in **I**.	Ratings from **u** of items in **I**.	Identify users in **U** similar to **u**, and extrapolate from their ratings of **i**.
Content-based	Features of items in **I**	**u**'s ratings of items in **I**	Generate a classifier that fits **u**'s rating behavior and use it on **i**.
Demographic	Demographic information about **U** and their ratings of items in **I**.	Demographic information about **u**.	Identify users that are demographically similar to **u**, and extrapolate from their ratings of **i**.
Utility-based	Features of items in **I**.	A utility function over items in **I** that describes **u**'s preferences.	Apply the function to the items and determine **i**'s rank.
Knowledge-based	Features of items in **I**. Knowledge of how these items meet a user's needs.	A description of **u**'s needs or interests.	Infer a match between **i** and **u**'s need.

Rich's system used hand-crafted attributes with numeric confidence values. Pazzani's model uses Winnow to extract features from users' home pages that are predictive of liking certain restaurants. Demographic techniques form "people-to-people" correlations like collaborative ones, but use different data. The benefit of a demographic approach is that it may

not require a history of user ratings of the type needed by collaborative and content-based techniques. [2]

3.4 Utility-Based And Knowledge-Based

Utility-based and knowledge – based recommenders do not attempt to build long-term generalizations about their users, but rather base their advice on an evaluation of the match between a user's need and the set of options available. Utility-based recommenders make suggestions based on a computation of the utility of each object for the user. Of course, the central problem is how to create an utility function for each user. Tête-à-Tête and the e-commerce site PersonaLogic2, each one have different techniques for arriving at a user-specific utility function and applying it to the objects under consideration. The user profile therefore is the utility function that the system employs constraint satisfaction techniques to locate the best match. The benefit of utility-based recommendation is that it can factor non-product attributes, such as vendor reliability and product availability, into the utility computation, making it possible for example to trade off price against delivery schedule for a user who has an immediate need. [2]

3.5 Knowledge-Based Recommend- Ation

In this approach, used frequently to customize products, the user answers several questions, until receiving a customized result such as a list of products. This approach is mostly based on heavy planning and manual preparation of a careful set of questions, possible answer combinations, and customizations by an expert. It suffers from a lack in intelligence (no automatic learning), and tends to be static. [9]

4. ANALYSIS OF USER PROFILE

Another phase of the personalization process is the analysis of raw user data. The result of this phase is a set of structured data or rules usable to build a tailored Web application. A Neural nets. Neural network [1] is a network of several simple processors ("units"), each possibly having a small amount of local memory. The units are connected by communication channels ("connections"), which usually carry numeric (as opposed to symbolic) data, encoded by various means. The units operate only on their local data and on the inputs they receive via connections. The restriction to local operations is often relaxed during training. Most neural networks have some sort of"training" rule whereby the weights of connections are adjusted on the basis of data. In other words, neural networks "learn" from examples (as children learn to recognize dogs Commercial Tools for the Development of Personalized Web Applications 101 from examples of dogs) and exhibit some capability for generalization beyond the training data. For personalization purposes, neural networks learn about the user's has derived for the user, and the system behavior and they can try to predict the user's interest after a learning phase, where someone must provide the neural networks with examples of personalization. [9, 7]

5. RECOMMENDER SYSTEMS

Among most popular methods of recommender system is one which is based on collaborative filtering and the ones based on fixed support association rule discovery may be the most difficult and expensive to use. This is because, for the case of high-dimensional (too many web pages or items) and extremely sparse (most items/web pages tend to be unrated/unvisited) Web data, it is difficult to set suitable support and confidence thresholds to yield reliable and complete web usage patterns. Similarly, collaborative models may struggle with sparse data, and do not scale well to a very large number of users [10]. However, user profiling on the Internet can move beyond its predecessors because websites have the ability to obtain information about its users directly from its users. A website can ask a user to register and request information such as their age, sex, likes and dislikes. A website can also keep track of information such as the user's purchases, which sections of the site have been visited and how long the user views a page. [6]

Once collected, this information can allow companies to adapt the information content so as to go better to meet the users' interests. These adjustments permit the company giving better satisfaction to its users. User profiling can be approached in one of three ways:

- Using stereotypes,
- Using surveys/questionnaires, or
- Using a "learned model".

The first two approaches rely on traditional marketing methods using known information or information collected in person or over the phone to build appropriate profiles. The third approach, using "learned models", is our area of interest. The approach entails creating a system

that has no knowledge of its users initially, but over time develops, a productive model based on interactions with the users. Profile models can be created individualistically, on a per-user basis, or collaboratively, collecting all users' data together to form a general profile of interests and behavior. We wanted to build a collaborative system that could "learn" a general user profile and test it's usefulness on a typical website.[6]

Web application discovers at run time groups of interest and so it captures users' behaviors in a dynamic way.

6. ELMAN ARTIFICIAL NEURAL NETWORKS

In this research we use Elman network for **Guidance or Recommender Systems.** The Elman network commonly is a two-layer network with feedback from the first-layer output to the first-layer input. This recurrent connection allows the Elman network to both detect and generate time-varying patterns [3,13]. A two-layer Elman network is shown in figure (3).

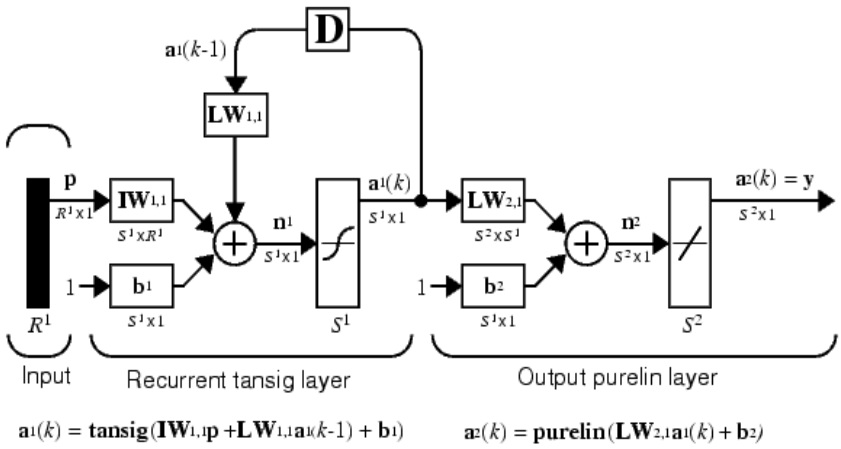

Fig. (3): Elman Neural Network

The Elman network has tansig (see appendix (A)) neurons in its hidden (recurrent) layer, and purelin (see appendix (B))neurons in its output layer. This combination is special in that two-layer networks with these transfer functions can approximate any function (with a finite number of discontinuities) with arbitrary accuracy. The only requirement is that the hidden layer must have enough neurons. More hidden neurons are needed as the function being fitted increases in complexity [12].

7. DESIGN OF THE PROPOSED SYSTEM:

Elmanweb.aspx website offers links to a large variety of chooses which we developed to analysis the user profiling system See figure (4).

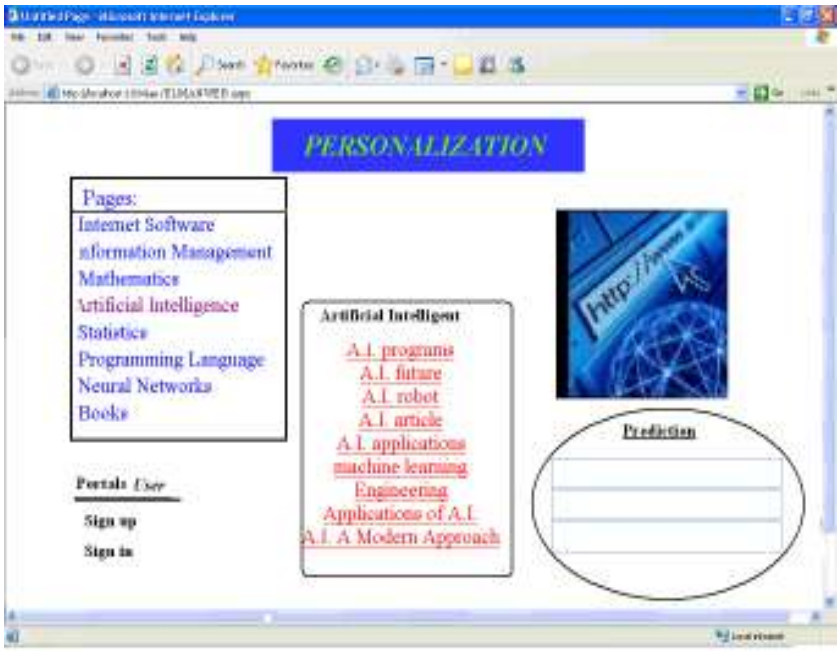

Fig. (4): Elmanweb.aspx is a Web Site

Elmanweb.aspx is a portal website that has various links to other sites. There are 8 categories of links in Elmanweb.aspx website organized into 8 pages a hierarchy to facilitate browsing. Such as Books, Mathematics, internet Software, statistic, etc. In total, Users can find a particular choice by working their way through the folder system on the middle of the page. When the final choice category is found, a group of links to websites that offer that choice are provided to the user.

The aim is to create a system that allows users to find what they are looking for quickly with greater ease through collaborative user profiling. The system which is based on past user interactions with the site should be able to learn a profile model and then use the model to adjust the website's content in order to get better aid future users. The web page content modification and user profile should be seat together on the website ASP.NET then HTML generation so as to provide a fast response time.

A click stream describes the path taken by previous user through the site in searching of for chose (it means the behavior of a previous user in the website). The Elmanweb.aspx website will track the categories that a user visits in sequence which known as a "click stream". Then, the click streams of many previous users provide the raw data for developing a model for predicting the category which a new user likes to visit next time. An ELMAN neural network will be used to develop the model. Giving the current category as input, the (ELMAN) model, will output the next best category links see figure (5) will output the next best category links

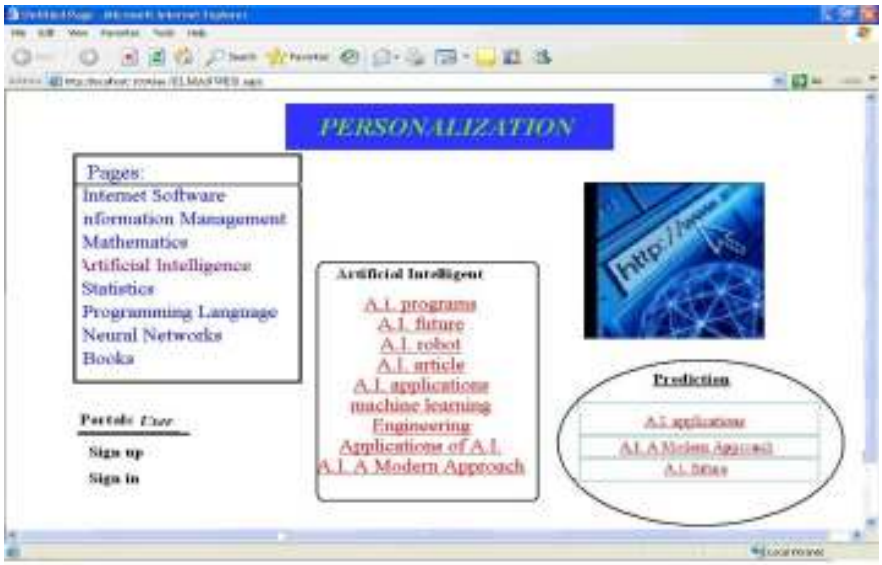

Fig. (5): Output the Next Best Category links by Using Elman ANN

Implementation of system is broken down into three steps. The first step collects the click-stream data generated by users and transforms that data so that it can be used as training examples for an ELMAN ANN modeling system. See figure (6) Second step creates the test neural network model. The final step integrates the model into the website so that it can be used to make predictions for new users. For Proposed system it is enough to collect the data of the website, develop the model and then integrate a Neural Network within the website.

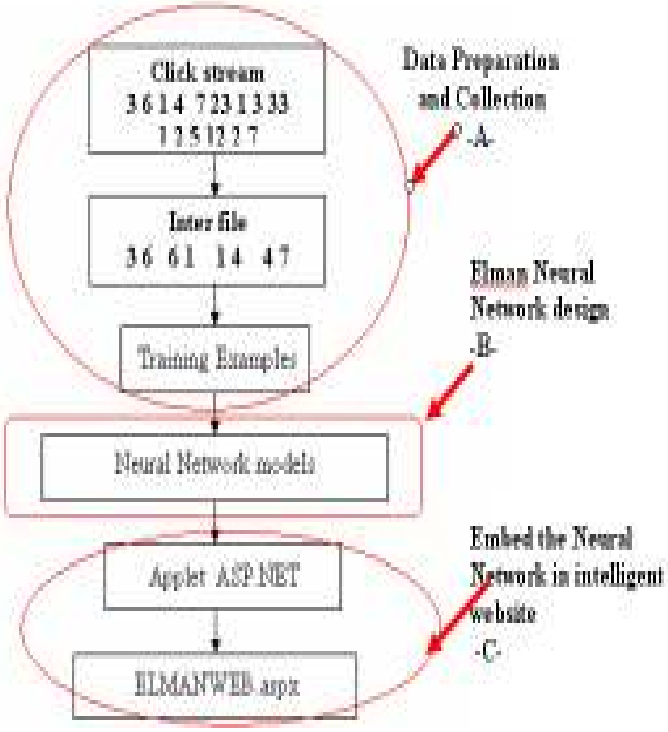

Fig. (6): Data Flow Model

7.1 Proposed Elman Ann For Elmanweb.Aspx

- **Structure of Elman ANN:** A three layer Elman neural network, with input layer, hidden layer and output layer see figure (3).To design Elman ANN, we have set the number of input nodes equal to numbers of categories in the Elmanweb.aspx website homepage organized into 8 choices, 4 nodes in hidden layer and the number of nodes in the output layer is set to 8.

The network is trained with Elman principle. The learning rate parameter is 0.00001, performance function is 'MSE', the performance goal (or tolerance limit) is 0.1. The network is trained for 2000 epochs. It is trained with standard data sets 8 nodes input, 4 nodes hidden and 8 nodes output which make the algorithm converge and it is trained and tested the network with a set of training data. See appendix (C).

- **Data Collection for Training and Testing Elman ANN:** The first step in building Elman ANN is to collect a set of training examples. For our problem these training examples are users' click-streams through the site. First each category is given a numeric identifier from 0-87 (e.g. mathematics=0, books=1,). All categories are similar in that each has a webpage that consists of all the links that lead to websites that contain that category. When accessed, each of these pages writes its particular identifier to the file (data base). A user's click stream might look like the following: 12 0 15 26 30 2 6 43 54 23 etc after a visit to ELAMWEB.aspx website.

The training examples for a recurrent ANN must consist of one input and one output as follows:

(12 0), (0 15), (15 26), (26 30)…

So we must create training examples from the stream that can be used by the ANN. Such sequence is the user movement from category 12 to 0, then from 0 to 15, then from 15 to 26, etc.

More data preparation is needed. Each page in the categories from 0-87 must change its identification to be between 0-7 because the website consists from 8 pages and 8 choices within each page to determine in which page the user access now. Therefore, the category identifier must be transformed from a numeric value to individual discrete variables that can be properly learned by the ANN. In the implementation a category is represented by a series of 8 '0's, with only a single '1' appearing in the nth place The click-stream is first gathered into a sequence of pairs of 2 category numbers (input and output) and those number pairs are then transformed into a series of '0/1' representations. The resulting binary representation which is used to train the neural network is the outline of the implementation.

- **Training Elman ANN: Website** that generates a lot of traffic of this process of creating the model would only be done periodically, once a day, week or month. We extracted a set of training, test and production examples. The training set is used actually to train the neural network, while the test set is used to confirm that the model being developed will perform well not only on the set it is being trained with, but on other randomly chosen examples. The production set is used at the end as a final test of how accurately the model can predict the next best product category.

As mentioned earlier, ELMAN ANN network architecture was chosen for this problem. The neural network program sets the number of hidden nodes based on number of inputs and outputs. We try out with alternative numbers of hidden nodes but found the default value worked well. Our final network architecture consisted of 8 input and output nodes and 4 nodes for the hidden layers. Iterating through the set of training examples until the lowest level of test set error is reached develops the ANN model. The network weights that produced the lowest error are kept to make up the new "learned model". The model is tested against the production set of examples that we created earlier to ensure a good general fit to future examples. Next we need to generate a representation of the model that can be used by Elmanweb.aspx software. There are an input array with a length of 8 and then outputs an array with a length of 8. To ensure an accurate model it must be re-trained the network model using some portion of old and new training examples.

8. SYSTEM INTEGRATION

Integrating the system profile model must be embedded within website so that we can use it when future visitors come to the site [11]. The aim of the system profile model is to predict the best three categories of products based on the last category chosen by the user. Example of the resulting website is shown in Figure (5). When a category's link page is viewed, the system must pass that category's identifying number to our learned model, return the models output and then

display the links to the categories the model feels the visitor is most likely to see.

To perform this task we use an ASP.NET applet. The applet's job is to display top 3 links in order to increase the chances that one of them is useful to the user

It must then determine the associated category link addresses and generate the appropriate ASP.NET applet for display see figure (7). Figure (5) shows the output of the applet displayed on the middle (see the circled area) with links to the top 3 categories that the profile model has determined the user is likely to see.

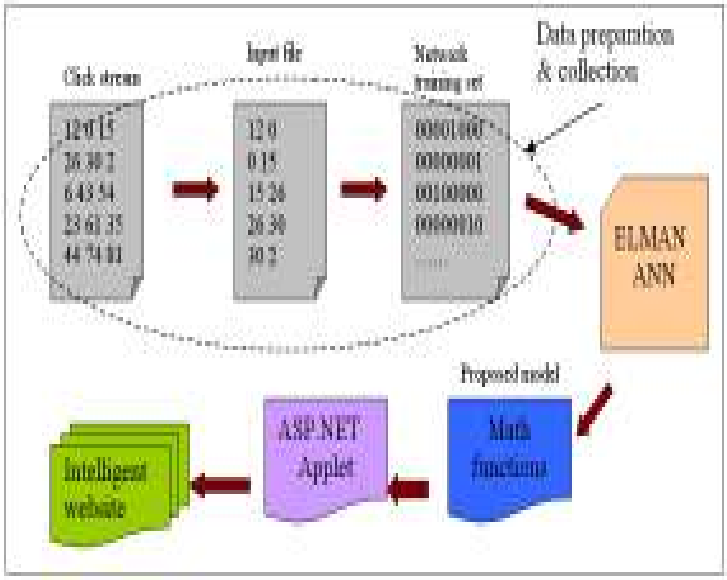

Fig. (7): system integration

9. SYSTEM TESTING

The most important test is to compare this website with another site that provided user with random best link to other sites, this test will be in two phases:

- **First phases:** selection of 100 participants users to interact with the site and give them four facades, but without giving them any guidance or recommendation and then trace the participants in the test, at the ends when all users to navigate the site, use these data to predict future choices.
- **Second phase:** includes the return of subscribers to the site, but this time draw users by giving them choices on the recommendation of the screen, tracing users now we shall get two models first models is to predict the next choice, second relying on random data.

And then demand the participants to categorize choices that have been given them on the screen to (useless (0), and somewhat useful (1), very useful (2)). The result is as follows which categorized choices dependent on data system classified. Table (2) presents ratios classification of the participants.

Table (2): Effectiveness test

	0 -Useless	1- Somewhat Useful	2 - Very Useful
Random	58.1%	29.1%	12.6%
User model	25.3%	34.2%	40.5%

As we said above, the most important test is to compare this website with another site that provide user with random best link to other sites. The test will be done by comparing the result of our system(web site Elmanweb.aspx) with the result from (web site personalization model design and implementation as standard web site) [11], see table (3), It is find that the proposed system have a better result than (web site personalization model design and implementation) especially in user model fields.

Table (3): Compare between Elmanweb.aspx and web site personalization model design and implementation

	Web site Elmanweb.aspx		
	0 -Useless	1 - Somewhat Useful	2 - Very Useful
Random	58.1%	29.3%	12.6%
User model	25.3%	34.2%	40.5%
Web site personal. model design and implementation			
Random	69.9%	24.4%	5.8%
User model	32.1%	42.8%	25.1%

10. DISCUSSIONS OF RESULTS

There are difference between the random system and the model driven one. Examining the user testing results would seem to indicate that the User Profiling system performs relatively well.

There are various factors that may have caused the system to perform better in the tests than it should have. For instance, the categories created at a critical states.

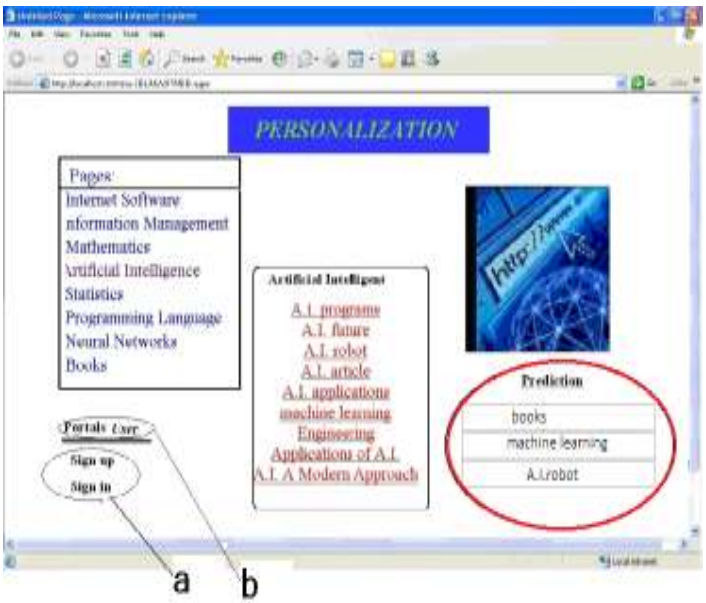

Fig. (8): examples of results

Also, the “books” category is rather popular when the test subjects went through most of the categories scenarios. As a result, the model that was generated output “books” as one of the top 3 links almost every single time. Since “books” is a category that can be useful in so many different situations, this trend resulted in a good deal of the “very useful” and “somewhat useful”

ratings the model driven system received. Nonetheless, the profiling system performed considerably better than the random system for every single user we tested it on.

11. CONCLUSION

In this paper we have shown which techniques can be used and what results are achieved in a project with real world data, This paper has reported on the development and testing of an intelligent user interface that is used to differentiate between web sites. The site employs user profiling and adaptive user interface methods to recommend the best next product categories to the user. A combination of ASP.NET, VB.NET Applet and ANN machine learning technology is used.

Experimental results explain that the systems are: Successful in recommending best links to new users based on profile models developed from previous user click stream data. Increasingly sophisticated profiling systems, data mining tools and other personalization methods will alter the way we interact with the Internet in the years to come. Hopefully these advancements will result in easier and friendlier to use systems that provide the right information, at the right time, to the right person. Personalization is a useful acronym for the effort and time visitor to the site, especially if the site contains a large number of pages and internal links where they work on privacy GPS and more links required by the user and placed on the facade directly without the need for massive search operations take a lot of time.

12. FUTURE WORK

Among the tasks possible for future work is to develop curriculum user's personal data entry or additional variables, also use another type of ANN and make compare between them.

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APPENDIX (A) : <u>tansig</u>

Hyperbolic tangent sigmoid transfer function

Syntax : A = tansig(N,FP)

Description : tansig is a neural transfer function. Transfer functions calculate a layer's output from its net input. tansig(N,FP) takes N and optional function parameters,N : S x Q matrix of net input (column) vectors

FP : Struct of function parameters (ignored) , and returns A, the S x Q matrix of N's elements

Algorithm : a = tansig(n) = 2/(1+exp(-2*n))-1

This function is a good tradeoff for neural networks, where speed is important and the exact shape of the transfer function is not.

APPENDIX (B) :purelin Linear transfer function

Syntax : `A = purelin(N,FP)`

Description : `purelin` is a neural transfer function. Transfer functions calculate a layer's output from its net input.

`purelin(N,FP)` takes `N` and optional function parameters,

N : S x Q matrix of net input (column) vectors

FP : Struct of function parameters (ignored) , and returns A, the S x Q matrix of N's elements

APPENDIX (C) :newelm Create Elman backpropagation network

Syntax

net = newelm(P,T,[S1 S2...S(N-l)],{TF1 TF2...TFNl}, BTF,BLF,PF,IPF,OPF,DDF)

Description

newelm(P,T,[S1 S2...S(N-l)],{TF1 TF2...TFNl}, BTF,BLF,PF,IPF,OPF,DDF) takes these arguments,

P : R x Q1 matrix of Q1 sample R-element input vectors

T : SN x Q2 matrix of Q2 sample SN-element input vectors

Si : Size of ith layer, for N-1 layers, default = [ ]. (Output layer size SN is determined from T.)

TFi :Transfer function of ith layer. (Default = 'tansig' for hidden layers and 'purelin' for output layer.)

BTF : Backpropagation network training function (default = 'trainlm')

BLF :Backpropagation weight/bias learning function (default = 'learngdm')

PF :Performance function (default = 'mse')

IPF:Row cell array of input processing functions. (Default = {'fixunknowns','removeconstantrows','mapminmax'})

OPF :Row cell array of output processing functions. (Default = {'removeconstantrows','mapminmax'})

DDF :Data divison function (default = 'dividerand')

and returns an Elman network.

The training function BTF can be any of the backpropagation training functions such as trainlm, trainbfg, trainrp, traingd, etc.

The learning function BLF can be either of the backpropagation learning functions learngd or learngdm.

The performance function can be any of the differentiable performance functions such as mse or msereg.

Algorithm

Elman networks consist of Nl layers using the dotprod weight function, netsum net input function,

and the specified transfer function. The first layer has weights coming from the input. Each subsequent layer has a weight coming from the previous layer. All layers except the last have a recurrent weight. All layers have biases. The last layer is the network output. Each layer's weights and biases are initialized with initnw. Adaption is done with trains, which updates weights with the specified learning function. Training is done with the specified training function. Performance is measured according to the specified performance function

الخلاصة

يواجه مستخدمي الانترنت في الوقت الحاضر مشاكل الحمل الزائد للمعلومات والغرق بسبب النمو الكبير والسريع في كمية المعلومات وعدد المستخدمين. نتيجة لذلك، هو كيفية تزويد مستخدمي الانترنت المعلومات المطلوبة بالضبط أصبحت مسألة حاسمة في تطبيقات الشبكة. في هذا العمل ، فإننا نهدف إلى تحسين أداء تطبيقات خصوصية الشبكة على الانترنت من خلال التوصيات التي نحصل عليها من خلال استخدام الشبكة العصبية المان . النتائج التجريبية تظهر نجاح هذه التوصية في التنبؤ من أفضل رابط للمستخدم استنادا إلى بيانات جديدة تم تطويرها بالاعتماد على بيانات المستخدم السابقة (الارتباطات التي تم النقر عليها سابقا).

پوختە

کا ر پُیکە رێُن ئە نتزنیتی لڤی دەمی تۆ شی ئاریشێُن هـە لگرتنا ژیرە یُن پُینزانینا ویە ررە یوونیُ بوینە ژبەر مە ژن یوونا بلـە ز درێُژە یا پُیزا نینان دا وژمارا کارپُیکەرا. ئە نجامیُ ڤیُ ، ئە گە بە کو چا وانبا دانا پُیزانینپُن پُیتڤی بو کار پُیکە رێُن ئەنتزنیُتی یا بویە ئاریشە کا مەزن. دڤیُ ڤە کولینیُ دا، ئارمانجامە ئە ڤە یە بەرزکرنا رولیُ بکارنینانا تایبە نمدیێُن شە بە کی ل سە ر ئە نتزنیُتی بها ریکا ریا وان ئاموژگاژین گە هشتینە مە لـە سەر رکارئینانا چە بە کا ئە لمان.

ئە نجامیُن پُراکتیکی دیارکەن سەرکە فتاڤی وە سیە شیُ ئیُکەر ژ باشترین گریدان بو کاربیکە ری بیشیە تناوان داتایُین ئوم گە هشتینیُ .

THE N-HOSOYA POLYNOMIAL OF $W_a \boxtimes W_b$

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ABSTRACT

For the wheels W_a and W_b ; composite graphs $W_a \boxtimes W_b$ is constructed by adding edges u_1u_2, u_1v_2, v_1u_2, and v_1v_2 where $u_1v_1 \in E(W_a)$ and $u_2v_2 \in E(W_b)$. The n – Hosoya polynomial and the n – index of $W_a \boxtimes W_b$ are obtained in this paper.

***KEYWORDS*:** n-distance, n-Hosoya polynomial, n-Wiener index, wheels.

1. INTRODUCTION:

For the definitions of concepts used in this paper, see the references [1,4,7, and 8]. Let v be a vertex of a connected graph G. The vertex polynomial with respect to n-distance, denoted by $H_n(v,G;x)$, is defined as

$$H_n(v,G;x) = \sum_{k\geq 1} C_n(v,G;k)x^k ,$$
.....(1.1)

where $C_n(v;G,k)$ is the number of all (n-1)-subsets of vertices S such that $d_n(v,S) = k$, $k \geq 1$, $d_n(v,S) = \min\{d(v,u): u \in S\}$. We call this polynomial n-Hosoya polynomial of v. It is clear that:

$$H_n(G;x) = \sum_{v\in V(G)} H_n(v,G;x) \ , \ n \geq 3 . \quad .....(1.2)$$

We call this polynomial $H_n(G;x)$, n-Hosoya polynomial of G , also it is defined by:

$$H_n(G;x) = \sum_{k=1}^{d_n} C_n(G,k)x^k ,$$

where $2 \leq n \leq p, d_n$ is the n-diameter of G ($d_n = \max\{d_n(v,S)\}$), and $C_n(G,k)$ is the number of ordered pairs $(v,S), v \in V(G), S \subseteq V(G), |S| = n-1$, such that $d_n(v,S) = k$, $k \geq 1$.

The n-Hosoya index of G is defined by

$$H(G) = \sum_{k\geq 1} k\, C_n(G,k) .$$

Many authors obtained n-Hosoya polynomials of special graphs and compound graphs (see [1-6]).

We shall use the following result [1]:

Lemma: If there are t vertices of distance $k \geq 1$ from the vertex u and there are s vertices of distance more than k from u , then

$$C_n(u,G,k) = \binom{s+t}{n-1} - \binom{s}{n-1}. \quad \blacksquare$$
.....(1.3)

Let G_1 and G_2 be disjoint connected graphs , and $u_1v_1 \in E(G_1)$ and $u_2v_2 \in E(G_2)$. We define $G_1 \boxtimes G_2$ as the graph constructed from G_1 and G_2 with the edges u_1u_2, u_1v_2, v_1u_2, and v_1v_2. It is clear that $p(G_1 \boxtimes G_2) = p(G_1) + p(G_2)$ and $q(G_1 \boxtimes G_2) = q(G_1) + q(G_2) + 4$.

In this paper , we obtain $H_n(G_1 \boxtimes G_2; x)$ and $W_n(G_1 \boxtimes G_2)$ where G_1 and G_2 are wheels.

The n-Hosoya Polynomial of $W_a \boxtimes W_b$:

It is clear that $p(W_a \boxtimes W_b) = a + b$,

$$q(W_a \boxtimes W_b) = 2(a+b)$$

and

$$\mathrm{diam}(W_a \boxtimes W_b) = 5$$ {since

$\mathrm{diam}(W_a \boxtimes W_b) = \max._{u_i \in V(G)}\{\max._{v_j \in V(G)} d(u_i,v_j)\}$, then $d(u_i,v_j)$ has maximum value when we choose u_i is one of the vertices of $V(W_\beta)$ for $4 \leq i \leq \beta-2$, and v_j is one of the vertices of $V(W_\alpha)$ for $4 \leq j \leq \alpha-2$. Therefore $\max.d(u_i,v_j)=5$, for

4≤i≤β-2 and 4≤j≤α-2, hence diam($W_a \boxtimes W_b$ **)=5**}, for $a, b \geq 6$.

Let $V(W_a) = \{v_1, v_2, \ldots, v_a\} = V$ and $V(W_b) = \{u_1, u_2, \ldots, u_b\} = U$, $a, b \geq 5$, then $W_a \boxtimes W_b$ is shown in Fig.1.

One can easily notice that :

$d(v_i, u_j) = 5$ for $4 \leq i \leq a-2$ and $4 \leq j \leq b-2$.

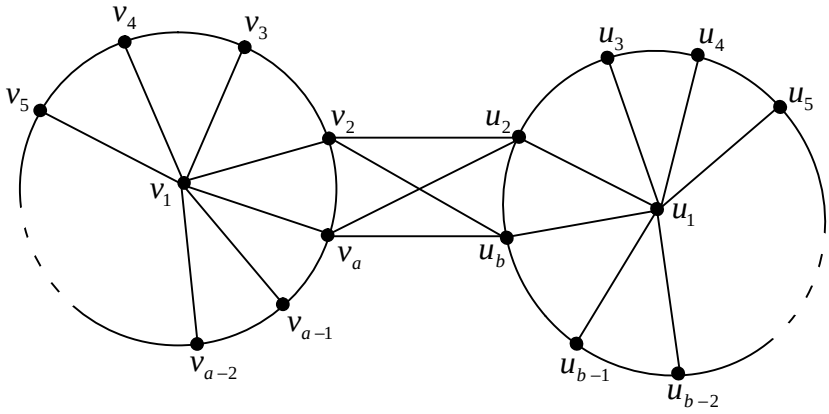

Fig.(1): The graph $\boldsymbol{W_a \boxtimes W_b}$, $a, b \geq 5$, $a \geq b$.

The n-diameter of $W_a \boxtimes W_b$ is determined easily in the following proposition. Throughout this section , we assume $a \geq b$.

<u>Proposition 2.1</u>: For $2 \leq n \leq a+b$,and $a, b \geq 6$,

$$diam_n(W_a \boxtimes W_b) = \begin{cases} 5, & if\ 2 \leq n \leq a-4, \\ 4, & if\ a-3 \leq n \leq a-1, \\ 3, & if\ a \leq n \leq a+1, \\ 2, & if\ a+2 \leq n \leq a+b-3, \\ 1, & if\ a+b-2 \leq n \leq a+b\ . \end{cases} \qquad \text{…..(2.1)}$$

■

We define for any nonempty subset A of vertices in G,

$$H_n(A, G; x) = \sum_{a \in A} H_n(a, G; x)\ . \qquad \text{…..(2.3)}$$

To find $H_n(W_a \boxtimes W_b; x)$ we determine $C_n(W_a \boxtimes W_b, k)$, for $1 \leq k \leq 5$. The graph $W_a \boxtimes W_b$ will be denoted by G .

It is known that [6]

$$C_n(G,1) = (a+b)\binom{a+b-1}{n-1} - (a+b-6)\binom{a+b-4}{n-1} - 4\binom{a+b-6}{n-1} - \binom{b}{n-1} - \binom{a}{n-1}.$$

…..(2.4)

<u>Proposition 2.2</u>: For $2 \leq n \leq p(=a+b)$, and $a, b \geq 5$,

$$C_n(V, G, 2) = (a-3)\binom{p-4}{n-1} + 2\binom{p-6}{n-1} - 2\binom{b-5}{n-1} - 3\binom{b-2}{n-1} - (a-6)\binom{b}{n-1}.$$

…..(2.5a)

$$C_n(U,G,2) = (b-3)\binom{p-4}{n-1} + 2\binom{p-6}{n-1} - 2\binom{a-5}{n-1} - 3\binom{a-2}{n-1} - (b-6)\binom{a}{n-1}.$$

…..(2.5b)

$$C_n(G,2) = (p-6)\binom{p-4}{n-1} + 4\binom{p-6}{n-1} - 2\binom{a-5}{n-1} - 2\binom{b-5}{n-1} - 3\binom{a-2}{n-1} - 3\binom{b-2}{n-1}$$
$$-(b-6)\binom{a}{n-1} - (a-6)\binom{b}{n-1}. \qquad \text{…..(2.5c)}$$

Proof:

There are exactly two vertices of distance 2 from v_1 , and there are $b-2$ vertices of distance more than 2 from v_1. Thus , by (1.3)

$$C_n(v_1,G,2) = \binom{b}{n-1} - \binom{b-2}{n-1}. \quad \text{…..(2.6)}$$

There are $a-1$ vertices of distance 2 from v_2 , and there are $b-5$ vertices of distance more than 2 from v_2 . Thus , by (1.3)

$$C_n(v_2,G,2) = C_n(v_a,G,2) = \binom{a+b-6}{n-1} - \binom{b-5}{n-1}. \qquad \text{…..(2.7)}$$

Also , there are $a-2$ vertices of distance 2 from v_3 , and there are $b-2$ vertices of distance more than 2 from v_3. Thus , by (1.3)

$$C_n(v_3,G,2) = C_n(v_{a-1},G,2) = \binom{a+b-4}{n-1} - \binom{b-2}{n-1}. \qquad \text{…..(2.8)}$$

Moreover , for $4 \le i \le a-2$, $a \ge 6$, there are $a-4$ vertices of distance 2 from v_i , and there are b vertices of distance more than 2 from v_i. Thus , by (1.3)

$$C_n(v_i,G,2) = \binom{a+b-4}{n-1} - \binom{b}{n-1}, \; 4 \le i \le a-2 \; . \qquad \text{…..(2.9)}$$

Therefore , from (2.6) - (2.9) we get (2.5a).

Similarly , we obtain (2.5b) by interchanging a and b in the formula (2.5a). Finally , we obtain (2.5c) by adding (2.5a) and (2.5b).

■

We shall obtain $C_n(G,3)$.

Proposition 2.3: For $2 \le n \le p$, and a , $b \ge 5$,

$$C_n(G,3) = (a-5)\binom{b}{n-1} + (b-5)\binom{a}{n-1} - \binom{b-5}{n-1} - \binom{a-5}{n-1}$$
$$-(a-8)\binom{b-2}{n-1} - (b-8)\binom{a-2}{n-1}. \qquad \text{…..(2.10)}$$

Proof:

There are three vertices of distance 3 from v_1 , and there are $b-5$ vertices of distance more than 3 from v_1. Thus , by (1.3)

$$C_n(v_1,G,3) = \binom{b-2}{n-1} - \binom{b-5}{n-1}. \qquad \text{…..(2.11)}$$

There are $b-5$ vertices of distance 3 from v_2 , and there is no vertex of distance more than 3 from v_2. Thus

$$C_n(v_2,G,3)=C_n(v_a,G,3)=\binom{b-5}{n-1}. \quad .....(2.12)$$

There are three vertices of distance 3 from v_3 , and there are $b-5$ vertices of distance more than 3 from v_3. Thus , by (1.3)

$$C_n(v_3,G,3)=C_n(v_{a-1},G,3)=\binom{b-2}{n-1}-\binom{b-5}{n-1} \quad .....(2.13)$$

For $4 \le i \le a-2$, $a \ge 6$, there are two vertices of distance 3 from v_i , and there are $b-2$ vertices of distance more than 3 from v_i. Thus , by (1.3)

$$C_n(v_i,G,3)=\binom{b}{n-1}-\binom{b-2}{n-1},\ 4 \le i \le a-2 \ . \quad .....(2.14)$$

Therefore , from (2.11) - (2.14) we obtain

$$C_n(V,G,3)=(a-5)\binom{b}{n-1}-(a-8)\binom{b-2}{n-1}-\binom{b-5}{n-1}. \quad .....(2.15)$$

Similarly , we have

$$C_n(U,G,3)=(b-5)\binom{a}{n-1}-(b-8)\binom{a-2}{n-1}-\binom{a-5}{n-1}. \quad .....(2.16)$$

Hence , from (2.15) and (2.16) , we get (2.10). ■

<u>Proposition 2.4</u>: For $2 \le n \le p$, and $a, b \ge 6$,

$$C_n(G,4)=(a-5)\binom{b-2}{n-1}+(b-5)\binom{a-2}{n-1}-(a-8)\binom{b-5}{n-1}-(b-8)\binom{a-5}{n-1} \quad .....(2.17)$$

<u>Proof:</u>

There are $b-5$ vertices of distance 4 from v_1 , and there is no vertex of distance more than 4 from v_1. Thus

$$C_n(v_1,G,4)=\binom{b-5}{n-1}. \quad .....(2.18)$$

There is no vertex of distance 4 from each of v_2 and v_a .

There are $b-5$ vertices of distance 4 from v_3 , and there is no vertex of distance more than 4 from v_3. Thus

$$C_n(v_3,G,4)=C_n(v_{a-1},G,4)=\binom{b-5}{n-1}. \quad .....(1.19)$$

For each $4 \le i \le a-2$, there are three vertices of distance 4 from v_i , and there are $b-5$ vertices of distance more than 4 from v_i. Thus , by (1.3)

$$C_n(v_i,G,4)=\binom{b-2}{n-1}-\binom{b-5}{n-1},\ 4 \le i \le a-2 \quad .....(2.20)$$

Therefore , from (2.18) - (2.20) we have

$$C_n(V,G,4)=(a-5)\binom{b-2}{n-1}-(a-8)\binom{b-5}{n-1}\text{.....(2.21)}$$

Similarly , we have

$$C_n(U,G,4)=(b-5)\binom{a-2}{n-1}-(b-8)\binom{a-5}{n-1}. \qquad \text{.....(2.22)}$$

Hence , from (2.21) and (2.22) , we obtain (2.17). ■

Proposition 2.5: For $2 \le n \le p$, and a , $b \ge 5$,

$$C_n(G,5)=(a-5)\binom{b-5}{n-1}+(b-5)\binom{a-5}{n-1}. \qquad \text{.....(2.23)}$$

Proof:

For each $4 \le i \le a-2$, $a \ge 6$, there are $b-5$ vertices of distance 5 from v_i , and there is no vertex of distance more than 5 from v_i . Thus

$$C_n(v_i,G,5)=\binom{b-5}{n-1},\ 4 \le i \le a-2 \text{ . .....(2.24)}$$

It is clear that there is no vertex of distance 5 from each of vertices v_1, v_2, v_3, v_a and v_{a-1} . Thus

$$C_n(V,G,5)=(a-5)\binom{b-5}{n-1}\text{.....(2.25)}$$

And similarly

$$C_n(U,G,4)=(b-5)\binom{a-5}{n-1}\text{.....(2.26)}$$

Therefore , (2.23) follows from (2,25) and (2.26). ■

Theorem 2.6: For $2 \le n \le p(=a+b)$, and a , $b \ge 6$,

$$H_n(W_a \boxtimes W_b;x)=\sum_{k=1}^{5} C_n(W_a \boxtimes W_b,k)x^k ,$$

in which $C_n(W_a \boxtimes W_b,k)$, for $k=1,2,3,4,5$ are obtained in (2.4) , (2.5c) , (2.10) , (2.17) and (2.23).

■

Corollary 2.7: For $2 \le n \le a+b$, and a , $b \ge 6$, the n-Wiener index of $W_a \boxtimes W_b$ is given by

$$W_n(W_a \boxtimes W_b)=p\binom{p-1}{n-1}+(p-6)\binom{p-4}{n-1}+(a-4)\binom{b}{n-1}+(b-4)\binom{a}{n-1}$$
$$+(a-2)\binom{b-2}{n-1}+(b-2)\binom{a-2}{n-1}+a\binom{b-5}{n-1}+b\binom{a-5}{n-1}+4\binom{p-6}{n-1}\text{.....(2.27)}$$

Proof: From Theorem 2.6 , we obtain

$$W_n(W_a \boxtimes W_b)=\sum_{k=1}^{5} k\,C_n(W_a \boxtimes W_b,k) .$$

Substituting $C_n(W_a \boxtimes W_b, k)$, for $k = 1,2,3,4,5$, from (2.4) , (2.5c) , (2.10) , (2.17) and (2.23), and simplifying the expression , we get (2.27) .

■

Finally , the relation between the 2-Hosoya polynomials of 2-distance and the Hosoya polynomials of distance (standard distance) [9] of a connected graph G is given by [4] , $H(G;x) = \frac{1}{2} H_2(G;x)$.

Thus

$$H(W_a \boxtimes W_b; x) = 2px + \frac{1}{2}(p^2 - 5p - 2ab + 32)x^2 + (2p - 11)x^3 + 3(p - 10)x^4 + (a - 5)(b - 5)x^5 ,$$

and

$$W(W_a \boxtimes W_b) = \frac{d}{dx} H(W_a \boxtimes W_b; x)\Big|_{x=1} = p^2 - 10p + 3ab + 4,$$

Where $p = a + b$, a , $b \geq 6$.

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KNOWLEDGE IN THE PLANNING PROCESS EVALUTION, USE OF GIS AS A TOOL SUPPORT, AN EXAMPLE

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ABSTRACT

In this paper it is evidence to the existing relation between knowledge and planning. Provides a framework of the knowledge and its development, and examines the type, roles and the characteristics in the planning process evolution in relation to the node knowledge.

It illustrates the necessity of the "selectioned" knowledge and its specific use in respect of the innovative instruments such as GIS.

The attempt of the research is to leading in relationship the planning relationship and Gis as a means of monitoring and management of territorial data. In this way emerge the tasks and roles of planning in the analyses of the cities, and the possibilities to use methods of GIS, as support instruments, in urban planning. The Paper provides a framework of analysis methodology, as a new approach useful both as instrument and operational procedure as a whole.

STATEMENT OF THE PROBLEM

It is evident that in planning the knowledge and its relation with the territory government's processes and instruments is a central knot.

We are facing the relation between two terms with strong and important meaning.

To know, which means to take possess intellectually, with a systematic activity, of each aspect of what is called reality (Magnaghi 2005: 23-27). In our case, it means, therefore, to take possess with a systematic activity of all the aspects which characterize the city and the territory: a task, this, which is certainly ambitious and difficult[i].

To plan, which means to project and to organize something through a precise plan and therefore to be equipped with a program which determines the objectives, the means, the tasks and the themes to reach, at the fixed term, a specific result decided by the community or, better, by its elected representatives and technically translated by city-planners, architects, sociologists, economists etc., in elaborates which integrate and render understandable, but also stable in time, plans and programs.

In more general terms the scope of knowledge for the sciences is that to constitute "learning", Thom (1980:14-17). He clams (1980:21), for whom to satisfy a human need is rather the scope of the technology rather than that of the sciences, "to put order to the transformations as it is done by who plans the territory is indeed a human need, we would find ourselves in assimilating the city-planning to the technologies rather than to the sciences".

In such a case the need of knowledge which is put to whom has the target to act on the territory (as it is the case of who operates in the city-planning) is that to get instruments and operational procedures rather than that to understand the territory in which he operates[ii].

So the knowledge which more interests us is the one that serves to operate, rather than the one designed exclusively to enable us to know[iii].

Just because it is indispensable to act and to govern the transformations, the knowledge is thus an absolute and prioritary necessary instrument for every city-planner, or, more generally, to each technician who operates in this field and to be able to develop it to the higher quality levels is one of the condition from which depends the efficacy of the technical action in this topic.

Consequently the role of the knowledge becomes the reality taken into consideration the complexity, uncertainty, quick and intense change as it is the reality of today's urban and territorial systems.

This knowledge is necessary (Magnaghi 2005, 72) in order that who governs the territory can decide:

-What components, spaces, relations, communication's channels changes can be promoted or allowed

-How to organize same so that they respond to the targets shared by the community

-How and when to intervene to correct the evolution if the transformations altogether shift from the fixed objectives.

1. KNOWLEDGE: TO KNOW WHAT?

To know in a systematic way the city's and the territory's most prominent aspects means to produce, through the reading of data and graphs, but also readings and bibliographic documentation, interpretations [iv] and analysis on what it is and what happens enabling to give, to the one who has the task to decide on the guture of the city and of the territory elements or at least hypothesis on the characteristics of the urban components and of the spaces that they occupy. They need to understand all factors that affect the value of land and real estate (Hoch, Charles, 2000), as well as on the relations in-between and therefore on the communication channels which make possible the relations, as synthesized and exemplified in the following table.

Table (1):- Components and their relations of Knowledge in the process of planning

Data		Interpretations
Maps	----->	
Bibliography		Analysis
COMPONENTS	**SPACES**	
population	housing	
activities	places of business	
agriculture	farms	
industry	factories	
private and public tertiary	shops, offices, schools, hospitals, parks	
|	|	
V	V	
LATIONS BETWEEN COMPONENTS (=flows of people, goods, money, information)	**CHANNELS**	
population and activities	roads	

The knowledge, however, must not be confined to the physical elements of the urban or territorial system (Edward J. Kaiser et al 1995), they must be extended to all the economic-social elements which produce or facilitate the changes and thus to the characteristics and behaviours of:

-actors of the changes (operators, institutions, associations, citizens)

-subjects of the planning (territorial bodies at various levels that is to say region, municipality etc)

1.1 Knowledge: To Build Interpretations

It must be immediately evidenced that in order to know it is not sufficient to describe the state of fact (to collect data, treat and represent same): it is needed to build interpretations useful to reach the objectives that the subjects of the action (municipalities, regions) have posed to themselves.

When we describe[v] we are not only representing some geographic realities, we are also creating meaning (Duncan Ley 1994).

Therefore a more complex route must be activated that leads to recognize the relations cause-effect of the continuous modifications to which the territory is subject or at least to build hypothesis on the evolution processes underway, to be verified through data and observations.

Knowledge thus must be oriented to precise scopes (Duncan Ley, 1994), so that on the most significant elements, and not on any aspect of the territorial system (Dematteis, 1995), can be obtained those systematic deepening of which we are in need in order to understand what, when, how, why, where the changes that who governs the territory is asked to direct towards the chosen objectives.

This means, according Duncan Ley (1994: 33-42) for example:

-to identify the critical points of a territory, or of an evolution phase and relevant causes, to control same and correct them if necessary;

-to recognize the specific characteristics of an area in order to exploit same;

-to understand how much and in which way the significant elements have changed in the last years;
-to point out the evolution tendencies;
-to compare the state of fact and the changes forecast of a territory with principles of general order (today, for example, the principles of the sustainable development which the international community has given to itself in order to reach the result of a condition of equilibrium between the development exigencies and the environment safeguard);
-to evaluate in advance the effects of the changes;
-to enable the decisions' subjects and the actors of the changes to understand in order to consciously participate to the plans' elaboration and actuation process;
-to observe the plans' actuation (monitoring), to evaluate the efficacy of the actions taken.

1.2 Knowledge: How To Know?

To reply to the mentioned complexity characteristics of the systems to be governed and for the operational and not only speculative purposes (Andy, 2005), of the knowledge of which we are in need it is necessary that same be
-precisely finalized
-articulated
-dynamic
-widely diffused
-built up with the participation of all involved subjects. To know in order to plan means all this. It is evident that to move in this direction it is necessary to dispose of the most updated technologies and today these technologies are those known as GIS (Geographical Information System) [vi] and which are those that better satisfy such exigencies. A GIS is a computer system capable of capturing, storing, analyzing, and displaying geographically referenced information; that is, data identified according to location (Burrough, P.A.1998).

The long series of necessary elaborations to obtain the many mentioned elements about the urban components and relevant spaces, on the relations between components and channels through which same are obtained involve the treatment of many quantitative and graphic data and it is necessary the use of Geographical informative systems [5]

Hence the whole knowledge field for planning has become, for the GIS friendly technicians a privileged working field in which more and more interesting perspectives, also for the future, are opening (Heywood, Carver, 2006).

These capacities differentiate the GIS from other informative systems and make them a very important instrument directed to a wide range of public and private users who need to visualize and analyses information with the purpose of explaining events, expecting results and planning strategies (Worboys, Duckham 2004).

We deem therefore that a great attention should be given to create the preliminaries so that those who works in this field may obtain, rather than specific instrumental knowledges, always more ephemeral due to the increasing speed of the technological evolution of the computer based techniques (How,1983).

The methodological formation suitable to find every time the technical solutions the more adequate to the available times and means and, therefore, the precise placing in the territory's management and planning in order to put one's own applicative capacities to the collective interest.

2. KNOWLEDGE AND PLANNING

2.1 Knowledge And New Tools

It is in this phase that the computer system applications begin to develop and are applied to the urban analysis (statistic analysis: factor analysis and cluster analysis (Biasini, Galetto Musso, Riganonti (1992), with the use of software such as SAS, SPSS etc, but also with data' cartographic renderings, technical and thematic cartography with the use of the first GIS SW (Burrough, 1998; How, 1983; Chang, 2005; Fondelli 1992),), and that the perception of the importance of an adequate cognitive base about the soil is taken into consideration which, starting from second half of 70s substitutes the state in setting planning rules (Duncan Ley, 1994; Berry, 1993).

The relation knowledge-planning, typical of this phase (Haley 1997), bases itself on the trust in public administrations' capacity to understand the public interest and to make it prevail in the conflict with the private one and in the parallel trust that the technician is able to propose, with the knowledge instruments, models for the future planning of the city and the territory on which to verify the conformity of the interventions (plan as an instrument to verify the conformity).

The target is that to produce cognitive instruments in support of the objective (Porter 1987), to favour the redistribution of functions

on the territory both through the administration's own policy for what it concerns services and through the verification of the conformity with this target of the singles Master Plans (Hoch, Linda and Frank 2000).

A typical proceeding is that to identify the areas with higher availability of services and compare same with the users' basins to subsequently reorganize the services network and promote a more balanced cultural, sporting, etc development (Castells, 1997ab; Magnaghi 2005),.

The cognitive course oriented to such scope can be that to set up:

-definitions of 1st and 2nd level services system

-1st level (services of culture, sport, spare time, tourism, services for the individual)

-2nd level (health services)

-definition of indicators characterizing each system

-definition of the importance to be given to each indicator

-calculation and representation of service units quantity present in each municipality

-evaluation of the services distribution for each of the systems taken into consideration (culture, sport, spare time etc) and therefater to classify the urban centres as provincial importance centres and municipal importance centres.

Basing on their services availability (functional hyearchies or centres' networks) to propose on the ground of these conclusions the actions to be taken for the reorganization of the services.

It is clear the benefit and the necessity of being able to dispose of GIS technologies [vii] to treat the quantitative data, to represent with thematic cartographies the geographical aspects of the issue, to spread the knowledge so produced, to make easier the updating. And it can be hypothesized the benefit constituted by the possibility to carry out, on many of the problems of a territory, articulate interpretations to help to take the most opportune decisions to in order to reach the targets chosen by the community through its elective organs.

The widening of the normative, the increase of the decisional levels (Mike, 1997), the explicit admission of the limits determined by the scarcity of available resources, the theoretical and methodological progresses and the development of new techniques in different disciplines (as in mathematic and statistic, with the development of *data analysis* techniques (How,1983; Mike,1997; Heywood, Cornelius, and Carver,. 2006), such as *multi-criteria analysis*) and the awareness that the plan realization involves the interaction with many operators, amongst whom the private ones, have undermined the scholars and technicians certainties and implied a critical review of the previous situation and the adoption of new models and new cognitive references.

Beginning from the 80s (Bramanti, Maggioni 1997), with the end of the city and of the economy expansion cycle, the government of the cities becomes a problem of

-restoration and reorganization without growth

-attention to new values (the historical centres, the environment, the landscape)

-new tools (the projects of parts of a city) to which entrust the task of formulating urban policies.

The research for total strategies (Perulli, 2000: 42-49), stops: the large cities administrations, with few exceptions, do not make new plans, let become obsolete those in force modifying the existing ones with partial changes and with partial, short term specific projects and give attention to

-architectural shape

-visual characters

-symbolic and spatial aspects rather than the understanding of the economical and social processes.

It prevails the refusal of the verification of the coherence between the projects that only a plan can guarantee and the "*deregulation*" (Mazza, 1997), aimed to speed up the decisional processes and to release the market resources.

The urban planning which enthusiastically entrusted itself to the schematic models originating from the social positivism [viii] has had to look new ways for a knowledge suitable to the new season: knowledge to measure the quality rather than the quantity in order to evaluate the environmental effects of the changes and to analyze historical backgrounds and landscapes values (Dematteis, 1997).

2.2 Knowledge And Planning Today

The present problems of today "knowledge-planning" relation are the heirs of this season but also of the previous one (Mazza, 1997). Today the territory planning sees the local authorities not anymore subject to the central ones but they are both on the same level according to the subsidiarity principle which means that each task has to be done by the authority which is the nearest to the problem.

The knowledge has not anymore as its scope the support to the authorization procedures by the superior checking authorities; new perspectives are opened to the knowledge courses Magnaghi 2005: 131-139).

-the planning levels increase (municipalities and regions) and therefore also increase the number of authorities who are in need of knowledge in order to plan.

-the plans autonomy increase as same is not anymore subject to quality control

-the conformity control is substituted with coherence verification between the changes forecast and the necessity to guarantee instead

-orientation

-coordination

-it reappears the necessity of a unitary picture to govern the territory, to understand and to follow its evolution in time

-it remains and increases the necessity to verify qualitative and environmental aspects

-grows continuously the quantity of available data on the most different aspects, not only through the specific data collection (as it happens with census or for researches specifically aimed to the elaboration of a plan) but overall through the many management activities that the authorities carry out for different necessities (certifications, taxation, tributes) and that produce articulated, dynamic, informatized data, provided with implicit interesting contents for those who govern the territory

-it is exploited, also thanks to GIS technologies, the cognitive content of management[xi] originated data (consider the cognitive content concerning the municipalities' population registry data, or the one concerning the buildings patrimony based on the land office data or on the municipal garbage collection).

2.3 Knowledge And Planning Yesterday

The recent past's experience (Castells, 1997b),with its many damages, inefficiencies, delays and the abuses in the use of the territory makes us suppose that often the relation knowledge-planning hasn't properly functioned or , even worse, it has been ignored or anyhow it has been very weak and insufficient: if we had understood more and better and, most important of all, if those who took decisions had at his disposal the knowledge instruments (Magnaghi, 2005) and had used same much more probably we wouldn't find ourselves to face and put remedy to:

-city's poor quality of life;

-damages caused to the landscape and to the environment;

-ruinous effects caused by the hydro-geological disturbance;

-decay of the artistic and architectural heritage.

In reality, if we should judge from the content of the plans produced in the first half of the twentieth century (Mazza, 1997; Haley, 1997; Piroddi, 1999), we should say that the necessity of knowledge was almost non existent.

The plans consolidated a state of fact, recognized a series of already taken initiatives and collected same into an instrument that finally might put order in a complex situation.

The plan didn't investigate neither the social nor the economic reality (Mazza, 1997: 53-55), and didn't formulate its own future forecast but collected the development forecasts of sections of the city, even if it liaising with some important conditioning physical elements (the customs borders, the distribution of the residential/industrial/commercial areas, the main public infrastructures etc).

It took anyway important decisions in respect of the general infrastructural system (road network, parks, squares, stations etc) but without developing analysis on these elements which it anyhow used.

Thus the necessary deemed knowledge was confined and limited to the space's aspects.

Therefore knowledge has had for a long time[x], and sometime it still has, a very marginal and "justificative" role for choices decided on the base of criteria which are extraneous to a true analysis work and reality interpretations.

This has meant, and sometimes it still means, to make the planning less effective also due to:

-poor significant analysis and same only "routinely" attached to the plans

-descriptions and interpretations produced "una tantum" and never repeated or updated

-poor cooperation between authorities and institutions

-difficult sharing of the available information data

-insufficient or total absence of communications of the produced knowledge

-modest participation of the actors to the decisions concerning the evolution of the territory

-negligence in the plans' actuation.

A gradual change of role has been obtained starting from 60s and 70s (Mazza, 1997; Piroddi,1999), with the development of the studies on the city and the territory obtained

from other disciplines (geography, sociology, economy) and from other countries (United States, Great Britain, France, Italy) with the perception of the many and serious problems arising on the territory because of the frenetic urban expansion and the fast industrialization (Becattini, Rullani 1994), and which have allowed to assume and to transfer to the territorial range models full of rationality demonstrating thesis, checking hypothesis, justifying obligations, calculating the optimal conditions to obtain complex results (Bramanti, Maggioni 1997).

The establishment of the belief [xi] that it could be possible to realize, starting from the knowledge of the reality, "models for the organization of the territory", capable to represent synthetically, through mathematic structures composed of quantitative variables and leaning on a preliminary work made of hypothesis and rules which can allow analytical deductions, has inspired "operational" versions of the models, feasible as long as the necessary information are available and that it be possible the use of calculation techniques, even very sophisticated, all based on the use of the computer and of well organized territorial informations archives.

Therefore knowledge as an instrument (Mazza, 1997; Magnaghi, 2005) to build the model of the future city with which to compare all the partial projects going through the three classic phases:

-survey
-analysis
-planning of alternatives.

Through two decades (60s and 70s) of evolution of the disciplines which refer to the urban and territorial analysis (Mazza, 1997: 81-85), as well as to the methods and techniques for the quantitative treatment of the data applied to the analysis of the

-economical and social processes
-use of the space
-study of the relations between places and activities have refined the instruments of knowledge which are still at the base of many of the methods and widely diffused techniques in the municipal , provincial and regional cognitive system.

3. GIS: A SUPPORT TO THE PRODUCTION OF SUITABLE KNOWLEDGES TO TODAY'S PLANNING

It is necessary of integrated wholes complete with all these datas and of the instruments [xii] needed to know and govern the changes of the whole territory (Mike, 1997), under all these aspects in order to follow same in space and time.

GIS technologies (Burrough, 1998; Chang, 2005; Haley, 1997) thus become an essential instrument to produce knowledge for planning purposes as they are able to: interpret at best huge quantities of data; represent same graphically allow their updating; make easier to treat complex issues (models, multicriteria analysis etc) [xiii].

The new technologies are thus absolutely necessary to better face such heavy tasks and therefore GIS systems (Burrough, 1998) are needed and same must coniugate following four tasks:

-to collect and elaborate the knowledge's raw material (the data) and further abstract informations treating same;
-to produce elaborations (charts, analysises etc) in order to help to build aimed interpretations to pursue the objectives;
-to promote, through the knowledge exchange, the cooperation between the cooperations subject;
-to expand the diffusion of the informations to increase the participation and the planning culture.

3.1 Today Knowledge's Needs For Planning

In a globalized modern, characterized by flexible processes of capital accumulation, the city structure must be such that it can adapt to a continually changing, the typical instability of networks that are structured at different levels: economic, social, planning, communication and information. The local context is not something static but becomes dynamic, in the sense that a dimension is recognized both spatial and socio-economic to build. We move from a purely geographical concept of "space" to the "territory" as "space relations" (Bianchini, 2004; Rullani, 2009). Spatial thinking and analysis are essential for intelligent urban policymaking in a globally connected world. For a planning in this today (Mazza, 1997; we require few forecasts and many **interpretations, evaluations, observations, verifications**, and which treats many and difficult problems such as:

-Environmental matters -quality of life and spaces in the city and in the territory
-recovery of historical-architectural heritage
-exploitation of local identities
-change without growth
-conciliation of the economic development with the environmental safeguard placed or addressed to new referrers or:
-new levels (the municipalities)
-new subjects (mixed societies, agencies).

The knowledge which is needed must respond to requisites coherent with different questions given by this context as follows in Table (2), and shown for each attribute.

Table (2):- Requirements of knowledge

Attributes Of Knowledge	With Reference To
Aimed	Objectives
Continues	Time
Diffuse	Accessibility
Shared	Involvement of actors
Articulated	Specificity / diversity
Qualitative and Quantitative	Quality / Quantity
Transparent	Documentation

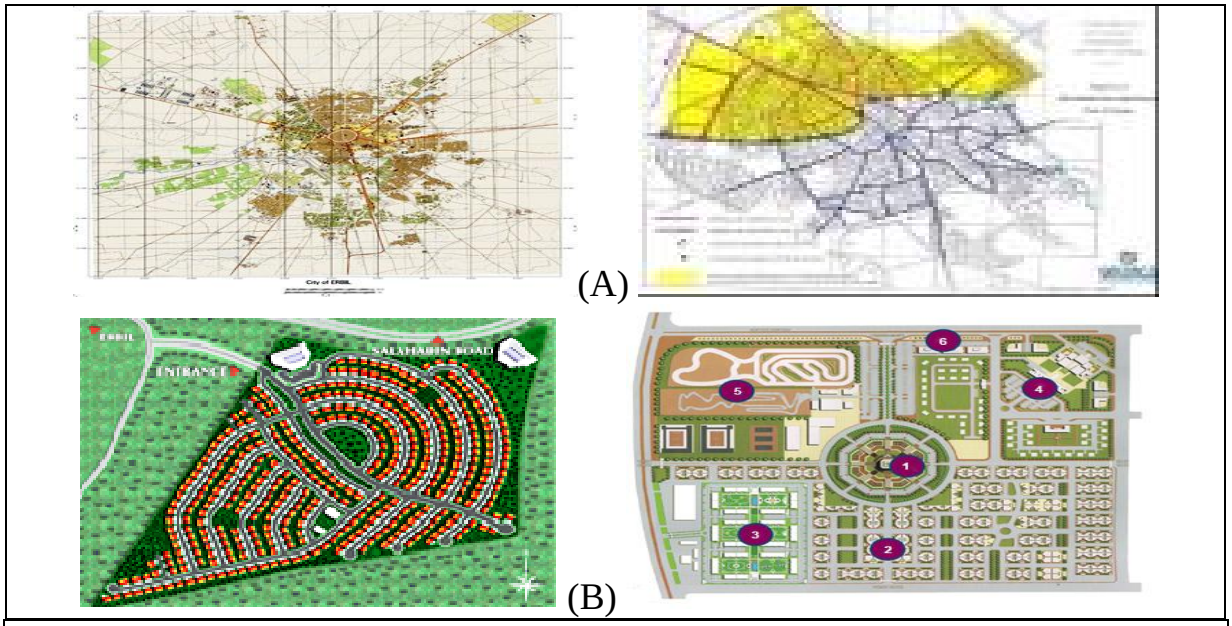

Fig. (1):- Master Plan: The forecasts of territorial changes in the Erbil province, analysis starting from the Master Plan - (A): Master plan of Erbil; (B): American Royal City

4. AN EVALUATION EXAMPLE

The monitoring of the Master Plan actuation, analysis of the building licenses (list of licensed Projects in Kurdistan Region: from 01/8/2006 to 30/9/2011) . Through the analysis of the georeferenced management data (the building licences released Erbil in the period 2006-2011) can be produced on the buildings productions dynamic

After having proven when, where, how much, with what changes new homes are built and, placing these empiric observations in a wider and more general picture built with the help of the subjects' disciplinary literature, hypothesis on the causes of changes can be obtained in the case of the above example it can be argued that to the 2006's consistent building industry production, which can be explained with the intention to anticipate the interventions fearing the issuance of a new Master Plan and thus new and unknown rules follows, in the period 2006/2011, a considerable growth, which can be linked back to the first impact [xiv] created by *The investment law nr. 4 2006* and by its new rules, by the new Master Plan[xv], to which again

follows the reprisal, modest at first - 2006 – and then more important in the year 2007 and subsequent).

Table (3):- Building licenses released in the period 2006-2011

Sector proj.	2007	2008	2009	2010	2011	% of Investment
Housing	10	6	19	19	17	61
Industry	6	5	1	11	10	33
Tourism	4	9	5	12	3	22
Trading	1	3	3	9	11	10
Health	1	3	2	9	1	16
Agriculture	2	4	3	5	2	15
Education	1	0	2	1	1	5
Bank/Service	0	2	2	0	0	4

Source: Investment Board, Information and Studies Department, Directorate of Information, Kurdistan Regional Government-Iraq, Erbil, 2011

Similarly observations and interpretations can be deducted from the analysis of the prevailing location of the building industry activity. Interesting, in the case of the above example, the reappearance of building concessions in the central areas after 2007, thanks to the new conditions allowed by the new Master Plan [xvi] and to the incentives for the intervention in the historical areas as foreseen by September 2007 UNESCO plan: *Revitalization of the Erbil Citadel and Erbil Conservation Master Plan*.

One similar support[xvii] obtainable from *Strategic Plan Development And Improvement (2008-2012)* for *the Erbil Municipality which foresees a multidimensional development of the city.*

The Master Plan allows to effect very important observations on the trends and on the fall back of the changes that it foreses and allows, obtaining useful indications for the compatibility verification between the allowed interventions and the fixed targets as in the example.

How does the settling plan proposed by the Master Plan react towards the diffusion tendencies?

How much high productive class agricultural soil will be withdrawn from its use as an effect of its change of use utilization which will transform today's agricultural areas into area where it will be possible to build?

What falls back will have the new expansion forecasts in relation to the environmental sustainability objectives adopted in terms of safeguard of "green spaces", in saving of not built space?

The knowledge is created thanks to the capacity of being able to put in relations datas and charts, to reconduct the specific case to the generality od known processes and consolidated experience; the planning edification efficacy depends also from the capacity to produce suitable knowledges (finalized, continuous, diffused, shared, articulate, transparent).The knowledge is that added value which transforms datas and charts into the interpretation of a context, of a period, of a process.

CONCLUSIONS

The fact that it is difficult to govern the territory and that often it has not been done adquately, doesn't mean that it cannot or must not be done. Above all it doesn't mean that it must be renounced to develop knowledge and interpretations and to equip with the most suitable means so that such a knowledge be updated, reliable, punctual so that there will not be valid alibi for who doesn't want to justify his own choices.

To develop the knowledge from time to time suitable to the changeable planning exigencies and thus correspondent to the new contents, to the new subjects, to the new methods made available to the technicians who attend the territory, is the correct route to realize it.

In order that this is possible, it is needed to exploit totally the potentialities which the computer system technologies make available. Therefore the task to develop these instruments and put same at disposal of who decides today falls in particular on the experts in the treatment of the territorial information.

All these information give to the cognitive system a fundamental role to obtain efficacy and quickness in the government of the territory and

dedicate in particular specific articles to the problem of collection and diffusion of the territorial knowledge, given mandate to the territorial authorities so that they can utilize, for this scope, "suitable technologies".

Even, if with different methods such territorial authorities dispose, for the systematic organization and the diffusion of informative fluxes, to provide the building of the fundamental cognitive references, for the definition of the territory government's actions and for the verification of their effects.

The purpose of this paper is to guide planners through those stages and methods in their process/program. For such a scope they dispose the institution of GIS defining their tasks:

-promotion of the computer system network of the local autonomies

-definition of standard and unified codes for the activation and efficient data' interchange

-promotion of the computer system c and telematic connections of local administrations

-diffusion of already acquired data and knowledge

-collection of data and realization of cartography to satisfy exigencies connected to knowledge, planning and designing.

With these actions and with these means the hard task to produce adequate knowledge to act certainly is not completed but it is endowed with the instruments to be able to proceed: GIS as necessary condition but not sufficient to understand and, consequently, to take correct decisions.

Commitment to the planning process is essential to a successful GIS implementation, especially in municipal government agencies and other public-sector organizations. The project proposal helps to secure the political commitment to the planning process. This is the moment to introduce the GIS planning process to the most senior executives of urban planning program. Arrange to keep them fully information of the planning progress.

The technique of GIS is particularly useful when several physical factors must be considered and integrated over a large area. In planning and urban analysis GIS is a tool that allows users to create interactive queries (user created searches), analyze the spatial information, and edit data. In the strictest sense, it is a computer system capable of integrating, storing, editing, analyzing, sharing, and displaying geographically- referenced information. These developments will lead to a much wider application of the technology throughout planning process.

NOTES

[i] Literature on this subject is very wide, particularly refer to: Gadamer (1986); Thom (1980); Magnaghi (2005); Majed (2009); Bramanti, Maggioni (1997); Castells (1997ab).

[ii] Quoted in Magnaghi (2005).

To promote interactive knowledge and representation of territorial heritage as tools for recognising values and resources Magnaghi (2005).

[iv] On this subject please see: Gadamer (1986); Habeemas (985).

[v] I had the opportunity deal with these issues in detail in a previous study (Majed, 2009)

[vi] A Geographical Information System is a group of procedures that provide data input, storage and retrieval, mapping and spatial analysis for both spatial and attributes data to support the decision-making activities of the organization (Burrough, 1998).

[vii] These capacities differentiate the GIS from other informative systems and make them a very important instrument directed to a wide range of public and private users who need to visualize and analyses information with the purpose of explaining events, expecting results and planning strategies (How, 1983; Burrough, 1998).

[viii] Angèle (1977), typical Characters of Social positivism:

- Science is the only possible knowledge and it is method is the only valid one.
- The philosophy coincides with the totality of positive knowledge, or the statement of the common principles to the various sciences.
- The method of science could be extended to all fields, including social.

[ix] Classification is analytical procedure for the determination of *classes* which gather homogeneous typologies of elements, for example the use of the ground, the kind of road, the urbanization, etc. See Chang (2005).

[x] Quoted in Piroddi (1999).

[xi] Quoted in (1994).

[xii] For example, a GIS can recognize and analyze the spatial relationships among mapped phenomena. Conditions of adjacency (what is next to what), containment (what is enclosed by what), and proximity (how close something is to something else) can be determined with a GIS.

[xiii] Date, (1981).

x[iv] The Kurdistan Region investment law was passed in July 2006 and an Investment Board was created to manage and promote nvestment in Kurdistan. Some highlights of the law are:

Foreign and local investors and capital are treated equally under the law (Article 3).

Foreign and local investors are entitled to own all the capital of any project (Article 3).

[xv] The Master Plan for Erbil City from 2005 to the year 2030, which has been prepared by Dar al-Handasa- a Jordanian engineering consultancy firm, shows the future city as a series of concentric circular roads starting from the citadel and extending more than 30 kilometers in all directions. In essence, therefore, this projected future plan starts with the "Bull's Eye"- the circle of the citadel and the rest of the radial growth is like ripples in water. It is most likely that the tremendous growth of Erbil City would have direct consequences on the future of the citadel- a factor the proposed Conservation Plan cannot afford to ignore.

[xvi] Under the new amended Memorandum of Understanding signed between UNESCO and the HCECR in May, 2008, a second training program was agreed upon to enforce local capacities in the field of conservation and restoration techniques.

The project is divided into two phases for a total duration of eight (08) months and it includes the following activities:

a. To collect data and prepare core documentation in order to establish the Conservation Master Plan of Erbil Citadel;

b. To assess the conditions of the buildings;

c. To prepare an architectural documentation of the Existing Fabric of the Citadel, building and streets;

d. To prepare a comprehensive survey and studies covering the structural situation of the Citadel (Buildings and Slopes);

e. To establish the Conservation Master Plan. This exercise is crucial and should be considered as a priority for the sustainable development of the Citadel, as cultural asset of Iraq.

[xvii] The document provides a strategic framework, sector strategies and the program which targets in rapid improvement of the life quality of the people of Erbil. That's why the PDS narrows the vision and follows up the quantity of targets in the economic growth field, provides job opportunities, fights poverty and improves rehabilitation and basic social services for the five years period of time.

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BONE OVERGROWTH FOLLOWING DIAPHYSEAL FRACTURE FEMUR IN CHILDREN

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1. ABSTRACT

Background: Femoral shaft fractures are common in children and leg length discrepancy is the most common complication. The overgrowth phenomenon is a physiological process associated with posttraumatic hyperemia rather than compensatory to the discrepancy.

Objectives: To evaluate the femoral discrepancy at time of union and the rate of overgrowth after one year of union following diaphyseal fracture of femur in children. Also to find the factors that accelerates the overgrowth phenomenon.

Patients and methods: this is a prospective study includes 20 children with closed diaphyseal femoral fractures, who were admitted to the orthopedic department in Duhok Emergency Teaching Hospital between August 2010 and September 2011, their age ranged from 1.3-7 years, 14 male and 6 female, fall from height was the most common cause of fracture, thirteen patients were treated conservatively and the other treated operatively. Follow up was done-twice for each patient- at time of union both clinically and radiologically and 12 months afterwards. The time of union ranged between 6-9 weeks.

Results: Shortening at time of union was noticed in 95% of fractured femur. After one year from union According to clinical measurement, overgrowth occurred in (16) 80% of cases with an average of 3.5 mm per year. By radiological assessment overgrowth occurred in 100% of the cases with an average of 8.4mm.It has been found that average bone overgrowth differs according to type of fracture and the site of fracture. Average overgrowth in those who had shortening of 1 cm or more at the time of union was 12mm and for those who had shortening of less than 1cm was 8 mm and this was statistically significant.

Conclusions: Cases with oblique fracture in the proximal third with shortening of one cm or more showed greater tendency to correct shortening. Incidence of femoral shortening following fracture femur was very high.

KEYWORDS: Femur, Children, Overgrowth, Clinical, X-ray

2. INTRODUCTION

Femoral shaft fractures are common in children (Abd- Alrahman, 2004), the annual rate is 19.15 per 100000 and boys has higher rate than girls at all ages. Fractures of femoral shaft usually are classified according the location as proximal, middle and distal thirds, fractures occur most commonly in the middle third. Most femoral fractures in children are closed injuries and traditionally have been treated by closed methods (tractions and spica) (Solomon et al., 2010), the choice of closed method depends largely on the age and weight of the child, if satisfactory reduction cannot be achieved by traction, internal or external fixation is justified, especially in older children and those with multiple injuries (Solomon et al., 2010). Leg length in equality is the most common complication reported after femoral shaft fractures in children (Wessel and Seyfriedt, 1996), usually resulting from overgrowth of the injured femur. The exact cause of this overgrowth is still not known but it has been attributed to age , gender, fracture type, fracture level, handedness and amount of overriding of the fracture fragments (Calandruccio and Jobe, 2008). The overgrowth is due to stimulation of the growth plate (Sulaiman et al., 2006); it is believed to be due to physiological process associated with posttraumatic hyperemia of the growth plate (Nordin et al., 2001). Opinions differs as to whether this phenomenon is a compensatory mechanism to adjust for discrepancy of length or an inevitable physiological response to trauma with no such compensatory role (Sulaiman et al., 2006), most authors agree that significant

overgrowth occurs in the first two years after injury and will not be further corrected (Wessel and Seyfriedt, 1996) . The purpose of this study is to analyze the residual overgrowth with clinical and radiological measurement following fractures of the femoral shaft in children and the factors that influenced femoral overgrowth.

3. PATIENTS AND METHODS

Study design: this is a prospective study conducted at Duhok Emergency Teaching Hospital during the period of August 2010 and September 2011. Twenty children with closed diaphyseal femoral fracture were included in the study.

Inclusion criteria: diaphyseal (shaft) femoral fracture, closed fractures, age less than 12 years, traumatic fracture, unilateral, isolated fracture femur, treated by either hip spica or plate and screws, six to nine weeks after fracture and all patients who were included were from duhok governorate.

Exclusion criteria: metaphyseal and epiphysis injuries, open fractures, pathological fractures, bilateral fracture femur, coxa vara, poliomyelitis, developmental Dysplasia of the Hip and external fixation and intramedullary nail.

Data collection: the patients were admitted to Duhok Emergency Teaching Hospital and the demographic and clinical data were collected by using a standardized questionnaire. Associated injuries were excluded through general examination e.g. head, chest, abdomen and pelvic injuries that take priority in the treatment. Antero-posterior and lateral views X-rays of the injured femur were then taken as well as x-rays of pelvis and ipsilateral knee. Preliminary skin traction provided as temporary splint in the emergency unit; the patient was then admitted to the orthopedic ward after general re-assessment. Specific treatment done for the patient under general anesthesia either spica or plate and screws; hip spica; were managed by either early or delayed reduction and spica cast application. Follow up was done-twice for each patient-at time of union both clinically and radio logically and 12 months afterwards(Sulaiman et al., 2006; Ashraf et al., 2007; Alani, 2007). The time of union ranged between 6-9 weeks (average was 7 weeks). At time of union, if the hip spica was applied, discarding it gently as outpatient -then looking for any complication, which might follows the application of spica e.g. pressure sore, blister..ect. Then X-Ray will be taken. Limb length discrepancy recorded clinically and radio logically as following:

A. clinical assessment: patient, pelvis and limb should be in correct position, after marking anterior superior iliac spine and medial knee joint line, these marking applied on both normal and fractured femurs. Length recorded and compared to length of normal femur of same patient. Mark of (- , 0 and +) used for shorter, equality and overgrowth respectively

B. X-Ray assessment: single exposure of both femurs including hip and knee joints, pelvis and patient in correct position. Highest bony point of femoral head was chosen and most distal bony out line of both condyles. Chosen as well, Drawing a line to the midpoint (intercondyles), connecting distal point to the proximal point. Same steps repeated in the normal femur and the length recorded as same as to the clinical assessment. Second assessment; after one year (12months) from the first measurement repeating same steps of the first assessment, clinical and radiological assessment, all data are recorded in the formulae again.

Data analysis: statistical analysis was performed, using statistical package for social sciences (SPSS version 14) and chi-square was used to compare discrete variables. A P value less than 0.05 was considered statistically significant.

4. RESULTS

Twenty patients with closed diaphyseal femoral fractures were included in our study, their age ranged from 1.3-7 years, 14 cases (70%) were male and 6 cases (30%) were female (Table 1) with a male to female ratio 2.3:1. Thirteen patients (65%) were treated by application of hip spica, the other seven patients(35%) by plate and screws (Table2). The frequencies of fracture side and site are seen in tables 3 and 4. Table 3 showed prominent fracture in non dominant side whereas table 4 showed 70% of the fractures in middle third of the bone. Fall from height was the most common cause of fracture (table 5). The majority of fractures were of spiral type (table 6).

Table (1): sex distribution

Sex	Frequency	Percent
Male	14	70%
Female	6	30%
Total	20	100.0

Table(2): types of treatment

Type of treatment	Frequency	Percent
Hip spica	13	65%
Plate&Screws	7	35%
Total	20	100.0

Table(3): Frequency of fracture side

Side of fracture	Frequency	Percent
Dominant	3	15%
Non dominant	17	85%
Total	20	100.0

Table (4): Frequency of fracture site

sites of fracture	Frequency	Percent
Proximal third	5	25%
Middle third	14	70%
Distal third	1	5%
Total	20	100.0

Table (5): Causes of fracture

Causes	Frequency	Percent
Fall From Height	16	80%
Road Traffic Accident	2	10%
Others	2	10%
Total	20	100.0

Table (6): Types of fracture

Types of fracture	Frequency	Percent
Spiral	11	55%
Oblique	4	20%
Transverse	5	25%
Total	20	100.0

At time of union by x-ray measurement; shortening(minus discrepancy) occurred in 19 out of 20 cases(95%), ranged between –(0.1 -2) cm , and average -0. 54cm.only one case(5%) was with +0.1cm lengthening(plus discrepancy).After one year of union, by x-ray measurement; shortening remained just in 3 cases (15.7%), ranging – (0.2-0.4) cm, and average of shortening was -0.3 cm. lengthening occurred in 16 cases (84.3%). At time of union by clinical assessment; shortening occurred in 10 out 20 cases (50%), ranging between-(0.1-1.4) cm, and average -0.57 cm, and the other 10 cases (50%) were without discrepancy. After one year of union by clinical assessment; shortening remained just in one cases (5%), (0.2) cm. All of cases at time of union were with limping, whereas after one year of union, all of them walked without limping as demonstrated in table 7.

Table (7): Discrepancy of Fractured Femur (F.F) as compared with Normal femur (N.F) twice at union and after one year, by X-Ray and clinical Measurement:

cases	X- Ray measurement		Clinical measurement (ASIMKJL)	
	Discrepancy **I** length femur(at union) **cm**	Discrepancy **II** length femur (after one year) **cm**	Discrepancy **I** length femur (at union) **cm**	Discrepancy **II** length femur(after one year) **cm**
1	-0.5	+0.5	-0.1	+0.2
2	-0.2	+04	0	**0**
3	-2	-0.4	-1.4	**-0.2**
4	-0.8	+0.4	-0.6	**0**
5	-0.4	+0.4	-0.2	**0**
6	-0.5	+0.3	-0.2	**0**
7	-0.2	+0.5	0	**+0.2**
8	-1	-0.2	-0.5	**0**
9	-0.2	+0.7	0	**+0.3**
10	-0.6	+0.2	-0.2	**0**
11	-1.5	-0.3	-1	**0**
12	-0.8	+0.2	-0.5	**0**
13	-0.2	+0.8	0	**+0.5**
14	+0.1	+0.6	-0.1	**+0.2**
15	-0.1	+0.6	0	**+0.2**
16	-0.1	+0.6	0	**+0.3**
17	-0.3	+0.3	0	**0**
18	-0.1	+0.9	0	**+0.7**
19	-0.4	+0.1	-0	**0**
20	-0.3	+0.2	0	**0**

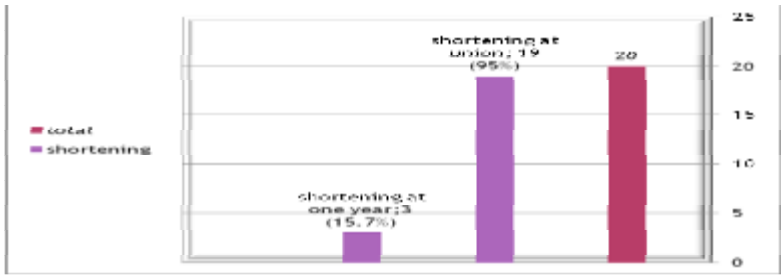

Fig. (1): Assessment of shortening

The rate of overgrowth per one year by x-ray measurement Ranged between5-16 mm, and average was 8.4 mm, overgrowth occurred in all cases (100%).The rate of overgrowth per one year by clinical assessment; ranged between 0-12 mm, and average was 4.5 mm, overgrowth occurred in 16 out of 20 cases (80%), while in4 out of 20 cases (20%), the discrepancy remained unchanged between first and second measurement the overgrowth not happened (clinically).Difference between x-ray &clinical measurement ranged between2-7 mm, and average was4.9 mm, P-value .093 which is not significant as demonstrated in(table 8).

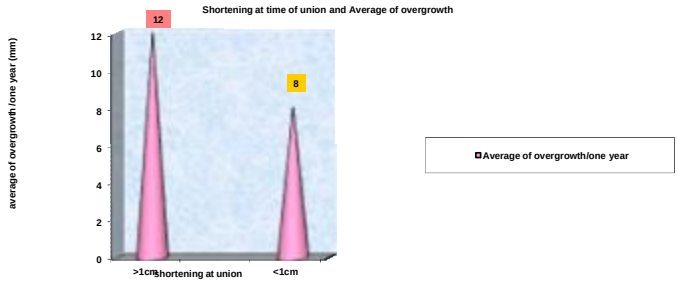

Fig. (2): Shortening at time of union and average of bone overgrowth

Table (8): Rate of overgrowth (per one year) of fractured femur by x- ray and clinical measurements.

Cases	x-Ray measurement Overgrowth/year(mm)	clinical measurement Overgrowth/year(mm)	Difference between x-ray & clinical measurement(mm)
1	10	3	7
2	6	0	6
3	16	12	4
4	12	6	6
5	8	2	6
6	8	2	6
7	7	2	5
8	8	5	3
9	9	3	6
10	8	2	6
11	12	10	2
12	10	5	5
13	10	5	5
14	5	3	2
15	7	2	5
16	7	3	4
17	6	0	6
18	10	7	3
19	5	0	5
20	5	0	5

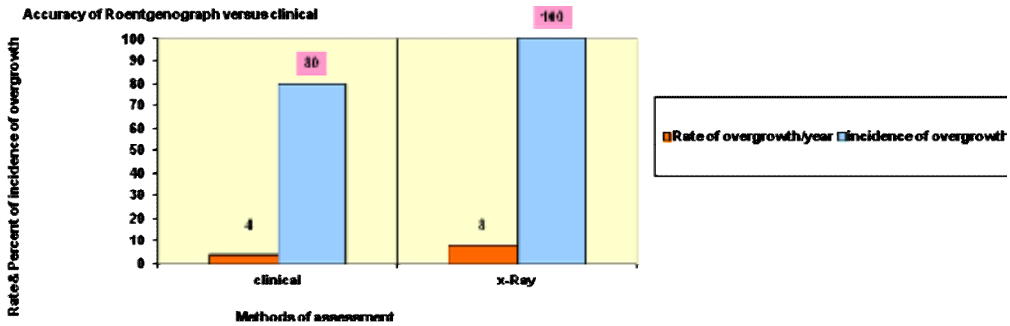

Fig. (3): Accuracy of clinical versus x-ray measurement

Range of overgrowth per one year by x-ray measurement and age distribution was; out of 11 cases who their ages below or equal to3 years**;** 10 cases (81.8%) were between 6-12 mm. and only 1 case (9.09.7%) was more than 12 mm. Out of 9 cases that their ages above 3 years**;** 3 cases (33.33%) were with overgrowth below 6mm, 6 cases (66.66%) were between 6-12 mm. and none of cases (0%) was with overgrowth more than 12 mm. Range of overgrowth in children younger or at 3 years was (7-16) mm, average (9.5 mm).Range of overgrowth in children older than 3 years was (5-10) mm, average (6.3 mm).P-value 0.089 which is not significant.

Range of overgrowth per one year by x-ray measurement and type of fracture was; out of 11 spiral fractures, there were 3 cases (27.27%) with overgrowth below 6mm, 8 cases (72.72%) with overgrowth between 6-12mm and no case (0%) with overgrowth above 12mm.Out of 4 cases oblique fractures there were 3 (75%) with overgrowth between 6-12 mm. and one case (25%) above 12mm. 5 cases transverse fractures **all cases** (100%) with overgrowth between 6-12 mm. Range of overgrowth in spiral fractures was (5-12) mm, average (8mm).Range of overgrowth in oblique fractures was (6-16) mm, average (10.5mm).Range of overgrowth in transverse fractures (7-9) mm, average (7.8 mm).

Range of overgrowth per one year by x-ray measurement and type of treatment was: out of 13 hip spica, there was only 1 case (7.69%) with overgrowth below 6mm, 11 cases (84.6%) were with overgrowth between 6-12 mm and 1 case (7.69%) with overgrowth more than 12 mm. Out of 7cases with plate and screws**,** there were 2cases (28.57%) with overgrowth below 6 mm, 5 cases (71.42%) with overgrowth between 6-12 mm. and there was no overgrowth more than 12 mm. Range of overgrowth in fractures treated by spica was (5-16) mm, and average was (9.1 mm).Range of overgrowth in fractures treated by plate and screws was (7-10) mm, and average was (7.1mm), P-value 0.37 which is not significant.

Range of overgrowth per one year by x-ray measurement and side of fracture was; out of 3 dominant cases, there was one case (33.66%) had overgrowth below 6mm, 2 cases (66.66%) had overgrowth between (6-12).Out of 17non dominant cases, there was 2 cases (11.76%) were with overgrowth below 6mm, 14Cases (82.35%) were between 6-12mm, one case (5.88%) with overgrowth above 12mm.Range of overgrowth in non dominant side was (5-16) mm, average (8.5 mm).Range of overgrowth in dominant side was (5-10) mm, average (7.66mm), P-value 0.593 which is not significant.

Range of overgrowth per one year by x-ray measurement and site of fracture was; out of 5 proximal third fractures, there were 4 cases (80%) with overgrowth between 6-12mm and only1case (20%) with overgrowth more than 12mm. Out of 14 middle third fractures, there were 3 cases (21.42%) with overgrowth below 6mm, 11 cases (78.58%) with 6-12mm overgrowth and no case(0%) was with overgrowth above 12mm. Distal third fracture only one case with overgrowth between (6-12mm).Range of overgrowth in proximal third (10-16) mm, average (11.6mm).Range of overgrowth in middle third (5-12) mm, average (7 mm), P-value 0.362 which is not significant.

Range of overgrowth by x-ray measurement per one year after union and Sex was; out of 14 male, there were 2 male (14.28%) with overgrowth less than 6mm, 11 male (78.58%)were with 6-12mm overgrowth and only 1 male (7.14%)was with overgrowth above 12mm.Out of 6female, there was only one female (16.66%) with overgrowth less than 6mm, 5 female (82.34%) were with 6-12mm of overgrowth and none of female (0%) had overgrowth more than 12mm. Range of overgrowth in male was (5-16) mm, average (8) mm. Range of overgrowth in female was (5-10) mm, average (7.5) mm, P-value 0.796 .

Range of overgrowth by x-ray measurement per one year after union and rate of shortening at time of union was; out of3 cases that were with shortening more or equal than 1cm at time of union there was no case (0%) with overgrowth below 6 mm, 2 cases (66.66%) were within 6-12 mm. and one case (33.33%) with overgrowth above12 mm. Out of 16cases who were with shortening less than 1cm at time of union ;there were 3 cases (17.64%) with overgrowth below 6 mm, 14 cases (82.34%) with overgrowth between 6-12 mm. and no

case (0%) with overgrowth more than 12mm .Range of overgrowth in cases who had (at time of union) shortening less than 1 cm was (5-12) mm, average (8 mm).Range of overgrowth in cases who had (at time of union) shortening more or equal than 1 cm was (8-16) mm, average (12 mm), P-value 0.043 which is significant.

5. DISCUSSION

Sex distribution: in this study the ratio of male to female 2.3:1.The distribution of sex was almost identical to other studies, Boys were involved more often than girls with a ratio of 2.6:1 (Terry et al., 2005).

Age incidence in this study: 10 out of 20cases (50%) their age were between 2-5 years. This is in identical to other report, which noted the maximum incidence of bone overgrowth in children to be between two and five years of age (Nordin et al., 2001) .20% of cases their ages <2years, 30% of cases ages>5years.

Type of treatment: in this study; 13 out 20 cases (65%) were treated by hip spica. This result, in agreement with other series that; the recommended treatment for paediatric femoral fractures is mainly non-operative (Wessel and Seyfriedt, 1996). Operative treatment is recommended in the multiple-injured patients and Fixation devices used to anatomically stabilize paediatric femoral fractures (Nordin et al., 2001). Therefore, the number of cases treated with this method in our institutions is smaller than non operative one-value was not significant.

Cause of fracture: 16 cases (80%), the causative agent was fall from Height. This result is in agreement to other series that; fractures of femur are usually due to direct violence e.g. road accident or a fall from height (Solomon et al., 2010).

Duration of follow up: in this study the follow up duration was 12months, which is in agreement (Alani, 2007), while in other studies (Rockwood and Wilkins, 2006; Terry et al., 2005) , the follow up ranged 18-48 months. The aim of this study is mainly to evaluate the rate of femoral overgrowth in first year of the healing process, not to determine the maximum period of femoral overgrowth or maximum rate of overgrowth throughout the healing process which is expected to continue until 2 years, but greatest bone overgrowth occurs in the first 6-12 months after union and less in the second year (Rockwood and Wilkins, 2006; Terry et al., 2005). Further follow up of data planned throughout third measurement- two years after union-for further documentation of our work.

Accuracy of radiological assessment: In this study, both radiological and clinical method applied for assessment of femoral discrepancy and femoral overgrowth, revealed that the average of difference between both methods was 4.85 mm. As in other series reported, the radiographic assessment is more accurate than Clinical assessment because Clinical measurement has an accuracy only to the nearest 5 to 10 mm while radio graphical measurement is inaccurate by 2 to3 mm due to distortion by magnification and CT scan gram has an accuracy of 0.2mm (Sulaiman et al., 2006).

In this study, the assessment in both methods confound to femur and assessment of tibial length excluded, because in other series, the overgrowth of tibia after femoral fracture is controversial, Edvardsen and Syversen, (1976) Reported in thier study that Growth of the tibia was not affected by the femoral fracture. Other Investigated in their study that The overgrowth of the limb was observed only within the femur, the legs were equal in every case (Buchholz et al., 2002). If we use x-ray by single exposure of entire lower limb, it require special large cassette.

Incidence of shortening: In this study, By x-ray measurement, femoral discrepancy twice; at time of union and one year following union was shortening occurred in 95% and 15% respectively, The average of residual shortening after one year was (-0.3 cm), which was acceptable gait and cases were without limping. This result is in agreement with (Rockwood and Wilkins, 2006) who stated that: The most common sequel after femoral shaft fractures in children is leg length discrepancy. The fractured femur may be initially short from overriding of the fragments at union; growth acceleration occurs to “make up” the difference, but often this acceleration

continues and overgrowth occurs (Terry et al., 2005).

Rate of overgrowth per one year: In this study, The rate of overgrowth per one year by x-ray measurement Ranged between 5-16 mm, and average was 8.45 mm, whereas by clinical assessment; ranged between2-12 mm, and average was 4.5 mm. This result compatible with other series; Sulaiman et al.(2006), used radiographical measurements and found that majority of cases had overgrowth with mean of 0.9 cm. Nordin, et al. (2001) have used clinical measurement, the average femoral overgrowth in their study was 1.17 cm, whereas Sulaiman et al. (2006) have used CT scan, the femoral overgrowth was with a mean of 1.15 cm. The difference in the result probably due to longer follow up (18-24 months) in other studies, while in this study follow up was 12 months.

Radiological versus clinical overgrowth assessment: In this study; By x-ray assessment, overgrowth occurred in all cases (100%), while by clinical assessment; 80% of cases had overgrowth, the rest discrepancy remained unchanged between first and second clinical assessment this difference could be due to different methods of assessment but the p-value was 0.283 which was not significant. Sulaiman et al.(2006) used block test measurement and found the occurrence of overgrowth 41.2% of cases. According to Nordin et al. (2001) the overall femoral overgrowth by clinical measurement occurred in 77.4% of the children. Radiographic and CT scan gram revealed that femoral overgrowth occur in 100% of cases (Sulaiman et al., 2006).

Age and overgrowth: in this study, the average of overgrowth in children younger than 3 years was (9.4 mm), while average in those who were older than 3 years was (7.22 mm) but the p-value was 0.089 which was not significant. This result was in agreement with Other studies who were concluded that there is a relationship between overgrowth and age. Sulaiman et al.(2006)O found a greater overgrowth in children between four and seven years old compared to those who were outside this age range and they found that the overgrowth decreases as the age increases, and Nordin et al. (2001) found that the majority of children who sustained femoral shaft fractures before eight years of age equalized their limb length at the final follow-up.

Type of fracture and overgrowth: in this study; averages of overgrowth in spiral, oblique, and transverse fractures were (8mm), (10.5 mm), (7, 8 mm) respectively. Spiral and oblique fractures had higher average of overgrowth than transverse fracture but the p-value was not significant (0.127). In other studies, most researchers believe that no specific relationship exists between fracture type and overgrowth (Rockwood and Wilkins, 2006), but some have reported overgrowth to be more frequent after spiral, oblique, and comminuted fractures associated with greater trauma (Terry et al., 2005). Edvardsen and Syversen (1976) reviewed that Overgrowth was promoted by comminuted and long oblique fractures. According to Zwierzchowski et al. (2003), the overgrowth was remarked in the cases of spiral fracture with overriding.

Dominancy &overgrowth: In this study, averages of overgrowth in dominant and non dominant side were (7.6 mm) and (8.5mm) respectively, over growth in non-dominant side was more than overgrowth in dominant side but the p-value was not significant (0.593).In other studies found that femoral overgrowth tended to be greater when the non-dominant limbs were injured (Nordin et al., 2001). While Zwierzchowski et al. (2003) have reported that the overgrowth was remarked in fracture of the opposite site to dominant hand.

Site of fracture &overgrowth: in this study proximal third, middle third and distal third fractures were (11.6 mm), (7.07 mm) and (12 mm) respectively. Average of overgrowth in proximal third more than middle third but p-value was not significant(0.362). Same result was found by Nordin et al. (2001) who has documented that proximal third fractures showed a significant overgrowth compared to middle and lower third fractures

Rate of shortening at time of union and overgrowth: In this study the average of overgrowth in cases who had (at time of union) shortening less than 1 cm was (5-12) mm, (8 mm), while those who had (at time of

union) shortening more than 1 cm the range was (8-16) mm and the average was (12 mm).The p-value was significant (0.043). The bone overgrowth proportionate with shortening at time of union. In contrast to most other series, according to Nordin et al. (2001), the initial shortening of femoral shaft at time of union has slight difference in the range of overgrowth, Whereas, Stephens et al. (1989) reported that excessive fracture overlap at the time of injury, but not at union, increases limb overgrowth. Ashraf et al. (2007) reported that the greater the initial shortening, the stronger appeared to be the stimulus for overgrowth. It has been suggested that an increase in shortening of a fractured bone induces more callus formation, a longer period of periosteal hyperemia and epiphysis stimulation (Buchholz et al., 2002).

Type of fixation and overgrowth: In this study range of overgrowth in fractures treated by spica was (5-16) mm, and average was (9.92 mm),while of plate and screws was (5-10) mm, and average was (7.1mm). P-value was not significant (0.375) although the average of overgrowth that was treated by hip spica greater than the average of who were fixed by plate and screws, the overgrowth occurred in both groups of patients. This result in agreement with other studies (Sulaiman et al., 2006). Sulaiman et al. (2006) reported that overgrowth phenomenon can still occur even without length discrepancy caused by the trauma, and who were treated by anatomical open reduction and plate fixation - eliminated the factor of overlapping at fracture site. Hence, the only remaining cause of over lengthening was a physiological response to trauma. Overgrowth occurs whether the fracture is short, at length, or over pulled in traction at the time of healing (Terry et al., 2005). The greater mean of overgrowth of spica probably due to increase in shortening of a fractured bone that induced more callus formation, a longer period of periosteal hyperaemia and epiphysis stimulation (Buchholz et al., 2002).

6. CONCLUSIONS

Bone overgrowth after femoral shaft fracture occurred in 100% (average 0.8 cm) and 80% (average 0.4 cm) on radiological and clinical measurements, respectively within a year. Hence radiographic assessment is superior to the clinical assessment. Additionally, radiographic assessment of femoral discrepancy by single exposure of both femurs is clinically more conclusive. Although, the incidence of femoral shortening following fracture femur was 95% at time of union, it decreased to 15% after one year of union. Limping is unlikely if shortening at time of union by x-ray measurement within range (0.2 - 2) cm, average 0.7cm. Therefore, the bone overgrowth was proportionate to the rate of the shortening of femur at time of union. Fracture femur before the age of three years, oblique, spiral, proximal-third, non dominant side, and male sex fractures had higher ability to correct the shortening. Excessive shortening at time of union and in older children is not accepted. It is highly recommended to consider twice yearly follow up in the first year of union for children who are clinically with limping and for those with shortening in radiological measurement of more than 2cm.

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EXPERIMENTAL INVESTIGATION OF NATURAL CONVECTION HEAT TRANSFER FROM SQUARE CROSS SECTION CYLINDER IN A VENTED ENCLOSURE

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ABSTRACT

In the present work, the natural convection heat transfer from horizontal cylinder with square cross section situated in a square enclosure, vented symmetrically from the top and the bottom is investigated experimentally. The experimental work includes temperature measurements of the cylinder surface and the environment during transient state to determine Nu for the unbound and the bound cylinder. The studied variable ranges were: 10^7 £ Ra £ 6.6´ 10^7, 2 £ W/D £ 4, 0.25 £ O/D £ 4. The results indicated an increase in Nu with increasing Ra. Furthermore, Nu increased proportionally with the vent opening size at low enclosure widths. It showed inverse proportionality with opening size for high enclosure widths. The maximum percentage of the enhancement is more than 20% for bounded square cylinder as compared with unbounded square cylinder.

KEYWORDS: Heat Transfer, Square Cylinder, Enclosure

1. INTRODUCTION

Natural convection heat transfer from relatively long horizontal cylinders of noncircular section has received only limited attention in the literature even though there are a number of practical applications where such heat transfer needs to be predicted. Furthermore, there is even less information relating to the natural convection heat transfer for the case of cylinders enclosed in vented enclosures. The natural convection heat transfer from unbounded horizontal cylinder has been of interest to several investigators because of its importance in technology. The earliest measurements were those of Nusselt (Jaluria Y., 1980). McAdams, W.H., 1954, and Churchill, S. W. and Chu H. H. S., 1975 gave a correlation for Nusselt number (Nu) in laminar and turbulent regions. Kuehn T. H., and Goldstein R. J., 1976, presented a correlating equation for the natural convection heat transfer from horizontal circular cylinders to a cylindrical enclosure using the conduction layer model. The results approached the correlation for heat transfer from a free horizontal cylinder as the outer cylinder diameter became infinite and approached quasi steady as the inner cylinder diameter approached zero.

Hollands et al., 1994, experimentally investigated the natural convection heat transfer from long isothermal horizontal cylinders of noncircular cross sections at various orientations, covering the Rayleih number (Ra) range from 10^3 to about 10^9. The resulting correlation only requires the geometric specifications of the body height and perimeter with agreement with previous data of about ±10 percent.

When it comes to enclosed cylinders, the paucity of information is surprising considering the many applications of such configuration. Sparrow and Pfeil, 1986, performed a comprehensive study to determine the natural convection heat transfer from heated cylinder situated in a vertical channel in air. The height ranging from 5 to 15 times the cylinder diameters, inter wall spacing ranging from 1.5 to 10 diameters and Ra ranging from 1.5×10^4 to 2×10^5. It was found that a cylinder situated in a vertical channel experiences enhanced heat transfer as compared with an unshrouded cylinder. Enhancements of up to 40% were encountered for the investigated conditions. Farouk et al., 1984 experimentally studied natural convection heat transfer from a horizontal isothermal cylinder placed between two vertical adiabatic walls. The experiment covered $2\times10^3 < Ra < 3\times10^5$ and wall spacing to cylinder diameter ratios of 1.5 to 12. The enhancement of heat transfer from the cylinder decreased with increased spacing between the walls for the entire range of Ra with maximum

enhancement of 45 percent obtained at the smallest Ra and W/D studied.

Al-Mahroom, 2000, experimentally investigated the natural convection heat transfer from a horizontal circular cylinder placed in a vented square enclosure with symmetrical openings at the bottom and the top of the enclosure. The study included temperature measurements to obtain Nu and flow visualization to display the flow patterns. The study included the effect of enclosure width (W) and opening size (O). A maximum enhancement of 25% in Nu was reported at Ra = 10^5 and minimum values of W/D and O/D of 1.5 and 0.5 respectively.

There are some numerical investigations deals with natural convection heat transfer from cylinders in closed enclosure. Kim, et. al., 2008 investigated numerically the characteristics of two dimensional natural convection problems in a cokl.oled square enclosure with a heated circular cylinder. The finite volume method was used to simulate the flow and heat transfer over an inner circular cylinder. A detailed analysis for the distribution of streamlines, isothermals and Nusselt numbers were carried out to investigate the effect of the locations of the heated inner cylinder on the fluid flow and heat transfer in the cooled square enclosure for different Ra in the rang $10^3 \leq Ra \leq 10^6$.

Habeeb S. J., 2010, study the effect of hot square cylinder placed on a cooled elliptical enclosure of a laminar natural convection numerically. The governing equations in the vorticity-stream function formulation which was transformed into body fitted coordinate system. An elliptical function is used, which makes the coordinate transformation from the physical domain to the computational domain be set up by an analytical expression. About 48 tests are performed for different ratios of the geometry and Ra range from 10^3 to 10^6. The results showed that, the increase of the major axis of the enclosure leads to increase the average Nusselt number and decrease the flow strength for all Ra.

The present work deals with experimental investigation of natural convection heat transfer from a horizontal cylinder of square cross section situated in a vented square enclosure. The vented enclosure will have two symmetrical openings on its upper and lower sides. The experimental work includes temperature measurements of the cylinder surface and its environment to determine the Nu from the unbounded cylinder and cylinder situated in a vented enclosure. The effect of Ra, enclosure width and opening size on Nu will be evaluated.

2.EXPERIMENTAL WORK

1.1. Theory of the Experiment

Implicit in the transient cooling method adopted in this work was the assumption that the temperature decay is slow enough that the measured results are close enough to the steady state condition. Hollands et al., 1994, checked this assumption, the results agreed with the transient results, well within experimental error.

In the present work, each run included heating the cylinder to the specified temperature then shutting off the heater and allowing it to freely cool down while recording the data over the designed intervals. This allows the coverage of a wide range of Ra over a relatively short time, approximately three hours for each experiment. The cylinder was assumed as isothermal (constant temperature). The system is assumed as lumped capacitance model, (Biot number = hD/k_a = 0.002 on the average for this experiment). k_a is the thermal conductivity of the air, W/m.°C. The radiation and end heat losses are negligible; the heat transfer model reduces to:

$$\frac{(T - T_\infty)}{(T_i - T_\infty)} = e^{-\frac{h\,A}{r\,c\,V}t} \qquad \text{.... (1)}$$

Where T_i is the initial temperature of the cylinder at the beginning of the cooling state in °C, T is the temperature at each time step in °C, T_∞ is the environment air temperature at each time step in °C, ρ is the density of the material in kg/m^{3,} c is the specific heat of the material in kJ/kg°C, V is the volume of the cylinder in m^{3,} and A is the surface area of the cylinder in m^2.

Once the heat transfer coefficient is found, Nu and Ra are calculated as follows:

For circular cylinder:

$$Nu_D = hD/k\,,\; Ra_D = gb\,\Delta T\,D^3\,\mathrm{Pr}/u^2 \qquad \text{... (2a)}$$

For square cylinder:

$$Nu_H = hH/k\,,\; Ra_H = gb\,\Delta T\,H^3\,\mathrm{Pr}/u^2 \qquad \text{.... (2 b)}$$

In the above, D is the circular cylinder diameter, $H = \left(4 z_f \overline{P}^2\right)^{1/3}$ is characteristic length of non circular cylinders, and the air properties are calculated at the film temperature T_f. The

symbols P and z_f are the cylinder perimeter and the largest vertical height of the square section, Hollands et al., 1994,.

1.2. The Experimental Setup

Two cylinders of different cross sectional shapes (the circle, and the square) were used as shown in figure (1). Each model (or cylinder), as shown in figure (2), was nominally 590 mm long including the length of its two ends. The circular cylinder, has a diameter of 50 mm and the square cylinder has a side length of 50 mm. Each model was machined from aluminum with a 20 mm diameter longitudinal hole drilled along its full length to accommodate the electrical heating element. The heater assembly is enclosed in a 7 mm diameter brass tube and centrally located within the test specimen using fine-grade sand fill. The cylinders were highly polished to minimize radiation losses. End plugs were fabricated of mica and attached to each end of the cylinder to centrally hold the heating elements. Additional caps, made of cork were used to further control the heat losses from the ends.

The enclosure was constructed of Perspex sheets to form a box of 50 cm inside length with variable dimensions of the square cross section. Widths of 20, 12.5, 10 cm can be achieved as shown in figure (3). Four moveable black Perspex sheets of 3 mm thickness situated at the bottom and the top of the enclosure in order to control the size of the opening. Copper-Constantan thermocouples were fixed at the center of each Perspex sheet to measure the temperature of the enclosure. The entire setup was housed within a rigid frame made of brass supports, of dimensions 0.5 m by 0.5 m by 0.8 m. The cylinder was situated at the center of the enclosure in a position (0.75m) above the floor. The whole rig was placed in a closed isolated room. A schematic configuration of the enclosure is shown in figure (3). Twelve copper-constantan thermocouples were embedded in putty made of Aluminum papers (4 mm below the surface) in each body at locations on opposite faces 15 mm, 170 mm, 330 mm, and 485 mm from one end, figure (3). Measurements confirmed the uniformity of the surface temperature distribution of the cylinder. The thermocouples were placed at various locations axially and circumferentially along the cylinder. Six copper-constantan thermocouples were distributed equally at location 0.5 m above and beneath the cylinder and in axial direction along the cylinder to measure the temperature of the environment air. A Comark type display unit was used for temperature measurements in conjunction with a 12-channel selector switch.

Preliminary tests were conducted before running the main experimental works. These experiments included the calibration of the measuring devices, air stratification, uniformity of surface temperature, and radiation and convection heat losses. The temperature-measuring device was calibrated using mercury in glass thermometer. The difference between the measurements of the thermometer and the thermocouple were correlated and corrected. The temperature gradient along the height of the test rig, externally, was about 0.25°C/m that ensures negligibility of the air stratification. The maximum difference between temperature measurements along the cylinder surface was less than 2% of maximum temperature in longitudinal and circumferential directions. The value of heat losses, as compared with convection heat transfer from the cylinder, was about 2-3% for radiation and 2.5% for conduction end losses.

Uncertainty analysis was performed to establish the reliability of the results. The analysis method is based on a careful specification of the sources of uncertainties in the various primary experimental measurements. In the present work, the final result is Nu which is a function of the independent variables T, T_s, $T_¥$, k, D, t, r, …., etc. thus,

$$Nu_D = Nu_D(T, T_s, T_\infty, k, r, D, t) \qquad \text{…. (3)}$$

Let w_{Nu} be the uncertainty in Nu and w_T, w_{Ts}, $w_{T\infty}$, w_t, w_D, w_r, w_k be the uncertainties in the independent variables.

Assume that the uncertainties of the density, thermal conductivity, and specific heat are negligible and $w_T = w_{Ts} = w_{T\infty}$. Then the uncertainty of Nu can be calculated from Ali, 2008:

$$w_{Nu_D} = \left\{ \left(\frac{\partial Nu_D}{\partial D} w_D \right)^2 + \left(\frac{\partial Nu_D}{\partial t} w_t \right)^2 + \left(\frac{\partial Nu_D}{\partial T} w_T \right)^2 + \left(\frac{\partial Nu_D}{\partial T_s} w_T \right)^2 + \left(\frac{\partial Nu_D}{\partial T_\infty} w_T \right)^2 \right\} \quad \text{.... (4)}$$

Assume $w_T \approx w_{T_s} \approx w_{T_\infty} \approx 1.°C$, including cold junction uncertainty, w_t=1 second / total time of the cooling (in seconds), and $w_D = 10^{-6}$ m. The variation of uncertainties of square cylinder are 0.5% as minimum and 2% as maximum.

2. RESULTS AND DISCUSSION

The conducted experiments covered the following ranges of variables:

$10^7 \le Ra \le 6.6\times 10^7$

$2 \le W/D \le 4$

$0.25 \le O/D \le 4$

The work deals with the natural convection heat transfer from unbounded (free) cylinder (circular and square cross sections) to compare with previous data. Good agreement with Hollands et al., 1994, for square cylinder was indicated as well with maximum deviations of about 8%, as shown in figure (4). For bounded cylinder, the comparisons between the present work and those of Sparrow, 1986, Al-Mahroom, 2000, and Kuehn, 1976, for the circular cylinder, shown in figure (5), indicated excellent agreement with a maximum deviation of 3.5%. The effects of the Ra, enclosure width, and enclosure opening size on Nu for all cylinder cross sections are discuss in the following paragraphs:-

a- Rayleih number effects: The effects of Ra on Nu are displayed in figures (6-7). Nu increases with increasing Ra for all enclosure widths and opening sizes. The reason of this behavior is inherent in the definition of Ra. Ra is the ratio between buoyancy and viscous forces; therefore, the increase in Ra increases the fluid velocity around the cylinder, hence the heat transfer and Nu. It noted that the Nu increased by 15% when Ra value is increased with same enclosure width and opening size that display the noticeable effect of Ra on Nu. However, the ratio is nonlinear at 5 to 100. The correlation between Nu and Ra are exponential with exponent value of 0.23.

b- Enclosure width effects: the effects of changing the enclosure width on Nu are presented in figure 6. Nu variation with enclosure width depended on enclosure opening sizes. For all Ra, higher Nu was obtained for the enclosed cylinder in comparison with the free cylinder which ensures the importance of situating the cylinder in the vented enclosure. The results also indicated a strong dependence of Nu on the enclosure geometric dimensions. These effects are highlighted by comparing the enclosed cylinder Nu results for different enclosure widths with those of the free cylinder. As shown in figure (6), Nu varies proportionally with enclosure width at O=2.5cm and O/D=0.5 especially at high Ra. The strength of these effects decrease at the low Ra end of the results. Reduced effects are seen for larger opening sizes due to the reduced jet velocities impinging on the cylinders. For the full opening case, Nu decreases with increasing the enclosure width, again due to moving away from confined, guided flow to free unbound convection. The maximum Nu number increase for the square cylinder occurs at W/D=20cm, O=2.5 with a value 13.5%.

c- Opening size effects: the reduction in the opening size increases the inlet jet velocity of the air which led to an increase in Nusselt number. At high enclosure widths, the Nusselt number is inversely proportional with enclosure opening size. A maximum Nusselt number is obtained at W=20cm, O=2.5cm and Ra≈5.6×10^7 with value 20%, figure (7). The influence of opening size reduces with increasing its value to reach Nusselt numbers these values from unbounded (free) square cylinder. The behavior of the Nusselt numbers from square cylinder situated in low enclosure width is different, the Nusselt number increase is small and the maximum value of the increase is about 4-4.5%.

Nusselt number results for free horizontal cylinders of different cross sections are correlated with Rayleih number in the following manner:-

$Nu = 0.7929\ Ra^{0.2106}$ For circular cylinder ....(5)

$Nu = 0.8135\ Ra^{0.2295}$ For square cylinder ....(6)

The constants are obtained from a least square fit using Microsoft Excel 2003.

Nusselt number results from bounded horizontal cylinders of square cross section is correlated with Rayleih number, enclosure width, and opening size. The correlation equation is

$$Nu = 1.1184\ Ra^{0.21063} (W)^{0.07006} (O)^{-0.05289} \quad \text{.... (7)}$$

The constants are determined from the software program "Statistica" using Non-Linear

Multiple regression analysis with forward stepwise method.

Figures (8) display the observed values, from the experimental work, versus the predicted values, from equation (5), for circular cylinder. Both the correlation coefficients and residual values indicate a good strength of the correlations with an average residual percentage of about 2%.

3. CONCLUSIONS

Natural convection heat transfer from horizontal cylinder with square cross section shape in a square vented enclosure was investigated experimentally over a fairly wide range of Ra considering the effects of enclosure widths and opening sizes on Nu as well. The results yielded the following Nu-Ra correlation for unbounded cylinders:

$Nu = 0.7929 Ra^{0.2106}$ For circular cylinder

$Nu = 0.8135 Ra^{0.2295}$ For square cylinder

For $10^7 \le Ra_H \le 6.6 \times 10^7$

while the results yielded the following Nu-Ra correlation for the given ranges of enclosure width, and opening size:

$$Nu = 1.1184\, Ra^{0.21063} (W)^{0.07006} (O)^{-0.05289}$$

The ranges of the study are:

$10^7 \le Ra \le 6.6 \times 10^7$

$2 \le W/D \le 4$

$0.5 \le O/D \le 4$

The work indicated that enclosing the cylinder in the vented enclosure enhanced the heat transfer by 20% for the square shape. The Nu increased proportionally with enclosure width for low opening size. The heat transfer was enhanced by 20% for O=2.5cm and W=20cm as compared with the unbounded cylinder and 16% for O=2.5cm and W=10cm. The Nu is inversely proportional with enclosure width for full opening size. The enhancement is very poor because the W/D is relatively large. The Nu increased with decreasing opening size for large enclosure width. The heat transfer enhanced by 20% for O=2.5cm and W=20cm as compared with the unbounded cylinder and 11% for O=10cm and W=20cm.

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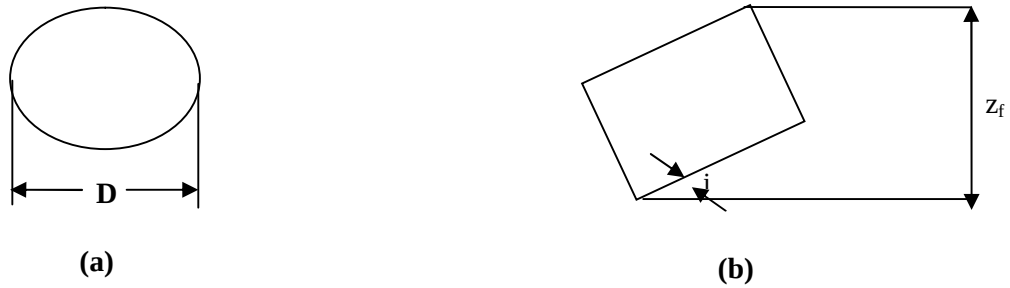


Fig. (1):- Different cross sectional shapes of the cylinders (a) circle, (b) square

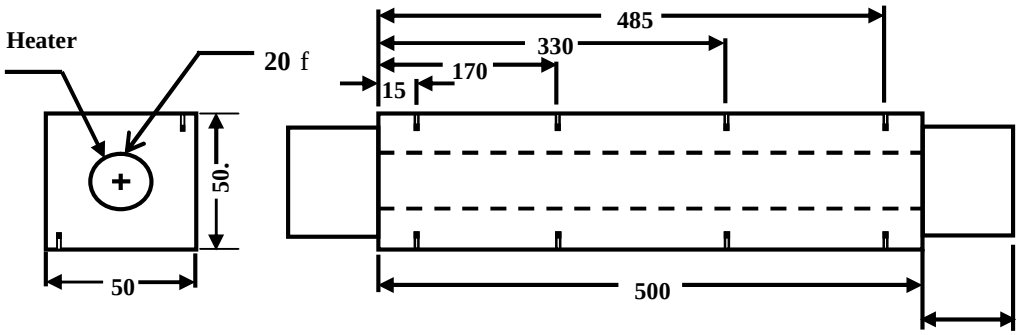


Fig. (2):- Drawing of square cross-section model showing holes for heater and thermocouple placements. (All dimensions in millimeters).

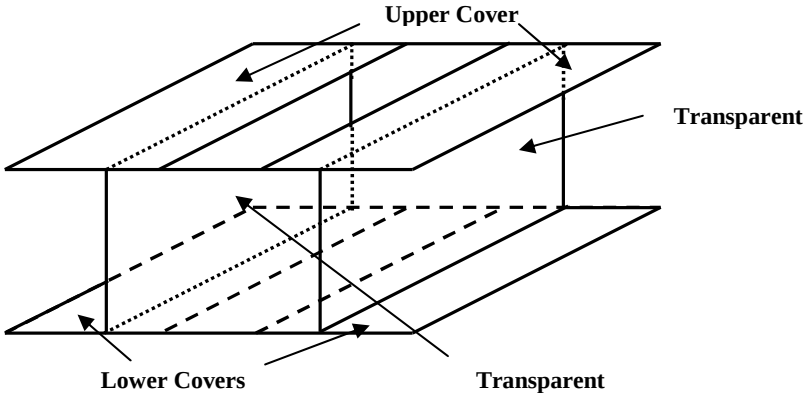


Fig.(3):- Schematic sketch of the enclosure.

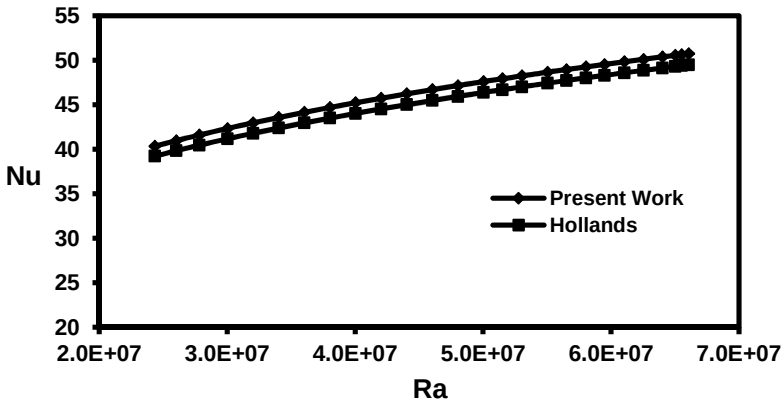


Fig. (4): Comparisons of the Nusselt number results from free cylinder between present work and previous data [10] for square cylinder

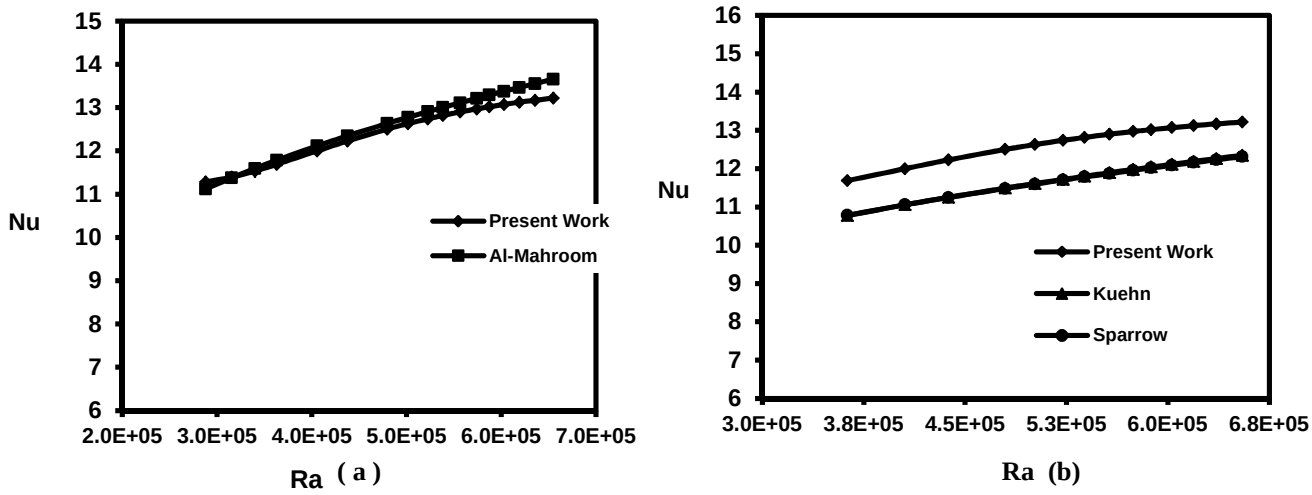
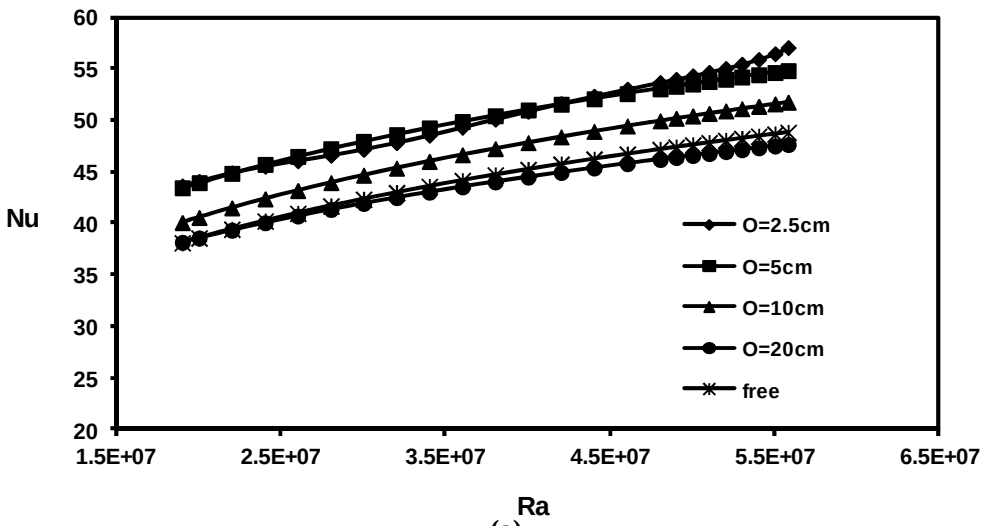
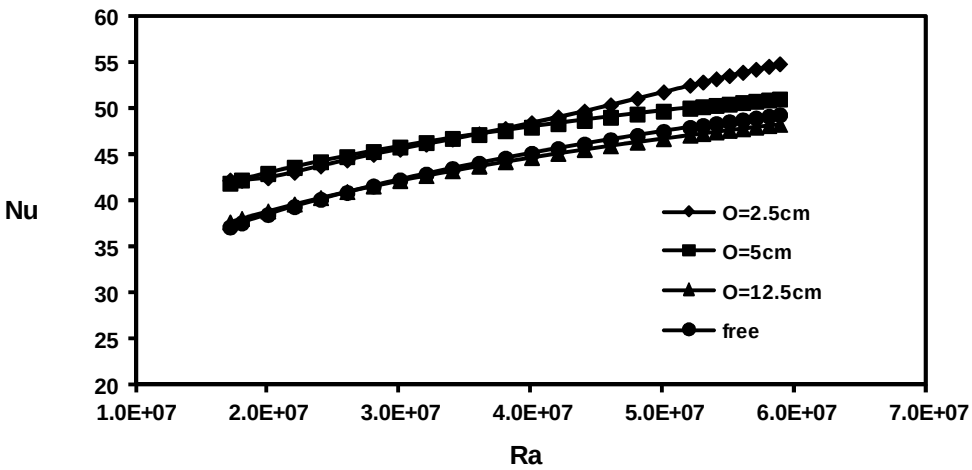


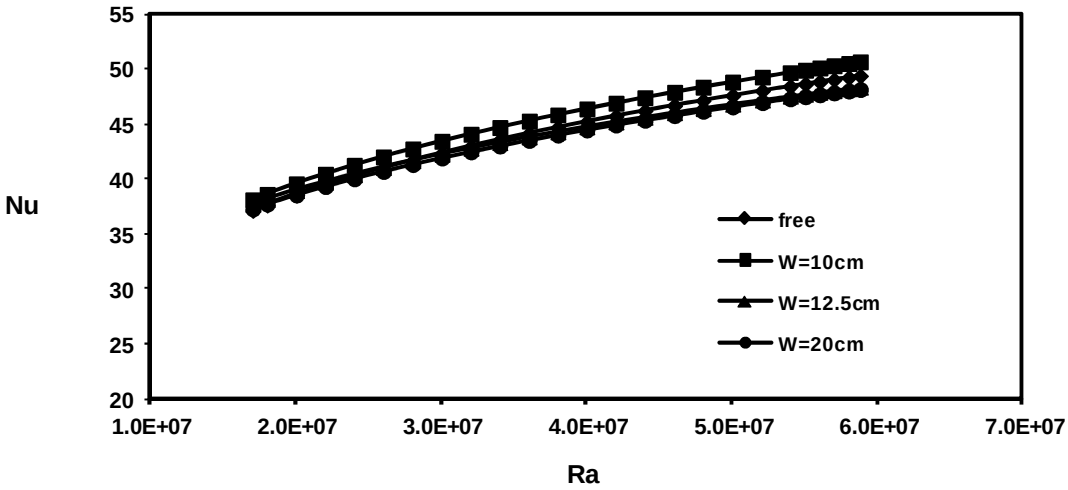
Fig. (5):- Comparisons of the Nusselt number results from free circular cylinder between present work and (a) Al-Mahroom, 2000 data, (b) Sparrow, and Kuehn, 1986 data



(a)

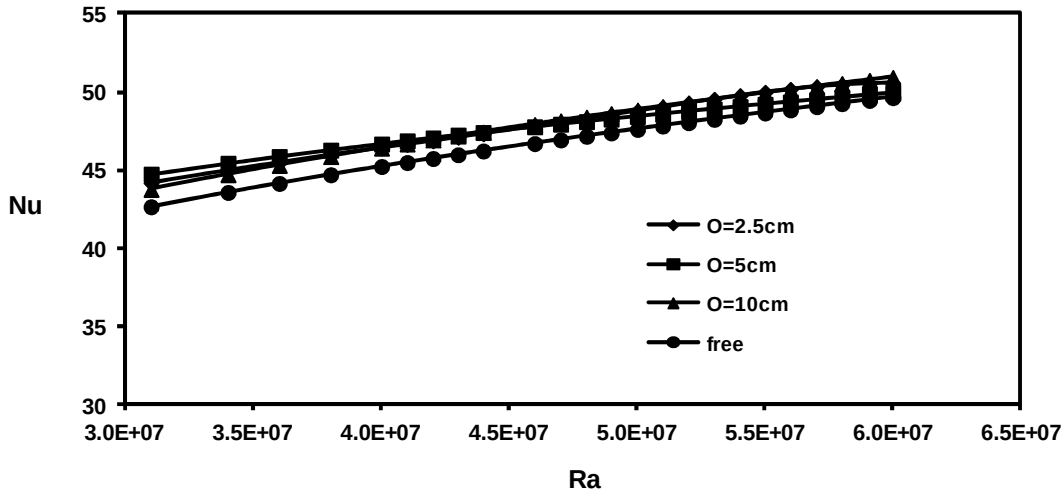


(b)

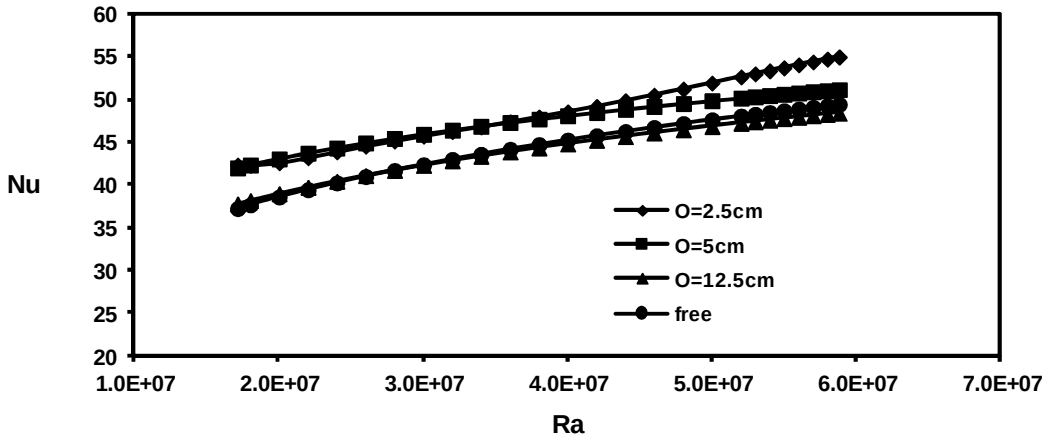


(c)

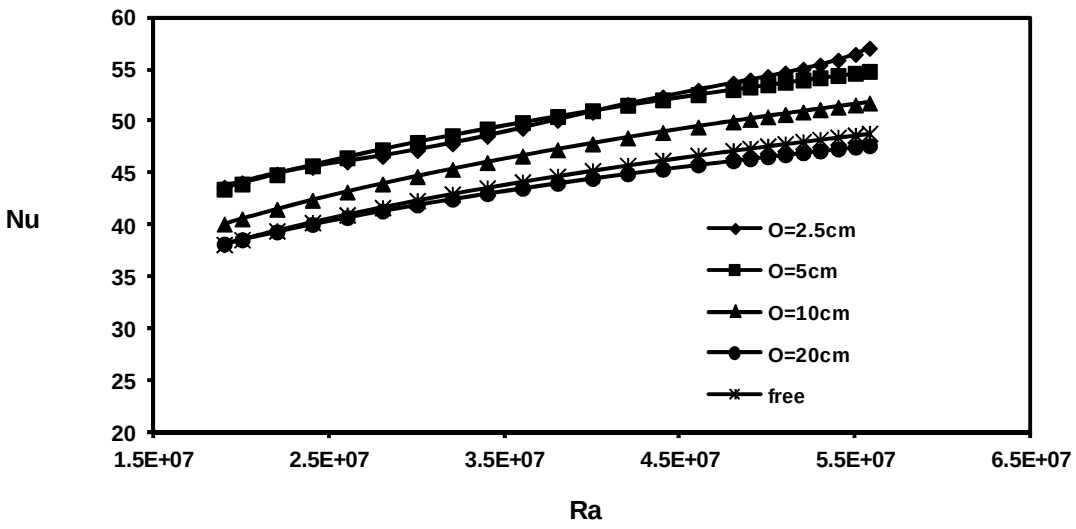
Fig. (6):- Nusselt number versus Rayleih numbers for square cylinder at different enclosure width and opening sizes (a) O=2.5cm, (b) O=5cm, (c) full opening.



(a)

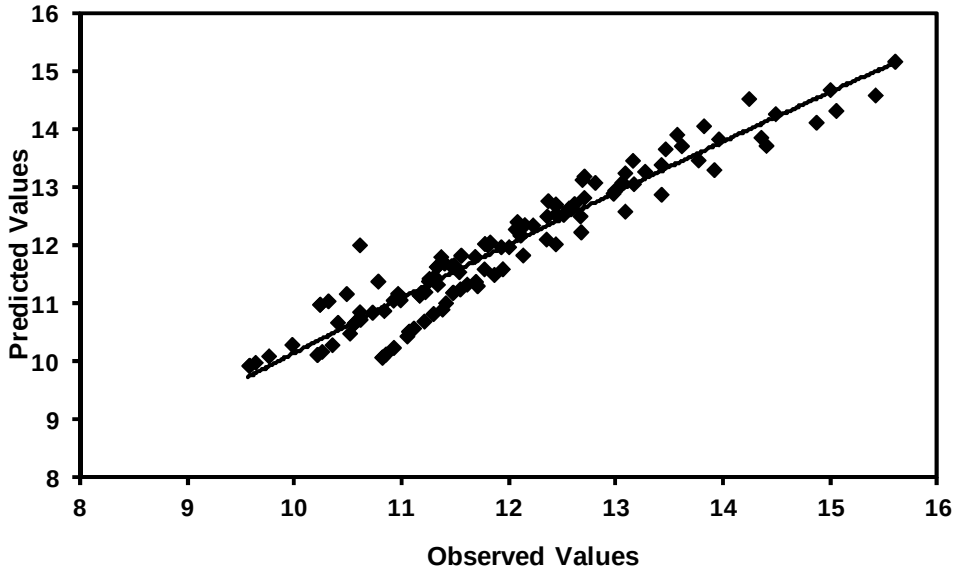


(b)

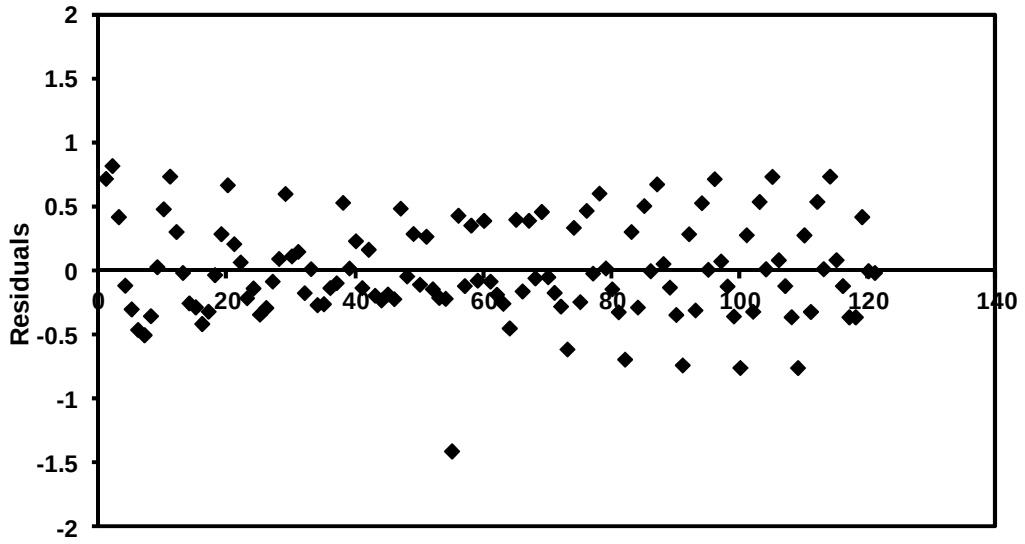


(c)

Fig. (7):- Nusselt number versus Rayleih numbers for square cylinder at different opening sizes and enclosure width (a) W=10cm, (b) W=12.5cm, (c) W=20.



(a)



(b)

Fig. (8):- (a) Observed values from experimental results versus predicted values from equation (6), (b) Residual of observed and predicted values, for circular cylinder

الخلاصة

يتناول البحث دراسة عملية لانتقال الحرارة بالحمل الطبيعي من اسطوانة افقية ذات مقطع مربع موضوعة في تجويف مهوى بشكل متناظر من الاسفل والاعلى. ويتضمن العمل قياس درجات الحرارة لسطح الاسطوانة والمحيط الخارجي خلال الحالة العابرة لحساب عدد نسلت للاسطوانة الحرة والمحاطة بغلاف. مدى الدراسة لعدد رايلي يتراوح بين **107** و **6.6×107** ونسبة عرض الغلاف الى قطر الاسطوانة يتراوح بين **2** و**4**، بينما نسبة فتحة الغلاف الى قطر الاسطوانة فيتراوح بين **0.25** و**4**. ويتبين من النتائج ان عدد نسلت يزداد بزيادة عدد رايلي. بينما يتناسب عدد نسلت بشكل طردي مع حجم فتحة التهوية عند عرض التجويف ذات الحجم القليل. ويتناسب عدد نسلت بشكل عكسي مع حجم فتحة التهوية عند عرض التجويف ذات الحجم الكبير.

پوختە

دڤی ڤەکولینی بخو فە گریدایە ب خواندنا براکتیکی بو ڤەکوهاستنا گەرماتیی ژ باراکی سەروشتی ل لولەك دەرژکەری بە شیوەکی چوار گوژی ل کورەکی ڤەکەری ژ بەنی وسەری. ئەف شولا بیکتیت گەردنا بەلا گەرماتیی بو دورماندوری لولەك ودەرفەی وەی ل کیسا بورینا دەمی بو ژمیریاریا ژمارا نوسلت بو لولەکا یا ئازاد وژوورڤی کورەکی. ژمارا رایلی ل ڤەی خواندنی دەستبیکەت ژ 107 بو 6.6×107، ریژیی ژ ستیراتیی سنووری بو ستیراتیی لولەکی ژ 2 بو 4، ریژیی ژ فەکرنا سنووری بو ستیراتیی لولەکی ژ 0.25 بو 4. دیاربی ژ ئەنجاما کو زیدەبینا ژمارا نوسلت ل کەل زیدبینا ژمارا رایلی. زیدەبینا ژمارا نوسلت ل کەل زیدبینا سایزا فەکرنا سنووری دەف کورەییت بجووك. زیدەبینا ژمارا نوسلت ل کەل کیماتیا سایزا فەکرنا سنووری دەف کورەییت مەزەن.

EXISTENCE OF A PERIODIC SOLUTION FOR NONLINEAR SYSTEM OF DIFFERENTIAL EQUATIONS WITH PULSE ACTION OF PARAMETERS

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ABSTRACT

In this paper we study the existence of a periodic solution for nonlinear system of differential equations with pulse action of parameters. The numerical-analytic method has been used to study the periodic solutions of the nonlinear ordinary differential equations that were introduced by Samiolenko.

INTRODUCTION

There are many subjects in physics and technology using mathematical methods that depends on the nonlinear differential equations, and it became clear that the existence of the periodic solutions and it's algorithm structure from more important problems in the present time. Where many of studies and researches dedicates for treatment the autonomous and non autonomous periodic systems and specially with the integral equations and differential equations and the linear and nonlinear intgro – differential equations and which is dealing in general shape with the problems about periodic solutions theory and the modern methods in its quality treatment for the periodic differential equations.

Somiolenko [6] assumed the numerical analytic method to study the periodic solutions for the ordinary differential equations and its algorithm structure and this method include uniformly sequences of the periodic functions and the result of that study is the using of the periodic solutions on a wide range in the difference of the new processes in industry and technology as in [4-6].

Consider the following system of nonlinear differential equation, which has the form

$$\left.\begin{aligned} \frac{dx}{dt} &= \lambda x + f(t,x,y) \quad , \quad t \neq t_i \quad , \quad \Delta x \Big|_{t\,=\,t_i} = I_i(x,y) \\ \frac{dy}{dt} &= \beta x + g(t,x,y) \quad , \quad t \neq t_i \quad , \quad \Delta y \Big|_{t\,=\,t_i} = G_i(x,y) \end{aligned}\right\} \quad \ldots (1)$$

where $x \in D_\lambda \subseteq R^n$, $y \in D_\beta \subseteq R^n$, D_λ is a closed and bounded domain.

The vector functions $f(t,x,y)$ *and* $g(t,x,y)$ are defined on the domain:

$$(t,x,y) \in R \times D_\lambda \times D_\beta = (-\infty,\infty) \times D_\lambda \times D_\beta \quad \ldots (2)$$

Which are continuous in t , x , y and periodic in t of period T, where D_β is bounded domains subset of Euclidean spaces R^m , and the functions $I_i(x,y)$, $G_i(x,y)$ are continuous in the domain (2), where $I_{i+p}(x,y) = I_i(x,y)$, $G_{i+p}(x,y) = G_i(x,y)$ *and* $t_{i+p}(x,y) = t_i + T$ for p is a positive integer and $\{t_i\}$ is finite positive sequence of numbers.

Suppose that the vector functions in (1) satisfy the following inequalities :

$$\max_{\substack{(x,y)\in D_\lambda\times D_\beta \\ t\in[0,T]}} \|f(t,x,y)\| \le M_1 \quad , \quad \max_{\substack{(x,y)\in D_\lambda\times D_\beta \\ t\in[0,T]}} \|g(t,x,y)\| \le M_2 \qquad \ldots (3)$$

$$\max_{\substack{(x,y)\in D_\lambda\times D_\beta \\ 1\le i\le p}} \|I_i(x,y)\| \le M_3 \quad , \quad \max_{\substack{(x,y)\in D_\lambda\times D_\beta \\ 1\le i\le p}} \|G_i(x,y)\| \le M_4 \qquad \ldots (4)$$

$$\| f(t,x_1,y_1) - f(t,x_2,y_2)\| \le K_1\|x_1 - x_2\| + K_2\|y_1 - y_2\| \qquad \ldots (5)$$

$$\| g(t,x_1,y_1) - g(t,x_2,y_2)\| \le L_1\|x_1 - x_2\| + L_2\|y_1 - y_2\| \qquad \ldots (6)$$

$$\| I_i(x_1,y_1) - I_i(x_2,y_2)\| \le K_3\|x_1 - x_2\| + K_4\|y_1 - y_2\| \qquad \ldots (7)$$

$$\| G_i(x_1,y_1) - G_i(x_2,y_2)\| \le L_3\|x_1 - x_2\| + L_4\|y_1 - y_2\| \qquad \ldots (8)$$

where $t \in R'$, $x , x_1 , x_2 \in D_\lambda$, $y , y_1 , y_2 \in D_\beta$ and $M_1 , M_2 , M_3 , M_4 , K_1 , K_2 , K_3 , K_4 , L_1 , L_2 , L_3 , L_4$ are a positive constant , $\| . \| = \max_{0\le t\le T} |.|$.

Let λ , β are a positive parameter defined in (2), provided that

$$\left.\begin{aligned} &\left\|e^{\lambda(t-s)}\right\| \le H \\ &\left\|e^{\beta(t-s)}\right\| \le F \end{aligned}\right\} \qquad \ldots (9)$$

where H and F are positive constants.

We define the non-empty sets as follows :

$$\left.\begin{aligned} D_{\lambda f} &= D_\lambda - \left(\left(HT - \frac{\lambda T H^2 T}{1+e^\lambda}\right) M_1 + pH\left(1 + \frac{\lambda T}{1+e^\lambda}\right)\right) , \\ D_{\beta f} &= D_\beta - \left(\left(FT - \frac{\beta T F^2 T}{1+e^\beta}\right) M_2 + pF\left(1 + \frac{\beta T}{1+e^\beta}\right)\right) \end{aligned}\right\} \qquad \ldots (10)$$

Further more, we suppose that the largest eigen-value for the following matrix :

$$\Lambda_0 = \begin{bmatrix} W_1 & W_2 \\ W_3 & W_4 \end{bmatrix}$$

is less than one, i.e :

$$q_{max} = \frac{W_1 + W_4 + \sqrt{(W_1+W_4)^2 + 4(W_2W_3 - W_1W_4)}}{2} \quad , \qquad \ldots (11)$$

where

$$W_1 = \left(HT - \frac{\lambda T \quad {}^2T}{1+e^\lambda}\right) K_1 + 2pH\left(1 + \frac{\lambda T}{1+e^\lambda}\right) K_3 \quad ,$$

$$W_2 = \left(HT - \frac{\lambda T \quad {}^2T}{1+e^\lambda}\right) K_2 + 2pH\left(1 + \frac{\lambda T}{1+e^\lambda}\right) K_4 \quad ,$$

$$W_3 = \left(FT - \frac{\beta T F^2 T}{1+e^\beta}\right) L_1 + 2pF\left(1 + \frac{\beta T}{1+e^\beta}\right) L_3 \quad ,$$

$$W_4 = \left(FT - \frac{\beta T \quad {}^2T}{1+e^\beta}\right) L_2 + 2pF\left(1 + \frac{\beta T}{1+e^\beta}\right) L_4 \quad ,$$

$$M_5 = \left(HT - \frac{\lambda T \quad {}^2T}{1+e^\lambda}\right) M_1 + 2pH\left(1 + \frac{\lambda T}{1+e^\lambda}\right) M_3 \quad ,$$

$$M_6 = \left(FT - \frac{\beta T F^2 T}{1+e^\beta}\right) M_2 + 2pF\left(1 + \frac{\beta T}{1+e^\beta}\right) M_4 \quad .$$

Approximation solution of (1).

The investigation of approximation solution of the system (1) will be introduced by the following theorem :

Theorem 1

If the system of nonlinear differential equations with pulse action (1) satisfy the inequalities (3) -- (8) and the conditions (9-10) then the sequences of functions :

$$x_{m+1}(t,x_o,y_o) = x_o + \int_0^t e^{\lambda(t-s)}[f\big(s,x_m(s,x_o,y_o),y_m(s,x_o,y_o)\big) - \\ - \int_0^T \frac{\lambda}{1+e^{\lambda T}} e^{\lambda(T-s)} f\big(s,x_m(s,x_o,y_o),y_m(s,x_o,y_o)\big)ds]ds + \\ + \sum_{0<t_i<t} e^{\lambda(T-s)} I_i\big(x_m(t,x_o,y_o),y_m(t,x_o,y_o)\big) - \\ - \frac{\lambda}{1+e^{\lambda T}} \sum_{i=1}^{p} e^{\lambda(T-s)} I_i\big(x_m(t,x_o,y_o),y_m(t,x_o,y_o)\big) \qquad \ldots (12)$$

with

$x_o(t,x_o) = x_o e^{\lambda t}$, $m = 0, 1, 2, \ldots\ldots,$

and

$$y_{m+1}(t,x_o,y_o) = y_o + \int_0^t e^{\beta(t-s)}[f\big(s,x_m(s,x_o,y_o),y_m(s,x_o,y_o)\big) - \\ - \int_0^T \frac{\beta}{1+e^{\beta T}} e^{\beta(T-s)} f\big(s,x_m(s,x_o,y_o),y_m(s,x_o,y_o)\big)ds]ds + \\ + \sum_{0<t_i<t} e^{\beta(T-s)} G_i\big(x_m(t,x_o,y_o),y_m(t,x_o,y_o)\big) - \\ - \frac{\beta}{1+e^{\beta T}} \sum_{i=1}^{p} e^{\beta(T-s)} G_i\big(x_m(t,x_o,y_o),y_m(t,x_o,y_o)\big) \qquad \ldots (13)$$

with

$y_o(t,x_o) = y_o e^{\beta t}$, $m = 0, 1, 2, \ldots\ldots,$

are periodic in t of period T, and are uniformly convergent as $m \to \infty$ in the domain :

$(t,x_o,y_o) \in R \times D_{\lambda f} \times D_{\beta f}$ . . . (14)

to the limit function $x_\infty(t,x_o,y_o)$ and $y_\infty(t,x_o,y_o)$ define in the domain (14), which is periodic in t of period T and satisfying the system of integral equations :

$$x(t,x_o,y_o) = x_o + \int_0^t e^{\lambda(t-s)}[f\big(s,x(s,x_o,y_o),y(s,x_o,y_o)\big) - \\ - \int_0^T \frac{\lambda}{1+e^{\lambda T}} e^{\lambda(T-s)} f\big(s,x(s,x_o,y_o),y(s,x_o,y_o)\big)ds]ds + \\ + \sum_{0<t_i<t} e^{\lambda(T-s)} I_i\big(x(t,x_o,y_o),y(t,x_o,y_o)\big) - \\ - \frac{\lambda}{1+e^{\lambda T}} \sum_{i=1}^{p} e^{\lambda(T-s)} I_i\big(x(t,x_o,y_o),y(t,x_o,y_o)\big) , \qquad \ldots (15)$$

and

$$y(t,x_o,y_o) = y_o + \int_0^t e^{\beta(t-s)}[f\big(s,x(s,x_o,y_o),y(s,x_o,y_o)\big) - \\ - \int_0^T \frac{\beta}{1+e^{\beta T}} e^{\beta(T-s)} f\big(s,x(s,x_o,y_o),y(s,x_o,y_o)\big)ds]ds +$$

$$+\sum_{0<t_i<t} e^{\beta(T-s)} G_i\big(x(t,x_o,y_o), y(t,x_o,y_o)\big) -$$

$$-\frac{\beta}{1+e^{\beta T}}\sum_{i=1}^{p} e^{\beta(T-s)} G_i\big(x(t,x_o,y_o), y(t,x_o,y_o)\big) \quad , \qquad \ldots (16)$$

which is a unique solutions of the system (1), provided that :

$$\|x^o(t,x_o,y_o)-x_o\| \le \left(HT-\frac{\lambda T^{\ 2}T}{1+e^{\lambda T}}\right)M_1 + 2pH\left(1+\frac{\lambda T}{1+e^{\lambda T}}\right)M_3 \qquad \ldots (17)$$

$$\|y^o(t,x_o,y_o)-y_o\| \le \left(FT-\frac{\beta T^{\ 2}T}{1+e^{\beta T}}\right)M_2 + 2pF\left(1+\frac{\beta T}{1+e^{\beta T}}\right)M_4 \qquad \ldots (18)$$

$$\begin{pmatrix} \|x_\infty(t,x_o,y_o)-x_m(t,x_o,y_o)\| \\ \|y_\infty(t,x_o,y_o)-y_m(t,x_o,y_o)\| \end{pmatrix} \le \Lambda_o^m (E-\Lambda_o)^{-1} V_o \quad , \qquad \ldots (19)$$

for all $t \in [0,T]$, $x_o \in D_{\lambda f}$, $y_o \in D_{\beta f}$, where E is identity matrix: and

$$V_o = \begin{pmatrix} \left(HT-\frac{\lambda T^{\ 2}T}{1+e^{\lambda T}}\right)M_1 + 2pH\left(1+\frac{\lambda T}{1+e^{\lambda T}}\right)M_3 \\ \left(FT-\frac{\beta T^{\ 2}T}{1+e^{\beta T}}\right)M_2 + 2pF\left(1+\frac{\beta T}{1+e^{\beta T}}\right)M_4 \end{pmatrix}$$

Proof :

Setting m = 0 and using (12) , and the condition (9), we get

$$\|x_1(t,x_o,y_o)-x_o\| = \int_0^t \|e^{\lambda(t-s)}\| \|f(s,x_o,y_o)\| ds -$$

$$-\frac{\lambda t}{1+e^{\lambda T}}\int_0^T \|e^{2\lambda(T-s)}\| \|f(s,x_o,y_o)\| ds + \sum_{0<t_i<t} \|e^{\lambda(T-s)}\| \|I_i(x_o,y_o)\| -$$

$$-\frac{\lambda t}{1+e^{\lambda T}}\sum_{i=1}^{p} \|e^{\lambda(T-s)}\| \|I_i(x_o,y_o)\|$$

$$\le \left\|H-\frac{\lambda t H^2}{1+e^{\lambda T}}\right\| \int_0^t \|f(s,x_o,y_o)\| ds - \frac{\lambda t H^2}{1+e^{\lambda T}}\int_0^T \|f(s,x_o,y_o)\| ds +$$

$$+H\sum_{0<t_i<t} \|I_i(x_o,y_o)\| - \frac{\lambda t H}{1+e^{\lambda T}}\sum_{i=1}^{p} \|I_i(x_o,y_o)\|$$

Hence

$$\|x_1(t,x_o,y_o)-x_o\| \le \left(HT-\frac{\lambda T H^2 T}{1+e^{\lambda T}}\right)M_1 + 2pH\left(1+\frac{\lambda T}{1+e^{\lambda T}}\right)M_3 \qquad \ldots (19)$$

So that $x_1(t,x_o,y_o) \in D_\lambda$, for all $t \in R'$, $x_o \in D_{\lambda f}$, and by mathematic induction we get :

$$\|x_m(t,x_o,y_o)-x_o\| \le \left(HT-\frac{\lambda T^{\ 2}T}{1+e^{\lambda T}}\right)M_1 + 2pH\left(1+\frac{\lambda T}{1+e^{\lambda T}}\right)M_3$$

and

$$\|y_1(t,x_o,y_o)-y_o\| \le \left(FT-\frac{\beta T F^2 T}{1+e^{\beta T}}\right)M_2 + 2pF\left(1+\frac{\beta T}{1+e^{\beta T}}\right)M_4 \qquad \ldots (20)$$

Hence $y_1(t,x_o,y_o) \in D_\beta$, for all $t \in R'$, $y_o \in D_{\beta f}$. and by mathematic induction we get :

$$\|y_m(t,x_o,y_o)-y_o\| \le \left(FT-\frac{\beta T F^2 T}{1+e^{\beta T}}\right)M_2 + 2pF\left(1+\frac{\beta T}{1+e^{\beta T}}\right)M_4$$

Then $x_m(t,x_o,y_o) \in D_\lambda$, $y_m(t,x_o,y_o) \in D_\beta$, $x_o \in D_{\lambda f}$, $y_o \in D_{\beta f}$.

We claim that the sequence of functions (12) and (13) are uniformly convergent on the domain (14).

By using (19), and when m = 1 , we get

$$\|x_2(t,x_o,y_o) - x_1(t,x_o,y_o)\| = \int_0^t \|e^{\lambda(t-s)}\| \|f(s,x_1,y_1)\| ds -$$
$$- \frac{\lambda t}{1+e^{\lambda T}} \int_0^t \|e^{2\lambda(T-s)}\| \|f(s,x_1,y_1)\| ds + \frac{\lambda t}{1+e^{\lambda T}} \int_0^T \|e^{2\lambda(T-s)}\| \|f(s,x_1,y_1)\| ds +$$
$$+ \sum_{0<t_i<t} \|e^{\lambda(T-s)}\| \|I_i(x_1,y_1)\| + \frac{\lambda t}{1+e^{\lambda T}} \sum_{i=1}^{p} \|e^{\lambda(T-s)}\| \|I_i(x_1,y_1)\| -$$
$$- \int_0^t \|e^{\lambda(t-s)}\| \|f(s,x_o,y_o)\| ds + \frac{\lambda t}{1+e^{\lambda T}} \int_0^t \|e^{2\lambda(T-s)}\| \|f(s,x_o,y_o)\| ds +$$
$$+ \frac{\lambda t}{1+e^{\lambda T}} \int_0^T \|e^{2\lambda(T-s)}\| \|f(s,x_o,y_o)\| ds - \sum_{0<t_i<t} \|e^{\lambda(T-s)}\| \|I_i(x_o,y_o)\| -$$
$$- \frac{\lambda t}{1+e^{\lambda T}} \sum_{i=1}^{p} \|e^{\lambda(T-s)}\| \|I_i(x_o,y_o)\| \quad ,$$

then

$$\|x_2(t,x_o,y_o) - x_1(t,x_o,y_o)\| \le \left[\left(HT - \frac{\lambda T \quad {}^2T}{1+e^{\lambda T}}\right) K_1 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right) K_3\right]$$
$$\|x_1(t,x_o,y_o) - x_o\| +$$
$$+ \left[\left(HT - \frac{\lambda T H^2 T}{1+e^{\lambda T}}\right) K_2 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right) K_4\right]$$
$$\|y_1(t,x_o,y_o) - y_o\| \qquad \ldots (21)$$

And by mathematic induction we get :

$$\|x_{m+1}(t,x_o,y_o) - x_m(t,x_o,y_o)\| \le \left[\left(HT - \frac{\lambda T H^2 T}{1+e^{\lambda T}}\right) K_1 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right) K_3\right]$$
$$\|x_m(t,x_o,y_o) - x_{m-1}(t,x_o,y_o)\| +$$
$$+ \left[\left(HT - \frac{\lambda T H^2 T}{1+e^{\lambda T}}\right) K_2 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right) K_4\right]$$
$$\|y_m(t,x_o,y_o) - y_{m-1}(t,x_o,y_o)\| \ , \qquad \ldots (22)$$

and

$$\|y_2(t,x_o,y_o) - y_1(t,x_o,y_o)\| \le \left[\left(FT - \frac{\beta T F^2 T}{1+e^{\lambda T}}\right) L_1 + 2pF\left(1 + \frac{\beta T}{1+e^{\lambda T}}\right) L_3\right]$$
$$\|x_1(t,x_o,y_o) - x_o\| +$$
$$+ \left[\left(FT - \frac{\beta T \quad {}^2T}{1+e^{\lambda T}}\right) L_2 + 2pF\left(1 + \frac{\beta T}{1+e^{\lambda T}}\right) L_4\right]$$
$$\|y_1(t,x_o,y_o) - y_o\| \qquad \ldots (23)$$

And by mathematic induction we get :

$$\|y_{m+1}(t,x_o,y_o) - y_m(t,x_o,y_o)\| \le \left[\left(HT - \frac{\lambda T \quad {}^2T}{1+e^{\lambda T}}\right) K_1 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right) K_3\right]$$
$$\|x_m(t,x_o,y_o) - x_{m-1}(t,x_o,y_o)\| +$$
$$+ \left[\left(HT - \frac{\lambda T \quad {}^2T}{1+e^{\lambda T}}\right) K_2 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right) K_4\right]$$
$$\|y_m(t,x_o,y_o) - y_{m-1}(t,x_o,y_o)\| \ , \qquad \ldots (24)$$

Rewrite inequalities (22) and (24) in vector form as :

$$V_{m+1}(t,x_o,y_o) \le \Lambda(t)\, V_m(t,x_o,y_o) \qquad \ldots (25)$$

where

$$V_{m+1}(t,x_o,y_o) = \begin{pmatrix} \|x_{m+1}(t,x_o,y_o) - x_m(t,x_o,y_o)\| \\ \|y_{m+1}(t,x_o,y_o) - y_m(t,x_o,y_o)\| \end{pmatrix}$$

$$\Lambda(t) = \begin{pmatrix} N_1(t) & N_3(t) \\ N_2(t) & N_4(t) \end{pmatrix}$$

where

$$N_1(t) = \left(HT - \frac{\lambda T \quad {}^2T}{1+e^{\lambda T}}\right)K_1 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right)K_3 \quad , \qquad W_1 = \max_{t\in[0,T]} N_1(t)$$

$$N_2(t) = \left(HT - \frac{\lambda T H^2 T}{1+e^{\lambda T}}\right)K_2 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right)K_4 \quad , \qquad W_2 = \max_{t\in[0,T]} N_2(t)$$

$$N_3(t) = \left(FT - \frac{\beta T \quad {}^2T}{1+e^{\lambda T}}\right)L_1 + 2pF\left(1 + \frac{\beta T}{1+e^{\lambda T}}\right)L_3 \quad , \qquad W_3 = \max_{t\in[0,T]} N_3(t)$$

$$N_4(t) = \left(FT - \frac{\beta T \quad {}^2T}{1+e^{\lambda T}}\right)L_2 + 2pF\left(1 + \frac{\beta T}{1+e^{\lambda T}}\right)L_4 \quad , \qquad W_4 = \max_{t\in[0,T]} N_4(t)$$

and

$$V_m(t,x_o,y_o) = \begin{pmatrix} \|x_m(t,x_o,y_o) - x_{m-1}(t,x_o,y_o)\| \\ \|y_m(t,x_o,y_o) - y_{m-1}(t,x_o,y_o)\| \end{pmatrix}$$

It follows form the inequality (25) that :

$$V_{m+1} \le \Lambda_o(t)\, V_m \qquad \ldots (26)$$

where

$$\Lambda_o = \max_{t\in[0,T]} |\Lambda(t)|$$

By iterating the inequality (3.20) , we find that

$$V_{m+1} \le \Lambda_o^m V_o$$

where

$$V_o = \begin{pmatrix} \left(HT - \frac{\lambda T H^2 T}{1+e^{\lambda T}}\right)M_1 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right)M_3 \\ \left(FT - \frac{\beta T F^2 T}{1+e^{\beta T}}\right)M_2 + 2pF\left(1 + \frac{\beta T}{1+e^{\beta T}}\right)M_4 \end{pmatrix}$$

which leads to the estimate

$$\sum_{i=1}^{m} V_i \le \sum_{i=1}^{m} \Lambda_o^{i-1} V_o \qquad \ldots (27)$$

Since the matrix Λ_o has eigen-values like as (12), then the series (27) is uniformly convergent, i.e.

$$\lim_{m\to\infty} \sum_{i=1}^{m} \Lambda_o^{i-1} V_o = \sum_{i=1}^{\infty} \Lambda_o^{i-1} V_o = (E - \Lambda_o)^{-1} V_o \qquad \ldots (28)$$

where E is a unity matrix.

The limiting relation (28) signifies a uniform convergent of the sequence $x_m(t,x_o,y_o)$ and $y_m(t,x_o,y_o)$ in the domain (14).

Let

$$\left.\begin{aligned} \lim_{m\to\infty} x_m(t,x_o,y_o) &= x_\infty(t,x_o,y_o) \\ \lim_{m\to\infty} y_m(t,x_o,y_o) &= y_\infty(t,x_o,y_o) \end{aligned}\right\} \qquad \ldots (29)$$

Since the sequences of functions $x_m(t,x_o,y_o)$ and $y_m(t,x_o,y_o)$ are periodic in t with period T, then the limiting of them are also periodic in t with period T, end thus $x_\infty(t,x_o,y_o) = x(t,x_o,y_o)$, $y_\infty(t,x_o,y_o) = y(t,x_o,y_o)$.

Also from (29) the following inequality

$$\begin{pmatrix} \|x_\infty(t,x_o,y_o) - x_m(t,x_o,y_o)\| \\ \\ \|y_\infty(t,x_o,y_o) - y_m(t,x_o,y_o)\| \end{pmatrix} \le \Lambda_o^m (E - \Lambda_o)^{-1} V_o \quad , \qquad \ldots (30)$$

is hold for $m \ge 1$, and hence

$x_\infty(t,x_o,y_o) = x(t,x_o,y_o)$, $y_\infty(t,x_o,y_o) = y(t,x_o,y_o)$

which are the solutions of the system (1).

Uniqueness of Solution of (1)

Let all assumptions and conditions of theorem 1 were given, then the two functions $x(t,x_o,y_o)$ and $y(t,x_o,y_o)$ are uniqueness of solution of (1) in the domain (14).

Proof :

Let

$$\begin{aligned} \hat{x}(t,x_o,y_o) = x_o &+ \int_0^t e^{\lambda(t-s)}[f\big(s,\hat{x}(s,x_o,y_o),\hat{y}(s,x_o,y_o)\big) - \\ &- \int_0^T \frac{\lambda}{1+e^{\lambda T}} e^{\lambda(T-s)} f\big(s,\hat{x}(s,x_o,y_o),\hat{y}(s,x_o,y_o)\big)ds]ds + \\ &+ \sum_{0<t_i<t} e^{\lambda(T-s)} I_i\big(\hat{x}(t,x_o,y_o),\hat{y}(t,x_o,y_o)\big) - \\ &- \frac{\lambda}{1+e^{\lambda T}} \sum_{i=1}^{p} e^{\lambda(T-s)} I_i\big(\hat{x}(t,x_o,y_o),\hat{y}(t,x_o,y_o)\big) \ , \qquad \ldots (31) \end{aligned}$$

and

$$\begin{aligned} \hat{y}(t,x_o,y_o) = y_o &+ \int_0^t e^{\beta(t-s)}[f\big(s,\hat{x}(s,x_o,y_o),\hat{y}(s,x_o,y_o)\big) - \\ &- \int_0^T \frac{\beta}{1+e^{\beta T}} e^{\beta(T-s)} f\big(s,\hat{x}(s,x_o,y_o),\hat{y}(s,x_o,y_o)\big)ds]ds + \\ &+ \sum_{0<t_i<t} e^{\beta(T-s)} G_i\big(\hat{x}(t,x_o,y_o),\hat{y}(t,x_o,y_o)\big) - \\ &- \frac{\beta}{1+e^{\beta T}} \sum_{i=1}^{p} e^{\beta(T-s)} G_i\big(\hat{x}(t,x_o,y_o),\hat{y}(t,x_o,y_o)\big) \quad , \qquad \ldots (32) \end{aligned}$$

are another solutions for the system (1), then we shall prove that $x(t,x_o,y_o) = \hat{x}(t,x_o,y_o)$, $y(t,x_o,y_o) = \hat{y}(t,x_o,y_o)$, and to do this we need to prove the following inequality by induction,

$$\begin{pmatrix} \|\hat{x}(t,x_o,y_o) - x_m(t,x_o,y_o)\| \\ \\ \|\hat{y}(t,x_o,y_o) - y_m(t,x_o,y_o)\| \end{pmatrix} \le \Lambda_o^m \begin{pmatrix} \|\hat{x}(t,x_o,y_o) - x_{m-1}(t,x_o,y_o)\| \\ \\ \|\hat{y}(t,x_o,y_o) - y_{m-1}(t,x_o,y_o)\| \end{pmatrix} \quad \ldots (33)$$

for $m \ge 1$, where

$$M_1^* = \max_{\substack{(x,y)\in D_\lambda \times D_\beta \\ t\in[0,T]}} \|f(t,x,y)\| \quad , \quad M_2^* = \max_{\substack{(x,y)\in D_\lambda \times D_\beta \\ t\in[0,T]}} \|g(t,x,y)\|$$

$$M_3^* = \max_{\substack{(x,y)\in D_\lambda \times D_\beta \\ 1\le i\le p}} \|I_i(x,y)\| \quad , \quad M_4^* = \max_{\substack{(x,y)\in D_\lambda \times D_\beta \\ 1\le i\le p}} \|G_i(x,y)\|$$

For m = 0 in (15) and (16), we have

$$\|\hat{x}(t,x_o,y_o) - x_o\| \le \left(HT - \frac{\lambda T \quad {}^2T}{1+e^{\lambda T}}\right) M_1^* + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right) M_3^* \qquad \ldots (34)$$

and

$$\|\hat{y}(t,x_o,y_o) - y_o\| \le \left(FT - \frac{\beta T F^2 T}{1+e^{\beta T}}\right) M_2^* + 2pF\left(1 + \frac{\beta T}{1+e^{\beta T}}\right) M_4^* \qquad \ldots (35)$$

and for m = 1, we get also

$$\begin{aligned}\|\hat{x}(t,x_o,y_o) - x_1(t,x_o,y_o)\| \le & \left[\left(HT - \frac{\lambda T \quad {}^2T}{1+e^{\lambda T}}\right) K_1 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right) K_3\right] \\ & \|\hat{x}(t,x_o,y_o) - x_o\| + \\ & + \left[\left(HT - \frac{\lambda T H^2 T}{1+e^{\lambda T}}\right) K_2 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right) K_4\right] \\ & \|\hat{y}(t,x_o,y_o) - y_o\| \qquad \ldots (36)\end{aligned}$$

and

$$\begin{aligned}\|\hat{y}(t,x_o,y_o) - y_1(t,x_o,y_o)\| \le & \left[\left(FT - \frac{\beta T \quad {}^2T}{1+e^{\lambda T}}\right) L_1 + 2pF\left(1 + \frac{\beta T}{1+e^{\lambda T}}\right) L_3\right] \\ & \|\hat{x}(t,x_o,y_o) - x_o\| + \\ & + \left[\left(FT - \frac{\beta T F^2 T}{1+e^{\lambda T}}\right) L_2 + 2pF\left(1 + \frac{\beta T}{1+e^{\lambda T}}\right) L_4\right] \\ & \|\hat{y}(t,x_o,y_o) - y_o\| \qquad \ldots (37)\end{aligned}$$

Suppose that (33) is true for m = p -1 , i.e.

$$\begin{pmatrix} \|\hat{x}(t,x_o,y_o) - x_{p-1}(t,x_o,y_o)\| \\ \\ \|\hat{y}(t,x_o,y_o) - y_{p-1}(t,x_o,y_o)\| \end{pmatrix} \le \Lambda_o^{p-1} \begin{pmatrix} \|\hat{x}(t,x_o,y_o) - x_{p-2}(t,x_o,y_o)\| \\ \\ \|\hat{y}(t,x_o,y_o) - y_{p-2}(t,x_o,y_o)\| \end{pmatrix} \ldots (38)$$

then

$$\begin{aligned}\|\hat{x}(t,x_o,y_o) - x_p(t,x_o,y_o)\| \le & \left[\left(HT - \frac{\lambda T H^2 T}{1+e^{\lambda T}}\right) K_1 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right) K_3\right] \\ & \|\hat{x}(t,x_o,y_o) - x_{p-1}(t,x_o,y_o)\| + \\ & + \left[\left(HT - \frac{\lambda T \quad {}^2T}{1+e^{\lambda T}}\right) K_2 + 2pH\left(1 + \frac{\lambda T}{1+e^{\lambda T}}\right) K_4\right] \\ & \|\hat{y}(t,x_o,y_o) - y_{p-1}(t,x_o,y_o)\|\end{aligned}$$

and

$$\begin{aligned}\|\hat{y}(t,x_o,y_o) - y_p(t,x_o,y_o)\| \le & \left[\left(FT - \frac{\beta T \quad {}^2T}{1+e^{\lambda T}}\right) L_1 + 2pF\left(1 + \frac{\beta T}{1+e^{\lambda T}}\right) L_3\right] \\ & \|\hat{x}(t,x_o,y_o) - x_{p-1}(t,x_o,y_o)\| + \\ & + \left[\left(FT - \frac{\beta T F^2 T}{1+e^{\lambda T}}\right) L_2 + 2pF\left(1 + \frac{\beta T}{1+e^{\lambda T}}\right) L_4\right] \\ & \|\hat{y}(t,x_o,y_o) - y_{p-1}(t,x_o,y_o)\|\end{aligned}$$

i.e.

$$\begin{pmatrix} \|\hat{x}(t,x_o,y_o) - x_p(t,x_o,y_o)\| \\ \\ \|\hat{y}(t,x_o,y_o) - y_p(t,x_o,y_o)\| \end{pmatrix} \le \Lambda_o^{p} \begin{pmatrix} \|\hat{x}(t,x_o,y_o) - x_{p-1}(t,x_o,y_o)\| \\ \\ \|\hat{y}(t,x_o,y_o) - y_{p-1}(t,x_o,y_o)\| \end{pmatrix}$$

Then the inequality (33) is true for m = 0, 1, 2, . . .

By iterating the inequality (33) gives :

$$\begin{pmatrix} \|\hat{x}(t,x_o,y_o) - x_m(t,x_o,y_o)\| \\ \\ \|\hat{y}(t,x_o,y_o) - y_m(t,x_o,y_o)\| \end{pmatrix} \le \Lambda_o^m \begin{pmatrix} \|\hat{x}(t,x_o,y_o) - x_{m-1}(t,x_o,y_o)\| \\ \\ \|\hat{y}(t,x_o,y_o) - y_{m-1}(t,x_o,y_o)\| \end{pmatrix}$$

But from the condition (11) we obtain $\Lambda_o^m \to 0$ as $m \to \infty$, hence, proceeding in the last inequality to the limit we obtain that $x(t,x_o,y_o) = \hat{x}(t,x_o,y_o)$ and $y(t,x_o,y_o) = \hat{y}(t,x_o,y_o)$ which proves that the two solutions $x(t,x_o,y_o)$ and $y(t,x_o,y_o)$ are unique, and this completes the proof of theorem 2.

Existence of solution of (1)

The problem of existence solution of the system (1) is uniquely connected with the existence of zero of the function $\Delta(0,x_o,y_o)$ and $\Delta^*(0,x_o,y_o)$, which has the form :

$$\Delta(0,x_o,y_o) = \frac{\lambda}{1+e^{\lambda T}}\Big[\int_0^T e^{\lambda(T-s)} f\big(t, x_\infty(t,x_o,y_o), y_\infty(t,x_o,y_o)\big)dt + \\ + \sum_{i=1}^{p} e^{\lambda(T-s)} I_i\big(x_\infty(t_i,x_o,y_o), y_\infty(t_i,x_o,y_o)\big)\Big] \qquad \ldots (39)$$

$$\Delta^*(0,x_o,y_o) = \frac{\beta}{1+e^{\beta T}}\Big[\int_0^T e^{\beta(T-s)} f\big(t, x_\infty(t,x_o,y_o), y_\infty(t,x_o,y_o)\big)dt + \\ + \sum_{i=1}^{p} e^{\beta(T-s)} G_i\big(x_\infty(t_i,x_o,y_o), y_\infty(t_i,x_o,y_o)\big)\Big] \qquad \ldots (40)$$

where $x_\infty(t,x_o,y_o)$ and $y_\infty(t,x_o,y_o)$ the sequence's limiting (12) and (13) successively, and this function is approximately determined from the sequence of functions:

$$\Delta_m(0,x_o,y_o) = \frac{\lambda}{1+e^{\lambda T}}\Big[\int_0^T e^{\lambda(T-s)} f\big(t, x_m(t,x_o,y_o), y_m(t,x_o,y_o)\big)dt + \\ + \sum_{i=1}^{p} e^{\lambda(T-s)} I_i\big(x_m(t_i,x_o,y_o), y_m(t_i,x_o,y_o)\big)\Big] \qquad \ldots (41)$$

$$\Delta_m^*(0,x_o,y_o) = \frac{\beta}{1+e^{\beta T}}\Big[\int_0^T e^{\beta(T-s)} f\big(t, x_m(t,x_o,y_o), y_m(t,x_o,y_o)\big)dt + \\ + \sum_{i=1}^{p} e^{\beta(T-s)} G_i\big(x_m(t_i,x_o,y_o), y_m(t_i,x_o,y_o)\big)\Big] \qquad \ldots (42)$$

where $m = 0, 1, 2, \ldots$

Theorem 3 :

Let all assumptions and conditions of theorem 1 were given, then the following inequality :

$$\begin{pmatrix} \|\Delta(0,x_o,y_o) - \Delta_m(0,x_o,y_o)\| \\ \\ \|\Delta^*(t,x_o,y_o) - \Delta_m^*(0,x_o,y_o\| \end{pmatrix} \le Q\,\Lambda_o^m (E-\Lambda_o)^{-1} V_o \qquad \ldots (43)$$

where

$$Q = \begin{pmatrix} \frac{\lambda HT}{1+e^{\lambda T}}K_1 + \frac{\lambda pH}{1+e^{\lambda T}}K_3 & \frac{\lambda HT}{1+e^{\lambda T}}K_2 + \frac{\lambda pH}{1+e^{\lambda T}}K_4 \\ \\ \frac{\beta FT}{1+e^{\beta T}}L_1 + \frac{\beta pF}{1+e^{\beta T}}L_3 & \frac{\beta FT}{1+e^{\beta T}}L_2 + \frac{\beta pF}{1+e^{\beta T}}L_4 \end{pmatrix}$$

Is holds for $m \ge 0$, $t \in [0,T]$, $x_o \in D_{\lambda f}$, $y_o \in D_{\beta f}$.

proof :

According to (39) and (41) , we have.

$$\| \Delta(0,x_o,y_o) - \Delta_m(0,x_o,y_o)\| \le \frac{\lambda}{1+e^{\lambda T}} \int_0^T \|e^{\lambda(T-s)}\| \| f\big(t, x_\infty(t,x_o,y_o), y_\infty(t,x_o,y_o)\big) - -f\big(t, x_m(t,x_o,y_o), y_m(t,x_o,y_o)\big)\| dt + + \frac{\lambda}{1+e^{\lambda T}} \sum_{i=1}^{p} \|e^{\lambda(T-s)}\| \| I_i\big(x_\infty(t_i,x_o,y_o), y_\infty(t_i,x_o,y_o)\big) - - I_i\big(x_m(t_i,x_o,y_o), y_m(t_i,x_o,y_o)\big)\| \le$$

$$\le \frac{\lambda HT}{1+e^{\lambda T}} [K_1 \|x_\infty(t,x_o,y_o) - x_m(t,x_o,y_o)\| + K_2 \|y_\infty(t,x_o,y_o) - y_m(t,x_o,y_o)\|] + + \frac{\lambda pH}{1+e^{\lambda T}} [K_3 \|x_\infty(t,x_o,y_o) - x_m(t,x_o,y_o)\| + K_4 \|y_\infty(t,x_o,y_o) - y_m(t,x_o,y_o)\|]$$

So that

$$\| \Delta(0,x_o,y_o) - \Delta_m(0,x_o,y_o)\| \le \left(\frac{\lambda HT}{1+e^{\lambda T}} K_1 + \frac{\lambda pH}{1+e^{\lambda T}} K_3\right) \|x_\infty(t,x_o,y_o) - x_m(t,x_o,y_o)\| + \left(\frac{\lambda HT}{1+e^{\lambda T}} K_2 + \frac{\lambda pH}{1+e^{\lambda T}} K_4\right) \|y_\infty(t,x_o,y_o) - y_m(t,x_o,y_o)\| \quad \ldots (44)$$

By the same method and by (40) and (42) , we have

$$\|\Delta^*(t,x_o,y_o) - \Delta_m^*(0,x_o,y_o\| \le \left(\frac{\beta FT}{1+e^{\beta T}} L_1 + \frac{\beta pF}{1+e^{\beta T}} L_3\right) \|x_\infty(t,x_o,y_o) - x_m(t,x_o,y_o)\| + \left(\frac{\beta FT}{1+e^{\beta T}} L_2 + \frac{\beta pF}{1+e^{\beta T}} L_4\right) \|y_\infty(t,x_o,y_o) - y_m(t,x_o,y_o)\| \quad \ldots (45)$$

And so on, rewrite the inequalities (44) and (45) in vector form as :

$$\begin{pmatrix} \| \Delta(0,x_o,y_o) - \Delta_m(0,x_o,y_o)\| \\ \\ \|\Delta^*(t,x_o,y_o) - \Delta_m^*(0,x_o,y_o\| \end{pmatrix} \le Q \begin{pmatrix} \|x_\infty(t,x_o,y_o) - x_m(t,x_o,y_o)\| \\ \\ \|y_\infty(t,x_o,y_o) - y_m(t,x_o,y_o)\| \end{pmatrix}$$

And by (30) , we get

$$\begin{pmatrix} \| \Delta(0,x_o,y_o) - \Delta_m(0,x_o,y_o)\| \\ \\ \|\Delta^*(t,x_o,y_o) - \Delta_m^*(0,x_o,y_o\| \end{pmatrix} \le Q\, \Lambda_o^m (E - \Lambda_o)^{-1} V_o$$

Theorem 4 :

Let the function $f(t,x,y)$ and $g(t,x,y)$ in the system (1) be defined on the intervals [a, b] and [c, d] respectively, and periodic in *t* with period *T*.

Let the sequence of functions (41) satisfying the next inequalities :

$$\left.\begin{array}{l} \min\ \Delta_m(0,x_o,y_o) \le -\delta_m \\ a + M_5 \le x_o \le b - M_5 \\ \\ \max\ \Delta_m(0,x_o,y_o) \ge \delta_m \\ a + M_5 \le x_o \le b - M_5 \end{array}\right\} \quad \ldots (46)$$

Let the sequence of functions (42) satisfying the next inequalities :

$$\left.\begin{array}{l} \min\ \Delta_m^*(0,x_o,y_o) \le -\varepsilon_m \\ c + M_6 \le y_o \le d - M_6 \\ \\ \max\ \Delta_m^*(0,x_o,y_o) \ge \varepsilon_m \ , \\ c + M_6 \le y_o \le d - M_6 \end{array}\right\} \quad \ldots (47)$$

for $m \ge 0$ where :

$$\delta_m = \left[\left(\frac{\lambda HT}{1+e^{\lambda T}} K_1 + \frac{\lambda pH}{1+e^{\lambda T}} K_3\right) + \left(\frac{\lambda HT}{1+e^{\lambda T}} K_2 + \frac{\lambda pH}{1+e^{\lambda T}} K_4\right)\right] \Lambda_o^m (E - \Lambda_o)^{-1} M_5 ,$$

$$\varepsilon_m = \left[\left(\frac{\beta FT}{1+e^{\beta T}} L_1 + \frac{\beta pF}{1+e^{\beta T}} L_3\right) + \left(\frac{\beta FT}{1+e^{\beta T}} L_2 + \frac{\beta pF}{1+e^{\beta T}} L_4\right)\right] \Lambda_o^m (E - \Lambda_o)^{-1} M_6$$

Then the system (1) has periodic solution of period T, $x = x(t, x_o, y_o)$ and $y = y(t, x_o, y_o)$ for which $a + M_5 \le x_o \le b - M_5$, $c + M_6 \le y_o \le d - M_6$.

Proof:

Let x_1 , x_2 be any two points in the interval $[a + M_5, b - M_5]$ such that :

$$\left.\begin{aligned} \Delta_m(0, x_1, y_1) &= \min_{a + M_5 \le x_o \le b - M_5} \Delta_m(0, x_o, y_o) \\ \Delta_m(0, x_2, y_2) &= \max_{a + M_5 \le x_o \le b - M_5} \Delta_m(0, x_o, y_o) \end{aligned}\right\} \quad \ldots (48)$$

Let y_1 , y_2 be any two points in the interval $[c + M_6, d - M_6]$ such that :

$$\left.\begin{aligned} \Delta^*_m(0, x_1, y_1) &= \min_{c + M_6 \le y_o \le d - M_6} \Delta^*_m(0, x_o, y_o) \\ \Delta^*_m(0, x_2, y_2) &= \max_{c + M_6 \le y_o \le d - M_6} \Delta^*_m(0, x_o, y_o) \end{aligned}\right\} \quad \ldots (49)$$

By (43) and (46), we get :

$$\left.\begin{aligned} \Delta(0, x_1, y_1) &= \Delta_m(0, x_1, y_1) + [\Delta(0, x_1, y_1) - \Delta_m(0, x_1, y_1)] < 0 \\ \Delta(0, x_2, y_2) &= \Delta_m(0, x_2, y_2) + [\Delta(0, x_2, y_2) - \Delta_m(0, x_2, y_2)] > 0 \end{aligned}\right\} \quad \ldots (50)$$

From (43) and (47), we get :

$$\left.\begin{aligned} \Delta^*(0, x_1, y_1) &= \Delta^*_m(0, x_1, y_1) + [\Delta^*(0, x_1, y_1) - \Delta^*_m(0, x_1, y_1)] < 0 \\ \Delta^*(0, x_2, y_2) &= \Delta^*_m(0, x_2, y_2) + [\Delta^*(0, x_2, y_2) - \Delta^*_m(0, x_2, y_2)] > 0 \end{aligned}\right\} \quad \ldots (51)$$

It follows from the functions (39) , (40) and the relations (50) , (51) in virtue of the continuity of the Δ-constant, that there exists $x_\infty = x_o$, $x_\infty \in [x_1, x_2]$ and $y_\infty = y_o$, $y_\infty \in [y_1, y_2]$ such that $\Delta(0, x_\infty, y_\infty) = 0$, $\Delta^*(0, x_\infty, y_\infty) = 0$. And this proved that the system (1) has a periodic solution $x = x(t, x_o, y_o)$ for $x_o \in [a + M_5, b - M_5]$and $y = y(t, x_o, y_o)$ for $y_o \in [c + M_6, d - M_6]$.

Remark 1 [6] :

When $R^n = R'$, i.e. when x is a scalar theorem 4 can be strengthens by giving up the requirement that the singular point shout be isolated, thus we have

Theorem 5 :

Let the function $\Delta(0, x_o, y_o)$ defined as $\Delta : D_{\lambda f} \to R'$

$$\Delta(0, x_o, y_o) = \frac{\lambda}{1 + e^{\lambda T}} \Big[\int_0^T e^{\lambda(T-s)} f\big(t, x_\infty(t, x_o, y_o), y_\infty(t, x_o, y_o)\big) dt + \\ + \sum_{i=1}^{p} e^{\lambda(T-s)} I_i\big(x_\infty(t_i, x_o, y_o), y_\infty(t_i, x_o, y_o)\big) \Big] \quad \ldots (52)$$

Let the function $\Delta^*(0, x_o, y_o)$ defined as $\Delta^* : D_{\beta f} \to R'$

$$\Delta^*(0, x_o, y_o) = \frac{\beta}{1 + e^{\beta T}} \Big[\int_0^T e^{\beta(T-s)} f\big(t, x_\infty(t, x_o, y_o), y_\infty(t, x_o, y_o)\big) dt + \\ + \sum_{i=1}^{p} e^{\beta(T-s)} G_i\big(x_\infty(t_i, x_o, y_o), y_\infty(t_i, x_o, y_o)\big) \Big] \quad \ldots (53)$$

where the functions $x_\infty(t, x_o, y_o)$ and $y_\infty(t, x_o, y_o)$ are the limit of a sequence of periodic functions (12) , (13) respectively, then the following inequalities are holds :

$$\|\Delta(0, x_o, y_o)\| \le \left(Ht - \frac{\lambda t H^2 T}{1 + e^{\lambda T}} \right) M_1 + 2pH \left(1 + \frac{\lambda t}{1 + e^{\lambda T}} \right) M_3 \quad \ldots (54)$$

$$\|\Delta^*(0,x_o,y_o)\| \le \left(Ft - \frac{\beta t\ \ ^2T}{1+e^{\beta T}}\right)M_2 + 2pF\left(1+\frac{\beta t}{1+e^{\beta T}}\right)M_4 \qquad \ldots (55)$$

$$\begin{aligned}\|\Delta(0,x_o^1,y_o^1) - \Delta(0,x_o^2,y_o^2)\| \le\ & \overline{W_1}(1-\overline{W_1}-\overline{W_2}\ \overline{W_3}(1-\overline{W_4})^{-1})^{-1}\,[\|x_o^1-x_o^2\| + \\ & +\overline{W_2}(1-\overline{W_4})^{-1}\|y_o^1-y_o^2\|] + \\ & +\overline{W_2}(1-\overline{W_4}-\overline{W_2}\ \overline{W_3}(1-\overline{W_1})^{-1})^{-1}\,[\|y_o^1-y_o^2\| + \\ & +\overline{W_3}(1-\overline{W_1})^{-1}\|x_o^1-x_o^2\|] \qquad \ldots (56)\end{aligned}$$

$$\begin{aligned}\|\Delta^*(0,x_o^1,y_o^1) - \Delta^*(0,x_o^2,y_o^2)\| \le\ & \overline{W_3}(1-\overline{W_1}-\overline{W_2}\ \overline{W_3}(1-\overline{W_4})^{-1})^{-1}\,[\|x_o^1-x_o^2\| + \\ & +\overline{W_2}(1-\overline{W_4})^{-1}\|y_o^1-y_o^2\|] + \\ & +\overline{W_4}(1-\overline{W_4}-\overline{W_2}\ \overline{W_3}(1-\overline{W_1})^{-1})^{-1}\,[\|y_o^1-y_o^2\| + \\ & +\overline{W_3}(1-\overline{W_1})^{-1}\|x_o^1-x_o^2\|] \qquad \ldots (57)\end{aligned}$$

where

$$\overline{W_1} = HT\left[\left(K_1 - \frac{\lambda T K_1}{1+e^{\lambda T}}\right) + \left(K_3 + \frac{\lambda K_3 p}{1+e^{\lambda T}}\right)\right],$$

$$\overline{W_2} = HT\left[\left(K_2 - \frac{\lambda T K_2}{1+e^{\lambda T}}\right) + \left(K_4 + \frac{\lambda K_4 p}{1+e^{\lambda T}}\right)\right],$$

$$\overline{W_3} = FT\left[\left(L_1 - \frac{\beta T L_1}{1+e^{\beta T}}\right) + \left(L_3 + \frac{\beta L_3 p}{1+e^{\beta T}}\right)\right],$$

$$\overline{W_4} = FT\left[\left(L_2 - \frac{\beta T\ \ ^2}{1+e^{\beta T}}\right) + \left(L_4 + \frac{\beta L_4 p}{1+e^{\beta T}}\right)\right],$$

for all x_o , x_o^1 , $x_o^2 \in D_{\lambda f}$ and y_o, y_o^1 , $y_o^2 \in D_{\beta f}$.

proof :

From the properties of the function $x_\infty(t,x_o,y_o)$ and $y_\infty(t,x_o,y_o)$ established by theorem 1, it follows that the functions $\Delta = \Delta(0,x_o,y_o)$ and $\Delta^* = \Delta^*(0,x_o,y_o)$ are continuous and bounded with the positive constants

$\left(Ht - \frac{\lambda t\ \ ^2T}{1+e^{\lambda T}}\right)M_1 + 2pH\left(1+\frac{\lambda t}{1+e^{\lambda T}}\right)M_3$ for $x_o \in D_{\lambda f}$, and

$\left(Ft - \frac{\beta t F^2 T}{1+e^{\beta T}}\right)M_2 + 2pF\left(1+\frac{\beta t}{1+e^{\beta T}}\right)M_4$ for $y_o \in D_{\beta f}$, respectively.

By using (52) , we have

$$\begin{aligned}\|\Delta(0,x_o^1,y_o^1) - \Delta(0,x_o^2,y_o^2)\| \le\ & \frac{\lambda}{1+e^{\lambda T}}\int_0^T \|e^{\lambda(T-s)}\|\big\|f\big(t,x_\infty(t,x_o^1,y_o^1),y_\infty(t,x_o^1,y_o^1)\big) - \\ & -f\big(t,x_\infty(t,x_o^2,y_o^2),y_\infty(t,x_o^2,y_o^2)\big)\big\|dt + \\ & + \frac{\lambda}{1+e^{\lambda T}}\sum_{i=1}^{p}\|e^{\lambda(T-s)}\|\big\|I_i\big(x_\infty(t_i,x_o^1,y_o^1),y_\infty(t_i,x_o^2,y_o^2)\big) - \\ & - I_i\big(x_\infty(t_i,x_o^1,y_o^1),y_\infty(t_i,x_o^2,y_o^2)\big)\big\| \le \\ \le\ & \frac{\lambda HT}{1+e^{\lambda T}}[K_1\|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| + K_2\|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\|] + \\ & + \frac{\lambda pH}{1+e^{\lambda T}}[K_3\|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| + K_4\|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\|]\end{aligned}$$

So that

$$\begin{aligned}\|\Delta(0,x_o^1,y_o^1) - \Delta(0,x_o^2,y_o^2)\| \le\ & \frac{\lambda H}{1+e^{\lambda T}}[(TK_1+pK_3)\|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| + \\ & +(TK_2+pK_4)\|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\|] \quad \ldots (58)\end{aligned}$$

And we will find by the same method and by (53) , we have :

$$\begin{aligned}\|\Delta^*(0,x_o^1,y_o^1) - \Delta^*(0,x_o^2,y_o^2)\| \le\ & \frac{\beta F}{1+e^{\lambda T}}[(TL_1+pL_3)\|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| + \\ & +(TL_2+pL_4)\|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\|] \quad \ldots (59)\end{aligned}$$

where $x_\infty(t,x_o^1,y_o^1)$, $x_\infty(t,x_o^2,y_o^2)$ and $y_\infty(t,x_o^1,y_o^1)$, $y_\infty(t,x_o^2,y_o^2)$ are the solutions of the following integral equations :

$$x(t,x_o^k,y_o^k) = x_o^k + \int_0^t e^{\lambda(t-s)}[f\left(s,x(s,x_o^k,y_o^k),y(s,x_o^k,y_o^k)\right) -$$
$$- \int_0^T \frac{\lambda}{1+e^{\lambda T}} e^{\lambda(T-s)} f\left(s,x(s,x_o^k,y_o^k),y(s,x_o^k,y_o^k)\right) ds]ds +$$
$$+ \sum_{0<t_i<t} e^{\lambda(T-s)} I_i\left(x(t_i,x_o^k,y_o^k),y(t_i,x_o^k,y_o^k)\right) -$$
$$- \frac{\lambda}{1+e^{\lambda T}} \sum_{i=1}^{p} e^{\lambda(T-s)} I_i\left(x(t_i,x_o^k,y_o^k),y(t_i,x_o^k,y_o^k)\right) , \qquad \ldots (60)$$

and

$$y(t,x_o^k,y_o^k) = y_o^k + \int_0^t e^{\beta(t-s)}[f\left(s,x(s,x_o^k,y_o^k),y(s,x_o^k,y_o^k)\right) -$$
$$- \int_0^T \frac{\beta}{1+e^{\beta T}} e^{\beta(T-s)} f\left(s,x(s,x_o^k,y_o^k),y(s,x_o^k,y_o^k)\right) ds]ds +$$
$$+ \sum_{0<t_i<t} e^{\beta(T-s)} G_i\left(x(t_i,x_o^k,y_o^k),y(t_i,x_o^k,y_o^k)\right) -$$
$$- \frac{\beta}{1+e^{\beta T}} \sum_{i=1}^{p} e^{\beta(T-s)} G_i\left(x(t_i,x_o^k,y_o^k),y(t_i,x_o^k,y_o^k)\right) , \qquad \ldots (61)$$

where $k = 1,2$

From (60) , we have

$$\|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| = x_o^1 + \int_0^t e^{\lambda(t-s)}[f\left(s,x_\infty(s,x_o^1,y_o^1),y_\infty(s,x_o^1,y_o^1)\right) -$$
$$- \int_0^T \frac{\lambda}{1+e^{\lambda T}} e^{\lambda(T-s)} f\left(s,x_\infty(s,x_o^1,y_o^1),y_\infty(s,x_o^1,y_o^1)\right) ds]ds +$$
$$+ \sum_{0<t_i<t} e^{\lambda(T-s)} I_i\left(x_\infty(t_i,x_o^1,y_o^1),y_\infty(t_i,x_o^1,y_o^1)\right) -$$
$$- \frac{\lambda}{1+e^{\lambda T}} \sum_{i=1}^{p} e^{\lambda(T-s)} I_i\left(x_\infty(t_i,x_o^1,y_o^1),y_\infty(t_i,x_o^1,y_o^1)\right) -$$
$$- x_o^2 - \int_0^t e^{\lambda(t-s)}[f\left(s,x_\infty(s,x_o^2,y_o^2),y_\infty(s,x_o^2,y_o^2)\right) -$$
$$- \int_0^T \frac{\lambda}{1+e^{\lambda T}} e^{\lambda(T-s)} f\left(s,x_\infty(s,x_o^2,y_o^2),y_\infty(s,x_o^2,y_o^2)\right) ds]ds -$$
$$- \sum_{0<t_i<t} e^{\lambda(T-s)} I_i\left(x_\infty(t_i,x_o^2,y_o^2),y_\infty(t_i,x_o^2,y_o^2)\right) +$$
$$+ \frac{\lambda}{1+e^{\lambda T}} \sum_{i=1}^{p} e^{\lambda(T-s)} I_i\left(x_\infty(t_i,x_o^2,y_o^2),y_\infty(t,x_o^2,y_o^2)\right) \le$$
$$\le \|x_o^1 - x_o^2\| + HK_1 t\, \|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| +$$
$$+ HK_2 t\, \|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\| + \frac{\lambda t HTK_1}{1+e^{\lambda T}} \|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| +$$
$$+ \frac{\lambda t HT}{1+e^{\lambda T}}^2 \|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\| + HK_3 t\, \|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| +$$

$$+ HK_4 t \, \|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\| + \frac{\lambda t H T K_3}{1+e^{\lambda T}} p \|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| +$$

$$+ \frac{\lambda t H T K_4}{1+e^{\lambda T}} p \|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\|$$

$$\leq \|x_o^1 - x_o^2\| + Ht \left(K_1 + \frac{\lambda T \;\; {}_1}{1+e^{\lambda T}} + K_3 + \frac{\lambda T K_3 p}{1+e^{\lambda T}}\right) \|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| +$$

$$+ \; Ht \left(K_2 + \frac{\lambda T K_2}{1+e^{\lambda T}} + K_4 + \frac{\lambda T \;\; {}_4 p}{1+e^{\lambda T}}\right) \|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\| \quad \ldots (62)$$

By the same method and by (61), we find :

$$\|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\| \leq \|y_o^1 - y_o^2\| +$$

$$+ \; Ft \left(L_1 + \frac{\beta T L_1}{1+e^{\beta T}} + L_3 + \frac{\beta T L_3 p}{1+e^{\beta T}}\right) \|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| +$$

$$+ \; Ft \left(L_2 + \frac{\beta T L_2}{1+e^{\beta T}} + L_4 + \frac{\beta T \;\; {}_4 p}{1+e^{\beta T}}\right) \|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\| \quad \ldots (63)$$

From (62), we have:

$$\|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| \leq \left(1 - Ht \left(K_1 + \frac{\lambda T K_1}{1+e^{\lambda T}} + K_3 + \frac{\lambda T K_3 p}{1+e^{\lambda T}}\right)\right)^{-1}$$

$$\left(\|x_o^1 - x_o^2\| + Ht \left(K_2 + \frac{\lambda T K_2}{1+e^{\lambda T}} + K_4 + \frac{\lambda T K_4 p}{1+e^{\lambda T}}\right) \|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\|\right) \quad \ldots (64)$$

By (63), we have :

$$\|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\| \leq \left(1 - Ft \left(L_2 + \frac{\beta T L_2}{1+e^{\beta T}} + L_4 + \frac{\beta T L_4 p}{1+e^{\beta T}}\right)\right)^{-1}$$

$$\left(\|y_o^1 - y_o^2\| + Ft \left(L_1 + \frac{\beta T L_1}{1+e^{\beta T}} + L_3 + \frac{\beta T \;\; {}_3 p}{1+e^{\beta T}}\right) \|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\|\right) \quad \ldots (65)$$

By substitute (65) in (64) , we obtain : $\overline{W_3}(1-\overline{W_4})^{-1}$

$$\|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| \leq \|x_o^1 - x_o^2\| + \overline{W_1}\|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| +$$
$$+ \overline{W_2}(1-\overline{W_4})^{-1}(\|y_o^1 - y_o^2\| + \overline{W_3}\|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\|)$$

So that

$$\|x_\infty(t,x_o^1,y_o^1) - x_\infty(t,x_o^2,y_o^2)\| \leq (1 - \overline{W_1} - \overline{W_2}\,\overline{W_3}(1-\overline{W_4})^{-1})^{-1}(\|x_o^1 - x_o^2\| +$$
$$+\overline{W_2}(1-\overline{W_4})^{-1}\|y_o^1 - y_o^2\|) \quad \ldots (66)$$

And also, we have

$$\|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\| \leq \|y_o^1 - y_o^2\| + \overline{W_4}\|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\| +$$
$$+ \overline{W_3}(1-\overline{W_1})^{-1}(\|x_o^1 - x_o^2\| + \overline{W_2}\|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\|)$$

So that

$$\|y_\infty(t,x_o^1,y_o^1) - y_\infty(t,x_o^2,y_o^2)\| \leq (1 - \overline{W_4} - \overline{W_2}\,\overline{W_3}(1-\overline{W_1})^{-1})^{-1}(\|y_o^1 - y_o^2\| +$$
$$+\overline{W_3}(1-\overline{W_1})^{-1}\|x_o^1 - x_o^2\|) \quad \ldots (67)$$

Now by substitute (66) and (67) in (58) and (59), we obtain on (56) and (57) respectively.

Remark 2 [1]:

The theorem 5 to ensure solution's to the system (1), in view of to happen small change in the point x_0 , to requite small change on the function's behavior $\Delta = \Delta(t, x_0, y_0)$.

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پوختە

دڤێ ڤەکولینێ دا ، خواندنا هەبوون و نزیکبوونا شیکارێ خولەکی بو سیستەمێ ژ هاوکێشەیێن تەواوکاری – جیاکارییێن نە هێلی ( ). و هەروسا پشتبەستنێ ب رێکا ڤەڤارتنێن ژمارەیی یێ بو خواندنا شیکارێن خولەکی ژ هاوکێشەیێن جیاکارییێن ێن سادەیێن نە هێلی ێت (Samoilenko A. M.) .

الخلاصة

يتضمن هذا البحث دراسة وجود وتقارب الحل الدوري لنظام مكن المعادلات التكاملية – التفاضلية اللاخطية ذات التأثير النبضي مع المعالم. وذلك بالاعتماد على الطريقة التحليلية – العددية لدراسة الحلول الدورية للمعدلات الاعتيادية لـ Samoilenko.

ON FUZZY COMPLEX SEQUENCES

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ABSTRACT

In this paper we define and study the concepts of complement normalized fuzzy numbers (CNFNs), bounded closed complex CNFNs (BCCCNFNs), and sequences of BCCCNFNs in terms of γ-level and some generalizations of them are given. The concepts of fuzzy distance $\tilde{\xi}$, $\tilde{\Pi}$, and $\tilde{\Gamma}$ of CNFNs, generalized CNFNs, and generalized BCCCNFNs are also introduced and studied, so that some basic properties and some characterizations are presented that play an important role in studying fuzzy complex sequences.

KEYWORDS: Bounded closed complex fuzzy numbers, Distance, Convergences.

1. INTRODUCTION

The concept of fuzzy sets and fuzzy numbers was first introduced by Zadeh [25, 26] in 1965 and 1975. Many authors have interested in the study of the theory of fuzzy numbers (see [1, 2, 12, 21, 23]). It is well known that fuzzy complex numbers and fuzzy complex analysis were first introduced by Buckley [2, 3, 4] in 1989 – 1992. He gave some elementary properties of fuzzy complex numbers and fuzzy complex analysis, Buckley in [4] suggested that introducing a metric on the space of fuzzy complex numbers provide to study convergence, continuity and differentiation of fuzzy complex function (see [7-8, 10-11, 13-16, 22, 24, 27]). Several scholars have extensively studied the theory of fuzzy complex numbers and fuzzy complex analysis (see [5, 6, 9,17-20, 28]).

A fuzzy set $\tilde{A}$ defined on the universal set X is a function $\mu(\tilde{A},x) : X \to [0,1]$. Frequently, we will write $\tilde{A}(x)$ instead of $\mu(\tilde{A},x)$. The family of all fuzzy sets in X is denoted by $\mathcal{F}(X)$. The strong α–level of a fuzzy set $\tilde{A}$, denoted by ${}^{\alpha+}\tilde{A}$, is the non-fuzzy set of all elements of the universal set that belongs to the fuzzy set $\tilde{A}$ at least to the degree $\alpha \in [0,1]$. The weak α–level ${}^{\alpha-}\tilde{A}$ of a fuzzy set $\tilde{A} \in \mathcal{F}(X)$ is the crisp set that contains all elements of the universal set whose membership grades in the given set are greater than but do not include the specified value of α. The largest value of α for which the α-level is not empty is called the height of a fuzzy set $\tilde{A}$ denoted $\alpha_{\tilde{A}}^{max}$. The core of a fuzzy set $\tilde{A}$ is the non-fuzzy set of all points in the universal set X at which $\sup_x \tilde{A}(x)$ is essentially attained. Let $\tilde{A}_i \in \mathcal{F}(X)$. Then the union of fuzzy sets $\tilde{A}_i$, denoted $\bigcup_i \tilde{A}_i$, is defined by $(\bigcup_i \tilde{A}_i)(x) = \sup_x \tilde{A}_i(x) = \bigvee_x \tilde{A}_i(x)$, the intersection of fuzzy sets $\tilde{A}_i$, denoted $\bigcap_i \tilde{A}_i$, is defined by $(\bigcap_i \tilde{A}_i)(x) = \inf_x \tilde{A}_i(x) = \bigwedge_x \tilde{A}_i(x)$, and the complement of $\tilde{A}_i$, denoted $\neg\tilde{A}_i$, is defined by $\tilde{A}_i(x) + \neg\tilde{A}_i(x) = 1$, for all x in the universal set X.

A fuzzy number $\tilde{a}$ is a fuzzy set defined on the set of real numbers R^1 characterized by means of a membership function $\tilde{a}(x): R^1 \to [0,1]$, which satisfies: (1) $\tilde{a}$ is upper semicontinuous, (2) $\mu_{\tilde{a}}(x) = 0$ outside some interval $[c,d]$, (3) There are real numbers a, b such that $c \le a \le b \le d$ and $\mu_{\tilde{a}}(x)$ is increasing on $[c,a]$, $\mu_{\tilde{a}}(x)$ is decreasing on $[b,d]$, $\mu_{\tilde{a}}(x) = 1$, $a \le x \le b$. We denote the set of all fuzzy numbers by $\mathcal{F}^{\star}$. $\hat{Z}$ is a fuzzy complex number if and only if (1) $\mu_{\hat{Z}}(z)$ is continuous; (2) ${}^{\alpha-}\hat{Z}, 0 \le \alpha < 1,$ is open, bounded, connected and simply connected; and (3) ${}^{1+}\hat{Z}$ is non-empty, compact, arcwise connected, and simply connected. We use $\mathcal{F}^{\star\star}$ to the set of all fuzzy complex numbers.

2. OPERATIONS ON COMPLEX CNFNS

In this section, the concepts of BCCCNFNs, generalized rectangular valued BCCCNFNs (GRVBCCCNFNs), and other related objects are introduced and some characterizations are given. The properties of extended operations have been investigated.

Definition 2.1. CNFN $\tilde{\mu}$ is a fuzzy set $\tilde{\mu}$ of the real line, such that core of $\neg\tilde{\mu}$ is empty and ${}^{\gamma+}\neg\tilde{\mu} = \begin{cases} \{u: \mu_{\neg\tilde{\mu}}(u) \geq \gamma\} & \text{if } \gamma \in (0, \alpha_{\neg\tilde{\mu}}^{max}] \\ \bigcup_{0\leq\gamma\leq\alpha_{\neg\tilde{\mu}}^{max}} {}^{\gamma-}\neg\tilde{\mu} & \text{if } \gamma = 0 \end{cases}$ is compact. We use $\tilde{\mathcal{F}}_{\neg N}^{*}$ for the fuzzy power set of CNFNs.

Definition 2.2. For CNFNs $\tilde{\mu}$ and $\tilde{\lambda}$ with membership functions $\mu(\tilde{\mu}, \mu_1)$ and $\mu(\tilde{\lambda}, \lambda_1)$, respectively, we call $\tilde{Z} = \tilde{\mu} \boxplus i\,\tilde{\lambda}$ a BCCCNFN with membership function $\mu(\tilde{Z}, z) = \mu(\tilde{\mu}, \mu_1) \wedge \mu(\tilde{\lambda}, \lambda_1)$, where $z = \mu_1 + i\,\lambda_1$ and we denote by $\tilde{\mathcal{F}}_{\neg N}^{**}$ the class of all the BCCCNFNs.

Definition 2.3. For BCCCNFNs $\tilde{Z} = \tilde{\mu} \boxplus i\,\tilde{\lambda}, \widetilde{W} = \tilde{\gamma} \boxplus i\,\tilde{\beta}$, and $\gamma \in I_{[0}^{1[} := (0, \alpha_{\tilde{Z}}^{max}]$ we define ${}^{\gamma+}\tilde{Z}$ and $\tilde{Z} \boxed{*} \widetilde{W}$ respectively as follows ${}^{\gamma+}\tilde{Z} = {}^{\gamma+}\tilde{\mu} \times {}^{\gamma+}\tilde{\lambda}$, $\tilde{Z} \boxed{*} \widetilde{W} = (\tilde{\mu} \boxed{*} \tilde{\gamma}) \times (\tilde{\lambda} \boxed{*} \tilde{\beta})$.

Theorem 2.4. For BCCCNFNs $\tilde{Z} = \tilde{\mu} \boxplus i\,\tilde{\lambda}, \widetilde{W} = \tilde{\gamma} \boxplus i\,\tilde{\beta}$, and $\gamma \in I_{[0}^{1[}$ we have ${}^{\gamma+}(\tilde{Z} \boxed{*} \widetilde{W}) = {}^{\gamma+}\tilde{Z} * {}^{\gamma+}\widetilde{W}$.

Proof: ${}^{\gamma+}(\tilde{Z} \boxed{*} \widetilde{W}) = {}^{\gamma+}(\tilde{\mu} \boxed{*} \tilde{\gamma}) \times {}^{\gamma+}(\tilde{\lambda} \boxed{*} \tilde{\beta})$
$= {}^{\gamma+}\tilde{\mu} \circledast_{int} {}^{\gamma+}\tilde{\gamma} \times {}^{\gamma+}\tilde{\lambda} \circledast_{int} {}^{\gamma+}\tilde{\beta}$
$= {}^{\gamma+}\tilde{\mu} \times {}^{\gamma+}\tilde{\lambda} * {}^{\gamma+}\tilde{\gamma} \times {}^{\gamma+}\tilde{\beta}$

Definition 2.5. The fuzzy conjugate $\tilde{Z}^{\circ}$ of BCCCNFN $\tilde{Z} = \tilde{\mu} \boxplus i\,\tilde{\lambda}$ is defined as $\mu(\tilde{Z}^{\circ} = \tilde{\mu} \boxminus i\,\tilde{\lambda}, z) = \mu(\tilde{Z}, z^{\circ} = \mu - i\,\lambda)$.

Definition 2.6. The fuzzy modulus $\widetilde{W}^{*}$ of BCCCNFN $\widetilde{W}$ is defined by $\mu(\widetilde{W}^{*}, w) = \wedge\{\mu(\widetilde{W}, z = \mu + i\,\lambda) : w = z^{*} = (\mu^2 + \lambda^2)^{0.5}\}$.

Definition 2.7. For every $\tilde{Z}, \widetilde{W} \in \tilde{\mathcal{F}}_{\neg N}^{**}$, we say that $\tilde{\mu} \boxplus i\,\tilde{\lambda} = \tilde{Z} = \widetilde{W} = \tilde{\gamma} \boxplus i\,\tilde{\beta}$ if ${}^{\gamma+}\tilde{\mu} = {}^{\gamma+}\tilde{\gamma}$ and ${}^{\gamma+}\tilde{\lambda} = {}^{\gamma+}\tilde{\beta}$. We say that $\tilde{Z} < \widetilde{W}$ if ${}^{\gamma+}\tilde{\mu}^{-} > {}^{\gamma+}\tilde{\gamma}^{-}$, ${}^{\gamma+}\tilde{\mu}^{+} < {}^{\gamma+}\tilde{\gamma}^{+}$, ${}^{\gamma+}\tilde{\lambda}^{+} < {}^{\gamma+}\tilde{\beta}^{+}$ and ${}^{\gamma+}\tilde{\lambda}^{-} > {}^{\gamma+}\tilde{\beta}^{-}$.

Definition 2.8. Let $\tilde{Z}$ be a BCCCNFN and f be an unary operation from complex field $\mathbb{C}$ into $\mathbb{C}$. Based on extension principle we define $f(\tilde{Z})$ as

$$f(\tilde{Z}) = \left(f(\neg\tilde{Z})\right)_{\neg} = \left(\left(f(N\neg\tilde{Z})\right)_{N}\right)_{\neg}$$

here N denotes the normalized set.

Theorem 2.9. Let $\tilde{Z}$ be a BCCCNFN and f be an unary operation from complex field $\mathbb{C}$ into $\mathbb{C}$, then $\mu(f(\tilde{Z}), w) = \wedge_{w=f(z)}\mu(\tilde{Z}, z)$.

Proof: We have $\mu\left(\left(\left(f(N\neg\tilde{Z})\right)_{N}\right)_{\neg}, w\right) = 1 - \mu(f(N\neg\tilde{Z}), w)$

$$\begin{aligned} &= 1 - \vee_{w=f(z)}\mu(N\neg\tilde{Z}, z) \\ &= 1 - \vee_{w=f(z)}\left(1 - \mu(\tilde{Z}, z)\right) \\ &= 1 - \left(1 - \wedge_{w=f(z)}\mu(\tilde{Z}, z)\right) \\ &= \wedge_{w=f(z)}\mu(\tilde{Z}, z) \end{aligned}$$

Theorem 2.10. Let $\tilde{Z}, \widetilde{W} \in \tilde{\mathcal{F}}_{\neg N}^{**}$ and $f(z', z'') = w$ be any mapping from $\mathbb{C} \times \mathbb{C}$ into $\mathbb{C}$, then $\mu(\tilde{Z} \boxed{*} \widetilde{W}, w) = \wedge_{f(z',z'')=w}\left(\mu(\tilde{Z}, z') \vee \mu(\widetilde{W}, z'')\right)$.

Proof: Suppose that $\mu(N\neg\tilde{Z} \circledast N\neg\widetilde{W}, w)$ attains its value at (z_0', z_0''). That is, $\mu(N\neg\tilde{Z} \circledast N\neg\widetilde{W}, w) = \vee_{f(z_0',z_0'')=w}\left(\mu(N\neg\tilde{Z}, z_0') \wedge \mu(N\neg\widetilde{W}, z_0'')\right) = \mu(N\neg\tilde{Z}, z_0') \wedge \mu(N\neg\widetilde{W}, z_0'')$.

If $\mu(N\neg\tilde{Z}, z_0') \wedge \mu(N\neg\widetilde{W}, z_0'') = \mu(N\neg\widetilde{W}, z_0'')$ then $\mu(N\neg\widetilde{W}, z_0'') \leq \mu(N\neg\tilde{Z}, z_0')$ and for each (z', z'') so that $f(z', z'') = w$, we have $\mu(N\neg\widetilde{W}, z_0'') \geq \mu(N\neg\tilde{Z}, z') \wedge \mu(N\neg\widetilde{W}, z'')$. Implies $1 - \mu(N\neg\widetilde{W}, z_0'') \geq 1 - \mu(N\neg\tilde{Z}, z_0')$ and for each (z', z'') so that $f(z', z'') = w$, we have $1 - \mu(N\neg\widetilde{W}, z_0'') \leq \left(1 - \mu(N\neg\tilde{Z}, z') \vee 1 - \mu(N\neg\widetilde{W}, z'')\right)$. That is, $1 - \mu(N\neg\widetilde{W}, z_0'') = \wedge_{f(z',z'')=w}\left(\left(1 - \mu(N\neg\tilde{Z}, z')\right) \vee \left(1 - \mu(N\neg\widetilde{W}, z'')\right)\right)$.

If $\mu(N\neg\tilde{Z}, z_0') \wedge \mu(N\neg\widetilde{W}, z_0'') = \mu(N\neg\tilde{Z}, z_0')$, a similar proof could be given.

Now, $\mu\left(\left(\left(N\neg\tilde{Z} \circledast N\neg\widetilde{W}\right)_{N}\right)_{\neg}, w\right) = 1 - \mu(N\neg\tilde{Z} \circledast N\neg\widetilde{W}, w)$

$= 1 - \left(1 - \wedge_{f(z',z'')=w}\left(\left(1 - \mu(N\neg\tilde{Z}, z')\right) \vee \left(1 - \mu(N\neg\widetilde{W}, z'')\right)\right)\right)$

$= \wedge_{f(z',z'')=w}\left(\left(1 - \mu(N\neg\tilde{Z}, z')\right) \vee \left(1 - \mu(N\neg\widetilde{W}, z'')\right)\right)$

$= \wedge_{f(z',z'')=w}\left(\mu(\tilde{Z}, z') \vee \mu(\widetilde{W}, z'')\right)$

Theorem 2.11. Let $\tilde{Z}, \widetilde{W} \in \tilde{\mathcal{F}}^{**}_{\neg N}$ and $*$ is the four basic arithmetic operations, then $\left(\tilde{Z} \boxed{*} \widetilde{W}\right)^{\circ} = \tilde{Z}^{\circ} \boxed{*} \widetilde{W}^{\circ}$ and $\widetilde{W}^{\circ\circ} = \widetilde{W}$.

Proof: $\mu\left(\left(\tilde{Z} \boxed{*} \widetilde{W}\right)^{\circ}, w\right) = \mu\left(\tilde{Z} \boxed{*} \widetilde{W}, w^{\circ}\right)$

$= \wedge_{z'^{\circ} * z''^{\circ} = w^{\circ}}\left(\mu(\tilde{Z}, z'^{\circ}) \vee \mu(\widetilde{W}, z''^{\circ})\right)$

$= \wedge_{z' * z'' = w}\left(\mu(\tilde{Z}^{\circ}, z') \vee \mu(\widetilde{W}^{\circ}, z'')\right)$

$= \mu\left(\tilde{Z}^{\circ} \boxed{*} \widetilde{W}^{\circ}, w\right)$

Second, $\mu\left(\widetilde{W}^{\circ\circ}, w\right) = \mu\left(\widetilde{W}^{\circ}, w^{\circ}\right) = \mu\left(\widetilde{W}, w^{\circ\circ}\right) = \mu\left(\widetilde{W}, w\right)$.

Theorem 2.12. If $\tilde{Z}, \widetilde{W}$ are BCCCNFNs and $\divideontimes \in \{\cdot, \div\}$, then we have $\left(\tilde{Z} \boxplus \widetilde{W}\right)^{*} \preccurlyeq \tilde{Z}^{*} \boxplus \widetilde{W}^{*}$ and $\left(\tilde{Z} \boxed{\divideontimes} \widetilde{W}\right)^{*} = \tilde{Z}^{*} \boxed{\divideontimes} \widetilde{W}^{*}$.

Proof: $\mu\left(\tilde{Z}^{*} \boxplus \widetilde{W}^{*}, w\right) = \wedge\left\{\mu(\tilde{Z}^{*}, z_1) \vee \mu(\widetilde{W}^{*}, z_2) : w = z_1 + z_2\right\}$

$= \wedge\left\{\wedge\left\{\mu(\tilde{Z}, z') : z_1 = z'^{*}\right\} \vee \wedge\left\{\mu(\widetilde{W}, z'') : z_2 = z''^{*}\right\} : w = z_1 + z_2\right\}$

$= \wedge\left\{\wedge\left\{\mu(\tilde{Z}, z_1) \vee \mu(\widetilde{W}, z_2) : z_1 = z'^{*}, z_2 = z''^{*}\right\} : w = z_1 + z_2\right\}$

$= \wedge\left\{\wedge\left\{\left(\mu(\tilde{Z}, z_1) \vee \mu(\widetilde{W}, z_2)\right) : z_1 = z'^{*}, z_2 = z''^{*}\right\}, w = z'^{*} + z''^{*}\right\}$

$\geq \wedge\left\{\wedge\left\{\left(\mu(\tilde{Z}, z_1) \vee \mu(\widetilde{W}, z_2)\right) : z_1 = z'^{*}, z_2 = z''^{*}\right\}, w = (z' + z'')^{*}\right\}$

$= \wedge\left\{\wedge\left\{\mu(\tilde{Z}, z_1) \vee \mu(\widetilde{W}, z_2) : z_1 = z'^{*}, z_2 = z''^{*}\right\}, w = (z' + z'')^{*}\right\}$

$= \wedge\left\{\mu(\tilde{Z} \boxplus \widetilde{W}, z' + z'') : w = (z' + z'')^{*}\right\} = \mu\left(\left(\tilde{Z} \boxplus \widetilde{W}\right)^{*}, w\right)$

The proof of the other part is similar.

Definition 2.13. We call $\mu_{[\tilde{\mu}]}(\delta): R^1 \to \left\{[\gamma^-, \gamma^+];\ \gamma^- \leq \gamma^+ \text{ and } \gamma^-, \gamma^+ \in I^{1[}_{[0}\right\}$ as a generalized CNFNs (GCNFNs) if $\mu_{[\tilde{\mu}]}(\delta) = \left[\mu_{\tilde{\mu}^l}(\delta), \mu_{\tilde{\mu}^u}(\delta)\right]$ for $\tilde{\mu}^l, \tilde{\mu}^u \in \tilde{\mathcal{F}}^{*}_{\neg N}$. The set of all GCNFNs is denoted by $[\tilde{\mathcal{F}}^{*}_{\neg N}]$. We call $\lambda([\tilde{Z}], \delta + i\,\Delta): \mathbb{C} \to \left\{[\gamma^-, \gamma^+]: (\gamma^-, \gamma^+) \in \left[0, \alpha^{max}_{\tilde{Z}}\right]^2;\ \gamma^- \leq \gamma^+\right\}$ is a GRVBCCCNFNs if $\lambda([\tilde{Z}], \delta + i\,\Delta) = \left[\lambda(\underline{\tilde{Z}}, \delta + i\,\Delta), \lambda\left(\overline{\tilde{Z}}, \delta + i\,\Delta\right)\right]$ for BCCCNFNs $\underline{\tilde{Z}}$ and $\overline{\tilde{Z}}$. Sometime, we write $[\tilde{Z}]$ to be $[\tilde{Z}] = \left[\underline{\tilde{Z}}, \overline{\tilde{Z}}\right] = [\tilde{\mu}]\,[+]\,i\,[\tilde{\lambda}] = \left[\tilde{\mu}^{\ell} \boxplus i\tilde{\lambda}^{\ell}, \tilde{\mu}^{u} \boxplus i\tilde{\lambda}^{u}\right]$, and we say $[\tilde{Z}] \preccurlyeq [\widetilde{W}] = [\tilde{\gamma}][+]i[\tilde{\beta}]$ if ${}^{[\gamma^{*},\gamma^{**}]+}[\tilde{\mu}] \leq {}^{[\gamma^{*},\gamma^{**}]+}[\tilde{\gamma}]$ and ${}^{[\gamma^{*},\gamma^{**}]+}[\tilde{\lambda}] \leq {}^{[\gamma^{*},\gamma^{**}]+}[\tilde{\beta}]$. The set of all GRVBCCCNFNs is denoted by $[\tilde{\mathcal{F}}^{**}_{\neg N}]$.

Definition 2.14. Let $[*] \in \{[+], [-], [\cdot], [\div], [\vee], [\wedge]\}$. For GRVBCCCNFNs $\left[\underline{\tilde{Z}}, \overline{\tilde{Z}}\right]$, $\left[\underline{\widetilde{W}}, \overline{\widetilde{W}}\right]$, we define $\left[\underline{\tilde{Z}}, \overline{\tilde{Z}}\right][*]\left[\underline{\widetilde{W}}, \overline{\widetilde{W}}\right]$ as $\lambda\left(\left[\underline{\tilde{Z}}, \overline{\tilde{Z}}\right][*]\left[\underline{\widetilde{W}}, \overline{\widetilde{W}}\right], \gamma + i\,\beta\right) = \wedge_{\gamma + i\,\beta = (\delta + i\,\Delta) * (\mu + i\,\nu)}\left(\lambda\left(\left[\underline{\tilde{Z}}, \overline{\tilde{Z}}\right], \delta + i\,\Delta\right) \vee \lambda\left(\left[\underline{\widetilde{W}}, \overline{\widetilde{W}}\right], \mu + i\,\nu\right)\right)$.

Theorem 2.15. Let $[\tilde{Z}], [\widetilde{W}] \in [\tilde{\mathcal{F}}^{**}_{\neg N}]$, then $[\tilde{Z}]\,[*]\,[\widetilde{W}] \in [\tilde{\mathcal{F}}^{**}_{\neg N}]$.

Proof: $\wedge_{\gamma + i\beta = (\delta + i\,\Delta) * (\mu + i\,\nu)}\left(\lambda([\tilde{Z}], \delta + i\,\Delta) \vee \lambda([\widetilde{W}], \mu + i\,\nu)\right)$

$= \wedge_{\gamma + i\beta = (\delta + i\,\Delta) * (\mu + i\,\nu)}\left(\left[\lambda(\underline{\tilde{Z}}, \delta + i\,\Delta), \lambda\left(\overline{\tilde{Z}}, \delta + i\,\Delta\right)\right] \vee \left[\lambda(\underline{\widetilde{W}}, \mu + i\,\nu),\ \lambda\left(\overline{\widetilde{W}}, \mu + i\,\nu\right)\right]\right)$

$= \wedge_{\gamma + i\beta = (\delta + i\,\Delta) * (\mu + i\,\nu)}\left[\lambda(\underline{\tilde{Z}}, \delta + i\,\Delta) \vee \lambda(\underline{\widetilde{W}}, \mu + i\,\nu), \lambda\left(\overline{\tilde{Z}}, \delta + i\,\Delta\right) \vee \lambda\left(\overline{\widetilde{W}}, \mu + i\,\nu\right)\right]$

$= [\wedge_{\gamma + i\beta = (\delta + i\,\Delta) * (\mu + i\,\nu)}\left(\lambda(\underline{\tilde{Z}}, \delta + i\,\Delta) \vee \lambda(\underline{\widetilde{W}}, \mu + i\,\nu)\right),\ \wedge_{\gamma + i\beta = (\delta + i\,\Delta) * (\mu + i\,\nu)}\left(\lambda\left(\overline{\tilde{Z}}, \delta + i\,\Delta\right) \vee \lambda\left(\overline{\widetilde{W}}, \mu + i\,\nu\right)\right)]$

$= \left[\lambda(\underline{\tilde{Z}} \boxed{*} \underline{\widetilde{W}}, \gamma + i\beta), \lambda\left(\overline{\tilde{Z}} \boxed{*} \overline{\widetilde{W}}, \gamma + i\beta\right)\right]$

On the other hand $\lambda([\tilde{Z}]\,[*]\,[\widetilde{W}],\gamma+i\beta)=\left[\lambda\left(\underline{(\tilde{Z}\ \boxed{*}\ \widetilde{W})},\gamma+i\beta\right),\lambda\left(\overline{(\tilde{Z}\ \boxed{*}\ \widetilde{W})},\gamma+i\beta\right)\right]$. Hence $\lambda(\underline{\tilde{Z}}\ \boxed{*}\ \underline{\widetilde{W}},\gamma+i\beta)=\lambda\left(\underline{(\tilde{Z}\ \boxed{*}\ \widetilde{W})},\gamma+i\beta\right)$ and $\lambda\left(\overline{\tilde{Z}}\ \boxed{*}\ \overline{\widetilde{W}},\gamma+i\beta\right)=\lambda\left(\overline{(\tilde{Z}\ \boxed{*}\ \widetilde{W})},\gamma+i\beta\right)$. Since $\underline{\tilde{Z}}$, $\underline{\widetilde{W}}$, $\overline{\tilde{Z}}$, $\overline{\widetilde{W}}$ are BCCCNFNs, it follows from Theorem 2.9 that $\underline{\tilde{Z}}\ \boxed{*}\ \underline{\widetilde{W}}$ and $\overline{\tilde{Z}}\ \boxed{*}\ \overline{\widetilde{W}}$ are BCCCNFNs, and so $\underline{(\tilde{Z}\ \boxed{*}\ \widetilde{W})}$, $\overline{(\tilde{Z}\ \boxed{*}\ \widetilde{W})}$ are BCCCNFNs. Hence $[\tilde{Z}]\,[*]\,[\widetilde{W}]$ is GRVBCCCNFNs.

Theorem 2.16. Let $[\tilde{Z}],[\widetilde{W}],[\tilde{Y}]\in[\tilde{\mathcal{F}}^{**}_{\neg N}]$, $[*']\in\{[+],[\cdot]\}$, $[*'']\in\{[\wedge],[\vee]\}$ then

1. $\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][+]\left(\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right][*'']\left[\underline{\tilde{Y}},\overline{\tilde{Y}}\right]\right)=\left(\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][+]\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right]\right)[*'']\left(\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][+]\left[\underline{\tilde{Y}},\overline{\tilde{Y}}\right]\right)$
2. $\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][-]\left(\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right][\vee]\left[\underline{\tilde{Y}},\overline{\tilde{Y}}\right]\right)=\left(\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][-]\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right]\right)[\wedge]\left(\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][-]\left[\underline{\tilde{Y}},\overline{\tilde{Y}}\right]\right)$
3. $\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][-]\left(\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right][\wedge]\left[\underline{\tilde{Y}},\overline{\tilde{Y}}\right]\right)=\left(\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][-]\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right]\right)[\vee]\left(\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][-]\left[\underline{\tilde{Y}},\overline{\tilde{Y}}\right]\right)$
4. $\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][*']\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right]=\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right][*']\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right]$
5. $\left(\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][*']\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right]\right)[*']\left[\underline{\tilde{Y}},\overline{\tilde{Y}}\right]=\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][*']\left(\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right][*']\left[\underline{\tilde{Y}},\overline{\tilde{Y}}\right]\right)$

Proof: The proofs of (2), (3), (4), and (5) are similar to (1), so we only prove (1).

1. $\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][+]\left(\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right][*'']\left[\underline{\tilde{Y}},\overline{\tilde{Y}}\right]\right)=\left[\underline{\left(\tilde{Z}\boxplus(\widetilde{W}\ \boxed{*''}\ \tilde{Y})\right)},\overline{\left(\tilde{Z}\boxplus(\widetilde{W}\ \boxed{*''}\ \tilde{Y})\right)}\right]$

$=\left[\underline{\tilde{Z}}\boxplus\underline{(\widetilde{W}\ \boxed{*''}\ \tilde{Y})},\overline{\tilde{Z}}\boxplus\overline{(\widetilde{W}\ \boxed{*''}\ \tilde{Y})}\right]$

$=\left[\underline{\tilde{Z}}\boxplus(\underline{\widetilde{W}}\ \boxed{*''}\ \underline{\tilde{Y}}),\overline{\tilde{Z}}\boxplus\left(\overline{\widetilde{W}}\ \boxed{*''}\ \overline{\tilde{Y}}\right)\right]$

$=\left[(\underline{\tilde{Z}}\boxplus\underline{\widetilde{W}})\ \boxed{*''}(\underline{\tilde{Z}}\boxplus\underline{\tilde{Y}}),\left(\overline{\tilde{Z}}\boxplus\overline{\widetilde{W}}\right)\ \boxed{*''}\left(\overline{\tilde{Z}}\boxplus\overline{\tilde{Y}}\right)\right]$

$=\left[\underline{(\tilde{Z}\boxplus\widetilde{W})\ \boxed{*''}(\tilde{Z}\boxplus\tilde{Y})},\overline{(\tilde{Z}\boxplus\widetilde{W})\ \boxed{*''}(\tilde{Z}\boxplus\tilde{Y})}\right]$

$=\left[\underline{\left((\tilde{Z}\boxplus\widetilde{W})\ \boxed{*''}(\tilde{Z}\boxplus\tilde{Y})\right)},\overline{\left((\tilde{Z}\boxplus\widetilde{W})\ \boxed{*''}(\tilde{Z}\boxplus\tilde{Y})\right)}\right]$

$=\left(\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][+]\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right]\right)[*'']\left(\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right][+]\left[\underline{\tilde{Y}},\overline{\tilde{Y}}\right]\right)$

Definition 2.17. Let $[\tilde{Z}]\in[\tilde{\mathcal{F}}^{**}_{\neg N}]$ and $(\gamma^-,\gamma^+)\in I^{1[}_{[0}\times I^{1[}_{[0}$. We define $[\gamma^-,\gamma^+]$-level of $[\tilde{Z}]$ as ${}^{[\gamma^-,\gamma^+]+}[\tilde{Z}]={}^{\gamma^-+}\underline{\tilde{Z}}\cap{}^{\gamma^++}\overline{\tilde{Z}}$.

Theorem 2.18. For GRVBCCCNFNs $[\tilde{Z}]$ and $[\widetilde{W}]$ and $[\circ]\in\{[+],[-],[\cdot],[\div]\}$ we have ${}^{[\gamma^-,\gamma^+]+}([\tilde{Z}][\circ][\widetilde{W}])={}^{[\gamma^-,\gamma^+]+}[\tilde{Z}]\circ{}^{[\gamma^-,\gamma^+]+}[\widetilde{W}]$.

Proof: $\lambda([\tilde{Z}]\,[\circ]\,[\widetilde{W}],\gamma+i\beta)=\left[\lambda(\underline{\tilde{Z}}\ \boxed{\circ}\ \underline{\widetilde{W}},\gamma+i\beta),\lambda\left(\overline{\tilde{Z}}\ \boxed{\circ}\ \overline{\widetilde{W}},\gamma+i\beta\right)\right]$. Hence

${}^{[\gamma^-,\gamma^+]+}([\tilde{Z}][\circ][\widetilde{W}])={}^{\gamma^-+}(\underline{\tilde{Z}}\ \boxed{\circ}\ \underline{\widetilde{W}})\cap{}^{\gamma^++}\left(\overline{\tilde{Z}}\ \boxed{\circ}\ \overline{\widetilde{W}}\right)$

$=\left({}^{\gamma^-+}\underline{\tilde{Z}}\circ{}^{\gamma^-+}\underline{\widetilde{W}}\right)\cap\left({}^{\gamma^++}\overline{\tilde{Z}}\circ{}^{\gamma^++}\overline{\widetilde{W}}\right)$

$=\left({}^{\gamma^-+}\underline{\tilde{Z}}\cap{}^{\gamma^++}\overline{\tilde{Z}}\right)\circ\left({}^{\gamma^-+}\underline{\widetilde{W}}\cap{}^{\gamma^++}\overline{\widetilde{W}}\right)$

$={}^{[\gamma^-,\gamma^+]+}[\tilde{Z}]\circ{}^{[\gamma^-,\gamma^+]+}[\widetilde{W}]$

Definition 2.19. A fuzzy distance $\tilde{\Gamma}$ of GRVBCCCNFNs $\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right]=\left[\tilde{\mu}^\ell\boxplus i\tilde{\lambda}^\ell,\tilde{\mu}^u\boxplus i\tilde{\lambda}^u\right]$, $\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right]=\left[\tilde{\gamma}^\ell\boxplus i\tilde{\beta}^\ell,\tilde{\gamma}^u\boxplus i\tilde{\beta}^u\right]$ is defined as follows $\tilde{\Gamma}\left(\left[\underline{\tilde{Z}},\overline{\tilde{Z}}\right],\left[\underline{\widetilde{W}},\overline{\widetilde{W}}\right]\right)=\left[\tilde{\xi}(\tilde{\mu}^\ell,\tilde{\gamma}^\ell)\vee\tilde{\xi}(\tilde{\lambda}^\ell,\tilde{\beta}^\ell),\tilde{\xi}(\tilde{\mu}^u,\tilde{\gamma}^u)\vee\tilde{\xi}(\tilde{\lambda}^u,\tilde{\beta}^u)\right]$, where

$\tilde{\xi}(\tilde{\mu},\tilde{\lambda})=\int_0^{\alpha^{max}_{\tilde{\lambda},\tilde{\mu}}}\gamma\left[\left|{}^{\alpha^{max}_{\tilde{\lambda},\tilde{\mu}}+}\tilde{\mu}^--{}^{\alpha^{max}_{\tilde{\lambda},\tilde{\mu}}+}\tilde{\lambda}^-\right|,\vee_{\gamma\le\psi\le\alpha^{max}_{\tilde{\lambda},\tilde{\mu}}}\left|{}^{\psi+}\tilde{\mu}^--{}^{\psi+}\tilde{\lambda}^-\right|\vee\left|{}^{\psi+}\tilde{\mu}^+-{}^{\psi+}\tilde{\lambda}^+\right|\right]$.

Theorem 2.20. For GRVBCCCNFNs $[\tilde{X}]=\left[\tilde{\delta}^\ell\boxplus i\,\tilde{\Delta}^\ell,\tilde{\delta}^u\boxplus i\,\tilde{\Delta}^u\right]$, $[\tilde{Z}]=\left[\tilde{\mu}^\ell\boxplus i\,\tilde{\lambda}^\ell,\tilde{\mu}^u\boxplus i\,\tilde{\lambda}^u\right]$, $[\widetilde{W}]=\left[\tilde{\gamma}^\ell\boxplus i\,\tilde{\beta}^\ell,\tilde{\gamma}^u\boxplus i\,\tilde{\beta}^u\right]$, $[\tilde{Y}]=\left[\tilde{\eta}^\ell\boxplus i\,\tilde{\nu}^\ell,\tilde{\eta}^u\boxplus i\,\tilde{\nu}^u\right]$, and $[*]\in\{[+],[-]\}$ we have

1. $\tilde{\Gamma}([\tilde{Z}][*][\tilde{X}],[\widetilde{W}][*][\tilde{Z}])=\tilde{\Gamma}([\widetilde{W}],[\tilde{X}])$.

2. $\tilde{\Gamma}([\widetilde{W}],[\tilde{Z}]) \preccurlyeq \tilde{\Gamma}([\tilde{X}],[\widetilde{W}])[+]\tilde{\Gamma}([\tilde{X}],[\tilde{Z}])$.
3. $\tilde{\Gamma}([\tilde{Z}],[\widetilde{W}]) \preccurlyeq [\tilde{\xi}(\tilde{\mu}^{\ell},\tilde{\gamma}^{\ell}) \boxplus \tilde{\xi}(\tilde{\lambda}^{\ell},\tilde{\beta}^{\ell}), \tilde{\xi}(\tilde{\mu}^{u},\tilde{\gamma}^{u}) \boxplus \tilde{\xi}(\tilde{\lambda}^{u},\tilde{\beta}^{u})]$.
4. If $[\tilde{X}] \preccurlyeq [\tilde{Z}] \preccurlyeq [\widetilde{W}]$ and $[\tilde{X}] \preccurlyeq [\tilde{Y}] \preccurlyeq [\widetilde{W}]$ then $\tilde{\Gamma}([\tilde{Y}],[\tilde{Z}]) \preccurlyeq \tilde{\Gamma}([\tilde{X}],[\widetilde{W}])$ and $\tilde{\Gamma}([\tilde{X}],[\tilde{Z}]) \vee \tilde{\Gamma}([\widetilde{W}],[\tilde{Z}]) \preccurlyeq \tilde{\Gamma}([\tilde{X}],[\widetilde{W}])$.
5. **Proof:** Obvious.

3. FUZZY SEQUENCES OF GRVBCCCNFNS

Throughout this section, some important results on fuzzy sequences of GRVBCCCNFNs based on $\tilde{\Gamma}$-converge and $[\gamma^{\star},\gamma^{\star\star}]$-level converges are presented.

Definition 3.1. Let $[\tilde{\lambda}],[\tilde{\gamma}] \in [\tilde{\mathcal{F}}^{*}_{\neg N}]$, we define fuzzy distance $\widetilde{\Pi}$ between GCNFNs $[\tilde{\lambda}]$ and $[\tilde{\gamma}]$ as follows $\widetilde{\Pi}([\tilde{\lambda}],[\tilde{\gamma}]) = [\tilde{\xi}(\tilde{\lambda}^{l},\tilde{\gamma}^{l}), \tilde{\xi}(\tilde{\lambda}^{u},\tilde{\gamma}^{u})]$. Let $([\tilde{\mu}_{\eta}]) \subset [\tilde{\mathcal{F}}^{*}_{\neg N}]$. We say that $([\tilde{\mu}_{\eta}])$ is $\widetilde{\Pi}$-converges to $[\tilde{\mu}]$ written as $([\tilde{\mu}_{\eta}]) \xrightarrow{\widetilde{\Pi}} [\tilde{\mu}]$, if for any $\bar{\varepsilon} = [\varepsilon,\varepsilon] > \bar{0}$, there exists a positive integer N such that $\widetilde{\Pi}([\tilde{\mu}_{\eta}],[\tilde{\mu}]) \preccurlyeq \bar{\varepsilon}$ as $\eta \geq N$, and we say that $([\tilde{\mu}_{\eta}])$ is $[\gamma',\gamma'']$-level converges to $[\tilde{\mu}]$ written as $([\tilde{\mu}_{\eta}]) \xrightarrow{[\gamma',\gamma'']-leve} [\tilde{\mu}]$, if ${}^{\gamma'+}\tilde{\mu}_{\eta}^{l-} \vee {}^{\gamma''+}\tilde{\mu}_{\eta}^{u-} \longrightarrow {}^{\gamma'+}\tilde{\mu}^{l-} \vee {}^{\gamma''+}\tilde{\mu}^{u-}$ and ${}^{\gamma'+}\tilde{\mu}_{\eta}^{l+} \wedge {}^{\gamma''+}\tilde{\mu}_{\eta}^{u+} \longrightarrow {}^{\gamma'+}\tilde{\mu}^{l+} \wedge {}^{\gamma''+}\tilde{\mu}^{u+}$ for all $(\gamma',\gamma'') \in I^{1[}_{[0} \times I^{1[}_{[0}$.

Definition 3.2. Let $([\tilde{Z}_{\eta}] = [\tilde{\mu}_{\eta}][+]i[\tilde{\lambda}_{\eta}]) \subset [\tilde{\mathcal{F}}^{**}_{\neg N}]$, $[\widetilde{W}] = [\tilde{\gamma}][+]i[\tilde{\beta}] \in [\tilde{\mathcal{F}}^{**}_{\neg N}]$. We say that $([\tilde{Z}_{\eta}])$ is $\tilde{\Gamma}$-converges to $[\widetilde{W}]$ written as $([\tilde{Z}_{\eta}]) \xrightarrow{\tilde{\Gamma}} [\widetilde{W}]$, if for any $\bar{\varepsilon} = [\varepsilon,\varepsilon] > \bar{0}$, there exists a positive integer N such that $\tilde{\Gamma}([\tilde{Z}_{\eta}],[\widetilde{W}]) \preccurlyeq \bar{\varepsilon}$ as $\eta \geq N$.

Definition 3.3. Let $([\tilde{Z}_{\eta}] = [\tilde{\mu}_{\eta}][+]i[\tilde{\lambda}_{\eta}]) \subset [\tilde{\mathcal{F}}^{**}_{\neg N}]$, $[\tilde{Z}] = [\tilde{\gamma}][+]i[\tilde{\beta}] \in [\tilde{\mathcal{F}}^{**}_{\neg N}]$ and $(\gamma^{\star},\gamma^{\star\star}) \in I^{1[}_{[0} \times I^{1[}_{[0}$. We say that $([\tilde{Z}_{\eta}])$ is $[\gamma^{\star},\gamma^{\star\star}]$-level converges to $[\tilde{Z}]$ written as $([\tilde{Z}_{\eta}]) \xrightarrow{[\gamma^{\star},\gamma^{\star\star}]-le} [\tilde{Z}]$, if ${}^{\gamma^{\star}+}\tilde{\mu}_{\eta}^{l-} \vee {}^{\gamma^{\star\star}+}\tilde{\mu}_{\eta}^{u-} \longrightarrow {}^{\gamma^{\star}+}\tilde{\gamma}^{l-} \vee {}^{\gamma^{\star\star}+}\tilde{\gamma}^{u-}$, ${}^{\gamma^{\star}+}\tilde{\mu}_{\eta}^{l+} \wedge {}^{\gamma^{\star\star}+}\tilde{\mu}_{\eta}^{u+} \longrightarrow {}^{\gamma^{\star}+}\tilde{\gamma}^{l+} \wedge {}^{\gamma^{\star\star}+}\tilde{\gamma}^{u+}$, ${}^{\gamma^{\star}+}\tilde{\lambda}_{\eta}^{l-} \vee {}^{\gamma^{\star\star}+}\tilde{\lambda}_{\eta}^{u-} \longrightarrow {}^{\gamma^{\star}+}\tilde{\beta}^{l-} \vee {}^{\gamma^{\star\star}+}\tilde{\beta}^{u-}$ and ${}^{\gamma^{\star}+}\tilde{\lambda}_{\eta}^{l+} \wedge {}^{\gamma^{\star\star}+}\tilde{\lambda}_{\eta}^{u+} \longrightarrow {}^{\gamma^{\star}+}\tilde{\beta}^{l+} \wedge {}^{\gamma^{\star\star}+}\tilde{\beta}^{u+}$.

Theorem 3.4. Let $([\tilde{Z}_{\eta}]) \subset [\tilde{\mathcal{F}}^{**}_{\neg N}]$, $[\widetilde{W}] \in [\tilde{\mathcal{F}}^{**}_{\neg N}]$, $\gamma^{\star} \in I^{1[}_{[0}$. Then $([\tilde{Z}_{\eta}]) \xrightarrow{\tilde{\Gamma}} [\widetilde{W}]$ if and only if $([\tilde{Z}_{\eta}])$ is $[\gamma^{\star},\gamma^{\star}]$-level converges to $[\widetilde{W}]$.

Proof: Suppose $([\tilde{Z}_{\eta}]) \xrightarrow{\tilde{\Gamma}} [\widetilde{W}]$. For any $\bar{\varepsilon} > \bar{0}$, there exists a positive integer N such that $\tilde{\Gamma}([\tilde{Z}_{\eta}],[\widetilde{W}]) \preccurlyeq \bar{\varepsilon}$. Implies $\left[\tilde{\xi}(\tilde{\mu}_{\eta}{}^{\ell},\tilde{\gamma}^{\ell}) \vee \tilde{\xi}\left(\tilde{\lambda}_{\eta}{}^{\ell},\tilde{\beta}^{\ell}\right), \tilde{\xi}(\tilde{\mu}_{\eta}{}^{u},\tilde{\gamma}^{u}) \vee \tilde{\xi}(\tilde{\lambda}_{\eta}{}^{u},\tilde{\beta}^{u})\right] \preccurlyeq \bar{\varepsilon}$. Then $\tilde{\xi}(\tilde{\mu}_{\eta}{}^{\ell},\tilde{\gamma}^{\ell}) \vee \tilde{\xi}\left(\tilde{\lambda}_{\eta}{}^{\ell},\tilde{\beta}^{\ell}\right) \preccurlyeq \varepsilon$ and $\tilde{\xi}(\tilde{\mu}_{\eta}{}^{u},\tilde{\gamma}^{u}) \vee \tilde{\xi}(\tilde{\lambda}_{\eta}{}^{u},\tilde{\beta}^{u}) \preccurlyeq \varepsilon$. Then $\tilde{\xi}(\tilde{\mu}_{\eta}{}^{\ell},\tilde{\gamma}^{\ell}) \preccurlyeq \varepsilon$, $\tilde{\xi}\left(\tilde{\lambda}_{\eta}{}^{\ell},\tilde{\beta}^{\ell}\right) \preccurlyeq \varepsilon$, $\tilde{\xi}(\tilde{\mu}_{\eta}{}^{u},\tilde{\gamma}^{u}) \preccurlyeq \varepsilon$, and $\tilde{\xi}(\tilde{\lambda}_{\eta}{}^{u},\tilde{\beta}^{u}) \preccurlyeq \varepsilon$. Then

$$\int_0^{\alpha^{max}_{\tilde{\mu}_{\eta}{}^{\ell},\tilde{\gamma}^{\ell}}} \gamma \left[\left|{}^{\alpha^{max}_{\tilde{\mu}_{\eta}{}^{\ell},\tilde{\gamma}^{\ell}}+}\tilde{\mu}_{\eta}{}^{\ell-} - {}^{\alpha^{max}_{\tilde{\mu}_{\eta}{}^{\ell},\tilde{\gamma}^{\ell}}+}\tilde{\gamma}^{\ell-}\right|, \vee_{\gamma \leq \psi \leq \alpha^{max}_{\tilde{\mu}_{\eta}{}^{\ell},\tilde{\gamma}^{\ell}}} \left|{}^{\psi+}\tilde{\mu}_{\eta}{}^{\ell-} - {}^{\psi+}\tilde{\gamma}^{\ell-}\right| \vee \left|{}^{\psi+}\tilde{\mu}_{\eta}{}^{\ell+} - {}^{\psi+}\tilde{\gamma}^{\ell+}\right|\right] \preccurlyeq \varepsilon,$$

$$\int_0^{\alpha^{max}_{\tilde{\lambda}_{\eta}{}^{\ell},\tilde{\beta}^{\ell}}} \gamma \left[\left|{}^{\alpha^{max}_{\tilde{\lambda}_{\eta}{}^{\ell},\tilde{\beta}^{\ell}}+}\tilde{\mu}_{\eta}{}^{\ell-} - {}^{\alpha^{max}_{\tilde{\lambda}_{\eta}{}^{\ell},\tilde{\beta}^{\ell}}+}\tilde{\beta}^{\ell-}\right|, \vee_{\gamma \leq \psi \leq \alpha^{max}_{\tilde{\lambda}_{\eta}{}^{\ell},\tilde{\beta}^{\ell}}} \left|{}^{\psi+}\tilde{\mu}_{\eta}{}^{\ell-} - {}^{\psi+}\tilde{\beta}^{\ell-}\right| \vee \left|{}^{\psi+}\tilde{\mu}_{\eta}{}^{\ell+} - {}^{\psi+}\tilde{\beta}^{\ell+}\right|\right] \preccurlyeq \varepsilon,$$

$$\int_0^{\alpha^{max}_{\tilde{\mu}_{\eta}{}^{u},\tilde{\gamma}^{u}}} \gamma \left[\left|{}^{\alpha^{max}_{\tilde{\mu}_{\eta}{}^{u},\tilde{\gamma}^{u}}+}\tilde{\mu}_{\eta}{}^{u-} - {}^{\alpha^{max}_{\tilde{\mu}_{\eta}{}^{u},\tilde{\gamma}^{u}}+}\tilde{\gamma}^{u-}\right|, \vee_{\gamma \leq \psi \leq \alpha^{max}_{\tilde{\mu}_{\eta}{}^{u},\tilde{\gamma}^{u}}} \left|{}^{\psi+}\tilde{\mu}_{\eta}{}^{u-} - {}^{\psi+}\tilde{\gamma}^{u-}\right| \vee \left|{}^{\psi+}\tilde{\mu}_{\eta}{}^{u+} - {}^{\psi+}\tilde{\gamma}^{u+}\right|\right] \preccurlyeq \varepsilon$$

$\int_0^{\alpha^{max}_{\tilde{\lambda}_\eta{}^u,\tilde{\beta}^u}} \gamma \left[\left|{}^{\alpha^{max}_{\tilde{\lambda}_\eta{}^u,\tilde{\beta}^u}+}\tilde{\mu}_\eta{}^{u-} - {}^{\alpha^{max}_{\tilde{\lambda}_\eta{}^u,\tilde{\beta}^u}+}\tilde{\beta}^{\ell-}\right|, \vee_{\gamma\le\psi\le\alpha^{max}_{\tilde{\lambda}_\eta{}^u,\tilde{\beta}^u}} \left|{}^{\psi+}\tilde{\mu}_\eta{}^{u-} - {}^{\psi+}\tilde{\beta}^{u-}\right| \vee \left|{}^{\psi+}\tilde{\mu}_\eta{}^{u+} - {}^{\psi+}\tilde{\beta}^{u+}\right|\right] \preccurlyeq \varepsilon$

Hence

$\left|{}^{\psi+}\tilde{\mu}_\eta{}^{\ell-} - {}^{\psi+}\tilde{\gamma}^{\ell-}\right| \vee \left|{}^{\psi+}\tilde{\mu}_\eta{}^{\ell+} - {}^{\psi+}\tilde{\gamma}^{\ell+}\right| \le \varepsilon$, $\left|{}^{\psi+}\tilde{\mu}_\eta{}^{\ell-} - {}^{\psi+}\tilde{\beta}^{\ell-}\right| \vee \left|{}^{\psi+}\tilde{\mu}_\eta{}^{\ell+} - {}^{\psi+}\tilde{\beta}^{\ell+}\right| \le \varepsilon$, $\left|{}^{\psi+}\tilde{\mu}_\eta{}^{u-} - {}^{\psi+}\tilde{\gamma}^{u-}\right| \vee \left|{}^{\psi+}\tilde{\mu}_\eta{}^{u+} - {}^{\psi+}\tilde{\gamma}^{u+}\right| \le \varepsilon$, and $\left|{}^{\psi+}\tilde{\mu}_\eta{}^{u-} - {}^{\psi+}\tilde{\beta}^{u-}\right| \vee \left|{}^{\psi+}\tilde{\mu}_\eta{}^{u+} - {}^{\psi+}\tilde{\beta}^{u+}\right| \le \varepsilon$.

$\left|{}^{\psi+}\tilde{\mu}_\eta{}^{\ell-} - {}^{\psi+}\tilde{\gamma}^{\ell-}\right| \le \varepsilon$, $\left|{}^{\psi+}\tilde{\mu}_\eta{}^{\ell+} - {}^{\psi+}\tilde{\gamma}^{\ell+}\right| \le \varepsilon$, $\left|{}^{\psi+}\tilde{\mu}_\eta{}^{\ell-} - {}^{\psi+}\tilde{\beta}^{\ell-}\right| \le \varepsilon$, $\left|{}^{\psi+}\tilde{\mu}_\eta{}^{\ell+} - {}^{\psi+}\tilde{\beta}^{\ell+}\right| \le \varepsilon$, $\left|{}^{\psi+}\tilde{\mu}_\eta{}^{u-} - {}^{\psi+}\tilde{\gamma}^{u-}\right| \le \varepsilon$, $\left|{}^{\psi+}\tilde{\mu}_\eta{}^{u+} - {}^{\psi+}\tilde{\gamma}^{u+}\right| \le \varepsilon$, $\left|{}^{\psi+}\tilde{\mu}_\eta{}^{u-} - {}^{\psi+}\tilde{\beta}^{u-}\right| \le \varepsilon$,and $\left|{}^{\psi+}\tilde{\mu}_\eta{}^{u+} - {}^{\psi+}\tilde{\beta}^{u+}\right| \le \varepsilon$.

${}^{\psi+}\tilde{\mu}_\eta{}^{\ell-} \longrightarrow {}^{\psi+}\tilde{\gamma}^{\ell-}$, ${}^{\psi+}\tilde{\mu}_\eta{}^{\ell+} \longrightarrow {}^{\psi+}\tilde{\gamma}^{\ell+}$, ${}^{\psi+}\tilde{\mu}_\eta{}^{\ell-} \longrightarrow {}^{\psi+}\tilde{\beta}^{\ell-}$, ${}^{\psi+}\tilde{\mu}_\eta{}^{\ell+} \longrightarrow {}^{\psi+}\tilde{\beta}^{\ell+}$, ${}^{\psi+}\tilde{\mu}_\eta{}^{u-} \longrightarrow {}^{\psi+}\tilde{\gamma}^{u-}$, ${}^{\psi+}\tilde{\mu}_\eta{}^{u+} \longrightarrow {}^{\psi+}\tilde{\gamma}^{u+}$, ${}^{\psi+}\tilde{\mu}_\eta{}^{u-} \longrightarrow {}^{\psi+}\tilde{\beta}^{u-}$, and ${}^{\psi+}\tilde{\mu}_\eta{}^{u+} \longrightarrow {}^{\psi+}\tilde{\beta}^{u+}$.

Theorem 3.5. Let $([\tilde{Z}_\eta]) \subset [\tilde{\mathcal{F}}^{**}_{\neg N}]$, $[\widetilde{W}] \in [\tilde{\mathcal{F}}^{**}_{\neg N}]$. Then $([\tilde{Z}_\eta])$ is $[\gamma^\star, \gamma^{\star\star}]$-level converges to $[\widetilde{W}]$ if and only if ${}^{[\gamma^\star,\gamma^{\star\star}]+}[\tilde{\mu}_\eta] \longrightarrow {}^{[\gamma^\star,\gamma^{\star\star}]+}[\tilde{\gamma}]$ and ${}^{[\gamma^\star,\gamma^{\star\star}]+}[\tilde{\lambda}_\eta] \longrightarrow {}^{[\gamma^\star,\gamma^{\star\star}]+}[\tilde{\beta}]$.

Proof: $([\tilde{Z}_\eta]) \xrightarrow{[\gamma^\star,\gamma^{\star\star}]-leve} [\widetilde{W}]$ if and only if ${}^{\gamma^\star+}\tilde{\mu}_\eta^{l-} \vee {}^{\gamma^{\star\star}+}\tilde{\mu}_\eta^{u-} \longrightarrow {}^{\gamma^\star+}\tilde{\gamma}^{l-} \vee {}^{\gamma^{\star\star}+}\tilde{\gamma}^{u-}$, ${}^{\gamma^\star+}\tilde{\mu}_\eta^{l+} \wedge {}^{\gamma^{\star\star}+}\tilde{\mu}_\eta^{u+} \longrightarrow {}^{\gamma^\star+}\tilde{\gamma}^{l+} \wedge {}^{\gamma^{\star\star}+}\tilde{\gamma}^{u+}$, ${}^{\gamma^\star+}\tilde{\lambda}_\eta^{l-} \vee {}^{\gamma^{\star\star}+}\tilde{\lambda}_\eta^{u-} \longrightarrow {}^{\gamma^\star+}\tilde{\beta}^{l-} \vee {}^{\gamma^{\star\star}+}\tilde{\beta}^{u-}$ and ${}^{\gamma^\star+}\tilde{\lambda}_\eta^{l+} \wedge {}^{\gamma^{\star\star}+}\tilde{\lambda}_\eta^{u+} \longrightarrow {}^{\gamma^\star+}\tilde{\beta}^{l+} \wedge {}^{\gamma^{\star\star}+}\tilde{\beta}^{u+}$ if and only if

$\left[{}^{\gamma^\star+}\tilde{\mu}_\eta^{l-} \vee {}^{\gamma^{\star\star}+}\tilde{\mu}_\eta^{u-}, {}^{\gamma^\star+}\tilde{\mu}_\eta^{l+} \wedge {}^{\gamma^{\star\star}+}\tilde{\mu}_\eta^{u+}\right] \longrightarrow \left[{}^{\gamma^\star+}\tilde{\gamma}^{l-} \vee {}^{\gamma^{\star\star}+}\tilde{\gamma}^{u-}, {}^{\gamma^\star+}\tilde{\gamma}^{l+} \wedge {}^{\gamma^{\star\star}+}\tilde{\gamma}^{u+}\right]$, and

$\left[{}^{\gamma^\star+}\tilde{\lambda}_\eta^{l-} \vee {}^{\gamma^{\star\star}+}\tilde{\lambda}_\eta^{u-}, {}^{\gamma^\star+}\tilde{\lambda}_\eta^{l+} \wedge {}^{\gamma^{\star\star}+}\tilde{\lambda}_\eta^{u+}\right] \longrightarrow \left[{}^{\gamma^\star+}\tilde{\beta}^{l-} \vee {}^{\gamma^{\star\star}+}\tilde{\beta}^{u-}, {}^{\gamma^\star+}\tilde{\beta}^{l+} \wedge {}^{\gamma^{\star\star}+}\tilde{\beta}^{u+}\right]$ if and only if

$\left[{}^{\gamma^\star+}\tilde{\mu}_\eta^{l-}, {}^{\gamma^\star+}\tilde{\mu}_\eta^{l+}\right] \cap \left[{}^{\gamma^{\star\star}+}\tilde{\mu}_\eta^{u-}, {}^{\gamma^{\star\star}+}\tilde{\mu}_\eta^{u+}\right] \longrightarrow \left[{}^{\gamma^\star+}\tilde{\gamma}^{l-}, {}^{\gamma^\star+}\tilde{\gamma}^{l+}\right] \cap \left[{}^{\gamma^{\star\star}+}\tilde{\gamma}^{u-}, {}^{\gamma^{\star\star}+}\tilde{\gamma}^{u+}\right]$ and

$\left[{}^{\gamma^\star+}\tilde{\lambda}_\eta^{l-}, {}^{\gamma^\star+}\tilde{\lambda}_\eta^{l+}\right] \cap \left[{}^{\gamma^{\star\star}+}\tilde{\lambda}_\eta^{u-}, {}^{\gamma^{\star\star}+}\tilde{\lambda}_\eta^{u+}\right] \longrightarrow \left[{}^{\gamma^\star+}\tilde{\beta}^{l-}, {}^{\gamma^\star+}\tilde{\beta}^{l+}\right] \cap \left[{}^{\gamma^{\star\star}+}\tilde{\beta}^{u-}, {}^{\gamma^{\star\star}+}\tilde{\beta}^{u+}\right]$ if and only if

${}^{\gamma^\star+}\tilde{\mu}_\eta^{l} \cap {}^{\gamma^{\star\star}+}\tilde{\mu}_\eta^{u} \longrightarrow {}^{\gamma^\star+}\tilde{\gamma}^{l} \cap {}^{\gamma^{\star\star}+}\tilde{\gamma}^{u}$ and ${}^{\gamma^\star+}\tilde{\lambda}_\eta^{l} \cap {}^{\gamma^{\star\star}+}\tilde{\lambda}_\eta^{u} \longrightarrow {}^{\gamma^\star+}\tilde{\beta}^{l} \cap {}^{\gamma^{\star\star}+}\tilde{\beta}^{u}$ if and only if ${}^{[\gamma^\star,\gamma^{\star\star}]+}[\tilde{\mu}_\eta] \longrightarrow {}^{[\gamma^\star,\gamma^{\star\star}]+}[\tilde{\gamma}]$ and ${}^{[\gamma^\star,\gamma^{\star\star}]+}[\tilde{\lambda}_\eta] \longrightarrow {}^{[\gamma^\star,\gamma^{\star\star}]+}[\tilde{\beta}]$.

Theorem 3.6. Let $([\tilde{Z}_\eta]) \subset [\tilde{\mathcal{F}}^{**}_{\neg N}]$, $[\widetilde{W}] \in [\tilde{\mathcal{F}}^{**}_{\neg N}]$. Then $([\tilde{Z}_\eta]) \xrightarrow{\tilde{\Gamma}} [\widetilde{W}]$ if and only if $([\tilde{\mu}_\eta]) \xrightarrow{\tilde{\Pi}} [\tilde{\gamma}]$ and $([\tilde{\lambda}_\eta]) \xrightarrow{\tilde{\Pi}} [\tilde{\beta}]$.

Proof: If $([\tilde{Z}_\eta])$ is $\tilde{\Gamma}$-converges to $[\widetilde{W}]$, for any $\bar{\varepsilon} > \bar{0}$, there exists a positive integer N such that $\tilde{\Gamma}([\tilde{Z}_\eta], [\widetilde{W}]) \preccurlyeq \bar{\varepsilon}$ as $\eta \ge N$. Implies $\left[\tilde{\xi}(\tilde{\mu}_\eta{}^{\ell}, \tilde{\gamma}^{\ell}) \vee \tilde{\xi}\left(\tilde{\lambda}_\eta{}^{\ell}, \tilde{\beta}^{\ell}\right), \tilde{\xi}(\tilde{\mu}_\eta{}^{u}, \tilde{\gamma}^{u}) \vee \tilde{\xi}(\tilde{\lambda}_\eta{}^{u}, \tilde{\beta}^{u})\right] \preccurlyeq \bar{\varepsilon}$. Therefore,

$\tilde{\xi}(\tilde{\mu}_\eta{}^{\ell}, \tilde{\gamma}^{\ell}) \vee \tilde{\xi}\left(\tilde{\lambda}_\eta{}^{\ell}, \tilde{\beta}^{\ell}\right) \preccurlyeq \varepsilon$ and $\tilde{\xi}(\tilde{\mu}_\eta{}^{u}, \tilde{\gamma}^{u}) \vee \tilde{\xi}(\tilde{\lambda}_\eta{}^{u}, \tilde{\beta}^{u}) \preccurlyeq \varepsilon$. This implies that $\tilde{\xi}(\tilde{\mu}_\eta{}^{\ell}, \tilde{\gamma}^{\ell}) \preccurlyeq \varepsilon$, $\tilde{\xi}\left(\tilde{\lambda}_\eta{}^{\ell}, \tilde{\beta}^{\ell}\right) \preccurlyeq \varepsilon$ $\tilde{\xi}(\tilde{\lambda}_\eta{}^{u}, \tilde{\beta}^{u}) \preccurlyeq \varepsilon$, $\tilde{\xi}(\tilde{\mu}_\eta{}^{u}, \tilde{\gamma}^{u}) \preccurlyeq \varepsilon$. This means that $\left[\tilde{\xi}(\tilde{\mu}_\eta{}^{\ell}, \tilde{\gamma}^{\ell}), \tilde{\xi}(\tilde{\mu}_\eta{}^{u}, \tilde{\gamma}^{u})\right] \preccurlyeq \bar{\varepsilon}$ and $\left[\tilde{\xi}\left(\tilde{\lambda}_\eta{}^{\ell}, \tilde{\beta}^{\ell}\right), \tilde{\xi}(\tilde{\lambda}_\eta{}^{u}, \tilde{\beta}^{u})\right] \preccurlyeq \bar{\varepsilon}$. So that $\tilde{\Pi}([\tilde{\mu}_\eta], [\tilde{\gamma}]) \preccurlyeq \bar{\varepsilon}$ and $\tilde{\Pi}([\tilde{\lambda}_\eta], [\tilde{\beta}]) \preccurlyeq \bar{\varepsilon}$.

Theorem 3.7. Let $([\tilde{Z}_\eta] = [\tilde{\mu}_\eta][+]i[\tilde{\gamma}_\eta]), ([\widetilde{W}_\eta] = [\tilde{\lambda}_\eta][+]i[\tilde{\beta}_\eta]), ([W'_\eta] = [\tilde{\delta}_\eta][+]i[\tilde{\Delta}_\eta]) \subset [\tilde{\mathcal{F}}^{**}_{\neg N}]$ and $([\tilde{Z}] = [\tilde{\mu}][+]i[\tilde{\gamma}]), ([\widetilde{W}] = [\tilde{\lambda}][+]i[\tilde{\beta}]), ([\widetilde{W}'] = [\tilde{\delta}][+]i[\tilde{\Delta}]) \in [\tilde{\mathcal{F}}^{**}_{\neg N}]$, $[*] \in \{[+], [-], [\cdot], [/]\}$. If $([\tilde{Z}_\eta]) \xrightarrow{[\gamma^\star,\gamma^{\star\star}]-le} [\tilde{Z}]$ and $([\widetilde{W}_\eta]) \xrightarrow{[\gamma^\star,\gamma^{\star\star}]-l} [\widetilde{W}]$, then

1. $([\tilde{Z}_\eta])[*]([\widetilde{W}_\eta]) \xrightarrow{[\gamma^\star,\gamma^{\star\star}]-l} [\tilde{Z}][*][\widetilde{W}]$.
2. $[\tilde{Z}] = [\widetilde{W}]$ where $([\tilde{Z}_\eta])$ is also $[\gamma^\star, \gamma^{\star\star}]$-level converges to $[\widetilde{W}]$.
3. $([\widetilde{W}'_\eta]) \xrightarrow{[\gamma^\star,\gamma^{\star\star}]-l} [\widetilde{W}']$ where $[\tilde{Z}] = [\widetilde{W}]$ and $[\tilde{Z}_\eta] \preccurlyeq [\widetilde{W}'_\eta] \preccurlyeq [\widetilde{W}_\eta]$.
4. $[\tilde{Z}] \preccurlyeq [\widetilde{W}']$ where $[\tilde{Z}_\eta] \preccurlyeq [\widetilde{W}']$.

Proof: By hypothesis, we have ${}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\mu}_{\eta}] \longrightarrow {}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\mu}]$, ${}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\gamma}_{\eta}] \longrightarrow {}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\gamma}]$, ${}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\lambda}_{\eta}] \longrightarrow {}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\lambda}]$, ${}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\beta}_{\eta}] \longrightarrow {}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\beta}]$, ${}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\delta}_{\eta}] \longrightarrow {}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\delta}]$, ${}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\Delta}_{\eta}] \longrightarrow {}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\Delta}]$. Hence

1. ${}^{[\gamma^{\star},\gamma^{\star\star}]+}([\tilde{Z}_{\eta}][*][\widetilde{W}_{\eta}]) = {}^{[\gamma^{\star},\gamma^{\star\star}]+}\left(\left[\underline{\tilde{Z}}_{\eta}, \overline{\tilde{Z}}_{\eta}\right][*]\left[\underline{\widetilde{W}}_{\eta}, \overline{\widetilde{W}}_{\eta}\right]\right)$

$= {}^{[\gamma^{\star},\gamma^{\star\star}]+}\left(\left[\underline{\tilde{Z}}_{\eta}, \overline{\tilde{Z}}_{\eta}\right]\right) * {}^{[\gamma^{\star},\gamma^{\star\star}]+}\left(\left[\underline{\widetilde{W}}_{\eta}, \overline{\widetilde{W}}_{\eta}\right]\right)$

$= {}^{[\gamma^{\star},\gamma^{\star\star}]+}([\tilde{Z}_{\eta}]) * {}^{[\gamma^{\star},\gamma^{\star\star}]+}([\widetilde{W}_{\eta}])$

$\longrightarrow {}^{[\gamma^{\star},\gamma^{\star\star}]+}([\tilde{Z}]) * {}^{[\gamma^{\star},\gamma^{\star\star}]+}([\widetilde{W}])$

$= {}^{[\gamma^{\star},\gamma^{\star\star}]+}\left(\left[\underline{\tilde{Z}}, \overline{\tilde{Z}}\right]\right) * {}^{[\gamma^{\star},\gamma^{\star\star}]+}\left(\left[\underline{\widetilde{W}}, \overline{\widetilde{W}}\right]\right)$

$= {}^{[\gamma^{\star},\gamma^{\star\star}]+}\left(\left[\underline{\tilde{Z}}, \overline{\tilde{Z}}\right][*]\left[\underline{\widetilde{W}}, \overline{\widetilde{W}}\right]\right)$

$= {}^{[\gamma^{\star},\gamma^{\star\star}]+}([\tilde{Z}][*][\widetilde{W}])$

2. ${}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\mu}_{\eta}] \longrightarrow {}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\mu}]$, ${}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\gamma}_{\eta}] \longrightarrow {}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\gamma}]$, ${}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\mu}_{\eta}] \longrightarrow {}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\lambda}]$, ${}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\gamma}_{\eta}] \longrightarrow {}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\beta}]$. Implies ${}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\mu}] = {}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\lambda}]$ and ${}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\gamma}] = {}^{[\gamma^{\star},\gamma^{\star\star}]+}[\tilde{\beta}]$, this implies that $[\tilde{\mu}] = [\tilde{\lambda}]$ and $[\tilde{\gamma}] = [\tilde{\beta}]$. Hence $[\tilde{Z}] = [\widetilde{W}]$.

3. $\tilde{\mu}^{l} = \tilde{\lambda}^{l}$, $\tilde{\mu}^{u} = \tilde{\lambda}^{u}$, $\tilde{\gamma}^{l} = \tilde{\beta}^{l}$, $\tilde{\gamma}^{u} = \tilde{\beta}^{u}$, $\tilde{\mu}^{l}{}_{\eta} \preccurlyeq \tilde{\delta}^{l}{}_{\eta} \preccurlyeq \tilde{\lambda}^{l}{}_{\eta}$, $\tilde{\mu}^{u}{}_{\eta} \preccurlyeq \tilde{\delta}^{u}{}_{\eta} \preccurlyeq \tilde{\lambda}^{u}{}_{\eta}$ and $\tilde{\gamma}^{l}{}_{\eta} \preccurlyeq \tilde{\Delta}^{l}{}_{\eta} \preccurlyeq \tilde{\beta}^{l}{}_{\eta}$, $\tilde{\gamma}^{u}{}_{\eta} \preccurlyeq \tilde{\Delta}^{u}{}_{\eta} \preccurlyeq \tilde{\beta}^{u}{}_{\eta}$. Implies $[\tilde{\mu}] = [\tilde{\lambda}]$, $[\tilde{\gamma}] = [\tilde{\beta}]$, $[\tilde{\mu}_{\eta}] \preccurlyeq [\tilde{\delta}_{\eta}] \preccurlyeq [\tilde{\lambda}_{\eta}]$ and $[\tilde{\gamma}_{\eta}] \preccurlyeq [\tilde{\Delta}_{\eta}] \preccurlyeq [\tilde{\beta}_{\eta}]$. From theorems on GCNFNs we have $[\tilde{\delta}_{\eta}] \xrightarrow{[\gamma^{\star},\gamma^{\star\star}]-level} [\tilde{\delta}]$ and $[\tilde{\Delta}_{\eta}] \xrightarrow{[\gamma^{\star},\gamma^{\star\star}]-l} [\tilde{\Delta}]$. Hence $([\widetilde{W}'_{\eta}]) \xrightarrow{[\gamma^{\star},\gamma^{\star\star}]-l} [\widetilde{W}']$

4. Obvious.

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دەربارەی یەك لـە دوای یەكە ئاڵۆزە تەماوییەكان

پوختە

لـەم توێژینەوە یە چەمكەكانی ژمارە تەماوییەكان لـە شیوازی CN، ژمارە سنورداره ئاڵۆزە تەماوییەكان لـە شێوازی CN وە یەك لـەدوای یەكی ژمارە سنورداره ئاڵۆزە تەماوییەكان لـە شیوازی CN بە نسبەت ئاستی-γ پێشكەش كران و لیكۆڵینەوەو گشتاندنمان بۆكردوون و چەند ئەنجامییێكمان دەستكەوتووە. هەروەها چەمكەكانی دووری لێڵی $\tilde{\xi}$، $\tilde{\Pi}$ وە $\tilde{\Gamma}$ بۆ ژمارە تەماوییەكان لـە شیوازی CN، ژمارە تەماوییە گشتییەكان لـە شیوازی CN وە ژمارە سنورداره ئاڵۆزە تەماوییە گشتییەكان لـە شیوازی CN پێشكەش كرانو لیكۆڵینەوەمان لـەسەركردوون و هەندێ لـە تایبەتمەندییەكانیانمان خستووەتە روو كە ڕۆڵی زۆر گرنگ دەبینن لـە لیكۆڵینەوەی یەك لـەدوای یەكە تەماوییە ئاڵۆزەكان.

حول المتتابعات العقدية الضبابية

الخلاصة

في هذا البحث تم تقديم و دراسة مفاهيم الاعداد الضبابية من النمط (CN) ، الاعداد العقدية المغلقة والمقيدة الضبابية من النمط (CN) و متتابعات هذه الاعداد بدلالة (γ -level) واعطيت بعض التعميمات لها و كذلك تم تقديم و دراسة مفاهيم البعد الضبابي $\tilde{\xi}$ ، $\tilde{\Pi}$ و $\tilde{\Gamma}$ للاعداد الضبابية من النمط (CN) ، الاعداد الضبابية من النمط (CN) المعممة و الاعداد العقدية المغلقة والمقيدة الضبابية من النمط (CN) المعممة حيث تم اعطاء بعض الخواص الاساسية و بعض التعميمات لها و التي تلعب دورا مهما في دراسة المتتابعات العقدية الضبابية .

LEAD AND SOME TRACE ELEMENTS CONCENTRATION IN COCOA CANDIES

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ABSTRACT

The distribution of lead, zinc, lithium, aluminum, cerium, vanadium, antimony and arsenic was investigated in cocoa candy samples collected from Basra local markets. The samples were analyzed by inductively coupled plasma-mass spectrometer (ICP-MS). Concentration of these trace elements (µg/g fresh weight) ranged between 0.1065 – 0.4371 for pb, 0.1791 – 1.289 for Li, 8.460 – 52.0728 for Al, and from not detected to 0. 2923, 0.0091 and 0.0272 for Ce, V and Sb respectively, while As was not detected in all samples.

The average amount of trace elements present in samples in general, below the maximum permitted concentration. These data indicate that the consumption of candies are safe in moderate quantities.

KEYWORDS. Trace Elements, Lead, Cocoa, Contamination

1. INTRODUCTION

Trace elements are an important source of food contamination. The main menaces to human health are associated with exposure to lead, arsenic cadmium and copper (Jarup, 2003). Normally the food chain is exposure to pollution by trace elements in industrial sluge and sediment (Islam et al., 2009). All the vegetables commonly consumed in diets contain dangerously high concentrations of trace elements (Alam, 2003). Chocolate is a complex sample with a high content of organic compounds (Leggli *et al.*, 2011). It contains essential trace elements and nutrients like iron, calcium and potassium and some vitamins on the other hand it has highest natural source for magnesium where as lead is very harmful element to human body. Most studies were determinate trace elements in food such as Hashim and Hamid (1995) they were focusing in evaluation of trace elements in the diet of female university students. Hamurcu *et al.* (2010) showed that pb and Zn has high levels in the fruit samples. The French food safety agency (AFSSA) estimated dietary exposures to the main minerals and trace elements from 1319 samples of food typically consumed by the French population, one of them was dark chocolate have the highest levels of Cr, Mn, Co, Ni and Cu (Noel *et al.*, 2012). While minor studies focus in candy, Onianwa *et al.*(1999) found the average lead content of cocoa powder in Nigeria to be 310 ng/g with a range of 80 – 880 ng/g while the Dahiya *et al.* (2005) found the range of lead concentrations in cocoa-based chocolates in India between 0.05 – 8.3 µg/g. Chocolate products and the manufactured cocoa contain relatively high levels of lead contaminant compared with baseline value for Nigerian cocoa beans used in making those products indicate most lead contamination in those products occurs after the beans harvested and dried, during the shipping of beans and / or the manufacturing of cocoa , chocolate bonbons and the other source of contamination of the finished products is tentatively attributed to atmospheric emissions of leaded gasoline during fermentation and sun drying of beans (Rankin *et al.*, 2005). Kim *et al.* (2010) indicate that harmful metals such as pb and cr could migrate from the printed outer packages to food, lead was detected at concentrations of 110.3 – 1429.3 mg / kg in candy. In addition to Leggli *et al.* (2011) study some trace element in chocolate samples. For these reasons above this study focus to determinant lead and other elements perhaps available in candy due to contamination for protection public health against the hazardous of elements toxicity.

2. MATERIALS AND METHODS

Candies were collected from Iraqi markets (Basra), in two orders of same type, the period between first and second order one month. All these candies cover with cocoa, available, cheap and likely for kids; on the other hand, it was differ in originator. Cocoa was isolated from 5 pieces by plastic knife than, homogenized by

porcelain mortar. About 1g of cocoa (triplicate) was then put in digestive tubes, mixed with 10 ml HNO_3 and 5ml $HCLO_4$, incubated for 6 hours in laboratory temperature, the mixture was heated up to 150 c for 1 hour. The tubes were removed and allowed to cool after that 2 ml of H_2O_2 were added (the addition of H_2O_2 can increase the solubilizing power of acids and decomposition of organic matter), tubes were heated again for five hours until the HNO_3 boils off and $HCLO_4$ white fumes begin to appear digestion was complete. Samples were filtrated through Whatman No. 1 filter paper and th en diluted to 25 ml volume with deionized water according to Twyman (2005).

A blank digest were carried out in the same way. The mineral contents of the samples were quantified against standard solutions of know concentrations which were analyzed concurrently (skujins, 1998). The samples were run on an inductively coupled plasma mas spectrometer (ICP-MS). All reagents were of analytical grade, deionised water was used throughout, glassware were washed in diluted HNO_3 and rinsed with deionised water.

Statistical analysis

Data from concentration of 8 elements in cocoa were compared for both orders by independent samples T- test and correlations. Data analysis was carried out using the soft ware program SPSS 16. Differences were considered significant at P< 0.01 by one way ANOVA between trace elements.

3. RESULTS

In this study, a total number of 120 candy pieces were collected from Iraqi market. About 66.67 % from candies were Turkish, 16.67 Syrian, 8.33 Iranian and 8.33 Iraqis as available in markets. Concentrations of trace elements (pb, Zn, Li, Al, Ce, V, Sb and As) in candies between two orders and each other were compared. The overall concentrations in this studied cocoa were provide in tables 1 to 7 and presented in µg/g wet weight. The order of mean elements concentration in cocoa samples was Zn> Al > pb > Li > Ce > Sb > V > As. Approximate average in both orders were found for pb, the values range between 0.1065 – 0.4317 µg/g fresh weight was observed in Turkish sample (tab. 1) pb concentrations were detected in all samples as well as Zn, Al and Li. The highest values of zinc was 50.743 µg/g fresh wt. and lowest values was 0.3065 µg/g fresh wt. The levels of Li in cocoa are shown in Tab 3, highest and lowest values were 1.266 and 0.1791 µg/g fresh wt. found in same product. Sample no.2 was has highest concentration of Al in both orders while the lowest concentration was in sample no. 4 reach to 9.2046 µg/g fresh wt. as showed in Tab. 4. on the other hand, the Ce, V and Sb concentrations were showed in Tab. (5,6 and 7) and found to be present in some samples only especially for Sb that available in one sample only while As was not detected in all samples.

Significant differences to all elements were not found between orders (p>0.01) while Significant differences found (p<0.01) between Zn and pb, Li, Ce, V, Sb and (p<0.01) between al and pb, Li, Ce, V, Sb.

Table (1): lead concentrations and SD in cocoa by µg/g fresh wt.

Pb		***first order***		**second order**	
no.	country	con.	SD	con.	SD
1	Turkey	0.2091	0.0061	0.2091	0.0577
2	Turkey	0.3188	0.0683	0.4371	0.0656
3	Turkey	0.3474	0.0817	0.2059	0.0993
4	Turkey	0.1065	0.0117	0.1065	0.0521
5	Turkey	0.1125	0.0384	0.179	0.0333
6	Turkey	0.2729	0.0563	0.1753	0.0708
7	Turkey	0.2792	0.0858	0.1306	0.0956
8	Turkey	0.1669	0.0410	0.238	0.0515
9	Iraq	0.2458	0.0135	0.2692	0.0523
10	Iran	0.1885	0.0139	0.1644	0.0175
11	Syria	0.3583	0.0624	0.1502	0.0711
12	Syria	0.2042	0.0086	0.1893	0.0540
correlation 0.313447			p> 0.01		

Table (2): Zinc concentrations and SD in cocoa by µg/g fresh wt.

Zn		***first order***		**second order**	
no.	country	con.	SD	con.	SD
1	Turkey	0.3065	0.0577	3.2727	0.0585
2	Turkey	20.0021	0.9504	50.743	0.5011
3	Turkey	43.7327	0.5000	23.3597	0.8083
4	Turkey	14.5723	0.9517	13.7175	0.1166
5	Turkey	14.194	1.4422	21.521	0.7071
6	Turkey	29.4661	1.0149	18.0682	0.5980
7	Turkey	20.2819	0.4448	24.1161	0.5469
8	Turkey	19.2519	0.5132	30.5422	0.6017
9	Iraq	26.5543	0.5774	21.4934	0.7211
10	Iran	27.5352	1.0786	19.4057	1.5275
11	Syria	23.5258	0.7211	8.3398	0.2150
12	Syria	6.7809	0.4041	8.8963	0.5179
correlation 0.340574			p> 0.01		

Table (3): Lithium concentrations and SD in cocoa by µg/g fresh wt.

Li		***first order***		**second order**	
no.	country	con.	SD	con.	SD
1	Turkey	0.8253	0.0344	0.7658	0.0361
2	Turkey	0.5211	0.0169	0.4918	0.0169
3	Turkey	0.4958	0.0818	0.3541	0.0818
4	Turkey	0.3321	0.0577	0.3321	0.0064
5	Turkey	0.2650	0.0111	0.2843	0.0108
6	Turkey	0.2937	0.0285	0.2443	0.0285
7	Turkey	1.2669	0.6280	0.1791	0.0476
8	Turkey	0.9972	0.1017	1.1734	0.3847
9	Iraq	0.4772	0.0489	0.3925	0.0763
10	Iran	0.2597	0.0438	0.1839	0.0438
11	Syria	0.7049	0.0729	0.5787	0.0706
12	Syria	0.6080	0.0778	0.4732	0.0778
correlation 0.455854			p> 0.01		

Table (4): Aluminum concentrations and SD in cocoa by µg/g fresh wt.

Al		***first order***		**second order**	
no.	country	con.	SD	con.	SD
1	Turkey	9.4984	0.4028	13.196	1.0151
2	Turkey	35.4954	1.9760	52.0728	1.9760
3	Turkey	20.4124	0.6333	19.3155	0.6333
4	Turkey	9.6402	0.5774	9.2046	0.5884
5	Turkey	9.3012	0.7294	10.5646	0.7294
6	Turkey	18.1138	0.8845	13.3501	0.8845
7	Turkey	18.8718	0.7654	21.497	1.5386
8	Turkey	18.4527	0.7308	25.7184	1.1354
9	Iraq	18.2401	1.3858	15.8398	0.5035
10	Iran	18.0675	1.0396	13.5596	0.2932
11	Syria	17.593	1.2315	8.460	0.2672
12	Syria	21.9592	0.4718	8.6264	0.7071
correlation 0.796741			p> 0.01		

Table (5): Cerium concentrations and SD in cocoa by µg/g fresh wt.

Ce		***first order***		**second order**	
no.	country	con.	SD	con.	SD
1	Turkey	0.0002	0.0001	ND	0
2	Turkey	ND	0	0.0796	0.0230
3	Turkey	0.0215	0.0027	ND	0
4	Turkey	ND	0	ND	0
5	Turkey	ND	0	0.0333	0.0120
6	Turkey	0.2923	0.0574	0.0364	0.0034
7	Turkey	0.0126	0.0034	ND	0
8	Turkey	0.0152	0.0030	0.0156	0.0040
9	Iraq	0.0030	0.0009	ND	0
10	Iran	0.1454	0.0442	0.0334	0.0034
11	Syria	ND	0	ND	0
12	Syria	ND	0	ND	0
correlation 0.311866			p> 0.01 ND= not detected		

Table (6): Vanadium concentrations and SD in cocoa by µg/g fresh wt.

Zn		***first order***		**second order**	
no.	country	con.	SD	con.	SD
1	Turkey	ND	0	ND	0
2	Turkey	ND	0	ND	0
3	Turkey	ND	0	ND	0
4	Turkey	ND	0	ND	0
5	Turkey	ND	0	ND	0
6	Turkey	ND	0	ND	0
7	Turkey	ND	0	0.034	0.0091
8	Turkey	0.0040	0.0015	ND	0
9	Iraq	ND	0	ND	0
10	Iran	ND	0	ND	0
11	Syria	0.0044	0.0013	ND	0
12	Syria	ND	0	ND	0
correlation -0.13466			p> 0.01 ND= not detected		

Table (7): Antimony concentrations and SD in cocoa by µg/g fresh wt.

Sb		***first order***		**second order**	
no.	country	con.	SD	con.	SD
1	Turkey	ND	0	ND	0
2	Turkey	ND	0	ND	0
3	Turkey	0.0272	0.0084	ND	0
4	Turkey	ND	0	ND	0
5	Turkey	ND	0	ND	0
6	Turkey	ND	0	ND	0
7	Turkey	ND	0	ND	0
8	Turkey	ND	0	ND	0
9	Iraq	ND	0	ND	0
10	Iran	ND	0	ND	0
11	Syria	ND	0	ND	0
12	Syria	ND	0	ND	0
p> 0.01			***ND= not detected***		

4. DISCUSSION

Trace elements are of high ecology significance since they are not removed from soil as a result of self purification, but accumulated in reservoirs and enter the food chain (Loska and Wiechu, 2003). All the cocoa plantations in Nigeria were polluted with some trace elements (Aikpokpodion *et al.*, 2010). The concentration of Zn and pb in soil may be derived from various sources including anthropogenic pollution, weathering of natural high background rocks and metal deposits (Senesi *et al.*, 1999). According to Howe, *et al.* (2005) all the study results for As and Ce were below the respective sample detection limits but even among these, some of the maximum values observed indicated that the source of cocoa powder was different in origin or industrial contamination take place. Some pb (0.3583 – 0.4371 µg/g) occur at concentration levels above these reported from the other countries but it seems unlikely that most of these will contribute significantly to public health risks as reported in Howe *et al.*(2005). Some trace element were detected at high concentration may be due to migration of element from the printed outer packages to candy (Kim *et al.*, 2008)

Zinc is distributed widely in plant and animal tissues and presents in all living cells. It is essential for plants in lipid and carbohydrate metabolism and is required at levels of 10 – 20 ppm (Kabata-pendias and Pendias, 1992). Therefore, it was normally available in cocoa and it was not harmful for children if they take up with the current reference daily intake 15 mg/day (Acholonu, 2005) but over load of Zn > 100 mg/ day also can be dangerous. It can depress the immune system and cause anemia (Akhter *et al.*, 2002) therefore Zn levels in cocoa was conceder normal and cocoa not contamination even at high concentration like 50.743 µg/g wet weigh.

The aluminum concentration in this study lowest than Leggli *et al.*(2011) of (27.2 – 92.1 µg/g) for dark chocolate. The FAO/WHO Expert Committee on food additives (1989) has established a provisional tolerable daily intake of 1 mg/kg of body weigh, which equates to a tolerable daily intake of 70 mg for a 70 kg adult. The amount of Al resulting in this study does not

pose a hazard for a healthy population (Leggli *et al.*,2011)

Lithium concentration was high (0.1839 – 1.2669 µg/g fresh wt.) compared with Noel *et al.* (2012) was 0.008 µg/g fresh wt. (max 0.013) in dark chocolate, due to differences in origin or industrial contamination occurrence (Rankin *et al.*, 2005)

Vanadium concentration was below (0.034 µg/g) and available in three samples only, Hepkins and Mohr (1974) clarify essentiality of V in man has been hypothesized but not demonstrated. V was believed to be involved in N_2 fixation but it has not been proved to be essential for plants, it is essential for some animal but it not required by humans, levels required by animal for optimum growth are 0.05 – 0.5 ppm in food and toxic in large amounts (Van Zinderen Bakker and Jaworski, 1980). Plants may be required vanadium at low levels (0.002 ppm) (Tisdale *et al.*, 1985). Thus we can consider cocoa candy in this study without contamination by vanadium. Howe *et al.*(2005) reported that As concentration in crops (ginger) were generally low (0.001 – 0.016 µg/g dry wt.) as well as Demirozu and Saldaml (2002) reported arsenic values varying between 21.87 and 29.00 ng/g and 42.63 and 57.02 ng/g in the semolina and Wheat respectively while in this study was not available in all cocoa samples.

This result will compliment available baseline data on food composition in Iraq and will be useful in estimating dietary intake of these metals in the general Iraqi children.

5. REFERENCE

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الخلاصة

شخص توزيع الرصاص والليثيوم والالمنيوم والسيروم والفاناديوم والانتيمون والزرنيخ في عينات كاكاو الحلويات المجموعة من اسواق البصرة. حللت العينات بجهاز inductively coupled plasma-mass spectrometer **تراوح تركيز العناصر الترة (مايكوغرام / غرام وزن رطب) من** 0.1065 – 0.4371 **للرصاص و** 0.1791- 1.289 **لليثيوم و**8.460 – 52.0728 **للالمنيوم وتراوح التركيز من غير المحسوس الى** 0.2923 **و**0.0091 **و**0.0272 **لعناصر السيروم والفاناديوم والانتيمون على التوالي بينما الزرنيخ ليس له تركيز محسوس في جميع العينات.**

معدل تركيز العناصر في العينات كان اقل من الحد الاعلى المسموح به وهذا يشير الى الاستهلاك الأمن لتلك الحلويات.

SYNTHESIS AND STUDY OF SOME PYRAZOLINES AND PYRIMIDINES DERIVATIVES

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ABSTRACT

The present work includes the preparation of a series of substituted chalcones (1-5) and condensation of these chalcones with phenyl hydrazine and thiosemicarbazide to afford the new pyrazolines (6-12) through 1,4 nuclephilic addition (Michael addition) under basic condition . Also some new pyrimidines (13-16) were prepared by 1,4 nucleophilic addition of guanidine hydrochloride to the chalcones under basic condition . The spectroscopic methods and physical properties were used to confirm the structure of the new product . The suggested mechanisms of most of the reactions were investigated theoretically on the basis of the values of heat of formation and steric energy of the product.

INTRODUCTION

Pyrazolines and pyrimidines could be prepared by several methods, the most important method is the nucleophilic addition in wich the α,β-unsaturated carbonyl react with substituted hydrazine [Li J.T.*et al.,* 2007, Kamble R.R. et al., 2008, Behrooz M.*etal*.2009, Albert L. *et al.,* 2009, Ravindra K.*et al.,* 2010, Uandana S. *et al.,* 2009, Sridevi C.*et al.,* 2010.] and quinoline [Sridevi C.*etal.*, 2010, Naik T.A. *et al.,* 2007, Rahman S.A. *et al.,* 2009, Ramesh B. *et al.,* 2009, Kuomar D.B.*et al.,* 2006]respectively . the continuous interest in pyrazoline chemistry which was manifested by numerous papers are attributed to their biological activities as antimicrobial [Hirose M.*et al.,* 2009, Hammam A.G. *et al.,* 2000] anti-inflammatory [Chementi F.*et al.,* 2005, Palaska E.*et al.,* 2001], antidepressant and anticonvulsant activities [Zuhal Özdemir *et al.,* 2007]. On the other hand, pyrmidine derivative are known to possess anticancer [L.W.Wattenberg *et al.,* 1994, A.T.Dinkova-Kostova *et al.,* 1998], anticytotoxic [C.CYit *etal* 1994], antimicrobial [Y.Rajendia Prasad*et al.,* 2007,Ramesh B. *et al.,* 2009.]. In the present work the synthesis of some new substituted pyrazoline and pyrimidine were achieved.

EXPERMENTAL:

I. Instrumentation :

1. Melting point were determined by Electrothermal 9000 Digital series 1998 apparatus (uncorrected).

2. Ultraviolet spectra were obtained using SPECORD200 UV-Visible double beam Analytikjenta spectrophotometer.

3. Fourier-Transform Infrared (FT-IR) spectrophotometer.

II. Synthesis :

1. Preparation of chalcone (1-5) [B.Ramesh *et al.,* 2010.]**:**

General procedure

A mixture of 2-acetylfuran (0.01mol) and appropriate aromatic aldehyde (0.01mol) was stirred in ethanol (30 ml) and then an aqueous solution of KOH (40%,15 ml) was added to it. The mixture was kept overnight at room temperature and then it was poured in to crashed ice and acidified with HCl. The solid separated was filtered and crystallized from ethanol. The structure, name, some physical properties and spectra data were illustrated in Table(1).

2. Preparation of 3-(2-furyl)-1-(sub. Phenyl)-5-phenyl-4,5-dihydro-1H-pyrazole (6-9) [Ramesh B. *et al.,* 2010]**:**

General procedure:

A chalcone of 2-acetylfran (1-5) (0.005mol) dissolved in (20ml) of ethanol and phenylhydrazine (0.01mol) was added to it .To this mixture (20ml,0.025mol) of ethanolic sodium hydroxide was added dropwise at room temperature with stirrer .After that the mixture was refluxed for 4 hours. The product was poured into ice water and the crude product which was separated out was filtered and crystallized from ethanol.Table(2).

3. Preparation of 3-(2-furyl)-5-sub. Phenyl -4,5-dihydro-1H-pyrazole-1-carbothioamide. (10-12)[Ramesh B. *et al.,* 2010]**:**

General procedure :

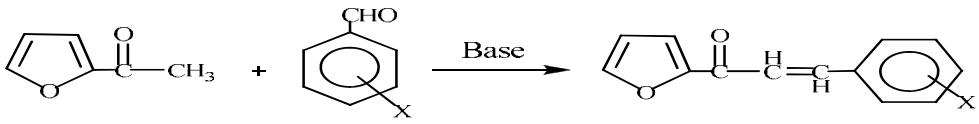
The solution of appropriate chalcone (1-5) (0.005mol) and thiosemicarbazide (0.01mol) in

ethanol(50ml) was stirred . To this mixture (0.025 mol in 5ml water) of sodium hydroxide was added .The mixture was refluxed for 2 hours. The product was poured into ice water and the crude product which was separated out was filtered ad crystallized from ethanol. Table(2).

4. Preparation of 4-(2-furyl)-6-sub. Phenyl pyrimidine-2-amine (13-16)[Ramesh B. *et al.*, 2009]**:**

General procedure:

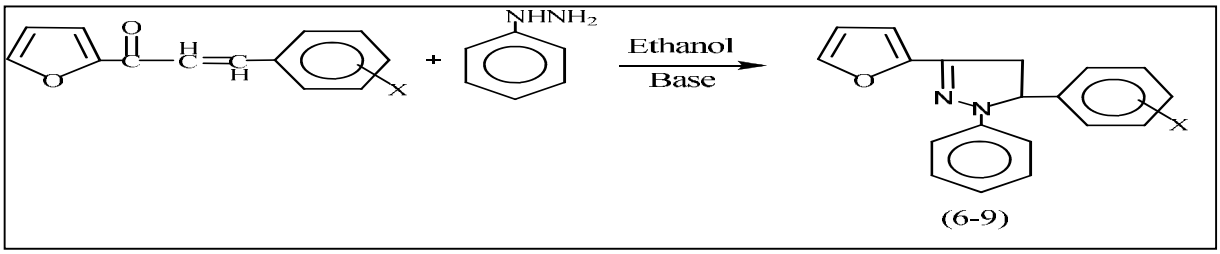
A mixture of chalcones of 2-acetylfuran (1-5) (0.005mol) and guanidine hydrochloride (500mg) in absolute ethanol (10ml) was stirred for 10 minutes. To this mixture (20ml, 0.025mol) of ethanolic sodium hydroxide was added dropwise. The mixture was refluxed on a water bath for 4-6 hours .The solvent was completely evaporated and residue was poured in to ice water . The precipitated solid was collected by filtration and crystallization from ethanol. Table(3)



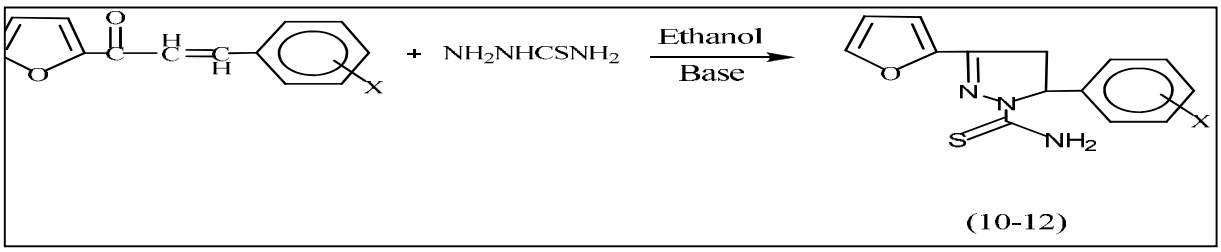
(1-5)

Table(1): The structure ,name ,some physical properties and spectra data of (1-5) compounds

Comp. No.	X	Name	m.p. (C°)	Yield (%)	U.V ($CHCl_3$) λmax(nm)	IR(KBr)cm^{-1}	
						C=O	C=C
1	2-Cl	3-(2-chlorophenyl)-1-(2-furyl)-2-propen-1-one	107-109	75	246	1720	1635
2	3-Cl	3-(3-chlorophenyl)-1-(2-furyl)-2-propen-1-one	70-72	80	245	1710	1620
3	4-OCH_3	3-(4-methoxyphenyl)-1-(2-furyl)-2-propen-1-one	76-78	85	243	1700	1610
4	3,4-diOCH_3	3-(3,4-dimethoxyphenyl)-1-(2-furyl)-2-propen-1-one	90-92	80	246	1690	1610
5	3-NO_2	3-(3-nitrophenyl)-1-(2-furyl)-2-propen-1-one	140-142	85	239	1730	1605



(6-9)

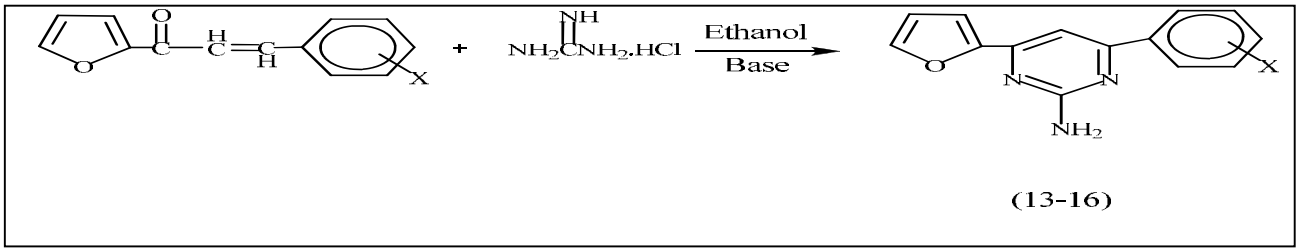


(10-12)

Table(2): The structure ,name ,some physical properties and spectra data of (6-12) 2-pyrazolines

Comp. No.	X	Name	m.p. (C°)	Yield (%)	Color	U.V ($CHCl_3$) Λmax	IR(KBr)cm-1		
							N-H	C=N	Other
6	2-Cl	5-(2-chlorophenyl)-3-(2-furyl) -4,5-dihydro-1H-pyrazole	133-135	58	Brown	330	---	1512	C-O-C 1060
7	4-OCH3	5-(4-methoxyphenyl)-3-(2-furyl) -4,5-dihydro-1H-pyrazole	146-148	80	Yellow	300	---	1510	C-O-C 1063
8	3,4-diOCH3	5-(3,4-dimethoxyphenyl)-3-(2-furyl)-4,5-dihydro-1H-pyrazole	150-152	75	Yellow	357	---	1505	C-O-C 1055
9	3-NO2	5-(3-nitrophenyl)-3-(2-furyl)- 4,5-dihydro-1H-pyrazole	162-164	60	Deep Brown	328	---	1528	C-O-C 1060
10	3-NO2	5-(3-nitrophenyl)-3-(2-furyl)-1-thiocarbamoyl- 4,5-dihydro pyrazole	182-184	53	Brown	331	3467	1614	C-O-C 1065 C=S 1357
11	2-Cl	5-(2-chlorophenyl)-3-(2-furyl)-1-thiocarbamoyl- 4,5-dihydro pyrazole	177-179	60	Brown	311	3460	1610	C-O-C 1070 C=S 1355
12	3,4-diOCH3	5-(3,4-dimethoxyphenyl)-3-(2-furyl)-1-thiocarbamoyl- 4,5-dihydro pyrazole	190-192	55	Yellow	348	3455	1599	C-O-C 1050 C=S 1350

compounds



Table(3):- The structure ,name ,some physical properties and spectra data of (13-16) ompounds

Comp. No.	X	Name	m.p. (C°)	Yield (%)	Color	U.V ($CHCl_3$) Λmax (nm)	IR(KBr)cm^{-1}		
							N-H	C=N	other
13	3-NO_2	6-(2-furyl) -4-(3-nitrophenyl) -2-aminopyrimidine	182-184	53	Brown	340	3317	1629	C=C 1590
14	4-OCH_3	6-(2-furyl) -4-(4-methoxyphenyl) -2-aminopyrimidine	170-172	65	Yellow	358	3335	1640	C=C 1599
15	3,4-diOCH_3	6-(2-furyl) -4-(3,4-dimethoxyphenyl) -2-aminopyrimidine	188-190	77	Yellow	344	3350	1630	C=C 1592
16	3-Cl	6-(2-furyl) -4-(3-chlorophenyl) -2-aminopyrimidine	130-132	72	Brown	320	3345	1635	C=C 1580

RESULTS AND DISSCATION

Claisen-Schimdt condensation had been used to afford the chalcones(1-5) to be used as a starting material to the pyrazolines and the pyrimidines products after their reaction with the phenyl hydrazine, thiosemicarbazide and guanidine hydrochloride respectively through 1,4 nucleophilic addition (Michael addition) (Scheme 1,2,3).

The UV spectra[L.W.Wattenberg *et al.,* 1994, A.T.Dinkova-Kostova*et al.,* 1998, B.Ramesh *et al.,* 2010] for (1-5) reflect arrange of (293-246)nm, which agree with the literature value for such compounds (n→π* bonds for α,β –unsaturated ketones).

The IR spectra[L.W.Wattenberg *et al.,* 1994, A.T.Dinkova-Kostova*et al.,* 1998, B.Ramesh *et al.,* 2010], showed arrange of stretching vibration of (1690-1730)cm^{-1} related to carbonyl group and a range of (1605-1635)cm^{-1} which concerns the carbon-carbon double bond (Table-1).

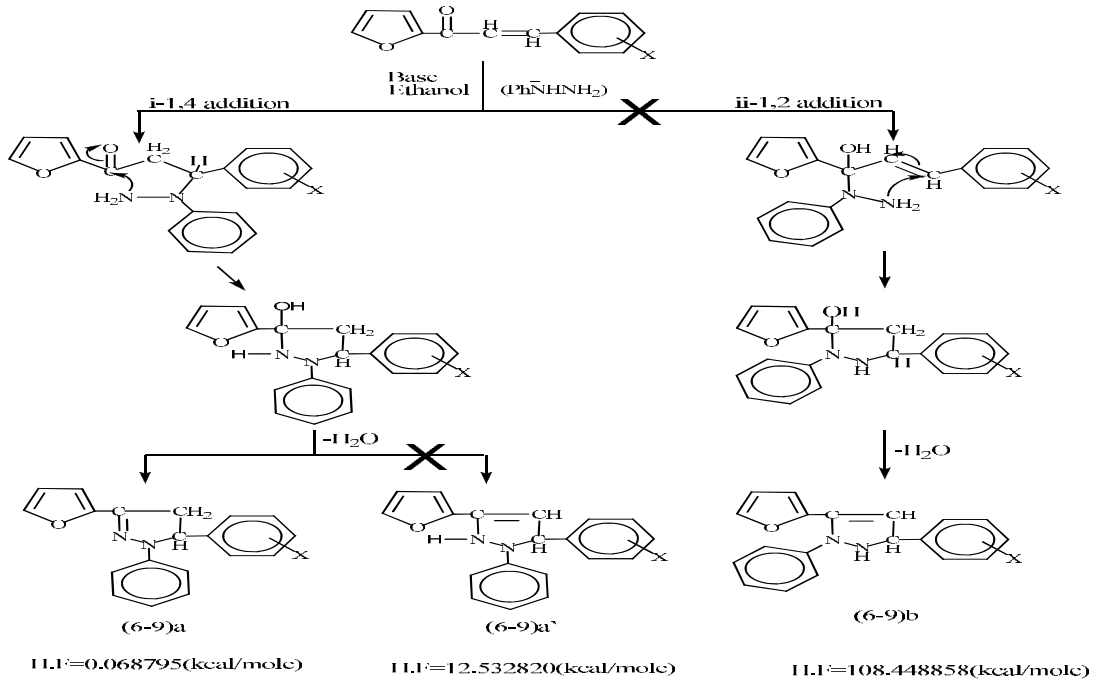
The afforded 2-pyrazolines (6-12) and their structures were supported using physical properties and valid spectral data (Table 2) , the UV spectra ,showed a range of (300-357)nm for the wave lengths at maximum absorption which lies in the range of similar compounds [Li J.T.*et al.,* 2007, Kamble R.R. *et al.,* 2008, Behrooz M.*etal*.2009, Albert L. *et al.,* 2009, Ravindra K.*et al.,* 2010, Uandana S. *et al.,* 2009, Sridevi C.*et al.,* 2010.,Ramesh B. *et al.,* 2010, Zuhal Özdemir *et al.,* 2007] .

The IR spectra manifested arrange of (1505-1614)cm^{-1} attributed to the carbon-nitrogen double bond stretching vibration,while the other(o-c-o)(ethereal) vibration seemed at the range of (1050-1070)cm^{-1} for the symmetrical vibration . For compounds (10-12) a brood bands seemed at (3455-3467)cm^{-1} is related to NH stretching vibration , finally ,the carbon-sulfur double bond stretching vibration denoted at arrange of (1350-1357)cm^{-1}.

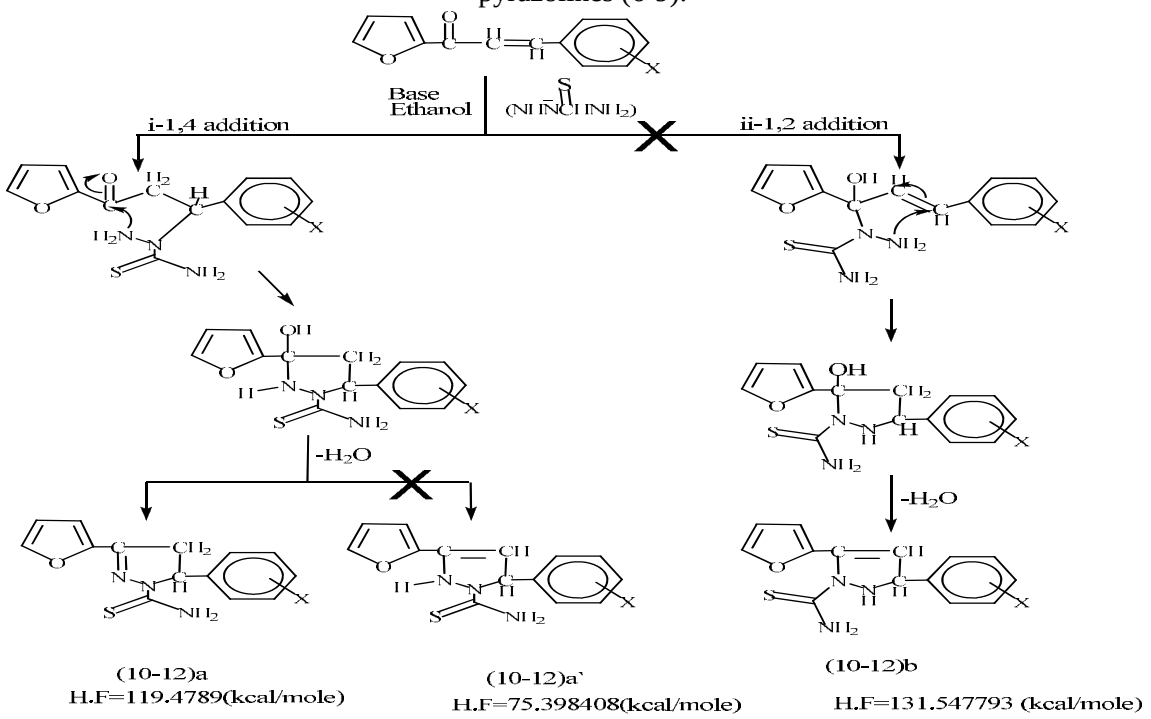
The nucleophilic addition of phenyl hydrazine and thiosemicarbazide to chalcones(1-5) is passed through the following suggested mechanism [A.R.Katrizky*et al.,* 1984] .

(Scheme 1 and 2) which include two route, the first include the attack on the carbon-carbon double bond by existing base (1,4-addition), while the second include the attack on the carbonyl group in chalcone (1,2-addition) followed by the loss of a water molecule to give a final product (6-12)a, (6-12)a` and (6-12)b respectively. In the light of the values of the heat of formation (H.F) and the steric energy (S.E) (Table 4), through these values shows that the compounds (6-12)a are the most stable and fastest preparation compared to the(6-12)a`and (6-12)b. On the light of spectroscopic evidences. The structures of final product (6-12)a may established as well as the Michael reaction (1,4-addition) is the most widely accepted.

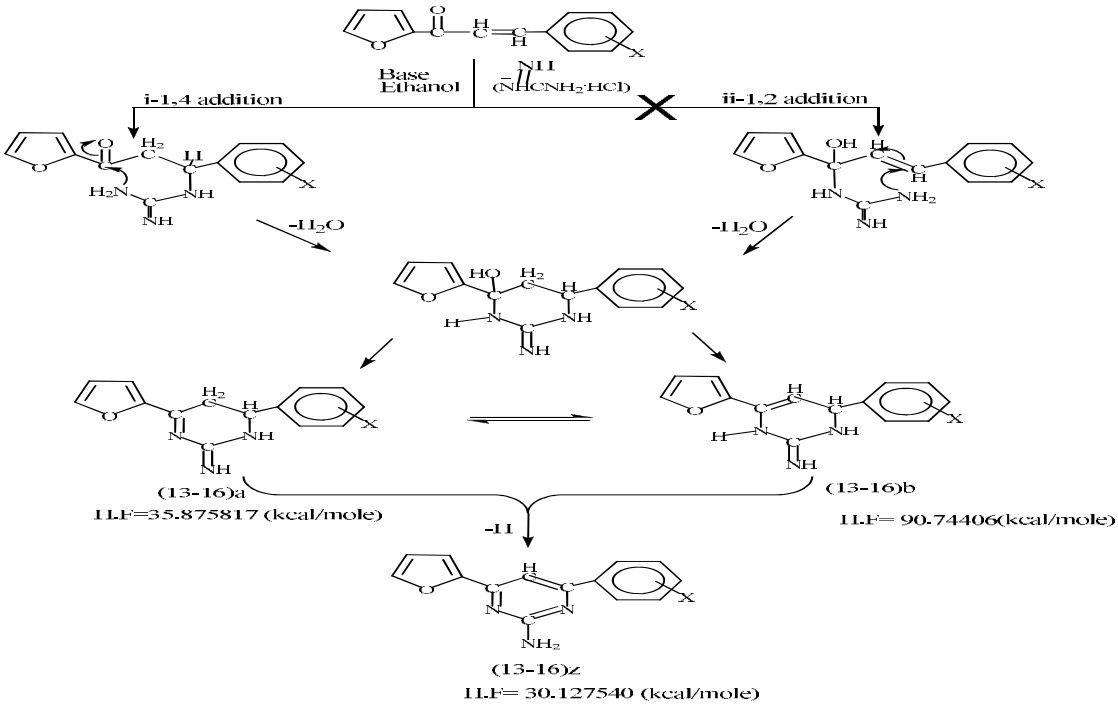
The 1,4-addition and 1,2-addition of quanidine hydrochloride in the alkaline medium to the chalcone (1-5) give the pyrimidines (13-16)z. The UV spectra showed arrange of (320-358)nm which is related to such cycles, that is to say that the presence of furan and phenyl with some different substituents causes the absorption at such λmax in addition to the pyrimidine ring. The most effective transition is the n→π*. The IR spectra showed arrange of absorption bands for carbon-nitrogen double bond (1629-1640)cm^{-1}, while broad bands in the range of(1629-1640)cm^{-1} related to the stretching vibration of N-H. The other carbon-carbon double bond vibration seemed at the range of (1580-1599)cm^{-1}. The spectroscopic methods and physical properties confirmed the validity the structure of the resulting compounds (13-16)z. Where they are found close to similar compound[Naik T.A. *etal* 2007, Rahman S.A.*et al.,* 2009, Ramesh B. *et al.,* 2009, Kuomar D.B.*et al.,* 2006,Hirose M. *et al.,* 2009,22].



Scheme 1:- mechanism of condensation of chalcones (1-5) with phenyl hydrazine to produce pyrazolines (6-9).



Scheme 2:- mechanism of condensation of chalcones (1-5) with thiosemicarbazide to produce pyrazolines (10-12).



Scheme 3:- mechanism of condensation of chalcones (1-5) with guanidine hydrochloride to produce pyrazolines (13-16).

Table (4):- Heat of formation (H.F) and Steric energy (S.E) of final products(6-16).

Comp. No.	X	H.F(kcal/mole)	S.E(kcal/mole)
6a	o-Cl	0.068795	55.779
6a′	o-Cl	12.532820	55.849
6b	o-Cl	108.448858	32.110
7a	p-OCH_3	-34.580317	66.271
7a′	p-OCH_3	93.915754	53.662
7b	p-OCH_3	39.199600	44.830
8a	3,4-diOCH_3	-70.355190	76.039
8a′	3,4-diOCH_3	-56.970393	72.841
8b	3,4-diOCH_3	1.420195	56.476
9a	m-NO_2	5.695648	70.203
9a′	m-NO_2	77.992529	66.487
9b	m-NO_2	79.218632	49.700
10a	m-NO_2	119.478946	58.334
10a′	m-NO_2	75.398408	73.530
10b	m-NO_2	131.547793	59.257
11a	o-Cl	109.644050	35.921
11a′	o-Cl	62.255489	51.849
11b	o-Cl	122.342283	37.220
12a	3,4-diOCH_3	41.82588	60.487
12a′	3,4-diOCH_3	-16.223336	68.300
12b	3,4-diOCH_3	55.077054	59.246
13a	m-NO_2	35.875817	71.413
13b	m-NO_2	30.127540	53.553
13z	m-NO_2	90.744062	91.447
14a	p-OCH_3	33324	54.833
14b	p-OCH_3	-10.663093	48.652
14z	p-OCH_3	57.392497	31.163
15a	3,4-diOCH_3	-42.885238	70.880
15b	3,4-diOCH_3	-48.540101	63.832
15z	3,4-diOCH_3	14.281066	55.018
16a	m-Cl	25.584738	55.616
16b	m-Cl	20.155731	38.087
16z	m-Cl	82.712189	25.798

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تحضير ودراسة بعض مشتقات البيرازولينات والبريميدينات

الخلاصة

يتضمن البحث تحضير سلسلة من الجالكونات المعوضة (1-5) وتكثيفها مع الفنيل الهيدرازين والثايوسيميكاربازايد في الوسط القاعدي لإنتاج البايرازولينات الجديدة (6-12) من خلال الإضافة النيوكليوفية (1،4). كما تم تكاثف الجالكونات المعوضة مع الكواندين هيدروكلورايد في ظروف قاعدية لإنتاج البريميدينات المقابلة (13-16). تم استعمال الطرق الطيفية والصفات الفيزيائية لإثبات تراكيب النواتج الجديدة .إن الميكانيكيات المقترحة لأكثر التفاعلات تم التحقق منها نظرياً اعتماداً على قيم حرارة التكوين و طاقة الإعاقة للنواتج.

ئامادەکردن و لێکۆلینێن هندەك پێکهاتیێن پایرازولینان و پێرمیدینان

پوختە

ئەم تو بیژینەوەیە باسی ئامادە کردنی زنجیرە یەك لە الجالکونات گۆلی ینەوە (1-5) وەخەست بوونەووە لەگلەلێ الفنیل هیدرازین والپایوسیمکاربازاید لە ناوە ندێکی تفتدا بۆ بەرهەم هێنانی البایرازولینات نوێ (6-12) دەکات بەخیتە سەری النیکلیوفیلیە (1 ، 4) وەخەست بوونوەی الجالکونات ئالوگوریە لە گەلێ الگواندین هایدروکلورایدلە بارو دۆخی تفتدا بۆ بەرهەم هێنانی البریمیدینات بەرامبەر (13-16). وهەروەصا بە کلرهینانی رێگای شەبەنگ و روەشتە فیزیائی بۆ دلینیایی لە ئیکی هێنانا بەرهەمی نوێ.

وە جیکا نیکێتی دلێشمنیاری بۆ بتر لە کارلێکە کسانی هاتە دیارکردن بەشێوەکی بیردۆزی بەپشت بەستنا لە سەر گەرمی و ئێك هێنان و وزەی لەیێ گر بۆ بەرهەم هێزاو.

THE ROLE OF EPIDERMAL GROWTH FACTOR ON THE PROLIFERATION AND MULTIPLICATION OF ALBINO MICE DERMAL FIBROBLAST CELLS *IN VITRO*

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ABSTRACT

Dermal fibroblast cells are fast growing cells and can be rapidly expanded in culture. These cells are suitable for behavioral, functional, biochemical and genomic studies. So in this study we investigate the mitogenic effect of epidermal growth factor (EGF) on the proliferation and multiplication of mice newborn dermal fibroblast cells *in vitro*. Dermal cells were isolated from newborn albino mice (*Mus musculus*) and were divided into two groups: first group treated with DMEM+10ng EGF/ ml, while the second group treated with DMEM only as control group. Fibroblast cells are spindle-like shape with a prominent nucleus with unipolar or bipolar and showed high rate of growth in culture. Results of this study showed that the effect of EGF as a mitogenic factor were increased with the time of administration, so the number of fibroblast cells were highly increased after two weeks from treatment with EGF and these cells tend to form several layers of fibroblast cells in culture. In conclusion, EGF has an important role in the proliferation and multiplication of newborn dermal fibroblast cells *in vitro*.

KEYWORDS: Newborn albino mice, in vitro, EGF, dermis, fibroblast cells.

INTRODUCTION

The vertebrate skin is composed of an epidermis and dermis which derive from embryonic ectoderm and mesoderm, respectively. The epidermis is the outermost layer of the skin and this layer is a stratified squamous epithelium made up of multiple layers of keratinocytes resting on a basement membrane that separates it from the underlying dermis (Watt and Hogan, 2000).While dermal layer is the layer which lies between the epidermis and subcutaneous layer, consists mostly of connective tissue and is much thicker than epidermis. It composed of three major types of cells: fibroblasts, macrophages, and adipocytes. It is responsible for the skin's strength, elasticity and mechanical resistance and also is involved in the regulation of the body temperature (Sam Naficy, 2010).

Dermal fibroblasts are the source of collagen and elastin of the extracellular matrix (ECM). Procollagens are secreted through the Golgi apparatus in the extracellular space where the N-terminal and C-terminal propeptides are cleaved by specific proteases. The mature processed collagen molecules aggregate to form larger collagen fibrils and help to form the ECM with other components. Therefore, normal structural and functional type I collagen production and deposition to make normal physiological connective tissue needs regulation at several steps. So abnormality in any step may cause hypo-, hyper-, or defective synthesis and accumulation of collagen in ECM, which in turn causes different diseases in humans, such as osteogenesis imperfecta, scurvy, scleroderma or systemic sclerosis, keloids, and others (Uitto and Kouba, 2000).

Dermal fibroblasts are also an important source of several cytokines, e.g., interleukin-1 (IL -1) and 6, chemokines, e.g., cyclooxygenase 2 (COX-2) and growth factors, e.g., fibroblast growth factor (FGF), insulin like growth factor-1 α (IGF-1 α) (Kessler-Becker *et al*., 2004). Dermal fibroblasts play also a significant role in inflammation (Warner *et al*., 2004). Dermal fibroblasts may contribute to the epidermal hyperplasia of psoriasis by promoting keratinocyte proliferation through IGF-1, the secretion of which could be modulated by inflammatory cytokines, such as interferon- α (IFN-α) (Miura *et al*., 2000).

A disruption in the skin that results in damage to the epidermis or dermis constitutes a wound. Wound healing is a natural body function by which the body repairs itself after injury (Agyingi *et al*., 2010 and Bascom *et al*., 2010).

Many researchers have reported on the important role of EGF on healing of skin

wounds (Niall *et al*., 1982; Olsen and Nexo, (1983) pointed out that the skin wounds healed more rapidly with the effect of EGF. It is a well-known fact that topical application of EGF on skin accelerates wound healing (Niall *et al*., 1982).

Epidermal growth factor, which was first isolated from submandibular gland of male rats, is a mono-chain polypeptid hormone that weighs 6000 kilodalton (Cohen, 1962). This factor is known to be a mitogenic polypeptide hormone, stimulates the proliferation, growth and maturation of ectodermal and endodermal cells *in vivo* and *in vitro* (Cohen and Eliot, 1963; Bem and Richardson, 1971; Cohen, 1983 and Tsutsumi *et al*., 1986). Tsutsumi *et al*., (1987) reported that EGF is important physiologically in maintaining normal structures of epidermal cells, and as mentioned by Karadede *et al*., (2010), that in addition to the main function of EGF which known to be effective on various cell types, is epithelial growth and maturation, as its name indicates. So the present study was designed to study the role of EGF on the proliferation of mice dermal fibroblast cells *in vitro*.

MATERIALS AND METHODS

Animals and housing

Newborn mice (*Mus musculus*) (n=8, 1–3 days old) of strain Balb/C were used in this study. These animals were obtained from Animal House/Faculty of Veterinary Medicine/ University of Duhok. The experimental work of this study was done in the Animal Tissue Culture Laboratory of Scientific Research Center/ Faculty of Science/ University of Duhok.

Dermal cells isolation and culture:

Newborn mice were killed by Chloroform (Gainland Chemical Company). Then under sterile conditions, the trunk skin was removed by using surgical scissors and a scalpel. The skin samples were placed in sterile Petridish containing phosphate buffer saline (PBS).

After removing fat and membranous materials, the skin samples was sliced into 10nm wide strips, immersed in protease (Sigma) (250mg in 100ml serum-free Dulbecco's modified minimum essential medium"DMEM" (Sigma) and placed at 4°C overnight.

1983; and Olsen *et al*., 1984). Olsen and Nexo

After the incubation, the epidermis was separated from the dermis by gently pulling the tissues apart by using a pair of sterile forceps and placed into a sterile flask containing trypsin: EDTA (0.25%Trypsin: 0.04% EDTA) and mixed on a magnetic stirrer at 37°C for 45 minutes.

The cells suspension was filtered through sterile gauze and centrifuged for 10 minutes at 3000 rpm. Cells were resuspended in growth medium (DMEM) supplemented with 10% fetal calf serum (FCS) (Sigma) and 100units /ml penicillin and 100 µg/ml streptomycin (Reiisi *et al*., 2010).

The cell number and viability were determined by using Hemocytometer chamber (Neubauer type) and 0.4% trypan blue (prepared in 0.9% NaCl) (Pollard and Walker, 1997).

The cells were divided into two groups at a density of (32×10^4) cells for each group. First group was treated with DMEM + 10% FCS + 10ng EGF/ml (Sigma). While second group (control group) treated with DMEM + 10% FCS.

The cells suspension was cultured in a sterile tissue culture flask and incubated at 37°C with 5% CO2 for two weeks. Cultures were inspected daily for growth and differentiation by inverted microscope.

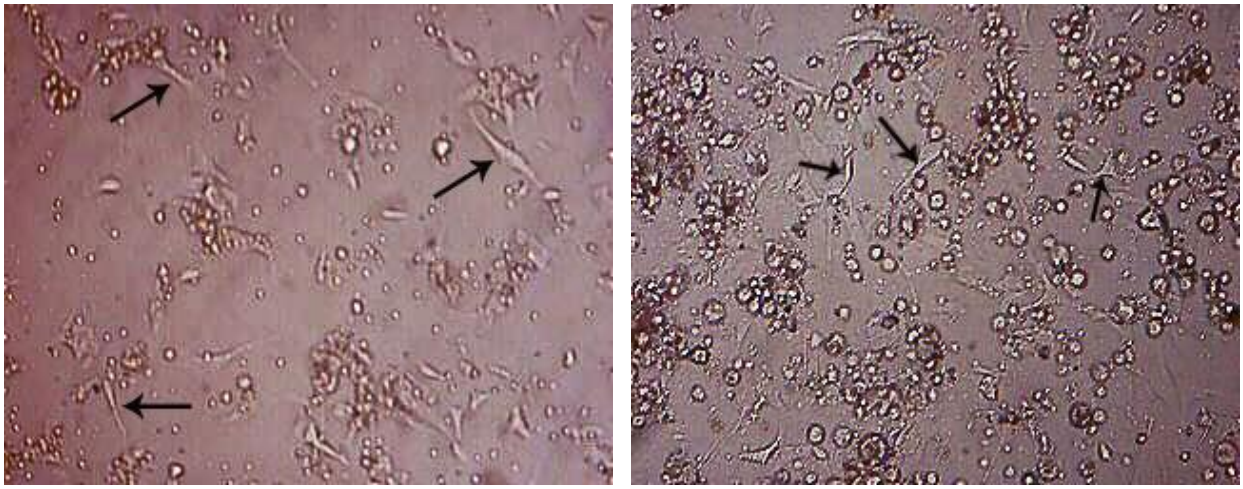
After two weeks the cells were recovered by using trypsin-EDTA. The numbers of viable cells were detected in each group, then these cells were passaged and cultured in the same conditions as describe above.

After determination the number of viable fibroblast cells, these cells were maintained in culture for further another two weeks. Then these cells were recovered, and the numbers of viable cells were detected. This experiment was repeated for eight times.

RESULTS

Morphological and cell expansion characteristic of dermal cells in culture

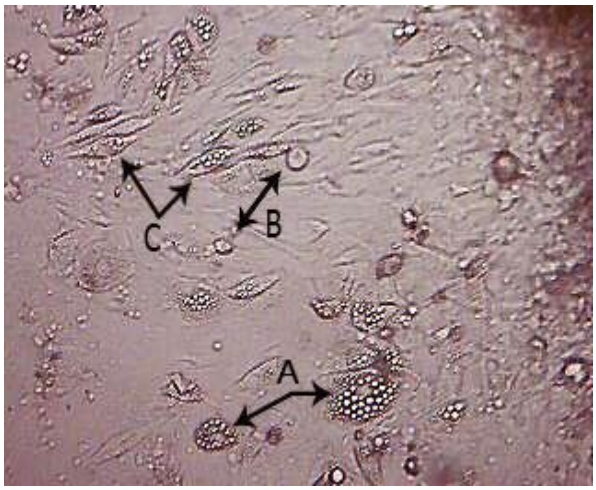
The result of the present study showed that within four days of culture some dermal cells in both groups began to attach and differentiate in the surface of the culture flask . (Fig.1 A & B).



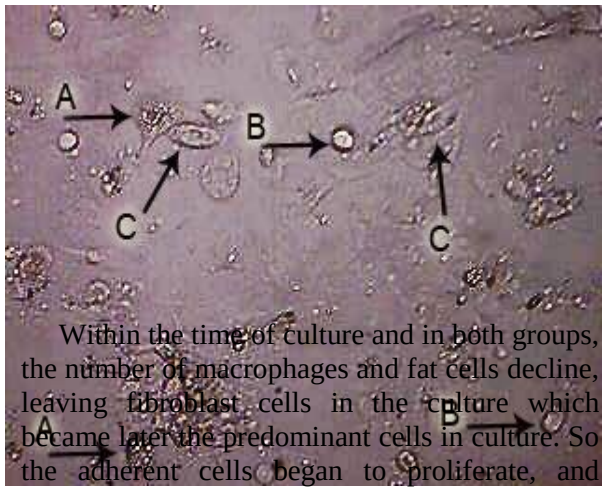
(A)(50X) **(B)** (50X)

Fig. 1:- (A: control; B: treated): During four days of culture some dermal cells began to attach and differentiate in the surface of culture flask (arrows) (Living material)

Then, between (8-9) days of culture we observed the formation of different types of dermal cells, such as cells with morphological feature of macrophages (which appeared as an ovoid mononuclear cells), fat cells which characterized by an enormous accumulation of lipid type of material, and an elongated flattened cells with a fibroblast-like structures, these cells appeared spindle-like shape with unipolar or bipolar and also as an individual cell or as a cluster of cells (Fig. 2 A & B).



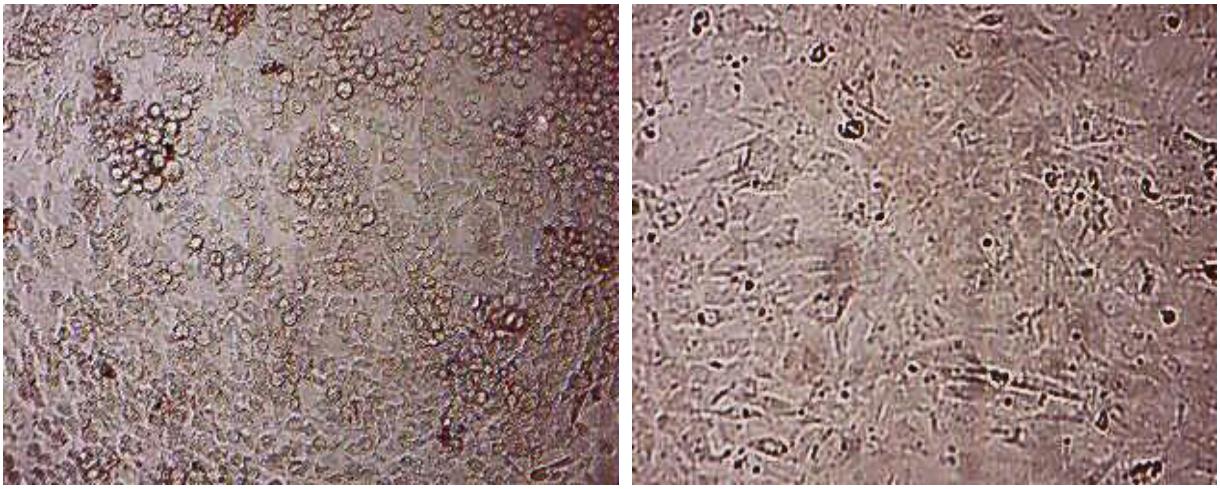
(A) (100 X)



(B) (100 X)

Fig. 2:- (A: control; B: treated): These figures indicate the formation of different types of dermal cells in culture such as: fat cells (A), macrophages (B), and fibroblast like cells (C) (Living material)

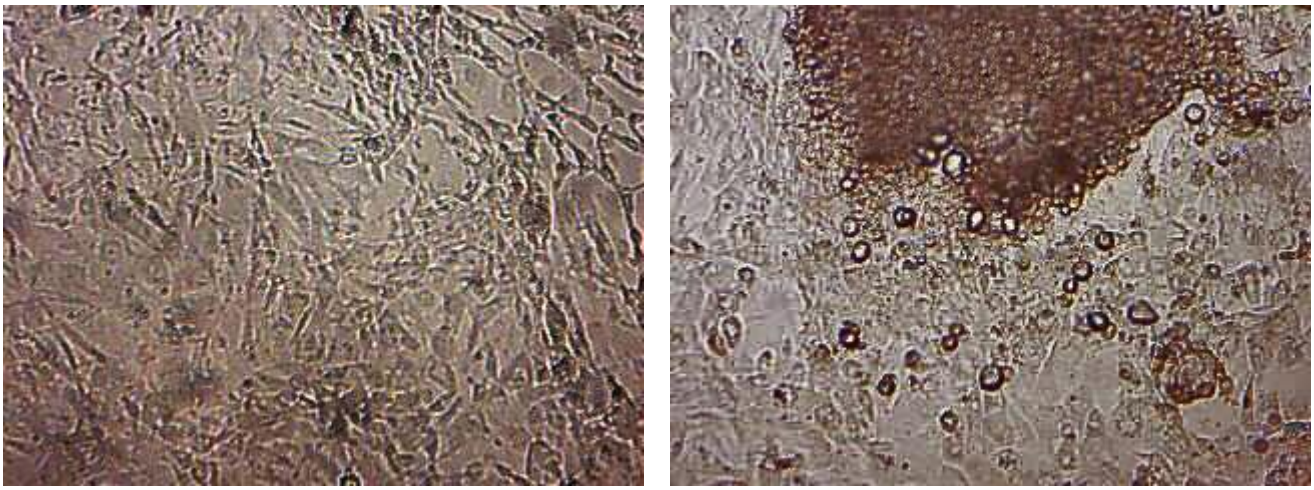
Within the time of culture and in both groups, the number of macrophages and fat cells decline, leaving fibroblast cells in the culture which became later the predominant cells in culture. So the adherent cells began to proliferate, and within fourteen days of cultivation, numerous fibroblasts- like cells were increased in their girth and formed confluent monolayer of fibroblast like cells, and at this stage the cells were ready for first passage (Fig. 3 A & B).



(A)(50 X**)** **(B)** (100X)

Fig. 3:- Fourteen days in culture (A: control; B: treated): Note the formation of confluent monolayer of dermal cells derived fibroblast like cells (Living material)

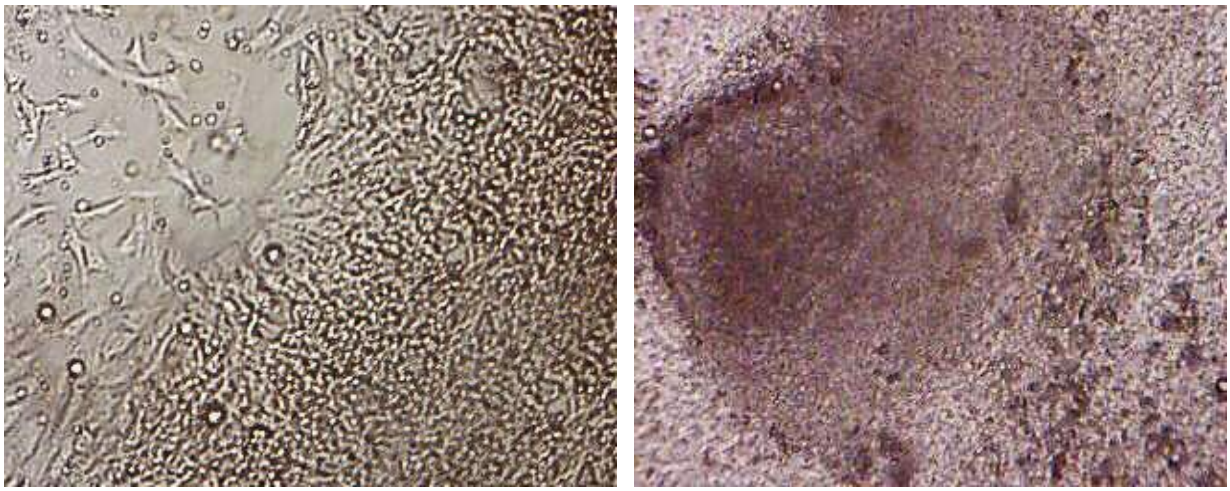
After first passage, the number of fibroblast cells in EGF treated group were increased and expanded in culture. So by five to ten days from first passage, a homogenous layer of fibroblast - like cells were observed (Fig. 4 A & B).



(A) (100X) **(B)** (100X)

Fig. 4:- After 5 days from first passage (A: control; B: treated): These figures indicate the formation of homogenous layer of fibroblast- like cells (Living material)

Fibroblast -like cells number increases more rapidly in the presence of EGF and within two weeks, these cells gradually form multilayer in culture (Fig. 5 A & B).



(A) (100 X) **(B)** (100 X)

Fig. 5:- (A: control; B: treated): These figures demonstrate the formation of multilayer of fibroblast cells in culture. Note the difference between the thickness of these layers between the EGF treated group and control groups (Living material)

Effect of EGF on the proliferation of dermis derived fibroblast like cells:

As shown in table (1), that after two weeks from treatment with EGF, this growth factor stimulate the proliferation of dermis-fibroblast cells in culture and caused a significant increase (P<0.01) in their number (38.0±0.981) if compared with control group (32.0±0.534).

The effect of EGF as a mitogenic factor increased with the time of culture, so after two weeks from first passage from treatment the number of these cells were highly significant increase (P<0.01) (43.0±0.963) compared with control group (20.0±0.462).

Table (1):- Effect of EGF on the proliferation of dermal derived fibroblast cells (Mean±SE)

Groups	Animal No.	Cells No. ×10^4		
		Initial culture	After 14 days from initial culture	After 14 days from 1st passage
Control	8	32.0±0.707[a]	32.0±0.534[b]	20.0±0.462[b]
Treated with (10ng EGF/ml)	8	32.0±0.707[a]	38.0±0.981[a]	43.0±0.963[a]

Means *with different letters within each column differed significantly P (ANOVA) < 0.01.*

DISCUSSION

The isolation and propagation of dermal fibroblast have helped not only in understanding the biology of these cells, but also the biology of other cells by serving as control cells for almost all investigative work done so far. They have also been used extensively in pharmacological testes and skin reconstruction (Abdel-Naser *et al*., 2005).

The *in vitro* growth of dermal fibroblast cells were investigate in the present study, and as

shown in our and other result (Layman *et al*., shape with a prominent nucleus and are small in diameter.

The results of the present study showed that newborn dermal fibroblast cells have high rate of growth and proliferation in culture. This observation also recorded by (West, 1994), that fibroblast cells obtained from newborn generally have greater mitogenic responsiveness than adult fibroblasts and that age associated loss of growth factor responsiveness may contribute to the decreased proliferative capacity of old dermis.

Growth factors are believed to play an important role in culture proliferation and wound healing and are capable of stimulating mitosis of quiescent cells in a nutritionally complete media lacking serum (Gartner *et al*., 1992). Also Bennett and Schultz, (1993) reported that most growth factors stimulate mitosis of more than one cell type involved in wound healing. However, each factor exhibits some degree of selectively. Epidermal growth factor, which is known to be a mitogenic polypeptide hormone, stimulates ectodermal (epithelial) and endodermal cells in *in vivo* and fibroblasts in *in vitro* (Cohen, 1983). Also Armelin (1973) demonstrated that EGF has been found to be an extremely potent mitogen for fibroblasts, and in 2010, Karadede *et al*., reported that EGF has an important role in skin development.

In our results when dermal fibroblast cells were cultured with medium containing EGF, showed high proliferative rate and this growth factor cause significant increase in the number of these cells compared with control group (untreated cells). The effects of this growth factor were increased also with the increasing time of administration. This results in agreement with the results obtained by (Bhora *et al*., 1995) who indicate that fibroblast growth factor (FGF), insulin growth factor-1 (IGF-1) and epidermal growth factor (EGF) are important mitogenes for wound healing and that EGF in particular is capable of stimulating epitheliazation. By using EGF alone with culture media resulted in the significant multiplication of fibroblast cells which then formed several layers of fibroblast cells. While in 2007, Lee *et al*., reported that the combination of EGF and insulin showed a more marked effect than a single factor, and histologically EGF as insulin alone induced a three – dimentional tissue containing several 1971) these cells have an elongated spindle layers of fibroblasts. The combination of EGF and insulin produced a thicker tissue, which composed of abundant extracellular matrix containing fibroblasts suggesting a dermis-like tissue.

From these results we can conclude that EGF has an important role in the newborn dermal fibroblasts proliferation and multiplication *in vitro*.

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رۆلێ فاکتەرێ گەشەکرنا پیستی لسەر زیدەبون ودووهندبونا خانێن ئەروماتیێن لیفیێن پیستی یێت مشکێن سپی ل ژدەرفەی لەشێ زیندی دا

پوختە

خانێن ئەروماتیێن لیفیێن پیستی ئەو خانەنە ئەوێن کەشەکرنێ وبەربەلافبونێ بخێرایی دکەن دناف ناوەندێ چاندنی دا. ئەڤ خانە دهێنە پێشبینیکرن کو دگرنگن ژبوخاندنێن سلوکی،کاریگەری، بایوکیمیاوی وخانەیی. لەورا دڤێ ڤەکولینا بەردەست دا پشکنینا کارتێکرنا یاریدەر یا فاکتەرێ گەشەکرنا پیستی لسەر دابەشبون وزیدەبون ودووهندبونا خانێن ئەروماتیێن لیفیێن پیستی یێت مشکێن شنی بۆین ل ژدەرفەی لەشێ زیندی دا هاتە کرن.خانێن پیستی هاتنە وەرگرتن ژ مشکێن سپی (*Mus musculus*) یێن شنی بۆین وپاشی هاتنە دابەشکرن بۆ دوو گروپا: گروپا ئێکێ هاتە سەرەدەرکرن ب ناوەندێ چاندنی (DMEM) +10 نانوگرام EGF/مل. بەلام گروبا دووێ (گروپا کونترۆل) هاتە سەرەدەرکرن بتنێ ب ناوەندێ چاندنی ڤە.

خانێن ئەروماتیێن لیفی ئێك تەوەرن یان دوو تەوەرن وشێوەیەکێ کەوانەی یێ هەی دگەل ناوکەکا ئاشکرا ، ڤان خانا رێژەکا بلند یاگەشەکرنێ دناف ناوەندێ چاندنی دا دیارکر.

ئەنجامێن ڤێ ڤەکولینێ دیارکر کو کارتێکرنا فاکتەرێ گەشەکرنا پیستی وەك فاکتەرەکێ یاریدەر بۆ دابە شبونێ زێدەت بیت ب زێدەبونا وەختێ سەرەدەرکرنێ، لەورا ژمارا خانێن ئەروماتیێن لیفی زێدەبونەکا بلند دیارکر پشتی دوو حەفتیا ژسەرەدەرکرنێ وڤان خانا هژمارەکا چینا ژخانێن ئەروماتیێن لیفی دناف ناوەندێ چاندنی دا چێکر.

لدویف ڤان ئەنجاما ئەم دشێن دەرئەنجام کەین کو فاکتەرێ گەشەکرنا پیستی رۆلەکێ گرنگ یێ هەی لسەر زێدەبون ودووهندبونا خانێن ئەروماتیێن لیفیێن پیستی ل ژدەرڤەی لەشێ زیندی دا.

دور عامل نمو البشرة على توالد وتضاعف خلايا الاورمات الليفية الجلدية للفئران البرصاء خارج الجسم الحي

الخلاصة

تمتاز خلايا الاورمات الليفية الجلدية بانها خلايا سريعة النمو والانتشار في الوسط الزرعي. وتعتبر هذه الخلايا مهمة للدراسات السلوكية، الوظيفية، البايوكيميائية والخلوية. لذا تتضمن الدراسة الحالية اختبار التأثير المحفز لعامل نمو البشرة عل انقسام وتوالد وتضاعف اعداد خلايا الاورمات الليفية الجلدية المشتقة من بشرة الفئران حديثي الولادة خارج الجسم الحي. تم عزل الخلايا الجلدية من الفئران البرصاء (*Mus musculus*) حديثي الولادة وقسمت الى مجموعتين. المجموعة الاولى عوملت بالوسط الزرعي (DMEM) + 10 نانوغرام EGF /مل، بينما المجموعة الثانية (مجموعة السيطرة) عوملت بالوسط الزرعي فقط.

تكون خلايا الاورمات الليفية مغزلية الشكل احادية القطب او ثنائية القطب وذات نواة واضحة ، واظهرت هذه الخلايا نسبة نمو عالية في الوسط الزرعي.

اظهرت نتائج هذه الدراسة بان تأثير عامل نمو البشرة كعامل محفز للانقسام يزداد بزيادة وقت المعاملة، لذا فان عدد خلايا الاورمات الليفية اظهر زيادة عالية بعد اسبوعين من المعاملة. وان هذه الخلايا كونت طبقات متعددة من خلايا الاورمات الليفية في الوسط الزرعي.

من خلال هذه النتائج يمكن الاستنتاج بأن لعامل نمو البشرة دور مهم على توالد وتضاعف خلايا الاورمات الليفية الجلدية خارج الجسم الحي.

A COMPARISON BETWEEN LIGHT CYCLER REAL-TIMEPOLYMERASE CHAIN REACTION (PCR) ASSAY AND SEROLOGICAL METHODS USED IN THE DIAGNOSIS OF HUMAN BRUCELLOSIS

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ABSTRACT

This study was conducted to compare the traditional diagnostic methods with PCR-basedassay for the diagnosisof human brucellosis. Two hundred sixty seven patients with symptoms of brucellosis were enrolled in this study. For traditional methods a Rose Bengal Agglutination test (RBA) was performed and the Nova TEC *Brucella*anti IgG and IgM Antibodies ELISA Test Kit has been designed for the detection and the quantitative determination of specific IgG and IgM antibodies against *Brucella* in serum. DNA was extracted from patient samples using a genomic DNA purification kit. Once the DNA was extracted, the RT- PCR was set up in a final volume of 20 µl with the Fast Start DNA Master SYBR Green I Kit.Seventy one cases were positive by PCR method, fifty one cases by ELISA and forty one cases by direct agglutination test (RBA).Sensitivity, specificity, positive prediction value, negative prediction value and diagnostic accuracy of *brucella* agglutination test in comparing with PCR were calculated as 53.52%, 89.66%, 92.68%, 44.07% and 64% respectively.Sensitivity, specificity, positive prediction value, negative prediction value and diagnostic accuracy of IgM antibodies by ELISA test in comparing with PCR were calculated as 45.07%, 96.55%, 96.97%, 41.79% and 60% respectively,while for IgG were calculated as 63.38%, 79.31%, 88.24%, 46.94% and 68% respectively.In Conclusion,the PCR method is more sensitive and specific than serological methods for the diagnosis of *Brucella* from peripheral blood samples in suspected cases.

KEYWORDS:BRUCELLA: Real-Time (PCR), Rose Bengal test and ELISA

INTRODUCTION

Brucellosis is the most common bacterial zoonosis world wide. According to the world health organization, half a million of new human cases are reported each year(World Health Organization, 2001). The disease is caused by small Gramnegativebacteria belonging to the genus *Brucella*.The disease is usually transmitted to humans by ingestion offresh unpasteurized dairy products or through contact ofskin or mucous membranes with infected animal carcasses or secretions(Plommet*et al*, 1998). This disease in humans causes fever, malaise,myalgia and may later develop into a chronic illness affectingvarious organs and tissues (Probert*et al*, 2004).To detect the presence of *Brucella*organismsin tissues, cultural, serologicaland PCR methods were used.The serological methods areusually employed for diagnostics of *Brucella*in blood specimens. The serologicalresponse, however, can be unspecific dueto cross-reaction or subsensitive reactionsin samples from areas with a low or subclinicalprevalence of brucellosis (Bogdanovich*et al*, 2004). Evaluation of various ELISA assays for IgG and IgM have shown that these techniques are generally more sensitive and specific than conventional tests, while they are able to distinguish specific antibodies of IgM and IgG classes associated with acute and chronic brucellosis(Gad *et al*, 2002).Because of their potential to detect very small numbers of organisms PCR-based assays such as real-time PCR that aresimpler, faster, less hazardous and usuallymore sensitive, have been developed for*Brucella*detection (Bricker, 2002). There are only a fewreports on the use of PCR for the diagnosis of humanbrucellosis from peripheral blood samples (Queipo-Ortuno*et al*, 1997). The aim of this study is compare the traditionaldiagnostic methods with PCR-based assay for the diagnosisof human brucellosis.

MATERIALS AND METHODS

Two hundred sixty seven patients (ages 17–65 years old, 189 men and 78 women) with symptoms of brucellosis were enrolled in this study during the period from the first of January, 2012 till the end of April 2012 at Azadi Teaching Hospital and Shilan Private Hospital. All patients presented clinical signs consistent with brucellosis that have been diagnosed by numbers of physicians specialists in internal medicine, fractures and bone surgery, heart disease, obstetrics and gynecology. To supported the physician's diagnosis and to avoid some of other conditions which could have similar clinical symptoms for brucellosis, perform for each patient the following tests:- (Widal test, ASO, CRP and RF) were performedusing the direct agglutination test methods using kitsfor each test prepared from(Biolabo Co. French) as described by the manufacturer's instructionsand performed these tests in Central lab of Shlilan Private Hospital. A total of 4-5 ml of blood was collectedfrom each suspicious patient, 3 ml ofblood was collected without anticoagulant and then serum from blood sampleswere separated by centrifugation (4,000Xg for 15 min) to detect antiBrucella antibodies by traditional methods and Enzyme Linked Immunosorbent Assay method (ELISA).For traditional methods a Rose Bengal Agglutination test (RBA) wasperformed according to previously described techniques (Alton GG, Jones).The Nova TECBrucellaIgG and IgM Antibodies ELISA Test Kit (Immunodianostic GmbH) and a Tecan classic ELISA reader has been designed for the detection and the quantitative determination of specific antiIgG and IgM antibodies against *Brucella* in serum according to the manufacturer's instructions.

The remaining 2 ml of blood sample was stored in tubes with EDTA at -20°C for later use for the PCR assay. DNA was extracted from blood samples with EDTA using a genomic DNA purification kit (Invitrogen, Paisley, U.K.) according to the manufacturer's recommendations. The total DNAconcentration was measured at 260 nm wavelength according to the method described by Sambrook andRussell (Sambrook and Russell, 2001).Once the DNA was extracted, the RT- PCR was set up in a final volume of 20 µl with the Fast Start DNA Master SYBR Green I Kit (Roche Diagnostic) as described according to the manufacturer's instructions and Fluorescence curves were analyzed with the Light Cycler software, version 3.5 (Roche Diagnostic).

RESULTS

Out of 276 suspected patients, 176 patients were excluded because the sera of these patients were positive with one or more of these tests (Widal test, CRP, ASO and RF). Out of 100 patients suspected with *brucellosis*, 66 were male. In this research, 100 blood samples were examined in suspected cases of brucellosis. Seventy one cases were positive by PCR method, 51cases by ELISA and 41 cases by direct agglutination test (Rose Bengal test). Distribution of studied samples based on PCR results and serology have shown in Tables 1-3. Most of cases with *brucellosis* were (results obtained from PCR) in age group between 30 to 39 yr and the least cases with *brucellosis* were in age group of 1 to 9 year. The difference between age groups and *brucellosis* was not faced (Table 4). Sensitivity, specificity, positive prediction value, negative prediction value and diagnostic accuracy of *brucella* agglutination test in comparing with PCR were calculated as 53.52%, 89.66%, 92.68%, 44.07% and 64% respectively Table.1.

Table (1): Ferequency of Brucella positive and negative cases diagnosed based on peripheral blood PCR and direct test(Rose Bengal test) methods.

		PCR		
		Positive	**Negative**	**Total**
DirectTest	Positive	38	3	41
	Negative	33	26	59
		71	29	100

Parameter	Estimate
Sensitivity	53.52%
Specificity	89.66%
Positive Predictive Value	92.68%
Negative Predictive Value	44.07%
Diagnostic Accuracy	64%

Sensitivity, specificity, positive prediction value, negative prediction value anddiagnostic accuracy of IgM antibodies by ELISA test in comparing with PCR were calculated as 45.07%, 96.55%, 96.97%, 41.79% and 60% respectively. While sensitivity, specificity, positive prediction value, negative prediction value and diagnostic accuracy of IgG antibodies by ELISA test in comparing with PCR were calculated as 63.38%, 79.31%, 88.24%, 46.94% and 68% respectively Table 2,3.

ELISAIgM		Positive	Negative	Total
	Positive	32	1	33
	Negative	39	28	67
		71	29	100

Parameter	Estimate
Sensitivity	45.07%
Specificity	96.55%
Positive Predictive Value	96.97%
Negative Predictive Value	41.79%
Diagnostic Accuracy	60%

Table(3): Ferequency of Brucella positive and negative cases diagnosed based on peripheral blood PCR and ELISA test (IgG).

ELISA IgG	Positive	Negative	Total
Positive	45	6	51
Negative	26	23	49
	71	29	100

Parameter	Estimate
Sensitivity	63.38%
Specificity	79.31%
Positive Predictive Value	88.24%
Negative Predictive Value	46.94%
Diagnostic Accuracy	68%

Table (4): frequency of brucellosis according to age (diagnosed by PCR method)

PCR	Positive		Negative		Total	
Age	Fre.	Percent	Fre.	Percent	Fre.	Percent
1-9	3	3%	3	3%	6	6%
10-19	7	7%	4	4%	11	11%
20-29	13	13%	3	3%	16	16%
30-39	21	21%	6	6%	27	27%
40-49	15	15%	7	7%	22	22%
50-59	8	8%	4	4%	12	12%
More than 60	4	4%	2	2%	6	6%
Total	71	71%	29	29%	100	100%

DISCUSSION

Brucellosis disease is prevalent in Mediterranean regions (Seimenis*et al*, 2006),India(Smits and Kadris, 2005)Arabian Peninsula and some parts of Mexico, Latin America and southern America(Pappas *et al*, 2006). Exact diagnosis of *brucellosis* is not just based on clinical symptoms, because it will be considered in differential diagnosis of other diseases such as malaria, typhoid and leptospirosis. Therefore defining organism in culture or identification of organism by serological and molecular methods for confirming clinical diagnosis is necessary(Richtzenhain*et al*, 2002).Considering *brucellosis* in different ages indicate that most infections are in ages 30 to 39 (21%) and after that (13%) related to ages 20 to 29. These age groups include active age groups. These peoples are settled in different manners in animal husbandry, dairying, working at home and have connection with livestock and products of livestock.

At all, there is no considerable difference in outbreak of disease in adults and children. Therefore, there is no any rational relationship between age and having *brucellosis*. But,(Cetinkaya*et al*, 2005)considered brucellosis serologically and indicated that there is relationship between age, sex and positivity. Roushan*et al*, 2005, havediagnosed *brucellosis* in Iran by Rose Bengal method and reported that 62.5% were positive. These cases were followed by 2ME and Wright methods. They considered cut-off for 2ME equivalent to 1/160 and for Wright test equivalent to 1/320 and 37.7% became positive. There are some investigations on diagnosis of *Brucellosis* by PCR method (Richtzenhain*et al*, 2002, Sreevatsan*et al*, 2000 and Al-Soud*et al*, 2000).Elfaki*et al*, 2005, diagnosed many positive *brucellosis*caese by agglutination tests, while there were 40% and 70% positive by ELISA and PCR methods. They believe that producing antibody against Brucella is not related to disease condition and for following up disease blood culture and PCR should be used. Salari*et al*, 2003,considered 792 cases for brucellosis with serological method and they believe that outbreak of disease in men is more than women. AlsoKarimi*et al*, 2003considered *brucellosis* outbreak in 415 healthy people including butchers and slaughterers by serology

method and con-firmed contribution of job in this disease.

By considering brucellosis epidemiology that was made by(Hasanjani*et al*, 2004)in Babol city, highest risk factor was from using of dairy products (fresh cheese). In aforementioned study, job (such as veterinarian) is not introduced as risk factor. Infection level was higher in rural areas and men were infected more than women. In conclusion the PCR method is more sensitive and specific than culture and serology for diagnosis of Brucella from peripheral blood in suspected cases.

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المقارنة بين طريقة البلمرة المعتمدة على جزيئات الحامض النووي وطرق التقليدية في تشخيص داء حمى مالطا في الانسان

الخلاصة

اجريت هذه الدراسة للمقارنة بين طرق التقليدية وطرق المعتمدة على جزيئات DNA في تشخيص داء حمى مالطا في الانسان. حيث تم اختيار 267 شخص مشتبه بهم والذين تظهر لديهم اعراض هذا المرض في هذه الدراسة. بخصوص الطرق التقليدية فقد تم استخدام كلا من طريقة التراص وطريقة ELISA في تشخيص الكلوبيولينات المناعية نوع (ام و جي) للجرثومة المسببة للمرض في مصل الاشخاص المشتبه بهم اما بنسبة للطرق المعتمدة على جزيئات DNA فقد تم استخدام طريقة البلمرة الجزيئية (RT-PCR). بعد اجراء الاختبارات فقد تبين ان 71 حالة كانت ايجابية للاخبيار تفاعل البلمرة PCR و51 حالة كانت ايجابية بالاستخدام طريقة ELISA في حين 41 حالة ظهرت ايجابية للاختبار التراص. لذا حساسية ونوعية وقيمة التنبؤية الايجابية وقيمة التنبؤية السلبية ودقة التشخيص للاخبتار التراص مقارنتأ مع الطرق البلمرة جزيئية كانت 53,52% ،89,66% ، 92,68% ، 44,07% و 64% على التوالي. في حين ان حساسية ونوعية وقيمة التنبؤية الايجابية وقيمة التنبؤية السلبية ودقة التشخيص للاختبار ELISA الخاص في تشخيص الغلوبيولين المناعي نوع (ام) مقارنتأ مع الطرق البلمرة جزيئية كانت على النحو التالي 45,07%، 96,55%، 96,97%، 41,79% و 60% اما بخصوص الغلوبيولين المناعي نوع (جي) بنسبة للنفس الطريقة كانت 63,38%، 79,31% ، 88,24%، 46,94% و 68% على التوالي. من هذا نستنتج بأن الطرق المعتمدة على جزيئات DNAهى اكثر حساسية ودقة من الطرق التقليدية في تشخيص داء حمى مالطا في الانسان.

هەڤبەرکرن دناڤبەرا ریکا پەلەرکرنا کو پشت بەستنێ دکەتە سەر گەردێن ترشێ ناڤکی و رێکێن کلاسیکی یێن ژبۆ دەستنیشانکرنا نەخوشیا تایا مالتایێ (تیفوئید) ل دەڤ مروڤی

پوختە

ئەڤ ڤەکولینە هاتیە ئەنجامدان ژ پێخەمەت هەڤبەرکرنا وان رێکێن کلاسیکی یێن بۆ دەستنیشانکرنا نەخوشیا تیفویێ ل دەڤ مروڤی دهێنە ب کارئینان دگەل وێ رێکێ یا پشت بەستنێ دکەتە سەر پەلەرکرنا گەردێن ترشێ ناڤکی DNA، بۆ ڤێ مەرەمێ 267 کەسێن گومانا نەخوشیا تیفویێ ل دەڤ هەی هاتینە وەرگرتن کو نیشانێن نەخوشیێ ل دەڤ وان دیاربوون. ل دەستپێکێ دوو رێکێن کلاسیکی هاتنە ب کارئینان کو ئەوژی رێکا ئەگلوتینەیشن و رێکا ئیلایزا ELISA کو تێدا گلوبینێن بەرگریێ ژ جورێ M و G یێن میکروبێن دبنە ئەگەرێ نەخوشیێ دناڤ زەرداڤا کەسێن گومان لێکریدا هاتنە پشکنین. دەربارەی رێکا پشت بەستنێ دکەتە سەر گەردێن ترشێ ناڤکی، تەکنیکا پەلەرکرنا گەردی (RT-PCR). پشتی ئەنجامدانا تاقیکرنان دیاربوو کو 71 حالەت بو تێستا پەلەرکرنا PCR دپوزەتیڤ بوون، 51 حالەت بۆ تێستا ELISA دپوزەتیڤ بوون، لێ بتنێ 41 حالەت بۆ رێکا ئەگلوتینەیشنێ د پوزەتیڤ بوون. ژبەر ڤێ چەندێ هەستیاری و جوراتی و بهایێ پێشبینیکرنا پوزەتیڤ و بهایێ پێشبینیکرنا نێگەتیڤ و هویربینیا دەستنیشانکرنێ بۆ تێستا تەرابسێ دگەل تێستا پەلەرکرنا گەردێن نرشێ ناڤکی ب ڤی رەنگی بوون 53,52٪ ، 89,66٪ ، 92,68٪ ، 44,07٪ و 64٪ . لێ هەستیاری و جوراتی و بهایێ پێشبینیکرنا پوزەتیڤ و بهایێ پێشبینیکرنا نێگەتیڤ و هویربینیا دەستنیشانکرنێ بۆ تێستا ELISA یا تایبەت بۆ دیارکرنا گلوبینێن بەرگریێ ژ جورێ M دگەل تێستا پەلەرکرنا گەردێن ترشێ ناڤکی ب ڤی رەنگی بوون 45,07٪ ، 96,55٪ ، 96,97٪ ، 41,79٪ و 60٪ .لێ ئەنجامێن گلوبینێ بەرگریێ ژ G بۆ هەمان تێست ب ڤی رەنگی بوون 63,38٪ ، 79,31٪ ، 88,24٪ ، 46,94٪ و 68٪ . پشتی ڤان ئەنجامان هوسا بو مە دیاردبیت کو رێکا پەلەکرنا گەردێن ترشێ ناڤکی بۆ دەست نیشانکرنا نەخوشیا تیفویێ ل دەڤ مروڤی پتر یا هەستیارە و یا هویربینە ژ رێکێن دی یێن کلاسیك بۆ دەستنیشانکرنا ڤێ نەخوشیێ.

ASSESSMENT OF WATER QUALITY INDEX FOR SOME WELLS AT AL-BA'AJ DISTRICT IN MOSUL CITY, IRAQ

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ABSTRACT

This research was conducted during the year of 2009 to evaluate the (WQI) for some wells at Al- Ba'aj district in Mosul city. The study has been carried out to determine suitability of groundwater for drinking. (WQI) was examined by analyzing of the following parameters: pH, total hardness, calcium, magnesium, chloride, total dissolved solids and sulphate. The (WQI) for examined wells ranges from 43.56 to 941.91 which indicated that 6% of water wells was (excellent), 28% (good), 33% (poor) and 33% was (unsuitable) for drinking due to the high value for (WQI) was due to high values of total hardness, calcium, chloride, total dissolved solids and sulphate in the groundwater. The results of this research recommend an intensive treatment before using the examined water for drinking shows the necessity of conducting primary treatment and disinfection consumption for the wells that can be used as a source of drinking.

KEYWORDS: Groundwater, Water Quality Index, water suitability for drinking.

INTRODUCTION

Water Quality Index (WQI) is a single number that can expresses the quality of water by integrating many water quality variables. It's used for providing a simple and concise method for expressing the water quality for various usage.

The use of groundwater as a source of domestic use went back to 7000 years BC. M., Groundwater of good quality can be used for many purposes i.e irrigation, industrial, recreation and all uses required for human development. These uses has been tremendously increased due to growth and modern of life requirements. (Mahmoud, 1981; Al-Rawi, 1990).

Underground water contains dissolved salts which differ in terms of quality and quantity, this variations depend on the source of minerals and the environment of the surrounding rock layers which the water is passing through. (Al- Ubaidy, 2008).

In the last few decades, there has been a tremendous increase in the demand of the fresh water due to rapid growth of population and the accelerated pace of industrialization. Human health is threatened by most of the agricultural development activities particularly in relation to excessive application of fertilizers. Rapid urbanization has affected the availability and quality of groundwater due to its overexploitation and improper waste disposal, particularly in urban areas. According to World Health Organization (WHO, 1993), about 80% of all the diseases in human beings are caused and\ or transformed by water. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source. It therefore becomes imperative to monitor the quality of groundwater regularly and to derive ways and means to protect it. Water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. (Tiwari & Mishra 1985, Singh, 1992, Mishra, 2001, Naik & Purohit 2001). It, thus, becomes an important parameter for the assessment and management of groundwater. The concept of (WQI) first proposed by Horten 1965. Water quality index indicate single number like a grade that express overall water quality index at certain area and time. It gives general idea of the possible problem with water in a particular region to public (Yadav et al., 2010). this number is dimension less value.

In this research, (WQI) applied on groundwater to discusses its suitability for human consumption in Al- Ba'aj district, this district was selected due to the lack of surface water.

Description of the study area

The study area, of Al- Ba'aj District; is located within latitudes 34°59'N to 36°16'N and longitudes 41°09'E to 42°23'E and covers an area of about 7,684 km^2 (Fig. 1).

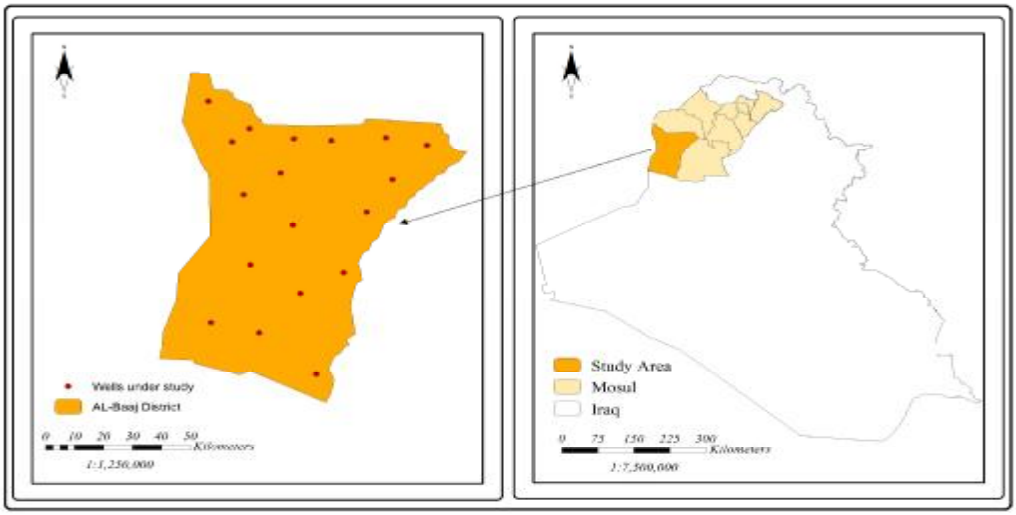

Fig. (1): Map of Study area

The area has a mean annual rainfall of 147.4 mm, and minimum temperature of 7.3 °C in January and maximum temperature of 34.1 °C in July. The mean monthly temperature is 20.41 °C.

There is no permanent surface water flow over the whole region of Al Ajeej Valley , However, during rainy season valley flow collects water from northwest toward the southwest passing through the valley and enhancing its depression and ground water aquifers with water. (Khuder and Faisal, 2011). Due to the high demand to groundwater in Al- Baaj district, therefore it is necessary to conduct a study to assess the quality of groundwater (wells water).

AL-Baaj is located in the composition of Injana and the soil of the north region is composed of red heavy which cover and shallow layers of plaster or sand and mud-rock, On the other hand the soils of the south region contains a gypsum desert soils. (State Company of Geological Survey and Mining, 2000).

Methodology

Eighteen water samples were collected from wells in Al- Ba'aj district located in the south west of Mosul city. Samples examined for Total hardness as $CaCO_3$, Total dissolved solids, Electrical conductivity, Sulphate, Magnesium, Calcium, Sodium, Potassium, Chloride, Total Alkalinity (Standard methods, 1998), the mentioned water chemical properties were analyzed from Water Directorate of Nineveh.

Calculation of WQI:

Three steps were followed for computing WQI. In the first step, each parameter has been assigned a weight (wi) according to its relative importance in the overall quality of water for drinking purposes (Table 1). Other In the second step, the relative weight (Wi) is computed from the following equation (Ramakrishnaiah et al., 2009):

$$= \frac{\quad}{\sum} \quad \text{.....(1)}$$

Where, Wi: is the relative weight

wi: is the weight of each parameter

n : is the number of parameters

In the third step, a quality rating scale (qi) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the Iraqi guidelines and the result multiplied by 100.

Table (1): Relative Weight of Chemical Parameters.

Chemical parameters	Iraqian Standards(1986)*	Weight (wi)	Relative weight (Wi)
pH	6.5- 8.5	4	0.173913
Total dissolved solids (TDS) (mg/l)	1000-1500	4	0.173913
Total hardness (TH) (mg/l)	500	3	0.130434
Sulphate (mg/l)	200-400	4	0.173913
Magnesium (mg/l)	50-150	1	0.043478
Calcium (mg/l)	100-200	2	0.086956
Sodium (mg/l)	200	2	0.086956
Chloride (mg/l)	200-600	3	0.130434
		∑ wi= 23	∑Wi= 1.000000

*(Environmental Regulation of Protected and improvement Iraqi Environment,1988)
(Abawi and Hassan,1990)

$$qi = \frac{Ci}{Si} \times 100 \ldots\ldots\ldots (2)$$

Where:
qi is the quality rating
Ci : is the concentration of each chemical parameter in each water sample in mg/l.
Si: is the Iraqi drinking water standard.
For computing the WQI, the SI is first determined for each chemical parameter, which is then used to determine the WQI as per the following equation

$$SIi = Wi \times qi \quad \ldots\ldots\ldots\ldots(3)$$

$$WQI = \sum SIi \quad \ldots\ldots(4)$$

SIi is the subindex of ith parameter.
The WQI values are classified into five types according to degree and\ or value of it purity of use for drinking, as shown in (Table 2).

Table (2): Water quality classification for drinking based on WQI value (Ramakrishnaiah et al., 2009)

WQI	Water quality
< 50	Excellent
50- 100	good
100-200	poor
200- 300	very poor
Above 300	unsuitable

RESULTS AND DISCUSSION

The calculated WQI of the studied wells varies from 43.56 to 941.91 (Table 3), this high values were due to the higher concentration of hardness, Sulphate, Magnesium, and chloride in the groundwater. The mean values of these contaminants also exceeded WHO standards (WHO, 2011) as revealed previously with the exception of total hardness (Ishaku 2011). According to classification in (Table 2) results indicated that 33% of studied wells (unsuitable) while 6% only (Excellent) as shown in (Fig. 2).

Table (3): WQI value and classification for studied wells

Sampling station	WQI value	Classification
1	103.21	poor
2	101.92	poor
3	124.04	poor
4	85.57	good
5	76.93	good
6	112.30	poor
7	318.21	unsuitable
8	43.56	Excellent
9	72.76	good
10	425.32	unsuitable
11	149.79	poor
12	79.22	good
13	80.32	good
14	413.56	unsuitable
15	538.26	unsuitable
16	379.16	unsuitable
17	136.74	poor
18	941.91	unsuitable

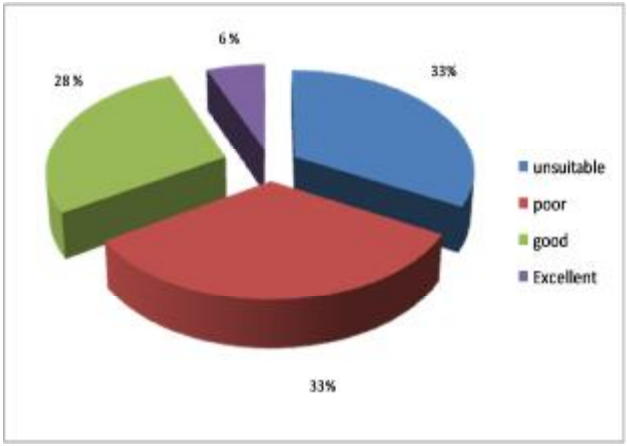

Fig (2): WQI Categories of samples (%) for studied wells

The mean WQI value is 283 indicates a water of very poor quality for this district. The variation in groundwater studied wells is certainly due to the variation in the source of feeding water and in the geological formation in which the water is passing through (Shihab 2007).

(Table 4) shows the percent of samples exceeding Iraqi water quality standards for 1986 (Environmental Regulation of Protected and improvement Iraqi Environment,1988), (WHO, 2011) and (EPA, 2009) water quality standards.

Descriptive statistics for studied wells are shown in (Table 5). It is obvious to see that pH value were ranging from 6.7 to 8.4 and this range is within the Iraqi Standards acceptable limits, also the mean value of alkalinity was 169.3 mg/l is below the value recorded in the Iraqi Standards and the groundwater tend to be alkaline. TDS and EC ranging between 320 to 7180 mg/l and 528 to 8519 µS/cm ,respectively.

The high EC value could be attributed to inflow of contaminated groundwater probably due to sewage effluent and indiscriminate waste disposal practice (Ishaku, 2011). TH varies from 260 to 2850 mg/l. The hardness values for the study area are found to be high for almost all locations and determined to fall above the desirable limit of Iraqi specification.

SO_4 was high (746.67 mg/l) may be due to action of leaching and anthropogenic activities in a metamorphic environment by release of sulfur gases from urban utilities get oxidized and enter into the groundwater system (Saxena, 2004).

The chloride content ranges from 10 to 4150 mg/l. this high values may be attributed to the widely distribute of chloride element in all types of rock. Therefore, its concentration is high in ground waters, where the temperature is high and rainfall is low. Soil porosity and permeability also play a vital role in building up the chloride concentration in ground water (Chanda , 1999).

The range of Magnisuim is between 27.32 to 366 mg/l with mean of 115.72 mg/l this high number might have been derived from dissolution of magnesium calcite, gypsum, and dolomite from source rock (Garrels and Christ, 1965).

Calcium value was high and range from (59.2 to 4150 mg/l) due to dissolution of precipitates of $CaCO_3$ and Ca Mg $(CO_3)_2$ during recharge. (Datta and Tyagi 1996; Lakshmanan et al., 2003). Sodium value varying between 3.5 to 490 mg/l with a mean value of 130.78 mg/l, this value is below Iraqi Standards for 1986.

Table (4): Comparison of groundwater quality with Iraqi (1986), WHO (2011) and EPA (2009) drinking water standards

Parameter	Unit	Iraqi Standards (1986)	% of samples exceeding limits	WHO Standards (2011)	% of samples exceeding limits	EPA Standards (2009)	% of samples exceeding limits
pH	-	6.5- 8.5	None	6.5- 8.5	None	6.5- 8.5	None
Electrical conductivity	µmohs/cm	-	-	500 *	100	-	-
Total dissolved solids	mg/l	1000	55	1000	55	500	94
Total hardness as CaCO3	mg/l	500	66	100	100	-	-
Sulphate	mg/l	200	83	250	66	250	66
Magnesium	mg/l	50	61	50 *	61	-	-
Calicium	mg/l	200	28	75 **	88	-	-
Sodium,	mg/l	200	28	200	28	20	27
Potassium	mg/l	-	-	200 *	None	-	-
Chloride	mg/l	200	39	250	22	250	22
Total Alkalinity	mg/l	170	33	-	-	-	-

*(WHO, 1998)
** (WHO,1993)

Table (5): Some statistics measures of chemical parameters

Parameter	Mean	Min.	Max.	Sd.	Variance
pH	7.73	6.7	8.4	0.48	0.232132
Electrical conductivity µmohs/cm	3189.4	528	8519	2729.22	7448627
Total dissolved solids mg/l	2324.78	320	7180	2120.02	4494482
Total hardness as $CaCO_3$ mg/l	1014.4	260	2850	880.82	784179.2
Sulphate mg/l	746.67	28	2150	717.87	515334.6
Magnesium mg/l	115.72	27.32	366	107.18	11487.16
Calicium, mg/l	442.53	59.2	4150	947.98	898671
Sodium, mg/l	130.78	3.5	490	163.36	26686.69
Potassium, mg/l	4.26	0.8	29	6.50	42.23223
Chloride, mg/l	458.28	10	4150	969.28	939505.6
Total Alkalinity, mg/l	169.3	72	344	69.36	4810.801

CONCLUSIONS

1. The mean of WQI for the studied wells was 283; therefore the quality of the water is classified as very poor water.

2. The high value of WQI (941.91) was due to the presence of hardness, Sulphate, Magnesium, and chloride in the groundwater, while the lowest value of WQI was (43.56).

3. This study reveals that the water quality is unsuitable for human consumption without treatment.

The Correlation Matrix in (Table 6) indicate positive interrelation between TH with Na r= 0.567, TH with Mg r=0.878, TH with TDS r=0.876 and TH with SO_4 r=0.990, Ca with SO_4 r=0.509, Ca with Cl r=0.963, Mg with Na r= 0.643, Mg with TDS r=0.827 and Mg with SO_4 r=0.882, TDS, Na, SO_4 (r= 0.849 to 0.859), The high positive correlation between the chemical parameters is an indication of common source (Ishaku 2011), the lack of strong relationship between the other analyzed parameters is most probably due to a source contamination (Habib et al. 1990).

Table (6): Correlation coefficient matrix of water quality parameters.

Parameter	pH	TH	Ca	Mg	Cl	TDS	SO_4	Na
pH	1							
TH	0.244	1						
Ca	0.165	0.448	1					
Mg	0.256	0.878**	0.289	1				
Cl	0.198	0.430	0.963**	0.324	1			
TDS	0.264	0.876**	0.368	0.827**	0.477*	1		
SO_4	0.212	0.990**	0.509*	0.882**	0.482*	0.859**	1	
Na	0.253	0.567*	0.063	0.643*	0.265	0.849*	0.511*	1

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

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تقييم مؤشر نوعية المياه لبعض الآبار في ناحية البعاج في مدينة الموصل، العراق

الخلاصة

يهدف البحث إلى تقييم مؤشر نوعية المياه لعدد من الآبار في ناحية البعاج التابعة لمدينة الموصل في العراق خلال العام 2009 وذلك لتحديد مدى صلاحية المياه الجوفية لأغراض الشرب في هذه المنطقة. وقد تم إيجاد قيم مؤشر نوعية المياه بالاعتماد على المعلمات التالية: الرقم الهيدروجيني والعسرة الكلية والكالسيوم والمغنيسيوم والكلوريد والمواد الصلبة الذائبة الكلية والكبريتات. وقد تراوحت قيم مؤشر نوعية المياه لهذه الآبار بين 43.56 إلى 941.91 حيث كانت 6 % من الابار (ممتازة)، 28 % (جيدة)، 33 % (ضعيفة) و33 % (غير ملائمة) للشرب ويرجع السبب في ذلك إلى القيم المرتفعة لكل من العسرة الكلية والكالسيوم والكلوريد والمواد الصلبة الذائبة الكلية والكبريتات في المياه الجوفية. ويوصي البحث بضرورة إجراء المعالجة الأولية والتعقيم للمياه الجوفية التي سيتم استخدامها كمصدر للشرب.

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