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Table of Contents

Volume: 5 Issue: 1 June 2021

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www.kjps.isnra.org

Talab S. A., Jasim S.S. Impact Of Maternal Factors on Birth weight In Salah- Aldeen general Hospital/Tikrit City. Al-Kitab Journal for Pure Sciences (2021); 5(1): 1-13. DOI: https://doi.org/10.32441/kjps.05.01.p1

Impact Of Maternal Factors on Birth weight In Salah- Aldeen general Hospital/Tikrit City

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Abstract

Birth weight is a crucial determinant of the developmental potential of the newborn. Birth weight is the body weight of a baby at its birth. The range of normal is between 2.5 and 4.5 kilograms (5.5 and 9.9 lb). On average, babies of south Asian and Chinese heritage weigh about 3.26 kilograms (7.2 lb). Abnormal newborn weights are associated with negative effects on the health and survival of the baby and the mother. World Health Organization has defined low birth weight as birth weight less than 2,500 grams. Giving birth to a low-birth-weight infant is influenced by several factors. This study aimed to identify key determinants that influence the frequency of normal and low birth weight in Salah Al-Deen general Hospital in Tikrit city-Iraq.

This study is a Cross- sectional study, was conducted in obstetric department in Salah Al-Deen general hospital during the period from 1st Feb to the 31st of August 2020. The study sample included full term babies (gestational age 37-42 week) chosen by using a convenient sampling method selecting 197 delivered babies with their mothers. Data collection done by face-to-face interview, using the structured questionnaire developed by the researcher include the following information: Information regarding the mother included demographic variables, reproductive health, medical and obstetrical history and antenatal care visits, use of ferrous sulfate and other supplements during pregnancy. Birth weight was measured at birth, to the nearest 50 g, with the nude infant lying on the available scale. Zero adjustment of the scale was frequently done

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to ensure accuracy of the readings. Birth weight was categorized into two as low birth weight (birth weight < 2500 grams), and normal birth weight (birth weight ≥ 2500 grams).

The current study showed that prevalence of low birth weight was (2.4%), macrosomia (15.6%) and normal birth weight was (82%). The study showed that the low birth weight was higher among primigravida (3.4%), than multigravida women (1.7%) and that the low birth weight was higher among 1st and 2nd birth order (3.4%), (6.7%) respectively while it was (0%) among the 3rd baby order. Previous history of Diabetes Mellitus was associated with 0(0%) low birth weight babies and (2.6%) of those women without Diabetes Mellitus had low birth weight babies. Those with history of iron deficiency anemia was more prone to had babies with low birth weight (3.1%), versus those without history of iron deficiency anemia (1.3%). Those with history of hypertension more prone to had babies with low birth weight (4%), versus those without history of iron deficiency anemia (2.2%). The current study showed that those with ferrous sulfate supplements had lower proportion of babies with low birth weight (1.2%), versus those without supplements (7.7%), this relation statistically significant .

This study has demonstrated that the younger maternal age, mother with diabetes mellitus, hypertension and irregular antenatal care had babies with lower birth weight. Previous history of low birth weight also is a predisposing factor for low birth weight.

Keywords*:* Salah Al-Deen general Hospital, reproductive health, low birth weight.

تأثير عوامل الأمومة على وزن الولادة في مستشفى صلاح الدين العام \ مدينة تكريت

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النسائية والتوليد كلية الطب جامعة تكريت

الخلاصة:

الوزن عند الولادة هو محدد حاسم لإمكانيات نمو الوليد. ترتبط الأوزان غير الطبيعية للمواليد بآثار سلبية على صحة وبقاء الطفل والأم. حددت منظمة الصحة العالمية انخفاض الوزن عند الولادة على أنه وزن عند الولادة أقل من 2500 جرام. تتأثر ولادة طفل انخفاض الوزن عند الولادة بعدة عوامل. تهدف هذه الدراسة إلى التعرف على المحددات الرئيسية التي تؤثر على انتشار الوزن الطبيعي والوزن المنخفض عند الولادة في مستشفى صلاح الدين العام بمدينة تكريت.

هذه الدراسة عبارة عن دراسة مقطعية أجريت في قسم التوليد بمستشفى صلاح الدين العام خلال الفترة من 1 فبراير 31 أغسطس 2020. وستشمل عينة الدراسة الأطفال الناضجين (عمر الحمل 36-40 أسبوعًا) تم اختيارهم باستخدام طريقة مريحة لأخذ العينات، واختيار 205 طفلًا ولدوا مع أمهاتهم. جمع البيانات الذي تم عن طريق المقابلة وجهاً لوجه، باستخدام الاستبانة المنظمة الذي طورها الباحث يتضمن المعلومات التالية: تتضمن المعلومات المتعلقة بالأم المتغيرات الديموغرافية، والصحة الإنجابية، والتاريخ الطبي والتوليد، وزيارات الرعاية السابقة للولادة، واستخدام كبريتات الحديدوز ومكملات أخرى أثناء الحمل. تم قياس وزن الولادة عند الولادة، لأقرب 50 جرامًا، مع وضع الرضيع عاريًا على المقياس المتاح. تم إجراء تعديل صفري للمقياس بشكل متكرر لضمان دقة القراءات. تم تصنيف الوزن عند الولادة إلى قسمين مثل الوزن المنخفض عند الولادة (وزن الولادة أقل من 2500 جرام)، والوزن الطبيعي عند الولادة (وزن الولادة 2500 جرام).

أظهرت الدراسة الحالية أن انتشار انخفاض الوزن عند الولادة كان (2.4٪)، الماكروسوميا (15.6٪) والوزن الطبيعي عند الولادة (82٪). أظهرت الدراسة الحالية أن انخفاض الوزن عند الولادة كان أعلى بين اللواتي لديهن ولادة واحده (3.4٪)، من النساء اللواتي لديهن ولادات متعددة (1.7٪)، وأظهرت الدراسة الحالية أن الاوزان المنخفضة كان أعلى بين ترتيب الولادة الأول والثاني (3.4٪)، (6.7٪) على التوالي. كان (0٪) ضمن ثالث ترتيب للأطفال. ارتبط التاريخ السابق لمرض السكري مع 0 (0٪) أطفال بأوزان منخفضه و (2.6٪) من هؤلاء النساء غير المصابات بمرض السكري كان لديهن أطفال بأوزان منخفضه. أولئك الذين لديهم تاريخ من الإصابة بفقر الدم الناجم عن نقص الحديد أكثر عرضة لإنجاب أطفال مصابين بنقص وزن الجسم (3.1٪)، مقابل أولئك الذين ليس لديهم تاريخ من فقر الدم بسبب نقص الحديد (1.3٪). أولئك الذين لديهم تاريخ ارتفاع ضغط الدم أكثر عرضة لإنجاب أطفال يعانون من انخفاض الوزن عند الولادة (4 ٪)، مقابل أولئك الذين ليس لديهم تاريخ من فقر الدم بسبب نقص الحديد (2.2 ٪). تظهر الدراسة الحالية أن أولئك الذين يتناولون مكملات كبريتات الحديدوز لديهم نسبة أقل من الأطفال الذين يعانون من انخفاض الوزن عند الولادة (1.2٪)، مقابل أولئك الذين ليس لديهم مكملات (7.7٪)، وهذه العلاقة ذات دلالة إحصائية.

أظهرت هذه الدراسة أن هناك علاقة إيجابية بين عمر الأم والوزن عند الولادة، وأن المواليد منخفضة الوزن عند الولادة كانت أعلى في الأمهات الأصغر سنًا، مما يجعل عمر الأم عاملاً مهمًا في حدوث ولادات اطفال بوزن منخفض. العوامل الأخرى التي تم العثور عليها لتكون مهمة تشمل مرض السكري وارتفاع ضغط الدم الأمومي. تُظهر هذه الدراسة ارتباطًا مهمًا بين الولادات منخفضه الوزن والأمهات اللاتي لا يحضرن رعاية الام والطفل بانتظام، وتاريخ الولادات منخفضه الوزن السابق، والأمهات المصابات بفقر الدم والامهات خلال الحمل الاول.

الكلمات المفتاحية: مستشفى صلاح الدين، الصحة الإنجابية، الولادات منخفضه الوزن.

Introduction:

Birth weight is the important determinant of the child growth, survival, development, and morbidity, as well as an indicator for the health and nutrition of the mother, in addition to quality of life. [1] Low birth weight (LBW) was defined as weight at birth < 2500 g (5.5 lb), regardless

of gestational age [1]. It is an important a global public health issue, as a result of its wide range of short- and long-term consequences [2]. The birth weight of a baby is notable because very low birth weight babies are 100 times more likely to die compared to normal birth weight babies. [3] As far as low birth weights prevalence rates changing over time, there has been a slight decrease from 7.9% (1970) to 6.8% (1980), then a slight increase to 8.3% (2006), to levels of 8.2% in (2016).[1] The prevalence of low birth weight has trended slightly upward from 2012 to present day.

LBW contribution to infant morbidity and mortality. About 50% of perinatal and 33.3% of infant deaths occur among LBW babies [2].

Several maternal and fetal factors contribute to LBW. The majority of the maternal factors, which are biologically and socially interrelated, are modifiable, making LBW a potentially preventable condition. Globally, LBW constitutes about 15% to 20% of all births worldwide, 20 million births with LBW per year. Considerable variation exists between different regions and countries regarding LBW, and the majority of LBW births are in low- and middle-income countries especially in most vulnerable populations [4].

Low birth weight (LBW) is more common in developing countries than in developed countries and significantly contributes to both neonatal and post neonatal mortality in those settings. Asia accounts for 75% of worldwide LBW incidence, followed by Africa which accounts for 20%. In Iraq, 13.4% of infants born with LBW, with variations between the governorates. However, percentages of infants with LBW did not vary much by urban or rural areas. It is reported that LBW prevalence in Iraq is increasing over the last three decades. [3]

Subject and Methods:

This study is a Cross- sectional study, was conducted in obstetric department in Salah Al-Deen general hospital during the period from 1st Feb to the 31st of August 2020. The study sample included full term babies (gestational age 37-42 week) chosen by using a convenient sampling method selecting 197 delivered babies with their mothers. Data collection done by face-to-face interview, using the structured questionnaire developed by the researcher include the following information: Information regarding the mother included demographic variables, reproductive health, medical and obstetrical history and antenatal care visits, use of ferrous sulfate and other supplements during pregnancy. Birth weight was measured at birth, to the nearest 50 g, with the nude infant lying on the available scale. Zero adjustment of the scale

was frequently done to ensure accuracy of the readings. Birth weight was categorized into two as low birth weight (birth weight < 2500 grams), and normal birth weight (birth weight ≥ 2500 grams).

Results:

The current study showed that prevalence of low birth weight was (2.4%), macrosomia (15.6%) and normal birth weight was (82%). The study showed that the low birth weight was higher among primigravida (3.4%), than multigravida women (1.7%) and that the low birth weight was higher among 1st and 2nd birth order (3.4%), (6.7%) respectively while it was (0%) among the 3rd baby order. Previous history of Diabetes Mellitus was associated with 0(0%) low birth weight babies and (2.6%) of those women without Diabetes Mellitus had low birth weight babies. Those with history of iron deficiency anemia was more prone to had babies with low birth weight (3.1%), versus those without history of iron deficiency anemia (1.3%). Those with history of hypertension more prone to had babies with low birth weight (4%), versus those without history of iron deficiency anemia (2.2%). The current study showed that those with ferrous sulfate supplements had lower proportion of babies with low birth weight (1.2%), versus those without supplements (7.7%), this relation statistically significant.

Analysis of 205 newborn babies that recruited in this study show that the mean birth weight was 3288.3±464, median was 3100 g, minimum birth weight was 2000g and the maximum was 4000 g.

The percentage of low birth weight was 5(2.4%), macrosomia 32(15.6%) and normal birth weight was 168(82%), as shown in this **figure 1**.

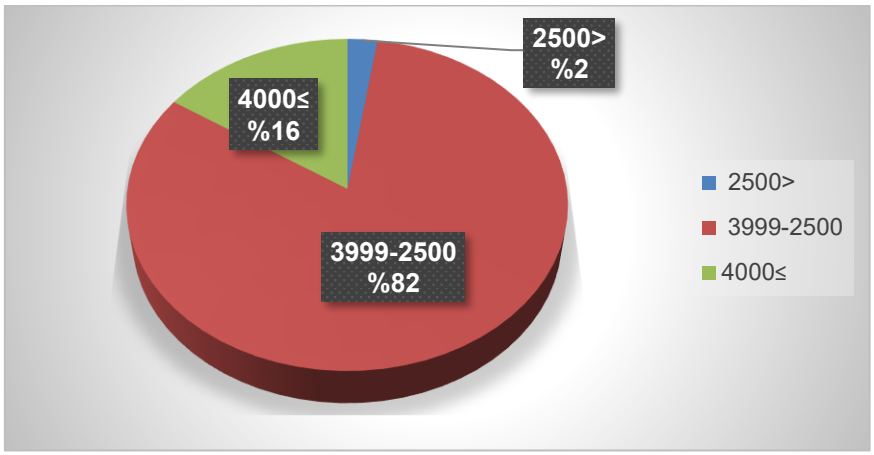

Figure 1: shows the distribution of sample according to birth weight.

The BW distribution according to mother age show that those aged < 25 years 3(2.7%) of their babied were LBW, and 20(18%) were ≥4000 g, while those aged ≥35 years none of their babies were LBW and 4(16.7%) were ≥4000 g, this relation was statistically not significant (P value>0.05), as shown in **table 1**.

Table 1. The BW distribution according to mother age

Age of mother	BW			Total
	<2500	2500-3999	≥4000	
<25	3	88	20	111
	2.70%	79.30%	18.00%	100.00%
25-34	2	60	8	70
	2.90%	85.70%	11.40%	100.00%
≥35	0	20	4	24
	0.00%	83.30%	16.70%	100.00%

Chi-sequre test X2 =2.1, df=4, P >0.05 not significant

LBW was higher among Primigravida 3(3.4%), than multigravida women 2(1.7%), this relation was statistically not significant (p value> 0.05).

LBW was higher among 1st and 2nd birth order 3(3.4%), 2(6.7%) respectively while it was 0(0%) among the 3rd baby order, this relation was statistically significant (p value> 0.05) as shown in **table 2**. Most of women living in rural area 5(6.5%) had LBW baby compared to urban 0(0%), this relation was statistically significant (P value<0.05). All women with higher education 12(100%) had normal birth weight, while 5(5.6%) of those who had 1ry education had babies with LBW, this relation was statically significant (P value<0.05) as shown in **table 2**.

Table 2. The relation of BW and the general characteristics of the women

Variables		BW			Total	P value
		<2500	2500-3999	≥4000		
Gravidity	Primigravida	3	72	12	87	>0.05NS *
		3.40%	82.80%	13.80%	100.00%	
	Multigravida	2	96	20	118	
		1.70%	81.40%	16.90%	100.00%	
Birth order	1	3	72	12	87	<0.05 S**
		3.40%	82.80%	13.80%	100.00%	
	2	2	20	8	30	
		6.70%	66.70%	26.70%	100.00%	
	≥3	0	76	12	88	
		0.00%	86.40%	13.60%	100.00%	
Residence	Urban	0	100	28	128	<0.05 S**
		0.00%	78.10%	21.90%	100.00%	
	Rural	5	68	4	77	
		6.50%	88.30%	5.20%	100.00%	
Education	Illiterate	0	28	4	32	<0.05 S**
		0.00%	87.50%	12.50%	100.00%	
	1ry	5	64	20	89	
		5.60%	71.90%	22.50%	100.00%	
	2ndry	0	64	8	72	
		0.00%	88.90%	11.10%	100.00%	
	high education	0	12	0	12	
		0.00%	100.00%	0.00%	100.00%	
Employment	Housewife	3	118	22	143	>0.05 NS**
		2.1%	82.5%	15.4%	100.00%	
	Teacher	2	42	8	52	
		3.8%	80.8%	15.4%	100.0%	
	Office working	0	8	2	10	
		0%	80%	20%	100%	

Discussion

The mean birth weight was (3288.3±464), the median was (3100 g), minimum BW was (2000g) and the maximum was (4000 g), and that percentage of low birth weight was (2.4%), macrosomia (15.6%) and normal birth weight was (82%). This also comparable to Adiba M Murad *et al* [5] (2013) who found that the mean birth weight of SGA cases was (2000 ± 258.2g) (Range 1650g-2480g), and the mean birth weight of appropriate for gestational age fetuses was 3168 ± 556.4g (Range 2600-4500g). [5]

This study showed that the birth weight distribution according to mother age show that those aged < 25 years (2.7%) of their babies were LBW, and (18%) were ≥4000 g, while those aged ≥35 years none of their babies were low birth weight and (16.7%) were ≥4000 g. This finding agrees with previous studies that found increased low birth weight among younger mothers like Makki [6] study (2002), and Jisuk B. *et al* [7] (2011), (16.6%) and (3.77%) respectively. Adiba M Murad *et al* [5] (2013) found that mothers whose age ≤16 year were 2.1 time at risk to get small for gestational age.

This study showed that most of women living in rural area had higher percentage of low birth weight (6.5%), Similar results have been found in other studies, Rezende Chrisman J et al [8], and Kayode GA et al [9], while it disagrees with Adiba M Murad *et al* [5] (2013) who found that the a rural area had no impact to get SGA (47%), probably explained by the small studied sample. The increased percentage of low birth weight in rural areas may be explained by lack of health services, antenatal care, and low socioeconomic status, and poverty in rural areas.

This study showed that the LBW was higher among prime para (3.4%), than multipara women (1.7%). This study also shows that the LBW was higher among 1st and 2nd birth order (3.4%), (6.7%) respectively while it was (0%) among the 3rd baby order. This agrees with Adiba M Murad *et al* (2013) found that primiparous mothers showed 3.47-time risk to get SGA. [5] The primipara mothers were at high risk for LBW births, and this goes in accordance with Makki AW (2002) [6], and Swamy, G. K et al [10] (2012) the explanation for this is that multiparous women know more about how to deal with their pregnancy and aware of previous dangerous pregnancy complications.

Another explanation is that women having a third birth in their early 30s compared with their early 20s are more likely to have adequate spacing between births. (The older women are also

more likely to have achieved a more stable financial status.) As a result, both the maternal age component and parity component exert a positive influence on birthweight.[10]

This study showed that regular ANC visits protective against LBW, and 5(6%) of those with irregular visits had LBW baby, and 26 (21.5%) of women with regular ANC visits give birth to baby with birth weight >4000g, while 6(7.1%) of those with irregular visits give birth to baby with birth weight >4000g , this agrees with Adiba M Murad *et al* [5] (2013) who found that mothers with irregular antenatal care (ANC) showed 5.532 time risk to get SGA. and in agreement with that of Hameed N *et al* (2011), [11] The mothers not attended ANC had (41%) SGA birth, and (16%) of those with adequate birth weight. Kayode GA et al [12] (2014), Tellapragada C et al [13] (2016) and - Mahmud RA *et al* [3] (2017) find the same results, Specifically, in women who failed to receive any ANC or had inadequate ANC than recommended, the risk of LBW was higher than in women attending the standard number of ANC visits.

The explanation is related to fact that adequate regular ANC may identify problems early, allowing treatment that may reduce risk of SGA newborns.

This study showed that the (4.8%) of women with previous history of LBW had babies with LBW, in comparison to (2.2%) of those who didn't have any history of LBW. Also found that LBW was higher among 1st and 2nd birth order (3.4%), (6.7%) respectively while it was (0%) among the 3rd baby order, this relation was statistically significant (p value> 0.05). this goes in accordance with Adiba M Murad *et al* (2013) found that Mothers with family history of SGA showed 17.471-time risk to get SGA newborn. [5]

Other studies reported that mothers with family history of SGA have strong risk of a newborn with SGA, this is compatible with Hameed N *et al* (2011) found that (24%) &(15.474) times risk to get SGA births in mothers with previous maternal history of SGA births in comparison with adequate weight group only (2%) had positive family history [11], Tsukamoto M. *et al* (2007) [14] Momeni M *et al* [15] (2017) and Bener A *et al* (2013) [16] support our findings and may related to genetic factors as consanguineous rather than nonconsanguineous was considered as risk factor for LBW by Momeni M et al [15] (2017) and Bener A et al [16].

This study revealed that the previous history of DM was not associated with LBW. This result agrees with Hameed N *et al* [11] (2011) show no significant association, and Zhu WW *et*

al [17] found relation of diabetes mellitus with macrosomia. Usta A *et al* [18] found that macrosomia represented 8.6% of babies born for mothers with gestational diabetes.

This study revealed that those with history of HT more prone to had babies with LBW (4%), this agrees with other studies that revealed that mothers with history of hypertension show increasing association with SGA, a finding supported by Hameed N *et al*(2011) [11] found that 27% of the babies born small for gestational age their mothers had hypertension with OR of 8.87, and Sehested LT and Pedersen P[19] and Sharma D et al [20] found that gestational hyper tension and history of chronic hypertension associated with increased risk of low birth weight.

Studying the pathophysiology of IUGR reveals those maternal disorders like preeclampsia, eclampsia, and chronic hypertension lead to IUGR by causing uteroplacental insufficiency. Due to decreased oxygenation of tissues, the organ growth and muscular maturation is impaired. Preeclampsia can cause placental infarction that disturbs the provision of nutrients and leads to IUGR, and poor placental flow and hence poor oxygenation of tissues cause restricted fetal growth.[21]

This study showed that those with history of iron deficiency anemia more prone to had babies with LBW (3.1%), versus those without history of iron deficiency anemia (1.3%). This agrees with other studies that revealed mothers with history of anemia show increasing risk of having SGA babies, a similar finding obtained by Hameed N *et al* (2011) [11] found Anemia contributed to about (43%) of SGA newborns, while it was (12%) in adequate weight newborns and goes with - Khan I *et al* [22] found maternal anemia have 5.4 times risk of getting LBW. This might be due to the fact that anemia may limit the amount of oxygen available for placental exchange.

Conclusion

1. The mean birth weight was (3288.3±464), median was (3100 g), minimum BW was (2000g) and the maximum was (4000 g).
2. The percentage of low birth weight was (2%), macrosomia (16%) and normal birth weight was (82%).
3. The current study show that the BW increased with increasing age, and parity of mother, birth order of the baby.
4. Risk factors of low birth weight include living in rural area, low educational level associated, previous history of LBW, history of hypertension, anemia and.

5. Mothers with ferrous sulfate, multivitamins, folic acid supplements, and calcium supplements had lower proportion LBW babies.

Those with regular antenatal care visits had lower proportion of babies with LBW, versus those with irregular antenatal care visits.

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Activity of Cloves, Cinnamon and Thyme Essential Oils Against Some Oral Bacteria

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Abstract

Background: Gastronomic natural flavors and spices have been used as both flavoring agents and preservatives in food preparation for many years. They have also been utilized in medical field for their biological properties shown in previous studies.

Objective: The study aimed to evaluate the inhibitory effect of the oil extracts from Cloves, Thyme, and Cinnamon compared with ampicillin on some oral bacteria (*Staphylococcus aureus, Streptococcus mutans, Lactobacillus* spp., *Pseudomonas aeruginosa,* and *Proteus* spp.).

Method: Evaluation of the antibacterial effect of herbal and spices essential oil was performed using Agar well diffusion test. Its effect was assessed against oral bacteria, which diagnosed in laboratory by culturing on enriched and selective media and by biochemical test.

Results: High inhibitory effect of cinnamon, clove against some Gram positive and Gram negative isolated oral bacteria (*Staphylococcus aureus, Streptococcus mutans, Lactobacillus* spp., *Pseudomonas aeroginosa,* and *Proteus* spp. comparing with ampicillin. While thyme essential oil shows inhibitory effect for the bacterial isolates except for *Pseudomonas aeroginosa* but less than the inhibitory effects of other essential oils and ampicillin.

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For *Psedomonas aeruginosa* result shows the bacteria have resistance to ampicillin and Thyme essential oil while both cloves and cinnamon have antibacterial effect.

Conclusions: Cloves, thyme and cinnamon essential oil have a wide antimicrobial activity against some oral bacteria, both cinnamon and cloves essential oils recorded superior antibacterial activity than ampicillin for (*Proteus* spp and lactobacillus), competence action with ampicillin for *Staphylococcus aureus* and *Streptococcus mutans* and novel antibacterial action against *Pseudomonas aeroginosa* which resist to ampicillin which may be a promising antibacterial management approach and resist development of antibiotic resistance strain if used instead than the antibiotic. Also, suggestion for using these oils orally may provide a degree of protection in oral cavity against some oral pathogens.

Keywords: Clove, thyme, cinnamon oil, antibacterial.

فعالية الزيوت الاساسية للقرنفل والدارسين والزعتر ضد بعض البكتريا الفموية

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المستخلص

تم استخدام النكهات والتوابل الطبيعية للطعام كعوامل منكهة ومواد حافظة في تحضير الطعام لسنوات عديدة. كما تم استخدامها في المجال الطبي لخصائصها البيولوجية الموضحة في الدراسات السابقة.

هدفت الدراسة إلى تقييم التأثير التثبيطي لمستخلصات زيت القرنفل والزعتر والقرفة مقارنة بالأمبيسيلين على بعض البكتريا الفموية ومنها

Staphylococcus aureus, *Streptococcus mutans*, *Lactobacillus spp.*, Escherichia *coli*, *Pseudomonas aeroginosa*, and *Proteus* spp

تم إجراء تقييم التأثير المضاد للبكتيريا للمستخلص العشبي (الزيت) باستخدام اختبار فحص الانتشار من الحفر، تم تقييم تأثيره ضد بكتيريا الفم، والتي تم تشخيصها في المختبر عن طريق الزراعة على الاوساط الاغنائية والانتقائية والاختبار البيوكيميائي.

النتائج: ارتفاع مستوى التأثير المثبط للقرفة والقرنفل وزيت الزعتر على بعض بكتيريا الفم الموجبة والسالبة الجرام (*Staphylococcus aureus*، *Streptococcus mutans*، *Lactobacillus* spp، *Escherichia coli*، *Pseudomonas aeroginosa* ، و *Proteus* spp) مقارنة بالأمبيسلين.

اظهرت بكتريا *Psedomonas aeroginosa* مقاومة للأمبيسيلين وزيت الزعتر الأساسي بينما كل من القرنفل والقرفة لهما تأثير مضاد لهذه البكتيريا.

استنتجت الدراسة الحالية بان الزيوت العطرية للقرنفل والقرفة والزعتر تملك نشاط مضاد للميكروبات واسع النطاق ضد بعض بكتيريا الفم، كلا من الزيوت العطرية للقرفة والقرنفل سجلت تأثير مضاد اعلى من التأثير المثبط للامبسلين على كل من بكتريا *Proteus* spp و*lactobacillus* وتأثيرا منافس للامبسلين بالنسبة لبكتريا *Staphylococcus aureus* و *Streptococcus mutans* كما لها تأثير مضاد لبكتريا *Pseudomonas aeroginosa* التي تقاوم الامبسلين. هذه الدراسة تعتبر طريقة واعدة في التضاد البكتيري ومقاومة ظهور سلالات مقاومة للمضادات الحياتية عند استخدامها بدلا عن المضاد الحياتي. اقتراح استخدام هذه الزيوت فمويا ربما يوفر درجة من الحماية في التجويف الفمي من بعض البكتريا المرضية الفموية.

الكلمات المفتاحية: القرنفل، الزعتر، زيت الدارسين ومضاد بكتيري .

Introduction:

Natural herbal elements and spices have been utilized as food additives (flavoring agent and preservatives) for hundreds of years. In addition, they have been used for medical purposes [1]

The increased exposure to antibiotics during eradication of bacterial infections has led to the development of resistant strains of bacteria. Not only for a certain antibiotic, but also there may be multidrug resistance. Recently, there has been a growing number of studies focusing on the use of natural botanicals as alternative antimicrobial agents (active or preservative) in topical preparation as well as in formulation for systemic use [2]. These cumulative works are mainly determined by safety and environmental concerning [3].

Essential oils have been prescribed to treat oral diseases as oral wash either conventionally or clinically in many periodontal disorders [4]. In addition to their ability to control resistant bacteria and other pathogenic microorganism [5].

Syzygium aromaticum L. belongs to family Myrtaceae. In Hindi this plant is famous as laung. It is an evergreen tree, native of Indonesia and Mallaca islands distributed in tropics of the old world. It is cultured in Tanzania, Indonesia, Penang, Malagasy, Mauritius as well as Srilanka. The extracted essential oil is used commonly as a food additive by Chinese. Also, it has been shown to improve digestion and inhibit growth of microorganism. Two of the main phenolic constituents of clove essential oil are eugenol and eugenyl acetate. Clove is a natural analgaesic and antiseptic used mainly in dentistry for its main ingredient eugenol. It is used as home remedy for dental pain relief, mainly toothache [5] also used in approach to deal with antibiotic resistance problem and have synergistic outcome of combination of essential oils and

antibiotics, and the possibilities of essential oil as the possible resistance modifying agent was highlighted [6].

The genus Thymus belongs to the Lamiaceae family. The leaves of thyme have been used in food as flavor, aroma and preservation. Its use as folk medicine is well known, particularly in Mediterranean countries since a long time ago [1].

The major components essential oil of thyme (*Thymus* Spp, *T. citriodorits, T. vulgaris-Labiatae/ Lamiaceae*) involve 20-40% thymol and carvacrol in addition to borneol, cineol, linalool, menthone, B-cymene, pinene and triterpenic acid. Thyme oil has a useful effect on human digestive system and can be used in the treatment of gastritis, enterocolitis and mouth ulcers. In addition, it showed activity against respiratory infections as well as effectiveness in cases of chronic obstructive airway disease. Furthermore, it has shown benefit in the management of gout, arthritis and other types of joint pain. Nevertheless, the antimicrobial effect of thyme is the most extensively investigated effect by studying the role of *Thymus vulgaris* L. (common thyme, German thyme) in inhibiting microbial growth. Several studies have shown that it is helpful in genitourinary tract infections [7]. In addition, it showed an effect against tooth infections [8] an effect that is thought to be a synergistic effect of thymol with other constituent in thyme or other essential oils. Its effect in decreasing dental caries may be due to its activity against *S. mutan*s [7]. In patients with orthodontic brackets, a dental varnish containing thymol decreased the growth of *Streptococcus mutans* in supragingival plaque adjacent to bracket [8]. Thymol is among the essential oils that have antibacterial action in Listerine [9]. According to Gislene and colleagues [10], Hili and colleagues [11] and Nzeako and colleagues [12]. Cinnamon is a bark spice obtained from the inner bark of several tree species from the genus Cinnamomum. It is frequently used as spices. The main aromatic essential oil components of cinnamon giving its special flavor are cinnamaldehyde (up to 90%) and eugenol. In addition, at least 80 other constituents are recognized to be found in cinnamon oil, such as cinnamyl alcohol, cinnamyl acetate and various coumarone that add to its general taste and smell [1]. *Cinnamomum zeylanicum* such as Blume (cinnamon) is widely studied [11]. Cinnamon essential oils have been incorporated widely in folk medicine for many years. Antibacterial activity of cinnamon oil has been recorded [11,13].

Antibacterial activity of cinnamon oil against oral pathogenic bacteria especially the pathogens in relation to periodontal disease, are still scanty [14]. Thus, this work concern for

assessment the anti-bacterial activity of these herbal and spices essential oils against some oral bacteria in comparison with the broad spectrum anti-bacterial activity of ampicillin [15].

Materials and Methods:

Herbal and spices essential oils (100% purity) were purchased from herbal shop in local markets these includes clove oil, thyme oil (HEMANI, Pakistan) and cinnamon essential oil.

Antibiotic: Broad spectrum ampicillin antibiotic [15] with concentration 10 mcg was used for study the antibacterial activity of herbal and spices essential oil in compare with activity of ampicillin.

Bacterial Isolates: Oral bacterial species (Gram positive & Gram-negative bacteria) were obtained from research unit-1 at Collage of Dentistry/ University of Babylon. These bacteria previously diagnosed in laboratory by culturing on enriched and selective media and by biochemical test.

***In Vitro* Assessment of Antibacterial Activity Using Agar Well Diffusion Assay:** The agar well diffusion technique was applied for the detection of antibacterial action of herbs' essential oils. Swab from bacterial growth was inoculated into liquid media and incubated at 37 °C for 18 hours. Normal saline was used for diluting bacterial suspensions. The suspension turbidity was adjusted to be comparable with standard tube (McFarland 0.5) to get an average suspension containing 1.5×10^8 CFU/ml. Muller- Hinton agar was prepared and poured 25 ml for each Petri dish and streaked by swab of bacterial suspension according to Kirby- Bauer techniques, wells were created on the culture media using the head of blue, 1000µl 9.8 x 70 mm pipette tip (Then 50µl of herbal and spices essential oils were added, then incubated at 37 C for 24 hours. All readings were measured in triplicate and zones of inhibitions were measured as diameter of inhibition zones in millimeter [16].

Table 1: Bacteria isolates used in this work.

Gram positive bacteria	Gram negative bacteria
Staphylococcus aureus	*Pseudomonas aeruginosa*
Streptococcus mutans	*Proteus* spp.
Lactobacillus spp.	

The activity of essential oils was compared to the effect of standard antibiotics, ampicillin, a wide spectrum antibiotic with an activity against many Gram-positive and Gram-negative bacteria.

Statistical Analysis: Means of triplicate of zones of inhibition as well as standard division were calculated by excel computer program.

Graph were performed using GraphPad Prism version 8.0.0, GraphPad Software, San Diego, California USA, 2020).

Results and discussion:

Our current study as explained in **table-2** and fig.1 shows that both cinnamon essential oil and ampicillin have antibacterial activity against the pathogenic bacteria *Staphylococcus aureus* followed by cloves and thyme essential oil. Cinnamon essential oil shows the highest antibacterial activity against cariogenic bacteria Streptococcus *mutans* followed by ampicillin, clove and thyme.

For *Lactobacillus spp.* cloves shows the highest activity followed by ampicillin, cinnamon and thyme.

For *Psedomonas aeruginosa* result shows the bacteria have resistance to ampicillin and thyme essential oil while both cloves and cinnamon shows antibacterial effect.

Cinnamon essential oil shows the highest activity against *Proteus* spp followed by ampicillin and cloves essential oil. Table-2, **fig.1**.

Thyme essential oil shows inhibitory effect for the bacterial isolates except for *Pseudomonas aeroginosa* but less than the inhibitory effects of other essential oils and ampicillin.

Table-2: Zone of inhibition induced by essential oils under investigation compared to ampicillin in a variety of bacterial species (Numbers represent the triplicate mean ±SD)

Treatment	**Zone of inhibition for each bacterial isolate**				
	Staphylococcus aureus	*Streptococcus mutans*	*Lactobacillus* spp.	*Pseudomonas aeruginosa*	*Proteus* spp.
Cloves	41.66±2.88mm	23.33±7.63mm	35±5mm	21.66±5.77mm	16±3.60mm
Cinnamon	43.33±2.88mm	31.66±2.88mm	30±5mm	16.66±10.4mm	36.66±5.77mm
Thyme	26.66±10.40mm	13.33±5.77mm	18.33±12.58mm	0±0	3.66±1.15mm
Ampicillin	43.33±2.88mm	26.66±7.63mm	33.33±5.77mm	0±0	21.6±5.7mm

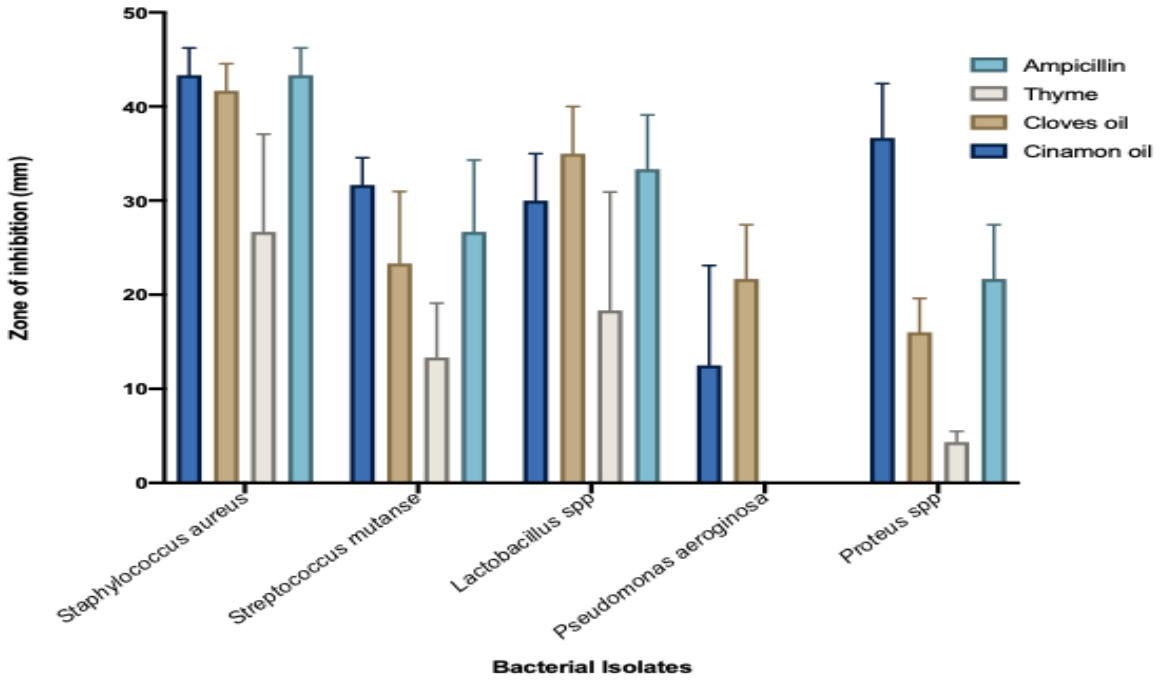

Fig. 1: Bacterial inhibition zone induced by cinnamon, cloves and thyme essential oil compared to ampicillin. (bar represent the triplicate mean ±SD)

Discussion:

Dental caries and periodontal disease are among the very frequent suffer of the mouth all over the world [17].

Dental plaque is characterized by diversity and complexity that why it is one of the frequently developed and propagated mouth disorders [18]. A lot of studies focused on using medicinal plant for treatment infectious disease [19-21].

Our findings showed that cinnamon oil is more effective as antibacterial than clove and thyme oil against several species of bacteria when compare the effect of these essential oils to the effect of ampicillin. Such effect of cinnamon essential oil was the most powerful against all the bacterial species investigated. These findings are consistent with those obtained by Rabuseenivasan and colleagues [22]. On the other hand, it was revealed that cinnamon, clove and rosemary oils have strong and consistent inhibitory activity against different pathogens [23]. The antibacterial effect of the oils may be attributed to the hydrophobic characteristics of essential oils and their constituents which allow them to penetrate the lipid parts of the bacterial cell wall, change the cell structure and increase membrane permeability [24, 25]. Hence, there will

be extensive leakage of essential molecules and ions through the bacterial cell wall leading death [26].

The chief constituent of cinnamon, cinnamaldehyde, has antimicrobial activities on microorganisms, as it inhibited the biosynthesis of cell wall, vital functions of cell membrane, and activity of various specific enzymes. There may be more specific cellular targets of cinnamaldehyde that can be clarified in prospect research [27].

Clove (*Eugenia caryohyllata*) is one of the Myrtaceae family. It is extensively utilized in medicine as antiseptic against infectious disorders like periodontal infectious pathologies due to its antimicrobial effects against various bacterial species in the mouth [28].

Results recorded that thyme essential oil shows inhibition effect against each of *Staphylococcus aureus*, *Streptococcus mutanse*, *Lactobacillus* spp and aginst *Proteus* spp, however this effect was lower than the effect of ampicillin.

Thyme and clove oil extracts are recognized to have some antimicrobial effects. They are utilized in several food preparations to improve their flavor and also in alternative medicine [29, 30]. In spite of the fact that the exact mechanism of action of the extracts are not fully explained, the antimicrobial activity of ingredients such as thymol, terpenes, eugenol, flavones, glycosides of phenolic monoterpenoids and aliphatic alcohols among other components widely used [31, 32, 33] may be due to single or synergism with each other leading to a broad spectrum of antimicrobial effects against both bacteria and fungi. Thyme and cloves oil have antibacterial activity against *S. aureus* [34]. *Pseudomonas aeruginosa* possess percent of antibiotic resistance for wide range of antibiotics [35], in our study this bacterium recorded resistance to ampicillin.

Both cinnamon and cloves essential oil have antibacterial activity against *Pseudomonas aeruginosa*, *Staphylococcus aureus* and Escherichia *coli* [36]. So, our present study confirmed the other previous works.

Conclusion:

Most herbs and spices essential oil shows significant inhibition against oral bacteria, and these results may be have benefit for human health and may be resist development of antibiotic resistance bacteria due to access using of antibiotics.

Also cloves and cinnamon essential oil shows wide spectrum of inhibition against all types of bacteria were used in our study and it shows higher inhibition activities than ampicillin. And both clove and cinnamon essential oil recorded anti *Pseudomonas aeruginosa* activity which resist to ampicillin.

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The Effect of Natural Gas Flaring on Air Pollution and its contribution to Climate Change in Basra City

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Abstract

The effects of climate change differ from one region to another, as its effects are not the same in all regions of the world. The consequences differ from one region to another, according to its geographical location, or according to the ability of the region and its social and environmental systems to adapt to climate change or mitigate its effects. One of the most important factors of climate change is global warming. There are two major sources of global warming: natural and human. The human resource contributes by adding heat and greenhouse gases to the atmosphere because of the global use of fossil fuels, nuclear energy, burning of natural gas, coal, timber, and others. Natural gas flaring is one of the most important challenges facing energy sources and the environment globally and locally. In this study, light was shed on the flaring of natural gas in Basra Governorate and its impact on the environment and climate change. The results showed that burning natural gas in Basra contributes to changing the local climate by adding heat and greenhouse gases to the atmosphere, which led to an increase in the air temperature in the region. In recent years, it has reached (52 degrees Celsius), and it also affects air pollution by increasing concentrations of toxic gases in the

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atmosphere, and it is one reason for the increase in the number of cancer patients in Basra Governorate. And there was a strong positive correlation between increased gas burning and an increase in cancer cases.

Keywords: gas flaring, fossil, methane, decades, oxidation.

تأثير حرق الغاز الطبيعي على تلوث الهواء ومساهمته في تغير المناخ في مدينة البصرة

عبد الحليم على المحي، فائز يونس العيداني

قسم الفيزياء البحرية، مركز علوم البحار، جامعة البصرة، العراق

الخلاصة:

تختلف اثار التغير المناخي من منطقه الى أخرى، وإن آثاره ليست متشابه في جميع انحاء العالم. بل تختلف من منطقة إلى أخرى، حسب الموقع الجغرافي لكل منطقه، أو حسب طبيعة المنطقة وأنظمتها البيئية على التكيف مع التغير المناخي أو التقليل من آثاره. أحد اهم عوامل التغير المناخي هو الاحتباس الحراري.

هناك مصدران رئيسيان للاحتباس الحراري: طبيعي وبشري. يساهم المصدر البشري من خلال إضافة حرارة وغازات دفيئة الى الغلاف الجوي نتيجة للاستخدام العالمي للوقود الاحفوري والطاقة النووية وحرق الغاز الطبيعي، والفحم، والاخشاب، وغيرها. يعد حرق الغاز الطبيعي أحد أكثر التحديات التي تواجه مصادر الطاقة والبيئة عالميا ومحليا. في هذه الدراسة تم تسليط الضوء على حرق الغاز الطبيعي في محافظة البصرة وتأثيره على البيئة وتغير المناخ وأظهرت النتائج أن حرق الغاز الطبيعي في محافظة البصرة يساهم في تغير المناخ المحلي من خلال إضافة حرارة وغازات الاحتباس الحراري إلى الغلاف الجوي مما أدى إلى ارتفاع درجة حرارة الهواء في المنطقة بالسنوات الأخيرة لتصل الى (52 درجة مئوية)، كما انه يؤثر على تلوث الهواء من خلال زيادة تراكيز الغازات السامة في الغلاف الجوي، ويعتبر أحد أسباب زيادة عدد مرضى السرطان في محافظة البصرة. ووجدت هناك علاقة طرديه قوية بين زيادة حرق الغاز وزيادة حالات السرطان.

ولتجنب هذا الهدر الهائل في الثروة الوطنية المتمثلة في حرق الغاز الطبيعي نوصي باستثماره بدلا من حرقه وبالتالي تجنب التأثير الضار للبيئة والمناخ الناتج عن حرقه.

الكلمات المفتاحية: حرق الغاز، الأحفوري، الميثان، العقود، الأكسدة.

Introduction:

The dependence on the oil and gas industry in Iraqis increasing as economies and infrastructure continue to depend entirely on petroleum-based products.

1. Natural gas

Natural gas (NG) is one of the fossil energies sources that was formed deep beneath the earth's surface. It is found in oil wells, in the form either dissolved in crude oil or exists separately in a form of a cap on top of the oil. Unless it is used for commercial purposes, the gas either is burned off upon reaching an oil well surface or directly vented into the atmosphere without burning. The composition of natural gas is different depending on the location. Each well has a different gas composition and different amounts of each component.[1] Iraq's proven reserves of the conventional natural gas amount to **(3.5 trillion cubic meters (tcm))**[2], placing Iraq 11th among global reserve-holders. Most of it is concentrated in the southern part of Iraq (Basra Province) **figure (1)**, mostly as the large associated gas reserves in the super-giant fields of Zubair, Rumaila, Nahr Umr, Majnoon, and West Qurna. [3] Gas production creates three major Climate Problems. **First:** Produces CO_2 when burned. **Second:** Methane, CH_4, purposefully vented and leaked during 1-drilling 2- initial frac fluid flow-back period. 3- liquid unloading 4-gas processing 5- transmission, storage, and distribution. 6- Continuously at the pad site via leaking wells and equipment. **Third:** Produces black carbon BC, (soot) during flaring and processing.

2. Natural gas flaring

The process of NG flaring has existed since the beginning of the production of crude oil. Realizing that NG has great value as a source of energy, companies began to reduce its flaring to the minimum. The impact of NG flaring is of local and global concern, it is one of the most challenging energy and environmental problems facing the world today whether regionally or globally [4] NG flaring is one of the upstream oil and gas industry processes to dispose undesirable NG through high-temperature oxidation at the tip of a stack [5] often with devastating effects on the local environment through visual pollution[6], noise, light, heat stress[7], acid rain[8], flaring emits volatile organic compounds (VOC), black carbon (BC), methane (CH_4), and carbon dioxide CO_2, the last three are powerful climate forcers, BC and VOCs are dangerous air pollutants. [9] [10]

3. Influence of Black carbon (BC) to atmosphere

Black carbon (BC) which is regarded as an important component of atmospheric aerosols is produced from the incomplete combustion of hydrocarbon-containing materials [8] There are two main emission sources of BC aerosols: first natural emission source, which includes

volcanic eruptions and forest fires, and second the anthropogenic emission sources which comprise the combustion of fossil fuels, oil, coal, and other fossil fuels like NG, burning of biomass, and car exhaust emissions.[11] The BC concentration in the atmosphere has increased rapidly because of human activities [12] one of these activities is gas flaring. Annually, the contribution of gas flaring to global BC concentration is estimated to be 260 Gg [13, 14] BC emission measurements from gas flaring compared to the traditional emission sectors relatively little studied. Black Carbon (BC) regards as atmospheric aerosol, which affects the climate directly and indirectly, via its mechanism, absorb solar radiation in the infrared and visible bands, heat the atmosphere and then change the characteristic of the climate and air quality. Intergovernmental Panel on Climate Change (IPCC) report indicates that the average direct radiative forcing of global BC aerosols is 0.4 Wm^{-2} [15] , therefore play a unique and important role in the climate systems.[11]

4. The effects of Natural gas flaring on the economics

From an economist's point of view, the flaring of this associated gas is a colossal waste to the communities, in terms of the loss of funds and revenue which it could have realized if it had preserved instead of flaring same.[4] Iraq gives a terrible example of such a loss. In this article, we discuss and analyze all these effects on the climate and pollution in Iraq and Basra in particular.

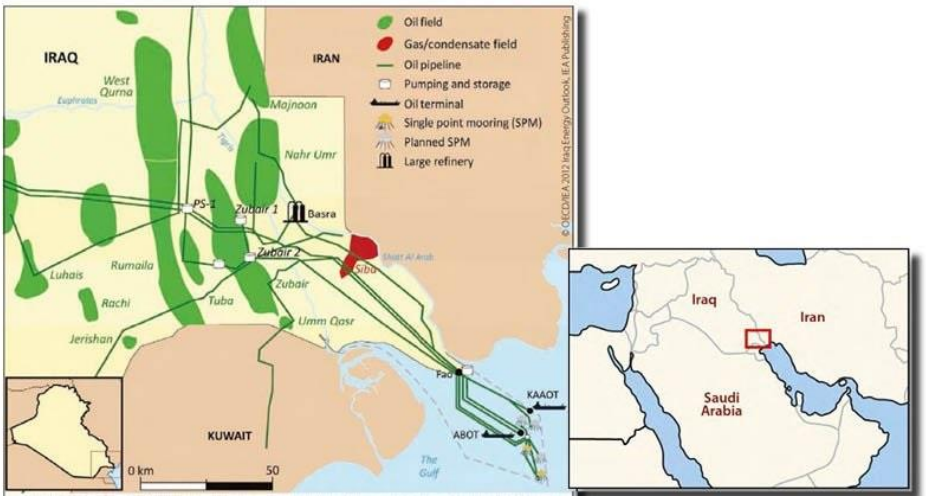

Figure (1) Study area[16]

Data and method:

The time series of annual mean temperature of Hui Al Hussain station in Basra for the period (1960-2019), annual total number of cancer cases in Basra for the period (2013-2019) and monthly natural gas flaring in Basra for the period (2018- 2019) sourced from the Iraqi

Meteorological Organization and Seismology, Reports of air pollutants and health indicators [17] and Report of Environment Statistics for Iraq [17, 18] respectively.

The sources of other data are from websites: top 30 countries gas flaring for the period (2014-2019) [19], Global average atmospheric Methane for the period (1984-2020) [20], CO_2 emission in Iraq for the period (1965-2019**)** [21]. We compute the amount of heat release from gas flaring and anomaly of annual CO_2 emission due to gas flaring, the time series have been plotted by using MS Excel, determine Pearson correlation coefficients between gas flaring and cancer in Basra city.

Results and discussion:

1. Gas flaring adding heat to the atmosphere.

The greenhouse effect still needs an explanation, and we agree with the interpretation that considers the warming results from heat emissions from the global consumption of non-renewable energy [22]. Global warming means that heat has been accumulating in air, ground, and water since 1880. The Heat was released into the atmosphere by heat dissipation from the global use of fossil fuel and nuclear power.[23] According to the World Bank, Iraq is currently flaring over 16 Bcm of associated gas each year; [14] **Figure (2)** shows the top 30-country gas flaring in the world.

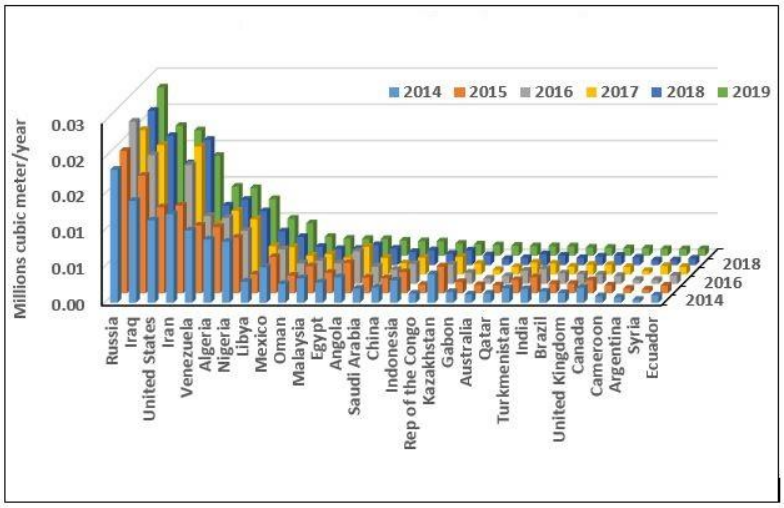

Fig. (2) Top 30 countries gas flaring for the period (2014-2019)

Discussing the amount of NG flaring**,** **Figure (3)** presents the monthly amount of gas flaring in Basra for the years 2018 and 2019. The largest amount of gas flaring appears during September 2018 and August 2019, this means that the Governorate of Basra contributes to adding heat to the atmosphere. Its amount was calculated per month for the years 2018 and

2019, as shown in **Figure (4)**, where the largest amount of heat added to the atmosphere was in September 2018, reaching (5256795567 Btu) and in August 2019 when it reached (46153121504 Btu) and the lowest amount was in February of the years 2018 (39426756496 Btu) and 2019 (37175013587 Btu). The neighboring countries of Basra Governorate in Iraq (Iran, Saudi Arabia, and Kuwait) are also oil and gas producing countries and they are among the top 30 countries gas flaring in the world, which are also contributed by adding heat and greenhouse gases to the atmosphere regionally and globally, This means that the region adding heat to the atmosphere and take part in accumulating heat to the atmosphere, and this is one reason for the high temperature in recent years in Basra Governorate and the region which reached its highest levels. Record of temperature highs in recent years show that five Arab countries, including Iraq (Basra, 52 °C) were affected, and the temperature is expected to reach new highs.**[24]**

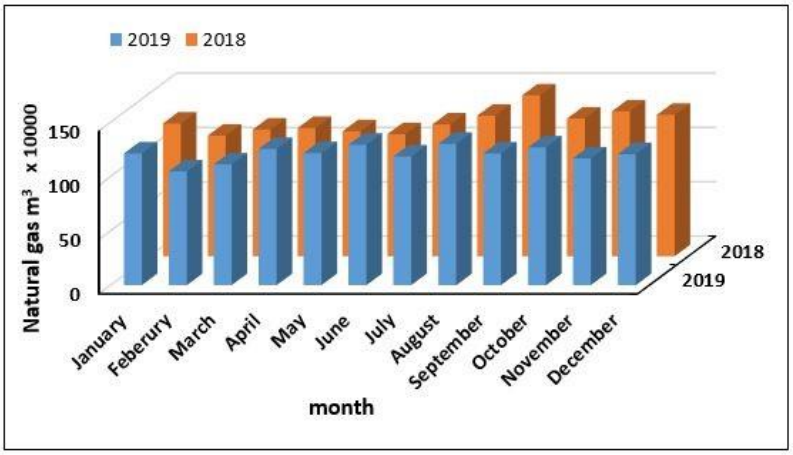

Fig. (3) Monthly Natural gas flaring in Basra for the year 2018 and 2019

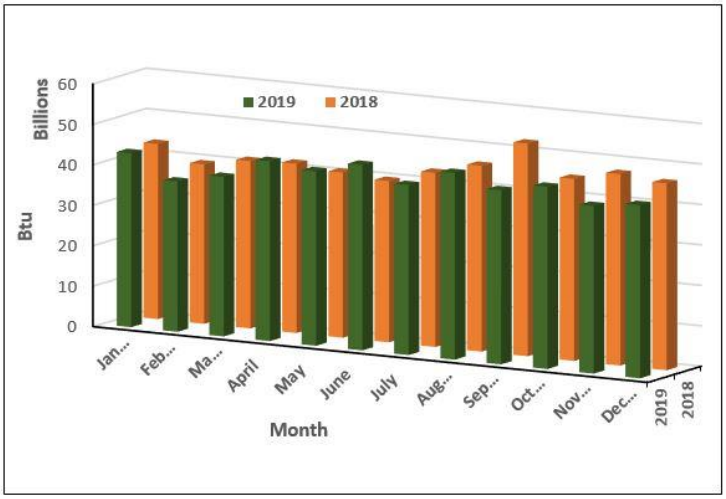

Fig. (4) Monthly amount of heat adding to the atmosphere by Natural gas flaring in Basra for the year 2018 and 2019

Figure (5) shows the annual average of temperatures and the monthly average for July and January, which represent the summer and winter seasons respectively, the temperature and its trend are gradually increasing.

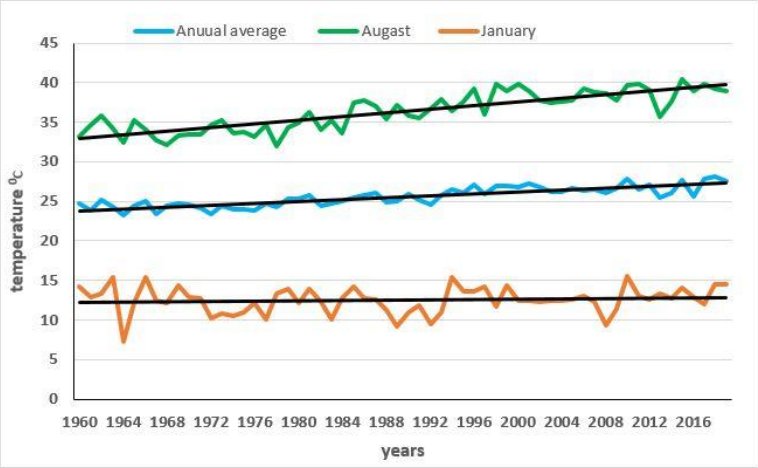

Fig. (5) Annual temperature variation and for the months of January and August in Basra

2. Gas flaring adding greenhouse gases (GHG) to the atmosphere

Another factor that the gas flaring process contributes to climate change is emitting greenhouse gases into the atmosphere and it plays a major role in increasing the temperature of the atmosphere. However, gas flaring results in less global warming impact than if it was venting into the atmosphere. This is because methane gas, one of the primary components of NG has a higher GWP than CO_2. Iraq annually adds CO_2 because of the combustion of NG as presented in **Figure (6)** which shows annually CO_2 emission by NG flaring in Iraq, and Governorate of Basra contributes 70% of the quantity. **[19]** This increase has been continuing since 1965, as we note the trend line increasing annually, also we note minimum value during the period 1991 to 2003 because Iraq through this period was under sanction.

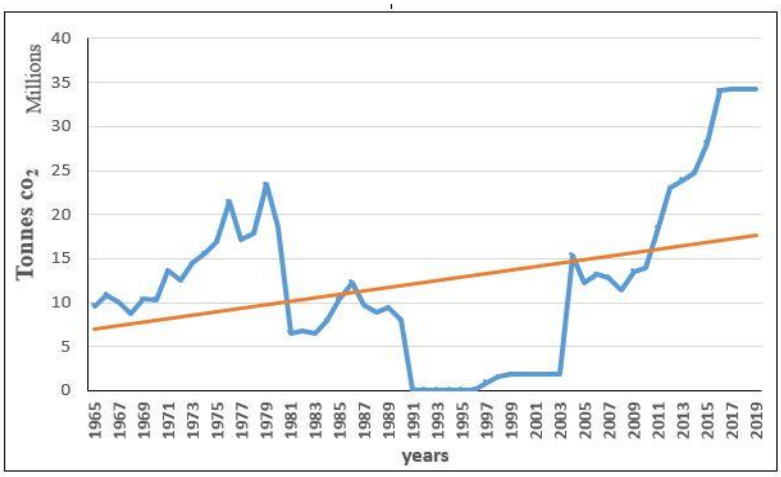

Fig. (6) Annually co_2 emission because of natural gas flaring in Iraq

Figure (7) shows the anomaly of annual CO_2 emitted. We can see four periods in the Time series, two negative and other two positives. This means that the first period from (1965 to 1970) and the third period from (1981 to 2003) are negative sign and they emitted CO_2 below the average, while the second period from (1971 to 1980) and the fourth period from (2004 to 2019) is a positive sign, they emit over annual average, and in the fourth period is very high compared to the length of the series. Among other greenhouse gases that are added to the atmosphere by natural gas, methane resulting from the venting process and released to the atmosphere, which affects greater than 25 times the effect of carbon dioxide**[14]**. Although the life of carbon dioxide lasts for hundreds of years, the time life of methane gas is short and estimated at tens of years.

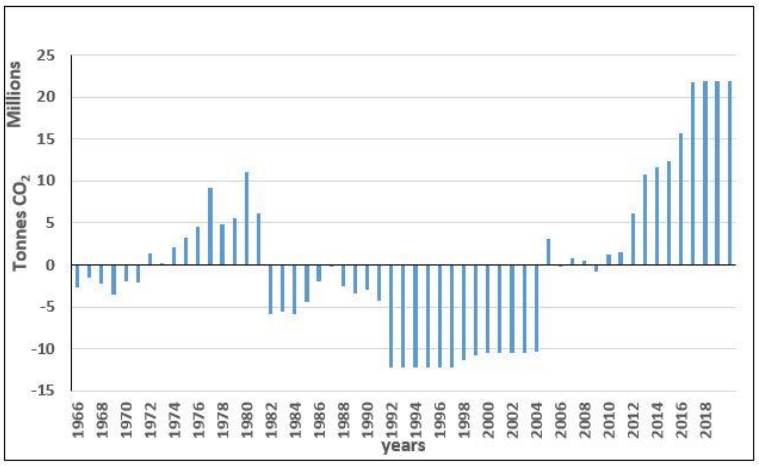

Fig. (7) Anomaly of annual co_2 emission due to gas flaring

Figure (8) shows the annual increase in globally averaged atmospheric Methane, and there are other gases released into the atmosphere as a result of burning natural gas, including hydrogen sulfide and carbon monoxide, and the gas flaring adds to the atmosphere black carbon BC**[25].**

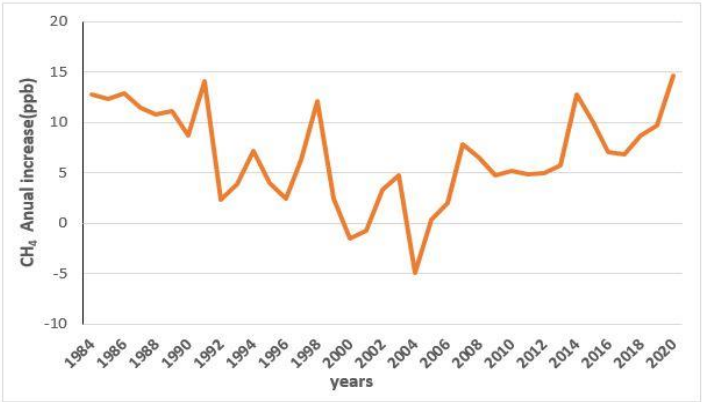

Fig. (8) Annual Increase in Globally Averaged Atmospheric Methane

3. Gas flaring adding Black carbon (BC) to the atmosphere

BC aerosols are the second-largest global warming factor after carbon dioxide.**[11, 13]** Unfortunately, there is no measurement to BC in Basra but everybody in Basra near natural gas flaring can see the black smoke rising in the sky from the tip of a stack. **Figure (9)** shows the rising plume during gas flaring in the northern Rumaila field. The researcher took this photograph on 10/15/2020, its location (30°12'53.3"N 47°23'16.3"E) as a sample of gas flaring in Basra. As we mentioned, Iraq is the second- largest country in the world in gas flaring after Russia, Basra contributes in 70% of that of Iraq, the annual average BC emissions from Russian flaring were 68.3 Gg/year, with 64.1 and 4.2 Gg/year from upstream and downstream flares, respectively. **[26]** We conclude from this, Iraq, and Basra Governorate, emit an enormous amount of BC after Russia to the atmosphere

Picture. (9) Photograph of rising plume during gas flaring in the northern Rumaila field. The Photograph was taken by the researcher

4. Air pollution due to gas flaring

The atmosphere has certain percentage of gases, any change by increasing or decreasing in the composition of these gases is harmful to survival. Air pollutants resulting from NG flaring include CH4, CO2, NOx, CO, H2S, N2O, hydrocarbons, PM, etc. PM from NG flaring mainly takes the form of soot or (BC). **[22]** Natural gas flaring has other harmful emissions, such as sulfur oxides and nitrogen oxides, which form acid rain, produced when these two types of pollutants combine with water in the atmosphere and then falls down on the surface of the Earth. In a study conducted on the acid rain in Basra, the results of the analysis of rain samples revealed a decrease in the pH values of pH below 5.6 for both observations, especially in areas close to Oil production fields in the districts of Al-Zubayr, Madinah, Qurna, Siba district**[27]**, which

can cause many problems in ecosystems and the environment. In addition to harming the environment, as a result of natural gas flaring or venting, polluting the air with toxic gases, including methane, hydrogen sulfide, and other gases, in addition to BC and soot, has a great impact on human and all living organisms and plants. The symptoms of this pollution appeared on the health of Basra residents and workers in the oil sector, who suffer from cancerous diseases, allergies, asthma and other diseases of the respiratory system. **Figure (10)** shows annually increasing in the number of cancer cases in Basra Province, which is directly proportional to the increase in the amount of annual gas flaring in the region. The relationship between gas flaring and cancer was examined by using Pearson correlation coefficient, its value equals (0.91754) showing a very strong and positive relationship.

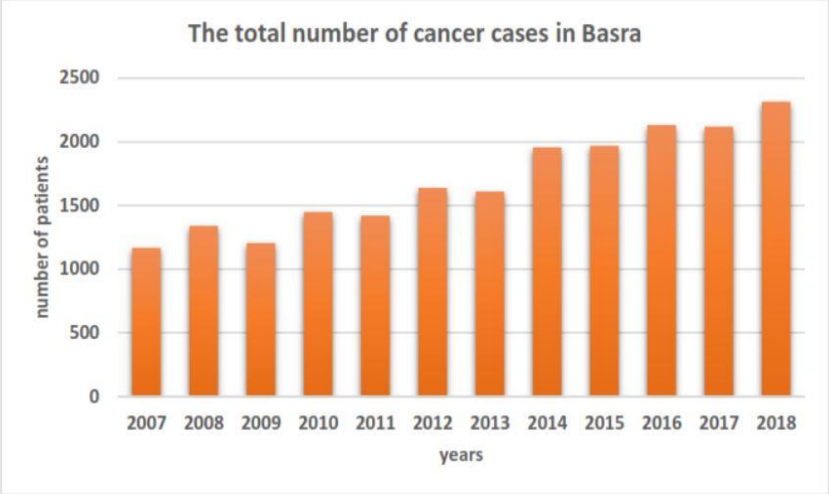

Fig. (10) Annually total number of cancer cases in Basra

The measurement shown in **tables (1 and 2)** and the results presented in many previously published papers indicate that some pollutants in different areas are over the international levels, which is a serious problem to the people and lives **[28]** and has effects on health like (CO, CO2. SO2, NO2). All these chemicals leading to exogenous estrogen (xenoestrogens) that mimic the action of hormones or directly affect pathways of endogenous hormones which in final result produce genotoxic substances.**[29]** Other studies (Global) suggest a link between air pollution and breast cancer.**[30]**

Table (1) monthly and annually average of (co and pm10) concentration in Basra city (air quality station in kour zaber) for the year 2018

month	CO ppm	Pm10 µg/m^3
January	5.620	604.667
February	5.510	547.380
march	7.570	…….
April	7.980	246.413
May	6.890	3205.000
June	8.920	288.163
July	7.660	291.813
august	8.000	547.380
September	7.450	293.677
October	7.720	278.281
November	7.470	252.223
December	……	345.590
Annual rat	7.345	627.326

Table (2) Annual average of pollutant gases and pm10 concentration Measurement in Basra (air quality stations) for the year 2018

Stations of Air quality	SO_2 ppm	NO Ppm	No_2 ppm	NOx ppm	CO ppm	CH_4 ppm	Pm10 µg/m3
Abu Al-Khasib	0.012	0.116	0.023	0.015	0.113	1.834	93.333
Basra Environment Office	0.005	0.250	0.015	0.023	0.110	0.984	

Another study showed annual and seasonal air quality index with AQI values, found high concentrations of pollutants distributed clearly in the study stations, as winter record the greatest values that most concentrations were higher than the global limitations.[31]

5. Economic Effects

Besides the impact of NG flaring on the environment, it has a significant impact on the national economy of the producing state[32]. NG is one of the most important alternative energy sources for oil, and one of Iraq's wealth that has not been optimally used for decades and has not been used to serve the development process and maximize resources well.

Iraq suffers from a severe shortage of gas supplies, which carries the public budget and balance of payments exorbitant costs to import it. Iraqi economic losses related to gas are estimated at approximately 45 billion US dollars, which is equivalent to 196,000 (B/D) crude oil at $70. Gas production and use, recently increased to 29.4 and 13.8 billion cubic meters annually, respectively, which means that gas-burning increased to 15.9 Bcm, which is equivalent to about 260 thousand (B/D), or a loss of about 20 million dollars per day [33]. This extensive amount

of NG flaring resources can help to employ the unemployed and contribute to the growth and prosperity of Iraq's economy.

Conclusion

We have concluded that natural gas flaring in Basra governorate contributes to adding heat to the atmosphere in addition to adding greenhouse gases. The neighboring countries of Basra also contributed by adding heat and greenhouse gases to the atmosphere regionally and globally. This is one reason for the high temperature in recent years in Basra Governorate and the region, which reached its highest levels. Besides harming the environment, polluting the air with toxic gases has a great impact on human health which leads to an increase in disease cases, including cancer, we found a strong statistical relationship between the increase in cancer cases and the increase in natural gas flaring.

Recommendation

In order to avoid this huge waste in the national wealth represented by burning natural gas, we recommend investing it instead of burning, thus we avoid the harmful impact on the environment and the contribution in climate changes. We hope Basra Gas Company (BGC), one of the largest flare reduction projects in the world, executing its plan to invest in natural gas.

"Conflict of Interest: The authors declare that they have no conflicts of interest."

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Geological, Mineralogical and Geochemical Studies of Kolosh Formation, Dokan Area, Kurdistan Region, Iraq

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Abstract

The geology, mineralogy and geochemical of The Kolosh Formation in Dokan area, northern Iraq has been studied. The formation sequence includes gray and dark gray marl that alternate from clastic submarine sediments represented by turbid deposits resulted from the last stages of the collision movement between the continental plates. The geochemical study showed that the Kolosh Formation is mainly dominated by detrital sediments (Clay) with a dominance of kaolinite illite, and albite wıth low amounts of quartz. The analysis revealed that the Kolosh Formation is dominated by relatively marginal marine sedimentation where shelf bay facies was deposited with carbonate facies deposited as shallow marine. In contrast, SiO2 is strongly negatively correlated with CaO and MgO, this supports their derivation from terrigenous sources during the deposition of Kolosh sediments.

Keywords: Kolosh Formation, sequences, mineralogy, geochemistry.

دراسات جيولوجية ومعدنية وجيوكيميائية لتكوين كلوش، منطقة دوكان، اقليم كردستان، العراق

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الخلاصة:

تمت دراسة تكوين كولوش جيولوجيا ومعدنيا وجيوكيميا، في منطقة دوكان، اقليم كردستان العراق تتضمن الدراسة التتابعية الطباقية للتكوين من المارل الرمادي والرمادي الداكن الذي يتناوب مع الرواسب البحرية التي تمثلها رواسب عكرة ناتجة عن المراحل الأخيرة من حركة الاصطدام بين الصفائح القارية. أوضحت الدراسة الجيوكيميائية أن تكوين كلوش يغلب عليه بشكل أساسي الرواسب الفتاتية (الطين) مع غلبة الكاولينيت وإيليت، والألبيت بكميات منخفضة من الكوارتز. أظهر التحليل أن تكوين كلوش يهيمن عليه ترسيب بحري هامشي نسبيًا حيث ترسبت سحنات خليج الرف مع سحنات كربونية بحرية ضحلة.

على النقيض من ذلك، يرتبط SiO2 ارتباطًا سلبيًا قويًا بـ CaO وMGO، وهذا يدعم اشتقاقها من مصادر أرضية أثناء ترسيب تكوين كولوش.

الكلمات المفتاحية: تكوين كولوش، تتابعية طباقية، علم المعادن، الجيوكيمياء.

Introduction:

The Kolosh Formation (Early Paleocene–Late Paleocene) is one of the most widely distributed formations in northern Iraq. It was first named by [1] at a type of section in the Kolosh village north of Koysingak, Zagros basin, northern Iraq. It is mostly made up of stratigraphic sequences of clastic deposits of varied thicknesses, including dark green sandy shale rocks, sandstone layers with dark gray to black clay, and shale beds. It also has lenses that include siltstone and limestone units, as well as a few conglomerates.

The main aim of current study is to analysis of Mineralogical sediments of kolosh formation, Parent rocks of kolosh, Depositional Environment.

Geological background:

Tectonically, Iraq is divided into three major regions: the stable zone, the unstable zone, and the Zagros Suture Zone. The unstable zone is further subdivided into the Low Folded Zone, the High Folded Zone, and the Imbricated Zone [3]. The study area is located within the boundary between the high and low folded zones. The unstable range is also a part of the Iraqi Western within the unstable shelf's high folds range, and it is characterized by the presence of an asymmetrical double plunging anticline, whose axes extend northwest-southeast, where the Lower Cretaceous layers are exposed in the core of the folds and the Upper Cretaceous-Tertiary layers are exposed in the folds' periphery. In comparison to rocks and clastic sediments, Tertiary limestone rocks form ridges with high resistance to erosion processes [4].

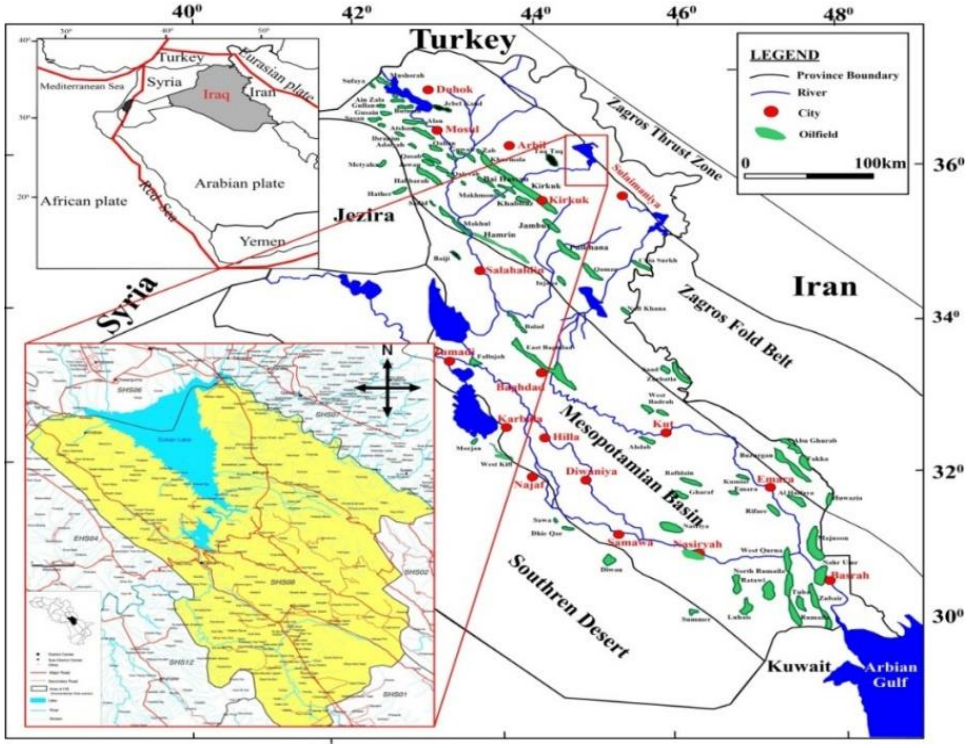

Fig. 1, Location map of Kolosh Formation Zagros basin, Northeastern Iraq.

Period	Age	Formation	Lithology	Description
TERTIARY	Early Paleocene (Danian)- Late Paleocene (Thanetian)	Khurmala		Successions of limestone
		Kolosh		Successions of thin layers; sandstone and marly limestone Dark grey successions of; sandstone, clay and dark shale. Green succession of; sandy shale beds
Upper Cretaceous		Tanjero		Dark grey succession; of shale beds

Fig. 2. Composite stratigraphic column of the Kolosh Formation

Tanjero Formation represents the lower boundary of the Kolosh Formation, which consists of green and yellowish green - olive-colored rocks consisting of sandstone, mudstone, shale, and aggregates, as sandstone is the main component, and mudstone and shale are loose and crushed. As for the compactions, they are found in the form of lenses with a thickness of up to (8) meters with soft pebbles. Also, at the boundary, the floating foraminifer's genera, indicate the upper Cretaceous and the emergence of new ones indicating the Paleocene, the upper boundary of the Koloh Formation is stratigraphically consistent with the Khurmala Formation.

An ideal formation section in the Kolosh area, north of the city of Koysinjak in northern Iraq is selected for the current work. It appears on both sides of the fold in the low areas in the study area. It is made up of dark gray sediments and thin brown layers that range in facies from shale to silt to clay to sandy rocks and contain rocky fragments. And different types of minerals, and the formation's lower boundary is stratigraphically incompatible with Tanjero, as evidenced by differences in the rocky facies, where limestone and marl sediments end and sand layers emerge, as well as the presence of a layer of basal compactions at the formation's lower limit. The sediment source of the Kolosh Formation is from the erosion of the Qulqula, Tanjero and other Jurassic to Cretaceous formations **[2]**. The formation is primarily composed of successive shale and sandstone grains of varying size and origin. **picture (2-5)**. The Kolosh Formation is distinguished by rapid and distinct lateral and vertical variations, which are gradual and overlapping with the Sinjar limestone formation as well as the Khurmala formation. The lower boundary of the Kolosh Formation is incompatible with the Tanjero Formation, and it is represented by a complete biological change with no transitional elements between them, while the upper boundary is compatible with the Khurmala Formation **[6]**. Kolosh formation is thin in studied area and thick in north Iraq so this depositional basin in margarine in studied area.

Materials and methods:

1. **XRD analysis:** X-ray diffraction analysis has been carried out on 10 rock powdered samples from the Kolosh rocks in order to determine the whole mineral constituents. X-ray diffractometer type PW3710 with Cu Kα radiation was used at the Metallurgy Institute of Minerals, Cairo. The scanning range was between 2θ 3º- 60º at scan speed

2θ 2 min-1. The X-ray diffractometer is computerized to measure the peak diffraction in 2θ and d spacing (Å). The computer software was used for calculating the percentages of minerals .

2. **Geochemical analysis:** Major oxides (SiO2, AL2O3, Fe2O3, CaO, MgO, MnO, Na2O, K2O, P2O5, SO3, and Cl) have been determined from 10 powdered samples retrieved from the Early Paleocene Late Paleocene Kolosh Formation. The X-ray fluorescence spectrometer Cu-Kα radiation type (AXIOS, WD-XRF-SEQUENTIAL spectrometer, PA Analytical, 2005) was used at the Metallurgy Institute of Minerals, Egypt.

Results and discussion:

1. XRD analysis

A total of and cutting samples from the Early Paleocene Late Paleocene Kolosh Formation has been analyzed. The XRD analysis **(Fig. 3)** showed that the Kolosh Formation is mainly dominated by detrital sediments (Clay) with a dominance of kaolinite illite, and albite with low amounts of quartz **[7]**. Calcite is recorded in small amounts at the top of the formation. The analysis revealed that the Kolosh Formation is dominated by relatively marginal marine sedimentation, where shelf bay facies was deposited.

The middle and upper part of the kolosh Formation witnessed a drop in sea level, accompanied by relatively shallow marine sedimentation, where carbonate facies was deposited.

2. Distribution and significance of geochemical elements

The original installation of rock is mostly affected by the depositional environment and the post-diagenetic processes **[8]**. Major elements geochemistry gives more or less a coherent picture of the geochemistry of carbonate rocks and the distribution of mineral of major elements-forming elements **[9]**. In this regard, a total of ten core and cutting samples retrieved from kolosh Formation at Dokan region, northern Iraq that geochemically analyzed using X-ray fluorescence spectrometer instrument of Cu-K_α radiation Oxides such as SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, MnO, Na_2O, K_2O, P_2O_5, SO_3 and Cl. Major elements are expressed in percentages and the results are summarized in **Table 1**.

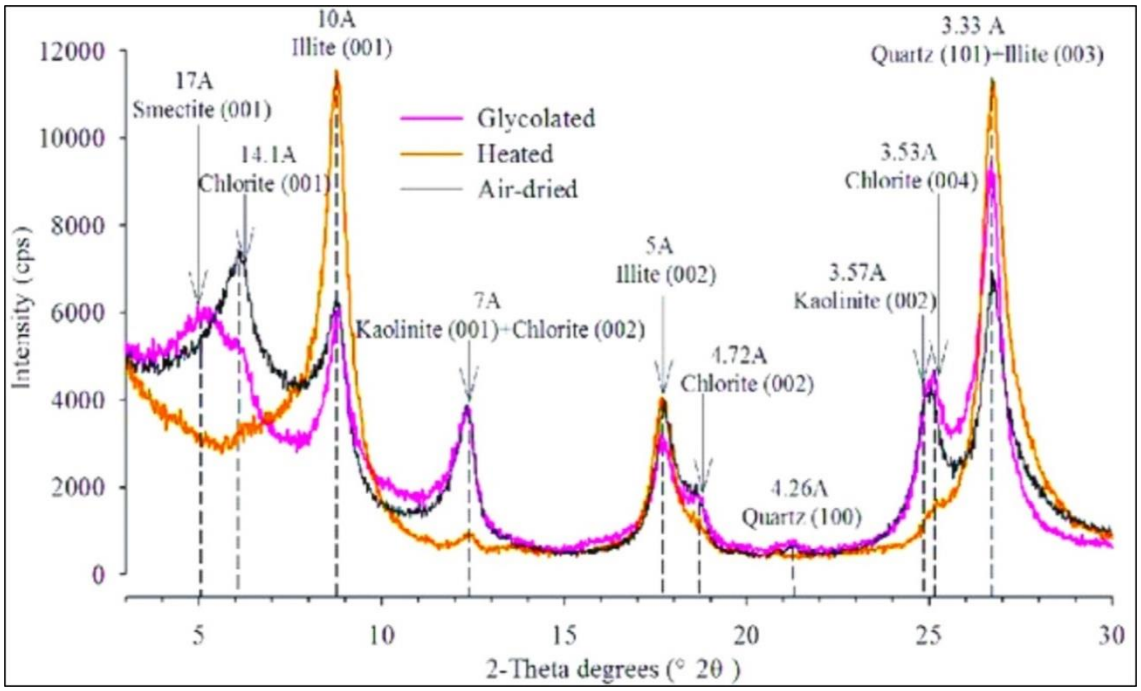

Fig. 3 Typical X-ray diffraction pattern showing the abundance of clay minerals within Kolosh Formation.

A marked variation in the clay content is seen in the analyzed samples **(Table 1; Fig. 4)**. It ranged between 0.53 - 43 % with an average of 28.81 %. Calculations of correlation coefficients of major element concentrations in the studied samples are shown in **Table 2**. High positive correlation exists between SiO_2 and Al_2O_3, TiO_2, Fe_2O_3, P_2O_5 (r = 0.58, 0.744, 0.79 and 0.69, respectively), **[10]**. Weak positive correlations existed between SiO_2 and Na_2O, K_2O and MnO (0.15, and 0.61 respectively). In contrast, SiO_2 is strongly negatively correlated with CaO and MgO (-0.77 and -0.84). This supports their derivation from terrigenous sources during the deposition of Kolosh sediments. Iron and manganese compounds are precipitated partly in the form of coatings on mineral particles **[11]**.

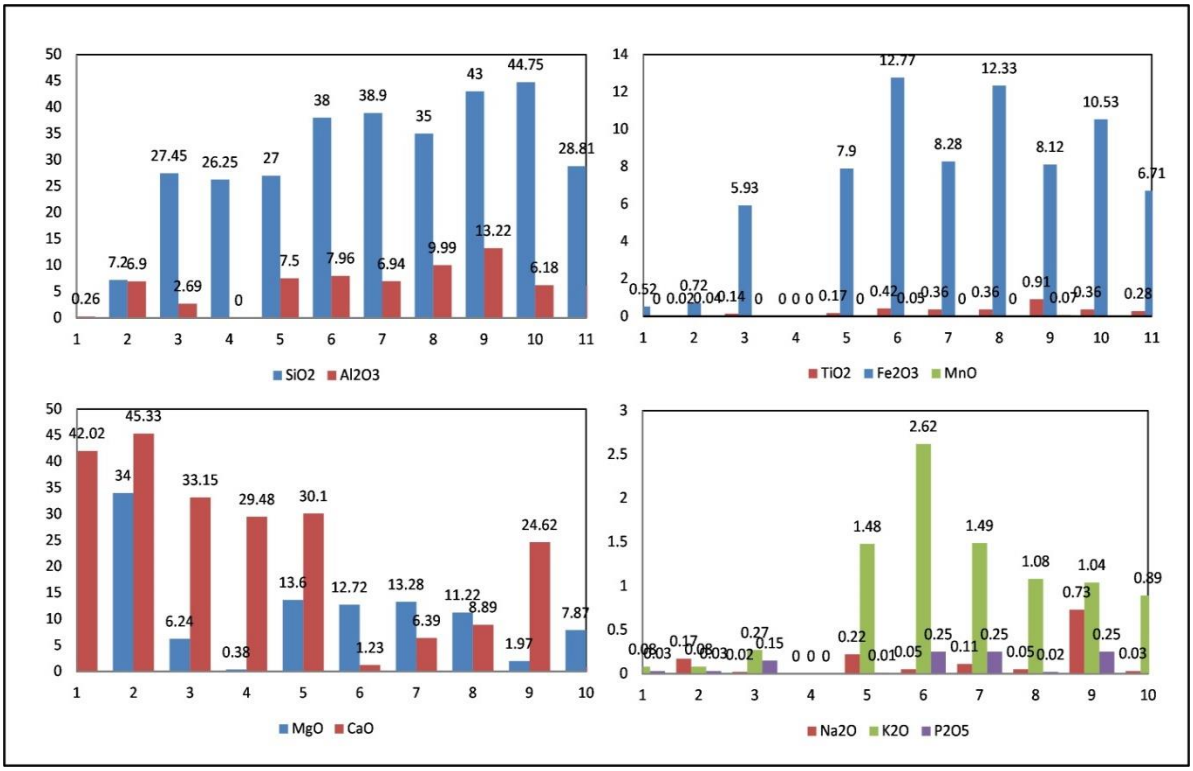

Fig. 4 Correlation of major oxides percentages for Kolosh Formation, Zagros Basin, NE Iraq.

The content of Al_2O_3 in the analyzed samples varied from 0.26- 13.22% with an average of 6.85%. Alumina has a strong positive correlation coefficient with TiO2, Fe_2O_3, MnO, Na_2O, K_2O, and P_2O_5 (r = 0.82, 0.67, 0.63, 0.62, 0.58, and 0.43, respectively), indicating its association with terrigenous argillaceous materials as evidenced by **[13]**.

Furthermore, the iron (Fe_2O_3) content ranged between 0.02- 12.77% with an average of 10.53%. Strong positive correlations between Fe_2O_3 and Na_2O, K_2O and P_2O_5 (r = 0.608, 0.82 and 0.56, respectively) suggest that the iron content was brought to the carbonates and shale samples generally with the terrigenous argillaceous materials. Thus, the iron content increased landward toward the source of terrigenous materials. The oxidation process took place during the subaerial exposure of these carbonates as is the case for goethite, which points to a near-shore environment for the upper part of the formation. The calcium (CaO) content varied between 0.88-45.33% with an average of 22.21% lower than the world average (42.3%) given for carbonates **[12]**. MgO fluctuates between 0.38 and 34% with an average of 12.92% higher than the average given for carbonates as of 7.79%. CaO and MgO exhibit a

negative correlation with other major oxid indicating shifting of the depositional environment toward the land, where evaporation allowed precipitation of carbonate and/or anhydrite.

Moreover, Titanium oxide is detected in 10 samples with values ranging from 0.02-0.91%, average 0.31%. TiO_2 has strong positive correlation with Fe_2O_3, MnO, Na_2O, K_2O, P_2O_5 and Cl (0.64, 0.67, 0.60, 0.7, 0.53, 0.71 and 0.06, respectively) indicating detrital origin.

Clay minerals derived of ancient sedimentary rocks and the acidic igneous evidence is Illite clay minerals. **[13]**. Digenetic processes and affecting shale and mudstone metamorphism compaction clay minerals are modified **[14]**. Igneous and metamorphic rocks are parents' rocks.

Sample no	sample code	Formation	Age	SiO_2	Al_2O_3	TiO_2	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	SO_3	Cl
1	RR1	Kolosh	Early Paleocene - Late Paleocene	0.53	0.26	0.02	0.52	–	27.87	42.02	0.15	0.08	0.03	22	0.15
2	RR2			7.2	6.9	0.02	0.72	0.04	34	45.33	0.17	0.08	0.03	1.53	0.15
3	RR3			27.45	2.69	0.14	5.93	–	6.24	33.15	0.02	0.27	0.15	22	0.15
4	RR4			26.25	–	–	–	–	0.38	29.48	–	–	–	41.38	–
5	RR5			27	7.5	0.17	7.9	–	13.6	30.1	0.22	1.48	0.01	12	–
6	RR6			38	7.96	0.42	12.77	0.05	12.72	1.23	0.05	2.62	0.25	19	0.15
7	RR7			38.9	6.94	0.36	8.28	–	13.28	6.39	0.11	1.49	0.25	22	0.15
8	RR8			35	9.99	0.36	12.33	–	11.22	8.89	0.05	1.08	0.02	20	0.15
9	RR9			43	13.22	0.91	8.12	0.07	1.97	24.62	0.73	1.04	0.25	1.03	–
10	RR10			44.75	6.18	0.36	10.53		7.87	0.88	0.03	0.89	0.22	26.4	1.2
	Average			28.81	6.85	0.31	7.46	0.05	12.92	22.21	0.17	1.00	0.13	18.73	0.30

Table-1, Distribution of major oxides in the studied Kolosh rock samples, Zagros Basin, NE Iraq.

	SiO2	Al2O3	TiO2	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl
SiO2	1.00											
Al2O3	0.58	1.00										
TiO2	0.74	0.82	1.00									
Fe2O3	0.79	0.67	0.64	1.00								
MnO	0.27	0.63	0.67	0.21	1.00							
MgO	-0.77	-0.14	-0.47	-0.38	-0.01	1.00						
CaO	-0.84	-0.41	-0.51	-0.85	-0.10	0.46	1.00					
Na2O	0.15	0.62	0.71	0.02	0.68	-0.11	0.20	1.00				
K2O	0.61	0.58	0.53	0.82	0.32	-0.20	-0.73	0.07	1.00			
P2O5	0.69	0.43	0.71	0.56	0.54	-0.35	-0.63	0.27	0.56	1.00		
SO3	0.09	-0.70	-0.43	-0.12	-0.66	-0.41	-0.26	-0.70	-0.17	-0.15	1.00	
Cl	0.32	-0.02	0.06	0.30	-0.15	-0.06	-0.47	-0.29	0.01	0.33	0.22	1.00

Table 2: Correlation coefficients of major oxides for the studied Early Paleocene-Late Paleocene Kolosh rock samples, Zagros Basin, NE Iraq.

Conclusion:

1. The Kolosh Formation is dominated by relatively deep marine sedimentation, where marginal shelf bay facies were deposited as the thickness and facies reduced -Parent rocks acidic, and basic igneous, metamorphic, and sedimentary rocks.
2. Thrusting and controlled lateral and vertical abundance clay minerals in the Kolosh Formation.
3. SiO2 is strongly negatively correlated with CaO and MgO، this supports their derivation from terrigenous sources during the deposition of Kolosh sediments .
4. Major oxid indicating shifting of the depositional environment toward the land, where evaporation allowed precipitation of carbonate and/or anhydrite.

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Analysis of Seasonality Precipitation Concentration in Northern of Iraq

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Abstract

This research is about analysis seasonality of precipitation concentration in the north of Iraq, by using multiple methods of precipitation concentration Index .The first is the standard vectors method that determines the date of concentration and the number of the rainy months, the second, precipitation concentration index (PCI) that classify the degree of (PCI) annually, supra-seasonal, seasonal depending on monthly precipitation data from nine metrological stations For 36 years (1979-2014), using Excel, Arc map 10.8 and Oriana software in calculates and representation of precipitation concentration. the result shows that all stations in the study area share the same date (Jan.-Feb.) and the stations differ in the length of the rainy season (7-9) month. and for PCI results, PCI annual shows denote a moderate concentration in the whole study area, PCI supra-seasonal value shows (in the wet season uniform rain distribution, the dry season value shows high concentration, PCI seasonal Shows (autumn) moderate concentration, winter: low concentration in all stations, in the spring: PCI value shows the moderate concentration in Erbil, Kirkuk, Sulaymaniyah, Salaheddin, and the other stations shows uniform rain distribution.

Keywords: seasonal rain concentration, mathematical vector, PCI.

تحليل التركز الفصلي للمطر شمالي العراق

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الخلاصة:

يتناول البحث تحليل التركز الفصلي للمطر في شمال العراق , باستخدام عدة مؤشرات للتركز المطري وفصلية الامطار منها اسلوب المتجهات الرياضية (STANDARD VECTORS) والذي يقيس موعد التركز وعدد الاشهر الممطرة, ومؤشر التركز المطري (PRECIPITATION CONCENTRATION INDEX) والذي يصنف درجة التركز على المستوى (السنوي ونصف السنوي والفصلي) بالاعتماد على المعدلات الشهرية لأمطار (9) محطات مناخية (أربيل، السليمانية، الموصل، دهوك، كركوك، سنجار، زاخو، صلاح الدين، بعاج) للفترة من (1979-2014), وتم الاستعانة ببرنامج EXCEL وبرنامج ORIANA 4في ايجاد وتمثيل هذا التركز وموعده ودرجته.

ولقد تبين من نتائج البحث ان محطات المنطقة تشترك في نفس خواص التركز , اذ اظهرت نتائج اسلوب المتجهات الرياضية ان أمطار المنطقة تتركز في اواخر شهر كانون الثاني وبدايات شهر شباط وان المحطات تختلف في طول الموسم المطري بين (7-9) اشهر, اما مؤشر التركز المطري فقد بين ان التركز المطري السنوي اظهر اعتدال متوسط في توزيع الامطار، اما بالنسبة للتركز المطري النصف سنوي اظهر النصف الرطب وجود اعتدال واضح في توزيع الامطار واما النصف الجاف فقد ظهر تركز شديد، اما التركز المطري الفصلي فقد اظهر فصل الخريف اعتدال متوسط في التوزيع في اما فصل الشتاء فقد اظهر تعادل واضح في التوزيع اما فصل الربيع فقد اظهرت بعض المحطات (اربيل ، السليمانية، كركوك، صلاح الدين) اعتدال متوسط اما باقي المحطات اظهرت عادل واضح في التوزيع .

الكلمات المفتاحية: التركز الفصلي للمطر، المتجهات الرياضية، مؤشر التركز المطري PCI.

Introduction:

The Studies that related to rainfall and measuring concentration and seasonality of rain are so important at present due to climate changes that are increasing and effects day after day, especially in marginal areas that already suffer from climatic fluctuations, specifically rain, which is the most important element of the climate and the most unsteady, it has a major impact on the environment and human activities.

1-1. Objective of Research

Measuring the seasonal concentration of precipitation using mathematical standard such as the method of mathematical vectors and the indexes of precipitation concentration.

1-2. Research issue

Variation in the seasonality of precipitation and its reflection on the seasonal concentration of precipitation.

1-3. Research importance

Determining the date of rain concentration and how to distribute the amount of precipitation during the months to an area is very important in determining the beginning of the agricultural season and the type of crop, as the actual value of rain is affected by the time of precipitation.

1-4. The location of the study area

The study area is Located in northern Iraq as it extends from latitude 37.22.55 to latitude 35.28.00 north, and from longitude 45.20.00 to longitude 41.50.00 east, which includes five Governorates.

Map 1 The location of the study area

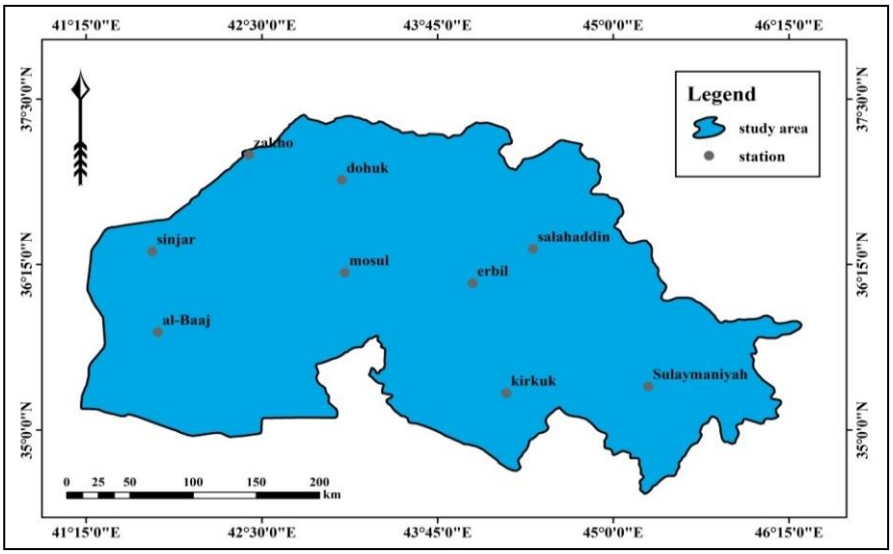


Table 1 stations of study area

station	altitude	Latitude	Longitude
Kirkuk	319	35.43	44.37
Sulaymaniyah	886	35.43	45.31
Al-Baag	301	36.06	41.87
Erbil	439	36.06	44.06
Mosul	288	36.06	43.12
Sinjar	522	36.37	41.87
Salahaddin	977	36.37	44.37
Dohuk	795	36.99	42.81
Zakho	835	37.31	42.50

2. Seasonality of Precipitation

By "seasonality of precipitation" meant the tendency for a place to have more rainfall in certain months or seasons than in others.

3. Precipitation Concentration

Which means the period that rain falls at a higher rate than the rest of the rainy season, and the concentration disappears if the rains of a region are falling distributed during the year without any drought period, and there is a huge concentration that rains fall in a certain area in one month of the year [1].

Precipitation concentration is measured to determine the rainiest period of the year, and it is based on a comparison of the monthly data of rains in the rainy seasons to give an idea of the rainiest season. Rainfall concentration can be measured at different levels, as it is measured at the annual level, as well as at the level of a specific season of the year.

To study the seasonal rain concentration, two equations were used to determine and measure this concentration in the study area due to the difference in the objectives of each method and based on the data of the precipitation series for 36 years from 1979-2014 to give the greatest clarity in determining the annual and seasonal rain concentration and its timing in each of the stations.

4. Method of Standard Vectors

(C.G. Markham) 1970 was the first to use it in determining the seasonal of Precipitation, the assumption can be made that mean monthly rainfall values are vector quantities with both magnitude and direction, magni- tude being the amount of rain, and direction being the month of the year expressed in units of arc. Vector direction for mean monthly rainfall is thus 15° for January, 44° for February, 74° for March, etc. [2]

The vector resultant is a measure of the seasonality of precipitation, its magnitude representing the degree of season- ality, and its direction representing the period of seasonal concentration. The ratio between the magnitude of the resultant and the total mean annual precipitation, expressed as a percentage, is here called the Seasonality Index. Large values show high seasonality, small values low. The maximum possible value for the Seasonality Index is 100 percent and would occur if all the precipitation came in a single month. The minimum value is zero percent, occurring if precipitation is evenly distributed throughout the year.

The resultant value is calculated by analyzing each vector into two components, the x component, and the y component, as in the equation:

$$R = \sqrt{(\sum_{i=1}^{12} vi \sin \emptyset i)^2 + (\sum_{i=1}^{12} vi \cos \emptyset i)^2}$$

R = summation value of all vectors.

vi = Monthly average of precipitation.

$\sin\emptyset$ = The sine of the angle made by the vector, which represents the Y component.

$\cos\emptyset$ = The cosine of the angle made by the vector, which represents the x component.

As for the angle made by the resultant, it can be estimated according to following equation:

$$\tan = \frac{\sum_{i=1}^{12} vi \sin \emptyset\, i}{\sum_{i=1}^{12} vi \cos \emptyset i}$$

Since tan represents the tangent of the angle made by the result with the x-axis, and through it the magnitude of the angle is found, while the context of the seasonal concentration is found through the following equation

$$\text{Concentration Index} = \frac{\text{summation value of all vectors}}{\text{Annual average of precipitation}} \times 100$$

It can be said that the pattern of rain concentration is determined by two factors, namely the percentage of rainfall concentration and its timing [3].

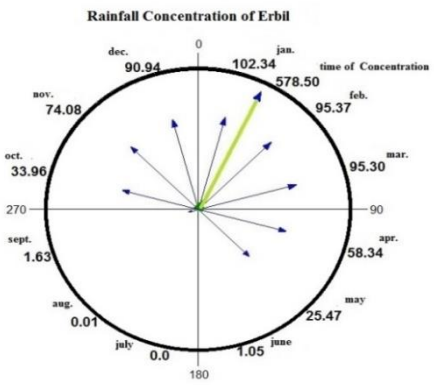
4-1. Equation application

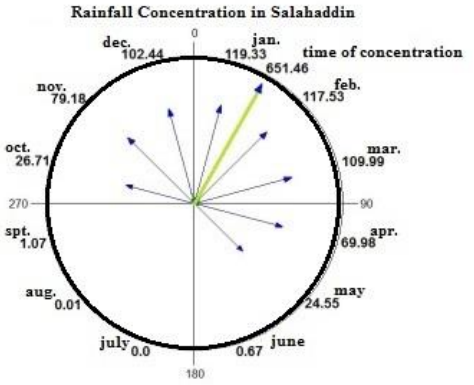
Table 2 The date of precipitation concentration in the stations of the study area and the percentage of concentration

station	The period of concentration begins from				Concentration ratio
	day	Month	day	Month	
Kirkuk	18	january	1	february	61.03%
Sulaymaniyah	21	january	4	february	61.68%
Al-Baag	18	january	1	february	56.38%
Erbil	19	january	2	february	58.70%
Mosul	19	january	2	february	57.05%
Singar	20	january	3	february	53.94%
Salahadin	22	january	5	february	61.83%
Dohuk	20	january	3	february	59.66%
Zakho	23	january	6	february	59.29%

It is noticed that the period of rainy concentration in all stations of the study area shares the same period of concentration, which starts from late January to early February, and this is clear in the analysis of the angles that made by the summation value of all vectors with the axis of the years in each station, which showed one type of seasonal concentration This is due to the fact that there is a great similarity in the factors affecting rain fall in all stations of the study area, as the Mediterranean depressions are the main source of rain in the region, which often extends during this period to include all stations of the study area, in addition to the factor of smallness of the study area and similarity Climatic conditions.

As for the percentage of rain concentration, we find that the rates ranged between (61.8) in Salaheddin, which is the highest percentage, and (53.9) in the Sinjar station, which is the lowest percentage, and the rest of the stations are distributed between these two percentages, and this means that the rain is distributed between more than (6) months and less than (8) months (6.49-7.44), and the reason is due to the lack of influence of the altitude and the location of the stations in relation to the latitude circles in the period and timing of concentration, as there is no significant difference in the length of the rainy season between stations





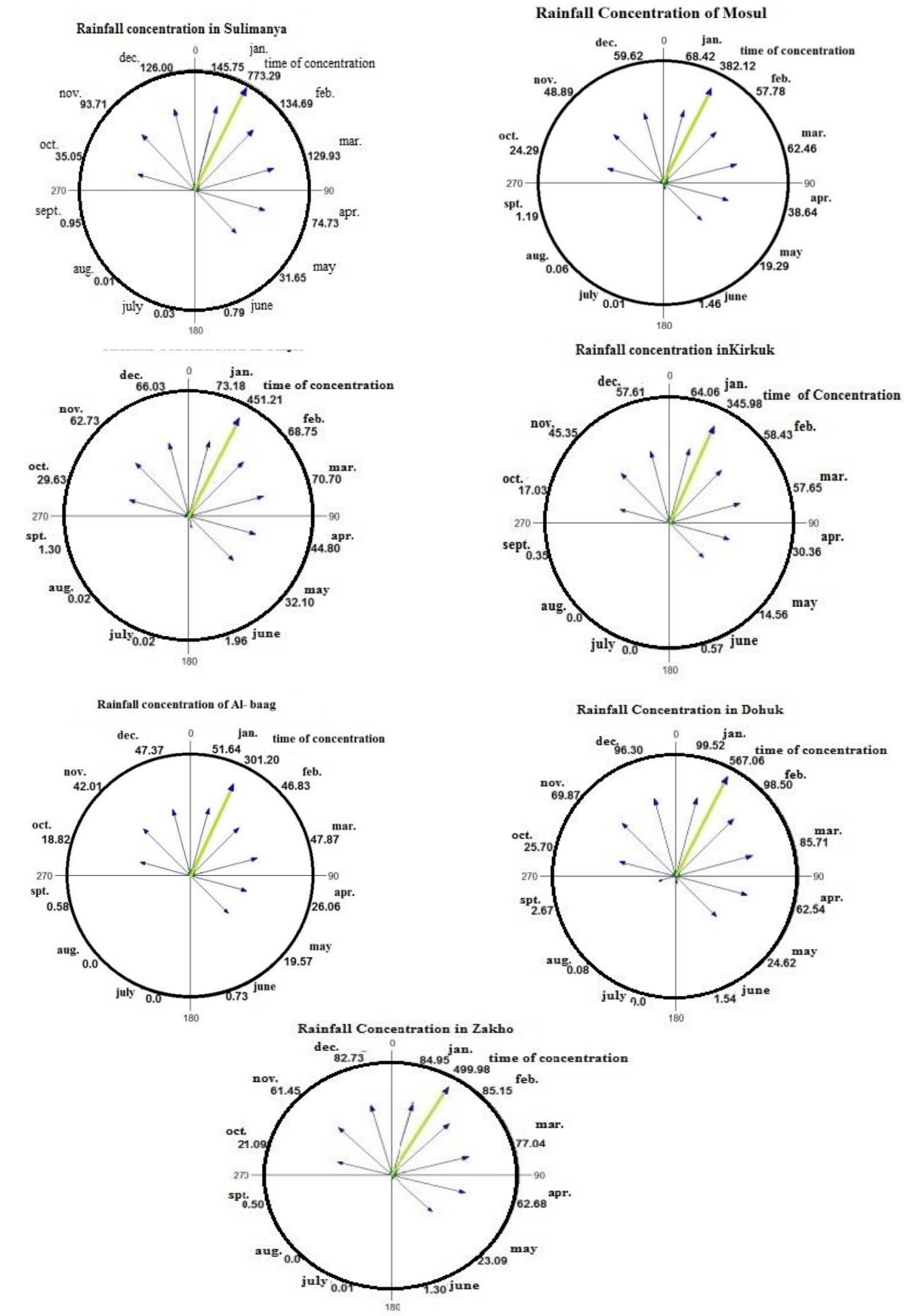


Figure 1 representation of Standard Vectors of rain concentration in all stations

5. Method of Precipitation Concentration Index (PCI)

Oliver 1980 was the first to suggest this indicator as an index of precipitation concentration and to measure the ability of rain to cause erosion [5], This index can measure the precipitation concentration at the annual level 12 months, the semi-annual level of 6 months, and the seasonal level 3 months, using the equations:

At the 12-month level

$$.100\ PCI\ annual = \frac{\sum_{i=1}^{12} pi^2}{(\sum_{i=1}^{12} pi)^2}$$

At the level of 6 months

$$.50\ PCI\ supra\ seasonal = \frac{\sum_{i=1}^{6} pi^2}{(\sum_{i=1}^{6} pi)^2}$$

At the level of 3 months

$$.25\ PCI\ seasonal = \frac{\sum_{i=1}^{3} pi^2}{(\sum_{i=1}^{3} pi)^2}$$

$pi =$ The amount of rain in a month [4].

The precipitation concentration index is applied based on the monthly rates for a certain number of years, symbolized by PCI1, and on the monthly averages for each year, symbolized by PCI2[6].

It has been observed that, in general, there is no relationship between the results of the index of rain concentration and the amount of annual rain for a certain period of time because this index focuses on most is the pattern of rain distribution during the year or season [7].

Table 3 values classifications of the precipitation concentration index (PCI)

(PCI)	Rainfall system
10≤	Uniform precipitation distribution (low precipitation concentration)
15 - 11	Moderate precipitation concentration
16 - 20	Irregular distribution
20≥	Strong irregularity (high precipitation concentration)

5-1. Equation application

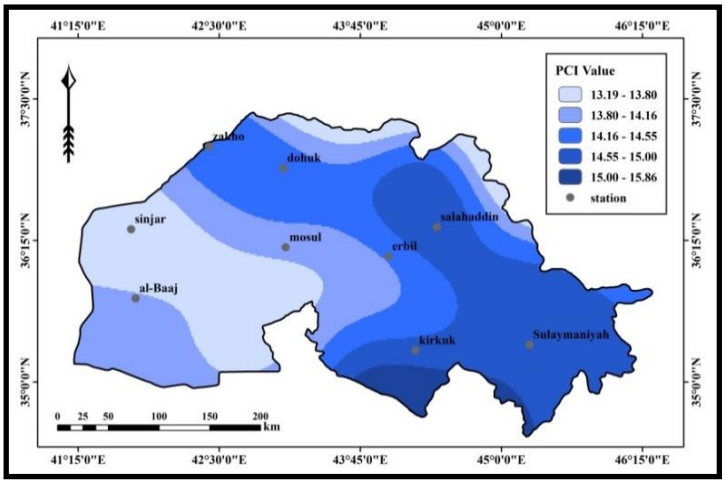
Table 4 PCI for the monthly data of the area's stations rains from 1979-2014[8]

station	Annual level		
	PCI1	PCI2	PCI1/PCI2
Kirkuk	14.74	20.62	0.71
Sulaymaniyah	14.84	19.43	0.76
Al-baaj	13.85	18.88	0.73
Erbil	14.23	19.28	0.74
Mosul	13.92	19.39	0.72
Sinjar	13.41	17.74	0.76
Salahaddin	14.88	19.72	0.75
Dohuk	14.40	18.96	0.76
Zakho	14.37	18.61	0.77
PCI1=The rain concentration index for the averages of the whole period of study is 36 years. PCI2=Average rainfall concentration index for each year separately. PCI1/PCI2=The result of dividing the rain concentration index for the whole. period by the average concentration for each year.			

5-2. Annual level

From the analysis of the previous table of the values of the annual rain concentration index (PCI1) for the stations of the study area, was found that all the stations had a moderate average rain concentration, as the values in all the stations were close to each other, while the values of the annual concentration index (PCI2) for each year alone showed that Severe concentration in the Kirkuk station, while the rest of the stations showed a seasonal precipitation system and an uneven distribution

Map 2 Annual Rainfall Concentration Index (PCI1)



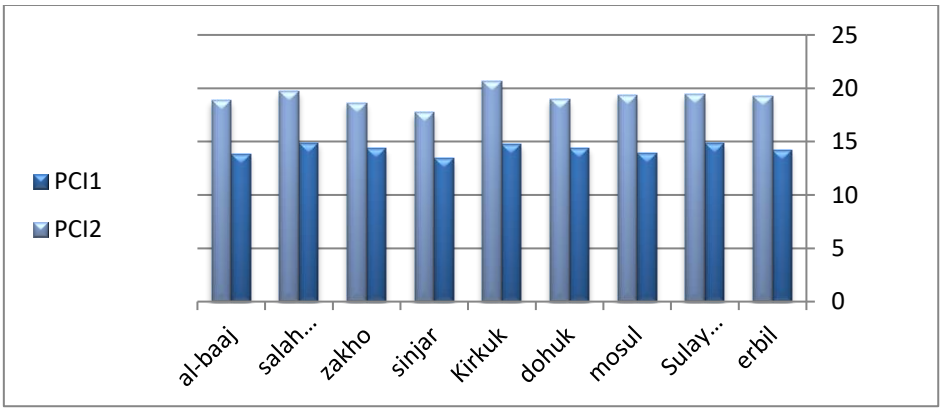


Figure 2 The difference between the values of the Precipitation Concentration Index (PCI1) and the values of the rain concentration index for years (PCI2) for the annual level

The result of dividing the index values of the averages on the index values for the years revealed a convergence in the concentration ratios. Zakho station recorded the highest percentage, while the Kirkuk station recorded the lowest concentration of the monthly amount of rain during the months of the year.

5-3. Semi-annual level

Regarding to the rainy season, which extends from November to April, the results of the PCI1 rainfall index showed that there is a clear parity in the distribution, as the amount of rain in this period is distributed over all months and this result included all the stations, as for the values of the annual rain concentration index (PCI2) It showed a moderate average in the concentration of rain in all stations of the study area.

The result of dividing the index values of the averages on the index values for the years during the rainy half. It indicated a similarity between the rain concentration ratios, while Kirkuk station recorded the lowest percentage, and both Sinjar, Dohuk and Zakho shared the highest concentration percentage.

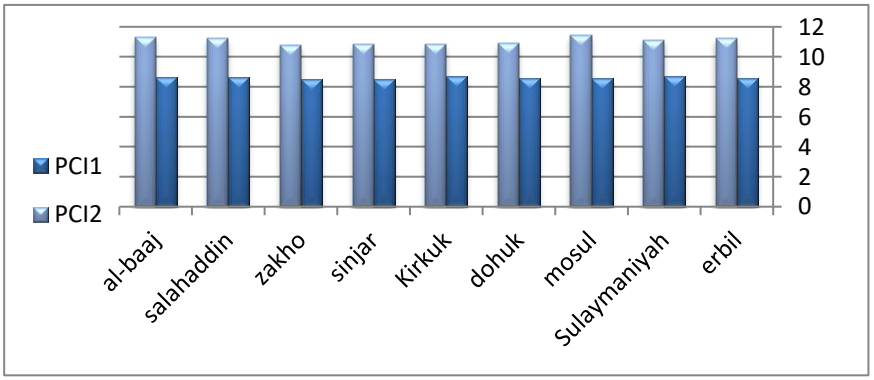
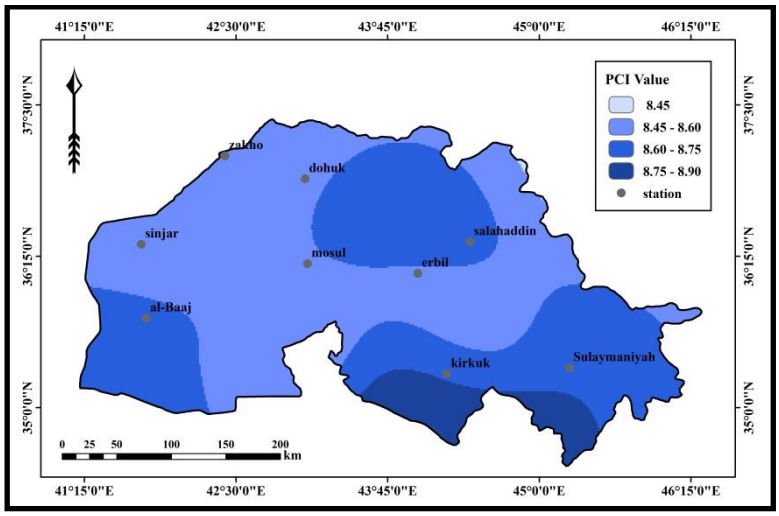


Figure 3 The difference between the values of the average precipitation index (PCI1) and the values of the rain concentration index for the years (PCI2) for the semi-annual level

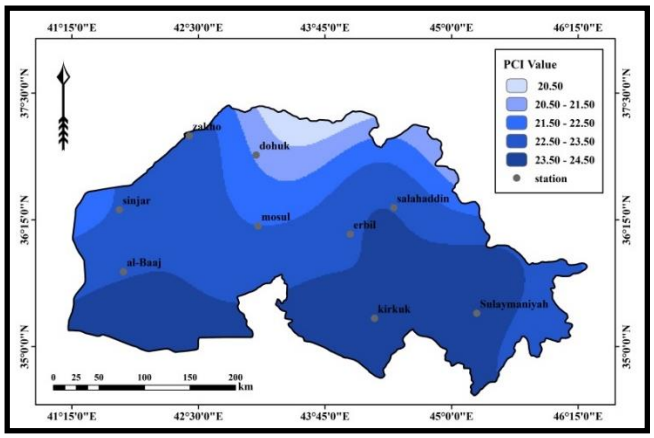
Map 3 Rainfall Concentration Index (PCI1) for the wet season



for the dry half, which extends from May to October, the results of the indicator ((PCI1) showed that all stations are similar in the classification of rain concentration in this season, which is represented by a clear irregularity in distribution and the presence of severe concentration in one or two months of this period, The same applies to the indicator of rain concentration for each year (PCI2) with the high concentration rates significantly, and this is due to the interruption of rain in the summer due to the change in the path of the depressions from the study area and the control of a system of high atmospheric pressure as the rains in this half of the year are concentrated in the late spring And early autumn, that is, the months of October and May.

. As for dividing the index values of rates on the index values for the years during the dry half, it indicated that the stations in Mosul, Dohuk and Kirkuk participated in the lowest concentration ratios, while the highest percentage of rain concentration was recorded in Sulaymaniyah station.

Map 4 Rainfall Concentration Index (PCI1) for the dry half year



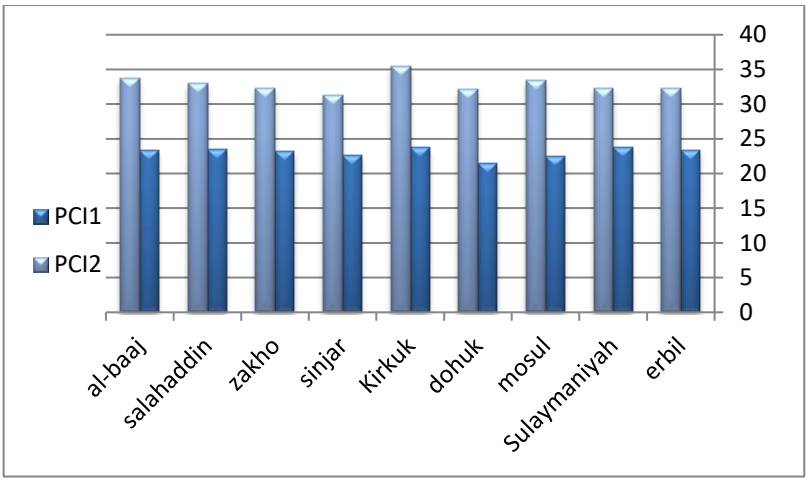


Figure 4 The difference between the values of the average precipitation index (PCI1) and the values of the rain concentration index for the years (PCI2) for the semi-annual level

Table 5 The rain concentration index for the monthly data of the area's stations rains for the period from 1979-2014

station	Rainy half of the year the			the dry half of the year		
	PCI1	PCI2	PCI1/PCI2	PCI1	PCI2	PCI1/PCI2
Kirkuk	8.72	10.82	0.74	23.76	35.40	0.67
Sulaymaniyah	8.71	11.12	0.78	23.80	32.32	0.74
Al-Baaj	8.64	11.27	0.77	23.40	33.77	0.69
erbil	8.59	11.22	0.77	23.39	32.24	0.73
mosul	8.58	11.42	0.75	22.52	33.47	0.67
sinjar	8.51	10.81	0.79	22.63	31.33	0.72
salahaddin	8.63	11.21	0.77	23.45	33.01	0.71
dohuk	8.57	10.91	0.79	21.39	32.14	0.67
zakho	8.48	10.79	0.79	23.17	32.31	0.72
PCI1=The rain concentration index for the averages of the whole period of study is 36 years. PCI2=Average rainfall concentration index for each year separately. PCI1/PCI2=The result of dividing the rain concentration index for the whole period by the average concentration for each year.						

5-4. Seasonal level

Autumn season

Which includes three months September, October, and November the results of the PCI1 index in **Table (7)** indicate that all stations in the study area are characterized by a moderate average in the concentration of autumn rains, although the values of the rain concentration index differ slightly from one station to another, but they remain within Same classification.,

As for the indicator values (PCI2), they indicated seasonality in the rainfall system and lack of moderation in distribution, and this result included all stations.

As for the result of dividing the index values of the rates on the index values for the years during the autumn season, it was found that the concentration ratios were high in all stations, and the rates were close to a large extent.

Table 7 PCI of the monthly data of the stations' rains in the study area for the period from 1979-2014

station	autumn			winter		
	PCI1	PCI2	PCI1/PCI2	PCI1	PCI2	PCI1/PCI2
Kirkuk	14.91	18.40	0.81	8.35	10.23	0.82
Sulaymaniyah	14.88	17.50	0.85	8.36	9.80	0.85
al-baaj	14.11	16.84	0.84	8.35	9.95	0.84
erbil	13.81	16.61	0.83	8.35	9.95	0.84
mosul	13.48	16.82	0.80	8.38	10.12	0.83
sinjar	13.72	15.80	0.87	8.35	9.94	0.84
salahaddin	15.26	17.63	0.87	8.37	9.79	0.85
dohuk	14.37	17.56	0.82	8.33	10.05	0.83
zakho	15.30	17.59	0.87	8.33	9.75	0.85
station	spring			PCI1=The rain concentration index for the averages of the whole period of study is 36 years. PCI2=Average rainfall concentration index for each year separately. PCI1/PCI2=The result of dividing the rain concentration index for the whole period by the average concentration for each year.		
	PCI1	PCI2	PCI1/PCI2			
Kirkuk	10.59	13.25	0.80			
Sulaymaniyah	10.51	12.55	0.84			
al-baaj	9.59	12.52	0.77			
erbil	10.24	12.48	0.82			
mosul	9.95	12.75	0.78			
sinjar	9.22	11.44	0.81			
salahaddin	10.52	12.68	0.83			
dohuk	9.92	12.04	0.82			
zakho	9.81	11.67	0.84			

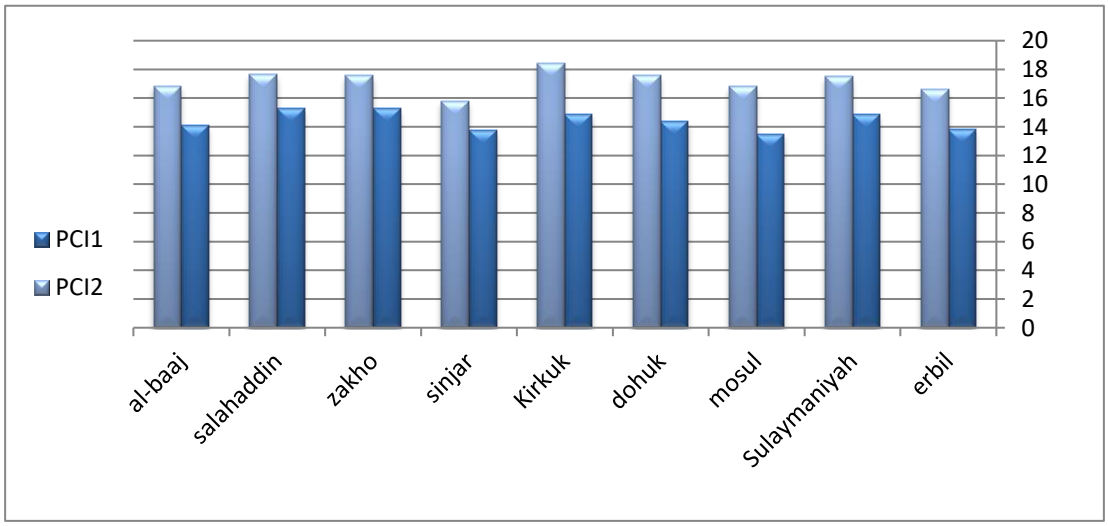
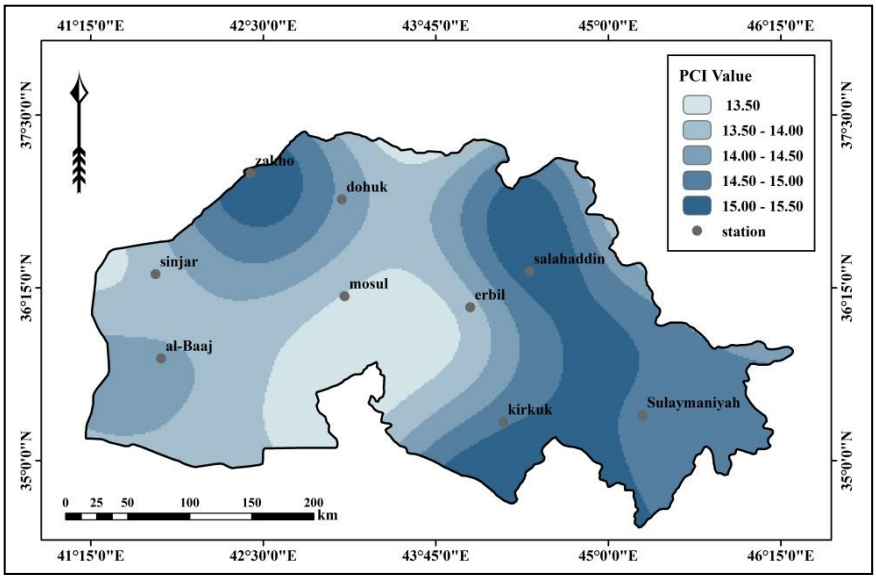


Figure 5 The difference between the values of the average precipitation index (PCI1) and the values of the rain concentration index for years (PCI2) at autumn season

Map 5 Rainfall Concentration Index (PCI1) for autumn



Winter season

Which includes the month of December, January and February, the index values showed that the results are very similar in the pattern of rain concentration (PCI1) in this season, which is a clear parity in the distribution, meaning that rain falls in all the months of winter, and this is despite the different amounts of rain from On the other hand, the same applies to the results of the concentration index for each year (PCI2), which showed a clear parity in the metric distribution during the season.

As for the result of dividing the index values for rates by the index values for the years during the winter season, high percentages were shown in all stations.

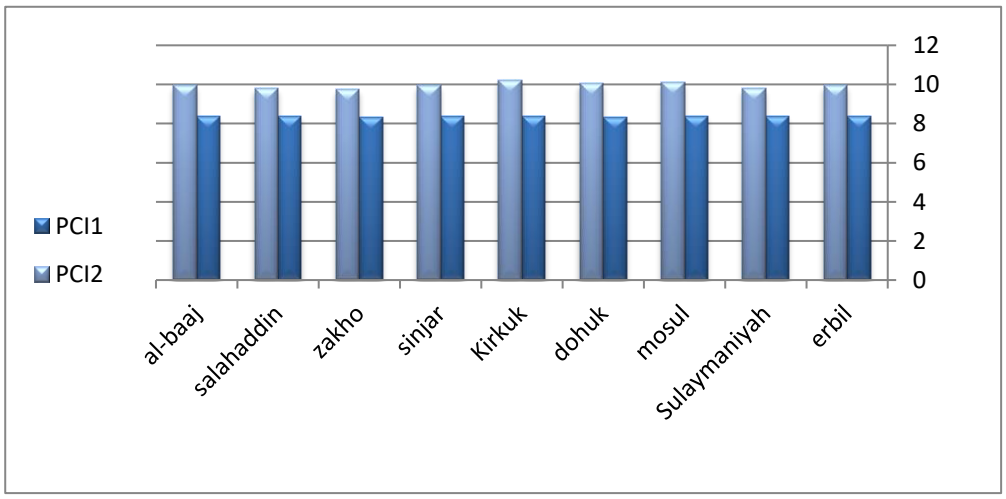
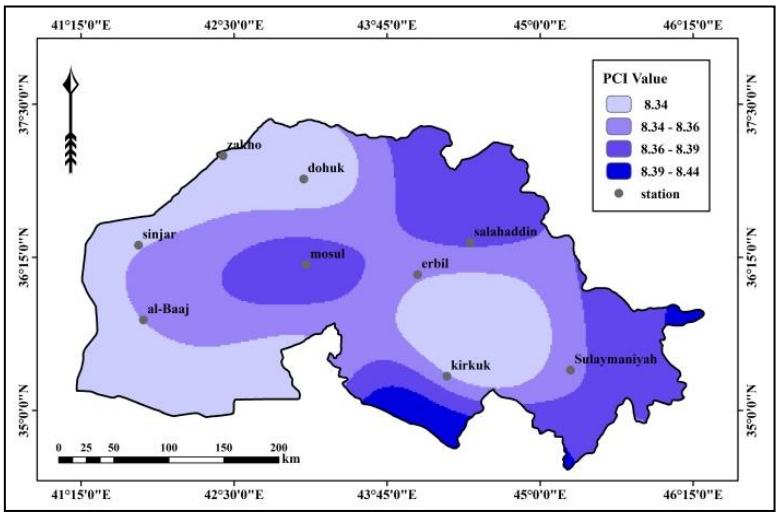


Figure 6 The difference between the values of (PCI1) and the values of (PCI2) at winter season

Map 6 Rainfall Concentration Index (PCI1) for the winter season



Spring season

Which includes the month of March, April and May. the analysis of the table we see that the concentration values (PCI1) showed in some stations (Erbil, Sulaymaniyah, Kirkuk, Salah al-Din) moderation in the distribution of rain in this season, as for the rest of the stations (Mosul, Zakho, Dohuk, Sinjar, Ba'aj). The concentration in it was clearly equal in the distribution of rain (ie, rain falls in all months). As for the values of concentration for each year, it indicated that there is an average moderation in the distribution of rain during the spring in all stations of the study area.

As for the result of dividing the index values of rates on the index values for the years during the spring season, it showed high concentration ratios in all stations, and the Dohuk station occupied the lowest rain concentration percentage in the region.

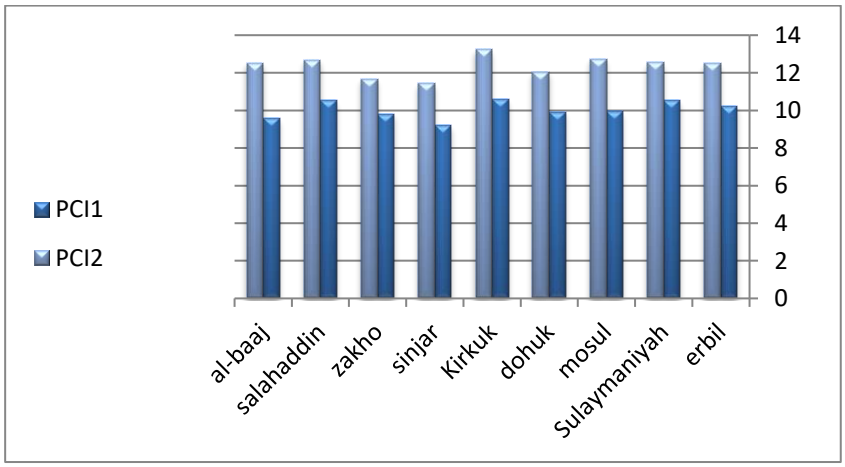
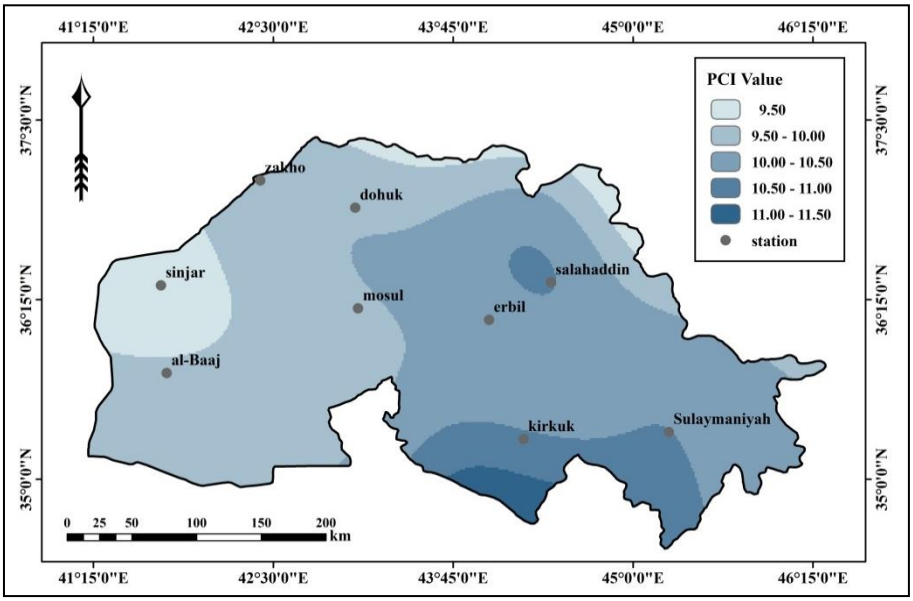


Figure 7 The difference between the values of the rain concentration index (PCI1) and the values of the rain concentration index for the years (PCI2) at spring season

Map 7 Rainfall Concentration Index (PCI1) for the spring season



Conclusion:

1-The precipitation concentrated in the study area started from the end of January to the beginning of February, and this includes all stations.

2- The length of the rainy season varies from one station to another and ranges between more than six months in Sinjar and less than nine months in Salaheddin.

3- The results of the annual precipitation concentration index (PCI1) showed that all the stations in the study area had moderate concentrated rains. The results of the concentration index for each year showed a high concentration in the Kirkuk station, while the rest of the stations showed a seasonal precipitation system and no moderation in distribution.

4- for the results of semi-annual precipitation concentration, (PCI1) in the wet half showed that all the stations in the region were similar in the type of concentration, which is equal to the distribution over all months, while the values of (PCI2) showed moderate equilibrium in the distribution of rain, in the dry half , the concentration values indicated (PCI1) refers to presence of severe concentration and irregularity in the distribution in all stations, as the rains are concentrated in one or two months of this season, as well as for the values of the (PCI2) index with a high concentration rate

5- for the results of semi-annual rain concentration, (PCI1) in the wet half showed that all the stations in the region were similar in the type of concentration, which is equal to the distribution over all months, while the values of (PCI2) showed moderate equilibrium in the distribution of rain, in the dry half the concentration values indicated (PCI1) To the presence of severe concentration and irregularity in the distribution in all stations, as the rains are concentrated in a month or two of this season. Likewise, the values of the (PCI2) index with a high concentration rate

6- for the results of seasonal rain concentration, the concentration index (PCI1) in the autumn season showed a moderation in the distribution of rain during this season. As for the values of (PCI2), they indicated the seasonality of precipitation and this included all stations, while the winter season indicated the values of (PCI1 and PCI2 values) To the existence of a parity in the distribution of rain in all the months of the season, in the spring season the values of the index (PCI1) showed that the stations (Erbil, Sulaymaniyah, Kirkuk, Salah al-Din) are characterized by the presence of moderate moderation in the rain concentration, while the rest of the stations (Mosul, Dohuk, Zakho, Sinjar, Al-Baaj), it indicated a clear parity in the distribution of rain during this season. As for the index values for each year (PCI2), they showed moderate moderation in all stations

7-The study showed that applying the equations to measure the precipitation concentration in the study area It led to accurate identification of the seasonality of rain and the percentage of concentration in each season, in addition to an accurate determination time of the heaviest rainfall and number of rainy months in each station.

8-The concentration values for each year (PCI2) showed an increase in the concentration rates at the annual, semi-annual and seasons levels.

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