Synbiotic Tarhana as a functional food

***Shreef G N Gabrial, ** Ahmed H Zaghloul, ***Abd El-Rahman M Khalaf-Allah, ***Nagwa M El-Shimi, *Rasha S Mohamed and *Gamal N Gabrial**

* Food Science and Nutrition Department, National Research Centre, Dokki, Cairo, Egypt.
**Dairy Science Department, National Research Centre, Dokki, Cairo, Egypt.
***Food Science Department, Faculty of Agriculture, Cairo University, Giza, Egypt.
snoub_2000@yahoo.com

Abstract: In the present study formulated synbiotic tarhana (Turkish fermented cereal food) was produced as a functional food from the fermentation of wheat flour, some spices [salt, pepper, dill and sweet marjoram (Organum majorana)], some vegetables [tomato (Lycoprsicum esculentum), pepper (Capsicum annum) and onion (Allium cepa)], and synbiotic yoghurt which prepared with prebiotic (inulin and lactose each 3%) and different concentrations of the probiotic culture (0.5, 1.5, 3, 4.5% DVS-ABT2 containing Streptococcus thermophilus, Lactobacillus acidophilus and Bifidobacterium bifidum). After fermentation (3 days), tarhana dough was dried in the sun. The effect of the fermentation (0, 1, 2 and 3 days) and the probiotic culture concentration on the chemical composition and the probiotic population of the wet tarhana were evaluated. The effect of the probiotic culture concentration on the chemical composition, the probiotic population and the sensory attribute of dried tarhana were evaluated. Also the effect of dried tarhana (prepared from yoghurt which was fermented by 4.5% probiotic culture) on the plasma lipid profile of human subjects was studied. The results showed that the pH value decreased while the acidity increased, acetaldehyde and diacetyl values increased during the fermentation period and by increasing the probiotic culture concentration of the wet and the dried tarhana. Neither the fermentation nor the concentration of the probiotic culture of wet and dried tarhana affected the crude protein, ether extract, crude fibre, and ash values. The numbers of probiotic bacteria increased until the second day of fermentation. However, in the following day, with an increase of the acid content their number decreased. Generally the increasing of the probiotic culture concentration increased the numbers of probiotic bacteria of the wet and dried tarhana. Also the concentration of the probiotic culture didn't affect the sensory attributes of dried tarhana. Subjects supplemented with dried tarhana showed significant reduction in total plasma cholesterol, low density lipoproteins (LDL-C) and triglycerides, while high density lipoprotein (HDL-C) increased.
[Shreef G N Gabrial, Ahmed H Zaghloul, Abd El-Rahman M Khalaf-Allah, Nagwa M El-Shimi, Rasha S Mohamed and Gamal N Gabrial. **Synbiotic Tarhana as a functional food**. Journal of American Science 2010;6(12):847-857]. (ISSN: 1545-1003). http://www.americanscience.org.

Key words: Tarhana, functional food, fermented food, probiotic, synbiotic yoghurt, serum lipids.

1. Introduction

Fermentation as an old and economical method of producing and preserving food, it is carried out to enhance flavor, aroma, shelf-life, texture, nutritional value and other pleasant and appealing properties of foods (Steinkraus, 2002). It is possible to obtain probiotic foods from several matrices, including both fermented and non-fermented products (Rivera-Espinoza and Gallardo-Navarro 2010). Tarhana is a traditional fermented milk-cereal mixture containing lactic acid bacteria with probiotic properties. Tarhana has been considered as one of the oldest probiotic foods (Ozdemir *et al*. 2007).

Tarhana is a popular traditional Turkish fermented wheat food produced both commercially and in homes. It is mainly used in the form of a thick and creamy soup consumed at lunch or dinner and is easily digested (Bilgicli and Elgun 2005). Tarhana is prepared by mixing wheat flour, yoghurt, yeast and a variety of cooked vegetables and spices (tomatoes, onions, salt, mint, paprika) followed by fermentation for one to seven days (Daglioglu 2000). Lactic acid bacteria and the yeast are responsible for the acid formation during fermentation and the leavening effect. The dough at fermentation is called as wet tarhana. Afterwards, the dough is dried in the sun or by dryer as a lamp, nugget or thin layers to obtain dry tarhana. Also the tarhana is locally consumed as snack after being dried as thin layer or nugget, not to be ground. Since there is no standard production method, nutritional properties of tarhana strictly depend on ingredients and their ratios in the recipe (Erbas *et al*. 2006).

Tarhana is a good source of minerals, organic acids and free amino acids which make it healthy for children, the elderly and medical patients. In addition, it is a good source of vitamins such as

thiamine, riboflavin and vitamin B12 (Ibanoglu *et al*. 1995). Ascorbic acid, niacin, pantothenic and folic acid are also present (Ekinci, 2005, Ekinci and Kadakal 2005). Lacticacid bacteria (LAB) from yoghurt also aid in absorption of nutrients, which would otherwise, be indigestible or poorly digestible. (Farnworth, 2003).

Fermentation of tarhana dough is generally carried out using yoghurt bacteria, such as Lactobacillus bulgaricus, Streptococcus thermophilus and Baker's yeast (Saccharomyces cerevisiae) (Bilgicli and Ibanoglu 2007). This is similar to other natural systems (e.g. Kefir grains) in which associations of LAB and yeasts are used in food fermentation (Gobbetti 1998). The fermentations occur simultaneously during this aspect of production (Bilgicli et al. 2006). Yeast fermentation proceeds through the Embden-Meyerhof pathway (EMP), in which glucose is transformed into ethanol (via piruvate and acetaldehyde), carbon dioxide, and traces of other acids and carbonyl compounds (Gobbetti 1998, Gelinas and McKinnon 2000). According to Mugula et al. (2003) a combined culture of yeasts and lactobacilli cause a more significant decrease in pH (increase in acidity), than with the use of single cultures in the fermented millet.

The present study was initiated to produce synbiotic tarhana and evaluate it as a functional food. The effect of fermentation time (0, 1, 2 and 3 days) and starter concentrations (0.5, 1.5, 3 and 4.5%) on the chemical composition and the probiotic bacterial counts of wet tarhana were evaluated. Also the effect of starter concentrations (0.5, 1.5, 3 and 4.5%) on the sensory attributes, chemical composition and the probiotic bacterial counts of dried tarhana were evaluated. The hypocholesterolemic effect of dried tarhana on human subjects was studied.

2. Material and Methods

Tarhana ingredients: Vegetables [Tomato (Lycopersicum Esculentum), Green Pepper (Capsicum Annum), Chicory (Cicohorium Intybus) and Onion (Allium Cepa)], Cereals [Wheat (Triticum oestivum)], Spices [salt, pepper, dill and sweet marjoram (Origanum majorana)], Yeast (Saccharomyces cervisiae, press form) were purchased from the local market, Cairo, Egypt. Lactulose syrup (52.40% lactulose, 4.3% lactulose and 2.5 galactose) was obtained from the Egyptian International Industries Company (EIPICO), Cairo, Egypt and Spray dried skim milk (low heat) was obtained from Dina for Agriculture Investments, Egypt.

Probiotic Culture: DVS-ABT2 (containing Streptococcus thermophilus, Lactobacillus acidophilus and Bifidobacterium bifidum) were obtained from Chr. Hansen's Lab., Copenhagen Denmark. M17 agar, MRS-Salccin agar, violet red bile agar (VRBA), potato dextrose agar, and MRS agar. All media were purchased from Oxoid LTD, London.

Preparation of Chicory Water-Soluble Extract

Chicory Water-Soluble Extract was prepared according to the methods described by Kim and Shin (1998) as follows: 10g dried chicory plant was dissolved into 200 ml distillated water, soaked for 24 hours under refrigeration, heated at 70^{o}C for 15 min, then filtered. Chicory extract was then added to the synbiotic yoghurt.

Preparation of synbiotic yoghurt

Milk samples were standardized by adding skim milk powder to achieve 16% total solids content, pasteurized (15 min. at 85^{o}C) and cooled to 40^{o}C. Chicory extract and lactulose syrup (3% each) were individually added to milk samples, then inoculated with different concentrations (0.5, 1.5, 3, 4.5%) of the DVS-ABT2 culture, then milk was dispensed into pasteurized plastic cups (100 ml), capped, incubated (5 hours at 44^{o}C) cooled and stored in the refrigerator at 5^{o}C to prepare synbiotic tarhana.

Preparation of synbiotic tarhana

The ingredients of tarhana are presented in Table (1). Production method of tarhana is presented in fig. (1). All ingredients were prepared (cleaned, peeled and cut), then mixed, blended, pasteurized (30 min. at 65^{o}C) and cooled at 25^{o}C, whole flour, salt, synbiotic yoghurt (with different concentrations of the probiotic culture) and Baker's yeast were added to the mixture, then kneaded to form tarhana dough. The dough was fermented (3 days at 25^{o}C) in an incubator. The samples were withdrawn at time intervals (0, 1, 2 and 3 days) for chemical analysis and microbial analysis. Also tarhana samples (fermented for 3 days) were dried in the sun, filled in small packages and stored. The dried tarhana were subject to chemical, microbial and sensory evaluation and it was also used in human studies to evaluate its hypolipidemic effect.

Chemical analysis

pH value, total acidity, crude proteins, ether extract, crude fiber and ash were determined according to AOAC (2000). Acetaldehyde was estimated as described by Lees and Jaco (1969). Diacetyl was determined according to Lees and Jaco (1970).

Microbial analysis

Bifidobacterium bifidum was enumerated according to Dave and Shah (1969) using the modified MRS agar supplemented with 0.05% L. cysteine-HCl. The plates were anaerobically incubated at 37°C for 48 hours using anaerogen sheets.

Lactobacillus acidophilus count was estimated according to Dave and Shah (1969) on MRS-salccin agar. Incubation was carried out at 37°C for 48 hours.

Streptococcus thermophilus count was estimated according to Terzaghi and Sandine, (1975) using M17 agar. Incubation was carried out at 25°C for 48 hours.

Moulds were enumerated according to standard methods for examination of dairy products (APHA, 1994). Incubation was carried out at 25°C for 4 – 5 days.

Coliform group bacteria were enumerated according to standard methods for examination of dairy products (APHA, 1994) using violet red bile agar (VRBA). Incubation was carried out at 37°C for 48 hours.

Sensory evaluations

Synbiotic tarhana samples were organoleptically evaluated by 10 panelists from the staff members of food science and nutrition department of the National Research Center, Dokki, Cairo, Egypt. The panelists evaluated the samples using a five point Hedonic scale (5 = Liked Extremely to 1 = Unacceptable) adopted from (Iwe, 2000). All samples were evaluated for appearance, taste and general acceptability. The samples were filled in small white porcelain bowl (150 ml) and they were coded with numbers and served to the panelists at random.

Human experiment

Fifteen hyperlipidemic volunteers aged between 40 and 55 years old were studied, all were in good general health, with no history of cardiovascular or gallbladder disease, non of the volunteers were taking any medications. They were given their regular diet which was daily supplemented with 200g of synbiotic tarhana (prepared from yoghurt which was inoculated by 4.5% probiotic culture) for 45 days.

Blood sampling

Blood samples were collected from each volunteer, before supplementation and at the end of the experimental period, after overnight fasting and withdrawn through heparinized tubes for serum. The blood was allowed to clot at room temperature for one hour, and then the serum was separated by centrifugation at 3000 rpm for 15 minutes, clear serum was divided into aliquots and stored at 20°C until analyzed.

Biochemical analysis

Blood lipids were estimated according to the following methods, total cholesterol (Allain et al., 1974), total triglycerides (Fossati and Prencipe 1982), high density lipoproteins (Lopes-Virella et al., 1977), and low density lipoproteins (Friedewald et al., 1977).

3. Results

Evaluation of tarhana dough

Changes in some of the chemical components of tarhana dough samples [prepared with yoghurt and inoculated by different concentrations (0.5, 1.5, 3 and 4.5%) of the probiotic culture (DVS-ABT2)] were studied in relation to different fermentation time. Table 2 shows that for all tested tarhana dough samples, fermentation time had no effect on crude fiber, ether extract and ash. However, fermentation time had an effect on pH value and acidity of tarhana dough. The acidity content of all studied tarhana dough samples increased by increasing the fermentation time and consequently the pH values decreased until the end of fermentation course. Also increasing of probiotic culture concentrations from 0.5 to 4.5% decreased the pH values and increased the acidity content of the resultant tarhana dough samples. The pH value decreased from 5.47, 4.89, 4.62 and 4.57 to 4.89, 4.09, 4.08 and 3.92 while the acidity increased from 3.9, 5.0, 6.8 and 7.7 to 7.4, 9.7, 10.2 and 13.6 respectively during the fermentation time when a probiotic culture inoculation of 0.5, 1.5, 3 and 4.5% respectively was added.

Acetaldehyde and diacetyl contents of tarhana dough samples increased during fermentation. Also they increased with increasing of the probiotic culture concentrations in tarhana dough as shown in Figure 2 and 3. The effect on fermentation time on microbial counts of tarhana dough samples are presented in Table 3. Results indicate that the microbial counts numbers increased by increasing the fermentation time reaching the highest level at the second day of fermentation, then these decreases by increasing that period to record the lowest level at the end of fermentation (3 days). It was found that increasing the probiotic culture concentrations 0.5, 1.5, 3 and 4.5% (samples A, B, C and D) increased the numbers of probiotic bacteria as shown in Table 3. The highest population of probiotic bacteria from tarhana dough samples that contained 0.5, 1.5, 3 and 4.5% probiotic culture was recorded at the second day of fermentation being 8.5 x 10^7, 5.9 x

10^9. 9.7 x 10^{10} and 9.9 x 10^{10} (cfu/g) for *L. acidophilus*, 7.2 x 10^7, 6.4 x 10^9, 6.1 x 10^{10} and 7.6 x 10^9 (cfu/g) for *S. thermophilus* and 6.4 x 10^7, 8.6 x 10^8, 8.2 x 10^9 and 9.0 x 10^9 (cfu/g) for *B. bifidum*. Also, the results indicate that all tarhana dough samples were free from coliform and mold during the fermentation period, indicating no contamination occurred from the environment or the row materials.

Sensory characteristics (flavor, body and texture and appearance) of dried tarhana samples (A, B, C and D) prepared with different concentrations of probiotic culture (0.5, 1.5, 3 and 4.5%) were evaluated as shown in Table 4. The obtained results show that the sensory evaluation properties of dried tarhana had good scores and were acceptable for all the samples which contained different concentrations of probiotic culture.

Chemical composition of dried tarhana samples prepared by yoghurt inoculated with different concentrations of probiotic culture (0.5, 1.5, 3 and 4.5%) is presented in Table 5. Results indicate that all dried samples (A, B, C and D) had a protein content that ranged between (19.87-19.88%). All dried samples (A, B, C and D) had a fiber and ash content that ranged between (3.80-3.82%) and (9.93-9.95%) respectively. All dried samples (A, B, C and D) had an ether extract that ranged between (2.90-2.92%). Concerning pH value and acidity content of dried tarhana sample results Table 5 disclose that the acidity increased and pH value decreased by increasing the concentration of the probiotic culture. The highest acidity (13.4) and the lowest pH value (3.9) were recorded for dried tarhana sample D (containing 4.5% probiotic culture). Acetaldehyde and diacetyl contents of the dried tarhana are shown in figure 4. Acetaldehyde and diacetyl contents of the dried tarhana samples increased by increasing probiotic culture concentration. The highest content of Acetaldehyde (0.65 µmol/ml) and diacetyl (0.55 µmol/ml) were obtained for tarhana samples contained 4.5% probiotic culture, while the lowest contents were obtained for sample having 0.5% probiotic culture being 0.46 and 0.31 µmol/ml consecutively.

Effect of sun drying on microbial population of tarhana samples (A, B, C, and D) is shown in Table 6, data presented disclose that all dried tarhana samples recorded a sharp decrease in probiotic bacterial counts after drying compared to the corresponding values at the end of fermentation (day three) as shown in Table 3.

Hypolipidemic effect

Table 7 shows the changes in total cholesterol, total triglycerides, low and high density lipoprotein of the subjects that consumed dried synbiotic tarhana for 45 days (prepared from yoghurt which was inoculated by 4.5% probiotic culture). Results show a significant hypocholesterolemic effect where the mean of the serum cholesterol concentration was (222.0 ± 5.2) at the start of experiment then decreased to (202.6 ± 8.5) at the end of the experiment, triglyceride level showed a highly significant reduction from (179.8 ± 5.4) at the start of experiment to (169.0 ± 5.5) at the end of the experiment, high-density lipoprotein cholesterol was significantly raised from (50.1 ± 1.0) to (57.8 ± 0.9) at the end of the experiment. As for the low-density lipoprotein cholesterol there was no significant change with a value of (92.7 ± 0.7) at the start of experiment to (81.9 ± 0.5) at the end of the experiment.

Table 1: Synbiotic Tarhana Ingredients (% w/w)

Ingredients	% w/w
Whole wheat flour	35
Synbiotic Yoghurt	25
Fresh onions	12
Fresh tomato	10
Fresh red pepper	6
Green pepper	4
Baker's yeast	4
Salt	2
Dill powder	1
Sweet marjoram	1

Table 2: Changing in pH value, acidity, crude protein, crude fibre, ether extract and ash of tarhana dough samples prepared with yoghurt fermented by different concentrations of DVS-ABT2 culture during fermentation.

Tarhana samples	Fermentation time (days)	pH	Acidity	Crude protein	Ether Extract	Crude Fibre	Ash
				(g/100g)			
A	0	5.47	3.9	19.88	2.90	3.80	9.94
	1	5.24	4.2	19.88	2.91	3.81	9.93
	2	4.90	7.4	19.87	2.91	3.81	9.94
	3	4.89	7.4	19.88	2.92	3.80	9.91
B	0	4.89	5.0	19.89	2.91	3.81	9.95
	1	4.67	6.9	19.90	2.92	3.80	9.97
	2	4.11	9.5	19.87	2.92	3.81	9.93
	3	4.09	9.7	19.88	2.91	3.81	9.94
C	0	4.62	6.8	19.89	2.91	3.82	9.96
	1	4.44	6.5	19.90	2.90	3.83	9.94
	2	4.10	10.0	19.88	2.93	3.82	9.95
	3	4.08	10.2	19.87	2.91	3.81	9.95
D	0	4.57	7.7	19.89	2.91	3.80	9.91
	1	4.36	9.2	19.89	2.90	3.82	9.94
	2	4.94	13.5	19.87	2.91	3.81	9.95
	3	3.92	13.6	19.88	2.93	3.81	9.93

(A): prepared using yoghurt incubation with 0.5% probiotic culture. (B): prepared using yoghurt incubation with 1.5% probiotic culture. (C): prepared using yoghurt incubation with 3% probiotic culture. (D): prepared using yoghurt incubation with 4.5% probiotic culture.

Table 3: Effect of fermentation time on microbial counts (cfu/g) of tarhana dough prepared with yoghurt fermented by different concentrations of DVS-ABT2 culture.

Tarhana samples	Fermentation time (days)	Microbial counts (cfu/g)				
		L. acidophilus	S. thermophilus	B. bifidum	Molds	Coliform
A	0	9.3×10^4	8.7×10^4	2.2×10^4	ND	ND
	1	7.9×10^5	6.7×10^5	5.3×10^5	ND	ND
	2	8.5×10^7	7.2×10^7	6.4×10^7	ND	ND
	3	4.0×10^6	6.9×10^5	5.0×10^6	ND	ND
B	0	5.9×10^7	7.2×10^7	8.3×10^6	ND	ND
	1	6.1×10^8	3.9×10^8	5.9×10^7	ND	ND
	2	5.9×10^9	6.4×10^9	8.6×10^8	ND	ND
	3	7.5×10^8	6.6×10^8	9.2×10^7	ND	ND
C	0	8.0×10^8	5.5×10^8	3.8×10^7	ND	ND
	1	2.9×10^9	2.5×10^9	1.1×10^8	ND	ND
	2	9.7×10^{10}	6.1×10^{10}	8.2×10^9	ND	ND
	3	8.4×10^9	6.9×10^9	8.0×10^8	ND	ND
D	0	8.9×10^8	7.3×10^9	8.8×10^7	ND	ND
	1	5.3×10^9	6.1×10^9	3.6×10^8	ND	ND
	2	9.9×10^{10}	7.6×10^{10}	9.0×10^9	ND	ND
	3	7.0×10^9	6.5×10^9	9.1×10^8	ND	ND

(A): Prepared using yoghurt incubation with 0.5% probiotic culture. (B): Prepared using yoghurt incubation with 1.5% probiotic culture. (C): Prepared using yoghurt incubation with 3% probiotic culture. (D): Prepared using yoghurt incubation with 4.5% probiotic culture.
ND = Not Detected

Table 4: sensory attributes of dried tarhana prepared with yoghurt fermented by different concentrations of DVS-ABT2 culture.

Tarhana samples	flavor	body and texture	appearance	Total (15)
A	4.5	4.6	3.5	12.6
B	4.6	4.6	4.0	13.2
C	4.5	4.5	4.0	13
D	4.5	4.6	3.5	12.6

Each value represents the mean of ten panel's degree
(A): Prepared using yoghurt incubation with 0.5% probiotic culture. (B): Prepared using yoghurt incubation with 1.5% probiotic culture. (C): Prepared using yoghurt incubation with 3% probiotic culture. (D): Prepared using yoghurt incubation with 4.5% probiotic culture.

Table 5: chemical composition of dried tarhana prepared with yoghurt fermented by different concentrations of DVS-ABT2 culture.

Components	Tarhana samples			
	A	B	C	D
pH	4.90	4.08	4.10	3.94
Acidity	7.5	9.5	10.4	13.4
Crude protein(g/100g)	19.87	19.88	19.87	19.89
Ether extract (g/100g)	2.92	2.92	2.91	2.90
Crude fiber (g/100g)	3.81	3.82	3.82	3.80
Ash (g/100g)	9.93	9.94	9.98	9.93

(A): Prepared using yoghurt incubation with 0.5% probiotic culture. (B): Prepared using yoghurt incubation with 1.5% probiotic culture. (C): Prepared using yoghurt incubation with 3% probiotic culture. (D): Prepared using yoghurt incubation with 4.5% probiotic culture.

Table 6: Microbial counts of dried tarhana samples prepared with yoghurt fermented by different concentrations of DVS-ABT2 culture.

Microorganisms (CFU/g)	Tarhana samples			
	A	B	C	D
L. acidophilus	5.0×10^2	6.2×10^3	4.0×10^4	7.4×10^4
S. thermophilus	9.2×10^2	4.0×10^3	3.6×10^4	7.9×10^4
B. bifidum	3.4×10^2	5.1×10^3	4.1×10^4	8.8×10^4
Molds	ND	ND	ND	ND
Coliform	ND	ND	ND	ND

(A): Prepared using yoghurt incubation with 0.5% probiotic culture. (B): Prepared using yoghurt incubation with 1.5% probiotic culture. (C): Prepared using yoghurt incubation with 3% probiotic culture. (D): Prepared using yoghurt incubation with 4.5% probiotic culture.
ND = Not Detected

Table 7: Plasma lipid profile of experimental group before and after 45 days of dietary supplement. [1]

Parameters	Before (Mean±SE)	After (Mean±SE)
Cholesterol (mg/dl)	222.0 ± 5.2	202.6 ± 8.5*
TGs (mg/dl)	179.8 ± 5.4	169.0 ± 5.5**
HDL-Ch (mg/dl)	50.1 ± 1.0	57.8 ± 0.9**
LDL-Ch (mg/dl)	92.7 ± 0.7	81.9 ± 0.5

[1] Supplement by dried synbiotic tarhana (prepared from yoghurt which was inoculated by 4.5% probiotic culture), n=15, *= significant $p<0.05$ **= high significant $p<0.01$
TGs = Triglycerides, HDL-Ch = high-density lipoprotein cholesterol , LDL-Ch = low-density lipoprotein cholesterol.

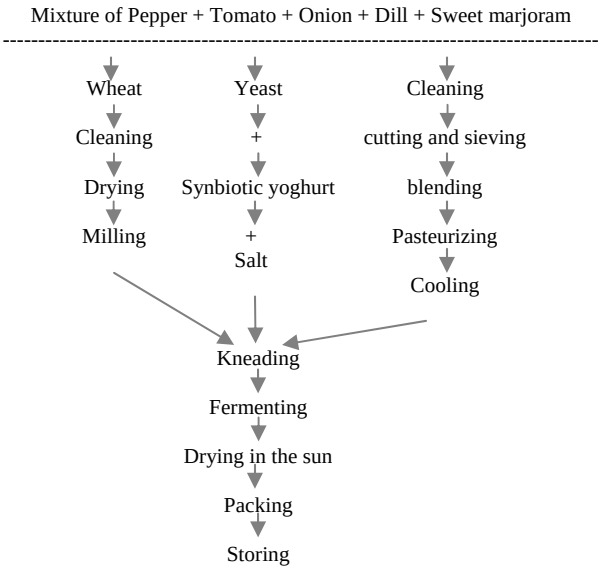

Figure 1: Flow chart for the preparation of tarhana.

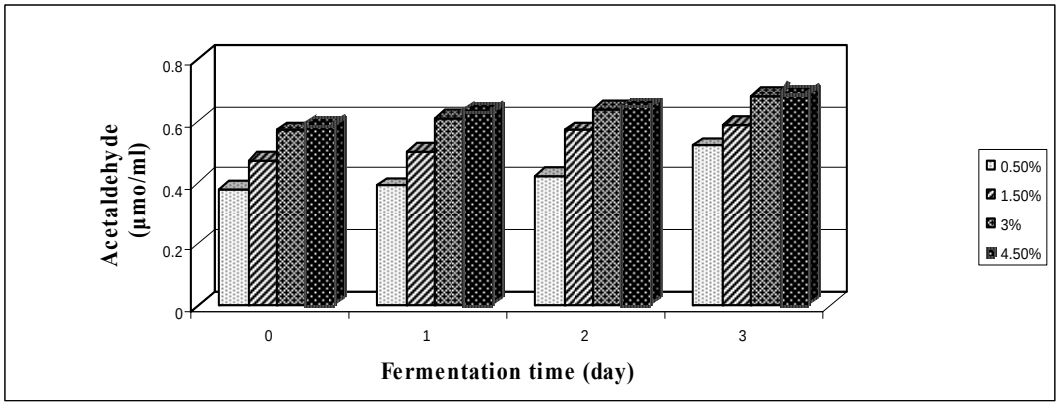

Figure 2: Effect of fermentation time on acetaldehyde contents (µmo/ml) of tarhana dough prepared with yoghurt fermented by different concentration (0.5, 1.5, 3 and 4.5%) of DVS-ABT2 culture.

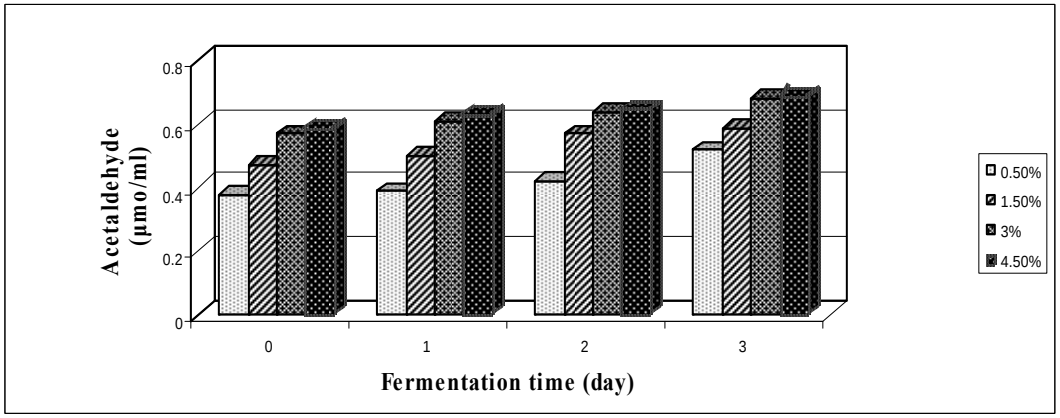

Figure 3: Effect of fermentation time on diacetyl contents (µmo/ml) of tarhana dough prepared with yohgurt fermented by different concentration (0.5, 1.5, 3 and 4.5%) of DVS-ABT2 culture.

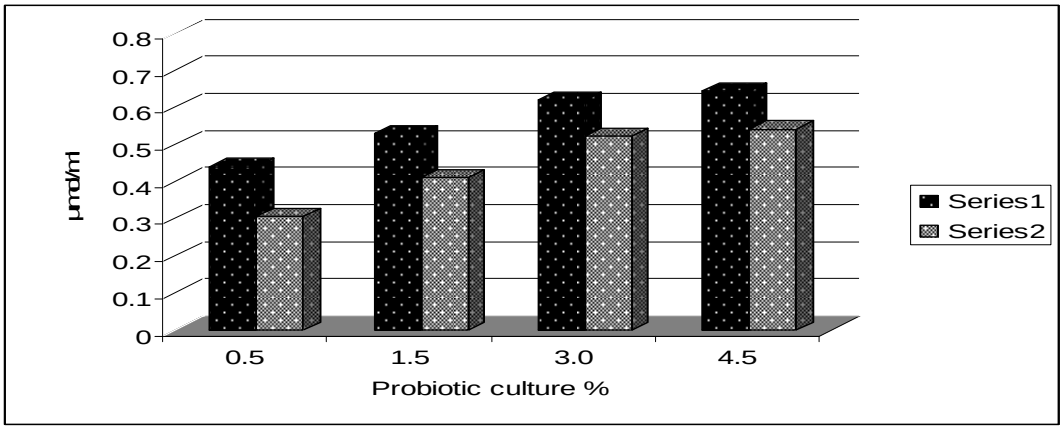

Figure 4: Acetaldehyde and diacetyl contents (µmol/ml) of the dried tarhana prepared with yoghurt fermented by different concentrations of DVS-ABT2 culture.

4. Discussion:

In the present study, changes in some of the chemical components of tarhana dough samples were studied in relation to different fermentation time. Results show that for all tested tarhana dough samples, fermentation time had no effect on crude fiber, ether extract and ash. This is in the agreement with the results obtained by Erbas *et al*. (2005), who found out that fermentation had no significant effect on dry matter, crude protein, ether extract and ash.

Data obtained revealed that the acidity content of all studied tarhana dough samples increased by increasing the fermentation time and consequently the pH values decreased until the end of fermentation course. The increase in the acidity followed by a decrease in pH value may be due to the formation of organic acids from fermentation of sugars mostly by probiotic bacteria. Such findings coincide with those reported by Ibanoglu *et al*. (1995) and Erbas *et al*. (2005), who demonstrated that the acidity of tarhana dough increased and the pH decreased during fermentation.

Acetaldehyde and diacetyl are two important aromatic compound. Acetaldehyde and diacetyl contents of the tarhana dough samples increased with increasing of the probiotic culture concentrations in tarhana dough. Acetaldehyde content is attributed to probiotic bacteria (Erbas *et al*. 2005).

Results indicate that the microbial counts numbers increased by increasing the fermentation time reaching the highest level at the second day of fermentation, then it decreases by increasing that period to record the lowest level at the end of fermentation (3 days). These results are in accordance with those obtained by Daglioglu *et al*. (2002) using Turkish tarhana. The results of bacterial counts are close to those reported by Capela *et al*. (2006), who, reported that the viability of probiotic organisms in yoghurt that had been inoculated with 4% was more than in yoghurt that had been inoculated with 2% before and after fermentation. Ibanoglu *et al*. (1999) found that the increasing of yoghurt amount from 500g to 1000g in tarhana during the fermentation increased the population of probiotic bacteria of tarhana.

Sun drying is a slower but a more common and economical approach for traditional tarhana production. As for the drying process the critical moisture value is 13 – 15% for the inhibition of undesirable microbial growth in dry recipes produced from wheat flour (Bozkurt and gurbuz, 2008). The moisture content of tarhana is low, that it can be stored for 2 or 3 years without deterioration (Ibanoglu et al. 1999, Tarakc et al. 2004).

The results of the sensory analysis show that the use of yeast in the tarhana formula had a positive effect on the sensory properties. This shows that yoghurt bacteria and yeast together produce lactic acid, ethyl alcohol, carbon dioxide, and other fermentation products, which give tarhana its characteristic taste and flavour (Koca et al. 2002).

The protein content of the dried samples was higher than that obtained by Daglioglu (2000), Kose and Cagndi (2002) who reported that the crude protein content of dried tarhana were between 14.5 – 16 %. The latter author added that dried tarhana is a good source of protein. This can be explained by the differences in the tarhana formulas produced in different regions of Turkey.

The fiber and ash content in the present study were higher than that obtained by Daglioglu (2000), Erbas *et al*. (2006) who reported that the crude fiber and ash content of dried tarhana were 1% and 6.2%. The ether extract content was less than that obtained by Daglioglu (2000), Erbas *et al*. (2006) who reported that the ether extract content of dried tarhana was 5.4%. This can be explained by the

differences in the tarhana formulas produced in different regions of Turkey.

Drying treatments can slightly affect the increase in the pH and the decrease in acidity contents of the tarhana samples. The acetaldehyde and diacetyl contents of the dried tarhana may be due to the formation of aromatic components which is attributed to the presence of probiotic bacteria as reported by Erbas et al. (2005).

The sharp decrease in probiotic bacterial counts after drying coincide with the results reported by Daglioglu et al. (2002) who observed a sharp drop in L.A.B. population of tarhana samples after conventional drying. Also Erbas *et al*. (2005) attributed the decrease of L.A.B. population to the low water content of dried tarhana samples.

In the present study it was found that increasing the probiotic culture concentrations increased the number of probiotic bacteria of dried tarhana. These results are in agreement with those reported by Capela *et al*. (2006) who, disclosed that the viability of probiotic organisms in freeze-dried yoghurt was increased by increasing the inoculums volume from 2 to 4 %.

Hypolipidemic effect

The relationship between atherosclerotic cardiovascular disease and nutrition is very important. Many functional foods have been found to be potentially beneficial in the prevention and treatment of cardiovascular disease. (Anderson 2003).

The hypocholesterolemic effect of dried tarhana may be due to its content of probiotic bacteria and prebiotic inulin because it is soluble in water and not hydrolyzed by human digestive enzymes, it is expected to behave like a soluble fiber and to have a hypolipidemic effect (Kim and Shin 1998), wheat flour which as explained by Illman et al. 1993 lowers plasma cholesterol and increases cecal steroids relative to whole wheat flour, wheat bran and wheat pollard in rats. Also wheat is among cereals containing high concentrations of ß-glucan which is known to have a cholesterol lowering effect (Newman et al. 1989, Mc Intoch et al. 1991). Vegetables such as onion have hypocholesterolemic effect by inhibiting hepatic cholesterol biosynthesis (Gupta and Porter 2001, Singh and Porter, 2006) , Lycopene from tomatoe led to reduction of serum total cholesterol (Agarwal and Rao 1998) and green pepper which prevents arteriosclerosis and lower cholesterol (Mezzetti et al. 1995).

5. Conclusion

Fermentation process is an important stage for the development of sensory profile of tarhana. Fermentation and increasing probiotic culture concentrations decreased the pH values and increased acidity, acetaldehyde and diacetyl values while neither the fermentation nor the concentrations of the probiotic culture affected crude protein, ether extract, crude fibre and ash values of wet and dried tarhana.

The increasing of the probiotic culture concentration from 0.5 to 3% ensured probiotic bacteria population of wet and dried tarhana at satisfactory level while increasing the probiotic culture concentration from 3 to 4.5% slightly increased probiotic bacteria population. Generally drying process decreased the viability of probiotic bacteria as drying decreased the water activity. So it has a poor medium for pathogens and spoilage organisms.

Since tarhana is a good source of B vitamins, minerals, organic acids, and free amino acids, and since it is a product of L.A.B. and yeast fermentation, it may be considered a functional and probiotic food with hypolipidemic effect.

Corresponding Author:
Shreef G.N. Gabrial
Food Science and Nutrition Department,
National Research Centre (NRC), Dokki, Cairo 12311, Egypt
E-mail: snoub_2000@yahoo.com

References

1. AOAC, Official Methods of Analysis. The Association of Official Agricultural Chem., 17th ed., U.S.A. (2000).
2. Agarwal, S and Rao, AV, Tomato lycopene and low density lipoprotein oxidation: a human dietary intervention study. *Lipids* 33:981- 4 (1998).
3. Allain CC, Poon LS, Chon CSG, Richmond U, Fu PC, Enzymatic determination of total serum cholesterol. Clin Chem 20:470–475 (1974).
4. American Public Health Association (APHA), Standard methods of the examination of dairy products. 16th ed., Washington, U.S.A. (1994).
5. Anderson, JW, Whole grains protect against atherosclerotic cardiovascular disease. *Proc.Nutr.Soc.* 62(1):135-142 (2003).
6. Bilgicli, N and Elgun, A, Changes in some physical and nutritional properties of tarhana, a Turkish fermented cereal food, added various phytase sources. *Food Science and Technology International*, 11(5):383-389 (2005).
7. Bilgicli, N and Ibanoglu, S, Effect of wheat germ and wheat bran on the fermentation activity, phytic acid content and colour or tarhana, a wheat flour- yoghurt mixture. *Journal of Food Engineering*, 78(2):681 – 686 (2007).

8. Bilgicli N, Elgun A, Herken EN, Turker S, Ertas N. and Ibanoglu, S, Effect of wheat and sensory quality of tarhana, a fermented wheat flour-yoghurt germ/bran addition on the chemical, nutritional product. *Journal of Food Engineering*, 77(3):680 – 686 (2006).
9. Bozkurt O and Gurbuz O, Comparison of lactic acid contents between dried and frozen tarhana. *Food Chemistry* 108:198 – 204 (2008).
10. Capela P, Hay TKC and Shah NP, Effect of cryoprotectants, preboitic and microencapsulatin on survival of probiotic organisms in yoghurt and freez-dried yoghurt. *Food Research International* 39:203 – 211 (2006).
11. Cavallero A, Empilli S, Brighenti F and Stanca AM, High (1-3, 1-4)-b-glucan barley fractions in bread making and their effect on human glycemic response. *Journal of Cereal Science* 36:59-66 (2002).
12. Daglioglu O, Tarhana as a traditional Turkish fermented cereal food. Its recipe, production and composition. *Die Nahrung* 44(2):85- 88 (2000).
13. Daglioglu O, Arici M, Konyali M and Gumus T, Effects of tarhana fermentation and drying methods on the fate of Escherichia coli O157:H7 and Staphylococcus aureus. *European Food Research and Technology* 215(6):515-519 (2002).
14. Dave RI, and Shah NP, Evaluation of media for selective enumeration of Streptococcus thermophilus, Lactobaccilus deblrueckii ssp. Bulgaricus, Lactobaccilus acidophilus and Bifidobacterium. *J. Dairy. Sci.* 79:1592 (1996).
15. Davidson MH, Maki KC and Synecki C, Evaluation of the influence of dietary inulin on serum lipids in adults with hypercholesterolemia. *Nutrition* 18: 503-17 (1998).
16. Ekinci R, The effect of fermentation and drying on the water-soluble vitamin content of tarhana, a traditional Turkish cereal food. *Food Chemistry* 90(2):127-132(2005).
17. Ekinci R and Kadakal C, Determination of seven water-soluble vitamins in tarhana, a traditional Turkish cereal food, by high-performance liquid chromatography. *Acta Chromatographica* 15:289-297 (2005).
18. Erbas M, Certel M and Uslu MK, Microbiological and chemical properties of tarhana during fermentation and storage as wet-sensorial properties of tarhana soup. *Swiss Society of Food Science and Technology* 38:409-416 (2005).
19. Erbas M, Uslu MK, Erbas MO and Certel M, Effects of fermentation and storage on the organic and fatty acid contents of tarhana, a Turkish fermented cereal food. *Journal of Food Composition and Analysis* 19:294-301(2006).
20. Farnworth ER, Handbook of fermented functional foods. Boca Raton, FL: CRC Press (2003).
21. Fossati P and Prencipe I, Serum triglyceride determintation colorimetrically with an enzyme that produce hydrogen peroxide. *Clin. Chem.* 28:2077 (1982).
22. Friedewald WT, Levy RI andFredrickson DS, Estimation of the concentration of low density lipoprotein cholesterol in plasma without the use of the preparative ultracentrifuge. Clin Chem 18:499–502, (1972).
23. Gelinas P and McKinnon C, Fermentation and microbiological processes in cereal foods. In Kulp K & Ponte JJ (Eds.). Handbook of cereal science and technology. New York: Marcel Dekker, Inc. vol. 99:741-754(2000).
24. Gobbetti M, The sour dough microflora: interactions of lactic acid bacteria and yeasts. *Trends in food science and technology* 9(7),267-274 (1998).
25. Gupta N and Porter TD, Garlic and garlic-derived compounds inhibit human squalene mono-oxygenase. *The Journal of Nutrition* 131:1662-1667 (2001).
26. Hayta M, Alpaslan M and Baysar A, Effect of drying methods on functional properties of Tarhana: a wheat flour-yoghurt mixture. *Journal of Food Science* 67(2):740-744 (2002).
27. Ibanoglu S, Ainsworth P, Wilson G and Hayes GD, The effect of fermentation conditions on the nutrients and acceptability of tarhana. *Food Chemistry* 53(2):143-147 (1995).
28. Ibanoglu S, Ibanoglu E and Ainsworth P, Effect of different ingredients on the fermentation activity in tarhana. *Food Chemistry* 64(1):103-106 (1999).
29. Illman R J, Storer G B and Topping D L, White wheat flour lowers plasma cholesterol and increases cecal steroids relative to whole wheat flour, wheat bran and wheat pollard in rats. *J. Nutr.* 123: 1094–1100 (1993).
30. Iwe MO, Sensory methods and analysis. *Regional Com., Aba, Nig.* 86-89 (2000).
31. Jacobs DR Jr, Marquart L, Slavin J and Kushi LH, Whole-grain intake and cancer: an expanded review and meta-analysis. *Nutrition and Cancer* 30(2):85-96 (1998).
32. Kim M and Shin HK The water-soluble extract of chicory influences serum and liver lipid concentrations, cecal short-chain fatty acid concentrations and fecal lipid excretion in rats. *The Journal of Nutrition* 128:1731-1736 (1998).

33. Koca AF, Yazici F, Anil M, Utilization of soy yoghurt in tarhana production. *European Food Research and Technology* 215: 293–297(2002).
34. Kose E and Cagindi OS An investigation into the use of different flours in tarhana. *Int. J. Food Sci. Tech.* 37(2):219-222 (2002).
35. Lees GJ and Jaco GR, Method for the estimation of acetaldehyde in cultured dairy products. Aust. J. Dairy Tech. 24:181 (1969).
36. Lees GJ and Jaco GR, The estimation of diacetyl in cultured in the presence of other carbonyl compounds. *J. Dairy Res.* 37:129 (1970).
37. Lopes-Virella MF, Stone P, Ellis S and Coldwell JA, Cholesterol determinations in high density liproproteins separated by three methods. Clin Chem 23:882–884, (1977).
38. McIntoch GH, Whyte J, McArther R and Nestel PJ, Barley and wheat foods: influence on plasma cholesterol concentrations in hypercholesterolemic men. *Am J Clin Nutr* 53(5):1205-1209 (1991).
39. Mensah P, Fermentation the key to food safety assurance in Africa. *Food Control* 8:271-278(1997).
40. Mezzetti A, Lapenna D, Piedromenico SD, Cala.ore AM, Constantini F, Riario-Sforza G, Imbastaro T, Neri M and Cuccurullo F, Vitamin E, C and lipid peroxidation in plasma and arterial tissue of smokers and non smokers, *Atherosclerosis* 112:91-99 (1995).
41. Mugula JK, Narvhus JA and Sorhaug T, Use of starter cultures of lactic acid bacteria and yeasts in the preparation of togwa, a Tanzanian fermented food. *International Journal of Food Microbiology*, 83(3):307-318 (2003).
42. Newman RK, Lewis SE, Newman CW, Boik RJ and Ramage RT, Hypocholesterolemic effect of barley foods on healthy men. *Nutritional Reports International* 39:749-760 (1989).
43. Nout MJR and Motarjemi Y, Assessment of fermentation as a household technology for improving food safety: a joint FAO/WHO workshop. *Food Control* 8:221-226 (1997).
44. Ozdemir S, Gocemen D and Kumral Y, A traditional Turkish fermented cereal food: Tarhana. *Food Rev. Int.* 23: 107-121 (2007).
45. Rivera-Espinoza Y and Gallardo-Navarro Y, Non dairy probiotic products. *Food Microbiology* 27:1-11 (2010).
46. Singh DK and Porter TD, Inhibition of sterol 4 alpha-methyl oxidase is the principal mechanism by which garlic decreases cholesterol synthesis. *Journal of Nutrition* 136:759-764 (2006).
47. Steinkraus KH, Fermentations in world food processing. Comprehensive Reviews in Food Science and Food Safety 1:23-30 (2002).
48. Tarakc Z, Dogan IS and Koca AF, A traditional fermented Turkish soup, tarhana, formulated with corn flour and whey. International Journal of Food Science and Technology 39:455-458 (2004).
49. Terzaghi BE and Sandine WE, Improved medium for lactic Streptococci and their bacterophages. Appl. Microbial 29:807 (1975).

11/1/2010