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Smoking and Khat Chewing Among Yemeni Women in Aden Governorate

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ABSTRACT

Background: khat is a plant which is cultivated in Yemen and the horn of Africa. The small leaves are chewed by people for their stimulating effects. The mental and physical stimulating effects of khat chewing are due to the sympathemimetic substances in khat. The most important is cathinone.
Smoking is also an increasing health problem in Yemen. The aims of this study, therefore, are to determine the prevalence of khat chewing and smoking habit among Yemeni women in Aden governorate and to find the association between khat chewing and smoking.
Methodology: A cross-sectional study was conducted which involved 250 women from different sectors of society in Aden governorate.
Results: The study showed that the life time prevalence of smoking was 80% while both life time smokers and chewers was 100%. Thirty three percent (33%) of the life time chewers and 32.7% of the life time smokers have duration of khat chewing and smoking from 10 to 19 years. 15.9% of the ever khat chewers and 19.6% of the ever cigarette smokers have had duration from 30 to 39 years. Also, the study shows that the habit of khat chewing is a very important risk factor in increasing the addiction of smoking with a frequency of 96.9% of smoking during khat chewing, compared to 3.3% of khat chewing without smoking.
Conclusion: The study demonstrated high prevalence of smoking and khat chewing among women in Aden governorate. Also, the study demonstrated the high prevalence of cigarette smoking among chewers.
Keywords: Khat chewing, Smoking, Women, Yemen

INTRODUCTION

Tobacco and khat are two of the many habits/drugs to which people can become addicted [1]. Chewing khat, a psychotropic plant, is a deeply rooted addictive habit in Yemeni society. Khat has been cultivated for use as a stimulant for centuries in Yemen, other parts of the Arabian Peninsula as well as the Horn of Africa [2, 3]. The khat chewing habit is particularly widespread in Yemen [4,5]. Although the habit was traditionally practiced by men, it is now prevalent among women and all socio-economic groups. It has been estimated that about 80% of Yemeni men and 60% of women chew khat [2]. It is especially common in social gatherings and ceremonies such as wedding celebrations and death mourning. Many Yemeni men and women also spend most of their afternoons chewing khat, owing to the pleasant stimulant action it provides. It is believed that khat offers a sense of euphoria, cheerfulness [4,5], relief from fatigue , increased energy levels, ability to communicate easily, capacity to associate ideas and to improve self confidence [4,5,6]. On the other hand, khat is addictive, and has many negative health consequences [7]. It contains several chemical elements, the most important of which is cathinone, a stimulant of the central nervous system and is believed to have the same effect as amphetamine. Khat chewing leads, therefore, to anxiety, mood disturbances, depression, and insomnia [4,5].The nicotine in cigarette smoke is known to have an addictive effect. Compulsive use, psycho-active effects, and drug-reinforced behaviour are the primary criteria for defining drug addiction [8, 9,10]. Cigarette smoking causes lung cancer, athero-sclerotic cardiovascular diseases, intrauterine growth retardation, spontaneous abortion, antepartum haemorrhage, female infertility, peptic ulcer disease, chronic obstructive lung disease, sexual dysfunction in men, and many other diseases. Passive smokers can also acquire diseases associated with cigarette smoking [10, 11, 12, 13, 14, 15,16]. Habits of khat chewing and smoking are major contributors to gross dental staining [17,18].

There are no available precise figures on the prevalence of khat usage and smoking among Yemeni women in Aden governorate. This study is thus timely to determine the prevalence of khat chewing and smoking habit among women in Aden governorate and to find the association between khat chewing and smoking.

METHODOLOGY

A Cross-sectional study was conducted in Aden governorate from 2002 to 2004, which is the economic and commercial capital of Yemen, and the most important sea outlet for Yemen to the Arabian Sea and the Indian Ocean.

Aden governorate consists of eight districts and occupies an area of 6980 km^2, with an estimated population of 590,000 inhabitants.

This cross sectional study involved 250 women from different parts of Aden (societies, institutes and colleges).

Twenty five women from each organization or institutions (Pharmacy, Economic and Education collages in Aden University, Yemen Women union association in Aden, Development charity association in Aden, Child care association in Aden, Aden University staff members, Ministry of Public Health office staff members in Aden, and 25 house wives in Aden community) were randomly selected using a convenience method.

A structured self-administered questionnaire was employed for data collection. The variables included were socio-demographic characteristics, use of khat/cigarettes,

motivating factors that initiate people to use khat/ smoking, reasons why people use khat/smoking, health hazards of khat chewing/smoking, and attitude towards khat use. Ethical clearance and permission were obtained from the Research Committee of Thamar University, and before starting the data collection, oral permission was also obtained from the individual target women, by explaining the purpose of the study and promising them that the information collected would be kept anonymous; and participation was totally voluntary.

The operational definitions used:-

I. Khat chewing:

(a) Non-user: Person, who has never used khat in any form, (b) Lifetime prevalence of chewing: the proportion of the study population who had ever chewed khat in their lifetime, (c) Ever chewer: An individual is considered an ever chewer even if she had chewed only once in her lifetime.

II. Smoking

Non-smoker: Person, who has never used cigarette in any form, (b) Lifetime prevalence of smoking: the proportion of the study population who had ever smoked in their lifetime, (c) Ever smoker: An individual is considered an ever smoker even if she had smoked only once in her lifetime.

Frequency tables were used for data presentation and the association between khat chewing and smoking was considered statistically significant at $p < 0.05$ by using chi-squared test. Data was analyzed using SPSS version 11.5.

RESULTS

Two hundred and fifty women were included in this study and the overall response rate was 214 (85.6%).One hundred and twelve (52.3%) were married, 68 (31.8%) were single, 12(5.6%) were divorced and 22 (10.3%) were widows (figure 1).

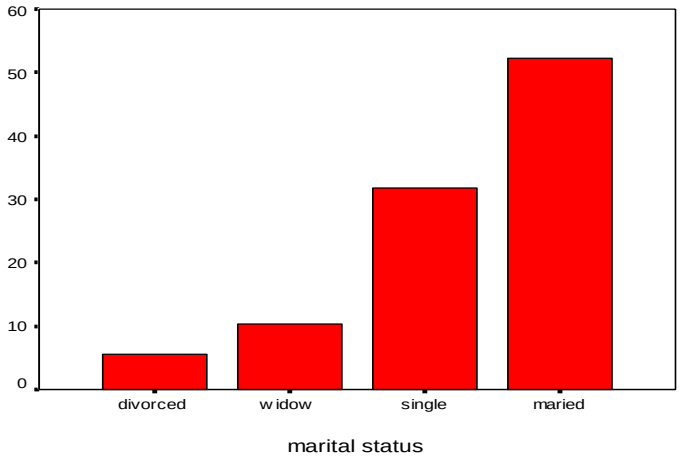

Figure (1): marital status of studied women

Figure 2 shows the age distribution among women included in this study. About 38.3% of the women were in the age group 20-30, the minimum age was 20 years and the maximum 72.

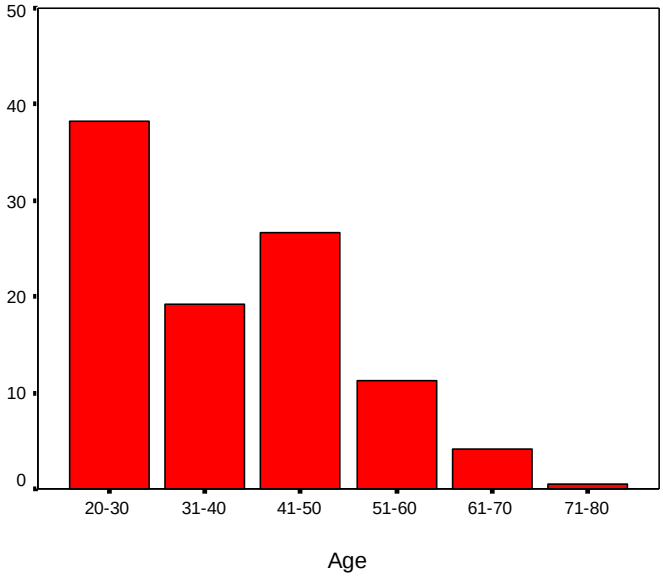

Figure (2): Age distribution among women included in this study.

The life time prevalence of smoking was 80%, while both life time smokers and chewers 100%, table 1.

Table (1): Prevalence of khat chewing and cigarette smoking among women in Aden governorate (gov.)

khat chewing /Smoking status	N0(total n=214)	Percent*
Neither chewer nor smoker	0	0%
Life time khat chewer	214	100%
Life time smoker	172	80%
Both life time chewer and smoker	172	80 %
Life time chewer or smoker	214	100%

*the percentages do not add up to 100% because one category can be included in the other

Seventy one (33.2%) of the lifetime chewers and 70 (32.7%) of the lifetime smokers have a duration of khat chewing and smoking from 10 to 19 years .Thirty four (15.9%) of the ever khat chewers and 28(19.6%) of the cigarette smokers have had duration from 30 to 39 years (Table 2).

Table (2): Duration of khat chewing /smoking among women in Aden gov.

Time in years	Ever khat chewers (total n=214; (No (%))	Cigarette ever smokers (total n=214; (No (%))
Less than 1 year (1<)	2 (0.9%)	1(0.5%)
1-9	71(33.1%)	70(32.7%)
10-19	70(32.7%)	40(18.7%)
20-29	37(17.3%)	33(15.4%)
30-39	34(15.9%)	28(13.1%)
Non chewers/smokers	0	42(19.6%)

The main reason given for chewing khat or smoking was for relaxation and pleasure (72.5%), to keep alert while working were the main reason for starting chewing or smoking,(20,6%). Table 3 shows the reasons for starting khat chewing or smoking.

Table (3): Reasons given by women in Aden for chewing khat and cigarette smoking

Reason	Khat chewing or cigarette smoking (n=214) No (%)
Relieve stress	15(7%)
To keep alert while working	44(20.6%)
For relaxation and pleasure	155 (72.4%)

On the contrary, many women believe that khat chewing and cigarette smoking have health risks. Sleeplessness (35.5%) was the main risk factor for the khat chewing, while the addiction mentioned as the main health problem of chewing khat or cigarette smoking (30.8%). Table 4 show the main health risks associated with khat chewing and cigarette smoking as perceived by the study group.

Table (4): Health risks of khat chewing/smoking mentioned by women in Aden gov.

Health risk	**N0 (%*)**
Addiction	66(30.8 %%)
Health risks	51(23.8%)
Increase susceptibility to many diseases	10(4.7%)
Gastrointestinal disorders	31(14.5%)
Sleeplessness	76(35.5%)
Anxiety	22(10.3%)
Family problems	37(17.3%)
Didn't mention any health risks	103(48.2%)

NB: *1. The percentages are calculated from the total number of women who reported that khat chewing/cigarette smoking has health risk n=214

2. The percentages do not add up to 100% because one responder can give more than one answer

The risk of smoking increased with chewing khat (X^2 = 186.9, P 0.0005), table 5.

Table (5): Shows the association between khat chewing and smoking.

Khat chewing /smoking status	Frequency	Chi-square test (X^2)	Df (degree of freedom)	p-value
Khat chewing with smoking	207(96.7%)	186.916	1	0.0005
Khat chewing without smoking	7(3.3%)			

DISCUSSION

This study revealed that 100% of the lifetime prevalence rate is for khat chewing and 80% for smoking among women in Aden governorate. Both life time prevalence rates in this study group are higher compared to previous studies done in Ethiopia and Aden by Kebede [1] ,Alkhader Laswer and Hashem [3] respectively .The possible explanation for this difference could be that the previous studies were done among college students.

The duration of taking khat or smoking ranges from 1 to 39 years among our study group. From this finding, possible explanation includes Yemeni social view; with increasing age there is an increasing social acceptance of khat chewing . In agreement with this statement is that the main reasons mentioned for started chewing khat / smoking were relaxation and pleasure (72.5%). To keep alert while working (20.6%) is the second reason mentioned by our study group. This is an important indication to direct interventions towards decreasing the prevalence of these habits.

Many women believe that khat chewing and smoking have health risks. Sleeplessness (35.5%) was the main risk factor for khat chewing, while addiction was mentioned as the main health problem of khat chewing and cigarette smoking. On the other hand, 48.2% didn't mention any health problems; this indicates that there is a need for health education and promotion about khat chewing and cigarette smoking.

About 20% of the study group were non-smokers, and these are good examples for smokers, in that stopping these habits is possible.

In this study 96.7% declare that they smoke during khat session .This finding indicates positive association between smoking and chewing khat ($X^2 = 186.916$, df=1, p=0.0005).

One limitation of this study is that 100% response was not obtained; of course this is one of the limitations of self-administered questionnaires. The other limitation could be that all women might not give genuine answer to the questions they were asked. This might underestimate the prevalence of cigarette smoking.

CONCLUSIONS

In general the prevalence of khat chewing and cigarette smoking among women in Aden governorate were high. Most of women knew the commonest health risks associated with khat chewing and cigarette smoking, while some of them didn't mention any health problems.

The association between smoking and khat chewing is statistically significant ($X^2 = 186.916$, df=1, p=0.0005).

RECOMMENDATIONS

Based on the finding of this study the following recommendations are made:

1. Colleges, institutes and women associations should educate their staff members on the health problems associated with khat chewing and cigarette smoking.
2. The mass media should also give emphasis to the problems of khat and cigarette smoking.

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انتشار ظاهرة القات والتدخين بين النساء في محافظة عدن بالجمهورية اليمنية

احمد علي قايد ثابت[1] ، سهام عبد الرب السروري[2] ، احمد الحضراني[3]

1. استاذ الوبائيات المشارك ،كلية الطب والعلوم الصحية ، جامعة ذمار
2. مدير ادارة المعلومات والبحوث ، الهيئة العليا للأدوية ، محافظة عدن
3. استاذ الجراحة العامة ، رئيس جامعة ذمار

ملخص

نبات القات يزرع في اليمن والقرن الأفريقي. وعادة يمضغ الناس أوراقه الصغيرة من اجل الحصول على الاثر التحفيزي. وتنتج الآثار النفسية والجسدية للقات عن وجود مواد ال sympathemimetics في القات. ومن اهمها الكاثينون. بينما يُعد التدخين من المشاكل الصحية الهامة في اليمن .

اهداف الدراسة : تهدف هذه الدراسة إلى تحديد مدى انتشار التدخين ومضغ القات بين النساء اليمنيات في محافظة عدن وكذا ايجاد العلاقة بين مضغ القات والتدخين.

المنهجية : أجريت دراسة مستعرضة وشملت 250 امرأة من مختلف قطاعات المجتمع في محافظة عدن.

النتائج : أظهرت الدراسة أن معدل انتشار التدخين ولو لمرة واحدة في العمر كان 80 ٪ في حين أن انتشار التدخين والقات بين المدخنين والماضغين ولو لمرة واحدة في العمر كان 100 ٪. وثلاثة وثلاثون في المئة (33 ٪) من الماضغين و32،7 ٪ من المدخنين مارسوا عادة التدخين ومضغ القات خلال مدة 10 وحتى 19 عاما. بينما 15،9 ٪ من ماضغي القات و19،6 ٪ من مدخني السجائر قد مارسوا عادة مضغ القات والتدخين خلال مدة 30 وحتى 39 عاما. كما اظهرت هذه الدراسة أن عادة مضغ القات عامل مهم جدا في زيادة مخاطر إدمان التدخين . حيث ان 96،9 ٪ من المدخين أثناء مضغ القات يزداد تناولهم للسجائر مقارنة ب 3،3 ٪ من ماضغي القات من دون تدخين.

الخلاصة : أظهرت الدراسة ارتفاع معدل انتشار التدخين ومضغ القات بين النساء في محافظة عدن. كما أظهرت الدراسة ارتفاع معدل انتشار التدخين بين ماضغي القات.

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Studies on Microbial, Physical and Chemical Quality of Fresh Yemeni Rabbit Meats During Storage in Taiz City

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ABSTRACT

The aim of this study is to evaluate the quality and the degree of contamination of local fresh Yemeni rabbit meats collected from Taiz markets in the Republic of Yemen, the changes of samples examined during storage at zero time and every day. The results illustrate an increase in microbial contamination and a decrease in physical and chemical characteristics, until signs of spoilage appeared after four days of storage . On other hand, the population of Aerobic, Anaerobic, Spore-formers bacteria, Yeast and Moulds, Enterobacteriaceae, Coli form groups, Salmonella spp , Staphylococcus spp, Streptococcus spp, Clostridium spp, Bacillus spp, Enterococcus spp and Proteolysis bacteria increased by the following percentages: 66.10%, 47.92%, 40.10%, 29.43%, 46.50%, 27.69%, 35.00%, 38.48%, 43.77%, 25.77%, 28.42%, 43.61% and 48.76%, respectively. The nutrition chemical characteristics i.e. [Moisture, Protein and Fat content] decreased as shown in these percentages: 0.81%, 0.35% and 0.65%, respectively. And the Carbohydrate content increased by 21.33%. The chemical indicators of spoilage i.e. [Total volatile nitrogen, Tri methyl amine, Ammonia nitrogen, Thiobarabituric acid, Total Energy and Water holding capacity] increased as shown in these percentages: 174.40%, 163.09%, 155.05%, 50.00%, 1.71% and 12.24%, respectively. The pH value and Bound water decreased by 1.315% and 3.126%, respectively, compared with the control samples. In addition, isolation and classification Eight species of Bacillus species, which were identified in previous samples were isolated and classified. They were Bacillus subtilus, B. pumilu, B. cireulans, B. megaterium, B. lentus, B. sphaerieus, B. macerans, B. cereus, shown in these percentages: 10.52%, 15.78%, 05.26%, 15.78%, 5.30%, 21.05%, 10.52% and 15.78%, respectively.

Key words : Microbial ,Physical, Chemical, Storage, Rabbit, Meat.

INTRODUCTION

From the earliest civilization, all societies have had two means for ensuring adequate supplies of safe and nutritious food to meet the needs of their people (Kaferstein and Moy 1999) . The quality of rabbit meat is the reflection of microbiological, physical and chemical characteristics before and during storage (Abd El-Latife, 1998). Protein plays an important role in the life of man and nation. Meat of cows, rabbit and fish is an important source of protein in human nutrition. Meat from fresh chicken, fish and rabbit is the most common source of high protein food (Gamal El-Deen, 2007). In Yemen most of people suffer from lack of meat, hence the local consumption decreased daily (day by day). Some villages in the Republic of Yemen have no electricity and they sell meat in the open air in retail stores. So the meat loses a great deal of its nutritious value. Storage of food (specially fresh food like meats) at high temperature also has been reported to cause a loss of nutritional value (Youssef, *et al.,* 2007). The chemical composition of the food and the metabolic activities of the organisms growing in the food determine the compounds which can be used as indicators (Sayed, 2002), because of the extreme tendency of some products to perish; and occasionally decomposed foods get into market channels. Therefore, the objective of our present investigation is to evaluate quality parameters of high nutrition and anther chemical composition in Yemeni rabbit meats, and to determine different total bacterial counts of tested samples. The aims of this study can be stated as follows**:-**

1-To find out the degree of bacterial contamination, evaluate the effect of storage at room-temperature on the different microbiological, physical and chemical quality of local fresh rabbit meats.

2- To find out the chemical nutritional characteristics of the samples under investigation.

3- To isolate and identify *Bacillus* species of all tested samples as a selection of rabbit meats contamination.

MATERIALS AND METHODS

1- Preparation and storage of samples:

Local fresh rabbit meats samples were collected and purchased from different local retail stores in Taiz city (Republic of Yemen). After the whole rabbit meat flesh was obtained the skin surface slime, dirt, head, legs, viscera and skeleton were immediately removed. Any residual blood was also removed. After that the meat was sent to the laboratory in Ice-box and was cut into small retail severance meat (each severance meat contain 50 grams). It was immediately stored at room-temperature (28 ^{o}C). The bacteriological, physical and chemical changes of retail severance meat carried out at zero time (as control samples) were examined, within 2 hours and day by day (every day) and during storage at room-temperature for four days, until signs of spoilage appeared by the border line of rabbit meats. Acceptability for total microbial count was found to be ($\geq 10^7$) cell/g and appearance of putrid smell was as reported by Microbiological Criteria for Arabia and Egyptian Standard Food (El-Shamery, 2001 and Gamal El-Deen, 2007) .

2-Chemical and physical analysis:

Moisture content (M.O), Total nitrogen (P.R), Crude Fat, and Ash content were determined according to the method described by A.O.A.C, (2002). The total carbohydrate (C.B) was

calculated by the differences according to (Egan *et al*., 1981). The total volatile bases nitrogen (T.V.N), Tri-methyl amine nitrogen (T.M.A), and Ammonia nitrogen (A.N) were determined according to the method mentioned by A.M.C, (1979) (Mg per/ 100gm sample on dry weight basis). Thiobarbituric-acid (T.B.A) was determined as indicated according to the method of (Siu and Draper, 1978) mg monoaldehyde per 100 gram sample on weight basis. The pH value was measured using the method described by Krilova and Liskovskain, (1961). Energy value was calculated using the equation given by Winton and Winton, (1958). Water holding capacity (W.H.C), and Water bound (B.W) were measured by following the filter press method of (Gram and Hamm, 1957) as described by Soloviev, (1966).

3-Microbiological examination :

Twenty five grams of random samples of the rabbit meats were blended with 225 ml of 0.1% peptone water in a sterile blender jar for 1-2 minutes and decimal dilutions prepared for testing. Numbers of viable organisms were determined by the plate count method. One ml of each dilution was inoculated with appropriate media for the particular group of organisms to be tested as Colony forming unit per gram (c.f.u/g). The total aerobic bacterial count (A.B) was determined according to (A.P.H.A, 1992) using Plate count agar medium incubated at 37 ^{o}C for 3-5 days;Anaerobic bacterial count (A.N.B) was determined according to (A.P.H.A, 1992) using cooked meat agar medium with Anaerobic Jars (Gas pak system by B. BL cockysville marland 21030 USA). Yeasts and Moulds (Y.M) were counted on Malt extract agar medium (Oxoid, 1985) incubated at 25-30 ^{O}C for 3-5 days as described by Pitt and Hocking, 1985. Spore-former bacteria count (S.P.O) were determined according to method described by Chalmers, 1955. The suitable dilution was subjected to 80 ^{O}C at 20 m for 48-72 hrs. Proteolysis bacteria count (P.R.O) inoculation were made TGY to which 10 % (10 ml / 100 ml medium) of Sterile skim med milk has been added just before pouring plates were incubated for 2-3 days at 30 ^{O}C (A.P.H.A, 1992) . Total *Streptococcus* spp bacterial count (S.T.R) was determined by using Dried brain heart infusion agar and MaCconky agar media (Oxoid, 1985) the inoculum was spread on the surface of plate, after incubation at 37^{o}C for 24-48 hrs as mentioned by Mossel and Tamminge, 1980. Enterobacteriaceae count (E.N.T) was determined on Violet red blue dextrose agar medium after incubation at 37 ^{O}C for 20-24 hrs as described by Robert *et al*., 1995. *Bacillus* spp count (B.A.C) was counted by using Mannitol egg yolk-poly myxin (MYP) agar and incubation for 16- 24 hrs at 37 ^{O}C as described by Roberts *et al* ., 1995. *Salmonell*a spp count (S.A.L) was carried out using the most probable number technique (M.P.N) according to (ISO, 1982) . After enrichment at 37 ^{o}C for 24 hrs in Selenite broth, the cultures were streaked on Brilliant green agar and incubated at 37 ^{o}C for 24 hrs; then colonies were biochemicaly examined in Triple Sugar Iron agar (TSI) and Lysine de carbonate broth. *Staphylococcus* spp count (S.T.P) was enumerated on Baird–parker medium using surface plating technique as recommended by I.A.E.A, 1990, and incubated at 37 ^{O}C for 24 hr. *Enterococci* spp count (E.N.S) was enumerated on Konamycin aesulin azide agar medium (Mossel and Tamminge, 1980). Positive colonies were confirmed by microscopic examination for the presence of short chain streptococci. Coli-form group count (C.O.L) was counted used the (M.P.N) method as reported by I.A.E.A, 1990 by inoculating MacConkey agar medium incubated at 44 ^{O}C for 24-48 hrs. *Clostridum* spp count (C.L.O) was counted using the Cooked meat agar medium incubated at 37 ^{O}C for 24

hrs, in anaerobic system using gas generation kit as mentioned by Craven *et al*., 1979 and Oxoid, 1985 .

4-Isolation and identification of Bacillus species :

Isolation and identification of *Bacillus* species were determined from the total count plates (APT) agar (A.P.H.A, 1992) colonies in opposite sectors were picked and transferred to agar slants of the same medium. After purification, bacterial grouping according to morphological characteristics and Gram stain was carried out. Gram- positive bacterai groups were identified to generic and species level with the aid of [Bergey's Manual for Systematic Bacteriology, 1986; Kotzekidou, 1996 and Bergey's Manual of Determinative Bacteriology, 1999]. The method of identification adopted for this purpose Genus *Bacillus* with standard tests and classification schemes described by Smith *et al*., 1952 in conjunction with [Holt *et al*., 1986] and examination were carried out according to [Holt *et al* ., 1986].

RESULTS AND DISCUSSION

A- Chemical and physical analysis of local fresh rabbit meat during storage at room temperature

Table (1) below shows the effect of storage at room-temperature on Moisture (M.O), Protein (P.R), Fat, Ash, Total carbohydrates contents (C.B) and chemical indicator for spoilage i.e. pH value, Total volatile bases nitrogen (T.V.N),Tri methyl amine (T.M.A), Ammonia nitrogen (A.N), Thiobarbituric acid (T.B.A), Total calories [Energy-value (E.N)] and Water-holding-capacity capacity (W.H.C). It determination as abound water (B.W) of local fresh rabbit meat for four days of storage at this stage of storage the control samples were completely rejected by the border line of rabbit meat acceptability for total microbial count in (table, 2) was found to be [$\geq 10^7$] cell /g and appearance of putrid smell as reported by microbiological and chemical criteria for Arabia and Egyptian Standard Food and by Shady, 1999 ; Abd-El-Daim, 2004 and Youssef, *et al*.,2007. From the data in table (1) it can be noticed that the moisture (M.O), Protein (P.R), Fat, Ash, Carbohydrate (C.B) contents, Total calories [Energy value (E.N)], pH value, Water holding capacity (W.H.C), Bound water (B.W), Total volatile nitrogen (T.V.N),Tri methyl amine (T.M.A), Ammonia nitrogen (A.N) and Thiobarbituric acid value (T.B.A) on control samples at 0.0 time of storage have these percentages: 72.00%, 71.251%, 22.857%, 3.928%, 1.964%, 142.284%, 6.08 pH value, 1.96%, 92.379%, 62.399%, 7.412%, 24.932% and 0.014% mg per/ 100g respectively. These results were in agreement with the chemical criteria for Arabia and Egyptian Standard Food and within the range of values of fresh rabbit meat as reported by El-Mongy *et al* ., 2001 and Gamal El-Deen, 2007. Regarding the room temperature storage of the Moisture (M.O), Protein (P.R), Fat contents, Bound-water (B.W) and pH value changes slightly decreased with an increase in the storage time on the first day of storage; 72.00%, 71.250%, 22.857%, 92.377% and 6.08 pH value of rabbit meat respectively and slightly decreased through storage to reached at the end of storage to 71.41%, 70.999%, 22.70%, 89.491% and 6.0 pH value after four days of storage for rabbit meat samples respectively. These results were in agreement with the findings of [Bader, 2004]. In other words, the decrease can be shown in these percentages 0.81% for the Moisture, 0.352% for the Protein, 0.65% for the Fat, 3.126% for the Bound water and 1.315% for the pH value of the above mentioned sample compared with the control sample

respectively. This decrease in moisture content of the above sample may be due to evaporation of water during storage. This is in line with Affi and El-Nashaby, 2001 ; Sayed, 2002 and El-Shamery, 2007. The decrease of protein content in the same samples may be due to the loss of nitrogen as volatile bases and nitrogenous substances. Moreover, the decrease of protein might be attributed to decomposition of meat by higher load of micro-organisms which formed volatile nitrogenous substances and soluble substances by the effect of Proteins that scalped from the tissues during storage [Min *et al*., 1998 ; El-Shamery, 2001 and Nam and Ahn, 2003]. Also, the decrease in Fat content of the above samples may be due to oxidation and hydrolysis by activity of microorganism, leading to the conversion of part of lipids into aldehydes, ketenes and other non fatty substances. [Anon, 2000; Jenniber *et al*., 2002 and Lee *et al*., 2004]. Meanwhile, the decrease in Bound water (B.W) of the above samples was attributed to protein denaturalization [El-Shourbagy *et al* ., 2003 and Youssef *et al*., 2007]. Moreover, the decrease of pH value in the above meats could be due to the formation of lactic acid and break down of glycogen. [Gray *et al.,* 1996 ; Bassiouny *et al*., 2002 and Aycicek *et al*., 2004]. In addition, it is clear from table (1) that the Total calorie [Energy value (E.N)], Carbohydrate (C.B), Water holding capacity (W.H.C), Total volatile nitrogen (T.V.N),Tri methyl amine (T.M.A), Ammonia nitrogen content (A.N) and Thiobarbituric-acid value (T.B.A) changes increased during storage at room temperature with the increase of storage time. The changes in the beginning [on the first day of storage] were 142.29%, 1.965%, 1.96%, 62.50%, 7.50%, 25.0% and 0.014% mg/100g samples of rabbit meat respectively, and increased through storage to reach at the end of storage to 144.727%, 2.384%, 2.20%, 171.20 %, 19.500%, 63.600% and 0.021% mg/100g samples after four days of storage for rabbit meat respectively. Such results were in agreement with Yilmaz *et al*., 2002 and El-Shamery, 2007 . In other words, the increase can be shown in these percentages : 1.71% for Total calories [Energy value(E.N)], 21.33% for Carbohydrate content, 12.24% for Water holding capacity, 174.40% for Total volatile nitrogen, 163.09% for Tri-methyl amine, 155.05% for Ammonia nitrogen content and 50.00% for Thiobarbituric acid of the previous samples, compared with the control samples. This increase of Energy may be due to an increase in Carbohydrate content and evaporation of water from the meat. (Xiong, 1997; El-Feky, 2002 and Redmond *et al.,* 2004). Also that increase in Carbohydrate during storage at room temperature may be due to the natural feeding which resulted to an increase of glycogen in muscle;s or it may be due to evaporation of water from the outer surface of meat. These results agree with (Zayas, 1997 ; Ali, 2004 and Gamal El-Deen, 2007). Moreover, the results of the increase in the Total volatile nitrogen (T.V.N) as an index of the degree putrefaction, decomposition and the degree of proteolysis break down as well as protein autolysis hand autolysis and breakable decomposition resulted in the high level of Total volatile nitrogen (T.V.N) These results were in line with El-Shamery, 2001 and Aycicek *et al*., 2004. Meanwhile, increasing of Tri methyl amine (T.M.A) in the above samples could be due to the breakdown of amino acids, phospholipids as lecithin and (T.M.A). These results agree with Affi and El-Nashaby, 2001 and El-Shamery, 2007 . The increase in Ammonia nitrogen (A.N) may be due to break down of proteins through proteolysis and decomposition by higher rate of microorganism as reported by Shady, 1999 ; El-Shamery, 2001; Lee *et al*., 2004 and Gamal El-Deen , 2007.

Table (1): Effect of storage at room-temperature on chemical composition and physical properties of local fresh rabbit meats

Compound		M.O %	P.R%	FAT %	ASH %	C.B %	E.N%	pH	W.H.C Cm^2 %	B.W%	T.V.N %	T.M.A %	A.N%	T.B.A %
Samples	Storage in days	W.W	D.W	D.W	D.W	D.W	W.W	Value	W.W	W.W	W.W	W.W	W.W	W.W
Control	0.0	72.00	71.251	22.85	3.928	1.964	142.284	6.08	1.96	92.379	62.399	7.412	24.932	0.014
Rabbit meat	1	72.00	71.250	22.85	3.928	1.965	142.290	6.08	1.96	92.377	62.500	7.5000	25.000	0.014
	2	71.85	71.100	22.73	3.907	2.263	142.905	6.05	2.01	90.285	87.033	12.433	34.813	0.016
	3	71.61	71.000	22.71	3.909	2.381	143.948	6.06	2.12	89.794	123.22	17.259	54.313	0.019
	4	71.41	70.999	22.70	3.917	2.384	144.727	6.00	2.20	89.491	171.20	19.500	63.600	0.021

W.W = Wet Weight basis %
D.W = Dry Weight basis%
M.O = Moisture Content %
P.R = Protein conten %
C.B = **Carbohydrate content %**
E.N = Energy value % cal /100g
W.H.C = Water holding capacity (cm^2)
B.W = Bound water %
T.V.N = Total volatile nitrogen content mg/100g
T.M.A = Trim ethyl amine content mg/100g
A.N = Ammonia nitrogen content mg/100g
T.B.A = Thiobarbituric acid value mg/100g

B- Microbiological quality of local fresh rabbit meat during storage at room temperature

The quality of fresh rabbit meat largely depends on its microbial contamination during sliding, hanging, handling, marketing and on storage temperature as reported (Affi and El-Nashaby, 2001 and Gamal El-Deen, 2007). The results in table (2) showed the effect of storage at room temperature on total differential counts of aerobic (A.B), Anaerobic (A.N.B), Spore formers bacteria (S.P.O),Yeast and Moulds (Y.M), Enterobacteriaceace (E.N.T), Coli form groups (C.O.L), *Salmonella* spp (S.A.L), *Staphylococcus spp* (S.T.P), *Streptococcus* spp (S.T.R), *Clostridium* spp (C.L.O), *Bacillus* spp (B.A.C), *Enterococcus* spp (E.N.S) and Proteolytic bacteria (P.R.O) as (colony forming unit per gram c.f.u/g) of fresh rabbit meat. The data in table [2] show that the initial organism counts of control samples [at zero time of storage] were $1.1x10^2$, $4.4x10^1$, $2.5x10^1$, $1.3x10^1$, $1.4x10^1$, 3.0, 2.5, $1.3x10^1$, $2.8x10^1$, 5.3, $1.1x10^1$, 3.4 and $1.2x10^1$ c.f.u/g for rabbit meat samples of above microbes respectively. This value is within the range of values of fresh rabbit meat as reported by Microbiological Criteria for Arabia and Egyptian Standard Food and by Lee *et al*., 2004 and El-Shamery, 2007. The same data in [table 2] also indicate that the differential microbial counts increased gradually during storage with the increase of storage time on the first day of storage: $1.3x10^4$, $1.1x10^2$, $4.5x10^1$, $3.5x10^1$, $2.9x10^1$, 3.5, 2.6, $1.8x10^1$, $5.4x10^1$, 6.1, $2.2x10^1$, 5.7 and $2.5x10^1$ c.f.u/g and reached to $9.5x10^7$, $1.2x10^4$, $9.9x10^2$, $9.9x10^1$, $1.0x10^3$, 4.5, 4.0, $2.7x10^2$, $2.2x10^3$, 9.4, $7.1x10^1$, 8.9 and $1.1x10^3$ c.f.u/g after four days of storage on rabbit meat samples of above microbes respectively. However, the samples were rejected after four days of storage and at this

stage, all the other counts of microbial examination were closed. This rejection of samples depended upon the total aerobic bacteria counts reached [$\geq 10^7$] cells /g and appearance of putrid smell also by the border line of fresh rabbit meat. This is acceptable as reported by Microbiological Criteria for Arabia and Egyptian Standard Food and by Gillespie *et al*., 2000; Jackson *et al*., 2001; Eleftheriadou *et al*., 2002; Ali, 2004 and El-Shamery, 2007. In other words, the increase can be shown in these percentages: 66.10%, 47.92%, 40.10%, 29.43%, 46.50%, 27.69%, 35.00%, 38.48%, 43.77%, 25.77%, 28.42%, 43.61% and 48.76% of Aerobic (A.B), Anaerobic (A.N.B), Spore formers bacteria (S.P.O),Yeast and Moulds (Y.M), Enterobacteriaceae (E.N.T),Coli fom-groups bacteria (C.O.L), *Salmonella* spp (S.A.L), *Staphylococcu*s spp (S.T.P), *Streptococcus* spp (S.T.R), *Clostridium* spp (C.L.O), *Bacillus* spp (B.A.C), *Enterococcus* spp (E.N.S) and Proteolytic bacteria (P.R.O) respectively. This increase in the total bacterial counts during storage at room temperature was expected as the fresh rabbit meat is considered to be the most perishable food that is highly susceptible to microbial invasion and to direct and indirect effects of higher temperature of storage on microorganism, (Davis *et al*., 1996 ; Bennett, 2001 ; Fang *et al*., 2003 ; Aycicek *et al*., 2004 ; Lee *et al*., 2004 and Gamal El-Deen, 2007). In addition, from table (2) the Total aerobic bacterial counts (A.B) were higher than anther bacterial counts on control samples. Also the *Salmonella* spp (S.A.L), Coli form groups (C.O.L), *Clostridium* spp (C.L.O) and *Enterococcus* spp (E.N.S) counts were lower levels of counts compared with other counts on the control samples or all the anther samples during storage extended. The Total aerobic bacterial counts (A.B) and the Proteolytic bacteria counts (P.R.O) counts were higher than anther bacterial counts during storage compared with other counts on all the samples, these results agree with[Satin, 2002; Gamal El-Deen, 2007 and El-Shamery, 2007].

C-Isolation and identification of Bacillus species from local fresh rabbit meat.

Table (3), indicated that nineteen bacterial isolates which are divided into Eight groups; all of these groups are subjected to extensive toxicity studies and classified into different eight species. These groups are: Group one was *Bacillus subtilus* , two species (10.526%) of total isolated. Group two was *Bacillus pumilus* their number of isolate were three species by percentage (15.789%). Group three was *Bacillus cireulans* by percentage (5.263%) of total isolated. Group four was three species of *Bacillus megaterium* by (15.789%). Group five obtained one species of *Bacillus lentus* , (5.263%) of totale isolated. Group six was four species of *Bacillus phaerieus* , by percentage (21.052%) of total isolated. Group seven was two species of *Bacillus macerans* obtained by percentage (10.526%) of total isolated. Group eight was three species of *Bacillus cereus* and isolated by (15.789%) of total isolated.

Table (2): Effect of storage at room- temperature on microbiological properties of local fresh rabbit meats

Microbes		A .B	A.N.B	S.P.O	Y.M	E.N.T	C.O.L	S.A.L	S.T.P	S.T.R	C.L.O	B.A.C	E.N.S	P.R.O
Samples	Storage in days	Count/g	Count/g	Count/g	Count/g	Count/g	Conu/g	Coun/g	Count/g	Count/g	Coun/g	Count/g	Coun/g	Count/g
Control	0.0	**$1.1x10^2$**	**$4.4x10^1$**	**$2.5x10^1$**	**$1.3x10^1$**	**$1.4 x10^1$**	**3.0**	**2.5**	**$1.3x10^1$**	**$2.8x10^1$**	**5.3**	**$1.1x10^1$**	**3.4**	**$1.2x10^1$**
Rabbit meat	1	$1.3x10^4$	$1.1x10^2$	$4.5x10^1$	$3.5x10^1$	$2.9x10^1$	3.5	2.6	$1.8x10^1$	$5.4x10^1$	6.1	$2.2x10^1$	5.7	$2.5x10^1$
	2	$2.6x10^5$	$5.1x10^2$	$7.3x10^1$	$6.6x10^1$	$9.8x10^1$	4.1	3.2	$2.9x10^1$	$9.2x10^1$	7.2	$3.6x10^1$	8.8	$8.2x10^1$
	3	$1.5x10^6$	$1.5x10^3$	$9.0x10^1$	$9.8x10^1$	$1.5x10^2$	4.2	3.9	$6.6x10^1$	$1.1x10^2$	8.8	$5.5x10^1$	8.9	$2.4x10^2$
	4	$9.5x10^7$	$1.2x10^4$	$9.9x10^2$	$9.9x10^1$	$1.0x10^3$	4.5	4.0	$2.7x10^2$	$2.2x10^3$	9.4	$7.1x10^1$	8.9	$1.1x10^3$

A.B = Aerobic Bacteria
A.N.B = Anaerobic Bacteria
S.P.O = Spore former Bacteria
Y.M = Yeast and Moulds
E.N.T = Enterobacteriaceace Bacteria
C.O.L = Coli form group Bacteria
S.A.L = *Salmonella* spp Bacteria
S.T.P = *Staphylococcus* spp Bacteria
S.T.R = *Streptococcus* spp Bacteria
C.L.O = *Clostridium* spp Bacteria
B.A.C = ***Bacillus* spp Bacteria**
E.N.S = *Enterococcus* spp Bacteria
P.R.O = Proteolytic Bacteria

Table (3): Numbers of groups , groups of identification, numbers of isolates, percent distribution, physiological and biochemical characteristics of the Bacillus species isolated from rabbit meat samples.

Number of groups	*Bacillus.* spp identification	No .of isolates	Percent distribution of (total isolates)	physiological and biochemical characteristics																	
				Roade -shape	Gram stain	Endospore formation	Anaerobic growth	V.P.test	Acid from D-glucose	Acid from L-arabinose	Acid from D-xylose	Acid from D-mannitol	Hydrolysis of casein	Hydrolysis of gelatin	Hydrolysis of starch	Utilization of citrate	Reduction of nitrate to nitrite	Formation of indole	Reduction of lecithinase	Growth at PH 6.8 (NB)	owth at PH 5.7(pH)
G1	Bacillus subtilus	2	10.526	+	+	+	–	+	+	+	+	+	+	+	+	+	+	–	–	+	+
G2	B. pumilus	3	15.789	+	+	+	–	+	+	+	+	+	+	+	–	+	–	–	–	+	+
G3	B. cireulans	1	5.263	+	+	+	–	–	+	–	–	–	+	+	–	+	–	–	–	+	–
G4	B. megaterium`	3	15.789	+	+	+	–	–	+	–	–	–	+	+	–	+	–	–	–	+	–
G5	B. lentus	1	5.263	+	+	+	–	–	+	+	+	+	–	+	–	–	+	–	–	+	–
G6	B. sphaerieus	4	21.052	+	+	+	–	–	–	–	–	–	+	–	–	–	–	–	–	+	–
G7	B. macerans	2	10.526	+	+	+	+	–	+	+	+	+	–	+	+	–	+	–	–	+	+
G8	B. cereus	3	15.789	+	+	+	+	+	+	–	–	–	+	+	+	+	+	–	+	+	+
Total .No of *Bacillus* spp		**19**	**100%**																		

(+) = Presente **(-)** = Absent **(*B.*)=** *Bacillus*

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دراسات عن الجودة الميكروبيولوجية والطبيعية والكيمائية للحوم الارانب اليمنيه الطازجه خلال التخزين فى مدينة تعز

جمال الدين محمد رسام الشميرى

قسم الميكروبيولوجى- كلية العلوم– جامعة تعز- تعز- الجمهورية اليمنية
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ملخص

تهد ف هذه الدراسة لمعرفة الجودة ومدى التلوث الميكروبى والطبيعى والكيـمائى للحوم الارانب اليمنية الطازجة والتي جمعت عيناتها من السوق المحلى لمدينة تعـز(الجمهورية اليمنية) ثم اجريت لها الاختبارات عند نقطـة الصفر وكل يوم خلال فترة التخزين ، وقد دلت النتائج على تدهور الجـودة الكيمائية و الطبيعية والميكروبية للحوم الارانب المخزنـة في الجو العادي مقارنـة بعينا ت الكنترول مما اد ى الى فسادها بعد اربعة ايام وكانت النتائج كالاتي:-

(1)- نقصان المركبات الكيمائية الغذائية بالنسب الاتية : 0.352% للبروتين و 0.65% للدهون و 0.81% للماء مع زيادة المركبات الكربوهيدراتيـة بنسبة 21.33% مع ثبا ت الرمـاد.

(2)- زيادة المركبات الطبيعية ا لدالة على الفساد بالنسب الاتيـة : 1.71% لقيم الطاقة و12.24 % لقيم السعة المائية و 174.48% لقيم الفولـتايل نتروجين الكلى و 163.09% لقيم التراى ميثايل امين و 155.05% لقيم الامونيا نتروجين و 50.00% لقيم الثايوبارابيوتريك اسيد مع نقصان لقيم الحموضة بنسبة 1.315% ولقـيم ارتباط الماء بنسبة 3.126% مقارنة بالكنترول.

(3)- زيادة الحمولة الميكروبيولوجية بالنسب الاتية: 66.10% للأعداد البكتيريا الكلية الهوائية الكلية و47.92% للأعداد البكتيريـا اللاهوائيـة و 40.10 % للأعداد المتجرثمـة و29.43% للفطريـات والخمـائر و 46.50 % لعائلـة البكتيريـا المعويـه الداخليـه و 27.69% لمجموعـة القولـون و 35.00% لاجنـاس السـالمونيلا و 38.48% لاجنـا س الاستافيلوكـس و 43.77% لاجناس الستربتوكوكاس و25.77% لاجنا س الكلوستريد يم و 28.42% لاجنا س البا سلس و 43.61% لاجناس الاننتروكوكاس و 48.76% للبكتريات المحللة للبروتين .

(4)- تم عزل وتصنيف ثمانية ميكروبات صنفت تبعا لاجنا س باسلس من كافة العينات ا لمختبرة وهم كالاتي : *Bacillus subtilus, B. pumilus, B. cireulans, B. megaterium, B. lentus, B. sphaerieus, B. macerans and B. cereus.*

وكانت نسب تواجدهم مقارنة بعدد عزلاتهم من العينات حسب الترتيب السابق كالاتى :

10.52%, 15.78%, 05.26%, 15.78%, 05.26%, 21.05%, 10.52% and 15.78%.

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Histology of the Hindgut of Solitary Locusta (Orthoptera: Acrididae)

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ABSTRACT

Hindgut of Solitary has been into its three regions: ileum, colon, and rectum, and each region was studied morphologically, histologically and functionally. Ileal structure has been investigated throughout its length from pyloric valve (the border between the midgut and the hindgut) to its end ,which marks the border between the ileum and the colon. The 6 layers apical wall of circular muscles were fully described with the longitudinal muscles. The 12 inner ileal epithelial folds consist of columnar cells with microvilli, which suggest that the ileum is involved with nutrition absorption. The 12 ileal folds are close to the inner wall of the proximal circular muscles, but in another locust are projecting inward the lumen centre. But in both structures the subintimal space is clear. The 12 ileal folds become reduced to the smallest in size and less in count. Their reduction continues to the lowest size till they become traces at the end of the ileum. The colon structure shows that the diameter becomes small and the tissue between the layer circular muscles and the 4 thick folds of the colon. The area between the circulat muscles and the inner columnar cells is full of thick longitudinal muscles. The rectal structure shows the 6 large rectal papillae and small rectal pads which grow to replace the rectal papillae. Rectal papillae are involved with mineral and water re-absorption. At the middle rectal area structure shows 6 areas occupied by rectal pads and 6 reduced between rectal areas, which have columnar epithelial cells. Their function is to facilitate the faeces evacuation by their contraction and expanding as they do as articulation. Rectal pads show different type of cells such principal cells, basic cells and junctional cells. Also intrapapillar lumen, tracheae, and also the circular and longitudinal muscles are very clear .

INTRODUCTION

The digestive system of insects is divided into foregut, midgut, and hindgut, which extended from the bucal cavity to the anal opening. The foregut is also divided into its four sub-regins, the Pharynx, Oesophagus, Crop and proventriculus, each of which is usually differentiated into two sub-regions (e.g. antenirar pharyrx and antenirar pharyrx anterior oesophagus and

posterior oesophasas, antenirar crop and posterior crop, anterior proventriculus and posterior proventriculus,) and that was according to their different histological structure. The foregut and the hindgut are lined with ectodermal cuticle, whereas the midget is of endodermal origin. The hindgut is generally divided into the pyloric valve, ileum, colon, and rectum (Caetano F.H. (1984, 1988).; Cane , J.F. (1987).; Chapman,R.F. (1998). Cruz-Landim, C.(1985 ,1996); Martins, G. F. Neves, C.A., Campos, L.A.O. Serrao, J.E. (2006); Melo, M.L.S., Vidal, B.C.(1978),; Snodgrass, R.E. (1956) the pyloric valve and malpighian tubules mark the border between the midgut and the hindgut. The malpighian tubules usually arise from this exact circle. Dispite that the Solitary locusta is amongst the insect that have symbionts in their hindgut, in which the ileum is expanded to accommodate them, such as Solitary locust, which ileum approximately $^1/_9$ (one nineth of the whole gut) , and the microorganisms of different bacteria had been found 32384091 per one hindgut of schistocerca gregaria (Hunt, J. and Charnley, A. K. 1982). In present studies the ileum is nearly one ninth of the whole gut. In bees the ileum is a long tube shows no clear anatomical specialization at anywhere throughout its length Santose et al, (2006) . In termites and scarabas beetles the ileal cuticle lining chambers is formed into elongated denticles serving as attachment to the microosganisms. The same finding is present in the cockroaches and crickets ileal cuticle. In Solitary locusta the ileum consist of 4 - 5 layers of circular musclese in some cases six layers are present. Also, the ileal twelve folds cosist of one layer of columnar or cuboidal cells in their shape. The epithelium is distinct sub-epithelial space, which is large at the base of the ileal epithelial folds, they are forming connective tissue and may be that is because of the ileum is involved in water and salts absorption and regulations, when salts and water intered into the ileum from malpighian tubules Figs. C and D and in some sections the arrangement of ileal folds vary from one to another, but in general they consist of the same structure. The Colon is becoming narrower in diameter than the ileum and the folds are reduced to less than half that arise in the ileum i.e. there are 4 large and a long folding projecting inward the lumen center and the connective tissue occupied a wide area. The colon is the posterior part of the ileum, so if it appears different in its histological structure then it can be called colon, but if it resembles the ileum in histological structure, then the inner epithelial folds count less than six i.e. there are four thicker folds due to the connective tissue which occupied large areas and these folds are full of longitudional muscles. The space between these folds reduces to nearly a half of the ileal area. The epithetium still has the same cuboidal or columnar cells. The columnar cells are less (140) in comparison to that existent in the epithelin of the ileum (648), that is 13.5 times. Longitudinal muscles count in great numbers and are large in comparison to longitudinal muscles present in ileum.

MATERIALS AND METHODS

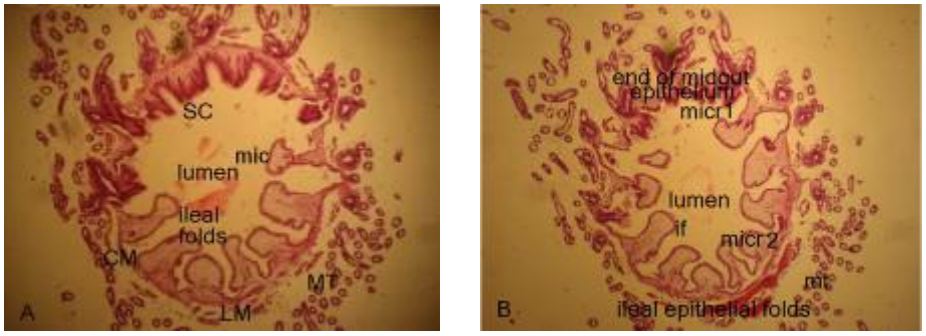
Males and females Solitary locust were collected from the garden of the Sana'a University which is full of green grasses and Pelargonium (the habitat in which the Solitary locusts exist) and from different areas of Sana'a province. Animals were placed in special cages for 48 hrs with the same food and animals for the experiment. Locusts were killed by breaking the cervical membrane at the back of the Pronotum, which severs the ventral never cord. The whole guts (Foregut, midgut, and hindgut) were removed and fixed in Harry Houdine fluid saturated $HgCl_2$, absolute alcohol 2: v/ v for 24 hrs. Sections were made at 5um on a rotary microtom (Swift optical instruments, Trowbridge) and transferred to glass

slides. For histological investigation, prepared tissues were dehydrated in series of ethanol, embedded in parafin wax. (MP 56 C) by the propan–2–o1/toluene method of Humanson (1972). Sections on the slides were stained with gram Twort procedure Ollett with DPX mountaint (B.D.H. chemicals). Pyloric valve and malpighian tubules determine the border between the midgut and hindgut. The hindguts consist of the ileum, colon and the rectum. Each has its own histological structures.

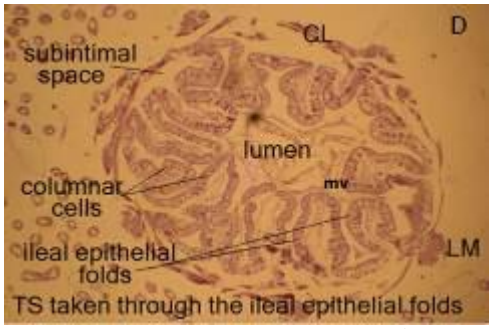
RESULTS

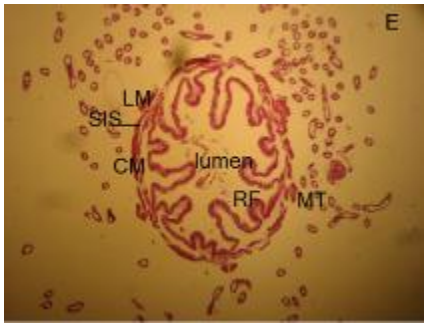
Hindgut is in general differentiated into pyloric valve, ileum, colon, and rectum. The ileum of an insect is corresponded to the tube running back from the midgut to the colon. The ileal inner wall throughout its length is lined by cuticular intima. Epithelium consists of twelve folds, which project to the lumen center. Structure in the present study was similar to those species which had been found by (Phillips I, II, and III), and Santose et al (2006), with variation in epithelial cells shape location of nuclei, and in thickness of cuticle lining. Transverse sections show that there are 3 –6 layers of circular muscles each consists of several fibers.

The twelve epithelium folds consist of one layer of columnar cells. The epithelium districts sub-epithelial spaces, which is wide at the back of some epithetial folds, it is may be because the ileum is involved in water absorption and salts regulation, when water and salts inter the ileum from malpighian tubules or may be to form an area to allow the entrance of tracheae figs. A, B, C, & D. The ileal epithelial cells have cuboidal to columnar shape and are lined with apical plasma membrance throughout its inner folds. Nuclei of the ileal epithelial cells are located at the basal side of the cell.

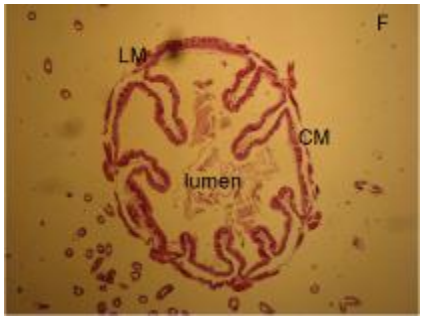


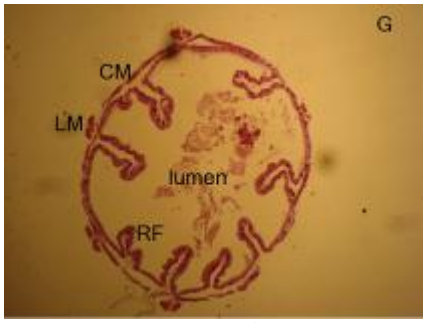
Both pictures A and B are taken through the border of the midgut of Solitary locust at the pyloric valve. Note the remain secretory cells of the midgut epithelium SC at the top of the above picture. Observe the7 ileal epithelial folds with the microvilli micr ,which are heavily red stained micr 1; note also the count of ileal folds at the above picture are 7folds and at the below picture are 9 folds.Circular muscles CM; longitudinal muscles LM; malpigighian tubules MT; A & B 40 x



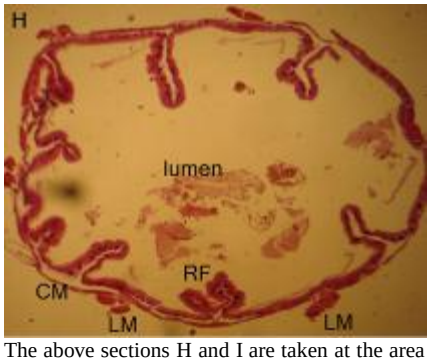


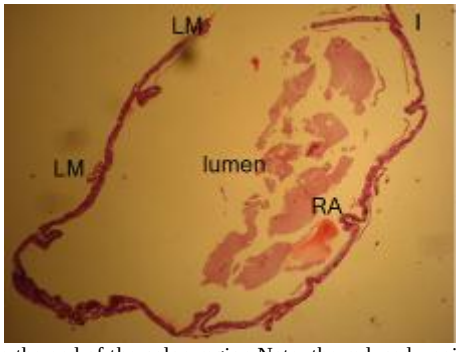
The above pictures D & E are the third and fourth sections taken in the ileum as a series, which show that the sections were taken completely at the whole ileum.Note the 12 ileal epithelial folds with microvilli. Observe the circular muscles CM; longitudinal muscles LM; malpighian tubules MT; and subintimal space. The below picture is a sectin taken further townward the colon.Note that nearly half of the ileal folds are becoming reuced in size RF.Observe the subintimal space SIS is also reduced to the smallest area. The section is taken through the ileal at the area,which show the small reduced folds, which will continue reducing in size up to yhe luist size(see below) ,figs F and on. D=x 400 ; E =x 40





The above picture F and G taken at the middle area of the ileum, show that the ileal folds reduced to the smallest in size and less in count. Note the circular muscles CM;longitudinal muscles LM; and the subintimal space.The below picture taken further downward to the colon area.Observe that the lumen becomes wider with thin circular muscles. Both pictures F & G 40 x



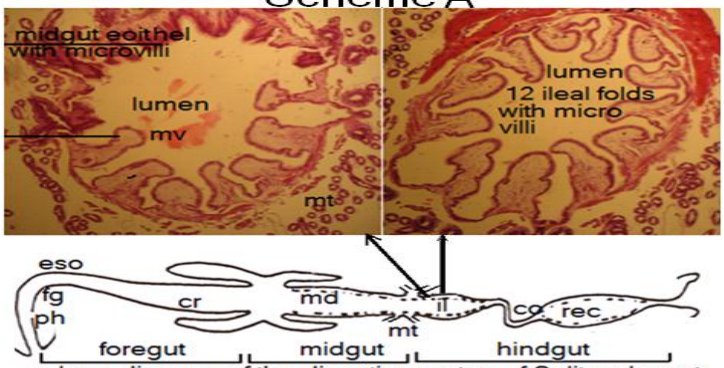


The above sections H and I are taken at the area before the end of the colon region.Note the reduced epithelial folds in size and count ,circular muscles CM; longitudinal muscles LM; and the wide lumen.The below picture the ileal folds are only traces that was compensated by the wide size of the lumen. Both G & I 40 x

Figs. A - I : a series of sections taken through different parts of the ileal epithelium. Note the reduction of the ileal folds as they become less in count and smaller in size untilthe folds traces seen very small. Notice the microvilli , columnar cells of the 12 ileal folds, circular muscles, longitudinal muscles. Note section A, which just is the end of the midgut and the beginning of the of the ileal epithelium, and section E, has small ileal folds. Section F, which has less folds: note also the section G has been taken at the end of the ileum; note the traces of the ileal folds. Sections H & I magnified folds show the columnar epithelial cells .Sections B, C , D, E & F have very clear microvilli. Figs. No. A , B , C , D

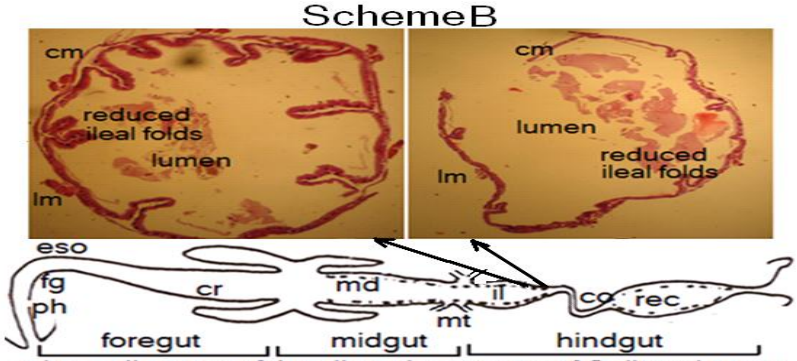
Scheme A shows the anterior part of the ileum and the arrows show the exact areas, at which the sections were taken. And scheme B shows the posterior part of the ileum and the arrows show the exact area, at which sections were taken.

Scheme A



a long diagram of the digestive systemof Solitary locust
Note the gut divisions: foregut fg □ pharynx ph □
oesophagus eso □ crop cr □ anterior caecae ac □
posterior pc □ midgut md malpighian tubules mt □
ileum il colon co rectum rec

SchemeB



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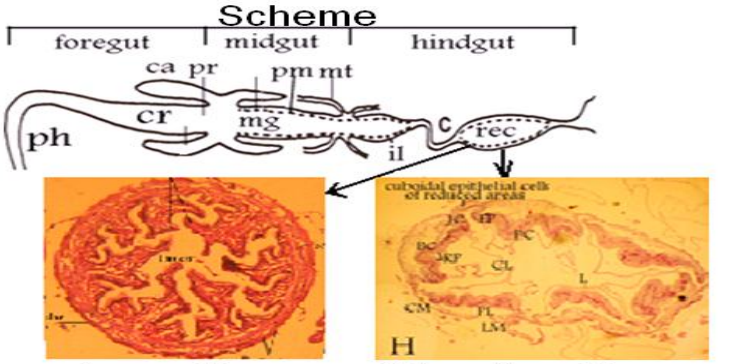
posterior pc □ midgut md □malpighian tubules mt □
ileum il □ colon co □ rectum rec

Rectum: Epithelial columnar cells vary in structure as seen, in which the space of the lumen appears to occupy the whole area except that papillar folds are running toward the center of the rectal lumen. They extend nearly to the whole area of the rectum. Fig.3 B shows the presence of six circular muscles, which is in agreement with the investigations on other locust. The cells are columnar in shape. The epithelium between the rectal pads is reduced and heavily darkened as was reported by Phillips I but, in the present study the interconnecting epithelial cells strap is stained as the whole rectum, but not as the areas in which the junction cells are. The whole epitheliual pads and in between structure are completely lined with cuticluar intima, the cuticular intima is attached to the pads, but at the tips of rectal pads they become loosen which is called subintimal space. Peeling the culcular lining off the rectal pads had been reported by Marshal& Hode (1939), Phillips I, II, III at small six rectal pads, which stay closely to the outer layer and if sectioning continue the large branches of six rectal pads were darkly stained.

Scheme C of the alimentary tract with detailed of 2 sections pointing at the exact areas that were taken: the detailed drawing shows the components of the digestive system in the Solitary locusta : Note the pharynx ph ; oesophagus oes ; crop cr ; gastric caecae ca ; proventriculus pr ; midgut mg ; peritrophic membrain pm ; malpighian tubules mt ; ileum il ; colon c ; and rectum rec.



a long diagram of the digestive system of Solitary locusta.Note the gut divisions:fore,mid, and hindguts. the hindgut,conserned in this study is consist of the ileum,colon and rectum

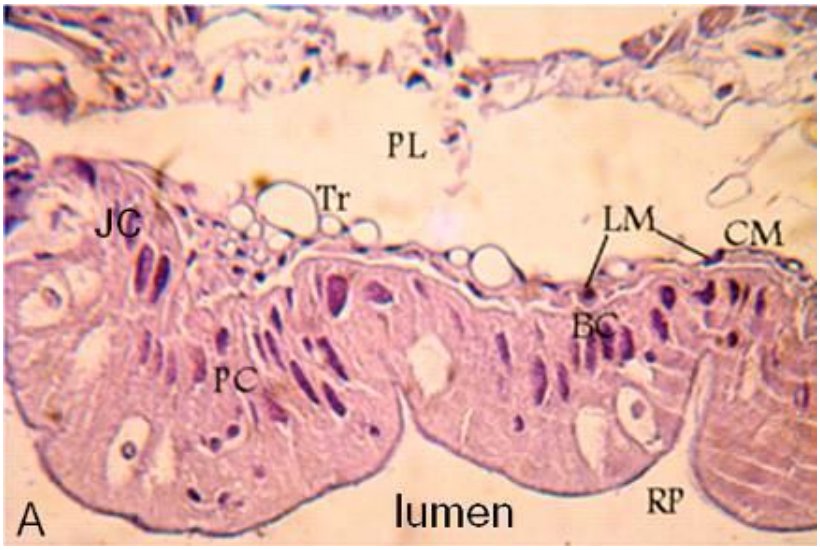


Figure (A): TS taken throught the rectal pads of adult Solitary Locusta. This sectin shows all detailed structure : principal cells BC; junctional cells JC; principal cellsPC; junctional cells JC, with elongated nuclei N and cuticular round nuclei N; intrapapillar lumen PL and lumen; cuticulat lining and folded rectal epithelium EP; circular muscles CM; longitudinal muscles LM, x 400 x

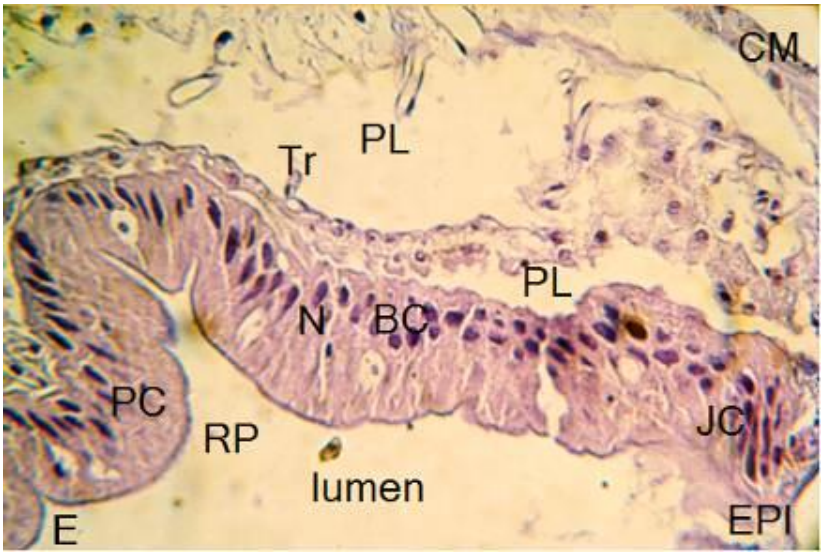


Figure (E): Rectal pads show the intrapapillar lumen PL; Observe the all cells types: principal cells PC; basic cells BC; junctional cells JC; circular muscles CM; and longitudinal muscles LM; tracheae Tr; and folded rectal epithelium EP; round nuclei N; and the lumen. 400 x

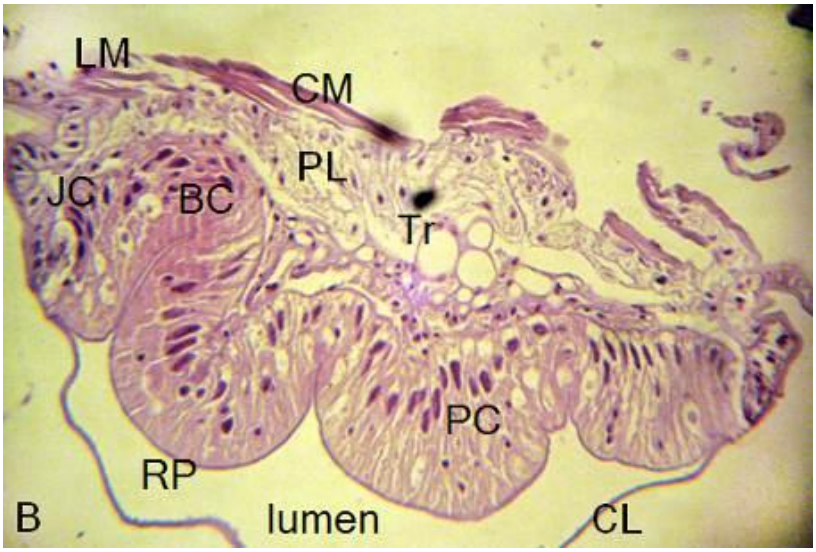


Figure (B): TS taken through one of the rectal pads shows detailed structure of all type of cells, basic cells BC, junctional cells JC principal cells PC. Note the intrapapillar lumen PL, the lumen L, round nuclei RN and tracheae TR. 400 x

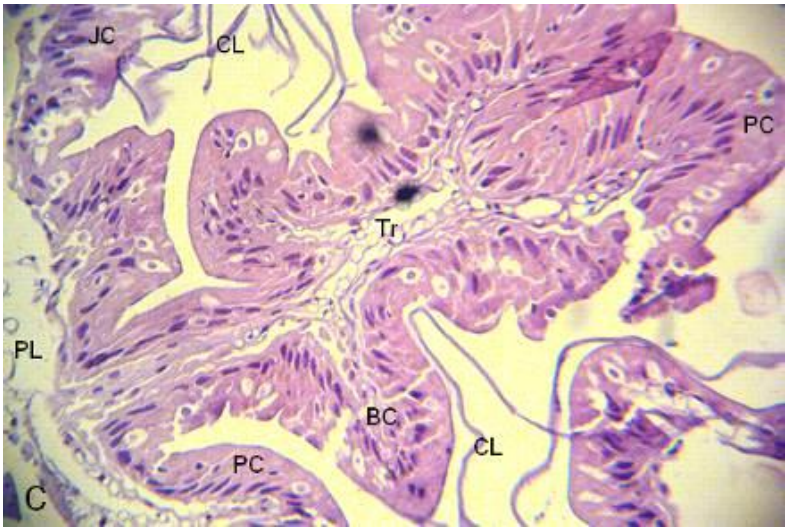


Figure (C): One of the rectal pads with very unusual elongated structure,but despite that the three type of cells still have obvious structures.Note the type cells: principal cells PC; basic cells BC; junctional cells JC; and nuclei N. 400 x

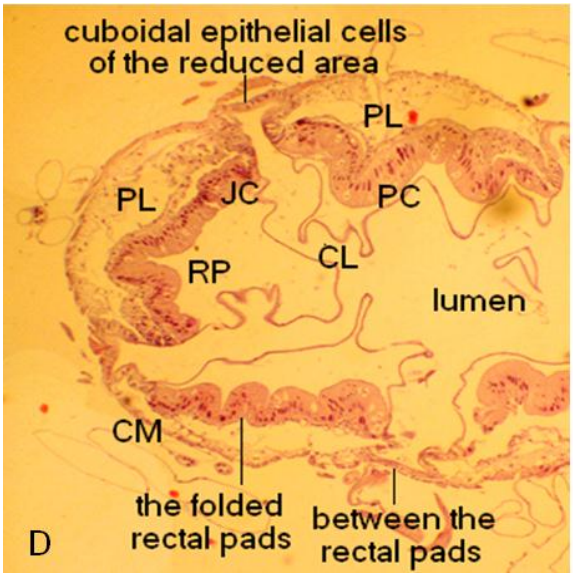
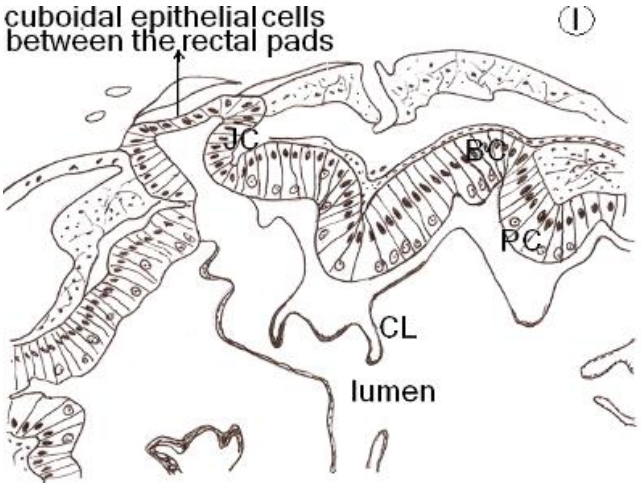


Figure (D): TS taken through the area between the neighbouring two rectal pads shows details of the cuboidal epithelial cells of reduced area joining the six folded rectal pads.These six reduced areas function as articular valves ,strap-like, facilate the feces evacuation by their contraction and expanding the rectal size. Note the intrapaoillar lumen PL; and the lumen L . 250 x



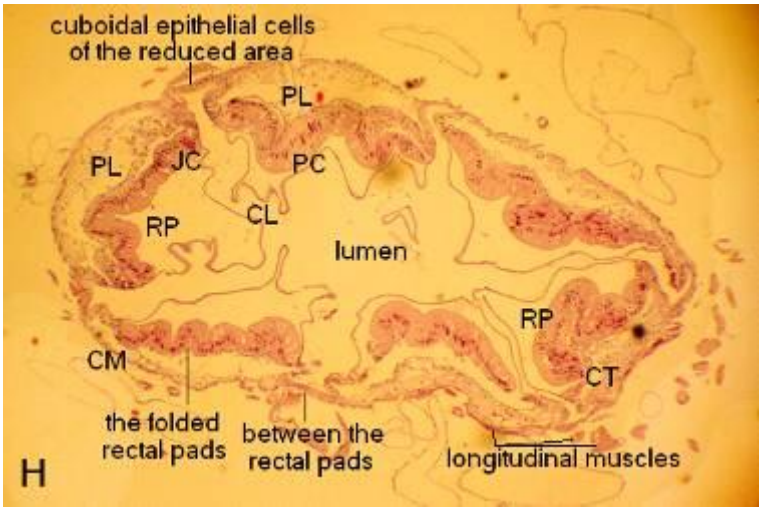
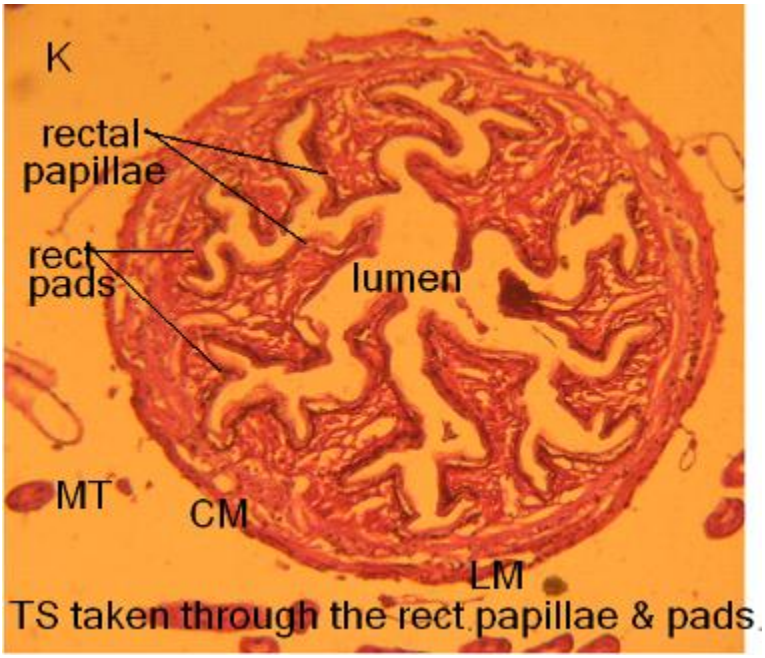


Figure (H): The whole transverse section shows all six rectal Pads .Intrapapillar lumen PL, columnar or cuboidal cells. Note the principal cells PC; basic cells BC; junctional cells JC; connective tissue CT; longitudinal muscles LM; circular muscles CM; cuboidal epitheal cells. The above drawing resembles the same explained in section. 40 x



TS, taken through the rectal papillae, shows the six rectal papillae and between them appear six small rectal pads. 128 x

DISCUSSION

The Ileum:

The presence of six layers of circular muscles in Solitary locust investigated have varied from that in some species such Apoidea, which has only one layer of curcular muscles Santose et al (2006) and in some species of Lepidoptera which has two layers of circular muscles (External circular, and inner longitudinal muscles) Levy, S.M. et al (2004). The hindgut lumen is lined throughout its length) by a cutcular lining (Figs. ileum, rectum). The cuticular lining of the epithelium has not the same thickness throughout its length, it varies from a place to another, as seen in the figures. Cells vary in shape and nuclei. Parts of the section are large, oval and round, and the cells are located basally and midially as seen in the transverse sections, between the rectal pads. The epithelium is considerably reduced and highly pigmented as it was investigated by Phillips 1964. The cuticular lining lines the inner wall of the hindgut and not only the areas between the rectal pads. This chitinous intima is attached to the epithelium, but at the tips of rectal pads seems to be peeled off making a space, which called subintima space. That may be due to rectal pads function, which is in fact re-absorption of water from the food residue and returning it into the insect body, or it may be due to the fecal scratch during its passage and may be due to the elasticity of cuticle and its plasticity. And that is why the cuticular lining seems to be thrown away from the tips of rectal pads. Another interpretation might be that it has different factors acting together or individually to rolling the feces prior to be thrown away. The tracheae filling the epithelial regions between the rectal pads and circular muscles nuclei are heavily stained. The function of the hindgut of an insect is to re-absorb the water and salts of the primary urine carried by the malpighian tubules into the ileal lumen in from NaCl. KCl. Chapman, R.F. (1998). The process happens mainly in the rectum, but it starts in the ileum which is active in water and ions absorption and regulates the balance of acid-base and Nitrogen excretion. Also, the crude urine carried by the malpighian tubules from the hemolymph to the ileum to be transported to the rectum, to be undergo, there to reabsorption the water and salts, which are then returned to the body of insects, Bradley. J. (1985). The same finding was reported by Irvine, et al (1988), in bees, cockroaches, crickets, Locusts, that have microflora in their hindguts, the ileum of these insects becomes larger to accommodate the microflora symbionts, flora. Solitary locusts are amongst insects that have symbiotic bacterial flora in their hindgut, the ileum becomes large to accommodate these bacteria. Cuticle intima lining these chamber place in which floral bacteria live .

Fig. H: Transverse section taken through the whole rectal papillae of the solitary locusts show that the rectal pads consist of different epithelial cell types: epithelial cells, basic cells, and juncitional cells *and the area between the* rectal pads were reduced to a very narrow strap of simple rectal cuboidal epithelial cells up to 1/30 of the actual size of the rectal periphery, which act as an articular junction joining the rectal pads. Epithelia between the rectal pads allow the rectum to evacuate feces by the contracting and expanding the inner rectal area (comparing higher animals this movement is called peristaltic movement).The loose cuticle over the rectal pads was broken under the stress movement of the whole rectum. The reduced areas between the rectal pads are compared with cuboidal epithelial cells figs.1 & 2 above the inner wall of the rectal pads and the area between the rectal pads are lined with culticular lining. The (interconnecting) areas between the rectal

pads are stained light brighter than the other areas of the whole rectum and that was contrary to the observation of Phillips (1964). The lining cuticle between the rectal pads is firmly attached to the epithelium, but over the rectal pads this chitinus intima has been detached and the rectal pads areas underneath are brightly stained than any other parts of the rectum.

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دراسة نسيجية للجراد المستوطن (Orthoptera: Acrididae)

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ملخص

تم تقسيم المعي الخلفي للجراد المستوطن الى المصرع الخلفي واللفائفي ، والقولون والمستقيم . وتمت دراست كل جزء من المعي الخلفي دراسة مورفولوجية ونسيجية ووظيفية من عند انابيب مالبيجي انابيب التي تشكل مع المصرع الخلفي حدود المعي المتوسط مع المعي الخلفي. تحقق من بنية اللفائفي من المصرع الخلفي إلى نهايته، التي تشكل حدوده من القولون. وهناك 6 طبقات للعضلات الدائرية، التي وضحت مع العضلات الطولية، والثنايا 12للنسيج اللفائفي تتكون من الخلايا العمودية مع الخملات ،التي توحي ان اللفائفي مرتبط به عملية امتصاص المواد الغذائية والثنايا اللفائفية ال12 قريبة من الغشاء الداخلي لطبقات العضلات الدائرية، لكن في بعض الجراد تمتد هذه الثنايا كالإصبع نحو مركز المحتوى الغذائي. كما أن خلايا النسيج اللفائفي مختلفة الشكل (مكعبة ، عمودية) ، لنسيج الخلايا العمودية طبقة غشائية جلدية تغطي جدارها الداخلي. مع ذلك تبقى الطبقة تحت النسيجية واضحة.الثنايا ال12 اللفائفية تتقلص عدديا و حجما الى ان تصل الى ما يشبه الاثار في نهاية اللفائفي تظهر بنية القولون اقل قطرا من اللفائفي وتبدو الثنايا ال 4 اكبر سمكا وهي مليئة بالعضلات الطولية .تظهر بنية المستقيم 6 ثنيات كبيرة الحجم و6 ثنايا صغيرة ،التي تكبر بدورها لتعوض الثنايا التي تشيخ وتاول الى الزوال.الثنايا الستقيمية مرتبط بها امتصاص المعادن والمياه من فضلات الغذاء قبل اخراجها كبراز. في المقاطع التالية يتغير شكل الثنايا فتصبح 6 حلمات الحلمات مستقيمية صغيرة ترتبط بأحزمة ذات خلايا نسيجية عمودية وظيفتها تسهيل اخراج الفضلات بتقلصها وتمددها حيث تؤدي هذه الحركة الى اخراج البراز الى الخارج عبر الفتحة الاخراجية(تدعى هذه العملية في الحيوانات الراقية بالتموجي وينحني القولون الى اسفل .

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TUJNAS

Slope Stability Assessment of The Garin Majjed Archeological Village Area, East of Yemen

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ABSTRACT

The stability assessment of sedimentary rock slopes of the area surround Garin Majjed archeological village which lay on cuesta shape hill in Wadi Dawa'an - East of Yemen was carried out. All important factors affecting slope stability in the area such as differential weathering, rainfall and runoff, sewage, discontinuities trends and inclinations, slope face orientation, and mechanical properties of rocks and joints filling materials were evaluated. Direct shear test of joints filling materials showed that the friction angle (Φ) values range between 11˚ and 31˚ and cohesion (C) Values between 0.00 and 0.5 MPa. The compressive strength (cσ) values of the nodular limestone rocks is 66 MPa and for shaley marly sandstone it is 12 MPa. It was found that rock fall is the main mode of failure in the area, while secondary toppling and/ or plane sliding are probable to occur. Some remedial measures are proposed to protect the slopes like erect well seal drainage path, supporting the toe of the dip slope and the overhanging parts, as well as grouting of joints by convenient filling material.

Keywords: Slope Stability, Garin Majjed, Archeological Village, Cuesta shape, Yemen.

1. INTRODUCTION

The study area is located at Wadi Leimen, the western tributary of Wadi Dawa'an which is 600 km to the south – east of Sana'a city; capital of Yemen (Fig.1). Wadi Leimen is U-shape Wadi to mountainous area with hot dry climate. The annual average temperature ranges between 9°- 42°c and the annual precipitation ranges between 50-150 mm/year (Al-kharasane, 2005) with a considerable vegetative cover.

This research aims to evaluate the slope stability of the area surrounding Garin Majjed archeological village which is one of the most important tourist villages (Photo.1) in Wadi Dawa'an (Ben Slman, 2007 and General Tourism Authority, 1999).

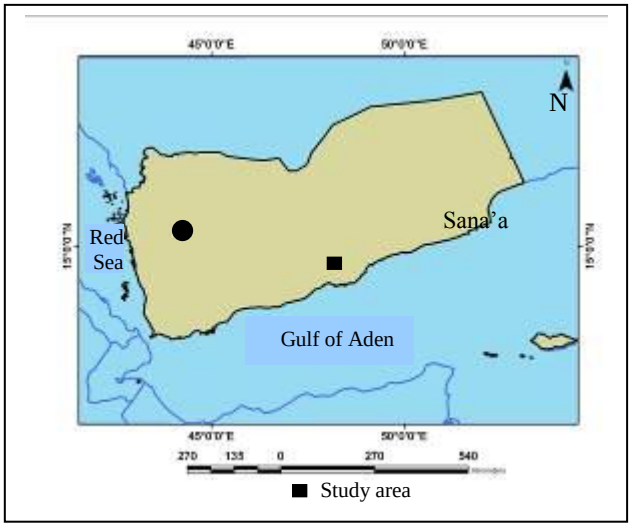

Figure (1): Yemen map showing the location of study area.

Photo (1): Side view of Garin Majjed archeological village. Photo direction south-east

The important factors affecting slope stability in the study area were evaluated. These include differential weathering and erosion, rainfall and runoff, sewage, discontinuities trends and inclinations, slope face orientation, engineering characteristics of rocks and their discontinuities as well as determining the type and direction of failures.

The engineering characteristics of the rock mass and discontinuities were described according to the geological society engineering group working party (Anon, 1972). The relationship between slopes faces and beds attitude are classified according to Al-Saadi's slope classification (AL-Saadi, 1981). The inclination of slope (or dip of strata) is indicated by two numbers, the one to the left (three digits) represents the direction and the one to the right (two digits) represents the dip angle. The symbol (OH) is used for overhanging slopes.

Stereographic projection was carried out to show the relationship between slope faces and discontinuities using Rock Pack III computer program.

The laboratory tests include performing a compressive strength test for 6 samples of nodular limestone and shaley marly sandstone as well as shear box test for 5 samples of discontinuities filling materials to estimate the two shear strength parameters; friction angle (Φ) values and cohesion (C) values. The tests are carried out in the laboratory of the ministry of public works & highway in Sana'a.

2. GEOLOGY OF THE STUDY AREA

The study area is located to the east of the Arabian shield as a part of the Arabian shelf (Beydoun et al., 1998). It is affected by faults and joints which associated with the opening of the Gulf of Aden since Oligo- Miocene. The dominant trends of these geological structures are NW-SE and NE-SW (Fig. 2).

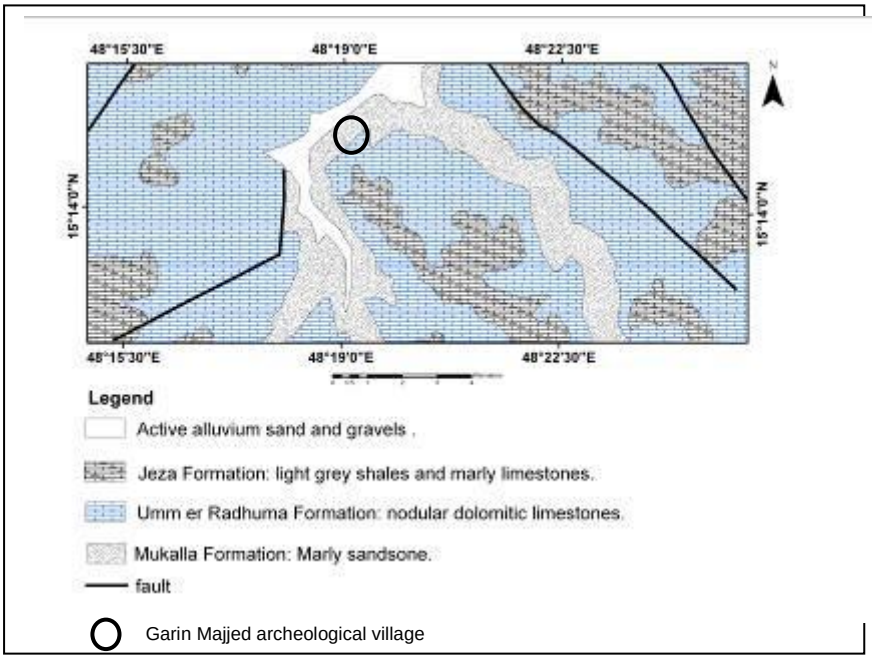

Figure (2): Geological map of study area (Modified after Robertson Group, 1990)

The Garin Majjed archeological village stands above cuesta shape hill with a dip (back) slope of 295°/30°, scarp- overhanging slope (090°/OH) and Southern side slope of 180°/80°-OH° (photo2 & Fig. 3). The average dip of contact between two rock units of the cuesta is 270°/26°. The upper part of the cuesta shape belongs to the Umm er Radhuma Formation (Upper Paleocene) which consists mainly of yellow and grey nodular limestone with some marl while the basal part belongs to Mukalla Formation (Cretaceous) which consists mainly of sandstone with some shale, silt and marl. Jeza formation (Early Eocene)

outcrops to the east, south and west of study area. This formation belongs to Hadramawt Group and consists of a series of yellow and pink papery shales with beds of marl and limestone (Beydoun et al., 1998).

3- ROCK MASS DESCRIPTION AND SLOPE STABILITY ANALYSIS

The Cuesta shape rock mass outcrop in Garin Majjed archeological village area consists of two rock units as mentioned before (Figure 2). In the upper part, a 12 m thick layer is exposed. It is grey, fine grained, very thickly bedded, moderately to very widely spaced joints, slightly weathered, nodular LIMESTONE, strong with uniaxial compressive strength (σc) of 66 MPa. The 5 m thick layer in the lower part of slopes is light yellowish brown, fine to medium grained, very thinly bedded, closely spaced joints, moderately to highly weathered, shaley marly SANDSTONE moderately weak with compressive strength (σc) of 12 MPa.

The limestone layers are cut by two main cracks, one in the attitude of 285°/62° and the other with attitude of 005°/86°. Stereographic projection of these two main cracks is shown on Figure 4D. The horizontal sandstone layers are cut by three sets of joints, S1, S2 and S3. The average dip of S1 joints is 265°/87° and the joints spacing are of >3 m. The persistence is about 2 m on the bedding planes and slope surfaces. The joints are almost close. The average dip of S2 joints is 205°/90° and the spacing ranges between 0.25-0.60 m while the persistence ranges between 0.20-0.40 m on the bedding planes and they are almost close. The average dip of S3 joints is 113°/90° and the spacing ranges between 0.20-0.40 m, their persistence ranges between 0.20-0.70 m on the bedding planes and they are almost close. Stereographic projections of S1, S2 and S3 are shown on Figures 4 A and C.

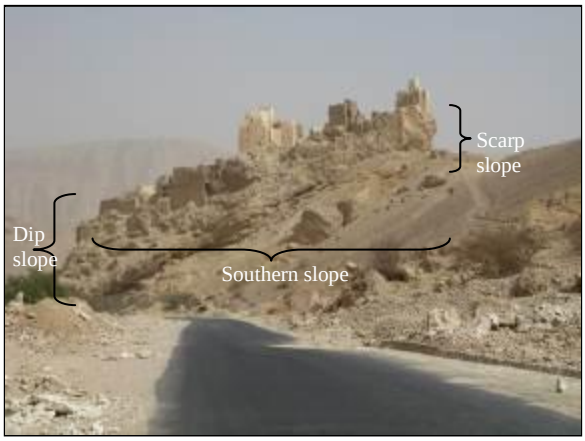

Photo (2): Side view of cuesta shape showing different slopes around the village. Photo direction to the north.

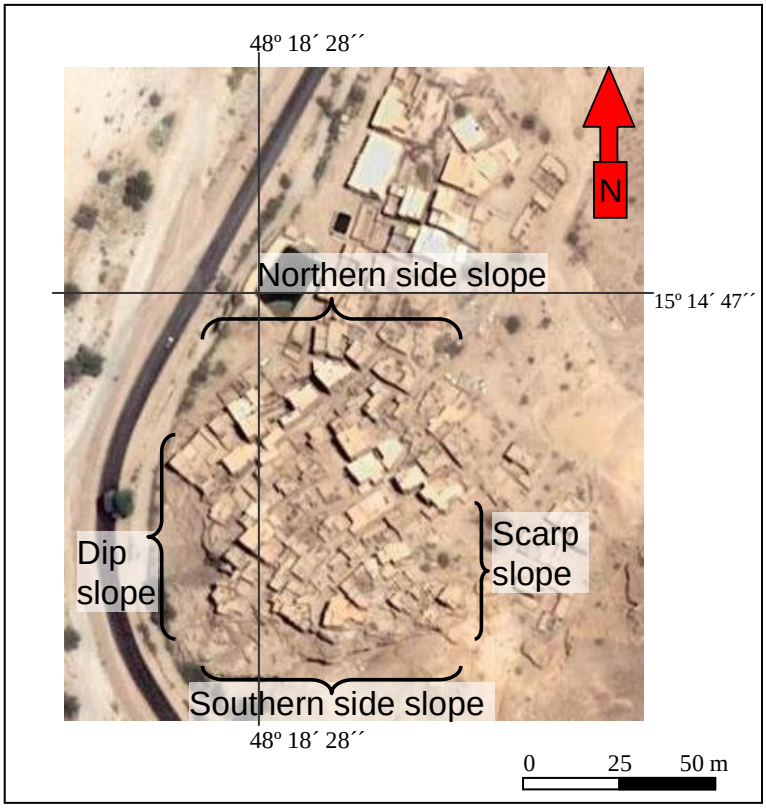

Figure (3): Satellite image showing the areal distribution of slopes in study area, (Google earth).

The areal distribution of slopes in the study area is shown in Figure 3. It can be divided into four main slopes. These are:

(i) Dip (back) slope

The slope is close to the main road as shown on Photo 2. It is 45 m high and 60 m long parallel to its trend. The slope inclination is 295°/30° with average dip of 270°/26° and it is daylighting at right part. According to Al-Saadi's slope classification this slope is parallel slope with 15° divergence angle and left emergent concordance (Fig. 4A & B),

(ii) Scarp slope

This slope is 15 m high and 20 m long parallel to its trend. The slope inclination is 088°/OH° with average dip of 270°/26° (fig. 4D). According to Al-Saadi's slope classification, it is a parallel slope with 02° divergence angle, right emergent and disconcordance.

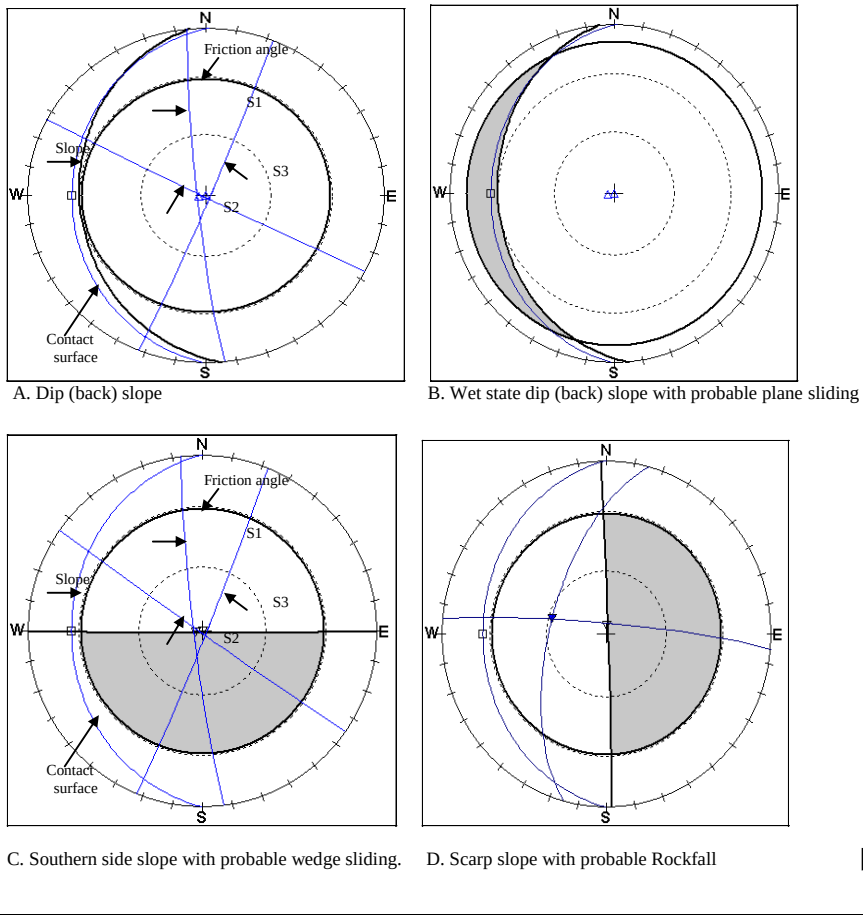

Figure (4): Stereographic projections showing the relationship between slopes (thick great circles), (□)contact surface, (▲) cracks, (△) joints S1, S2 & S3, and area of potential sliding for friction angle of 31° & 11°.

(iii) Southern side slope

The slope is 45 m high and 60 m long parallel to its trend. The slope inclination is 180°/80°-OH°) and the average dip of contact between the two rock units of the cuesta shape is 270°/26° (Fig. 4C). According to Al-Saadi's slope classification, it is orthogonal slope with 90° divergence angle.

(iv) Northern side slope

The slope is 45 m high and 60 m long parallel to its trend. The slope inclination is 360°/23° with average dip of 270°/26°. According to Al-Saadi's slope classification, it is orthogonal slope with (90°) divergence angle (AL-Saadi, 1981).

4- RESULTS AND DISCUSSIONS

The laboratory tests include performing of compressive strength as well as shear box tests. The average compressive strength of fresh to slightly weather nodular limestone (σ_c) is 66 MPa which indicate strong rock. This value decrease rapidly by weathering resulting from seasonal rainfall and runoff as well as from local sewage. For fresh to slightly weather shaley marly sandstone, the average compressive strength is 12 MPa. This value indicates moderately weak strength rock. Evaluation of the two shear strength parameters namely friction angle (Φ) and cohesion (C) for unconsolidated filling materials of discontinuities indicate $\Phi = 31^{\circ}$ and C = 0.22 MPa under 16 % moisture content and $\Phi = 11^{\circ}$ and C = 0.013 MPa. under moisture content of 29%. This mean that the friction angle of unconsolidated materials with more moisture content is smaller than sliding plane (contact surface) inclination which has dip of 26°

The discontinuities dissected the upper back slope as well as the exfoliation weathering of limestone help rainfall and sewage to penetrate inside the rock mass and reach the jointed marly sandstone. This resulting in disturb slope stability of the area. The scarp slope and southern side slope are strongly affected by this action; therefore, rockfall failure is dominant. Stereographic projection indicates wedge sliding along southern side slope but due to moderately wide spaceof joints, the rockfall occurs instead of wedge sliding for small rock fragments.

The northern side slop is rather stable. Although the dip (back) slope is stable at present, it may reach a critical state of secondary toppling (Hoek, E. & Bray, J.W., 1981) or plane sliding in the future if toe cutting by rabid differential weathering resulting from surface sewage and seasonal rainfall and runoff continue.

Because this village is one of the most important tourist villages in Wadi Dawa'an, and due to its heritage value, it is necessary to take some construction measures to treat the instability problem of the dip (back) slope, southern side slope and scarp slope. The following treatment may achieve:

1- Removing the unstable blocks which are liable to fall in the scarp slope.
2- Erecting well seal drainage conduit.
3- Supporting the toe of the dip (back) slope and the overhanging part of the southern side slope by retaining wall.
4- Grouting of discontinuities by convenient filling material like cement in order to increase the cohesion of the different parts of the rock mass and to prevent water infiltration to the lower part of the slope.

5- CONCLUSIONS

1- Weathering is the dominant cause of failure in the study area and most of discontinuities help to separate the rock blocks out of the slope.
2- The northern side slop is rather stable.
3- Rockfall is the main mode of failure that occurs in scarp and southern side slopes.
4- Sliding and/ or toppling are the probable mode of failure in dip (back) slope.
5- The treatment must be applied with well aspect.

6- ACKNOWLEDGEMENT

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تقييم استقرارية المنحدرات الصخرية في منطقة قرية قرن ماجد الأثرية – شرق اليمن

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ملخص

في هذه الدراسة تم تقييم إستقرارية المنحدرات الصخرية المحيطة بقرية قرن ماجد الأثرية و التي تقع على مرتفع من الصخور الرسوبية بشكل الكويستا في وادي دوعن - شرق اليمن. إذ تم تقييم جميع العوامل المؤثرة في عدم الإستقرارية في المنطقة مثل التجوية التفاضلية، سقوط المطر والسيول، الصرف الصحي، اتجاه و ميل الانقطاعات، اتجاه و انحدار وجه المنحدر، و الصفات الميكانيكية للصخور و المواد المالئة للانقطاعات. أظهرت نتائج فحص القص المباشر للمواد المالئة للفواصل أن قيم زاوية الاحتكاك الداخلي (Φ) تتراوح بين 11° و 31° و قيم التماسك (c) بين 0.00 و 0.5 ميقاباسكال. أما قيم المقاومة الانضغاطية فكانت 66 ميقاباسكال للصخور الجيرية العقدية و 12 ميقاباسكال للصخور الرملية المارلية الطفلية. خلصت هذه الدراسة إلى أن نمط السقوط الصخري هو الانهيار السائد في المنطقة كما توجد احتمالية لحدوث انهيارات من نوع الانقلاب الثانوي و / أو الانزلاق المستوي. بناءا على نتائج هذه الدراسة تم اقتراح عدد من الإجراءات الوقائية لحماية منحدرات منطقة الدراسة مثل إنشاء قنوات تصريف مبطنة، تدعيم أساس سفوح منحدر الميل و الأجزاء المعلقة و حقن الفواصل بمواد مالئة مناسبة.

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Synthesis and Characterization of Some New Heterocyclic Selenium Derivatives of 3,5-Naphtho–1-Seleoncyclohexane

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ABSTRACT

A new series of heterocyclic derivatives from 3,5–naphtho-1-selenocyclohexane have been prepared (C_{12} H_{10} SeX; X=CL Br, I) and $C_{12}H_{10}$ SeRX; R=CH3; X=I)
The new compounds were characterized by elemental analysis, IR, H^1NMR and molar conductance. Conductivity measurements of these compounds in DMSO solution indicated that they behave as week electrolytes

INTRODUCTION

The preparation, characterization and solution properties of heterocyclic tellurium and selenium had been described previously [1-9].
3,5-naphtho–1-tellurocyclohexane was studied firstly by Anderson et. al. [10] who studied the cyclic inversion that occurs in oxygen, sulphur, tellurium and selenium cyclic compounds.
Singh et. al. [11] have prepared 3,5- naphtho–1-tellurocyclohexane and 3, 5-naphtho–1-selenocyclohexane from 1,8-bis (bromo methyl) naphthalene.
Radhy [12] prepared charge transfer complexes from quinines. In the present work a new heterocyclic selenium compounds based on 3,5- naphtho–1-selenocycolhexane have been prepared and characterized by physical properties and spectroscopic methods.

EXPERIMENTAL

A) Physical measurements

All physical measurements were achieved in the University of Basrah. Infra-red spectra were recorded as KBr pellets in a range of 4000-400 cm^{-1} on a Pye-Uniecam SP300s infrared spectrophotometer. Elemental analysis were preformed using EA-1108 Carlo-Erba elemental analyzer. H^1 NMR spectra were recorded in $CDCl_3$ or DMSO-d6 solution containing TMS as internal standard using Joel EX-90 instrument 100MHz. Melting points were

determined by Gallenkamp apparatus and were uncorrected. Conductivity measurements were done with a WTW conductivity meter LBR using a standard conductivity cell with a constant of 0.8 cm^{-1}.

B) Synthesis

1, 8- bis(bromo methyl)naphthalene $C_{12}H_{12}Br_2$ (I)

A mixture of (2 g, 50 mmol) of 1,8-dimethylnaphthalene and (6.4 gm, 25mmol) N-bromosuccinimide (NBS) with (0.25g ,1mmol) from benzoyl chloride in 40 ml CCl_4 was heated to reflux for 5 hrs. A small quantity of pale yellow crystal was deposited from this reaction on cooling. The precipitate was washed with a small amount of water and recrystallized from benzene (m.p. 165°C).

3,5- naphtha-1-selenocyclohexane $C_{12}H_{10}Se$ (II) [11]

To a well-stirred suspension of selenium (0.12 g) (1.59 mmol) in water, sodium borohydride (0.12 gm, 1.59 mmol) was added in water (25ml) at room temperature .The selenium was consumed with in 10 min. 1,8-bis (bromomethyl) naphthalene (0.59mmol) in toluene (25ml) was there added through a dropping funnel. After addition of a phase–transfer catalyst, tetrabutylammoniumhydrogensulphate (0.1 g) the temperature was raised to 60 °C and kept at 60°C for 8 hrs. The organic layer was separated, washed with 5% aqueous sodium carbonate, then evaporated in vacuo to give an orange product. Recrystallization from petroleum ether (40–60°C) yielded orange crystals mp. 82°C (lit. [9]). 83.5– 84.5°C.

1, 1–Dibromo- 3,5–naphtha-1-selenocyclohexane $C_{12}H_{10}Se\ Br_2$ (III).

A solution of 3,5–naphtha-1-selenocyclohexane (3 mmol) in dry ether was treated dropwise with a solution of bromine (3 mmol) in ether. A white precipitate was formed immediately. The solution was evaporated and the residue was recrystallized from methanol to give white crystals (m.p. 202-204°C)

1,1-Dichloro-3,5–naphtha-1-selenocyclohexane (IV).

In ether was added slowly to a stirred solution of (3 mmol) of 3,5-naphtho-1-selenocyclohexane in the same solvent at room temperature. A white precipitate was formed immediately. The precipitate was washed with water and recrystallized from ethanol to give a white crystal (m.p. 200—201°C)

1,1-diodo-3,5-naphtholselenocyclohexane $C_{12}H_{10}SeI_2$ (V).

A solution of 3,5-naphto-1-selenocyclohexane (1 mmol) in dry ether (10 ml) was treated drop wise with a solution of iodine (0.39 g,1.5 mmol) in ether. A white precipitate was formed. The solution was evaporated and the residue was recrystallized from ethanol to give white crystals (m.p. 188-200 °C).

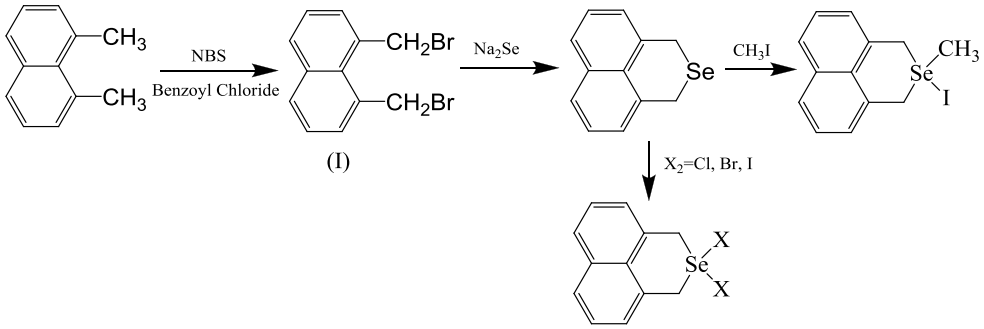
Iodo-1-methyl–3,5-naphho-1-selenocyclohexane $C_{13}H_{13}SeI$ (VI).

(3 mmol) of freshly distilled iodomethane was introduced with cyclic selenide (3 mmol). Recrystallization from ethanol/water (3/1) gave white crystals of m.p. 170-173°C.

RESULT AND DISCUSSION

This paper deals with the synthesis of 3,5-naphtho-1-selenocyclo hexane (II) which was then converted to dihalo derivatives through the reaction with halogen in 70% yield. Its treatment with methyl iodide gave compound $C_{12}H_{10}SeCH_3I$ (VI).

The synthesized compounds and their synthesis modes are shown in Scheme (1).



[Scheme-1]

All compounds are soluble in DMSO, their physical properties and elemental analysis are listed in Table (1).

The infrared spectra (KBr disk) of all compounds show a week to moderate band near 585-600 cm^{-1} which characteristic of the C-Se stretching [7].

Two strong absorption bands: the first was at 770- 780 cm^{-1} owing to bending stretching of C-H; and the second was at 1620-1590 cm^{-1} owing to aromatic stretching C=C Table(2).

In addition to these absorption bands, there is a number of characterization absorption such Se-Br, Se-Cl and Se-I stretching at 620, 610 and 605 cm^{-1} , respectively.

Table (1): Analytical and physical properties for compounds (II- VI).

No.	Chemical formula	Colour	M.P. °C	Yield %	Anal. Found (cal.) % C	H
II	$C_{12}H_{10}Se$	Orange	82	70	61.20 (61.81)	4.34 (4.32)
III	$C_{12}H_{10}SeBr_2$	White	202 – 204	75	36.10 (36.67)	2.51 (2.56)
IV	$C_{12}H_{10}SeCl_2$	White	200 – 201	70	47.47 (47.41)	2.29 (3.31)
V	$C_{12}H_{10}SeI_2$	White	188 – 200	70	29.58 (29.59)	2.40 (2.06)
VI	$C_{12}H_{10}SeCH_3I$	White	170 - 173	75	41.60 (41.62)	3.42 (3.49)

^{1}H NMR spectra of compounds (11-V1) were measured in $CDCl_3$ and DMSO-d_6. Compounds $C_{12}H_{10}SeX_2$ in $CDCl_3$ solvent gave two types of bands the first, singlet signal related to methylene protons (2,6) and the second multiple signal at 7-8.2 ppm for aromatic protons. Table (2),

^{1}H NMR of $C_{12}H_{10}SeCHI$ (V1) shows a quartet signal for methylene proton (2,6) at 5.23 ppm which are not equivalent as compared with $C_{12}H_{10}Se$ and $C_{12}H_{10}SeX_2$ compounds. This result is in agreement with $C_{12}H_{10}TeRX$ [13] and $C_{12}H_{10}SeRX$ [14].

Table (2): IR and ^{1}HNMR for (II–VI) compounds.

No.	Se–C cm^{-1}	C=C cm^{-1}	C-H_{ben} cm^{-1}	δ (ppm)	**Solvent**
II	585	1580	780	4.30 s ($H_{2,6}$) 7.70–8.00 ($H_{aromatic}$)	DMSO-d_6 2.15
III	585	1590	775	4.60 s ($H_{2,6}$) 7.20–8.10m($H_{aromatic}$)	$CDCl_3$
IV	590	1580	770	4.80 s ($H_{2,6}$) 7.20–8.20m($H_{aromatic}$)	$CDCl_3$
V	590	1620	770	4.50{S , H (2,6)} 7.20–8.00m ($H_{aromatic}$)	$CDCl_3$
VI	600	1608	780	1.20 {S , CH_3} 5.23 {M , H (2,6) } 7.20–8.20m ($H_{aromatic}$)	DMSO-d_6

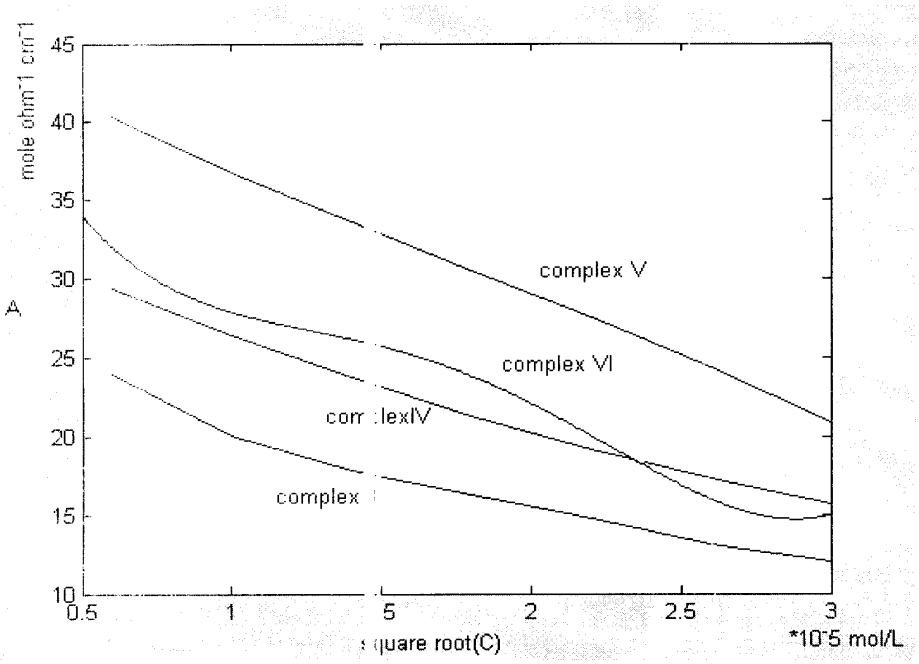


Figure (1): Molar conductivity versus square root of concentration.

The molar conductivity for these compounds in DMSO as solvent with concentration between 10^{-4}–10^{-5} molar were measured. The plots of molar conductance (ohm^{-1} cm^{-1} mole) against square root of concentration for compounds showed a typical behavior of week electrolyte in DMSO solvent (Fig.1) and this result is in agreement with previous studies [12-15].

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تحضير وتشخيص بعض مشتقات السلينيوم غير المتجانسة الجديدة لـ 3,5-Naphtho–1-Seleoncyclohexane

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ملخص

في هذه الدراسة تم تحضير سلسلة جديدة من مشتقات المركب 3, 5–naphtho -1- selenocyclohexane و هي $C_{12}H_{10}SeX$; X=CL Br, I و $C_{12}H_{10}SeRX$; R=CH3; X=I . وقد شخصت هذه المركبات باستخدام التحليل العنصري الدقيق (CHN) واطياف الأشعة تحت الحمراء (IR) واطياف الرنين النووي المغناطيسي(H^1-NMR) . واثبتت التوصيلية المولارية في مذيب ثنائي مثيل سلفوكسايد(DMSO) بان المركبات عبارة عن الكتروليتات ضعيفة.

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Mineralogical Composition of Some Iraqi Soil Samples

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ABSTRACT

Twenty five soil samples were collected from various parts of uncultivated areas in Iraq including Rabe'a, Mosul, Hatra, Beygee, Balad, Radhwnaia, Abu Graib, Wasit, Anbar and Basrah. These samples were examined by XRD to determine the mineral constituents. Clay fractions were separated for clay mineralogy.
The results showed that the clay minerals represent about 40% of the mineral constituents of the samples, dominated by montmorillonite, illite, palygorskite and chlorite having various proportions. The non-clay minerals are represented by calcite and dolomite which present as detrital grains and representing about 32% of the mineral constituents. Quartz comes with about 22% and feldspars with about 5%. The water-soluble salts in the soil samples varied according to the sampling location and represented about 0.3% on average, increasing from north to south.
The study showed the relation of the soil mineralogy with source rocks, and the most of the Iraqi soils are the results of erosion, weathering and transported by rivers. The authigenic minerals are locally precipitated from near-surface saline ground waters.

INTRODUCTION

Quaternary sediments cover most of Iraq and represent most of its soils. It includes recent flood plain sediments (Holocene) of Tigris and Euphrates and their tributaries, in addition to sediments transported by wind mainly sand dunes which spread over the north and north – western parts of the sedimentary plain (Yacoub,1983). Most of these deposits consist of clays and mud with sand, together with chemical deposits of carbonates and

evaporates formed as a result of evaporation. These recent alluvial deposits are different from the ancient alluvial deposits of Pliestocene age. The latter consists of alluvial terraces and widespread over the north and northwestern parts of the sedimentary plane forming relative highs and showing gradation from pebbles to sands, clays and mud (Domas, 1983).

In this study, the term soil is not used in its strict scientific meaning, which is, a weathering product. Instead, it is used as a cohesion less friable product, a weathering product in situ or a transported material by different erosional agents or a mix of both, which represent, most Iraqi soils form in situ. These soils are different in their constituents and stages of development from one area to another depending on conditions of weathering, transportation and deposition as well as the sort of diagenesis soils undergo.

Consequently, the mineralogical study of Iraqi soils gained importance and concern of several researchers. Al-Rawi, et. al., 1969, studied the mineralogy of Iraqi soils in northern and central parts of Iraq. They emphasized the mineralogical nature of soils and minerals of flood sediments and river terraces in addition to the mineral variability with soil depth. They found that montmrillonite is dominate in addition to other minerals in different proportions. Al-Rawi, 1977 studied recent sediments of Diwania region which were transported by Euphrates and its tributaries. He found that these sediments are sand, clay, mud and the grains of the latter are dominant. Banat and Al-Rawi, 1986; and Abdullah, 1982 studied the mineralogy of flood sediments of Diwania and Al- Hammar marshland as well as the clays along Euphrates is outlines. Al– Hassani, 1984, studied the mineralogical and chemical aspects of sabkha and shura soils in some regions of Iraq and found them alike.

Al–Ani, 1986 studied the geochemistry and sedimentology of sabkha in central and southern Iraq. He showed that montmorillonite is the major constituent of plain deposits and that these clays are detrital in origin transported by rivers and wind. He considered the igneous and metamorphic rocks in the upstream are the main source for these deposits in addition to some other sedimentary formations within the country.

A new outlook to the mineralogical nature of the Iraqi soils is adopted in this paper. It emphasises the influence of salinity, climate and source rocks on the type of minerals found in soils. The work is conducted on 25 samples selected from different areas of Iraq from north to south covered the provinces of Mosul, Salah – Al Din, Baghdad, Wasit, Al – Anbar , and Basrah (Fig.1).

MATERIALS AND METHODOLOGY

Twenty five non-cultivated agricultural soil samples were collected from different areas of Iraq (Table-1). After removing the upper layer, these samples were taken out by a shovel or auger from a depth of 30cm from the cleaned earth surface, and from areas cut by small wadis. Each sample was divided into two parts for grain size and mineral composition analysis.

Size gradation

100 grams of soil are taken after drying in an oven of 60C for a period of 24 hours. The sample is then washed in a 63 micron size sieve. The coarser part is dried in an oven of 60 C. The dried coarser part is placed into a sieve of 2 mm. The weights of sand (size 0.063 – 2.0 mm) and of pebbles (more than 2 mm) are determined. The rest of the sample (less than 63 microns) is left to settle for 24 hours and then dried.

Table (1): The distribution of sample localities and serial numbers.

City	area	Serial No.
Mosul	Mosul Rabea Hatra	4 1 -2 – 3 5
Salah Al-Deen	Bayjee Balad	6 7
Anbar	Kilo-160 Rutba Akashat	8 9 10
Baghdad	Abu Gharib Radhwania	13- 14-15 -16 -17 18 -19-20- 21 -22
Wasit	Wasit	11 – 12
Basrah	Basrah	23 – 24 – 25

To determine the clays proportions forty grams of Kalcon were taken and dissolved in a 100 milliliter with continuous stirring for half an hour. The sample now is left for another 24 hours, which is then put into a graduated cylinder (holds 1000 ml) and distilled water is added up to 1000 ml with continuous stirring. A hydrometer is put inside the cylinder. Readings are taken from a quarter of a minute to 24 hours. Then some arithmetic is executed to determine the proportions of mud and clays in the samples (Tamar–Agha and Mahdi, 1992).

Analysis of minerals

Samples were analyzed by X-ray diffraction to determine their mineral contents. Samples are grinded by agate mill and slides are made for testing.

Particles of clays were separated according to Jackson, 1958 and Al–Janabi et al, 1992and then determined and examined by X-ray diffraction. Clay minerals are determined and calculated sub- quantitatively as in Al–Janabi et al., 1992.

RESULTS AND DISCUSSION

Size gradation

Size analysis was performed on samples (Table-2) for the purpose of their classification depending on textural properties according to (Wentworth1922). Results show that 68 % of the samples is clayey mud soils (silty clay). Silt ranged from 29 – 48.4 % (table-2) while the clayey part showed a range of 17 – 50.5 % which reflects a transporting agent of low energy in the depositional plain region. 24 % of samples fall within the sandy soil type with a sand range of 26 – 48.2%. Clayey soils comprised 8 % of the studied samples.

Rabea is characterized by silty clayey soils with a sand percent not more than 5%. Southward of Mosul and Hatra sand percent increases and clay percent decreases, with silt percent remains almost constant (table-3). Some pebbles also appear but no more than 1.5%. The soils of Bayjee are characterized by a higher sand percent reach to 48%, and are classified as sandy clay loam. The reason for this is the presence of sand dunes in the region which influences the type of soil in these regions. Sands decrease in the southern direction in soils fringing Tigris river where clays and silt increase in Baghdad. The soil is classified as silty clay where it constitutes around 7.6% while silt content is 45.5 % (table-4) and clay

contents 46.4 %, such as the soil samples of Wasit and Basrah which are classified as silty clay. In Wasit, sands reach to 2.5 % and clays to 50.5 % which is the highest value in studied samples.

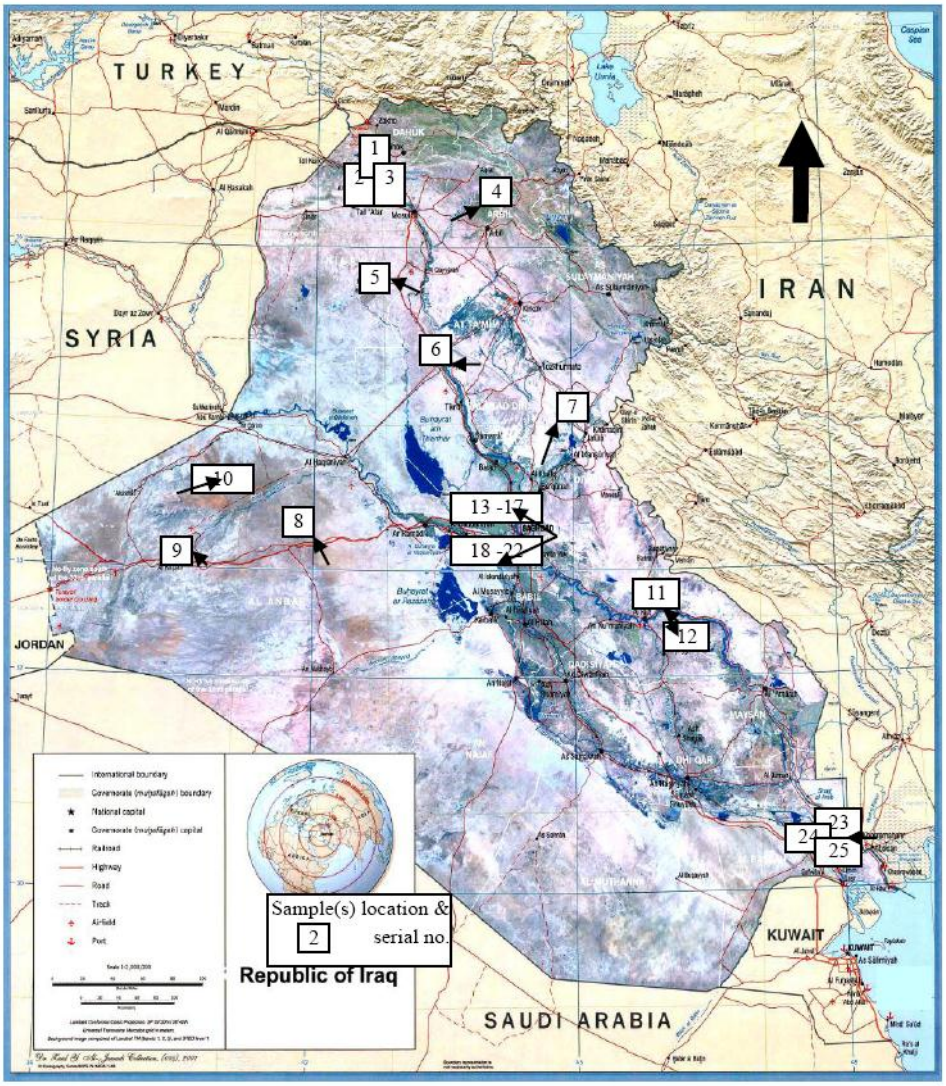

Figure (1) : Location map of the collected samples (Modified from Iraq Satellite Photomap,2003).

Table (2): Sieve analysis and classification of soil samples.

Serial No .	Samples	% *Gravel	% Sand	% Silt	% Clay	Texture Us Dep. Of Agriculture	Classification After Al-Taei,1968
1	Rabea-1	-	5	42	53	Clay Silty	Mollie Calciorthids (CM)
2	Rabe a-2	-	4	43	53	Clay Silty	Mollie Calciorthids (CM)
3	Rabe a-3	-	6	47	47	Clay Silty	Mollie Calciorthids (CM
4	Mosul	-	16	48	36	Silty Clay	Torrifluvents (TF)
5	Hatra	3	36	34	27	Sandy Silty Clay	Calciorthids and Lithic
6	Bayjee	-	48	23	29	Sandy Silty Clay	Calciorthids (CI)
7	Balad	-	4	53	43	Silty Clay	Torrifluvents (TF)
8	AL-Kilo-160	3	50	24	23	Sandy Silty Clay	Calciorthids (CL3)
9	Rutba	9	65	13	13	Sandy Silty Clay	Lithic Paleargids and Lithic Calciorthids (PL)
10	Akashat	5	30	50	15	Silty Sand	Paleargids and Lithic paleargids (PL)
11	Wasit - 1	-	2	41	57	Clay Silty	Salorthids Torrifluvents and Torrets (SI)
12	Wasit - 2	-	3	53	44	Silty Clay	Torrifluvent(TF)
13	Abu Garib-1	-	7	52	41	Silty Clay	Torrifluvent(TF)
14	Abu Garib-2	-	3	46	51	Clay Silty	Torrifluvent(TF)
15	Abu Garib-3	-	5	50	45	Silty Clay	Torrifluvent(TF)
16	Abu Garib-4	-	5	46	49	Clay Silty	Torrifluvent(TF)
17	Abu Garib-5	-	4	48	48	Clay Silty	Torrifluvent(TF)
18	Radhwania-1	-	13	38	49	Clay	Torrifluvent(TF)
19	Radhwania-2	-	5	49	46	Silty Clay	Torrifluvent(TF)
20	Radhwania-3	-	13	46	41	Silty Clay	Torrifluvent(TF)
21	Radhwania-4	-	15	37	48	Clay	Torrifluvent(TF)
22	Radhwania-5	-	6	43	51	Clay Silty	Torrifluvent(TF)
23	Basrah-1	-	2	50	48	Silty Clay	Salorthids(SI)
24	Basrah -2	-	1	54	45	Silty Clay	Salorthids(SI)
25	Basrah-3	-	13	41	41	Silty Clay	Salorthids(SI)

Gravel: >2.0mm Sand : 2.0 – 0.063 mm Silt : 0.063- 0.002 mm Clay:<0.002 mm

Table (3): The soil mean grain size according to geographical distribution.

Area	Gravel %	Sand %	Silt %	Clay %
Rabea	-------	5	44	51
Mosul + Hatra	1.5	26	41	31.5
Bayjee + Balad	-------	26	38	36
Anbar(Kilo-160+ Rutba + Akashat)	5.7	48.3	29	17
Wasit	------	2.5	47	50.5
Baghdad(Abu-Gharib +Radhwania)	------	7.5	45.5	46.9
Basrah	-------	5.3	48.4	46.3

Results also have shown a pebble highest content of 5.7 % in samples of Al-Anbar, in addition to the presence of high content of sands which reaches around 17%, classified as sand clay loam (Table-3). This is because of in situ origin of these soils and are influenced by wadi deposits that occurred by seasonal flash floods which carry clastics of different sizes of pebbles and sands.

Mineralogy of soil samples

In the light of X-RD investigation (Fig.2) it is possible to quantitatively estimate minerals present in the studied samples (Table-4 and Fig.2). Results show clays are predominant among soil minerals under study. Clays are present in about 40% with a range of 55 – 20 % (Table-5 and Fig.3A). Montmorillonite dominates in most samples (Fig.2) except Rabea and Mosul where mica (illite) or palygorskite comes first and montmorllonite remains the principal mineral in the samples of these regions. Also, palygorskite and montmorillonite dominate in the samples of Al-Anbar. Chlorite is the second in the samples next to montmorillonite inAl- Anbar and most samples of Basrah region. Illite is second in the samples of Abu-Gharib.

Kaolinite is the least distributed clay mineral in the studied samples except with individual samples in Basrah and Radhwania (Table-4). The main source of these minerals is the transported sediments by rivers and tributaries during flood seasons which carry along weathering products of different types of igneous and metamorphic rocks exposed within Tigris and Euphrates headwaters, in addition to sedimentary rocks which enrich Iraqi soils with extra clastics rich in clays derived from Injana and Muqdadia Formations. Also, few percentages of these minerals are a product of in situ weathering particularly in the soils of Al-Anbar. For weathering, chemical and mechanical, is a primary role in delineating the produced clay minerals (Degens, 1965),(sadiq,1985). For climate and topography, as well, have a long influence on the type of clay minerals produced. All of these lead us to believe that quite adverse mixture of these minerals is present in Iraqi soils.

Montmorillonite is the primary mineral in all samples which develops as a result of weathering of basic igneous and metamorphic rocks rich in iron, magnesium and calcium. These rocks are typical in Iraqi rivers headwaters, where they are eroded and transported by rivers to where their sediments accumulate. Here, it is noteworthy to mention that the three minerals (mica, illite, montmorillonite) do represent a chain of successive weathering stages. Micas frequently are a product of igneous and metamorphic rocks; they alter to illite by weathering, where part of potassium is replaced by hydrogen and form montmorillonite during successive stages of weathering by replacing potassium within the crystalline lattice with other ions such as calcium, which causes its increase in water. This reflects content of montmorillonite in most Iraqi soils. Climate has also a noticeable role in the formation of these minerals which are formed in arid and semiarid climate. In addition, this large proportion of montmorillonite is due to diagenesis which initiated weathering of chlorite as a result of sodium concentration particularly in samples of central and southern Iraq, which possibly was the major cause of chlorite decrease in these regions. The increasing of the concentration of mica (illite) in soil of Rabea and Mosul, north of Iraq, caused by nearness to regions of source rocks in northern and northeastern Iraq, igneous and metamorphic rocks rich in mica and may also be due to rock weathering of marl for example.

It is also noticed that palygorskite existence in the studied samples, considered in situ clay mineral, represent the major mineral in samples of western desert. But what explains its presence in most samples is the transportation and deposition of clastics derived from ancient formations, transported by rivers and wind. Kukal and Saadallah, 1978, Al – Khattab, 1972, and Buringh, 1960, have pointed out that dust storms, taken place in southern and western Iraq most of the year, which transport large quantities of sediments for long distances reaching up to hundreds of kilometers. Beside that is the possible diagenesis such as the transformation of montmorillonite to palygorskite as a result of

uptaking magnesium from soils (Weaver and Pollard, 1975). Climate of arid and semiarid dominant in the country is required for the formation of such minerals (Aqrawi, 1993).

Table (4): Mineral percentages and clay minerals in studied samples.

Serial No .	Samples	Carbonates %	Quartz %	Clays %	Feldspar %	Clay minerals
1	Rabea-1	27.5	22.0	47.5	3.0	Mica, Palygorskite, Montmorillonite, Chlorite
2	Rabea-2	28.0	0.27	45.0	-------	Palygorskite, Montmorillonite, Kaolinite, Mica
3	Rabea-3	27.5	20.0	52.2	-------	Mica, Palygorskite, Montmorillonite, Kaolinite
4	Mosul	43.5	12.0	44.5	-------	Mica, Palygorskite, Montmorillonite, Chlorite, Kaolinite
5	Hatra	24.5	25.0	45.5	5.0	Palygorskite, Montmorillonite, Kaolinite
6	Bayjee	30.0	18.0	47.0	5.0	Montmorillonite, Chlorite, Mica, Kaolinite
7	Balad	35.0	24.0	36.0	-------	Palygorrskite, Mica, Montmorillonite, Chlorite
8	AL-Kilo-160	35.0	30.0	35.0	-------	Palygorskite, Montmorillonite, Chlorite ,Kaolinite
9	Rutba	26.0	33.0	41.0	-------	Montmorillonite, Palygorskite,
10	Akashat	42.0	18.0	40.0	-------	Montmorillonite, Chlorite, Mica, Kaolinite
11	Wasit – 1	30.0	26.0	44.0	-------	Montmorillonite, Chlorite, Mica, Palygorskite, Kaolinite
12	Wasit – 2	32.0	25.0	39.0	4.0	Montmorillonite, Mica, Palygorskite, Kaolinite
13	Abu Gharib-1	26.5	21.0	43.5	9.0	Montmorillonite, Mixed Plated, Mica, Palygorskite,
14	Abu Gharib-2	26.0	30.0	36.0	8.0	Montmorillonite, Mica, Palygorskite, Kaolinite
15	Abu Gharib-3	30.5	18.0	43.5	8.0	Montmorillonite, Chlorite, Palygorskite, Kaolinite
16	Abu Gharib-4	27.0	18.0	37.0	18.0	Montmorillonite, Mixed Plated, Mica, Palygorskite
17	Abu Gharib-5	26.0	20.0	41.0	13.0	Montmorillonite, Mica, Palygorskite, Kaolinite
18	Radhwania-1	27.0	18.0	47.0	8.0	Montmorillonite, Chlorite, Mica, Palygorskite, Kaolinite
19	Radhwania-2	29.0	26.0	38.5	6.0	Montmorillonite, Chlorite, Palygorskite,
20	Radhwania-3	26.0	19.0	44.5	10.0	Montmorillonite, Kaolinite, Palygorskite, Mica,
21	Radhwania-4	25.0	15.0	40.0	20.0	Palygorskite, Montmorillonite, Kaolinite
22	Radhwania-5	28.0	25.0	32.0	15.0	Montmorillonite, Chlorite, Mica, Kaolinite
23	Basrah-1	48.0	20.0	30.0	2.0	Montmorillonite, Chlorite, Kaolinite
24	Basrah -2	45.0	20.0	35.0	Trace	Montmorillonite, Chlorite, Kaolinite
25	Basrah-3	55.0	25.0	20.0	Trace	Kaolinite, Montmorillonite

On the other hand, Kaolinite is the least present mineral in the studied samples. This reflects a weak chemical weathering upon the source rocks (Wollast, 1967, in Banat, 1980), because formation of kaolinite requires a humid equatorial climate, contrary to the existed semiarid climate. Moreover, the presence of salt and alkali concentration in some Iraqi soils within the depositional plain offers the wrong environment for the formation of kaolinite (Grim, et al., 1960). Also, its presence indicates strong heavy rainfall and efficient water drainage and high soil permeability. Therefore, the presence of a little proportion of kaolinite supports a detrital source carried by rivers from sediments occurring within the northern parts of the depositional plain.

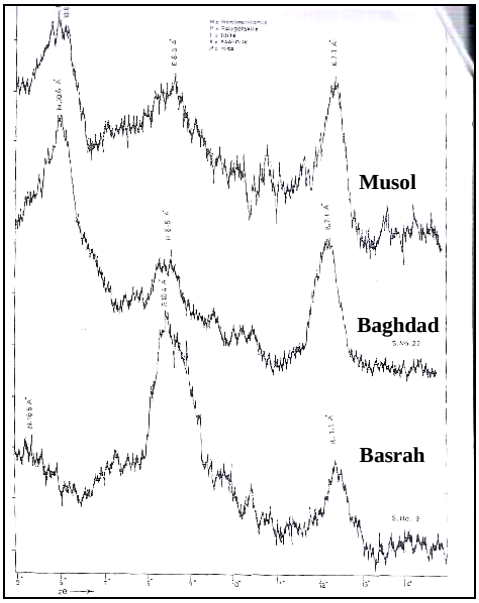

Figure (2): X-Ray diffractograms for clays separated from some soil samples.

Table (5): Results of mineral percentages and clay grain size individual studied geographic of encountered minerals in areas and their means and ranges.

Area	Number of samples	Carbonates %	Quartz %	Feldspar %	Clays XRD %	Clays grain size
Rabea	3	27.7	23.0	1.0	48.2	51
Mosul(Mosul – Hatra)	2	34.0	18.5	2.5	45.0	32
Salah Al-Deen(Bayjee–Balad)	2	32.5	21.0	2.5	41.5	36
Anbar (Kelo160 +Rutba +Akashat	3	34.3	27.0	-----	38.7	17
Baghdad (Abu- Gharib + Radhwania)	10	27.2	21.0	11.5	40.3	47
Wasit	2	31.0	35.5	2.0	41.5	51
Basrah	3	49.3	21.7	0.7	28.3	47
Percentage ranges Mean percentages		24.5-55.0 32.0	12-33 22.2	20-0 5.4	20-47.5 40.2	17-51

Carbonate minerals (calcite and dolomite) come next in abundance where their average in the studied samples is 33% with a range of 24.5 – 55.0 % (table-4). Samples of Basrah are characterized by the higher concentration of carbonate minerals where they reach an average of 49%, while samples of Rabea and Baghdad are characterized by the least percent (~ 27%). In general, and as shown in fig. 3-B, there is an inverse relationship between carbonate mineral content and clay mineral content in the studied samples. These minerals are present as rock fragments transported by rivers and wind from nearby rocks particularly

Euphrates and Dammam formations widespread in southwestern Iraq. This reflects the large proportion of carbonate minerals in the Basra samples, in addition to the possibility of their deposition from groundwater of low water table caused by evaporation. As of quartz, it represents the third mineral achieving an average of 22% and a range of 13 – 23 % .

The western desert samples are characterized by the highest quartz content accounting for 27 % (table-5), while it occurs with lowest concentration in Mosul samples of 18.5 % (fig . 3-C).

Results show little concentration of feldspar in the studied samples and none in most samples of Rabea, Mosul, Bayjee and Anbar, while feldspar is present in all Baghdad samples with an average of 5% and a range of 0 – 20%, and show highest concentration (table 5 and Fig. 3-D).

Quartz is present in the studied samples as grains transported by water and wind with high percent in the Anbar. The little occurrence of feldspar is due to absence of source rock or its little occurrence which is present in acidic igneous rocks such as granite. This little proportion of feldspar in Wasit and Baghdad samples is due to the effect of some formations such as Injana and Dibdiba which contain relatively high percentage, of clastics transported by rivers.

It is inevitable to indicate presence of different concentrations of evaporate minerals especially in the samples of central and southern Iraq (Fig. 2-E). The origin of these minerals is due to evaporation of irrigation water and near surface groundwater in areas of poor drainage and to type of groundwater (Al-Hazaa,et al., 2009).

CONCLUSIONS

The study shows that the studied soil samples consist of clay minerals (montmorillonit, illite, palygorskite and chlorite with little kaolinite) and carbonate minerals, in addition to quartz and feldspar. Clay minerals represent about 40% with their concentrations decrease in the samples of Anbar and increase in the samples of Baghdad and southern Baghdad soils. Carbonate minerals form about 33% with an increase in soils of Basrah. Quartz makes around 22% with a relative increase in the samples of western desert. Feldspar form around 5% of the soil mineral constituents. It increases in the samples of Baghdad. The study shows that the mineral constituents in most samples are transported detritus from eroded regions in the upper Euphrates, Tigris and their tributaries except samples of western desert which represent in situ soils.

As of the evaporate constituent, it has a secondary origin developed within the soil through evaporation from ground water and irrigation waters.

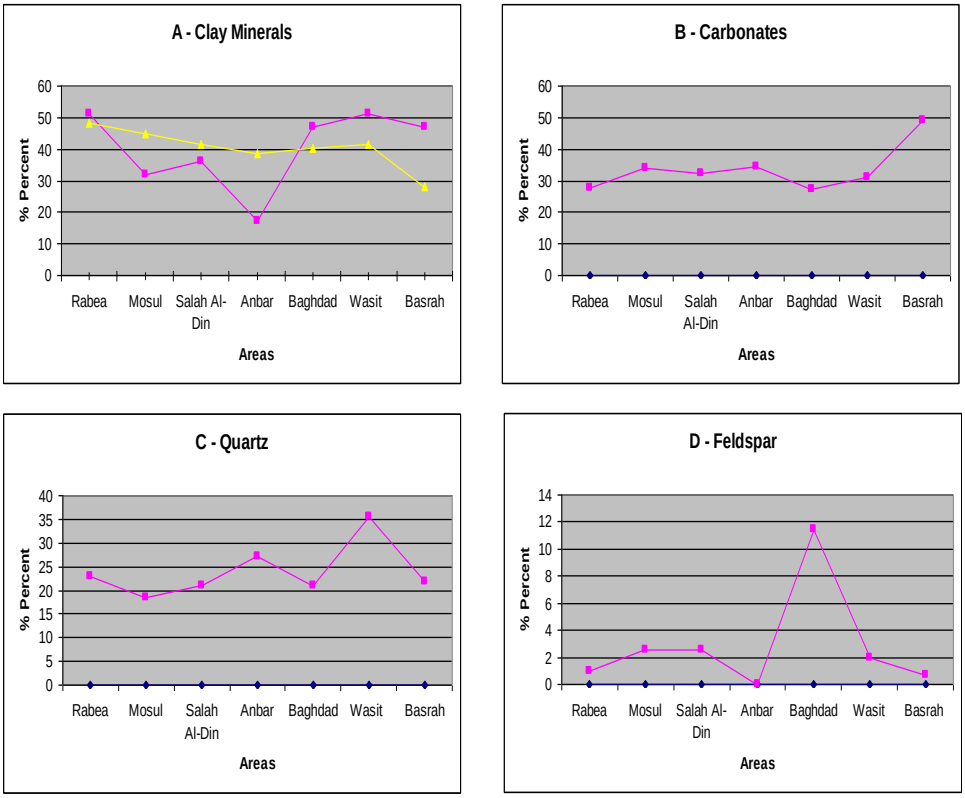

Figure (3): Mineral percentages of Iraqi soil samples according to geographical distribution

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التركيب المعدسني لعينات من الترب العراقية

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ملخص

أجريت نمذجة للتربة من مناطق غير مزروعة في أنحاء مختلفة من القطر هي ربيعة، الموصل، الحضر، بيجي، بلد، الرضوانية، أبو غريب، واسط، الأنبار والبصرة وبلغ عدد العينات(25) عينة. تم فحص العينات معدنياً بواسطة حيود الأشعة السينية لتحديد التركيب المعدني للتربة وفصل الجزء الطيني لتشخيص المعادن الطينية.

بينت النتائج أن المعادن الطينية تمثل حوالي 40% من المكونات المعدنية للعينات وتسود فيها معادن المونتمورلونايت والآلايت والباليغورسكايت والكلورايت بنسب مختلفة وحسب المواقع الجغرافية لعينات الدراسة.

المعادن غير الطينية تمثلت بالكالسايت والدولومايت الموجودة بشكل فتات صخري منقول. وبلغ مجموع المعادن الكاربونيتية حوالي 32% كمعدل في عينات الدراسة. يأتي الكوارتز بالمرتبة الثانية من بين المعادن غير الطينية وبلغ معدله حوالي 22% والفلدسبار كان معدله حوالي 5%. تباينت معادن الأملاح الذائبة في الماء في عينات الدراسة حسب المواقع الجغرافية وبلغ معدلها حوالي 0.3% ولوحظ زيادة تراكيزها من الشمال إلى الجنوب.

بينت الدراسة علاقة الصخور المصدرية مع المكونات المعدنية للتربة حيث أن معظم العينات تمثل رواسب منقولة ومترسبة في بيئات نهرية وقسم آخر متكون موقعياً بسبب عوامل التجوية. وتمثل الأملاح معادن متكونة موقعياً ضمن العمليات التحويرية ومصدرها المياه الجوفية القريبة من السطح وتعتمد نوعيتها على التركيب الكيميائي لتلك المياه

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Inverse Linear Goal Programming Problem

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ABSTRACT

This paper considers the inverse linear goal programming problem of multi-objective function in case the change in coefficient of the objective function.

Let S denote the set of feasible solutions points of linear goal programming problem of a multi-objective function, and let d^{+o}, d^{-o} be the positive and negative deviation variables of the maximum and minimum goals respectively, w^+, w^- be a specified cost vector, x^o be given feasible solution vector, and d^{+o}, d^{-o} be given tow vectors denoted the feasible positive deviation and the feasible negative deviation points of the max or min goals, respectively.

The inverse linear goal programming problem of multi-objective function is as follows:

Consider the change of the cost vectors w^+, w^- as less as possible such that the vectors feasible solution x^o, d^{+o}, d^{-0} becomes an optimal solution of LGP of multi-objective function under the new cost vectors λ^+, λ^- and $\| |\lambda^+ - w^+| + |\lambda^- - w^-| \|_p$ is minimal, where $\|.\|_p$ is some selected L_p-norm.

In this paper, we consider the inverse version ILGP of LGMP. under the L_1-norm where the objective is to minimize $\sum_{i \in I} |\lambda^+ - w^+| d^+ + |\lambda^- - w^-| d^-$, with I denoting the index set of variables x_i. We show that the inverse version of the considered under L_1-norm reduces to solving a problem for the same kind; that is, an inverse multi-objective assignment problem reduces to an assignment problem.

1. INTRODUCTION

An inverse linear goal programming problem of multi-objective function is defined as follows:

Let S denote the set of feasible solutions points of linear goal programming problem LGP of a multi-objective function, and let:

w^+ : be given the positive weight vector of the positive deviation variables,

w^- : be given the negative weight vector of the negative deviation variables,

d^+ : is the positive deviation variable of the maximum goals,

d^- : is the negative deviation variable of the minimum goals,

x^o : be given feasible solution vector of LGP of multi-objective function,

d^{+^o}, d^{-^0} : are given two vectors denoting the feasible positive deviation and the feasible negative deviation points of the max or min goals respectively.

The vectors feasible solution x^0 , $\mathbf{d}^{+^o}$, $\mathbf{d}^{-^o}$ may or may not be vectors optimal solutions of LGP of multi-objective function with respect cost vectors w^+, w^-.

The inverse linear goal programming problem ILGP of a multi-objective function is as follows.

Consider the change of the cost vectors w^+, w^- as less as possible such that the vectors feasible solution x^0 , $\mathbf{d}^{+^o}$, $\mathbf{d}^{-^o}$ becomes an optimal solution of LGP of multi-objective function. Under the new cost vectors λ^+, λ^- and $\left\| |\lambda^+ - w^+| + |\lambda^- - w^-| \right\|_p$ is minimal, where $\|.\|_p$ is some selected L_p-norm.

Inverse linear programming problem is a relatively new emerged one. In 1996, Zhang and Liu presented the earlier trial on this problem in the case of changing coefficient of the objective function [11, 12].

Ravindara K. Ahuja and James B. Orlin in 2001 described inverse optimization in the following manner [1, 2]:

Let S denote the set of feasible solutions of an optimization problem P, let c be a specified cost vector; and be a given feasible solution; that is, $P = \min\{cx : x \in S\}$. The inverse optimization problem is perturb the cost vector c to d so that x^0 is an optimal element of P with respect to the cost vector d , and $\|d - c\|_p$ is minimal, where $\|\cdot\|_p$ denotes some selected L_p-norm .

Ahuja and Orlin considered inverse optimization problems under L_1-norm, where the objective is to minimize $\sum_{j \in J} w_j |d_j - c_j|$ and under the weighted L_∞ - norm, the objective is min max $\{w_j |d_j - c_j| : j \in J\}$. Here, w_j are specified weights [2].

Ahuja and Orlin (1998a) also provided various references in the area of inverse optimization. Compile several applications, and developed algorithms to solve general inverse problem [2].

Abuja and Orlin (1998b) specialized their inverse optimization algorithms to inverse network flow problem [1].

Saif (2006) provided the inverse multi-objective linear programming problem within two cases [9]:

(i) Change in the sum of coefficient decision variables.

(ii) Change in at least one the right-hand side constraint.

Saif also presented a comparative study of the inverse optimization problems.

In this paper, we present the derivation of the inverse goal linear programming problem of multi-objective function, and its solution under the L_1-norm. Also, we present algorithms for solving the inverse versions to study assignment problem.

2. FORMULATING THE INVERSE LINEAR GOAL PROGRAMMING PROBLEM OF MULTI-OBJECTIVE FUNCTION

We consider the inverse version of the following linear goal programming problem of the multi-objective function.

First: given a multi-objective linear pro ramming problem as follow [3, 4]:

(MOLP)

$$\left.\begin{aligned} &\min z_1 = f_1(x_1, x_2, ..., x_n), \\ &\min z_2 = f_2(x_1, x_2, ..., x_n), \\ &\quad \vdots \\ &\min z_k = f_k(x_1, x_2, ..., x_n) \\ &\qquad \text{such that} \\ &\quad g_j(x_1, x_2, ..., x_n) \geq b_j \qquad (j = 1, 2, ..., m), \\ &\qquad x_1, x_2, ..., x_n \geq 0, \end{aligned}\right\} \qquad (1)$$

where:

$\underline{x} = (x_1, x_2, ..., x_n)$ the n-vector of decision variables,

$Z_i \ (i = 1,2,..., k)$ the vector of an objectives according to priority,

$f_i(\underline{x}) \ (i = 1, 2, ..., k)$ the objective function associated with priority,

$g_j(\underline{x}) \ (j = 1, 2, ..., m)$ the left hand side of the objective function,

$b_j \ (j = 1, 2, ..., m)$ the right hand side of the constraint,

Second: the linear goal programming problem of the above problem is [5, 6]:

(LGMOP)

$$\left.\begin{aligned}
&\min \quad Z = \sum_{i=1}^{k}\left(w_i^{+} d_i^{+} + w_i^{-} d_i^{-}\right) && \text{(2a)}\\
&\text{such that}\\
&\sum_{l=1}^{n} c_{il} x_l + d_i^{+} - d_i^{-} = b_i \qquad (i = 1,2,...,k), && \text{(2b)}\\
&\sum_{l=1}^{n} a_{jl} x_l \geq b_j \qquad (j = 1,2,...,m), && \text{(2c)}\\
&x_l, \quad d_i^{+}, \quad d_i^{-} \geq 0, && \text{(2d)}
\end{aligned}\right\} \quad (2)$$

where:

$f_i(\underline{x}) = \sum_{l=1}^{n} c_{il} x_l \quad (i = 1, 2, ..., k)$ the left-hand side of the linear objective function;

$g_j(\underline{x}) = \sum_{l=1}^{n} a_{jl} x_l \quad (j = 1, 2, ..., m)$ the left-hand side of the linear structural constraint;

c_{il} , a_{jl} $(i = 1,2,..., k;\ j = 1,2,..., m;\ l = 1,2,..., n)$ constants,

$b_i = \begin{bmatrix} b_1 \\ b_2 \\ . \\ . \\ b_k \end{bmatrix}$: the goals set by the decision maker for the objective $(i = 1, 2, ..., k)$,

$b_j = \begin{bmatrix} b_1 \\ b \\ . \\ . \\ b_m \end{bmatrix}$: the right-hand side bound on the structural constraint $(j = 1, 2, ..., m)$,

w_i^{+}, w_i^{-} $(i = 1,2,..., k)$ given positive and negative weights vectors of the positive and negative deviation variables respectively,

d_i^{+}, d_i^{-} $(i = 1,2,..., k)$ tow vectors positive and negative deviation variables of the max or min goals, respectively.

Third: the dual of (LGMOP) is the following [4, 8]:

$$\left.\begin{array}{l} max\ \ V = \sum_{i=1}^{k} b_i y_i + \sum_{j=k+1}^{k+m} b_j y_j \\ \quad such\ that \\ \sum_{i=1}^{k} c_{il} y_i + \sum_{j=k+1}^{k+m} a_{jl} y_j \le 0, \\ \quad y_i \le w_i^- \qquad (i = 1,2,..., k), \\ \quad -y_i \le w_i^+ \qquad (i = 1,2,..., k), \\ \quad y_i \quad : unrestricted\ in\ sign, \end{array}\right\} \qquad (3)$$

where:

y_i , y_j $\quad (i = 1,2,..., k \ ; \ j = k+1, k+2,..., k+m)$ are the dual variables with the constraint (2b), (2c) respectively.

Fourth: let X^O given feasible solution vectors,

d^{+o} , d^{-o} given two vectors denote the feasible positive deviation and feasible negative deviation points of the max or min goals, respectively, of problem (2),

and let B denote the index set of binding constraints (2b), (2c) with respect to X^O where:

$$B = \left\{ j \in J : \sum_{i=1}^{k} c_{il} x_l^o + d_l^{-o} - d_l^{+o} = b_i \ \ (i = 1,2,..., k), \ \sum_{i=1}^{k} a_{jl} x_l^o = b_j \right\} \qquad (4)$$

We only care about binding constraints and the dual decision variables y for binding constraints.

Fifth: using condition (4) in problem (3), we can formulate the inverse goal linear programming problem of multi-objective function under the L_1-norm according to the set of binding constraint B as follows.

(I LGMOP)

$$\left.\begin{array}{ll} min \quad Z_{inv} = \sum_{i=1}^{k} \left[\left| w_i^+ + \lambda_i^+ \right| + \left| w_i^- + \lambda_i^- \right| \right] = \sum_{l=1}^{n} \left(\theta_l^+ + \theta_l^- \right) & (5a) \\ \quad such\ that & \\ \sum_{l \in B} c_{il} y_i + \sum_{j=k+1 \in B} a_{jl} y_j - \left(\theta_l^+ + \theta_l^- \right) = 0, & (5b) \\ y_i - \theta_l^- = w_i^- \qquad (i \in B), & (5c) \\ -y_i - \theta_l^+ = w_i^+ \qquad (i \in B), & (5d) \\ y_i \ : unrestricted\ in\ sign \quad (i \in B), & (5e) \\ y_j \ge 0 \ , \forall\ j \in B \quad ; \quad \theta_l^+, \theta_l^- \ge 0 \quad (i \in B), & (5f) \end{array}\right\} \qquad (5)$$

3. THE SOLUTION OF INVERSE LINEAR GOAL PROGRAMMING PROBLEM OF MULTI-OBJECTIVE FUNCTION UNDER L_1 -NORM

Let us solve the inverse linear goal programming problem of multi-objective in problem (5) by following steps:

Step (1): we use the equation (4) to find the equivalent formulation for the problem (5):

$$\left.\begin{aligned} min \quad & Z'_{inv} = \sum_{i=1}^{k}\left(w_i^{+} d_i^{+'} + w_i^{-} d_i^{-'} \right) \\ & \text{such that} \\ & \sum_{i\in B} c_{il} y_i' + d_i^{-'} - d_i^{+'} = b_{i\in B}, \\ & \sum_{i\in B} a_{jl} y_j' \geq b_{j\in B}, \\ & d_i^{-'}, d_i^{+'}, y_i', y_j', w_i^{+}, w_i^{-} \geq 0, \end{aligned}\right\} \quad (6)$$

where:

$b_{i\in B}$ the value b_i according to B,

$b_{j\in B}$ the value b_j according to B,

We note that the inactive constraints are cancelled.

Step (2): we find the dual problem of the problem in equation (6):

$$\left.\begin{aligned} min \quad & V'_{inv} = \sum_{i=1}^{k} b_{i\in B} x'_i + \sum_{j=k+1}^{k+m} b_{j\in B} x'_j \\ & \text{such that} \\ & \sum_{l\in B} c_{li} x'_i + \sum_{j=k+1\in B} a_{lj} x'_j \leq 0, \\ & x'_i \leq w_i^{-} \qquad (i = 1,2,...,k), \\ & -x'_i \leq w_i^{+} \qquad (i = 1,2,...,k), \\ & w_i^{+}, w_i^{-} \geq 0 \;, x'_j \geq 0 \;, \quad x'_i : \text{unrestricted in sign} \end{aligned}\right\} \quad (7)$$

Step (3): we find $\left(w_i^{+} \right)^{\nu}$, $\left(w_i^{-} \right)^{\nu}$

$$\left(w_i^{+} \right)^{\nu} = w_i^{+} - \left[\sum_{l\in b} c_{li} x'_l + \sum_{j\in b} a_{ji} x'_j - x'_i \right], \quad (8)$$

$$\left(w_i^{-} \right)^{\nu} = w_i^{-} - \left[\sum_{l\in b} c_{li} x'_l + \sum_{j\in b} a_{ji} x'_j + x'_i \right], \quad (9)$$

Step (4): find the solution of the inverse goal linear programming of multi-objective (optimal value for weight λ^{+} , λ^{-}) as follow:

$$\lambda_i^{+} = \begin{cases} w_i^{+} - \left| \left(w_i^{+} \right)^{\nu} \right| & , \quad \left(w_i^{+} \right)^{\nu} > 0 \\ w_i^{+} + \left| \left(w_i^{+} \right)^{\nu} \right| & , \quad \left(w_i^{+} \right)^{\nu} < 0 \\ w_i^{+} & , \quad \left(w_i^{+} \right)^{\nu} = 0 \end{cases} \quad (10)$$

$$\lambda_i^- = \begin{cases} w_i^- - \left|\left(w_i^-\right)^\gamma\right| & , \ \left(w_i^-\right)^\gamma > 0 \\ w_i^- + \left|\left(w_i^-\right)^\gamma\right| & , \ \left(w_i^-\right)^\gamma < 0 \\ w_i^- & , \ \left(w_i^-\right)^\gamma = 0 \end{cases} \qquad (11)$$

4. APPLICATION OF INVERSE LINEAR GOAL PROGRAMMING PROBLEM OF A MULTI-OBJECTIVE FUNCTION IN AN ASSIGNMENT PROBLEM

The previous results for I.L.G.P of multi-objective can be used to study the inverse version of the assignment problem.

The assignment problem is the following multi-objective linear programming Problem [7, 8]:

$$\begin{aligned} & minZ_L = \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}^l x_{ij} && (l = 1,2,..., k) \\ & \quad s.t. \\ & \sum_{j=1}^{n} x_{ij} = 1 && (i = 1,2,..., n), \\ & \sum_{i=1}^{n} x_{ij} = 1 && (j = 1,2,..., n), \\ & c_{ij}^l \geq 0 && (l = 1,2,..., n \ ; \ i = 1,2,..., n), \\ & x_{ij} \geq 0 && (l = 1,2,..., n \ ; \ i = 1,2,..., n), \end{aligned} \qquad (12)$$

Where:

$$x_{ij} = \begin{cases} 1 & \text{if employee } i \text{ is assigned to task } j, \\ 0 & \text{otherwise} \end{cases}$$

c_{ij}^l : is denoting to coefficient decision matrix form rank j

The goal programming of last assignment problem in problem (12) is shown as follows [4]:

$$\begin{aligned} & min \ Z = \sum_{i=1}^{n}\left(w_{ij}^{\ +} d_{ij}^{\ +} + w_{ij}^{\ -} d_{ij}^{\ -}\right) && (j = 1,2,..., n) \\ & \quad s.t \\ & \sum_{j=1}^{n} c_{ij}^l x_{ij} + d_{ij}^{\ +} - d_{ij}^{\ -} = b_{ii} && (i = 1,2,..., n \ ; l = 1,2,..., k), \\ & \sum_{i=1}^{n} x_{ij} = 1 && (j = 1,2,..., n), \\ & \sum_{j=1}^{n} x_{ij} = 1 && (i = 1,2,..., n), \\ & x_{ij}, \ d_{ij}^{\ +}, \ d_{ij}^{\ -} \geq 0, \end{aligned} \qquad (13)$$

The dual problem of problem in (13) as follow [7, 8]:

$$\left.\begin{aligned} max\ \ V &= \sum_{i=1}^{n} b_{ii} y_{ii} + \sum_{j=1}^{n} y_{jj} + \sum_{i=1}^{n} y_{ii} \\ &s.t \\ \sum_{i=1}^{n} c_{ij}^{l} y_{ii} + \sum_{j=1}^{n} y_{jj} + \sum_{i=1}^{n} y_{ii} &\le 0 \qquad (l = 1,2,\ldots, k). \\ y_{ii} &\le w_{ii}^{-} \qquad (i = 1,2,\ldots, k). \\ -y_{ii} &\le w_{ii}^{+} \qquad (i = 1,2,\ldots, k), \\ y_{ii} &: \text{unrestricted in sign} \end{aligned}\right\} \quad (14)$$

The inverse assignment problem it means change in $\left(w_{ij}^{+}, w_{ij}^{-}\right)$ such that the feasible assignment becomes an optimal assignment.

Assume that the feasible solution X^{0} either 1 or 0, by use problem (5), with respect to X^{O} then the inverse assignment problem as linear goal multi-objective programming problem under L_1-Norm as follow:

$$\left.\begin{aligned} min\ \ U_{inv} &= \sum_{j=1}^{n} \left[\left|w_{ij}^{+} - \lambda_{ij}^{+}\right| + \left|w_{ij}^{-} - \lambda_{ij}^{-}\right|\right] = \sum_{i=1}^{n} \left|\theta_{ij}^{+} + \theta_{ij}^{-}\right| \qquad (j = 1,2,\ldots, n), \\ &s.t \\ \sum_{i=1}^{n} c_{ij}^{l} y_{ii} + \sum_{j=1}^{n} y_{jj} + \sum_{i=1}^{n} y_{ii} - \left(\theta_{ij}^{+} + \theta_{ij}^{-}\right) &= 0 \qquad (j = 1,2,\ldots, n), \\ y_{ii} - \theta_{ij}^{-} &= w_{ii}^{-} \qquad , \forall\, i \in J^{-}. \\ -y_{ii} - \theta_{ij}^{+} &= w_{ii}^{+} \qquad , \forall\, i \in J^{+}. \\ y_{ii} &: \text{unrestricted in sign} \quad (i = 1,2,\ldots, n), \\ y_{jj} \ge 0 \ , \quad \theta_{ij}^{+} \ ; \ \theta_{ij}^{-} &\ge 0 \qquad (j = 1,2,\ldots, n), \end{aligned}\right\} \quad (15)$$

Where:

$J^{-} = \{(i, j) : X_{ij}^{0} = 1\}.$

$J^{+} = \{(i, j) : X_{ij}^{0} = 0\}$

Using the result in equations (10), (11) gives us the following optimal cost vectors $\lambda_{ij}^{+*}, \lambda_{ij}^{-*}$ for the inverse assignment problem:

$$\lambda_{ij}^{+*} = \begin{cases} w_{ij}^{+} - \left|w_{ij}^{+} - \left[\sum_{(i,\ j)\in J^{-}} c_{ij} y_{ij} + \sum_{(i,\ j)\in J^{-}} a_{ji} y_{ij} - y_{ij}\right]\right| & , \ i = j \\ 0 & , \ otherwise \end{cases}$$

$$\lambda_{ij}^{-*} = \begin{cases} w_{ij}^{-} - \left|w_{ij}^{-} - \left[\sum_{(i,\ j)\in J^{-}} c_{ij} y_{ij} + \sum_{i,j)\in J^{-}} a_{ji} y_{ij} + y_{ij}\right]\right| & , \ i = j \\ 0 & , \ otherwise \end{cases}$$

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المشكلة العكسية لمشكلة البرمجة الخطية الصدفية وحيدة الهدف ومتعددة الأهداف ذات الأوزان

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ملخص

يتناول البحث إيجاد المشكلة العكسية لمشكلة البرمجة الخطية الهدفية الوحيدة والمتعددة الأهداف ذات الأوزان وذلك بالتغيير في معاملات دالة الهدف أو في الأوزان الذي يجعل من أي حل ممكن حلاً أمثلاً ومن ثم حل المشكلة العكسية باستخدام طرق حل مشاكل البرمجة الخطية وتطبيقاتها في الشبكات

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Effects of Some Gate Lip Shapes on Downpull Force in Dam Tunnels

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ABSTRACT

The gate which controls the flow through the dam tunnel is termed as lift gate. Such gates are subjected to the hydrostatic and hydrodynamics forces, since the flow passes over and beneath the gate and produces pressures at the top and bottom of the gate surfaces. The differences between these two pressure forces are termed as downpull force. The evaluation of this force is very important due to its effects on closure of the gate, its positive and / or negative values.

The estimation of downpull force requires the determination of top and bottom pressure coefficients for wide range of discharges, gate openings, velocity, and pressure distribution in many locations .For the present research these measurements have prepared for different types of gate lip shapes along with laboratory hydraulic tunnel model which have been used. Various flow conditions and gate openings have been examined .The results concluded from the measurements and analysis tend to confirm the effects of the gate lip shapes on the values of downpull force, which in case of its negative value will prevent the gate to close and make some failures and damages.

INTRODUCTION

Lift gates are among the common types of gates used for regulating the flow of water through the large conduits and outlets. One type of such gates is the tunnel gates which operate through a shaft located at a distance from the inlet of the tunnel and exposed to two main forces. The first one results from the flow passing over the gate top surface while the second one produced from flow issuing beneath the bottom gate surface.

The difference between these two forces induces an unbalanced force which may be in the downward direction, called a hydraulic downpull force, or in the upward direction termed negative downpull or uplift force. Since the magnitude of the downpull force affects the design of the gate –hoisting equipment, about which hydraulic engineers and designers greatly predict.

The evaluation of hydraulic downpull forces for various relevant parameters has been studied by many researchers .Cox et al [1] have developed a dimensionless relationship among many hydraulic variables for estimating the stability of the gate .Naudascher et al [2] have conducted

experiments on a hydraulic air model to formulate the effects of many parameters on high head leaf gates . The formulation can be expressed as follows:

$$F_d = (K_t - K_b).B.d.\rho.V_j^{\,2} / 2 \quad \text{.....(1)}$$

$$K_t = (H_t - Y_s)/(V_j^{\,2} / 2g) \quad \text{.....(2)}$$

$$K_b = (1/B.d)\iint [(H_i - Y_s)/(V_j^{\,2} / 2g)]dB.dX \quad \text{.....(3)}$$

Where:
Fd: downpull force,
B: gate width,
d: gate thickness,
ρ: water mass density,
Vj: velocity at the vena contracta beneath the gate,
Ht: piezometric head on gate on gate top surface,
Hi: piezometric head at a point on gate bottom surface ,and
Ys: piezometric head in the contracted jet.
The downpull force can also be expressed as follows [3]:

$$F_d = F_t - F_b \quad \text{.....(4)}$$

Or

$$F_d / 0.5\rho A V_j^{\,2} = F_t / 0.5\rho A V_j^{\,2} - F_b / 0.5\rho A V_j^{\,2} \quad \text{.....(5)}$$

Where:
Ft, Fb: forces on the top and bottom gate respectively ,and
A : appropriate cross sectional area of the gate.
The downpull force can also be expressed in terms of upstream head as shown below[8]:

$$K_d = F_d / \gamma H A \quad \text{.....(6)}$$

Where:
γ :weight density of water, and
H: operating head, m .

Sagar et al [5] have reported that the numerous geometrical features of the gate influencing the downpull force can be formulated as follows :

$$Fd = f(H, Y/Y_o, e/d, \theta, b_1/b_2, d'/d, d/Y_o, r/d) \quad \text{.....(7)}$$

Where:
H :operating head,
Y/Yo :opening ratio,
(e/d,θ) : gate bottom geometry,
b1/b2 :gap width ratio,
d′/d :thickness ratio of the skin plate to the top assembly,
d/Yo :gate thickness ratio ,and
r/d :curvature radius on upstream bottom portion of the gate.

The relation between the maximum downpull force and the operating head has been formulated by Poondi research station [4] as follows:

$$Fd = 7.3H^{0.427} \quad \text{.....(8)}$$

Uppal and paul [7] indicate that for gate with bottom concave curvature , the maximum downpull can be expressed as follows :

$$Fd = 0.0418H^{1.625} \quad \text{.....(9)}$$

In this research the downpull force has been evaluated by using the data obtained from experiments conducted on systematic hydraulic model with many types of gate lip shapes [6] ,and compared the results with those obtained from previous works.

RESULTS AND DISCUSSION

The experiments were achieved by the run of hydraulic model included all measurements required for evaluating the downpull force , especially the top and bottom piezometric head distribution which was necessary for determination the top and bottom pressure coefficients (Kt and Kb) .

Fig.(1) shows the different types of gate shapes used in the current research . Figures (2 to 5) show the variation of (Kt , Kb) and downpull force coefficient (Kd) for various gate shapes and openings.

It can be seen from Figure (2) that the (Kt) and (Kb) are both high and caused the downpull force coefficient (Kd) to be negative in values for gate openings (Y/Yo=0.6,0.7,0.8 and 0.9) , this may be because the gate shape is with the lip extension .Figure (3) indicates that for gate with curvature upstream bottom (r/d=1),the (Kt) and (Kb) differ much in values and tend the values of (Kd) to be positive for all gate openings except (Y/Yo=0.8 and Y/Yo=0.9) .Figure (4) shows that for gate lip shape inclined with θ=35º,the values of (Kd) are positive for all gate openings. Figure (5) indicates that for gate lip shape inclined with θ=45º ,the values of (Kd) are positive for the gate openings (Y/Yo=0.2,Y/Yo=0.4,and Y/Yo=0.6),then seem to be negative for the remaining gate openings ratios.

CONCLUSIONS

The comparisons between the gate lip shapes considered in the present research indicate that the use of gate lip shape with θ=35º has kept the (Kd) values as minimum and reduced the effects of negative downpull.

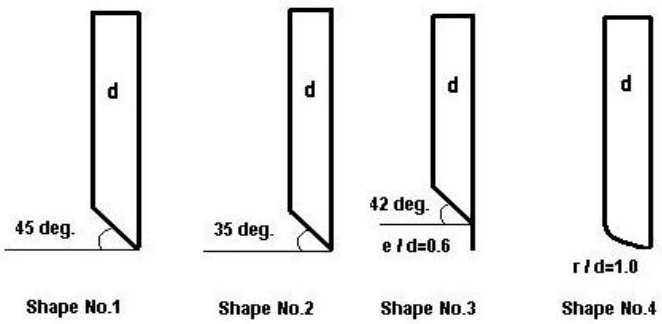

Figure (1): Lip gate shapes adopted in the analysis

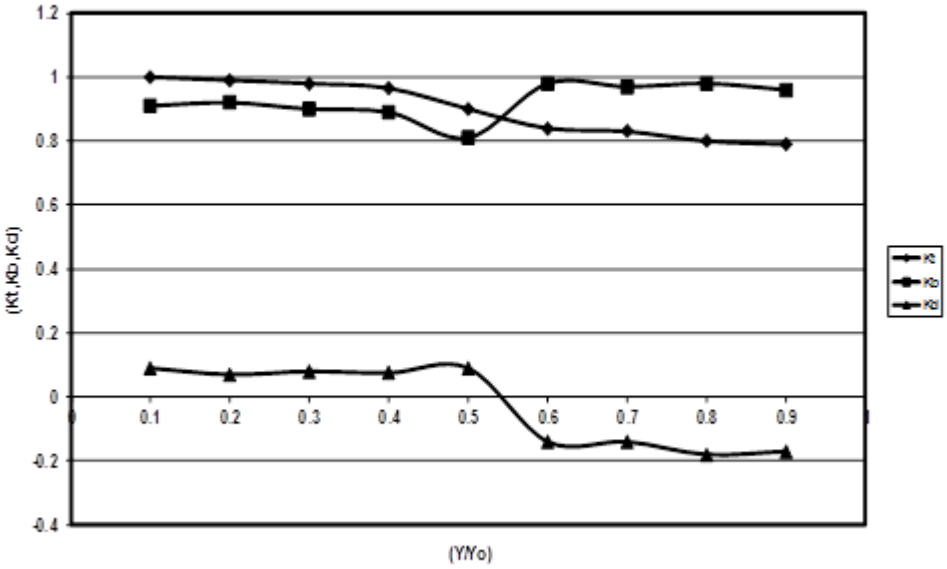

Figure (2):Variation of Pressure coefficients With Gate Openings.(Shape No.3)

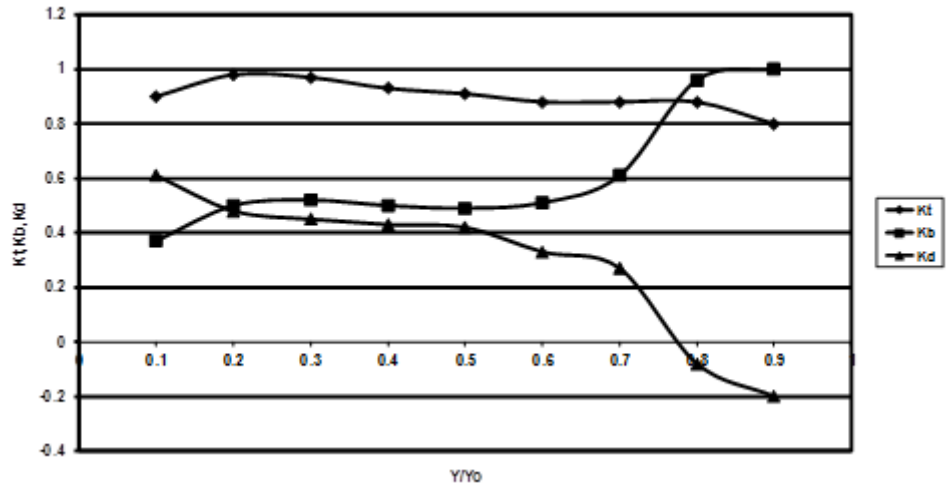

Figure (3):Variation of Pressure coefficients With Gate Openings.(Shape No.4)

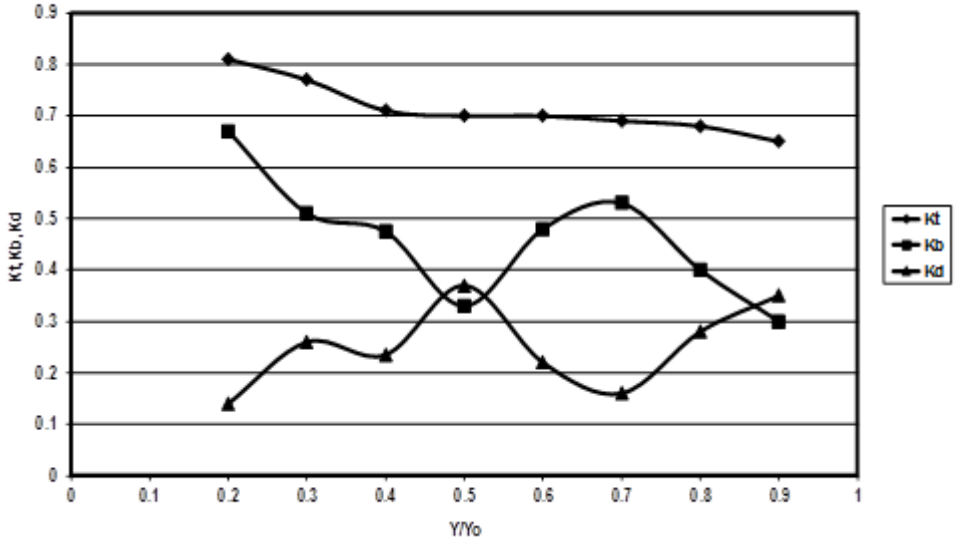

Figure (4): Variation of Pressure Coefficients with Gate Openings.(Shape No.2)

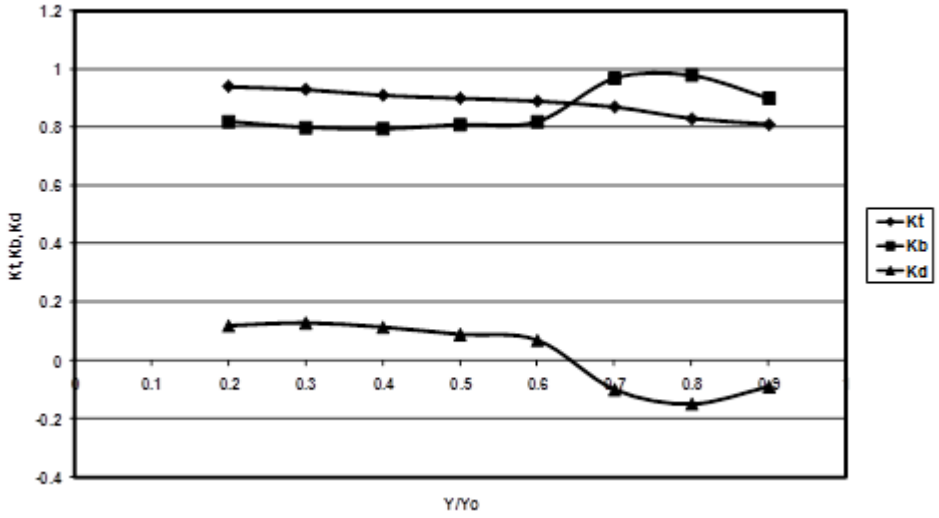

Figure (5):Variation of Pressure coefficients With Gate Openings.(Shape No.1)

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تأثير بعض أشكال أسفل البوابات على قوى السحب في أنفاق السدود

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ملخص

البوابة التي تسيطر على حركة الجريان في نفق السد يطلق عليها بوابة الرفع. هذا النوع من البوابات يتعرض الى قوى ستاتيكية وأخرى هيدروديناميكة نظرا لحركة الجريان من فوقها ومن تحتها ، وهذه الحركة تسبب حدوث ضغوط فوق البوابة وتحتها . يُدعى الفرق بين القوتين الناجمتين عن هذه الضغوط قوى السحب ، كما إن دراسة هذه القوى مهمة جدا بالنسبة لتأثيرها على إغلاق البوابات .

ويتطلب يجاد قيمة قوى السحب إيجاد قيم معاملات الضغوط في السطح العلوي والسطح السفلي للبوابة خلال مدى واسع من قيم التصريف وسرعة الجريان وتوزيع الضغوط مقابل قيم مختلفة لفتحات البوابة . في هذا البحث تم اختبار مجموعة من أشكال أسفل البوابة خلال قيم مختلفة من الجريان وفتحات البوابة في نموذج هيدروليكي لنفق السد . أكد تحليل نتائج القياسات على وجود تأثير لشكل أسفل البوابة على قيم قوى السحب ، خصوصا وأن القيم السالبة ستؤدي الى منع إغلاق البوابة حيث ستترتب عليه مخاطر وفشل في السد.

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دراسة إمكانية استعمال متغير تراكم الغيوم في حساب كمية الإشعاع الشمسي الكلي الساقط على الأراضي اليمنية

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ملخص

محدودية توفّر البيانات حول كمية الإشعاع الشمسي الكلي المرتبط بنسب تراكم الغيوم من محطات الرصد المناخي في اليمن تستدعى ضرورة استخدام الطرق غير المباشرة لحساباته ، و قد استخدمنا الطريقة المنهجية المقترحة من قبل الباحثين لبيرلياند.ت.ج ـ سروكينوي. ل.أ التي تعطى إمكانية لحساب هذا الإشعاع الشمسي باستخدام كمية الغيوم الحقيقية $\mathbf{n_s}$ المتواجدة في مراكز شبكة زوايا خطوط العرض ـ الطول كل $5^o \times 5$ ، التي تتطلب فقط بيانات شهرية حول نسب تراكم الغيوم ، التي يمكن أن تأخذ من الشبكة بدلالة إحداثيات زوايا خطوط الطول والعرض للمنطقة المعنية و دون الرجوع لمعرفة القيم الحقيقية لتراكم الغيوم للموقع المعني من مراكز الرصد المناخي$\mathbf{n_1}$.

تشير نتائج البحث إلى أن النسبة السنوية لمعدل انحراف كمية الإشعاع الشمسي الكلي عند تراكم الغيوم المحسوب بطريقة لبيرلياند.ت.ج ـ سروكينوي.ل.أ $\mathbf{Q_{Rns}}$ ، عن كمية الإشعاع الشمسي الحقيقي المأخوذ مباشرة من مراكز الرصد المناخي Q_F ، لكل من: عدن ، والريان ، وبريم ، وكمران و صنعاء على التوالي قد بلغت $|\Delta_A|=15.3\%$ $|\Delta_R|=11.3\%$ ، $|\Delta_P|=11\%$ ، $|\Delta_K|=8.3\%$ ، $|\Delta_S|=14.5\%$ ، وهي نسب تدخل في مجال المسموح به باستخدام النتائج النظرية للإشعاع الشمسي الكلي المحسوب بمعادلة لبيرلياند.ت.ج المرتبط بمتغير تراكم الغيوم $\mathbf{n_s}$ ، في الحسابات الحرارية لتصميم مجمعات و محطات الطاقة الشمسية. كما تؤكد هذه النتائج إمكانية استخدام متغير تراكم الغيوم n_s في حساب الإشعاع الشمسي الكلي $\mathbf{Q_{Rn1}}$ لأي موقع إحداثي في اليمن بدلا عن $\mathbf{Q_F}$ في حالة عدم توفره أو توفر قيمة معامل تراكم الغيوم الحقيقي $\mathbf{n_1}$ في مراكز الرصد المناخي اليمني.

الكلمات الدالة : حساب حراري ، الإشعاع الشمسي ، تراكم الغيوم ، اليمن.

المقدمة

إن مشكلة تأمين استمرارية مصادر الطاقة التقليدية لتغطية متطلبات البشرية الصناعية والزراعية و الاجتماعية من جهة ، وما تتركه من مخلفات و نفايات تضر بالبيئة البشرية و الطبيعية من جهة أخرى ، إضافة إلى ما تم عرضه في مداولات مؤتمر كوبنهاجن 2009 م حول الأثر السلبي للطاقة على البيئة كل ذلك يجعل مسألة الحصول على طاقة بديلة تحتل موقعا متقدّما في دائرة اهتمام كل دول العالم المتقدم والنامي على حد سواء ، بغض النظر عما يمتلكه البعض من احتياطيات هائلة من

النفط و الغاز الطبيعي كون تلك المصادر قابله للنفاد و النضوب الحتمي [1] . مع الإشارة إلى أن اليمن و المنطقة العربية تدخل في دائرة الدول التي تمتلك أعلى إشعاع شمسي في العالم ، إذ تصل كثافة الإشعاع الشمسي فيه كحد أقصى $1000\ W/m^2$ في منتصف النهار و بمتوسط من $250 - 300\ W/m^2$ ، أي بما يعادل $6\ kW.h/m^2/day$ [11,18] .

واليمن كغيرها من تلك الدول تشعر بخطورة المؤثرات السابقة و بالقلق من الجوع الطاقي المستقبلي كونها تعاني فعلا من انخفاض في معدل إنتاجها من النفط خلال الأعوام الماضية [2] ، كل ذلك يقابله دراسات وأبحاث تشير إلى ما تملكه اليمن من إمكانات تكنولوجية متاحة تتنبأ لها بإشراك مصادر من الطاقة البديلة و منها الطاقة الشمسية لتوليد نسبة من الطاقة الكهربائية الكلية تصل إلى حوالي 12% بحلول عام 2020 م [5]. مما يفتح مستقبلا أوسع لاستثمار الطاقة الشمسية فيها وخفض استنزاف احتياطياتها من المخزون النفطي المؤكد.

أهمية البحث

تبرز أهمية البحث في إيجاد قيم حسابية لكمية الإشعاع الشمسي الكلي لا تنحرف كثيرا عن قيم كمية الإشعاع الشمسي الحقيقي الكلي المسجلة بمحطات مراكز الرصد المناخي اليمنية لاستخدامها في الحسابات الحرارية . و يمكن أن تستعمل هذه القيم الحسابية بدلا عن القيم المسجّلة للإشعاع الشمسي الكلي لتلك المناطق التي لم تتوفر لها مثل تلك القيم و الراغبة في استثمار تكنولوجيا الطاقة الشمسية. إذ وجدنا أن إحصائية بيانات قيم كميات الإشعاع الشمسي الكلي بوجود الغيوم المسجّلة في محطات الرصد المناخي في اليمن إما أن تكون صعبة الحصول عليها أو غير متوفرة على الإطلاق لأغلب المواقع الفلكية اليمنية ، بسبب قلّة عدد المحطات أو التباعد فيما بينها، مما يؤدي إلى عرقلة مباشرة في تنفيذ الكثير من مشاريع الطاقة الشمسية الكهربائية أو الحرارية خصوصا في الأرياف و المناطق النائية .

الجهات المستفيدة من نتائج البحث

يمكن أن يستفيد من نتائج هذا البحث الأفراد في المجتمعات الريفية ، وكذا كل من وزارة الكهرباء ، وزارة الزراعة و الري ، وزارة المياه و البيئة ، وزارة النفط و المعادن عند وضع خططها ألاستراتيجيه الحالية أو المستقبلية لتوليد الطاقة الحرارية أو الكهربائية من الوقود الاحفوري ، من خلال دمج نسب من الطاقة الكهروشمسية أو الحرارية للإنتاج الطاقي الكلي التقليدي في اليمن، لهدف ترشيد الاحتياطي المؤكد لمخزونها من النفط و الغاز الطبيعي وحماية البيئة من التلوث فيها.

هدف البحث

يهدف البحث إلى معالجة مسألة شحّه الحصول على بيانات للإشعاع الشمسي الشهري عند تراكم نسب من الغيوم تكون مقاربة لكمية الإشعاع الشمسي الكلي الحقيقي للمناطق الداخلة في إطار الموقع الفلكي لليمن، مما يسمح بتحليلها وإمكانية وضعها في منحنى بياني سنوي يساعد على الاستثمار في تكنولوجيا الطاقة الشمسية، إضافة إلى وضع منهج لحساب متوسط قيم كمية الإشعاع الشمسي الكلي بوجود نسب من تراكم الغيوم بواسطة معادلة حسابية أحادية المتغير(نسب تراكم الغيوم) و ترتبط فقط بزوايا خطوط العرض ـ الطول لأي موقع في لليمن و تحديد صحة نتائج عملها.

الحالة المناخية وإحداثيات الموقع المستهدف للبحث

يستهدف البحث كل الأراضي اليمنية الممتدة ضمن دائرتي زوايا العرض 12^o-20 شمالا ، وهذا يأخذ بالاعتبار المياه الإقليمية لجزيرة سقطرى ، و زوايا خطوط الطول التي تقع ضمن المنطقة الزمنية (42^o-) (`54^o.5-) . مناخه يتدرّج مابين حار رطب ومعتدل وصحراوي ، تتراوح ساعات سطوعه الشمسي بين 9.1-7.3 ساعة في اليوم و بمعدل سنوي من ساعات سطوع الشمس يصل إلى 3250 ساعة و يصل طول نهاره النظري مابين 11-13ساعة. وتبلغ كمية نسب تراكم الغيوم في المتوسط ما بين 2-3 نقطة وأحيانا قد تصل في الشتاء إلى 4 نقاط. المتوسط السنوي للأيام الخالية من السحب أكثر من 200 يوم. كما إن أكثر من 70% من مساحة اليمن تقل نسبة الغيوم فيها عن 30% [9,3].

منهجية وطرق البحث

ارتكز منهج البحث على الطريقة الحسابية والتحليل الإحصائي للبيانات النظرية و التطبيقية لكمية الإشعاع الشمسي الكلي بوجود الغيوم و معالجة نتائجها و تحديد درجة انحراف كمية الإشعاع الشمسي الكلي Q_{Rn1} المحسوب بطريقة تراكم الغيوم عن الحقيقي المرصود في مراكز الرصد n_1 بالإشعاع الشمسي الكلي Q_{Rns} المحسوب باستخدام معامل تراكم الغيوم n_s المأخوذ من الشبكة ، و مقارنه درجة انحراف كل منهما على حدة عن كمية الإشعاع الشمسي المأخوذ مباشرة من مراكز الرصد Q_F لتحديد مدى السماح باستعمال قيم كل من Q_{Rn1} و Q_{Rns} في الحسابات الحرارية و التصميمية بدلا قيم Q_F في حالة عدم الحصول عليها ، وقد تمّ لهذا الغرض استخدام المعادلة الرياضية المقترحة من قبل الباحثين لبيرلياند.ت.ج ـ سروكينوي.ل.أ التي استخدما فيها كمية تراكم الغيوم الحقيقية n_s المتواجدة في مراكز تقاطع الشبكة العالمية المرتبطة بزوايا خطوط الطول ـ العرض المقسمة وبفارق $5^o \times 5$ فيما بينها [10] . ولكي نستفيد من إمكانيات بيانات هذه الشبكة لتغطية متطلبات البحث قمنا باختيار جزء منها المحصور ما بين زوايا العرض (^{o}N20-12) ، و زوايا الطول (^{o}54-42`.5E)، (جدول(5)) وهو عبارة عن إحداثيات الموقع الفلكي الذي يحدد المساحة الإقليمية للجمهورية اليمنية ، من أجل حساب كمية سقوط الإشعاع الشمسي الكلي بوجود نسب من تراكم الغيوم n_s على كل متر مربع منه ، إذ أن حساب هذا الإشعاع الشمسي بهذه بالمعادلة 1 ، يتطلب فقط توفّر بيانات شهرية حول نسب تراكم الغيوم للمنطقة المعنية n_1 و في حالة غيابها يمكن أن تأخذ هذه النسب من شبكة تراكم الغيوم n_s الدولية بدلالة تقاطع إحداثيات خطوط زوايا الطول ـ العرض فيها و مساواتها أو مقاربتها بالموقع الفلكي لنفس المنطقة المعنية أو المستهدفة للبحث.

من تحليلنا و دراستنا للكثير من الأبحاث و الدراسات ذات العلاقة بحساب الإشعاع الشمسي الكلي عند تراكم الغيوم ، استنتجنا بان هناك الكثير من الطرق المنهجية والمعادلات المختلفة لحساب الإشعاع الشمسي الكلي المرتبط حلها بالكثير من المتغيرات الفيزوحرارية أو المناخية التي غالبا ما تكون بياناتها غير متوفرة أو دقيقة . من أهم تلك المعادلات الحسابية المرتبطة بحساب الإشعاع الشمسي الكلي للأغراض التطبيقية هو ما تم بحثه من قبل بعض الباحثين و انعكس في نماذجهم الحسابية غير المباشرة مستخدمين متغير نسب تغطية الغيوم لسماء المنطقة المعنية و غيره من المتغيرات الفيزوحرارية و المناخية المؤثرة في حساب هذا الإشعاع الشمسي ، يعتبر هذا المتغير مؤشر جيد للرصد المناخي وتكون قيمته مرتبطة بتغيرات شدة الإشعاع و بصورة خاصة في قيمة محصلته فالباحثين سافينوف ـ انقستريم اقترحا معادلة لحساب الإشعاع الشمسي الكلي الشهري

بوجود الغيوم آخذين بالاعتبار ضرورة معرفة مدة استمرارية الإضاءة الشمسية إضافة إلى إدخال معامل تجريبي يصف إمكانية الغيوم في تمرير الإشعاع الشمسي قصير الموجة [13]. أما العالم البيرت . ف فقد أشار إلى أن حساب قيمة هذا الإشعاع يتطلب معرفة متوسط ارتفاع الشمس للشهر المحدد [14] . في حين أوضح العالم افركييف .م.س بأن قيمة المعامل التجريبي في فصل الشتاء لا تعطي قيم جيده نظرا لعدم حساب اثر البيدو وهو ما يستدعى إيجاد بيانات إضافية لمعالجة ذلك[4] .أما معادلة كيريلوفا.ت.ب فتطلب معرفة كمية الغيوم و قيم المعامل الذي يصف إضعاف الغيوم للإشعاع الشمسي و نوع الغيوم [15]. الباحث بيرلياند ت. ج اقترح لحساب كمية الإشعاع الشمسي الكلي عند وجود الغيوم معادلة تتعلق فقط بمتغير واحد وهو معامل نسب تراكم الغيوم و معرفة الإحداثيات الفلكية للموقع المراد استثمار طاقته الشمسية [10] . كما أشارت علاقة بيج إلى أن حسابه الشهري يتم من خلال الربط بين كل من كمية الإشعاع الشمسي خارج الغلاف الجوي و عدد ساعات سطوع الشمس و درجة معامل الوضوح [19]. اقترح العالم اكراينتسفيم . ب .هـ معادلة لحساب قيم الإشعاع الشمسي الكلي اليومي و الشهري و لكنها ترتبط بمدة استمرارية إضاءة الشمس و بارتفاعها [12] ، العالمان ليو و يوردن عام 1960 اقترحا معادلة لحساب هذا الإشعاع ترتبط بضرورة معرفة ارتفاع الشمس و زاوية انحرافها و ساعة الوقت إضافة إلى معاملات فيزوحرارية و مناخية أخرى [20].

من خلال مناقشتنا و تحليلنا لعناصر هذه المعادلات التي تحسب الاشعاع الشمسي الكلي استنتجنا من ان اغلبها يتطلب بيانات إحصائية مناخية و رصدية كثيرة و متعددة ومختلفة الدقّة ومرتبطة بنظام دوري خاص عند القياس و الرصد والتسجيل مثل : كمية الغيوم المنخفضة و تصنيفاتها و ارتفاعاتها ، وعدد الأيام الصحو و شبه الصحو و الغائمة و مدة استمرارية الإضاءة الشمسية . و من المعلوم بان الحصول على هذه البيانات بالنسبة لمراكز الرصد المناخي اليمني غالبا ما تكون محدودة جدا أو غير متوفرة على الإطلاق مما يعني صعوبة في استثمار الطاقة الشمسية . و نتيجة لما تمّ مناقشته من المعادلات السابقة قمنا باختيار المعادلة التي اقترحها الباحث بيرلياند ت. ج لحساب كمية الإشعاع الشمسي الكلي عند وجود الغيوم التي نعتقد بأنها الأكثر إمكانية للتطبيق في الظروف المناخية للموقع الفلكي لليمن ، وكونها ترتبط بمتغير واحد هو معامل (تراكم الغيوم) تغطية الغيوم، لاسيما وإن اليمن يمتلك بعض البيانات الإحصائية النظرية و الحقيقية الجيدة لهذا المتغير و لفترة تمتد مابين 1941-1970 م لكل من مدينة عدن و الريان وهو عنصر أساسي يدخل في حل معادلة بيرلياند ت. ج ، و تكتب كالآتي [10]:

$$Q_c = Q_o\left[1-\left(an+bn^2\right)\right] \quad \ldots\ldots\ldots 1$$

Q_c : محصلة الإشعاع الشمسي الكلي بوجود نسب من تراكم الغيوم W/m^2 .

Q_o : محصلة الإشعاع الشمسي الكلي عند السماء الصافية W/m^2 ؛ جدول(3) .

n : متوسط نسب تراكم الغيوم لسماء الموقع قيد الدراسة ، و يعبّر عنه بجزء من الواحد الصحيح ، و يقاس بالنقاط .

a : معامل قيمته مرتبطة بزاوية خط العرض الموقع المعني بالدراسة . و يتم تعيينه من بيانات الجدول(1)،

b : معامل قيمته تساوي :0.38 . و المعاملان a,b تعيّنان حالة و تأثيرات الغيوم .

جدول (1): قيم المعامل a المستخدمة في المعادلة (1). [10]

زاوية خط العرض	10^o N	15^o N	20^o N
قيمة المعامل a	0.40	0.39	0.37

ولأجل التحقّق من صحة استخدام المعادلة 1 ، في حساب كمية الإشعاع الشمسي الكلي Q_{Rns} بوجود الغيوم لأي موقع فلكي في اليمن و مقارنتها بكمية الإشعاع الشمسي الحقيقي Q_F ، تمّ استخدام المعادلة 2 ، لتبيّن درجة انحراف قيم النتائج النظرية المتحصّل عليها من حل المعادلة 1 بالنسبة للقيم الحقيقية لمحصلة الإشعاع الشمسي الكلي Q_F المأخوذة مباشرة من بيانات محطات الرصد المناخي اليمنية ، التي تأخذ الصورة الرياضية الآتية :

$$\Delta = \frac{|Q_R - Q_F|}{Q_F} 100\% \ldots\ldots\ldots\ldots\ldots 2$$

Q_R : كمية الإشعاع الشمسي الكلي النظري و المحسوب من المعادلة 1 . W/m^2.
Q_F : كمية الإشعاع الشمسي الكلي الحقيقي المأخوذ مباشرة من محطات الرصد . W/m^2.
Δ : نسبة انحراف قيم الإشعاع الشمسي الكلي Q_R عند وجود الغيوم المحسوب بالمعادلة 1 ، بالنسبة لقيم الإشعاع الشمسي الحقيقي Q_F المأخوذة من البيانات الإحصائية لمحطات الرصد المناخي في الجمهورية اليمنية .

لقد استخدمنا في البحث ثلاث مراحل مترابطة :المرحلة الأولى تعمل على الحساب و المقارنة بين كمية الإشعاع الشمسي الكلي Q_{Rn1} المحسوب باستخدام نسب تراكم الغيوم الحقيقية n_1 ، و كمية الإشعاع الشمسي المأخوذ مباشرة من مراكز الرصد المناخي Q_F ، أما المرحلة الثانية فترتبط بنتائج المرحلة الأولى وتعطي مقارنه بين كمية الإشعاع الشمسي الكلي المحسوب باستخدام نسب تراكم الغيوم الحقيقية Q_{Rn1} و كمية الإشعاع الشمسي الكلي Q_{Rns} المحسوب باستخدام شبكة نسب تراكم الغيوم ns ، في حين تبين المرحلة الثالثة المقارنة بين كمية الإشعاع الشمسي المأخوذ من مراكز الرصد المناخي Q_F و كمية الإشعاع الشمسي الكلي Q_{Rns} المحسوب باستخدام شبكة تراكم الغيوم n_s .

وتنتهي كل مرحلة من المراحل الثلاث بتحديد درجة الانحراف بين قيم كل من كمية الإشعاع الشمسي المتحصل عليه في كل مرحلة ، حيث يتم في المرحلة الأولى : المقارنة مابين المعدل الشهري لقيم نتائج درجة الانحراف الإشعاع الشمسي المحسوب Q_{Rn1} عن الإشعاع الشمسي الحقيقي المرصود Q_F ، باستخدام العلاقة الآتية : $\Delta_1 = \frac{|Q_{Rn1} - Q_F|}{Q_F}\%$ و مقارنتها بقيم نتائج درجة الانحراف للمرحلة الثالثة باستخدام العلاقة الآتية : $\Delta_3 = \frac{|Q_{Rns} - Q_F|}{Q_F}\%$ ، أما نتائج

المرحلة الثانية فتبين درجة انحراف قيم Q_{Rns} بالنسبة لقيم Q_{Rn1} من خلال حل العلاقة $\Delta_2 = \frac{|Q_{Rns} - Q_{Rn1}|}{Q_{Rn1}}\%$.

وبعد تحليل نتائج كل معامل انحراف على حدة و التأكد من إن نتائج درجة معاملات الانحراف الكمي Δ_1 , Δ_2 , Δ_3 تقع في إطار المسموح لتلك المعادلات بالاستخدام لحل الحسابات الحرارية ، فيمكننا الاستنتاج بأن قيم Q_{Rn1} تقارب كميا Q_F وان قيم Q_{Rn1} تقارب كميا Q_{Rns} ، وهذا يعني أن Q_F تقارب كميا Q_{Rns} وهو ما سوف نسعى لإثباته مع نهاية هذا البحث ، وبالتالي يمكن التأكد من إمكانية استخدام معامل نسب تراكم الغيوم n_s في الأجواء اليمنية في حساب الإشعاع الشمسي الكلي Q_{Rns} باستعمال المعادلة 1 ، بدلا عن قيم الإشعاع الشمسي الكلي الحقيقي المأخوذ مباشرة من مراكز الرصد المناخي Q_F ، التي غالبا ما يكون الحصول عليها صعب جدا أو أنها غير موجودة على الإطلاق لأغلب مناطق ومدن و قرى الجمهورية اليمنية.

منهج حساب الإشعاع الشمسي الكلي بوجود نسب من تراكم الغيوم n_1 ، n_s في اليمن :

ارتكز حساب هذا الإشعاع الشمسي الكلي الشهري على المقارنة بين ثلاث مراحل حسابية الأولى تستخدم قيم المتغير الحقيقي لتراكم الغيوم n_1 ، و الثالثة متغير تراكم الغيوم n_s باستخدام الشبكة لكل شهر من أشهر العام بدلالة الموقع الفلكي اليمني المعني بالدراسة والمأخوذ من جدول 2 بالنسبة للمعامل n_1 أو الجدول 5 للمعامل n_s ، ومن ثمّ التعويض بقيمهما في معادلة 1 ، حسب متطلبات نوع المرحلة ، بعد ذلك نقوم بتحليل نتائج المعادلة1 لحساب كمية الإشعاع الشمسي الكلي عند وجود الغيوم n_s أو n_1 ، أما المعادلة 2 فنتائجها تستخدم لحساب درجة انحراف الإشعاع الشمسي النظري عن الحقيقي لكل مرحلة من المراحل الثلاث على حدة .

خطة البحث تسعى لمعرفة ما إذا كان بالإمكان استخدام قيم كمية الإشعاع الشمسي الكلي Q_{Rns} المحسوب باستخدام متغير تراكم الغيوم n_s بدلا عن قيم الإشعاع الشمسي الكلي الحقيقي Q_F المأخوذ من مراكز الرصد مباشرة في حالة عدم توفرها أم لا ؟ .

لذا فان نتائج المرحلة الأولى تؤدي إلى معرفة نسبة انحراف قيمة كمية الإشعاع الشمسي الكلي الحقيقي المباشر المرصود Q_F بالنسبة لقيمة كمية الإشعاع الشمسي المحسوب باستخدام معامل تراكم الغيوم الحقيقي Q_{Rn1} أما نتائج المرحلة الثانية : فتبحث فيها عن معرفة نسبة انحراف قيم الإشعاع الشمسي Q_{Rn1} باستخدام تراكم الغيوم الحقيقي n_1 بالنسبة لقيم كمية الإشعاع الشمسي الكلي Q_{Rns} باستخدام معامل تراكم الغيوم المتواجد في الشبكة n_s . في حين تشير نتائج المرحلة الثالثة إلى درجة انحراف قيم كمية الإشعاع الشمسي الكلي الحقيقي Q_F بالنسبة لقيمة كمية الإشعاع الشمسي الكليQ_{Rns} باستخدام معامل تراكم الغيم في الشبكة n_s ومعرفة مدى إمكانية استخدام قيم Q_{Rns} بدلا عن Q_F في حالة عدم توفرها .

بعد التأكد من أن قيم نسب معاملات الانحراف للحالات الثلاث ،Δ_3 ،Δ_2 ،Δ_1 ، تقع في مجال انحراف مابين 15.3% -7.7 (جدول 6) وهي من النسب المسموح باستخدامها في حل المعادلات الهندسية الحرارية ، وهذا يعني أن معدلات قيم كمية الأشعة الشمسية الداخلة في العلاقة Δ_1 تقترب من بعضهما وكذا الحال بالنسبة لمعدلات قيم معاملي الانحراف Δ_3 ، Δ_2 ، مما يعني بصورة غير مباشرة إن قيم كمية الإشعاع الشمسي Q_{Rns} تقترب من قيم كمية الإشعاع الشمسي Q_F . وهذا يعني امكانية الاستغناء عن قيم الإشعاع Q_F و استبدالها بقيم الإشعاع الشمسي Q_{Rns} ، لاسيما في حالة

عدم توفر بيانات مسجّلة لـ Q_F للمناطق اليمنية المحددة الإحداثيات المراد استثمار طاقتها الشمسية. و يتم ذلك من خلال إتباع الخطوات المبينة ضمن المراحل الثلاث الآتية :

المرحلة الأولى : حساب الإشعاع الشمسي الكلي باستخدام تراكم الغيوم الحقيقية Q_{Rn1}

* نحسب الإشعاع الشمسي الكلي بوجود الغيوم Q_{Rn1} باستخدام معامل تغطية الغيوم الحقيقي المأخوذ من مراكز الرصد المناخي في اليمن n_1 ، و مقارنته بقيمة الإشعاع الشمسي الحقيقي Q_F المأخوذ مباشرة من مراكز الرصد المناخي في اليمن .
* نحسب معامل الانحراف النسبي المئوي $\Delta_1\%$ باستخدام المعادلة 2 لإيجاد الانحراف الكمي بين قيم كل من الإشعاع الشمسي الكلي المرصود (الحقيقي) Q_F و قيم الإشعاع الشمسي الكلي النظري Q_{Rn1} المحسوب بالمعادلة (1) و باستعمال قيم نسب تراكم الغيوم الحقيقية المأخوذة من مراكز الرصد المناخي في اليمن n_1، لغرض المقارنة ومعرفة درجة الانحراف الكمي النسبي فيما بينهما ، وهل يقع ذلك الانحراف في مدى المجال المسموح باستبدال القيم النظرية Q_{Rn1} و إحلالها محل القيم الحقيقية Q_F في حل المعادلات الحسابية الحرارية و الهندسية أم لا ؟
* نحسب معامل الانحراف النسبي المئوي $\Delta 1\%$ باستخدام المعادلة 2 لإيجاد الانحراف الكمي بين قيم كل من الإشعاع الشمسي الكلي المسجل (الحقيقي) Q_F و قيم الإشعاع الشمسي الكلي النظري Q_{Rn1} المحسوب بالمعادلة (1) و باستعمال قيم نسب تراكم الغيوم الحقيقية المأخوذة من مراكز الرصد المناخي في اليمن n_1، لغرض المقارنة ومعرفة درجة الانحراف الكمي النسبي فيما بينهما وهل ذلك الانحراف يقع في مدى المجال المسموح باستبدال القيم النظرية Q_{Rn1} و إحلالها محل القيم الحقيقية Q_F في حل المعادلات الحسابية الحرارية و الهندسية أم لا ؟
* نحسب معامل الانحراف النسبي المئوي $\Delta 1\%$ باستخدام المعادلة 2 لإيجاد الانحراف الكمي بين قيم كل من الإشعاع الشمسي الكلي المسجل (الحقيقي) Q_F و قيم الإشعاع الشمسي الكلي النظري Q_{Rn1} المحسوب بالمعادلة (1) و باستعمال قيم نسب تراكم الغيوم الحقيقية المأخوذة من مراكز الرصد المناخي في اليمن n_1، لغرض المقارنة ومعرفة درجة الانحراف الكمي النسبي فيما بينهما وهل ذلك الانحراف يقع في مدى المجال المسموح باستبدال القيم النظرية Q_{Rn1} و إحلالها محل القيم الحقيقية Q_F في حل المعادلات الحسابية الحرارية و الهندسية أم لا ؟
* نحسب معامل الانحراف النسبي المئوي $\Delta 1\%$ باستخدام المعادلة 2 لإيجاد الانحراف الكمي بين قيم كل من الإشعاع الشمسي الكلي المسجل (الحقيقي) Q_F و قيم الإشعاع الشمسي الكلي النظري Q_{Rn1} المحسوب بالمعادلة (1) و باستعمال قيم نسب تراكم الغيوم الحقيقية المأخوذة من مراكز الرصد المناخي في اليمن n_1، لغرض المقارنة ومعرفة درجة الانحراف الكمي النسبي فيما بينهما وهل ذلك الانحراف يقع في مدى المجال المسموح باستبدال القيم النظرية Q_{Rn1} و إحلالها محل القيم الحقيقية Q_F في حل المعادلات الحسابية الحرارية و الهندسية أم لا ؟
* نحسب معامل الانحراف النسبي المئوي $\Delta 1\%$ باستخدام المعادلة 2 لإيجاد الانحراف الكمي بين قيم كل من الإشعاع الشمسي الكلي المسجل (الحقيقي) Q_F و قيم الإشعاع الشمسي الكلي النظري Q_{Rn1} المحسوب بالمعادلة (1) و باستعمال قيم نسب تراكم الغيوم الحقيقية المأخوذة من مراكز الرصد المناخي في اليمن n_1، لغرض المقارنة ومعرفة درجة الانحراف الكمي النسبي فيما بينهما وهل ذلك الانحراف يقع في مدى المجال المسموح باستبدال القيم النظرية Q_{Rn1} و إحلالها محل القيم الحقيقية Q_F في حل المعادلات الحسابية الحرارية و الهندسية أم لا ؟

* نحسب معامل الانحراف النسبي المئوي $\Delta 1\%$ باستخدام المعادلة لإيجاد الانحراف الكمي بين قيم كل من الإشعاع الشمسي الكلي المسجل (الحقيقي) Q_F و قيم الإشعاع الشمسي الكلي النظري Q_{Rn1} المحسوب بالمعادلة (1) و باستعمال قيم نسب تراكم الغيوم الحقيقية المأخوذة من مراكز الرصد المناخي في اليمن n_1، لغرض المقارنة ومعرفة درجة الانحراف الكمي النسبي فيما بينهما وهل ذلك الانحراف يقع في مدى المجال المسموح باستبدال القيم النظرية Q_{Rn1} و إحلالها محل القيم الحقيقية Q_F في حل المعادلات الحسابية الحرارية و الهندسية أم لا ؟

حل خطوات المرحلة الأول يتم من خلال الآتي :

i . نوجد قيمة المتوسط الشهري والسنوي لدرجات نسب تراكم الغيوم الحقيقية n_1 مقاسا بالنقاط لبعض مراصد مدن الجمهورية اليمنية المسجلة مابين 1941-1970م لكل من المواقع الآتية : عدن ، والريان ، ويريم ، وصنعاء و كمران . باستخدام بيانات الجدول 2 ، و من ثم نقسمها على عشرة و التعويض بها في المعادلة (1).

ii . نوجد قيمة الإشعاع الشمسي الكلي بغياب الغيوم Q_o ، بعد تحديد المواقع الفلكية للمواقع السابقة و اختيار اقرب زاوية للعرض بالنسبة لمواقعها الفلكية في الجدول (3) و الذي نجده يعادل 15^o شمالا و منها تعين قيمه لمتوسطه الشهري .

iii . نوجد قيمة المعامل a للمواقع اليمنية السابقة حسب مواقعها الفلكية بالنسبة لزاوية العرض ، ومن ثم اختيار زاوية خط العرض الأقرب لها في الجدول (1) والتي نجدها تعادل 15^o شمالا وبذلك تكون قيمته 0.39 .ومن ثم يتم التعويض بقيمته في المعادلة 1 لحساب كمية الإشعاع الشمسي الكلي Q_{Rn1} بوجود الغيوم n_1 لهذه المواقع المدروسة . أما قيمة المعامل b فقيمته ثابتة على الدوام لجميع المواقع و تساوي 0.38 .

iv . نحسب قيم الإشعاع الشمسي الكلي عند وجود الغيوم n_1 لكل أشهر العام Q_{Rn1} باستخدام معادلة بيرلياند ت.ج. وهي المعادلة 1، و ذلك بعد التعويض فيها بقيم العناصر الآتية $n_1;a;b;Q_o$، الداخلة في تركيبها باستخدام بيانات الجداول 1,2,3. وتقاس W/m^2 .

v . تسجل قيم الإشعاع الشمسي الكلي Q_{Rn1} المحسوب بقيم تراكم الغيوم الحقيقيةn_1 المتحصل عليها من حل المعادلة 1 ، لجميع أشهر العام و نسجلها في الجدول(4).

vi . للتأكد من مدى صحّة استخدام قيم نسب تراكم الغيوم الحقيقية n_1 (الجدول 2) في حساب الإشعاع الشمسي الكلي Q_{Rn1} باستخدام المعادلة 1 ، و معرفة نسبة درجة السماح التقني لها بالاستخدام في الحسابات الحرارية عند تصميم المحطات الشمسية ، ويتم التعبير عن ذلك بما يسمى بمعامل درجة انحراف القيم الحقيقية عن الحسابية $\Delta_1\%$.

و عليه تمّ استخدام المعادلة 2 لحساب قيم درجات الانحراف الكمي $\Delta_1\%$ لكافة أشهر العام لكمية الإشعاع الشمسي الكلي Q_{Rn1} المتحصل عليه من المعادلة 1 ، بالنسبة لكمية الإشعاع الشمسي الكلي الحقيقي المرصود مباشرة في محطات الرصد المناخي اليمنية Q_F من الجدول 2 . حيث إن قيم هذه المعامل يوضح الانحراف النسبي $\Delta_1\%$ بين قيم كميتي الإشعاع الشمسي المحسوب Q_{Rn1} بدلالة n_1 و الإشعاع الشمسي الحقيقي Q_F للمواقع المذكورة و تنعكس قيمها في بيانات الجداول 2,4 .

vii . يرسم شكل إحداثي لكمية الإشعاع الشمسي الكلي الساقط على لمدينة عدن تكون إحداثياته الصادي Q_F ، Q_{Rn1} والسيني أشهر السنة ، لمعرفة مدى انحراف قيم Q_F عن Q_{Rn1} ، إذ يلاحظ من تحليل الشكل 1 ، من إن مسار الانحراف الكمي خلال أشهر العام لكل من قيم Q_F , Q_{Rn1}

متقاربة وتقع في مجال القيم المسموح بها في الهندسة الحرارية مما يعني إمكانية استخدام قيم Q_{Rn1} بدلا من قيم Q_F في حالة التعذر في الحصول على قيم الأخيرة . إلا إن صعوبة الحصول على القيم الحقيقة لنسب تراكم الغيوم n_1 لكافة المواقع اليمنية من مراكز الرصد المناخي يعرقل حساب قيمة Q_{Rn1} ، و تحل هذه المسألة باستبدال قيم n_1 بقيم n_s المأخوذة من الشبكة ، وهو ما ستؤكده نتائج المرحلة الثانية.

جدول (2) : القيم الحقيقية للإشعاع الشمسي الكلي Q_F و نسب تراكم الغيوم الحقيقية n_1 المأخوذة مباشرة من محطات الرصد المناخي . W/m^2، و بالنقاط.

كمران		صنعاء		الريان*		عدن*		بريم		
15 °.20` 42 °.06` 6m		15 °.31` 44 °.18` 2190m		14 °.39 49 °.24 23m		12 °.50` 45 °.02` 3m		12 °.39` 43 °.24` 27m		N E H
Q_F	n_1	Q_F	n_1	Q_F	n_1	Q_F	n_1	Q_F	n_1	
215	2.3	244	1.7	270	2.5	250	4.0	240	2.9	***Jan***
256	3.2	285	2.2	296	2.5	288	3.0	260	3.3	***Feb***
300	2.3	332	3.3	320	2.5	332	3.0	310	3.0	*Mar*
310	3.1	340	3.5	330	2.5	340	3.0	320	3.4	***Apr***
245	3.0	255	1.9	260	2.5	255	2.5	250	3.3	***May***
300	3.9	331	2.2	340	2.5	331	2.0	330	3.7	*Jun*
300	4.3	312	3.0	320	2.5	318	2.5	310	3.9	***Jul***
310	2.8	313	4.0	330	2.5	319	2.5	320	3.2	***Aug***
320	4.5	318	2.2	340	3	324	2.5	320	3.9	***Sep***
310	2.3	317	1.5	320	2	317	2.0	300	2.4	*Oct*
250	1.7	275	1.5	290	2	286	2.5	280	3.7	*Nov*
210	3.1	260	4.0	280	2.5	260	3.0	270	3.8	*Dec*

المصدر: [17,7,6, 8,9,21] .N : شمال زاوية خط العرض ،E : شرق زراية خط الطول. * تعني إن القياس تم مابين أعوام 1941-1970م . h : ارتفاع المنطقة عن مستوى سطح البحر ، بالأمتار. n_1 : متوسط قيم نسب تراكم الغيوم : تقاس بالنقاط ، و قيمها تكون محصورة مابين 8 – 0.

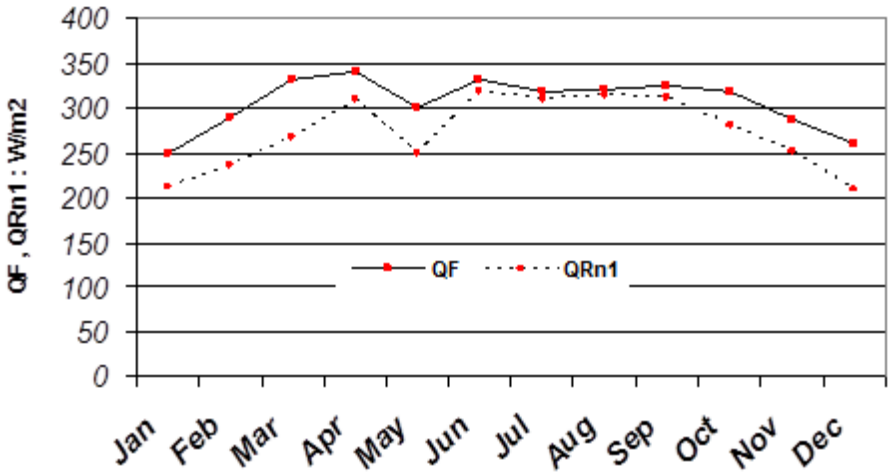
جدول (3): التوزيع السنوي للإشعاع الشمسي الكلي عند غياب الغيوم (عند السماء الصافية) Q_o الساقط على الموقع الإحداثي للجمهورية اليمنية المحصور مابين زوايا خطوط العرض 20^o N – 10^o (W/m^2)

20^o N	15^o N	10^o N	زاوية خط العرض
248	269	289	***Jan***
286	303	315	***Feb***
322	330	337	*Mar*
344	342	339	***Apr***
359	350	338	***May***
364	350	336	*Jun*
360	350	337	***Jul***
317	344	339	***Aug***
326	334	339	***Sep***
295	308	321	*Oct*
257	277	296	*Nov*
235	257	279	*Dec*

المصدر:[17] .

جدول (4): مقارنة بين قيم الإشعاع الشمسي الكلي Q_{Rn1} باستخدام نسب تراكم الغيوم الحقيقية n_1 ، وقيم الإشعاع الشمسي الكلي Q_{Rns} المحسوب بالمعادلة 1 باستخدام نسب تراكم الغيوم الحقيقية من الشبكة n_s ، مقاسا W/m^2.

الموقع	بريم		عدن		ريان		صنعاء		كمران	
	Q_{Rn1}	Q_{Rns}	Q_{Rn1}	Q_{Rns}	Q_{Rn1}	Q_{Rns}	Q_{Rn1}	Q_{Rns}	Q_{Rn1}	Q_{Rns}
Jan	230	232	211	212	237	232	248	201	240	232
Feb	251	233	237	257	237	234	271	215	253	233
Mar	280	254	345	280	281	254	274	232	294	254
Apr	282	284	310	338	250	286	279	284	301	286
May	291	295	317	240	288	295	319	290	297	295
Jun	281	286	317	337	332	287	313	297	279	286
Jul	277	284	317	340	340	284	326	284	267	284
Aug	288	290	312	332	255	290	270	292	296	290
Sep	264	273	312	348	331	273	290	275	250	276
Oct	272	298	279	296	318	319	287	295	274	298
Nov	224	234	251	272	319	234	256	230	256	234
Dec	205	233	208	235	324	233	200	235	215	190



شكل (1): مقارنة بين كمية و مسار الإشعاع الشمسي الحقيقي Q_F المأخوذ مباشرة من مراكز الرصد المناخي و الإشعاع الشمسي Q_{Rn1} المحسوب بمعامل تراكم الغيوم الحقيقي n_1 ، لمدينة عدن ، الجمهورية اليمنية.

المرحلة الثانية : حساب الإشعاع الشمسي الكلي بوجود نسب من تراكم الغيوم Q_{Rns}

i . نوجد قيم الإشعاع الشمسي الكليQ_{Rn1} باستخدام بيانات الجدول 4 نفسها لكافة المواقع .

ii . نحسب قيمة الإشعاع الشمسي الكلي بوجود الغيوم Q_{Rns} باستخدام المعادلة 1 و ببيانات مراكز شبكة زوايا خطوط العرض – الطول لتراكم الغيوم $5^o \times 5$ (المأخوذة من جدول 5) و نعوّض بها و بقيم العناصر الأخرى الداخلة فيها بتلك الموجودة في بيانات الجداول 1,3,5 . وقد اخترنا

من بيانات الشبكة العالمية المناخية $5^o \times 5^o$ التي تحدد كمية تراكم الغيوم n_s تلك التي لها علاقة بزوايا خطوط العرض – الطول ذات العلاقة بالموقع الفلكي لليمن و المحصور مابين – 10 20^o N . وبحل المعادلة 1 ، والتعويض بالعناصر الداخلة فيها، ويبين الجدول 4 نتائج حساب الإشعاع الشمسي الكلي Q_{Rns} .

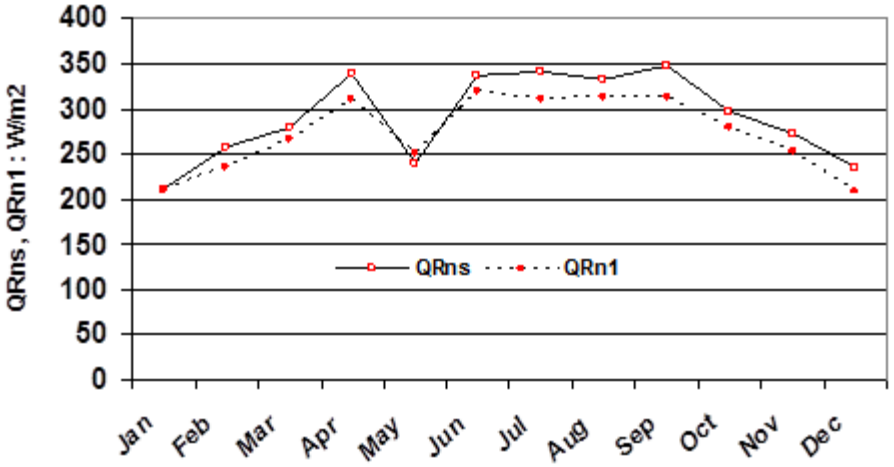
iii . نحسب قيم الانحراف الكمي Δ_2% لأشهر السنة بين القيم الحقيقية للإشعاع الشمسي الكلي Q_{Rn1} بوجود تراكم الغيوم الحقيقية n_1 و قيم كمية الإشعاع الشمسي الكلي Q_{Rns} بوجود الغيوم باستخدام بيانات شبكة $5^o \times 5^o$ لزوايا العرض – الطول لتراكم الغيوم على الأراضي اليمنية باستخدام قيم n_s من الشبكة ، ونجد هذه القيم في الجدول 6.

جدول (5): المتوسط الشهري لكمية تغطية الغيوم في أركان شبكة زوايا خطوط العرض - الطول $5^o \times 5^o$ في الموقع الإحداثي للجمهورية اليمنية n_s.مقاسا بالنقاط.

عرض N / الطول E	20^o / 40^o	20 / 45	20 / 50	20 / 55	15 / 40	15 / 45	15 / 50	15 / 55	10^o / 45^o
Jan	4.8	2.1	1.9	2.3	4.0	4.5	2.8	2.9	3.8
Feb	4.0	3.2	2.9	2.8	5.0	5.0	4.2	3.5	5.0
Mar	4.0	3.9	3.6	3.4	5.0	5.1	4.2	3.8	4.9
Apr	2.3	2.5	2.5	2.3	2.9	3.3	3.2	2.9	3.2
May	2.3	2.6	2.4	2.1	3.3	3.3	3.1	3.1	3.9
Jun	1.5	1.8	2.1	2.7	2.7	3.0	3.5	4.5	4.0
Jul	2.0	2.8	2.7	3.3	4.5	3.6	3.6	4.2	5.3
Aug	2.0	2.6	2.6	2.1	3.0	3.0	3.1	3.3	4.7
Sep	2.0	1.9	2.0	2.6	4.0	4.3	3.5	4.0	4.8
Oct	0.8	0.7	0.7	1.0	0.9	1.0	0.8	2.6	3.5
Nov	3.0	2.2	2.1	2.1	3.4	3.3	3.1	3.0	4.3
Dec	2.0	1.9	1.9	1.8	1.8	1.9	2.0	2.0	2.9

المصدر: [10]

iv . نرسم شكل بياني إحداثيّاته الصادي يمثل كمية الإشعاع الشمسي الكلي Q_{Rn1} ; Q_{Rns} مقاسا $W/^2$ و السيني يمثل أشهر السنة ، لهدف مقارنة نسبة الانحراف الكمي بين قيم كمية هذين الشعاعين و تحليل نتائج الانحراف و مساره ، الشكل(2).



شكل (2): مقارنه بين الإشعاع الشمسي Q_{Rn1} المحسوب بمعامل تراكم الغيوم الحقيقي n_1 و الإشعاع الشمسي Q_{Rns} المحسوب بمعامل تراكم الغيوم n_s المأخوذ من الشبكة الغيوم الدولية ، لمدينة عدن ، الجمهورية اليمنية.

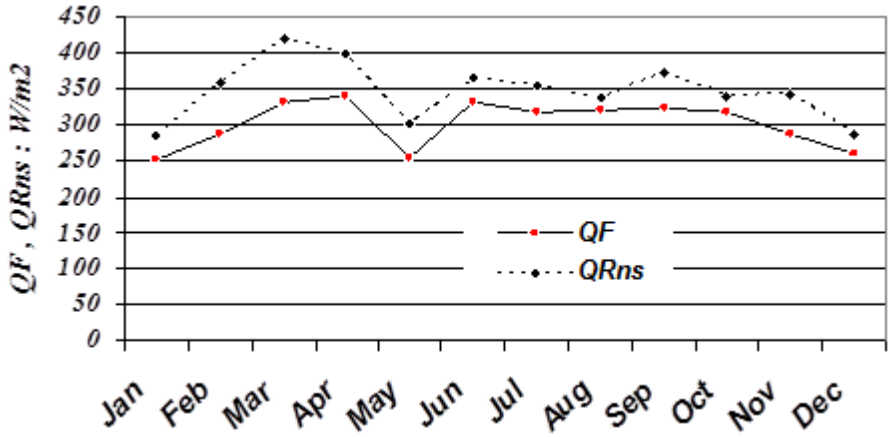
المرحلة الثالثة : المقارنة بين الإشعاع الشمسي الكلي الشهري Q_F و Q_{Rns} .

i . نوجد قيم الإشعاع الشمسي الحقيقي المرصود في مراكز الرصد المناخي اليمني Q_F باستخدام قيم بيانات جدول 2 . لاستخدامها في عملية معرفة مستوى الانحراف الكمي بين كمية الإشعاع الشمسي الحقيقي Q_F و الإشعاع الشمسي Q_{Rns} المحسوب بطريقة الشبكة المناخية للتغطية الغيوم في مجال حدود الموقع الاحداثي للجمهورية اليمنية ، جدول 4.

ii . نستخدم نفس قيم الإشعاع الشمسي بوجود الغيوم Q_{Rns} المدرجة في الجدول 4 .

iii. نحسب قيم الانحراف النسبي $\Delta_3\%$ لأشهر السنة ، ما بين القيم الحقيقية للإشعاع الشمسي الكلي بوجود الغيوم Q_F المأخوذة من الجدول 2 و قيم كمية الإشعاع الشمسي الكلي بوجود الغيوم باستخدام بيانات شبكة $5^o \times 5^o$ لزوايا العرض – الطول Q_{Rns} الساقط على أراضي الجمهورية المأخوذة من بيانات الجدول 4. وتسجّل نتائجه في الجدول 6.

iv . نرسم شكل بياني ألإحداثي الصادي فيه يمثل قيم كمية الإشعاع الشمسي الكلي الشهري ; Q_F Q_{Rns} ، والإحداثي السيني يمثل أشهر السنة . لهدف المقارنة و معرفة مدى درجة الانحراف الكمي فيما بينهما و حديد مساره ، شكل (3).



شكل (3): مقارنة بين قيم الإشعاع الشمسي Q_F المأخوذ مباشرة من مراكز الرصد و الإشعاع الشمسي Q_{Rns} المحسوب بمعامل تراكم الغيوم المأخوذ من شبكة الغيوم ns .لمدينة عدن ، الجمهورية اليمنية.

جدول (6): المعدلات السنوية لمعاملات انحراف قيم كمية الإشعاع الشمسي الكلي Q_{Rns} و Q_{Rn1} بالنسبة لقيم كمية الإشعاع الشمسي الكلي الحقيقي المأخوذ مباشرة من محطات الرصد Q_F الساقط على مواقع المحطات اليمنية : بريم ، وعدن ، والريان ، وصنعاء و كمران $\Delta_1\%$ ، $\Delta_2\%$ ، $\Delta_3\%$.

المعدل السنوي لمعامل الانحراف	المعادلة 2	بريم %	عدن %	الريان %	صنعاء %	كمران %
$\Delta_1\%$	$\frac{\lvert Q_{Rn1} - Q_F \rvert}{Q_F}\%$	12	10.8	8.3	10.7	7.3
Δ_2	$\frac{\lvert Q_{Rns} - Q_{Rn1} \rvert}{Q_{Rn1}}\%$	4.5	7.7	6.6	10	6
Δ_3	$\frac{\lvert Q_{Rns} - Q_F \rvert}{Q_F}\%$	11	15.3	11.3	14.5	8.3

النتائج و المناقشة

استنتجنا من خلال البحث في البيانات الإحصائية اليمنية حول المناخ بان الحصول على الإشعاع الشمسي الكلي بوجود نسب من التغيم لسماء عموم الجمهورية غير متوفرة أو منعدمة بشكل مطلق للكثير من المواقع الإحداثيّة لأغلب مدن و قرى و أرياف محافظات الجمهورية ، مما يربك المهتمين بمصادر الطاقة الشمسية من تنفيذ الخطط لاستثمارها بهدف ترشيد الوقود الكربوني وحماية البيئة [8].

ونتيجة لما قمنا به من مناقشة و تحليل للكثير من المعادلات الحسابية ذات العلاقة بحساب هذا الإشعاع الشمسي، وقع اختيارنا لمعادلة بيرلياند ت.ج. [10] من بين تلك المعادلات بسبب اعتمادها

المباشر على متغير واحد وهو معامل نسبة تراكم الغيوم الذي هو متوفر لدى بعض مراكز الرصد المناخي اليمني و له بيانات رصد مناخي تمتد إلى حوالي 30 عام (1970-1941) المسجلة في كل من محطات مراكز الرصد المناخي في مطاري عدن و الريان ، والبعض الأخر من تلك البيانات يمكن أن يتم أخذه من مراكز مراصد المناخ العالمي لعدم توفرها في اليمن [17,7,6] ، مع الإشارة إلى أن طول المدة الزمنية للرصد لقيم متوسط معامل تغطية الغيوم تعطي دقّة اكبر في النتائج ، مما يجعل حساب هذا الإشعاع أكثر اقترابا من القياسات الحقيقية .

كما استنتجنا من أن اليمن يتمتع بصفه عامة بمعامل نسبة تراكم غيوم منخفضة ، إذ يبلغ في متوسطه السنوي مابين 2-3 نقطة ، و قد يرتفع إلى حوالي 4 نقاط ، كما في جزيرة سقطرى و بعض المواقع في الجمهورية ، أما جزر كمران و بريم وجد أن اكبر كمية من تراكم الغيوم فيها تكون في يوليو وسبتمبر و قد تزيد أحيانا عن 3 نقاط بقليل و اقلها تكون في نوفمبر. و عليه يمكن القول بأن الخارطة المناخية السنوية لليمن بالنسبة لتغطية الغيوم تشير إلى أن جزء صغير من الأراضي اليمنية لا يزيد عن 30% ويشهد ارتفاع في كميات الغيوم و ذلك خلال فصل الشتاء حيث قد تصل في يناير إلى 4 نقاط ، في حين تظل باقي أشهر فصول السنة تتميز بتغير في كميات الغيوم لا تتعدى المتوسط العام [8].

مما سبق مناقشته ومن تحليل بيانات الجدول 4 و الأشكال 1,2,3 المتحصل عليها من حل المعادلة 1 و الجدول 6 المتحصل عليه من حل معادلة 2 يمكن استنتاج النقاط الآتية :

* إن استثمار تكنولوجيا الطاقة الشمسية يستلزم توفر بيانات حول الإشعاع الشمسي الكلي بوجود الغيوم ، وهذه البيانات غالبا ما تكون متوفرة لاماكن محدده فقط في اليمن ، مما يجعل التفكير في استثمار طاقة الشمس أكثر صعوبة و اقل مردود .
* اليمن تمتلك بيانات محدودة جدا حول الإشعاع الشمسي الكلي عند وجود الغيوم خلال أشهر العام ، مما يعني ضرورة البحث عن طرق غير تقليدية تقدم بيانات تغطي اغلب المواقع الفلكية اليمنية بهدف استثمار تكنولوجيا الطاقة الشمسية و بمرود عال .
* أظهرت نتائج البحث قدرة معادلة بيرلياند ت.ج. باستخدام بيانات تواجد الغيوم n_s في مراكز شبكة تقاطع زوايا العرض – الطول $5^o \times 5$ في حساب الإشعاع الشمسي الكلي الساقط على أي موقع إحداثي من الأراضي اليمنية المحصور بين خطوط زوايا العرض 20^o N – 10 و خطوط زوايا الطول المحصورة بين 55^o E – 40 ، بفارق 5^o فيما بينها(جدول 5)، على حل مسألة ذلك النقص في توفير تلك البيانات حول الإشعاع الشمسي الكلي بوجود الغيوم في حالة عدم توفّر قيمها الحقيقة من مراكز الرصد المناخي.
* تشير نتائج المرحلة الأولى بالنسبة لمدينة عدن كونها تمتلك إحصائية مناخية جيده من الإشعاع الشمسي الكلي و قيم نسب تراكم الغيوم (1941-1970) ، إلى أن قيم معدل معامل الانحراف % Δ_1 بين قيم الإشعاع الشمسي الحقيقي الكلي Q_F بالنسبة لقيم الإشعاع الشمسي Q_{Rn1} المحسوب بوجود نسب من الغيوم الحقيقية n_1 يتزايد من شهر ديسمبر و حتى شهر مارس و تتراوح قيمته ما بين 15-20% ، و في باقي الأشهر تتذبذب بين النسب 2-12% ، وهذا يعني أن قيم هذا المعامل تقع في مجال العمل المسموح به في الهندسة الحرارية ، مما ينتج عنه إمكانية استخدام Q_{Rn1} في الحسابات الحرارية المتعلقة بتقنيات الطاقة الشمسية بدلا من قيم Q_F في حالة عدم الحصول عليها من مراكز محطات الرصد المناخي المحلية.
* تشير نتائج المرحلة الثانية إلى إن قيم معامل الانحراف % Δ_2 بين كمية الإشعاع الشمسي Q_{Rn1} بالنسبة لكمية الإشعاع الشمسي Q_{Rns} تتراوح ما بين 1-12% مما يعني إمكانية استخدام قيم

نسب تراكم الغيوم n_s المأخوذة من بيانات مراكز شبكة الغيوم المحصورة في إطار الموقع الفلكي لليمن المحصور بين 20^oN – 12 المقسمة إلى $5^o \times 5$ بين كل من زوايا خطوط الطول ـ العرض (انظر جدول 5) بدلا عن قيم نسب تراكم الغيوم الحقيقية n_1 في حالة عدم الحصول عليها من مراكز محطات الرصد المناخي اليمني(جدول(2)).

* تشير نتائج المرحلة الثالثة إلى أن قيم معامل الانحراف Δ_3% بين قيم كمية الإشعاع الشمسي Q_{Rns} بالنسبة لكمية الإشعاع الشمسي Q_F بلغت في حدود 6-20% و بمتوسط سنوي لا يزيد عن 15% خلال أشهر العام ، هذه النسبة تعني إن الفارق الكمي بين كمية الإشعاع الشمسي الكلي المرصود بمراكز الرصد المناخي Q_F و كمية الإشعاع الشمسي الكلي Q_{Rns} المحسوب بمعادلة بيرلياند ت.ج ، باستعمال قيم تراكم الغيوم المأخوذة من شبكة الغيوم n_s ، يقع في حدود المسموح باستخدام Q_{Rns} في الحسابات الحرارية الهندسية بدلا عن كمية الإشعاع الشمسي Q_F في حالة تعذر الحصول على الأخيرة من مراكز الرصد المناخي.
* ارتفاع نسبة الانحراف Δ في بعض نتائج البحث إلى أكثر من 15% و التي لا تزيد عن 1/4 من مجمل النقاط للمواقع المدروسة ، وتعزى حسب استنتاجنا إلى التناقض بين بيانات المصادر المختلفة في تحديد كمية الإشعاع الشمسي الكلي الحقيقي [9, 18,21] .
* نتائج البحث في حالة تطويرها و توفّر دقة أعلى لبياناتها ، يمكن أن تساعد على وضع خرائط مناخية تعكس منحنيات تساوي الإشعاع الشمسي الكلي بوجود نسب من الغيوم بالتزامن مع منحنيات تساوي معاملات تغطية الغيوم بالنسبة لإحداثيات خطوط الطول ـ العرض الداخلة في مجال الموقع الاحداثي للجمهورية اليمنية .

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A study on the possibility of using cloud accumulation variable for calculating the total quantity of solar radiation falling on the Yemeni terrain

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Abstract

In the limitation of gathering actual data of the total amount of solar radiation in the presence of clouds from the climatological stations in Yemen, other indirect methods were used to calculate them. A systematic method suggested by two researchers in the literature, viz., Liberlyand T. G., and Sarukinoi, L. I. were applied to give the possibility of calculating the solar radiation by using the actual cloud quantity "ns" available at the stations. This requires only the monthly data of the percentage of the cloud quantity that can be taken from the network stations (coordinates) without referring to the actual values of the cloud quantity of the specified climatological stations "n1".

The results show that the percentage degree of deviation from the total quantity of solar radiation "QRns" when the clouds accumulate "ns" that were calculated using the method introduced by Liberlyand and Sarukinoi from the actual quantity of solar radiation "Qf" taken directly from the climatological stations for Aden, Riyan, Perim Island, Kamaran Island and Sana'a was $|\Delta_A| = 15.3\%$, $|\Delta_R| = 11.3\%$, $|\Delta_P| = 11\%$, $|\Delta_K| = 8.3\%$ and $|\Delta_S| = 14.5\%$ respectively.

These percentages are within the allowable ranges for the theoretical calculations in the thermal energy. Consequently, the results give evidence of the possibility for using the total quantity of solar radiation calculated from the cloud accumulation variable "ns" with the use of the theoretical total solar radiation "QRn1" in any station in Yemen instead of "Qf" if its value cannot be obtained or due to the limitation of getting the value of the actual cloud accumulation "n1" in the climatological stations.

Key words: Thermal calculations; Solar radiation; Clouds; Yemen.