Effect of Adding Wheat Germ as a Fortifying Source of Vitamin E and Minerals on Quality of Sesame-Seed Sweet (*Halawa Tahinia*)

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ABSTRACT

Wheat germ as a rich source of vitamin E and minerals was used to replace Tahina at levels of 5, 10, 15 and 20% in the manufacture of *Halawa Tahinia* (HT) which is a well known oriental sweet. Two types of *Halawa Tahinia* were investigated, namely plain (PHT) and coated with chocolate (CHT).

The chemical composition of wheat germ indicated that it is rich in numerous macro and micro mineral elements and vitamin E. Data indicated that the samples containing 15% of wheat germ were almost accepted as the controls. Thus, such supplemented samples (15% level) were further evaluated along with their controls. Incorporation of wheat germ in the manufacture of PHT and CHT resulted in elevating of protein content by 15 and 17%, ash content by 15 and 17% and vitamin E content by 16 and 14% for PHT and CHT, respectively. An increase was figured out in mineral elements especially Mn, K and P as a result of fortification. Meanwhile, statistical analysis of type of *Halawa Tahinia* and the incorporated level of wheat germ explored high positive significant effect on colour.

High quality as well as high vitamin E containing *Halawa Tahinia* could be produced via introducing wheat germ in the formulation.

Key words: Gross composition, minerals, vitamin E, sensory evaluation, wheat germ, Halawa Tahinia, oriental sweet.

INTRODUCTION

Sesame seed sweets known locally as *Halawa Tahinia* or *halawa* is a product manufactured by the thorough mixing and tempering of cooked sugar, sesame seed butter (*Tahina*) and other ingredients added in small quantities for emulsifying and flavour enhancing purposes. After cooling, the product becomes solid having a colour ranging between straw to light amber. It has a pleasant sweet nutty flavour, it is believed to have originated in Turkey where it is known as halwa Asmirly (Abou-Elkhier, 1986).

Halawa Tahinia is a very popular item in the diet of the population in Egypt because of its high caloric value, pleasant taste, availability throughout the year at very reasonable prices as well as the long shelf life (El-Sayed, 1965).

Wheat germ which constitutes only about 2% of the whole wheat grain is removed in the milling process for industrial reasons. Rolling milling by milling rolls are operated to separate wheat germ which forms an important and useful by-product of the milling industry (Attia & Abou-Ghariba, 2011). Furthermore, wheat germ has relatively high content of protein, fat and minerals. Moreover, it is a good source of vitamin B and E (El-Nagar, 2005).

Wheat germ contains α-, ß-, γ- and δ-tocopherols, the total tocopherol content being 2.0-3.4 mg/100 gm. The biological vitamin E activities of ß-, γ- and δ-tocopherols are 30%, 7.5% and 40%, respectively, of that of the α-tocopherol. The total tocopherol contents of germ, bran and wheat flour 80% extraction are about 30, 6 and 1.6 mg/100, respectively. α-tocopherol predominates in germ, γ-tocopherol in bran and endosperm, giving α-equivalents of 65%, 20% and 35% for the total tocopherols of germ, bran and 80% extraction flour, respectively (Kent, 1983).

Vitamin E is the name given to α-tocopherol. It scavenges free radicals and prevents them from damaging cell membranes. Vitamin E also protects easily oxidized nutrients such as polyunsaturated fatty acid (PUFA), vitamin A and vitamin C from oxidation. It may also be protective for diseases, such as some types of cancer, arthritis and ischemic

heart disease in which free radicals are thought to be involved. Tocopherols are used in the food industry as antioxidants. There is evidence that vitamin E can help to prevent the occurrence of a serious eye disease. Lack of vitamin E renders male rats sterile and female rats deficient in the vitamin can conceive but the pregnancy is interrupted and no offsprings are born. The dietary requirement of vitamin E is related to the PUFA content of the diet and it is estimated that 0.4 mg of the vitamin is required for each gram of PUFA. A man with a dietary energy intake of 2550 K cal where 6 percent of the energy is supplied by PUFA would require 7 mg of vitamin E per day (Fox & Cameron, 1995).

Numerous studies have indicated that wheat germ could be added to some food products such as, *Halawa Tahinia*, biscuits, bread, noodles, ice milk and beverages (El-Bardeny, 1993, Abou-Elmaattie, *et al*., 1996, Sidhu *et al*., 2001, Yiqiang *et al*., 2001, Salama & Azzam, 2003, Tang-& Guo, 2002).

The present study was undertaken to utilize wheat germ as a source of vitamin E and minerals in *Halawa Tahinia* manufacture. Therefore, effects of wheat germ on quality attributes of plain and chocolate *Halawa Tahinia* were investigated.

MATERIALS AND METHODS

Materials

Sesame-seed butter (*Tahina*), sucrose, citric acid, extract of saponaria root (Radix Saponariae Albae), monoglycerides, lecithin, chocolate liquor for coating, and wheat germ from hard white Australian wheat (Overtail the sieve No. 17GG, 1250 microns) are obtained from Alexandria Flour Mills and Bakeries Company.

Methods :

Preparation of wheat germ

Wheat germ was toasted in hot-air oven for 1 hr. at 100°C with frequent stirring to denature the enzymes and prevent rancidity.

Preparation of *Halawa Tahinia* in the plant

The *Halawa Tahinia* was prepared in Alexandria Flour Mills and Bakeries Company (Sacs Factory) according to the method followed by the plant (Figure 1). The levels of 5, 10, 15 and 20% of toasted wheat germ were used for fortification of *Halawa Tahinia* with vitamin E and minerals.

Halawa Tahinia were shaped into bar forms. Half of the samples were coated with chocolate liquor and the other half was left without coating. The samples were wrapped with aluminum foil and kept at room temperature.

Sensory Evaluation of *Halawa Tahinia* :

The samples of plain *Halawa* "PHT" and coated with chocolate "CHT" were evaluated for their sensory characteristics, as leakage of oil, odour, texture, taste and colour. The evaluation was carried out by 10 members in Foods Science and Technology Department according to the method of Kramer & Twig (1962) on a descriptive scale. Scoring of the attributes was carried out according to the following scheme :

Properties	Numerical value		
	9–10	7–8	>5
- Leakage of oil	Dry	slightly leaky	very leaky
- Odour	Normal	slightly rancid	rancid
- Texture	Consistent	loose	very loose
- Taste	Smooth	chewy	tough
- Colour	Normal	slightly dark	dark

Chemical Analysis :

Gross chemical composition

The moisture content of wheat germ was determined by drying the sample in air oven at 130°C for 1 hr (AOAC, 1998, method No. 925.10). Vacuum oven at 70°C was used to determine the moisture content of *Halawa Tahinia* (AOAC, 1998, method No. 925.45 D).

Ash was determined by incineration of the sample at 550°C in an electrical muffle furnace (AOAC, 1998, method No. 923.03).

Ether extract of wheat germ was determined according to the procedure described in the AOAC, (1998) (method No. 920.85). Ether extract of *Halawa Tahinia* was determined in the oven-dried samples according to the AOAC (1998) (method No. 920.177).

Nitrogen content was determined by micro-Kjeldahl method as described by the AOAC, (1998) (method No. 960.52). The total protein content was calculated by multiplying the total nitrogen by 5.7 for wheat germ and 6.25 for *Halawa Tahinia*.

Crude fiber content was determined according to the method described in the AOAC (1998) (method No. 920. 86) using defatted samples.

Nitrogen free extract content was calculated by difference.

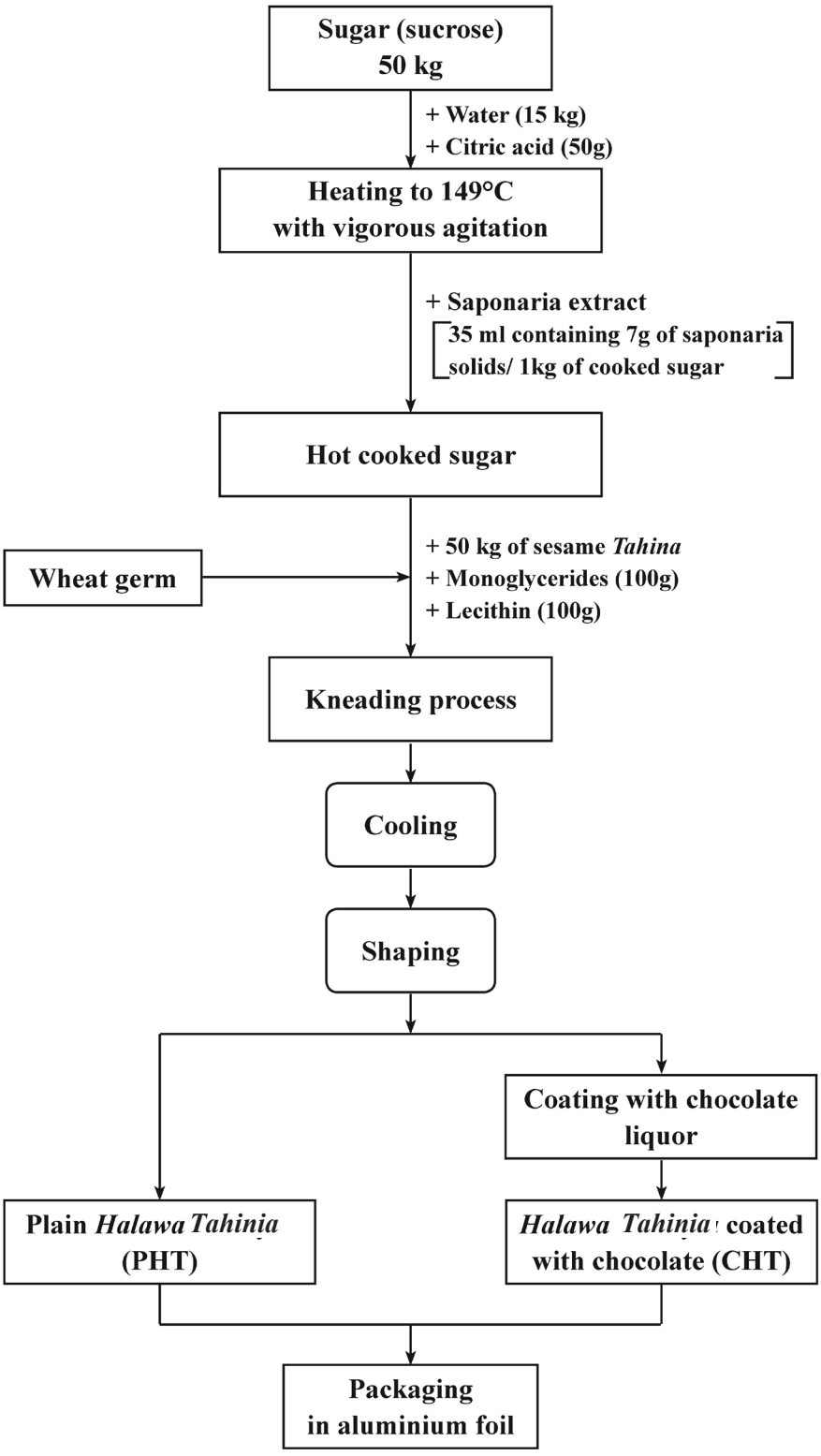

Fig. 1: Flow sheet of the manufacture steps of plain and chocolate coated *Halawa Tahinia*

Minerals

Minerals content of calcium, magnesium, iron, manganese, copper and zinc was determined using Perkin Elmer Atomic Absorption Spectrophotometer (Model 2380) according to the AOAC (1998), (method No. 985.35). Potassium and sodium were determined using flame Photometer (Gallenkamp, FGA 330C) according to the AOAC (1998) (method No. 963.13).

Phosphorus was determined by colorimetric method at 680 nm using speckol spectrocolorimeter (Spekol 11, Carl Zeiss Jena, Germany) (Pearson, 1981).

Minerals determination was conducted on wheat germ and the samples of *Halawa Tahinia* that gained the highest scores by panelists along with the controls.

Vitamin E

Oil was extracted from the samples of wheat germ and *Halawa Tahinia* then the determination of vitamin E was conducted on the oil according to the Furter-Meyer method (Association of Vitamin Chemists, 1966). A suitable weight of oil (1 g) was placed into a 100 ml flask fitted with a reflux condenser then 10 ml absolute alcohol and 20 ml 1M alcoholic sulphuric acid were added. The condenser and the flask were wrapped in aluminum foil, reflux for 45 min then cooling, 50 ml water were added, and the contents were transferred to a separating funnel (Covered with aluminum foil) with the aid of further 50 ml of water. The unsaponifiable matter was successive extracted 5 times (30 ml diethyl ether for each). The combined ether extracts free from acids were washed and dried over anhydrous sodium sulphate. The extract was evaporated at a low temperature whilst protecting it from light, the final traces of solvent were removed in a stream of nitrogen. Then the residue was dissolved immediately in 10 ml absolute alcohol.

Aliquots of the samples and standards (0.3-3.0 mg vitamin E) were transferred to a 20 ml volumetric flask, 5 ml absolute alcohol was added, followed by 1 ml conc. nitric acid (CARE add dropwise with constant swirling). The flask was placed on a water bath at 90°C for exactly 3 min. then cooled rapidly under running water and adjusted to volume with absolute alcohol. The absorbance was measured at 470 nm (using Speckol spectrocolorimeter, Spekol 11, Carl Zeiss Jena, Germany) against a blank containing 5 ml absolute alcohol and 1 ml of conc. nitric acid treated in a similar manner.

Statistical Analysis

Data of the sensory evaluation were statistically analysed. An analysis of variance was performed according the to the method of Steel & Torrie (1980). All scores of sensory evaluations were subjected to analysis of variance, ANOVA, with the following variable, kind of *halawa* "A", concentration of wheat germ "B" and the interaction "AB". The significance difference of the differences between treatments was calculated by the least significance difference test (L.S.D).

RESULTS AND DISCUSSION

Chemical Composition of Wheat Germ

Data presented in Table (1) indicate that wheat germ exhibited the following gross chemical composition: crude protein (24.05), crude fat (13.79), crude fiber (5.04%), ash (3.74%) and nitrogen free extract (42.06%). These data are not in agreement

Table 1: Gross chemical composition, minerals contents and vitamin E content of wheat germ (on dry weight basis).

Gross chemical composition (%)	
Protein (%) (N x 5.7)	24.05 ± 0.15
Crude Fat (%)	13.79 ± 0.16
Crude Fibre (%)	5.04 ± 0.46
Ash (%)	3.74 ± 0.04
*Nitrogen free extract (%)	42.06
Minerals (mg/100 g)	
Macro elements (mg/100 g)	
Calcium	141.42 ± 15.51
Potassium	707.12 ± 49.4
Magnesium	203.30 ± 22.3
Sodium	8.84 ± 0.79
Phosphorus	2529.70 ± 50.6
Micro elements (mg/100 g)	
Copper	2.74 ± 0.35
Iron	5.14 ± 0.6
Manganese	13.31 ± 1.73
zinc	1.14 ± 0.07
Vitamin E (mg/100 g)	
Vitamin E	128.3 ± 1.15

Results are expressed as mean values of triplicates ± standard deviations.

*Calculated by difference.

with the gross chemical composition of wheat germ found by El-Bardeny (1993). He reported lower ether extract (8.15%). Such variations can be explained on the basis that different varieties of wheat may vary in terms of the chemical compositions of their germs. Yet the data presented here are in accordance with that of El-Nagar (2005).

Phosphorous (2529.70 mg/100 g), potassium (707.12 mg/100 g), magnesium (203.30 mg/100 g) and calcium (141.42 mg/100 g) were found to be the most predominant minerals in wheat germ. Meanwhile wheat germ contains small amounts of manganese (13.31 mg/100g), sodium (8.84 mg/100 g), iron (5.14 mg/100 g), copper (2.74 mg/100 g) and zinc (1.14 mg/100 g) (Table 1).

The present data exhibited higher contents of all mineral elements than those reported by El-Nagar (2005).

Vitamin E showed higher value (128.3 mg/100 g) than that reported in the literature being (30 mg/100 g) (Kent, 1983).

Such variation in the chemical composition of wheat germ could be attributed to the utilization of different wheat varieties in the other studies under comparison from the wheat variety used in our study.

Sensory Evaluation of *Halawa Tahinia*

The samples of plain *Halawa Tahinia* (PHT) and that coated with chocolate (CHT) containing 5, 10, 15 and 20% of wheat germ were subjected to sensory evaluation.

Table (2) shows that *Halawa Tahinia* coated with chocolate (CHT) was superior to plain *Halawa Tahinia* (PHT) in terms of holding oil and colour, as judged by panelists. Meanwhile the two types of *Halawa Tahinia* were quite comparable in terms of odours consistency and taste.

Statistical analysis of ANOVA further confirmed the highly significant effect of type of *Halawa Tahinia* (A) on oil holding and colour properties. On the other hand, level of wheat germ (B) was found to affect significantly the taste and colour of *Halawa Tahinia* as judged by the panelists (Table 3).

Colour of *Halawa Tahinia* was the only subjective quality attribute influenced by A x B interaction (Table 3). It was obvious that panelists preferred the colour of *Halawa Tahinia* coated with chocolate (CHT) as compared to plain sample (PHT). Type of *Halawa Tahinia* (A) and level of wheat germ (B) interaction possessed highly sig-

Table 2: Effect of type of *Halawa Tahinia* on sensory attributes

Treatment	Means of Sensory attributes				
	Leakage of oil	Odour	Texture	Taste	Colour
Plain *Halawa Tahinia*	7.28^{b}	8.12^{a}	7.36^{a}	6.68^{a}	7.24^{b}
Halawa Tahinia coated with chocholate	8.16^{a}	8.12^{a}	7.64^{a}	7.0^{a}	7.84^{a}
L.S.D.	0.456	0.273	0.496	0.532	0.334

Means followed by the same letter are not significantly different at $P<0.05$.

Table 3: ANOVA Test for the sensory evaluation of *Halawa Tahinia* containing different concentrations of wheat germ

S.O.V	D.F	Mean squares				
		Sensory attributes				
		Leakage of oil	Odour	Texture	Taste	Colour
Replication	9	8.996	12.55	5.267	3.45	5.69
Type of Halawa "A"	1	19.36**	0.0^{ns}	1.96^{ns}	2.56^{ns}	9.0**
Concentrations "B"	4	2.54^{ns}	2.54^{ns}	3.8^{ns}	12.26**	14.46**
Interaction "AB"	4	2.86^{ns}	0.3^{ns}	1.16^{ns}	0.46^{ns}	1.90*
Error	81	1.312	0.472	1.553	1.79	0.766

* Significant ** Highly significant ns : Non significant

nificant effect on colour of *Halawa Tahinia*. It was obvious that CHT sample was more acceptable by panelists than PHT sample when the A x B interaction was statistically analyzed (Table 4).

Gross chemical composition of *Halawa Tahinia*

The gross chemical composition of plain *Halawa Tahinia* (PHT) and that of coated with chocolate (CHT) is shown in Table (5). It was clear that incorporation of wheat germ at 15% level in PHT resulted in an increase of the crude protein content from 14.54 to 16.66% and the ash content from 1.89 to 2.44%. The same trend could be traced for CHT, since crude protein increased from 13.92% in the control to 16.29% for the supplemented sample. Meanwhile, the ash content (2.13%) for CHT sample being higher than that of the control (1.68%). In this respect, it is worth to mention that the CHT sample exhibited higher content of crude fiber (1.50%) than the control (0.87%). Data presented here are in accordance with those of El-Dokany (1953) and El-Sayad (1965). On the other hand, ash content was 2.44% for PHT sample, while it was 1.89% for the control. As for crude fiber content, it exhibited values of 1.57 and 1.31% for PHT sample and the control, respectively.

Table 4 : Effect of interaction "AB" on colour of *Halawa Tahinia*

Type of *Halawa Tahinia*	Concentration	Colour
Plain	0	8.4 [b]
	5	8.4 [b]
	10	6.6 [h]
	15	7.0 [g]
	20	5.8 [i]
Coated with chocolate	0	8.6 [a]
	5	8.2 [c]
	10	7.4 [e]
	15	7.8 [d]
	20	7.2 [f]
	L.S.D.	0.07

A : Type of *Halawa Tahinia*
B : Concentrations of wheat germ.
Means followed by the same letter are not significantly different at P<0.05.

Mineral Elements of *Halawa Tahinia*

The results shown in Table (6) indicate that phosphorus was found to be the most abundant mineral element in both types of *Halawa Tahinia*.

It was obvious that the supplemented PHT had higher contents of macro elements than the controls being as follows : Ca (81.70), K (201.57), Mg (114.90), P (1283.70) mg/100g. The percentage of increase in the macro elements of PHT due to the fortification with wheat germ (15%) ranged between 23.38 to 96.52. Meanwhile, it varied from 23.87 to 77.76 in CHT samples (Table 6). Whereas, sodium was found to be almost similar to the supplemented sample (128.77) and the control (130.02) mg/100g. The same trend could be traced for CHT.

It is worth to mention that incorporation of wheat germ at 15% level resulted in an increase in all micro element contents of both types of Halawa, with Mn being the highest in this respect since it increased from 1.20 to 4.80 for PHT and from zero to 3.54 mg/100 g for CHT. On the other hand, micro elements in the control of PHT ranged be-

Table 5 : Gross chemical composition of *Halawa Tahinia* (plain and coated with chocolate) supplemented with 15% wheat germ (on dry weight basis)

Product / composition	Plain *Halawa Tahinia*		Halawa Tahinia coated with chocolate	
	Control	Supplemented with 15% wheat germ	Control	Supplemented with 15% wheat germ
Crude protein (%) (N × 6.25)	14.54 ± 0.04	16.66 ± 0.12	13.92± 0.09	16.29 ± 0.16
Crude fat (%)	26.72 ± 0.32	26.92 ± 0.35	27.95 ± 0.24	29.42 ± 0.33
Crude fibre (%)	1.31 ± 0.19	1.57 ± 0.15	0.87 ± 0.20	1.50 ± 0.23
Ash (%)	1.89 ± 0.02	2.44 ± 0.001	1.68 ± 0.05	2.13 ± 0.01
*Nitrogen free extract (%)	55.54	52.48	55.58	52.59

Results are expressed on dry weight basis as mean values of triplicates ± standard deviations.
*Calculated by difference.

Table 6: Mineral elements and Vitamin E content of *Halawa Tahinia* (Plain and coated with chocolate) supplemented with 15% wheat germ

Composition \ Type of *Halawa*	Plain			Coated with chocolate		
	Control	Supplemented with 15% wheat germ	% increase	Control	Supplemented with 15% wheat germ	% increase
Macro elements (mg/ 100g)						
Ca	60.90± 5.40	81.70 ± 7.20	34.15	56.20 ± 5.04	77.45 ± 6.90	37.81
K	102.57±9.20	201.57 ± 16.10	96.52	128.50±11.52	228.43±18.20	77.76
Mg	93,20±11.16	114.90 ± 12.54	23.28	99.60 ± 11.88	123.35±13.53	23.87
Na	130.02±11.70	128.77 ± 11.52	---	131.74± 11.85	130.44 ± 10.70	---
P	893.70±26.70	1283.70 ± 25.7	43.63	895.90± 17.90	1288.80±25.70	43.86
Micro elements (mg/ 100g)						
Cu	1.17 ± 0.15	1.55 ± 0.20	32.49	1.05 ± 0.13	1.45 ± 0.17	30.09
Fe	2.23 ± 0.28	2.73 ± 0.35	22.42	2.31 ± 0.30	2.78 ± 0.36	20.35
Mn	1.20 ± 0.15	4.80 ± 0.52	300.0	0.00	345 ± 0.33	34.50
Zn	3.33 ± 0.26	4.49 ± 0.03	34.93	2.46 ± 0.19	3.32 ± 0.23	34.95
Vit. E (mg/100 g)	67.00± 0.89	78.00 ± 0.97	16.41	64.00±0.78	73.00±1.1	14.06

Results are expressed on dry weight basis as mean values of triplicates ± standard deviations.

tween 1.17 (Cu) and 3.33 mg/100 g (Zn). The control of CHT exhibited a range of zero (Mn) to 2.46 mg/100g (Zn) (Table 6).

Vitamin E of *Halawa Tahinia* :

Plain *Halawa Tahinia* sample supplemented with 15% wheat germ exhibited a value of vitamin E of 78.00 mg/100 g. The corresponding value for *Halawa Tahinia* coated with chocolate was 73.00 mg/100 g (Table 6). Accordingly, incorporation of wheat germ in both *Halawa Tahinia* recipes (PHT and CHT) is advisable for sake of elevating the vitamin E content of *Halawa Tahinia* which currently consumed by the majority of population in the Middle East Countries. Recently, attention has been paid towards vitamin E family, tocopherols and tocotrienols, as high potent antioxidants along with other health promoting properties.

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تأثير إضافة جنين القمح كمصدر لفيتامين هـ علي جودة حلوي السمسم (الحلاوة الطحينية)

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تم إضافة جنين القمح كمصدر لفيتامين هـ عند مستويات ٥ ، ١٠ ، ١٥ ، ٢٠٪ في صناعة الحلاوة الطحينية والتي تعد من الحلوي الشرقية المعروفة . واستخدم في الدراسة نوعان لهذه الحلوي هما السادة والمغطي بالشيكولاته .

أوضحت نتائج التقويم الحسي أن العينة التي إحتوت علي ١٥٪ من جنين القمح كانت مقبولة تقريبا كالعينة الكونترول (التي لا تحتوي علي جنين القمح) وذلك لكلا النوعين من الحلوي ، ومن ثم فقد استخدمت العينتان المحتويتان علي ١٥٪ جنين قمح في اجراء الدراسة التفصيلية مقارنة بعينتي الكونترول المقابلتين .

أوضح التحليل الكيماوي لجنين القمح غناه في العديد من العناصر المعدنية الأساسية ومعادن الأثار بالاضافة الي فيتامين هـ . وتبين أن استخدام جنين القمح في الحلوي السادة والحلوي المغطاة بالشيكولاته قد أدي الي رفع نسبة كل من البروتين بنحو ١٥٪ ، ١٧٪ والرماد بنحو ١٥٪ ، ١٧٪ وفيتامين هـ بنحو ١٦٪ ، ١٤٪ لكل من الحلوي السادة والحلوي المغطاة بالشيكولاته علي الترتيب. تجدر الإشارة إلى أن تدعيم الحلاوة بجنين القمح قد أدى إلى زيادة المعادن وبخاصة المنجنيز، البوتاسيوم، الفوسفور بمعدلات مرتفعة.

كذلك فقد أوضح التحليل الاحصائي أن للتداخل بين نوع الحلوي وتركيز جنين القمح المضاف تأثيرا إيجابيا عالي المعنوية علي لون الحلوي لكلا النوعين .

أوضحت النتائج إمكانية انتاج حلوي طحينية عالية الجودة وذات محتوي عالٍ من فيتامين هـ وذلك عن طريق إضافة جنين القمح بنسبة ١٥٪.