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Study of Physico - Chemical and Nutritional Properties of Some Processed Pickles

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ABSTRACT

This study was conducted in the laboratories of the Department of Food Science/College of Agriculture, University of Tikrit for the period 2016/10/1 to 2017/10/1. Results of chemical composition of processed pickles. They included(E:Sour cucumber pickle, F: Carrot pickle with spices herps (slow method),G:Cucumber pickles(rapid method),H: Carrot pickles(rapid method), I: Cucumber pickle with spices(slow method herps), J:Soure carrot pickle) showed significant increase to values of moisture ,dry matter ,protein ,fat, ash, carbohydrate, acidity and pH to the pickles J,F.I.G,E,F,H and H respectively, which they were 95.380%, 6.795% ,2.150%, 0.805%, 3.415%,1.910% ,3.130% and 3.99 respectively .Results of physical properties indicated that pickles samples of E,H were significantly higher than the other treatments at hardness and TSS which they were 15.00 mm and 13.00%, respectively .At storage, results revealed a decrease in values of acidity and hardness and increases at pH .The concentrations of Pb ,Cu, and Zn in local pickles were within permitted limits of international organizations or specifications ,WHO, USDA. Concentrations of Zn ,Fe, Ca, and Mg in processed pickles were at the ranges of (0.01-0.11),(0.15- 0.22),(0.09-0.15) and (0.01-0.17) M/ml .Results showed that the highest content of vitamins B_1,B_2,B_6,B_9,B_3 and C were16.921,13.297 , 17.451,20.086 , 24.117,and12.597 M/ml for E,E,G,J,F, and H samples respectively .The total phenolic compounds content was within the range of 12.00-15.50mg/100g for each G,J respectively. While TPC content of fresh fruits L,K was 16.90 and 14.90 mg/100g respectively .The higher content of salicalic acid ,vanillin , catechol and recoresenol was revealed at H, E, E, and K samples ,its value was 17.0, 12.0, 8.4, 5.0 M/l respectively .

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INTRODUCTION

Fermentation had been practiced since ancient times to conserve and store food. Fermentation had been taken place for thousands of years without understanding its microbial mechanism until the 19th century (Irkin and Songun,2012). Fermented beverages had appeared in Babylon since 5000 BC ,in ancient Egypt since 3150 BC, in Mexic since 2000 BC and in Sudan since 1500 BC, the first fermentation processes included the production of beer in Babylon, soy sauce in Japan and China, fermented milk drinks in the Balkans and middle Asia(Maki,2004). Fermentation is one of the oldest methods of food preservation and has many benefits as it works to give taste, smell, color and textures to fermented food make the food is different from the raw material made from them (Choi et al, 2013) .In addition, the process of fermentation is of good nutritional importance,Which increases the nutritional value by the production of some vitamins, such as B_6 and B_{12}, and transforms the complex nutrients that are not digestible by humans to easy digestible compounds (Bamforth, 2005). Fruits

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and vegetables are a major component of fermentation and processing of pickling. They play an important role in providing a balanced diet, especially in terms of micronutrients, which provide the body, vitamins and minerals necessary to build and keep it active(Mani,2017). In addition, fruits and vegetables are good sources of natural antioxidants such as carotenoids, flavonoids and polyphenols. At present the world produces about 52.2 million tons of fruits and vegetables. A large part of this product is exposed to damage during circulation, transportation and storage. The loss is estimated at 25-30% lack of means to extend the period of conservation so, it was resorted to search for ways to preserve food and protect it from damage so, fermentation and pickling were used (BBS 2010). The objective of this study was to estimate the changes in the chemical and physical properties of some processed pickles and estimate some vitamins and phenolic compounds in them

Materials and methods:

First: Rapid making Method:

This method was used to pickle cucumbers and carrots according to Ingham (2002) which included :

1- Cucumber pickling (Pickle G):

Ingredients: Cucumber (1 kg), Water (2 liters), Salt (62.5 g) ,Herb seeds(dill, mustard, celery) 3g to each of it.

The pickling solution consists of:

White vinegar concentration of 5% (400 ml), Salt (42 g), Sugar (14 grams), Water (528 ml)

Method:

1- Selection of cucumbers which is suitable for pickling , performed on the basis of size, shape and type, and washed with water well.

2-Brine solution was prepared by dissolving the amount of salt in the specified water volume.

3 - Cucumber fruits were soaked with brine solution in a suitable container and left for 12 hours and then discharged from the solution.

4 - Appropriate glass containers cans were prepared and sterilized with their covers by boiling with water for 15 minutes and packaged with fruits and herbs.

5 – The hot pickling solution was prepared by (dissolving salt, sugar, vinegar and water in specified quantities mentioned above and heating to boiling) leaving a head space aboat of half inch and removing bubbles formed.

6 – Cans was sealed tightly and sterilized with boiled water for 15 minutes and then kept at room temperature until conducting the tests.

2-Macking of carrot pickles (pickle H):

Ingredients: Carrot (1 kg) ,White vinegar concentration 5% (366 ml), Water (66.5 ml), Sugar (55.5 g),Salt (5.5 g), citric acid 1.5 g

Method:

1 - Fruits suitable for picking were sorted on the basis of size and shape ,washed with a ragged cloth to remove all outstanding impurities and cut with form of rings of thickness of 2 cm.

2. Salt and sugar were dissolved with water and vinegar and heated the solution to boiling point. then pieces of the carrots were added to the solution and leaving in boiling until they ripens. The process took 10 minutes.

3. Cans with covers were sterilized, seed herbs were put at the base of each can and then filled with hot solution fruit containing (mentioned in step 2 and left head space of half inch).

4. To remove the bubbles that cans tightly and sterilized with boiling water for 15 minutes.

5 - keeping the product at room temperature until the tests.

Second : Slow making Method (Lactic fermentation):

Cucumbers and carrots pickles (E,F,I,J) were made by method of Halabo *et al* (1995) where whole cucumber and carrot fruits were prepared as followed **:**

1. Brine solution (10%) was prepared and fruit(cucumber and carrot) were soaked in it.

2. Salt was added to the fruits in step 1 at 9% w/w by dissolving it in part of the brine ,and final concentration was measured .

3. Solution concentration was weekly increased at rate 1% until reach to the final concentration of 16% pickles made were called salt stalk.
4. After the end of this period and reaching this concentration, the brine was discharged and the raw materials were soaked in cold water for 10 hours with changing it continuously, the last water was changed with warm water (40-50) c and left for 5 hours.
5. The frayed fruits were removed and the produced fruit were used to make the following type of pickles:soure cucumber pickle ,soure carrot pickle ,soure cucumber pickle with spices herps,sour carrot pickle with spices herps
6. Cans were sterilized with their covers and the seeds of spices (celery, dill, mustard) placed in the base of each tray.
7. The sour pickle **(J, E**) was perpased by packaging the fruit in the cans and soacked by vinegar (5%) then cans were tightly closed and left for a period to acquire the acid taste.
8. The soure pickles (**F, I)** were prepared by the method, with addition spices seed, at bottom of each can then pickling solution was added to them.
9. Cans were pasteurized on 10c for half an hour, the products were kept at room temperature for testing.

Chemical tests and some physical properties of processed pickles:

The percentages of moisture, dry matter, protein, fat, ash, carbohydrate, total acidity, pH and hardness, total soluble solids percentage in sample were estimated according to the methods described in (A.O.A.C 2004).

Determination of mineral elements:

Some mineral elements in pickle sample were estimated using an atomic absorption apparatus according to the method used by (A.O.A.C, 2004).

Determination of vitamins: The vitamins were estimated using HPLC according to the method proposed by Ekinci and Kadakal (2005). The column type (STR ODS-11) (50 x 4.6 mm I.D) and the mobile phase (A) 0.01 M Potassium phosphate pH 2.6: 5 Mm octan sulphonate (Ion-Pair) (B) acetonitrile, A: B (9: 1 v / v).

Extraction and estimation of phenolic materials:

The total phenolic materials were extracted according to the method used by(Afifty *et al*., 2012) by stirring1 g of dried pickles with10 ml of 80% methanol in a dark vial for two hours using magnetic stirrer then centrifuged at 3000 rpm for 5 minutes, the filterate was used for analysis and the total phenolic compound estimated. The analysis and determination the concentration of total phenolic substances was according to the method used from (Turkmen *et al*.,2007).

Determination of phenolic compounds:

Some phenolic compounds were estimated by the method used by (Gao *et al*., 2010) by HPLC.

Sensory evaluation

The sensory evaluation of the pickles was conducted by number of panelists of the Food Science Department. The sensory evaluation of the products was done through the evaluation test of the Hedonic scale (1-9), which includes the following grades:
1. Completely unacceptable 2. Highly unacceptable 3. Frequently unacceptable 4. Not acceptable moderately 5. Unacceptable 6. Poorly acceptable 7. Accepted moderately 8. Completely acceptable 9. Ideal (Akter,2013).

Statistical analysis:

The results were statistically analyzed using ANOVA. Duncan test scores were compared with statistical analysis of the Duncan test according to the Statistical Package for Social Science, 2009 (SPSS).

RESULTS AND DISCUSSION:

Chemical composition of processed pickles:

Moisture :

Table (1) shows that moisture percentage reached 95.380% in pickle (J) while the lower content was 93.205% in pickle (F), compared with moisture in fresh fruit (L,K) which amounted to 93.405%,94.135% respectively. This difference of moisture was attributed to the difference of chemical composition of the studied pickles and the natural variance in fruits moisture as well as the pickles making method that affect the process of dewatering from fruit (Akter,2013) .

Dry matter:

Table (1) showes significant differences between the dry matter percentage in the processed pickles. The dry matter was significantly higher in the pickle (F) reaching, 6.795%, while the dry matter was significantly lower in J it was (4.620%). The dry matter of pickles processed with slow method was higher comparing with the other types. The increasing of dry matter was caused by the decreasing of moisture. The drymatter in fresh fruits (L,K) used in processing had values of (6.595%,5.865%) respectively, and the increasing in dry matter is due to high moisture in the pickles,in addition, to the diffrent of moisture of fruits used in processing and the making method (Akter, 2013).

Protein:

The percentage of protein in the processed pickle was between (1.450% - 2.150%) as shown in Table (1). There were also significant differences between the protein percentage of the pickles, with highest percentage of pickles (I) reaching 2.150% while lowest percentage of protein in pickle (J) which was 1.450% proportion of protein in fresh fruits (L, K) .

Fat:

The results of Table (1) showed significant differences between the percentages of fat in the processed pickles, with a significant increase in fat percentage in pickles (G), which reached 0.805%, while the fat content was significantly reduced in pickles (F). The percentage of fat in rapid-processed pickles has exceeded the slow-processed pickles and the increase in fat percentage may be due to the use of spices. In addition, the percentage of fat in fresh fruits (L, K) were higher than in pickles (E, F) (Shanta et al ,2014).

Ash :

The percentage of ash in the processed pickles ranged between (1.350% - 3.415%) for pickles J.E respectively. The increase in ash content in pickle could be explained due to as higher and lower percentage moisture content of the processed pickles and the increased salt absorption during the fermentation process (Joshi and Sharma, 2009).

Carbohydrates:

The results showed no significant differences between the treatments of carbohydrate percentages. The highest percentage of carbohydrates was in pickle F, reaching 1.910% and the lowest one in pickle I reaching to 0.945%.

Acidity:

Acidity plays an important role in producing distinctive flavors of pickles as well as reducing the activity of undesirable microorganisms (Jordan, 2010). The percentage of acidity in processed pickles ranged between (2.325% - 3.130%) Table (1)). The decrease in acidity was due to the low absorption of acid added by the fruit (acetic acid) as well as the difference in the manufacturing method used (Srivastava and Kumar, 2002).

pH:

Table 1 shows the pH values of processed pickles ranging from 2.950 to 3.900. The pH values for fresh fruits (L,K) were higher comparing with processed pickles reaching 6.30 and 6.10 respectively.PH was considered as indicator on acidity values as the decreasing of PH meant increasing of acidity therfore they were associated together.

Hardness:

Table (1) shows that there are significant differences between the hardness values of the processed pickles, the highest hardness was in pickle (E) which reached (15,000) mm. Significaly, while it

decreased significantly in pickle (H),which amounted to 10mm .Hardness of fresh fruit was 35.000,32.000mm in (L,K) respectively .The decrease in hardness is associated with extension storage time and the presence enzymes responsible of pectin hydrolysis and the other enzymes which hydrolyzed plant tissues(Rahman et al.,2014).

Total Soluble Solids in Pickling Solution:

The percentage of total soluble solids in pickling solution ranged between (3.100 -13,000%). Table (1) showed significant difference between processed pickles. The highst value was for pickle(H). Processed pickles by rapid method had the highest percentage of T.S.S comparing with the slow one. The increase in T.S.S is attributed to the use of many raw materials which were soluble in water. Typically, soluble carbohydrate and nitrogenous materials were the reason of this.

Table (1) Chemical composition and some physical properties of processed pickles (%)

Samples	T.S.S(%)	Hardness(mm)	pH	Acidity(%)	Carbohydrates (%)	Ash(%)	Fat(%)	Protein(%)	Dry matter (%)	Moisture (%)
E	5.800c	15.000 c	3.700 b	2.325c	0.575a	3.415 a	0.315 d	1.590b	5.975b	94.025c
F	3.100d	10.500 f	2.950 d	4.485c	1.910a	2.950 b	0.230 d	1.705ab	6.795a	93.205e
G	6.300b	12.500 e	3.800 b	2.610b	1.020a	2.250 c	0.805 a	2.070a	6.395a	93.605d
H	13.000 a	10.000 f	3.900 b	3.130a	1.040a	3.025 b	0.599 bc	1.815ab	6.375a	93.625d
I	5.850c	12.000 e	3.400 c	2.635b	1.090a	2.100 d	0.650 b	2.150a	5.090c	94.910b
J	3.100d	14.000 d	3.100 d	3.030a	1.170a	1.350 e	0.695 b	1.450b	4.620d	95.380a
K	2.000e	32.000 b	6.100 a	0.445d	0.945a	2.260 d	0.566 c	2.095a	5.865b	94.135c
L	3.000d	35.000 a	6.300 a	0.409d	2.300a	2.125 d	0.550 c	1.580b	6.595a	93.405d

E-Soure Cucumber pickle (slow method), **F**-Carrot pickle with spices herps (slow method) **G**-Cucumber pickles (rapid method) ,**H**-Carrot pickles (rapid method), **I**- Cucumber pickle with spices(slow method herps), **J**-Soure Carrot pickle (slow method), **K**-Cucumber fresh, **L**-Carrot fresh

Mineral elements in pickles:

Table (2) show concentration of zinc in processed pickles reached to(0.09, 0.01, 0.11, 0.05, 0.11, 0.08 µg / ml) in pickles (E, F, G, H, I ,J) respectively. The values were within the permissible limits of the kenyan standard of pickles ,which indicated that maximum permissible level of this element was 5.0 µg / ml (Coast *et al*, 2016). Its value in fresh fruit (carrot, cucumber) was 0.09, 0.11 µg / ml respectively .Table (2) also showed the iron concentration in the produced pickles which amounted to(0.22,0.19,0.15,0.18,0.21,0.20 µg /ml) to the pickle E,F,G,H,I,J respectively .Its content was (0.25,0.23 µg / ml) in fresh fruit. Also the table indicated that calcium and magnesium concentration reached to (0.12, 0.15, 0.09, 0. 11 ,0.13, 0.15 µg / ml) and (0.10, 0.16, 0.17, 0.11, 0.01, 0.02 µg / ml) respectively to the pickles mentioned while their content were(0.15,0.14 µg /ml),(0.17 , 0.18 µg /ml) for fresh cucumber and carrot respectively. The revealed decrease in minerals studied due to dissolving of same salts of these minerals and their transmission in pickling solution(USDA,2011) .

Table (2) Minerals elements in processed pickles (µg / ml)

Samples	Zinc	Iron	Calcium	Magnesium
E	0.09	0.22	0.12	0.10
F	0.01	0.19	0.15	0.16
G	0.11	0.15	0.09	0.17
H	0.05	0.18	0.11	0.11
I	0.11	0.21	0.13	0.01
J	0.08	0.20	0.15	0.02
K	0.11	0.25	0.14	0.17
L	0.09	0.23	0.15	0.18

E-Soure Cucumber pickle (slow method), **F**-Carrot pickle with spices herps (slow method) **G**-Cucumber pickles (rapid method) ,**H**-Carrot pickles (rapid method), **I**- Cucumber pickle with spices(slow method herps), **J**-Soure Carrot pickle (slow method), **K**-Cucumber fresh, **L**-Carrot fresh

Vitamins:

Table (3) indicated content of vitamin B_1 in processed pickles which amounted to (16.921, 9.963, 14.353, 9.963, 12.137, 14.354, µg / mL) for pickles E,F,G,H,I,J respectively while its content 35.405, 24.970 µg / mL in fresh fruit (K, L) respectively. These values show small loss of this vitamin during pickles production. Also the results show that concentrations of vitamin B_2 were(13.297, 6.501, 4.973, 6.254, 5.246, 5.798, µg / mL) to the same products, respectively, and (5.343, 6.799µg / mL) for fresh fruit respectively which they were higher than that noticed from Tripuraneni (2011) who reported that the concentration of this vitamin in cucumber was 0.027 mg/100g .The same table shows that the concentrations of B_6 were (11.873, 9.399, 17.451, 0.554, 7.243, 1.1795, 6.835,14.410µg / mL) to the processed pickles (E,F,G,H,I,J) respectively. The results show increasing of B_6 content in pickles I,G,E compared with fresh cucumbers(K) .Results show high level of Folic acid(B_9) in pickle J which reached to 20.086µg / mL compared to0.772, 17.721, 6.130, 17.1128, 15.5239 µg / mL for pickle (E,F,G,H,I) respectively. The results also revealed that folic acid content measured of fresh fruit of carrot(L) and cucumber(K) were(4.959, 16.459 µg / mL), and they were higher than values indicated by(USDA,2011) .Vitamin B_3 concentration was noticed at high level in pickle (F) 24.11797 µg / mL compared with fresh fruit which were amounted to 22.9484, 5.1811µg / mL. Table (3) shows the amount of vitamins C in processed pickles which they were (8.0584, 2.4416, 10.3852, 12.5973, 9.5755, 5.9142, µg / mL) for pickles (E,F.G.H.I.J) respectively, while the concentration of this vitamin in the fresh fruit (L, K) was higher than that of the processed pickles, they were 15.2646, 13.422µg / mL respectively. The loss of this vitamin was lower in pickles H,G which made by rapid method and this was attributed to its waste during making because of acidity and heating of medium (Montano *et al.*, 2004).

Table (3) vitamins (µg / ml) in processed pickles

Sample	B_1	B_2	B_6	B_9	B_3	C
E	16.921	13.297	11.878	0.772	9.710	8.058
F	9.963	6.501	9.399	17.721	24.117	2.441
G	14.353	4.973	17.451	6.130	7.284	10.385
H	9.963	6.254	0.554	17.112	19.230	12.597
I	12.137	5.246	7.243	15.523	6.374	9.575
J	14.354	5.798	1.179	20.086	19.660	5.914
K	35.405	5.343	6.835	16.459	22.948	12.264
L	24.970	6.799	14.410	4.959	5.181	13.422

E-Soure Cucumber pickle (slow method), **F**-Carrot pickle with spices herps (slow method) **G**-Cucumber pickles (rapid method) ,**H**-Carrot pickles (rapid method), **I**- Cucumber pickle with spices(slow method herps), **J**-Soure Carrot pickle (slow method), **K**-Cucumber fresh, **L**-Carrot fresh

Total phenolic compounds in processed pickles(TPC):

Figure (1) shows the total content of total phenolic compounds (TPC) in processed pickling models, noting that the TPC of pickles reached 2112, 14.90, 12.00, 12.25, 14.88, 15.52 mg / 100g for pickles (E, F, G) , H, I and J), respectively, while the TPC (14.9), 16.9 mg /100g for both carrot fruits and fresh cucumbers (K and L), respectively. The value of TPC for pickles was similar to that observed by Sayin and Alkan (2015), who showed that the TPC value of fresh and pickled vegetables was 12.23, 14.18, 16.51, 14.21 mg / 100g for pickled cucumbers, carrot pickles, fresh cucumbers, carrots Which he studied respectively.

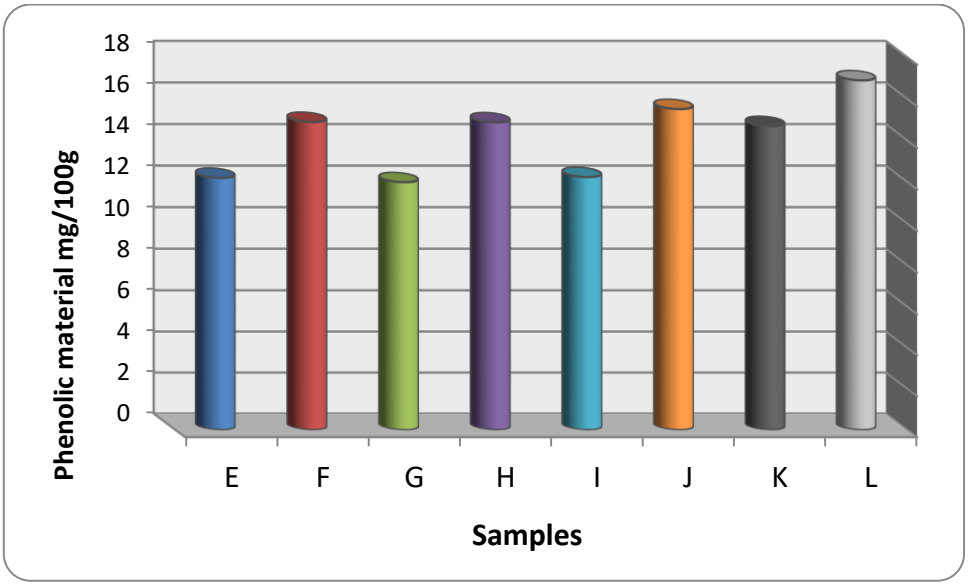

Figure (1) Total phenolic compounds in processed pickles and fresh fruits**.**

E-Soure Cucumber pickle (slow method), **F**-Carrot pickle with spices herps (slow method) **G**-Cucumber pickles (rapid method) ,**H**-Carrot pickles (rapid method), **I**- Cucumber pickle with spices(slow method herps), **J**-Soure Carrot pickle (slow method), **K**-Cucumber fresh, **L**-Carrot fresh

Phenolic compound content:

Figure (2) indicates content of some phenolic compounds in processed pickles. It was noticed that Rcoresenol was lost in pickles produced while their quantities were (5,2.4 µg / mL) at fresh carrot and cucumber .Catechol concentrations were (8.4,7.6,13,7.5,6.6 µg / mL) at (E,F, H, J) while it was not found at pickles I,G in addition to the fresh cucumber .The same figure shows that Vanillin concentrations were(12,11,7.1,21,7.1,9.2,4.2 µg / mL) in E,F,G,H,I,J,K,L pickles respectively. The higher content of this compent was at pickle (H) which reached to (21 µg / mL), it was also noted the increasing of vanillin in processed pickles compared to fresh fruit. Figure (2) shows also an increase of salicylic acid concentration in pickle (H) which amounted to (7.4 ,6.5, 5.3, 5.3, 5.9 µg / mL) at E,F,G,I,J respectively. Its concentration was increased at processed pickle compared to fresh fruit of cucumber and carrot (4.4, 1.3 µg / mL) respectively. During our follow-up to scientific literature on phenolic compounds, we found no studies interested to phenolic compounds we studied in pickles, while there were studies about another phenolics like Caffeic acid ,P,coumaric acid, Ferulic acid, Sinapic acid which were observed at Chinese cabbage .which amounted to 21.72, 34.41, 38.29, 39.56 µg / mL respectively (Jiang *et al*,2013).

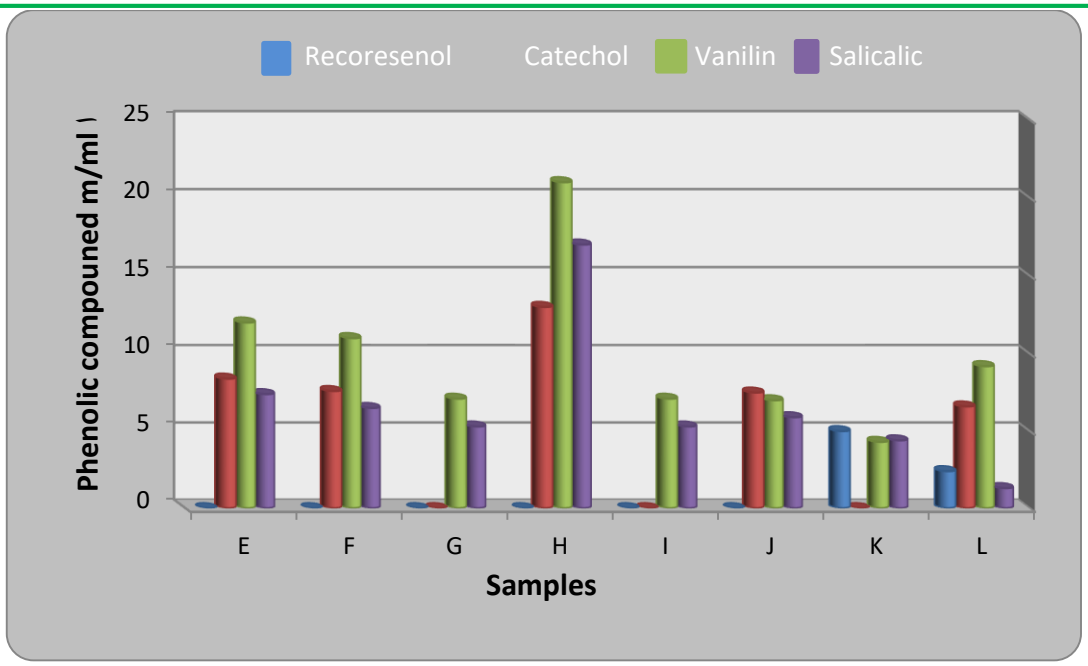

Figure (2) phenolic compounds in processed pickles and fresh fruits.

E-Soure Cucumber pickle (slow method), **F**-Carrot pickle with spices herps (slow method) **G**-Cucumber pickles (rapid method) ,**H**-Carrot pickles (rapid method), **I**- Cucumber pickle with spices(slow method herps), **J**-Soure Carrot pickle (slow method), **K**-Cucumber fresh, **L**-Carrot fresh

Sensory evolution:

Color:

Table (4) shows the superiority of color characteristic of pickles (E,I,H) significantly which reached to (7.65 ,7. 5 ,7.25).The use of spices and sugar in the manufacturing process may improve the color of the pickles produced when compared with locally produced pickles (Rahman *et al*,2014).

Table (4) Sensory Evaluation of Pickles Models

Samples	Color	Taste	Flavor	Texture	Overall acceptability
E	7.65a	7.30ab	7.52bc	8.10a	7.60ab
F	7.00b	6.75c	7.25c	7.65a	7.00c
G	7.00b	7.12bc	8.10a	7.95a	8.00a
H	7.25ab	7.15bc	7.80ab	7.94a	7.37bc
I	7.50a	7.62a	7.00c	7.52a	7.62ab
J	6.30c	6.62c	7.25c	7.62a	7.37bc

E-Soure Cucumber pickle (slow method), **F**-Carrot pickle with spices herps (slow method) **G**-Cucumber pickles (rapid method) ,**H**-Carrot pickles (rapid method), **I**- Cucumber pickle with spices(slow method herps), **J**-Soure Carrot pickle (slow method), **K**-Cucumber fresh, **L**-Carrot fresh

Taste and flavor:

The same table indicates the results of evaluation of taste and flavor of processed pickles. It show the increasing of the score of taste for (E,I) pickles compared with the rest of treatments ,while the score of flavor was the higher to treatment (G,H). Any how, the improving of these properties returned to fermentation process, the kind of additives and raw materials .

Texture:

It is noticed no significant difference between treatments which reached the values of 8.10, 7.65 ,7.95, 7.94, 7.52, 7.62 for the studied treatments. Typicaly, these properties related to the hardness of products which affected by action of enzymes and the kind of fruit used.

Overall acceptability:

The same table indicates the score of the characteristics of general acceptance of treatments, which reveal the superiority of (E,G,I) pickles , significantly. These results were attributed to the improving quality of these treatments compared with the others.

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دراسة الخواص الفيزيوكيميائية والتغذوية لبعض انواع المخللات المصنعة

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المستخلص

اجريت هذه الدراسة في مختبرات قسم علوم الأغذية /كلية الزراعة جامعة تكريت وللمدة بـين2016/10/1 ولغاية 2017 /10/1 اظهرت نتائج الاختبارات الكيميائية في المخـللات المصــنعة ,والتي تضمنت (Eمخلل خيار حامضي طريقة بطيئة , Fمخلل جزر بالتوابل طريقة بطيئة ,Gمخلل خيار بالطريقة السريعة ,Hمخلل جزر بالطريقة السريعة, I مخلل خيار بالتوابل طريقة بطيئة ,J مخلل جزر حامضي طريقة بطيئة(ارتفاع نسـبة رطوبة في مخلـلJ اذ كانت 95.380% في حين بلغت اعلى نسبة المادة الجافة 6.795% و6.395%و6.375% لكل من مخلل H,G,F على التوالي , وارتفعت نسبة البروتين معنوياً في مخلل I,G لتبلغ 2.070% , 2.150% على التوالي وكانت اعلى نسبة للدهن في مخلل 0.805% G كما بلغت اعلى نسبة للرماد في مخلل 3.415% E كما اظهرت النتائج ارتفاع نسبة الكربوهيدرات في مخلل F اذ بلغت 1.910% كما كانت نسبتها 2.300%, 0.945% في الثمار الطازجة K,L وبلغت نسبة الحموضة في مخلل(, 3.130% (Hفي حين بلغت اكبر قيمة الأس الهيدروجيني 3.700 3.800, , 3.900 pH لكل من مخللE,G,H على التوالي وبلغت درجة الصلابة في مخلل E 15.000 ملم في حين ارتفعت نسبة T.S.S في مخلل , 13.000 %Hاما تراكيز العناصر المعدنية Zn Mg, Ca ,Fe, فـــي المخللات المصـــــنعة فهـــــي في المديات (0.11−0.01),(0.22−0.15),(0.15−0.09) و(0.17−0.01) مايكرو غرام /مل . كما اظـهرت النتائـج ان المحتوى الأعـــــلى للفيتامينـات B3,B9,B6,B2,B1,وCهي 12.5973, 24.11797, 20.086, 17.451, 13.2973, 16.921 مايكرو غرام /مل (وذلك لنماذج المخللات F,J,G,E,E و H على التوالي. وبينت دراسة محتوى المركبات الفينولية الكلية انها ضمن المدى) 12.00− 215.5 ملغرام /لتر (للمخللين G, J على التوالي في حين ان محتوى الفاكهـــــة الطازجـــة L,K من هذه المركبات هو (16.90,14.90 ملغرام /لتر) على التوالي . المحتوى الأعلى لحامض الساليسلك والفانيلين والكاتيكول والريسورسينول كان في النمـــــاذج E,E,H و , Kوكانت قيمته 5,8 ,4.8 ,12.0 ,17.0 مايكرو غرام /مل, اظهرت نتائج التقييم الحسي لنماذج المخللات المصنعة تفوق المخللين E,G في الصفات المدروسة معنوياً على بقية النماذج.

الكلمات المفتاحية : التخمر اللاكتيكي، الخضر المتخمرة، التخليل، الحفظ.