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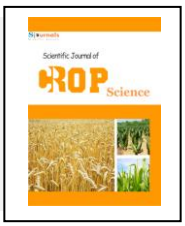

Original article

Nutritional assessment of barley, talbina and their germinated products

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ABSTRACT

Talbina is a food product with high potential applications as a functional food. Talbina was prepared from two barley varieties namely: Giza126 and Giza130 by adding whole barley flour to water (1:10 w/v) and (1:5 w/v) for germinated barley then heating at 80° C for 5 minutes with continuous stirring until reaching a porridge like texture. The present investigation was carried out in an attempt to clearly the nutritional assessment of talbina as a functional food. The study included the determination of gross chemical composition, caloric value, mineral composition, vitamins composition and the amino acids composition. Meanwhile, computation of the chemical scores (CS) and A/E ratios were carried out for raw, germinated barley, talbina, germinated talbina and commercial talbina. The data revealed that protein content of the all raw studied and processing treatments ranged from 8.75-18.34g/100g on dry weight basis. Besides, the all treatments recorded rather slight decrease in crude fat content. Likewise, ash and carbohydrates ranged between 2.29-2.86 and 73.40-82.66%, respectively. Whereas crude fiber had an increase after treatments and it ranged from 3.83-4.37%. On the other hand by making talbina iron, manganese, copper and zinc increased especially zinc, which recorded higher value than that recommended daily. Furthermore, germinated talbina130 recorded the highest amounts of vitamins B_2, Nicotinic acid, B_6 and folic acid. Moreover, the present study indicated that phenylalanine was the highest essential amino acid, followed by leucine

1. Introduction

World production of barley was approximately 9.4% of the total world area under cereal production and ranks fifth in the world (FAO, 2007). Whereas Baik & Ullrich (2008) reported that there were two main distinguished types of barley, two rowed and six rowed barleys. The principal uses of barley are as feed for animals, in the form of barley meal, and as grain for malting and brewing in the manufacture of beer and whisky (Molina-Cano et al., 2002 and Edney & Mather, 2004). However, the barley crop may be considered relatively underutilized with regard to its potential use as an ingredient in processed human foods (Malkki, 2004 and Trepel, 2004). Izydorczyk et al. (2000) and Quinde et al. (2004) showed that whole barley grain consisted of about 65–68% starch, 10–17% protein, 4–9% ß-glucan, 2–3% free lipids and 1.5–2.5% minerals. ß-glucans the major fiber constituents in barley, had been shown to lower plasma cholesterol, reduce glycemic index and reduce the risk of colon cancer (Brennan &Cleary, 2005).

Schneider (2005) showed that vitamin E is generally assigned a function as a radical scavenger in lipophilic environments and hence as a protector of the polyunsaturated fatty acids in membrane lipid. Moreover Scott et al. (1944) reported that thiamin (B_1) readily soluble in water, in thiamin deficiency the metabolism of sugar is incomplete and pyruvic acid accumulates in the tissues; also in nature riboflavin (B_2) may exist as riboflavin phosphate, or as a constituent of specific flavoproteins, the latter functioning as important enzymes in tissue respiration, with a deficiency of riboflavin a definite reduction in tissue concentration of the enzyme had been shown; while pyridoxine (B_6) was recognized through its ability to prevent dermatitis in rats which was observed during attempts to produce experimental pellagra in rats. Yamada et al. (1996) and Ball (1998) reported that vitamin B12 (cyanocobalamin) has an important function in human physiology. Vitamin B12 deficiency in humans is manifested by an anemia and a neuropathy (Martens et al., 2002).

Moreover Brown et al. (2001) mentioned that niacin is incorporated as nicotinamide adenine di nucleotides, to form the prosthetic group of some enzymes, involving in the electron transfer reactions of the respiratory chain and oxidative phosphorylation. Whereas folic acid had been recently finalized regulations mandating by The United States Food and Drug Administration (FDA) to fortification of enriched cereal-grain products with it and this action was taken to assist women in increasing their folate intake to reduce their risk of having a pregnancy affected by a neural tube birth defect (F.D.A., 1996a, b, c). Peter and Shewry (2007) determined the protein nutritional quality by the proportions of essential amino acids, which cannot be synthesized by animals and hence must be provided in the diet.

The wife of the prophet Mohammed peace be upon him “Aisha”, used to recommend talbina for the sick and for one who is grieving over a dead person. She used to say, "I heard the Messenger (Salla Allah alayhi wa sallam) saying, "The Talbina gives rest to the heart of the patient and makes it active and relieves some of his sorrow and grief‴ (Abd El-Rahman, 2001). Talbina is an Arabic word made of the word laban which means milk, this may also designate in the case of barley grains when they reach the milky stage, so the inside of these grains is white and liquid resembling milk (Abd El-Hassib, 2007).

The main objectives of this investigation were the utilization of whole barley flours and germinated barley flour to make talbina. In the present study the gross chemical composition, minerals, vitamins composition, and amino acids compositions were determined in two Egyptian raw barley varieties and their germinated forms as well as the talbina made from both, in an attempt to assess their nutritive value.

2. Materials and methods

Ten kilograms of each varieties of Egyptian barley grains (Hordeum Vulgare): Giza126 (hulled barley), and Giza130 (hull-less barley) were procured from Agricultural Research Center, Giza. 100g Commercial talbina (Giza132) was obtained from local market in Assiut Governorate. All samples were obtained in 8/1/2008.

2.1. Preparation of talbina

Talbina was prepared by adding whole barley flour to water (1:10 w/v) according to (**Youssef, 2008)**; and (1:5 w/v) for germinated barley then the mix was heated at 80°C for five minutes with continuous stirring until reaching a porridge like texture as described in Figure (1).

2.2. Preparation of germinated barley

Soaking: Seeds were freed from broken seeds, dust and other foreign materials, and then soaked in water (1:5 w/v) for 12 h at 25±5°C.

Germination: The presoaked (12 h) seeds were spread on wet cotton in aluminum baskets. The temperature ranged from 10°C (during the first 144h) to 25±5°C (in the last 24 h of sprouting). The germinated seeds were dried at 55°C for 24 h then at 71°C for the same period (Yaldagard et al., 2008).

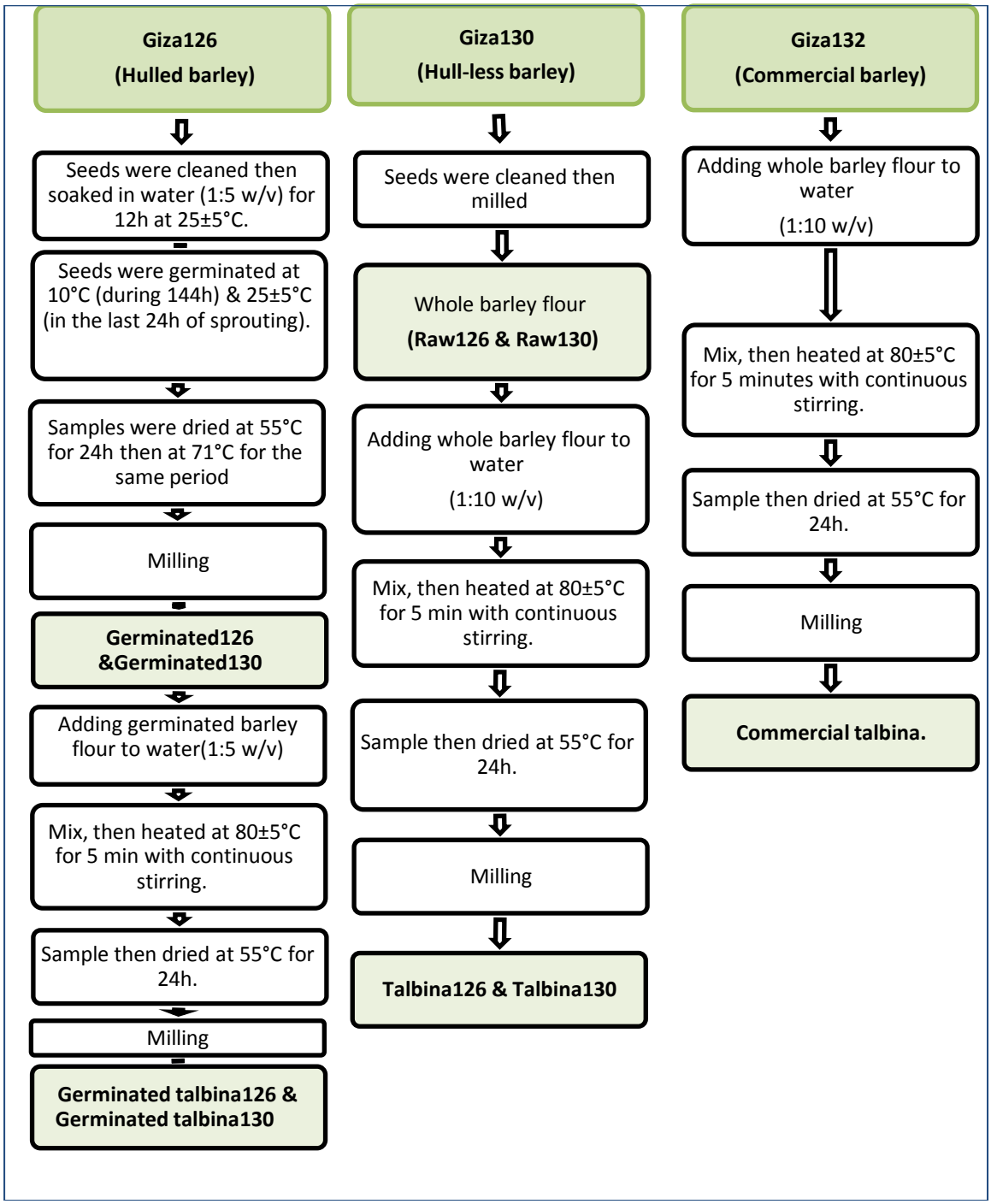

Fig. 1. Flow sheet for the preparation of talbina products.

2.3. Determination of gross chemical composition

Moisture, protein, crude fibers and ash contents were determined according to the methods described in the A.O.A.C. (1997). Crude fat content was determined as the ether extract according to A.O.C.S. (1994). Total carbohydrate was calculated by difference according to pellet and Sossy (1970). All determinations were performed in triplicates and the means were reported. The caloric value was calculated using values of 4k.cal. / g of protein, 4k.cal. / g of carbohydrates and 9k.cal./g of fat according to livesy (1995).

2.4. Determination of minerals content

To extract Na, K, Mg, P, Ca, Zn, Cu, Mn and Fe, samples were dried, ashed then the ash was dissolved in hydrochloric acid (Jackson, 1973). Sodium and potassium were determined according to (Chapman and Pratt, 1961) by the flame photometric procedure (Corning instrument model 400). Determination of phosphorus was preceded according to the procedure for phosphorus analysis by the sulfomolybdo-phosphate blue color method (Tan, 1996). Calcium and magnesium were determined by titration with version 0.0156 N according to (Jackson, 1973). Iron, zinc, copper and manganese were determined using a GBC Atomic Absorption 909 AA, as described in AOAC (1997).

2.5. Determination of vitamins

Vitamin E was colorimetrically estimated by the method of Quaife and Harris (1948); whereas HPLC technique as described by Batifoulier et al. (2005) was used for the separation and quantification of thiamine, folic acid, Pyridoxine, nicotinic acid, riboflavin and B_{12} by a new reversed-phase chromatographic method.

2.6. Determination of amino acids composition

Amino acids were determined according to the method described by Pellet and Young (1980) by using Beckman Amino acid Analyzer Model 119 CL.

2.7. Determination of tryptophan

Tryptophan was determined using spectrophotometer method as described by Sastry and Tummuru (1985).

2.8. Computation of chemical score

The chemical score (CS) was defined as follows:

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

According to Bhanu et al. (1991).

2.9. Computation of A/E ratio

It was calculated according to *(*FAO, 1965) as follows:

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

2.10. Statistical analysis

The data were analyzed for variance (ANOVA) procedures using the MSTAT-C statistical software package (Anonymous, 1988).

3. Results and disscuion

3.1. Gross chemical composition of samples

The gross chemical composition as well as caloric values of raw barleys, germinated barleys, talbina, germinated talbina and commercial talbina is presented in Table (1).

Moisture: The data represented in Table (1) indicated that the moisture of raw barleys, germinated barleys, talbina, germinated talbina and commercial talbina content ranged from 4.4-11.9%. Ereifej and Haddad (2001) reported that the moisture (g/100g) in barley from Jordan, Morocco and the FAO was 4.5, 7.8 and 10.1%; respectively. Moreover rather similar results were previously reported by (Erkan et al., 2006), who found that moisture in hulled barley flour ranged between 10.7-11.8%, whereas it was 11.9% in hull-less barley flour. It could be seen from the results given in table (1) that, the highest percentage of moisture was recorded for whole barley flour 126 (11.9%). On the contrary, germinated barley flour 126 recorded the lowest percentage of moisture content (4.4%). Such results showed that moisture contents of germinated, talbina and germinated talbina were decreased after all the studied processing treatments

Crude protein: Ereifej and Haddad (2001) determining the crude protein content found that it ranged from 7.6-14.1%, whereas Aman & Newman (1986); Bhatty (1992) and Anderson et al. (1999) reported that,

waxy naked barley contained 12.6-16.6% protein. While in the present study it ranged from 8.75-18.34 % for all studied samples (on dry weight basis). On the other hand commercial talbina recorded the highest percentage (18.34%), while raw126 recorded the lowest percentage (8.75%). It could be noticed from table (1) that there was a rather slight increase in protein content in all studied treatments when compared with raw varieties. Abrahamsen and Sudia (1966) showed that the increase in protein content with germination treatment might be due to the reduction in the carbohydrate fractions which utilized during the early stages of germination. Likewise, Dagnia et al. (1992) reported that, the increase in protein could be attributed to the utilization of fats and carbohydrates as energy sources for the developing sprouts. Similar results were recorded by Erkan et al. (2006), who showed that protein content in hulled barley flour ranged between 8-10%, whereas in hull-less barley it recorded the highest percent (13.4%). Likewise, the whole kernels protein content was significantly higher in hull-less barley (12.9-16.7%) than in hulled barley (10.3-13.6%) (Quinde et al., 2004). Moreover DeClerck (1957) showed that the protein content of normal malting barley ranged from 9 to 11%.

Crude fat: Data represented in Table (1) showed that crude fat content ranged from 1.5-2.9%. The crude fat content in the same table indicated that raw barley (Giza130) had the highest content, while commercial talbina had the lowest crude fat content on dry weight basis. Likewise it could be seen from the same table that treatments including germinated barley, talbina and germinated talbina recorded rather slight decrease in crude fat content. Kylen and Mc Cready (1975) showed that decrease of crude oil might be due to the increase activity of lipases during soaking and germination. Moreover, Ereifej and Haddad (2001) showed that crude fat content was 1.5-2.2%. Whereas fat content ranged between 1.62-1.92% in hulled barley and 1.9% in hull-less barley (Erkan et al., 2006). Similar results were shown by Welch (1978), who found that oil content ranged from 1.9-4.1% and represented positive correlation with protein content. Fiber, ash and carbohydrates: Crude fiber, ash and carbohydrates recorded 3-4.2%, 2.4-2.8% and 75.7-87.2%; in barley from Jordan, morocco and the FAO; respectively (Ereifej and Haddad, 2001). While in the present study it ranged between 3.83-4.37%, 2.29-2.86% and 73.40-82.66%; respectively. Vose and Youngs (1978) showed that crude fiber content was higher in the hulled barley (3.7%), while it was 1.9% in the dehulled barley; as well as hull-less barleys had more digestible energy than the hulled cultivars. Likewise, in agreement with the present study data, Quinde et al. (2004) reported that ash content of whole kernels was significantly higher in hulled barley (2.24-2.55%) than in hull-less barley (1.49-1.87%); on the other hand Erkan et al. (2006), showed that ash content was higher in hull-less barley(1.31%) than hulled barley (0.86-1.03%). Macleod (1960) stated that there was a negative relationship between carbohydrates and protein content of barley grain. Such relationship appeared in the present study especially in commercial talbina which had lowest percentage of carbohydrate (73.40%) and highest percentage of protein (18.34%).

Table 1

Gross chemical compositions* and caloric value of raw, germinated barley grains and talbina products (n=3).

Treatments		Moisture %	Crude protein %*	Crude fat %*	Crude fiber %*	Ash %*	Carbohydrates %**	Caloric value (Kcal)
Giza 126	Raw (Hulled)	11.90^{a}	8.75^{e}	2.70^{ab}	3.83^{g}	2.86^{a}	81.86^{a}	386.74
	Germinated (G)	4.40^{i}	9.67^{e}	2.40^{ab}	3.90^{f}	2.43^{f}	81.60^{abc}	386.68
	Talbina (T)	7.71^{c}	8.75^{e}	1.79^{ab}	3.94^{f}	2.86^{ab}	82.66^{ab}	381.75
	Germinated talbina (GT)	5.06^{g}	9.84^{e}	2.30^{ab}	3.84^{f}	2.48^{f}	81.54^{abcd}	386.22
Giza 130	Raw (Hull-less)	11.57^{b}	11.77^{de}	2.90^{a}	4.20^{d}	2.64^{cde}	78.49^{ef}	387.14
	Germinated (G)	5.37^{f}	13.08^{bc}	2.48^{ab}	4.37^{a}	2.29^{g}	77.78^{efg}	385.76
	Talbina (T)	5.72^{e}	11.78^{d}	1.76^{b}	4.27^{bc}	2.69^{c}	79.50^{e}	380.96
	Germinated talbina (GT)	4.75^{h}	13.13^{b}	2.28^{ab}	4.30^{b}	2.41^{f}	77.88^{efg}	384.56
Commercial albina (CT)		6.71^{d}	18.34^{a}	1.50^{c}	4.10^{e}	2.66^{cd}	73.40^{h}	380.46

* On dry weight basis, ** calculated by difference.

a,b,c,d, e, f, g, h, i: Different superscripts within the same column represent significant differences between the results ($p < 0.05$).

3.2. Mineral composition of samples

Ereifej and Haddad (2001) reported that the minerals (mg/100g) content in barley grown in Jordan, Morocco and by the FAO namely Ca, P, Mg, K, Na, Fe, Zn, Cu and Mn; were as follows, 69.3-69.9, 179-350, 92.7-135, 573-612, 6.5-20.3, 3.5-19.9, 2-2.8 ,2.29-3.5 and 0.8-1.94; respectively. Likewise, in the present study the same minerals ranged as follow, 120-160, 300-510, 130-180, 240-320, 15.17-47.35, 5.75-13.85, 3.27-39.9, 0.550-0.985 and 1.02-2.67 (mg/100g); respectively. In general, the results are shown in Table (2) revealed that iron, manganese, copper and zinc contents decreased with germination treatment, and increased after making talbina especially zinc, which recorded the highest value with talbina treatment. On the contrary Ca and P were increased with germination treatment. Likewise, it could be seen from Table (3) that sodium was decreased after all studied treatments and recorded the lowest value in germinated talbina126 (15.17).

Table 2
Mineral composition of raw, germinated barley grains and talbina products (Mg/100g; on dry weight basis)(n=3).

Treatments		Micro elements				Macro elements				
		Fe	Mn	Cu	Zn	Ca	Mg	Na	K	P
Giza 126	Raw	8.41	1.11	0.860	5.67	140	180	43.25	320	370
	Germinated	5.75	1.13	0.735	3.36	160	170	15.43	260	470
	Talbina	9.15	1.16	0.985	39.9	130	160	39.15	310	350
	Germinated talbina	6.78	1.02	0.550	3.27	140	140	15.17	270	450
Giza 130	Raw	8.96	1.47	0.655	29.25	120	150	47.35	290	300
	Germinated	7.25	1.45	0.600	3.48	140	180	19.60	240	490
	Talbina	10.27	1.49	0.835	39.6	120	130	41.70	300	320
	Germinated talbina	7.93	1.34	0.595	3.31	120	170	16.20	250	510
Commercial talbina		13.85	2.67	0.785	7.5	120	170	44.60	290	430
Recommended nutrient intakes (25-50 yr.)*	Male	10_{RDA}	2-5 $_{ESADDI}$	1.5-3 $_{ESADDI}$	15 $_{RDA}$	800_{RDA}	350_{RDA}	500_{MR}	2000_{MR}	800_{RDA}
	Female	15_{RDA}	2-5 $_{ESADDI}$	1.5-3 $_{ESADDI}$	12 $_{RDA}$	800_{RDA}	280_{RDA}	500_{MR}	2000_{MR}	800_{RDA}

*Welch and Graham (2004); RDA: recommended daily allowance, ESADDI: estimated safe and adequate daily dietary intake, MR: minimum requirement.

Vitamins: Vitamin E is a major biological antioxidant quenches free radicals and acts as a terminator of lipid per oxidation, particularly in membranes that contain highly unsaturated fatty acids (Burton & Traber, 1990). Cavallero et al. (2004) demonstrated the role of both genotype and location in determining tocols homologue contents of barley varieties, and they found that total tocols concentration of six barley genotypes averaged over locations ranged from 51.0 to 61.4 mg/ kg with a mean value of 54.5 mg/kg. It could be seen from Table (3) that, germination process increased the amount of vitamin E, and germinated130 had recorded the highest amount of vitamin E (622.33 IU/100g or 416.9 mg of α-tocopherol /100g). likewise, Peterson (1994) found that tocols in barley products resulted from milling, malting and mashing were 56.70, 52 and 152 mg/kg, while the tocotrienols were 77.50, 76.40 and 83.40 mg/kg; respectively. In barley, the content of tocopherols and tocotrienols were 13.5 and 15.58 µg/g (on dry basis), and vitamin E was 9.3 IU/Kg (Zielinski et al., 2001). Moreover, Panfili et al. (2008) reported that tocopherol amount was (11.1-21.5 mg/kg) on dry weight, and α-tocopherol ranged between7.8 to 12.7 mg/kg. While total tocols (which, including tocopherol and tocotrienols) ranged from 50.3 to 88.6 mg/kg on dry weight.

Data represented in Table (3) showed that germinated talbina130 recorded the highest amounts of vitamins B_2, Nicotinic acid, B_6 and folic acid, where germinated 130 had the highest amount of thiamin (B_1).

Lebiedzinska and Szefer (2006) reported that vitamins B_1, B_2, B_6 and niacin contents in barley were 0.356, 0.136, 0.262 and 4.07 mg/100g; respectively.

Table 3
Vitamins E (IU/100g) and B-complex (ppm) of raw, germinated barley grains and, talbina products. (n=3)

Vitamins	Treatments*									Recommended nutrient intakes (25-50 yr.)** RDA	
	Giza-126				Giza-130				C.T		
	Raw	G	T	G.T	Raw	G	T	G.T		Male	Female
Vitamin E (IU)	449.2	579.31	323.73	370.66	576.75	622.33	342.9	402.1	364.4	10 mg	8 mg
Thiamin B_1	ND*	ND	ND	ND	ND	60.19	ND	ND	16.70	1.5 mg	1.1 mg
Riboflavin B_2	63.11	126.7	27.39	16.19	ND	357.46	ND	561.6	67.28	1.7 mg	1.3 mg
Nicotinic acid	65.49	436.3	175.17	353.96	119.48	787.2	623.2	1497.9	474.2	19 mg	15 mg
Pyridoxine B_6	45.49	57.07	40.88	17.72	40.24	103.02	130.4	177.58	40.49	2 µg	1.6 µg
Folic acid	1.65	0.338	ND	0.29	ND	ND	ND	1.76	ND	200 µg	180 µg

*ND= not detected**, G=Germinated, T=Talbina, G.T=Germinated talbina, C.T=Commercial talbina.
*** RDA: Recommended Daily Allowance (Welch and Graham, 2004).

3.3. Essential amino acids

The essential amino acids determination was carried out on the studied processed barley grain products under investigation because of their importance from the nutritional point of view. The essential amino acids of raw, germinated barley and talbina products are tabulated in Table (4). Phenylalanine was the highest essential amino acid, followed by leucine. Moreover germinated126 had the highest value of leucine and lysine, whereas methionine and phenylalanine recorded the highest value in talbina130. Table (4) illustrated the essential amino acids patterns suggested by F.A.O. /W.H.O. (1985) for school child and adult amino acids requirements.

In general all studied treatments recorded higher content of all essential amino acids than that suggested by the FAO reference protein except of methionine, which had a low value in all studied treatments, with the exception of talbina130 treatment, which recorded higher value than that suggested by the FAO reference Protein.

It could be seen from Table (4) that there was a trend to increase the content of isoleucine, leucine, lysine, methionine, phenylalanine, and tryptophan in germinated 126 samples, which increased by 55.49%, 56.16%, 58.14%, 3.18%, 76.7% and 15.5%; respectively; whereas in germinated 130 the content of leucine, isoleucine, methionine, phenylalanine, threonine, tryptophan and valine increased by 0.2%, 12.8%, 38.3%, 21.5%, 5.53%, 74.57% and 14.28%. Similar results were previously reported by Tsai et al. (1975), who found that germination might offer a method for converting nutritionally poor-quality plant protein to a high quality for human consumption. The contents of isoleucine presented continuous increase since germinated for 24 h., and the lysine content of germinated oats was always higher than that of raw oats (Tian et al., 2010).

Table 4
Essential amino acids content of raw, germinated barley and, talbina products.

Essential amino acids (gr AA/100 gr protein)	**Treatments									FAO/ WHO (1985) g A.A/100 g protein.	
	Giza-126				Giza-130				C.T		
	Raw	G	T	G.T	Raw	G	T	G.T		School child	Adult
Isoleucine	3.82	5.94	7.39	2.85	2.57	2.90	5.68	2.90	2.96	2.8	1.3
Leucine	7.30	11.40	7.90	4.05	4.92	4.93	10.60	5.58	5.42	4.4	1.9
Lysine	4.30	6.80	4.70	1.7	2.69	2.26	4.63	1.11	2.32	4.4	1.6
Methionine	0.345	0.356	1.65	0.166	0.154	0.213	2.87	0.097	0.273	2.2	1.7
Phenylalanine	4.34	7.67	10.9	3.38	3.34	4.06	11.97	5.40	4.9	2.2	1.9
Threonine	3.79	ND*	2.73	ND	2.53	2.67	0.148	0.055	0.08	2.8	0.9
Tryptophan	2.13	2.46	2.68	4.38	1.77	3.09	2.33	3.14	1.18	0.9	0.5
Valine	5.10	1.72	4.85	ND	2.73	3.12	ND	ND	0.07	2.5	1.3
Total E.A.A	31.13	36.35	42.80	16.53	20.70	23.24	38.23	18.28	17.20		

*ND= not detected ** G=Germinated T=Talbina G.T=Germinated talbina C.T=Commercial talbina. (n=3)

Dalby and Tsai (1976) found an increase in lysine content expressed as per cent of dry weight of oat seeds during germination. The increase in the amino acids by germination might be due to an increase in proteolytic

activity during sprouting desirable for nutritional improvement of cereals because it leads to hydrolysis of prolamins and the liberated amino acids such as glutamic and proline are converted to limiting amino acids such as lysine (Chavan and Kadam, 1989). It could be seen from Table (4) that talbina treatment (cooked barley flour) resulted in a noticeable increase in the most of the essential amino acids including isoleucine, leucine, lysine, methionine, phenylalanine and tryptophan, which increased by 93.45% & 121%, 8.22% & 115.4%, 9.3% & 72.1, 378.3% & 271.6%, 151.2% & 258.4% and 25.8% & 31.6% in talbina 126 & talbina 130; respectively. On the other hand, there was a general trend to decrease of all essential amino acids in germinated talbina treatment (cooked germinated barley flour).

Data given in Table (5) outlined the chemical score of all studied treatments and revealed that, the first limiting amino acid was methionine in raw, germinated barleys and germinated talbina126; while valine was the second limiting amino acid in germinated barleys when both egg and human milk were used as the reference protein. Similar results were represented by *Eaker (1970),* who found that Leucine was the highest essential amino acid, whereas methionine was the first limiting amino acid and histidine was the second. Moreover, in raw barleys, valine was the second limiting amino acid when egg protein was used as the reference protein, whereas lysine was the second when human milk was used as the reference protein. Besides, threonine was the first limiting amino acid in talbina (made from Giza126 and Giza130) and lysine was the second when human milk was used as a reference protein. Table (5) indicated that talbina treatment (Giza126 and Giza130) recorded high chemical score in phenylalanine when both egg and human milk were used as the reference protein especially when comparing with the raw varieties. Likewise it could be seen from the table that phenylalanine had the highest chemical score in talbina130. Besides, Tkachuk and Irvine (1969), reported that Leucine was the highest essential amino acid in barley grains, while tryptophan was the first limiting amino acid and methionie was the second limiting amino acid.

Data given in Table (6) represented A/E ratio between individual essential amino acid content (mg) and total essential amino acid content (g) of raw barleys and processed as compared with FAO requirement patterns of school child (10-12 yr) and adult (1985). It could be seen from Table (6) that talbina and germinated talbina were considered as a rich source of isoleucine, (which recorded 172.6 & 172.5 in Giza 126 and 148.6, 158.6 in Giza 130), phenylalanine (254.7, 204.5 and 313.1, 295.4) and tryptophan (62.6, 265.0 and 60.9, 171.7); respectively, when compared with FAO requirement patterns.

On the contrary threonine was decreased after all studied treatments, as well as lysine, which decreased except in the case of germinated 126. Besides, phenylalanine recorded highest value in talbina130 (313.1).

These results are in accordance with that of (Wang and Fields, 1978), who found that germinated cereal grains had increased relative nutritive values (RNV) and increased levels of lysine, methionine and tryptophan when compared to ungerminated seeds. In addition, Abdus Sattar et al. (1985) indicated that germination improved the nutritional quality of cereal grains. This was mainly because these processes increased the essential amino acids and decreased the potential antinutrients.

Table 5

Chemical score and limiting amino acids of raw, germinated barley and talbina products.

Essential amino acids:	Whole egg (E)***	Human milk (M)***	Treatments**																	
			Giza-126								Giza-130								C.T	
			Raw		G		T		G.T		Raw		G		T		G.T			
	mg E.A.A/g protein		100 P/E	100 P/M	100 P/E	100 P/M	100 P/E	100 P/M	100 P/E	100 P/M	100 P/E	100 P/M	100 P/E	100 P/M	100 P/E	100 P/M	100 P/E	100 P/M	100 P/E	100 P/M
Isoleucine	56	52	68.0	73.3	106.1	114.2	131.9	142	50.9	54.8	45.9	49.4	51.8	55.7	101.4	109	51.8	55.7	52.8	56.9
Leucine	83	96	88.0	76.0	137.3	118.7	95.2	82.3	48.8	42.2	59.3	51.3	59.4	51.4	127.7	110.4	67.2	58.1	65.3	56.5
Lysine	63	69	68.3	62.3	107.9	98.5	74.6	68.1	27.0	24.6	42.7	39.0	35.8	32.7	73.5	67.1	17.6	16.1	36.8	33.6
Methionine	32	16	9.0	18.0	11.1	22.3	51.6	103	5.2	10.4	4.8	9.6	6.6	13.3	89.7	179.4	3.0	6.1	8.5	17.1
Phenylalanine	51	35	85.1	124.0	150.4	219	213.7	311.4	66.3	96.6	65.5	95.4	79.6	116.0	234.7	342.0	105.8	154.2	96.1	140
Threonine	51	46	74.3	82.4	ND*	ND	53.5	59.3	ND	ND	49.6	55.0	52.4	58.0	2.9	3.2	1.1	1.2	1.6	1.7
Tryptophan	18	17	118.3	125.3	136.6	144.7	148.8	157.6	243.3	257.6	98.3	104.1	171.6	181.7	129.4	137	174.4	184.7	65.5	69.4
Valine	76	60	67.1	85.0	22.6	28.6	63.8	80.8	ND	ND	35.9	45.5	41	52	ND	ND	ND	ND	0.921	1.2
First limiting AA			Met	Met	Met	Met	Met	Thr	Met	Met	Met	Met	Met	Met	Thr	Thr	Thr	Thr	Val	Val
Second limiting AA			Val	Lys	Val	Val	Thr	Lys	Lys	Lys	Val	Lys	Val	Val	Lys	Lys	Met	Met	Thr	Thr

*ND= not detected;**G=Germinated; T=Talbina; G.T=Germinated talbina; C.T=Commercial talbina.

***FAO/ WHO/ UNU/(1985). p= Amino acid of sample; E= Amino acid of whole egg; M= Amino acid of human milk.

Table 6

Computation of A/E ratio of raw, germinated barley and, talbina products.

Essential amino acids	Treatments**									FAO (1985)	
	Giza-126				Giza-130				C.T	School child (10-12 yr.)	Adult
	Raw	G	T	G.T	Raw	G	T	G.T			
Isoleucine	122.7	163.4	172.6	172.5	124.1	124.7	148.6	158.6	172.1	126	117
Leucine	235.0	313.6	184.6	245.1	237.6	212.1	277.3	305.2	315.1	198	171
Lysine	138.4	187.1	109.8	102.8	129.9	97.2	121.1	60.7	134.8	198	144
Methionine	9.3	9.8	38.5	10.0	7.4	9.2	75.1	5.3	15.8	99	153
Phenylalanine	139.7	211.0	254.7	204.5	161.3	174.7	313.1	295.4	284.8	99	171
Threonine	122.0	ND*	63.8	ND	122.2	114.8	3.8	3.0	4.6	126	81
Tryptophan	68.6	67.7	62.6	265.0	85.5	132.9	60.9	171.7	68.6	40	45
Valine	164.2	47.3	113.3	ND	131.8	134.2	ND	ND	4.1	112	117

*ND= not detected; ** G=Germinated; T=Talbina; G.T=Germinated talbina; C.T=Commercial talbina.

4. Conclusion

In conclusion, on the light of the above –mentioned data, barley talbina proved to have high levels of all the nine studied minerals, vitamins E, nicotinic acid and pyridoxine as well as it recorded good balanced essential amino acids composition required for human nutrition**.**

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