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NUTRITIONAL ASSESSMENT OF RAW, GAMMA IRRADIATED, MICROWAVE TREATED AND FERMENTED WHEAT GERMS.

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ABSTRACT

Wheat germ was irradiated with two types of radiations; gamma and microwave. Gamma irradiation was used at a dose of 6 k.Gy. Microwave radiation was performed by continuous supply of 200 W/Kg of wheat germ for 3 min, and wheat germ was fermented. The gross chemical composition as well as the caloric value of all studied samples, in addition the mineral composition and vitamins of these studied samples was estimated. The amino acid composition and fatty acids composition were studied as well. The results showed that treated and untreated wheat germ had relatively high content of protein, fat, and minerals. Moreover, it proved that it is a good source of vitamin E. It was also noticed that wheat germ protein was rich in most of the essential amino acids, especially leucine, and lysine. Data revealed that wheat germ is considered as a rich source of fatty acids ,and showed that the dominant fatty acid was the linoleic acid. The data revealed that fermented wheat germ recorded the highest percentages in crude protein (36.42%).However microwave treated wheat germ had the highest content of crude fiber (6.13%) . While gamma irradiated wheat germ recorded the highest percentages of carbohydrates (60.75%). On the other hand, raw wheat germ recorded the highest percentages of the ash (5.00%) on dry weight basis. The data concerning mineral contents of the present study are revealed that the fermented wheat germ had the highest iron, manganese, copper, sodium, potassium and sulphur levels. The data revealed that fermented wheat germ recorded the highest percentages in Vitamin (A) and Vitamin (C).However microwave treated wheat germ had the highest content of vitamin (E). Moreover, the data revealed that there were obvious variations in the amino acid composition and in the fatty acids composition as well among all studied types of wheat germ.

Keywords: raw wheat germ, gamma irradiated wheat germ, microwave treated wheat germ, chemical composition, mineral, vitamin, amino acids, fatty acids.

INTRODUCTION

Wheat germ constitutes about 2.5-3% of the wheat seed. Wheat germ is rich in protein and fat and contains carbohydrate especially sucrose and vitamins with special reference to vitamin E. Due to its high content of fat wheat germ deteriorates rapidly as a result to fat rancidity and appearance of off-smell products.

Sjovall *et al.* (2000), Arrigoni *et al.* (2002), Hessen (2003) found that the wheat germ, accounted for(2~3 %) of the whole grain and had a high nutritional value.Wheat germ is a by-product of the flour milling industry. Its

composition includes vitamins, minerals, dietary fibers, proteins and some essential trace elements and hence, also considering its low cost, it has a high nutritional value. Ge *et al.* (2002).

Ibrahim *et al.* (1990) showed that the mean proximate composition of crude wheat germ was: 13.35 %, 23.40 %, 6.04 %, 51.53%, 1.33 % and4.35 % for moisture, protein, fat, carbohydrates, fiber and ash contents; respectively (on dry basis). Rekha-Sharma *et al.* (1998) found that the proximate composition of wheat germ was:(8.40 %) moisture, (26.25%) protein , (6.20 %) ether extactives, (3.20 %)ash ,(1.87 %)crude fiber and (54.04%) carbohydrates. Sidhu *et al.* (1999) stated that the mean proximate composition of wheat germ was: 27.88+0.28%, 9.86 +0.11 and 4.33 +0.12% for protein , fat and ash content; respectively (on dry basis).Kozlov (2003) reported that the mean proximate composition of wheat germ was: (25.7 %) and (9.6 %) for protein and fat content; respectively. According to (ES), (2004) the proximate composition of wheat germ was: (14 % as maximal level) of moisture, (22 % as minimal level) of crude protein, (6 % as minimal level) of crude fat, (2.8 % as maximal level) of crude fiber and (5 % as maximal level) of ash (on dry basis). Pinark *et al.* (2004) reported that the mean composition of wheat germ was: 11.5 +0.005 %, 24.6 +0.071 %, 20.4+0.052%, 39.9+0.049% and 3.9 +0.07% for moisture, protein, crude oil, carbohydrate and ash content; respectively (on dry basis). Bilgiçli *et al.* (2006) and Bilgiçli and İbanoğlu (2007) found that the mean proximate of wheat germ was: 10.80 + 0.71 % 26.50 + 1.41 %, 8.56 + 0.79 % and 4.18 + 0.08 % for moisture, crude protein, crude fat and ash content; respectively (on dry basis). Arshad *et al.* (2007) stated that the mean proximate composition of defatted wheat germ was: 3.2 +0.3, 27.8 + 0.4 ,0.05+ 0.01,5.35 +0.3 and 4.52 + 0.2 for moisture, crude protein, crude fat, crude fiber and ash content; respectively (g / 100 g).

Bilgiçli *et al.* (2006) found that the mean mineral composition of wheat germ was: 365.1+ 7.21, 0.6 + 0.03, 9.45 + 0.35, 1365.1+ 21.35, 310.3 + 7.49, 13.0 + 1.41, 775.2 + 7.35 and 9.05 + 0.07 (mg / 100 g) for Ca, Cu, Fe, K, Mg, Mn, P and Zn content; respectively (on dry basis).

Arshad *et al.* (2007) detected that the mean mineral composition of defatted wheat germ was: 45.9 +0.3, 7.36 + 0.8 and 1050 +2.0 (mg / 100 g) for calcium, iron, and potassium content; respectively.Su (1993) found that the wheat germ contained 25.6 (mg / 100g). alpha-tocopherol and 9.8 (mg /100 g). beta- tocopherol.

Ibrahim *et al.* (1990) detected that the mean essential amino acid of the protein in crude wheat germ was:(3.70, 7.81, 6.72, 1.92, 5.00, 3.95, and 7.05) for isoleucine, leucine, lysine, methionine, phenylalanine, threonine, valine content; respectively. Meanwhile non essential amino acids were: (6.64, 4.50, 9.19, 0.65, 17.96, 6.09, 6.51, 4.75, and 2.55) for alanine, arginine, aspartic acid, cystine, glutamic acid, glycine, proline, serine, tyrosine content; respectively on wet basis.

Zhu *et al.* (2006) and Arshad *et al.* (2007) identified that the mean essential amino acid profiles of defatted wheat germ was: (2.92, 1.73), (6.64, 1.11), (6.69, 2.32), (1.64, 0.25), (4.06, 1.04), (4.50, 0.93), (1.15, 0.20),(4.53,1.40) (g /100 g) for isoleucine, leucine, lysine, methionine,

phenylalanine, threonine, tryptophane, valine. Meanwhile non essential amino acid profiles were: (7.89, 1.66), (6.43, 4.76), (9.43, 1.63), (15.19, 5.09), (5.64, 1.47), (4.46, 1.43), (2.39, 0.78) for alanine, arginine, aspartic acid, glutamic acid, glycine, serine, tyrosine content; respectively.

Ibrahim *et al.* (1990) outlined that the total unsaturated fatty acid of crude wheat germ oil amounted to (79.1 %). While the saturated ones were (20.9 %). Among the saturated fatty acid, palmitic acid C16:0 was found to be the major saturated acid having a percentage of (19.4 %)followed by myristic acid C14:0 (0.9 %) and Stearic acid C18:0 (0.6%)which were detected in minor percentages. Linoleic acid C18:2 was not only the major fatty acid in the unsaturated fatty acid group, but it was also the dominant fatty acid in crude wheat germ oil, reaching a value of (58.7 %) followed by oleic C18:1, which represented (18.6 %).the Linolenic acid was also detected at a lower level, being (1.8 %). Ostlund *et al.* (2003) founded that the fatty acid content of original wheat germ, original wheat germ oil and purified wheat germ oil was: C14:00 (0.12 ± 0.00, 011± 0.00, 0.11± 0.00); C16:0 (19.52 ± 0.05, 18.27 ± 0.06, 18.08 ± 0.02);C 16:1 (0.23 ± 0.01, 0.20 ± 0.00, 0.21 ± 0.00);C 18:0 (0.77 ± 0.01, 0.79 ± 0.00, 0.70 ± 0.00), C18:1 (17.38 ± 0.02, 16.58 ± 0.04, 18.14 ± 0.03);C18:2 (55.71 ± 0.07, 57.50 ± 0.11, 57.08 ± 0.05) and C18:3 (6.27 ± 0.01, 6.57 ± 0.01,5.69 ± 0.02).

In the present study, some processing methods were used to improve the stability of wheat germ. Such methods included microwave and gamma irradiation aiming to destroy the antinutritional factors present in the wheat germ. In the present investigation an attempt was carried out to evaluate the nutritive value of the stabilized wheat germ and the oil extracted from it.

MATERIALS AND METHODS

Materials:

Source of samples:

2 wheat germ varieties namely: Giza 60 and Saha 40 were mixed in the Asdekaa mill and the resultant wheat germ was used in the present study 20 Kg samples of wheat germ were procured from this mill during Marsh 2008.

Preparation of samples:

Twenty kilograms samples was divided into four samples. The first sample raw wheat germ (about 5.0 kilograms) was used as control. The second sample of raw wheat germ (about 5.0 kilograms) was irradiated at Egyptian Atomic Energy Authority using a 60Co gamma source at an average dose of (6 kGy), which is the average dose recommended by the (Codex Alimentarius commission (1990), to reduce microbial load and the number of pathogenic microrganisms for wheat germ. The third sample of raw wheat germ (about 5.0 kilograms) was treated by microwave radiation. The treatment using microwave radiation (MS143SCE, Samsung Electronics, Korea) was performed by continuous supply of wheat germ in the pasteurization chamber at 200 W/Kg of wheat germ for 3 min., where microwave oscillators allowed the sanitization with drastic reduction of the microbic contamination (Less than 103 microorganisms per gram).

The wheat germ was subjected to microwave heating for 3.0 min. at 200 W using a householed microwave oven . Sample was placed in a pyrex Petri dish (8.0) cm diameter by 1.0 cm deph; each Petri dish contained approx.25g) and heated for the required period. .after that the the wheat germ samples was allowed to cool at room temperature (Yousif (2004).On the other hand, the forth sample of wheat germ (about 5.0 kilograms) was fermented as described by(Hidvègi *et al.* (1999) .

Methods:

(1) Chemical methods:

Moisture, protein, fat, crude fiber, and ash contents were determined according to the methods described by A.O.A.C. (1990). While, total carbohydrates were calculated by difference according to Pellet and Sossy (1970).The caloric value was calculated according to Seleet (1990).

Determination of mineral contents:

The samples were wet acid-digested using a nitric acid and perchloric acid mixture (HNO3; HCSO4; 2:1 v / v). The amounts of iron, zinc, copper and manganese in the digested sample were determined using a GBC Atomic Absorption 906 A, as described in A.O.A.C.,(1990). Sodium and potassium were determined by a flame photometer 410, calcium and magnesium were determined by titration with version 0.0156 N according to Jackson (1967). Phosphorus, sulphur and selenium were determined according to the methods described by A.O.A.C. (1990).

Determination of vitamin contents:

Vitamin C was determined according to Bajaj and Kaur,(1981). On the other vitamins E. and A. were determined according to the methods described by Principal Central Lab. of Cairo University,(2008).

Determination of amino acids contents:

Amino acids were determined according to the method described by Block *et al.* (1958)using Automatic Amino Acid Analyzer AAA 400 INGOS Ltd at Principal Central Lab. of Cairo University,(2008). Tryptophan was determined by chromatography using UV-1601 PC, SHIMADZU. UV-VISBLE spectrophotometer (550 nm) according to the method described by Sastry and Tummuru (1985).

(II) Computation of chemical score:

The chemical score was defined according to Bhanu *et al.* (1991) as follows:

$$\text{Chemical score} = \frac{\text{mg of essential amino acids in 1 gm test protein}}{\text{mg of essential amino acid in 1 gm reference protein}} \times 100$$

(III) Computation of A/E ratio:

The relationship between the content of an individual essential amino acid in the food protein (A) and the total essential amino acids content (E) was calculated according to FAO, (1965) as follows:

$$\text{A/E ratio} = \frac{\text{mg of the individual essential amino acids}}{\text{mg of total essential amino acids}}$$

(IV) Computation of protein efficiency ratio (PER):

Protein efficiency ratio was calculated using the equation mentioned by Alsmeyer *et al.* (1974) as follow:

PER = - 0.684 + 0.456 (leucine) – 0.047 (proline)(g/100g protein)

(V) Computation of biological value (BV):

Biological value (BV) of protein samples was calculated according to the equation of Oser, (1959) as follows:

BV = 49.09 + 10.53 (PER)

Determination of fatty acids methyl esters by gas liquid chromatography:

The methyl esters of fatty acids were separated using a PYE Unicam Pro-GC gas liquid chromatography with a dual flame ionization and carried out on (3.0 m 0.25 mm) SP-2310 'packed with 55% cyanopropyl phenyl silicone dimensions. Column temperature: At first the temperature was 100˚C at the rate of 8˚ minute, and then isothermal for minutes at 195˚C. The injector and detector temperature were 250˚C and 300˚C; respectively (Rossell *et al.* , 1983). Carrier gas : Nitrogen at the rate 30 ml/minute. Hydrogen flow rate 33 ml/minute and air flow rate 330 ml/minute. The chart speed was 0.4 cm/minute. Peak identifications were established by comparing the retention times obtained with standard methyl esters. The areas under the chromatographie peak were measured with electronic integrator.

RESULTS AND DISCUSSION

Gross chemical composition and caloric value:

The data given in Table (1) revealed that fermented wheat germ recorded the lowest percentages in moisture, fiber and carbohydrates were (3.70%), (0.72%)and (49.73%) and highest percentages in crude protein (36.42%).However microwave treated wheat germ had the highest content of crude fiber (6.13%) . While gamma irradiated wheat germ recorded the highest percentages of carbohydrates (60.75%). On the other hand raw wheat germ recorded the highest percentages of the ash (5.00%) on dry weight basis. Besides, fermented wheat germ recorded the highest caloric value (421.46 K. cal.), while microwave treated wheat germ recorded the lowest caloric value (399.87 K. cal.). However both raw wheat germ and gamma irradiated wheat germ recorded intermediate position among the four studied wheat germ groups.

The data presented in Table (1) indicated that moisture content of raw wheat germ and gamma irradiated wheat germ were (13.49 %) and (13.17 %) .Such values are in close agreement with Ibrahim (1990), (ES), (2004),

and Arshad *et al.* (2007) .On the other hand , Pinark *et al.* (2004) recorded rather lower moisture values.

The data given in Table (1) showed that crude protein content of raw wheat germ, gamma irradiated wheat germ and microwave treated wheat germ agree with Ibrahim (1990), (ES), (2004), and Pinark *et al.* (2004) On the other hand the results in the present study were lower than that reported for crude protein value by Rekha-Sharma *et al.* , (1998) , Sidhu *et al.* (1999), Kozlov (2003), and Arshad *et al.* (2007) on dry weight basis. It is woth-noty that fermented wheat germ recorded the highest protein content among all studied wheat germ samples.

Table (1): Gross chemical composition of raw wheat germ, gamma-irradiated wheat germ, microwave treated wheat germ and fermented wheat germ.(On dry weight basis)*

Estimates %	Raw Wheat germ	Gamma irradiated wheat germ	Microwave treated wheat germ	Fermented wheat germ
moisture	13.49	13.17	09.28	03.70
Crude protein	23.47	22.54	23.12	36.42
Crude fat	08.72	08.99	08.35	08.54
Crude fiber	03.86	02.92	06.13	00.72
Ash	05.00	04.80	04.34	04.59
Carbohydrates**	58.95	60.75	58.06	49.73
Caloric value (K. cal)	408.16	414.07	399.87	421.46

***Mean of three replicates.**
****Carbohydrates were calculated by difference.**

The data given in Table (1) revealed that wheat germ and it's three studied treatments are good in accord with Bilgiçli *et al.* (2006) and Bilgiçli and İbanoğlu (2007). The data given in Table (1) indicated that the fiber content of raw wheat germ and gamma irradiated wheat germ (3.86 %) and (2.92 %), which coincides with (ES), (2004). The data given in Table (1) showed the ash content of wheat germ and it's three studied treatments quite agree with Ibrahim, (1990), Sidhu *et al.* (1999) and (ES), (2004), Bilgiçli *et al.* (2006) and Bilgiçli and İbanoğlu (2007), and Arshad *et al.* (2007).The data given in Table (1) revealed that the carbohydrates content of wheat germ and it's three studied treatments agree with Ibrahim, (1990), and Rekha-Shrama *et al.* (1998).

Generally, the recorded variations in the gross chemical composition of the four studied wheat germ samples could be attributed to the environmental, climatic conditions, soil type, as well as varietal differences (Mohamed (2006).

Mineral content:

The data concerning mineral contents of the present study are tabulated in Table (2) and revealed that the fermented wheat germ had the highest iron, manganese, copper, sodium, potassium and sulphur levels, and the lowest of phosphorus. Moreover, microwave treated wheat germ recorded

the lowest copper, and sulphur levels . Furthermore, gamma irradiated wheat germ recorded the highest level of phosphorus, and the lowest levels of iron, zinc, magnesium, sodium, potassium, and sulphur . Besides raw wheat germ recorded the highest zinc and magnesium levels.

Table (2): Minerals content of raw wheat germ, gamma-irradiated wheat germ,microwave treated wheat germ and fermented wheat germ. (mg /100g).*

Minerals	Raw Wheat germ	Gamma irradiated wheat germ	Microwave treated wheat germ	Fermented wheat germ
Fe	09.07	08.22	08.55	11.41
Mn	11.24	11.23	12.00	12.36
Cu	1.59	1.50	1.37	1.98
Zn	17.38	14.58	15.03	15.38
Mg	312	216	228	240
Ca	100	140	100	140
Na	70	65	75	95
K	440	430	455	491
P	705	748	708	690
S	344	401	310	504
Se	300	300	300	300

***Mean of three replicates.**

Arshad *et al.* (2007) detected that the mean mineral composition of defatted wheat germ was: 7.36 + 0.8 (mg / 100 g) for Fe contents. Such values are in rather agreement with that of the present study. While, Bilgiçli *et al.* (2006) found that the mean mineral composition of wheat germ was: 9.45 +0.35, 310.3 + 7.49,13.0 +1.41,775.2 + 7.35 and 9.05+0.07 (mg / 100 g) for Fe, Mg, Mn, P and Zn contents; respectively. Such values were similar with that of the present study.

Vitamins contents:

The data given in Table (3) revealed that fermented wheat germ recorded the highest percentages in Vitamin (A) and Vitamin (C) (16555.70 IU/100g) and (125.82 mg/100g) .However microwave treated wheat germ had the highest content of vitamin (E) (1840 IU/100g).While gamma irradiated wheat germ recorded the lowest percentages of Vitamin (A) and Vitamin (C) (7941.80 IU/100g and 87.78 mg/100g). On the other hand, raw wheat germ recorded the lowest percentages of Vitamin (E) **(**1312 IU/100g).

The results presented in Table (3) revealed that Retention of vitamin (E) was greater in steamed and dried germ.(Srivastava *et al.* (2007).

Table (3): Vitamins content of raw wheat germ, gamma-irradiated wheat germ, microwave treated wheat germ and fermented wheat germ.*

Treatments	Vitamin (A) IU/100g	Vitamin (E) IU/100g	Vitamin (C) mg/100g
Raw wheat germ	10343.23	1312	98.45
Gamma irradiated wheat germ	7941.80	1360	87.78
Microwave treated heat germ	16311.10	1840	106.17
Fermented wheat germ.	16555.70	1552	125.82

***Mean of three replicates.**

Amino acids content:

The data concerning the amino acids contents presented in Table (4) revealed that the fermented wheat germ had the highest threonine, praline, serine and tyrosine values, and the lowest isoleucine, lysine , methionine , arginine and histidine values. On the other hand, microwave treated wheat germ recorded the highest of methionine values and the lowest of aspartic acid and proline values.

Table (4): Amino acid composition of raw wheat germ, gamma-irradiated wheat germ, microwave treated wheat germ and fermented wheat germ.on dry weigh basis (g amino acid/ 100g protein).

Amino acids	Raw wheat germ	Gamma irradiated wheat germ	Microwave treated wheat germ	Fermented wheat germ
Isoleucine	04.06	03.47	04.05	03.34
Leucine	10.47	08.68	10.43	08.67
Lysine	10.26	08.30	10.14	05.57
Methione	02.08	01.97	02.20	01.77
Phenylalanine	05.03	04.24	05.03	04.45
Threonine	02.54	01.49	03.48	05.38
Tryptophan	01.80	01.25	01.00	01.24
Valine	06.21	05.09	06.10	05.11
Total Essential amino acids (A.A.)	**42.45**	**34.49**	**42.43**	**35.53**
Alanine	09.81	07.84	09.67	07.84
Arginine	11.28	09.13	11.21	08.33
Aspartic acid	02.49	09.91	02.34	03.49
Cystine	02.42	01.39	0.79	01.90
Glutamic acid	09.13	19.67	11.34	18.72
Glycine	08.90	08.07	08.78	08.08
Histidine	05.04	04.15	04.98	04.00
Proline	00.25	00.78	00.03	01.21
Serine	04.54	01.47	04.66	06.20
Tyrosine	03.69	03.10	03.77	04.70
Total Non Essential amino acids (N.E.A.A.)	**57.55**	**65.51**	**57.57**	**64.47**
E.A. A. / N.E.A.A.	**0.74**	**0.53**	**0.74**	**0.55**

Moreover, gamma irradiated wheat germ recorded the highest aspartic and glutamic acid values and the lowest of phenylalanine ,threonine , serine, phenylalanine and tyrosine. Besides raw wheat germ recorded the highest lysine, valine alanine arginine, cystine glycine, histidine and serine values and the lowest of glutamic acid values.

The results given in Table (4) revealed that methionine, threonine, valine, serine and tyrosine content of wheat germ are similer to Ibrahim et al findings (1990).

A/E ratio:

Table (5) showed that A/E ratio indicated the relationship between the content of essential amino acids in the food protein (A) and the total essential amino acids content (E).

High A/E ratio of Leucine level in wheat germ and in the other studied three treatment was recorded. Whereas, the lowest A/E ratio was recorded for tryptophan level in wheat germ and in the other studied three treatments.

Table (5): compution of A/E ratio of of raw wheat germ, gamma-irradiated wheat germ, microwave treated wheat germ and fermented wheat germ.(mg essential amino acids / mg of total essential amino acids)

Amino acids	Raw wheat germ	Gamma irradiated wheat germ	Microwave treated wheat germ	Fermented wheat germ
Isoleucine	0.10	0.10	0.10	0.09
Leucine	0.25	0.25	0.25	0.24
Lysine	0.24	0.24	0.24	0.16
Methione	0.05	0.06	0.05	0.05
Phenylalanine	0.12	0.12	0.12	0.13
Threonine	0.06	0.04	0.08	0.15
Tryptophan	0.04	0.04	0.02	0.03
Valine	0.15	0.15	0.14	0.14

Protein efficiency ratio (PER) and Biological value (B.V.):

Table (6) showed the PER values of wheat germ and its three studied treatments were more than(3.00) . This means that wheat germ protein is a good protein with a high quality ,Kumar *et al.* ,(1980); Gasiorowski and Czyz,(1981) and Barnes,(1982) reported that quantitatively cereals are poor sources of proteins and have poor protein efficiency ratio (PER).

The table (6) showed that the biological value of protein(BV) of raw wheat germ was similar to (BV) of microwave treated wheat germ ,and (BV) of gamma irraditated wheat germ was similar (BV) of fermented wheat germ.

The results given in table (6) showed that the (BV) of gamma irradiatin reduced (BV)of raw wheat germ .These results agree with Metta *et al*(1957) who reported that the BV of the pea protein was reduced by 5 % due to gamma irradiation.

Table (6): computation of protein efficiency ratio (PER) and Biological value (B.V.) of protein in raw wheat germ, gamma-irradiated wheat germ, microwave treated wheat germ and fermented wheat germ.

Ratio	Raw Wheat germ	Gamma irradiated wheat germ	Microwave treated wheat germ	Fermented wheat germ
PER	4.08	3.24	4.08	3.21
BV	92.05	83.21	92.05	82.89

The biological value (BV) is a very important nutritional parameter because it is directly related to the biological metabolism. It also shows the rate of utilization of the proteins absorbed into the body. Proteins that show BV of (90) or more, are considered as good source of nitrogen such as whole egg protein (93.7) and milk (91) (Renner, 1983). The data given in table (7) revealed that the BV of raw wheat germ was(92.05) nd ranged from (82.89) to (92.05) for theother treated samples as compared with casein (77), beef (74.3) and fish (76) (FAO,1970). Therefore the BV of wheat germ proteins could be considered equal to highly rated animal proteins. Lásztity *et al.* (1995)reported that the biological value ranged from (63-75) for the germs of wheat ,rye, barley, rice and maize.

From all the above-mentioned data it could be concluded that wheat germ could be used as an effective additive for increasing the protein content and improving the biological value of vegetative foods.

Chemical score and limiting amino acids :

The data present in table (7) revealed that threonine, tryptophan and leucine were the first limiting amino acids for raw wheat germ and the other three studied wheat germ treatments. However, isoleucine, methionine and tryptophan were the second limiting amino acids.

Fatty acids content:

The data concerning the fatty acid contents of the present study tabulated in Table (8) revealed that the fermented wheat germ had the highest palmitic , stearic, arachidic, and oleic levels. Moreover, microwave treated wheat germ recorded the highest of myristic and palmitoleic levels . Furthermore, gamma irradiated wheat germ recorded the highest level of arachidonic. Besides raw wheat germ recorded the highest linoleic and Lionlenic levels.

The data given in Table (8) revealed that palmitic acid and linoleic acid in raw wheat germ are in agreement with Ibrahim *et al.* (1990) and Ostlund *et al.* findings(2003).While lionlenic acid in raw wheat germ coincides agreement with Ostlund *et al.* findings (2003).

Table (7): Chemical score and limiting amino acids of raw wheat germ, gamma-irradiated wheat germ, microwave treated wheat and fermented wheat germ.

Essential amino acid (E.A.A.)	Whole eggs	Casein	Chemical score							
	mg (E.A.A.)/g protein		Raw wheat germ		Gamma irradiated wheat germ		Microwave treated wheat germ		Fermented wheat germ	
			D/E ×100	D/C ×100	D/E ×100	D/C ×100	D/E ×100	D/C ×100	D/E ×100	D/C ×100
Isoleucine	56	52	72.50	78.08	61.96	36.15	72.32	77.88	59.64	64.23
Leucine	83	96	126.14	109.06	104.58	90.42	125.66	108.65	104.46	90.31
Lysine	63	69	162.86	148.70	131.75	120.29	160.95	146.96	88.41	80.72
Methionine	32	16	65.00	130.00	61.56	123.13	68.75	137.50	55.31	110.63
Phenylalanine	51	35	98.63	143.71	83.14	121.14	98.63	143.71	87.25	127.14
Threonine	51	46	49.80	55.22	82.78	32.39	68.24	75.65	105.59	116.96
Tryptophan	18	17	100.00	100.59	60.94	70.35	90.44	100.00	60.89	70.29
Valine	76	60	81.71	103.50	66.97	84.83	80.26	101.67	67.24	85.17
First limiting amino acids			**Threonine**	**Threonine**	**Tryptophan**	**Threonine**	**Threonine**	**Threonine**	**Methione**	**Isoleucine**
Second limiting amino acids			**Methione**	**Isoleucine**	**Isoleucine**	**Isoleucine**	**Methione**	**Isoleucine**	**Isoleucine**	**Tryptophan**

D =amino acid of wheat germ. E= amino acid of whole egg. C = amino acid of casein.

Table (8): Fatty acid composition of raw wheat germ, gamma-irradiated wheat germ, microwave treated wheat germ and fermented wheat germ. (% of total fatty acids).

Fatty acids	Carbon chain	Raw Wheat germ	Gamma irradiated wheat germ	Microwave treated wheat germ	Fermented wheat germ
Myristic	C14:0	0.28	2.30	10.25	1.59
Palmitic	C16:0	19.06	17.47	15.27	19.66
Stearic	C18:0	0.45	0.52	0.42	0.95
Arachidic	C20:0	0.98	1.01	0.67	1.04
Palmitoleic	C16:1	N.D.*	0.93	3.10	0.13
Oleic	C18:1	13.91	13.77	11.62	15.74
Linoleic	C18:2	57.90	55.83	45.13	52.89
Lionlenic	C18:3	7.41	6.46	3.60	5.54
Arachidonic	C20:4	N.D.*	1.01	0.34	N.D.*
Total fatty acids		99.99	98.37	90.40	97.54
Unknown		-	1.63	9.6	2.46
SFA		20.77	21.30	26.61	23.24
USFA		79.22	77.07	63.79	74.30
SFA/USFA		0.26	0.28	0.42	0.31

***N.D=Not detect.**

Conclusion

In conclusion, the present study revealed that treated and untreated wheat germ had relatively high content of protein, fat, and minerals. Moreover, it is a good source of vitamin E. It was also noticed that wheat germ protein was rich in most of the essential amino acids, especially leucine, and lysine. Data revealed that wheat germ is considered as a rich source of fatty acids.

REFERENCES

A.O.A.C. (1990): Association of Official Analytical Chemists. "Official Methods of Analysis" 16th ed.Association of Official Analytical Chemists Washinglon.DC.

Alsmeyer, R.H., Cumningham, A.E. and Happich, M.L. (1974): Equations Predict PER From Amino Acid Analysis. Food Technol., July.34-40.Analyst 106,117.

Arrigoni, E.; Jörger, F.; Kollöffelm B.; Roulet, I.; Herensperger, M.; Meile, L. and Amadò R. (2002): In vitro fermentability of a commercial wheat germ preparation and its impact on the growth of bifidobacteria. Food Research International 35, 475-481.

Arshad, M. U.; Anjum, F. M. and Zahoor, T. (2007): Nutritional assessment of cookies supplemented with defatted wheat germ. Food Chemistry, 102, 123-128.

Bajaj,K.L. and Kaur,G.(1981): Spectrophotometric deyermination of L-ascorbic acid in vegetables and fruits. Analyst 106,117-120.

Barnes, P. J. (1982): Composition of cereal germ preparation. Nutr. Abst. Rev. 52,8271.

Bhanu, V., Ranacha, G. and Monterio, P. (1991): Evaluation of protein lsolate From Cassia Uniftora asa Source of plant protein.J. Sci Food Agric. 54:659-662.

Bilgiçli, N. and İbanoğlu, Ş. (2007): Effect of wheat germ and wheat bran on the fermentation activity, phytic acid content and colour color of tarhana, a wheat flour-yoghurt mixture. Journal of Food Engineering, 78, 681-686.

Bilgiçli, N.; Elgün, A.; Herken, E., N.; Türker, S.; Ertaş N. and İbanoğlu, Ş. (2006): Effect of wheat germ and wheat bran on the chemical,nutritional and sensory quality of tarhana, a fermented wheat flour-yoghurt product, Journal of Food Engineering, 77, 680-686.

Block, R. J. ; Durrum, E. L.;and Zweig, G. (1985). Annual of paper chromatography and paper electrophoresis. 2nd, ed. Academic press, New York P 75-80.

Codex Alimentarius Commission (1990): Federal Register Irradiation in the Production, Processing and Handling of Food, Vol. 55. No. 85.

El-Bardeny, A. E.; Abdel-Salam, A. M. H. and Saad, S. M.M.(1991): Studies on utilization of wheat germ in the production of enriched bread. Annals of Agricultural Science, Moshtohor 29(1): 223-239.

ES (2004): Wheat germ. Egyptian standards No. 4463.

FAO (1965): Food and Agriculture Organization of United Nations. Protein requirements. FAO(Nutrition Meetings Report Series. No. 37. Rome.

FAO (1970): Amino acid content of foods and biological data on protein , FAO nutritional studies, No. 24,(FAO,Rome, Italy).

Gasiorowski, K. and Czyz, I. (1981): Wheat germs: chemical composition and utilization. Nutr. Abst. Rev., 51, 4723.

Ge, Y.; Ni, Y,; Yan, H.; Chen, Y. and Cai, T. (2002): Optimization of the supercritical fluid extraction of natural vitamin E from wheat germ using response methodology.J. of Food Sci., vol. 67,no 1.

Hessen, K. R. F. (2003):Chemistry of cereals and cereals products, P. 16-17, Dar El-Kotob for publication and distribution, Cairo, Egypt.

Hidvègi, M.; Rásó, E.; Farkas, R. T. ; Lapis, K., and Szende, B. (1999): Effect of MSC on the immune response of mice. Immunopharmacology, 41, 183-186.

Ibrahim, A. A. M.; Abo zaid. M. M. and El-Mahdy, L.D. (1990): Studies on crude wheat germ produced as a by-product of milling industry. Annals of Agric. Sci., Moshtohor, Vol. 28 (2).

Jackson, M. L. (1967): Soil chemical analysis. Prentice-Hall of India. Private Limited, New Delhi.

Kozlov, S.G. (2003): Functional products based on whey. Molochnaya-Promyshlennost, ; (6):57-58.

Kumar, G. V. ;Verghese, E. T. ; Haridas, R. P. and Shurpalekar, S. R. (1980): Effect of heat treatment on the nutritive value of wheat germ. J. Fd. Sci. Technol. 17,257.

Làsztity, R.; Tömösközi, S.; Nagy, J.; Bajkai, T. and Sarkadi, L. (1995): Investigation of some functional and nutritive properties of cereal germ proteins. Per. Pol. Chem.. Chg., 39/1, 63-76.

Metta, V.; Norton, H. W. and Johnson, C. B. (1957): The effect of radiation sterilization on the nutritive value of foods. Journal of Nutrition, April 12.

Mohamed, M. M. H. Effect of some Egyptian vegetables on the cholesterol in blood serum of white rats. M.Sc.Thiesis, Faculty of Specific Education, Ain Shams University.

Oser, B.L.(1959): An integrated essential amino acid index for predicting the biological value of protein, in: "Protein and amino acid nutrition". Ed. A.A.Albanese, Published by Academic Press, New York.

Ostlund, R. E. Jr; Racette, S. B.and Stenson, W. F. (2003): Inhibition of cholesterol absorption by phytosterol-depleted wheat germ. Am. J. Clin. Nutr. 77: 1385-9. USA.

Pellet, P.L. and Sossy, S. (1970): Food Composition. Tables for use in the Middle East. American Univ. of Beirut. Beirut. Lebanon.

Pınark, İ. İbanoğlu, Ş. and Öner, M. D. (2004): Effect of storage on the selected properties of macaroni enriched with wheat germ. Journal of Food Engineering, 64, 249-256.

Principal Central Lab. of Cairo University, (2008): Vitamins Assay, Faculty of Agriculture, Cairo University .

Rekha-Sharma; Vali, S., A.; Shastri, P, N. and Rao, B., Y. (1998): Stabilization of wheat germ. Journal of Dairying Foods and Home Sciences; 17 (2): 111-115.

Renner, E. (1983). Milk and dairy products in human nutrition. Munich,
Rossell, J.B., King, B.and Downes, M.J.(1983): Detection of adulteration. J. Am. Oil Chem. Soc., 60:333.
Sastry, C.S.P. and Tummuru; M.K.(1985): Spectrophotometrie determination af tryplophan in protein.j. Food Science Technology,22:146-147.
Seleet, F.L.(1990): Preparation and Evaluation of some Infantile Foods. M. Sc. Thesis. Dept. of Food Sci. Fac. Of Agric. Cairo University, Egypt.
Sidhu, J. S.; Al-Hooti, S. N. and Al-Saqer, J. M. (1999): Effect of adding wheat bran and germ fractions on the chemical composition of high-fiber toast bread. Food Chemistry, 67, 365-371.
Sjovall, O.; Virtalaine, T.; Lapvetelainen, A.M. and Kallio, H. (2000): Development of rancidity in wheat germ analyzed by headspace gas chromatography and sensory analysis. Journal of Agricultural and Food Chemistry,48(8): 3522-3527
Srivastava, A. K.; Sudha, M. L.; Baskaran, V.and Leelavathi, K. (2007): Studies on heat stabilized wheat germ and its influence on rheological characteristics of dough. European-Food-Research-and-Technology, 224 (3): 365-372 .
Su, J. D. (1993): Studies of rapid determination of vitamin E and its application on natural foodstuffs. Journal of Food and Drug Analysis; 1(1): 61-70 .
Yousif, E. I. (2004): Functional properties and some utilization of wheat germ protein products. Annals of Agricultural Science Cairo; 49 (1) : 139-162.
Zhu, k.; Zhou, and qian, H., and Qian , H. F. (2006): Protein extracted from defatted wheat germ: nutritional and structural properties. Cereal Chem., 83(1): 69-75.

التقييم التغذوى لجنين القمح الخام والمعامل بأشعة جاما والميكروويف و المتخمر

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تمت الدراسة على عينات من جنين القمح الخام والمعامل ببعض المعاملات المختلفة ،والتى تمثلت فى تشعيع جنين القمح بنوعين من الأشعة و هما أشعة جاما وأشعة الميكروويف كما تم اجراء عملية تخمر لجنين القمح ليصبح بذلك أربعةعينات مدروسة هى جنين القمح الخام ، جنين القمح المعامل بأشعة جاما،جنين القمح المعامل بأشعة الميكرويف ،جنين القمح المتخمر.

تم تشعيع العينة باشعة جاما عند جرعة مقدارها ٦ كيلو جراى ،و بأشعة الميكروويف من مصدر اشعاعى مستمر عند معدل ٢٠٠ وات لمدة ٣ دقائق ،كما أجريت عملية تخمر لجنين القمح.

ولقد تمت دراسة مكونات جنين القمح المعامل وغير المعامل من حيث تقدير التركيب الكيميائى العام وحساب الطاقة السعرية ،وتقدير بعض الأملاح المعدنية و الفيتامينات ،والأحماض الأمينية ،والأحماض الدهنية.

أوضحت النتائج وجود نسبة عالية من البروتين والدهن فى جنين القمح الخام و المعامل بالمعاملات الثلاثة الختلفة السابقة الذكر ونسبة عالية من الأملاح وكذلك نسبة عالية من الفيتامينات وخاصة فيتامين (د) كما وجد ان بروتين جنين القمح غنى فى معظم الأحماض الأمينية الأساسية و خاصة حمض الليوسين وحمض الليسين كما أنه غنى بالأحماض الدهنية غيرالمشبعة كما اثبت الدراسة ان حمض اللينولييك هو الحمض الدهنى السائد. كما أوضحت النتائج ارتفاع قيمة معامل كفاءة البروتين ،القيمة الحيوية للبروتين.

وجد ان أعلى محتوى للبروتين فى العينات المدروسة كان فى بروتين جنين القمح المتخمر (٣٦,٤٢%) بينما أعلى محتوى للألياف كان فى ألياف جنين القمح المعامل بأشعة الميكروويف(٦,١٣%)، فى حين ان أعلى محتوى للكربوهيدرات كان فى جنين القمح المعامل بأشعة جاما(٦٠,٧٥.%) وأعلى محتوى للرماد كان فى جنين القمح الخام (٥ %) .

أوضحت النتائج ان أعلى نسبة لكل من الحديد،المنجنيز ، النحاس ، الصوديم ، البوتاسيوم، الكبريت فى العينات المدروسة كانت لجنين القمح المتخمر

أوضحت النتائج ان أعلى نسبة لكل من فيتامين(A)،و فيتامين(D) فى العينات المدروسة كانت لجنين القمح المتخمر بينما أعلى نسبة لفيتامين (E) كانت لجنين القمح المعامل بأشعة الميكروويف. و كان هناك تباينا فى الأحماض الأمينية والأحماض الدهنية بين العينات موضوع الدراسة .

الكلمات المفتاحية: جنين القمح الخام، جنين القمح المعامل بأشعة جاما، جنين القمح المعامل بأشعة الميكروويف، جنين القمح المتخمر، التركيب الكيميائى العام، الأملاح المعدنية، الفيتامينات، الأحماض الأمينية، الأحماض الدهنية .

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