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Production of Dried Fermented Camel Dairy Product Mixed with Some Cereals

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Abstract: Dried fermented camel milk with oat, barley or wheat was manufactured as new cereal camel milk product. The cereal ingredient was boiled, dried and crushed then mixed with fermented camel milk in 2:1 ratio. Onion, tomato paste, paprika, salt (NaCl), were added to the mixture The fermented mixtures were dried at 50 ± 2°C in an air- convection oven. After drying, the products were ground into powder. Chemical properties and microbiological analysis of grains, camel milk, fermented camel milk and kishk like products were determined. Color measurement, water/ oil binding capacity, viscosity and sensory analysis were done. The chemical composition of oat and barley were better than the wheat in protein, mineral, fiber, vitamin and amino acid. Oats kishk like products gave the best results and sensory evaluation. Moreover oat content of β-glucan gave the highest viscosity of prepared produces in comparing with the other products. Thus we recommend to produce these fermented cereal camel milk products as healthy and cheap nutraceutical product.

Key words: Wheat · Oats · Barley · Kishk powder · Nutraceutical

INTRODUCTION

Fermentation is a food preparing method with a long history, used mainly to improve shelf life and product quality. Traditional dried fermented milk products have been produced for centuries in many countries. Dried fermented milk products are popular in various parts of the world and can be important in the diets of these countries [1].

Traditional fermented foods prepared from different types of cereals (such as rice, wheat, corn or sorghum) are well known in many parts of the world [2]. Some are utilized as breakfast or light meal foods or beverages or colorants or flavor enhancers. In most of these products the fermentation is natural and involves mixed cultures of yeasts, bacteria and molds [3].

Fermented camel milk has a high biological value due to the high content of antimicrobial factors such as lysozyme, lactoperoxidase system and immunoglobins [4]. Shori [5] reported that recent data suggested that camel milk contained medicinal properties to controlling diabetes (type 1) and its complications such as high cholesterol level, liver and kidney disease, decreased oxidative stress and delayed wound healing.

Cereal grains are considered to be one of the most important sources of dietary proteins, carbohydrates, vitamins, minerals and fiber for people all over the world. However, the nutritional quality of cereals and sensory characteristics of its products generally less important compared to milk and dairy products [3].

Oats *(Avena sativa)* and barley *(Hordeum distychum)* contain many natural compounds beneficial to health. These include tocopherols, phenolics and phytosterols as well as soluble and insoluble fibres; however, beta-glucan (β-glucan), a unique soluble fibre, is the most recognized health promoting compound. Of the common cereals (wheat, rye, oats and barley), the largest (seed) amounts of β-glucan are found in barley (3-11%) and oats (3-7%) [6].

In oats, the β-glucan is in the endosperm and its wall, making dehulling and fractionation of the whole grain necessary to produce commercial β-glucan enriched brans. Using technology and processing controls, natural oat bran with high dietary fiber content (44%) and β-glucan content (up to 22%) can be achieved. Oats and other small-grain cereals were brought to Canada in the early 17^{th} century by European colonists. Oat was an

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important feed crop for the early settlers on the Prairies, who used horses as the main source of power for farming and transportation [7].

Over the years, oat has gained in importance because of the size and makeup of the livestock industry and an increased interest in oats in the human food market. Oats is one of the best sources of Inositol, which is very important for maintaining blood cholesterol level. It also contains very high levels of calcium, potassium and magnesium, coupled with Vitamin B-complex [6].

All these vitamins and minerals are very essential for the nervous system, thus eating oats regularly helps to keep the blood cholesterol level low. Oats have also been proven to act as anti-depressants. Cooked oats relieve fat from the body while unrefined oatmeal can reduce stress. Oats also prevents bowel cancer because of its high fiber content and eating oats can cure constipation and help in lowering chances of heart-disease [7].

In hull-less barley, β-glucan is distributed more evenly throughout the kernel so that even refined products like barley flour contain β-glucan. Therefore, it is critical to preserve the molecular weight and solubility of β-glucans during processing to ensure that these physical properties are maintained [8].

A fermented product made from the dry form of yoghurt cereal mixture in Syria, Palestine, Jordan, Lebanon and Egypt is known as kishk; tarhana in Turkey, trahanas in Greece, kushuk in Iraq and Iran; talkuna in Finland and thanu in Hungary; Madeer and Oggt in Saudi Arabia [9-11].

It can also benefit from the kishk product in the production of beverage, by solving the kishk pellets in hot water [12] or with the incorporation of vegetables, spices, garlic, herbs or dates, can form the base of savoury and sweet dishes [13].

The production of a product from fermented camel milk fortified with cereals helps to produce healthy functional camel milk products. Given the little of previous studies for the use of fermented camel's milk and cereals. The aim of this work was to make use of camel milk for as long as possible, especially during the period when milk miss during the year, with the lack of means of conservation and cooling of milk and Production of the functional food by grain as a producer and functional service desert Bedouin and healthy for the healthy child, adult, the elderly and medical patients.

MATERIALS AND METHODS

Materials: Camels' milk was obtained from the herd raised in Maruot Research Station, Desert Research Center, Alexandria Governorate. All animals were kept under the same conditions. Bulk camels' milk samples were analyzed for chemical composition. Three different commercial cereals namely; barely: Barley Two Rowed (*Hordeum distychum*), oat: Oats (Good Land), (*Avena sativa*) and wheat: Hard Red Spring Wheat (*Triticum aestivum*), were obtained from U.S.A which were from Regional Center for Food and Feed, Agriculture Research Central, Giza, Egypt. The commercial freeze-dried DVS mixed bacterial starters of (YC-X11 Yo -Flex®, Chr. Hansen, Honsholm, Denmark) (containing of *Lactobacillus delbrueckii ssp. bulgaricus* and *Streptococcus thermophilus*) as yoghurt were used in the fermentation process. Freeze-dried bacterial starters used in the fermentation process were prepared as mother cultures in autoclaved (121°C/10 min) fresh buffaloes' skim milk (0.1 % fat and 9.5% SNF) using a 0.2 % (w/v) inoculums. The cultures were incubated at 40°C for YC-X11 starter until curdling of milk. Cultures were prepared 24h before use.

Preparation of Grains: A twenty kg of each grain sample used in this investigation were stored at temperature 25°C and relative humidity less than 62% and taken samples from stores According to the methods described in USDA [14]. Grains samples were cleaned mechanically to remove dirt, dockage, imparters and other strange grains by Carter Dockage Tester and barley pearled by barley pearler according to the methods described in USDA [15]. The wheat samples were milled by Laboratory mill 3100 Perten while oat samples were milled by Vibratory bran finishers Chopin According to the methods described in AACC [16].

Manufacture of Yoghurt: Camel's milk was heated at 95°C for 5 minutes. Then, camel's milk was inoculated at 42°C with a yogurt starter consisting of YC-X11 starter. Inoculated milk was incubated at 40°C until the pH reached 4.5. The yogurt was then cooled to 5°C and stored at 5°C.

Manufacture of Kishk: Preparation of grains: Wheat and barley were prepared, cleaned from extraneous matter, were steeped in water (wheat/Barley: water; 2:3) for 30 min and then boiled until the water has been absorbed (ca. 80±90 min).

The cereal ingredient (Barley or whole wheat) was heated at 100°C for 15 min and then cooled to room temperature to reduce its microbial load. Yoghurt was added to a batch of barley/oats/ whole wheat (2:1 ratio) and the resulting mixture was kneaded in dough mixer for 5 min. and the rest was incubated in closed earthenware containers at 35°C for 24 h in the incubator. At the end of the fermentation, a sample was formed into small balls of 3±4 cm in diameter and dried at 55°C (ca. 18±22 h).

Production of Kishk Powder: To prepare kishk powder samples, kishk (barely, oats and wheat) (100%) pellets, dried onion 2.5% (w/w, Kishk), tomato paste 2.5% (w/w, kishk), paprika 7.5% (w/w, kishk) and salt (NaCl) 7.5% (w/w, kishk) were used. Vegetables used in kishk powder formulations can be thought as safe foods, because they were used after cooking process. On the other hand, spices used in this study as ingredients of kishk powder were commonly prepared by drying under the sterilization conditions. The ingredients were mixed in a mixer for 5 min. and dough samples were fermented at 30°C in fermentation for 3 days. The fermented dough samples were dried at 50 ± 2°C in an air-convection oven. After drying, kishk powder samples were ground into powder. The resulting powders were stored in a glass jar at room temperature until analyzed.

Methods

Chemical Properties and Microbiological Analysis of Grains: Moisture, crude protein, vitamins, ash, crude fiber, amino acid, minerals and fat were determined according to AOAC [17] and Grains Moisture according to USDA [18]. The nitrogen free extract (NFE) was calculated by difference. Minerals content (Mg, Zn and Fe) were determined after aching of different samples according to AOAC [17]. Measurements were carried out using Atomic absorption spectrophotometer model 3300 Perken for element. The data were calculated as mg metal / 100gm dry sample. Estimation of Aflatoxins content, Ochratoxin, Zearalenone and Fumonisin were determined by HPLC using the method of AOAC [17]. Total mold count and fungal identification were carried out using Rose Bengal chloramphenicol agar and incubated for 5 days at 25°C.

Chemical Properties and Microbiological Analysis of Kishk and Kishk Powder: The pH was measured using a pH-meter (HANNA-pH 210, Germany). The AOAC [17] methods were used for the determination of moisture, Protein, crude fat ash and crude fiber contents of the kishk/ kishk powder samples. Also the nitrogen content of the samples was determined by the Kjeldahl method and Converted to protein content using a factor of 6.25. The acidity degree of tarhana samples was measured according to Tamer *et al.* [19].

For the enumeration of Total aerobic bacteria (TAB), Lactic acid bacteria (LAB), Yeast and Mould (YM) and Coliform Bacteria, samples of kishk powder (10 g) were dispersed in 90 ml sterile Ringer's solutions and appropriate decimal dilutions were prepared by using 1/4-strength Ringer's solution under the aseptic conditions. Total count of TAB was enumerated by Plate Count Agar (Oxoid) after incubation at 37°C for 48 hours [20]. LAB were counted on MRS agar containing 0.1 g/L of cycloheximide after incubation at 30°C for 72 h in anaerobic conditions [20]. Dichloran Rose Bengal Chloramphenicol Agar (Oxoid) was used for YM enumeration and plates were incubated at 25°C for 5 days [20]. Coliform bacteria were enumerated on Violet Red Bile Agar (Oxoid) after incubation at 37°C for 24 h [20].

Color Measurement: Color measurement was determined according to the tristimulus Colour system described by Bilgiçli *et al.* [21] using spectrophotometer (MOM, 100 D, Hungary). The L*, a* and b* values were determined according to the CIELab color space system.

Water/ Oil Binding Capacity: Water/oil binding capacity of samples at different pH values was determined according to method of AOAC [17].

Viscosity: Viscosity was measured at 30, 45 and 60°C using the Brookfield rotational viscometer (model Brookfield DV- III ultra programmable rheometer BROOKFIELD ENGINEERING LABORATORIES, INC., 11 Commerce Boulevard, Middleboro, USA) using No. 4 spindle at 20 rpm. Two readings were recorded for each sample [22].

Sensory Analysis: The sensory evaluation of kishk powder soup was determined by the Department of Food science to determine color, taste, odor, mouth feel and overall acceptability according to Bilgiçli *et al.* [21].

Statistical Analysis: Data of the experiment was analyzed by the General Linear Model (GLM) procedure of SAS [23].

RESULTS AND DISCUSSION

Chemical Properties of Grains Cultivars: Chemical composition of different grains cultivars used in this study is given in Table (1). Grains moisture content of different varieties ranged from (10.20 to 13.30) for all studied samples. Oats had the highest value while barley had lowest value among all samples. As regards protein content, barley had the highest protein (12.30%) followed by wheat (12.20%), while oats (11.30%) had the lowest protein content. On other hand nitrogen free extracts (NFE) % ranged from 68.80% (Oats) to 82.30% (Wheat). Additionally wheat was lower in fat content (1.90) than other samples and lower in Ash content (1.70) than the other grains. Ash content of all grains was found quite close to each other. However, highest ash content was observed in oats (3.20%).The ash content of flour is related to the amount of bran in the flour and therefore to flour yield. The results of fiber showed that Oats had significant the highest value (11.90%) while Wheat had lowest value (1.90).

Minerals for Different Grains: Data in Table (1). it can be noticed that macro element ranged from (Mg) 45.30 to 1410.80 µg/g for all samples, where Barley had the highest Mg (1410.80 µg/g) followed by Wheat and Oats which have the lowest Mg(45.30 µg/g). But for micro element (Zn) it can be noticed which range 4.4 to 82.8 ppm for all samples. Oats had the highest Zn (82.8ppm) followed by Barley and Wheat which have the lowest Zn. Moreover it can be observed heavy metals for all samples of grains with the highest Fe than stander in all samples. This Standard is applied to the grain of soft and durum wheat to be used for food and non-food purposes and for export. Wheat division into types which represented indices, characteristics and quality norms of wheat according to classes; obligatory requirements for wheat grain, which guarantee human, animal and environmental safety and health (condition, odor and color of grain, infectiousness), (toxic elements, mycotoxins and pesticides), (safety and industrial sanitation requirements) and (natural environment protection) approved by the Ministry of Health of Ukraine (No. 137) [24]. These results agree with result obtained by Nagarajan [25].

Vitamins of different grains cultivars used in this study is given in Table (1) that Thiamine (B_1) of different grains ranged from (0.57 to 9.90) for all studied samples. Wheat had the highest value while Barley had lowest value among all samples. As regards Riboflavin (B_2), Wheat had the highest (B_2) (3.10%) followed by Barley (0.22%), while Oats (0.14%) had the lowest (B_2). On other hand Niacin (B_3) % ranged from 0.97% (Oats) to 48.30% (Wheat). Additionally Barley was lower in Pantothenic (B_5) (0.73) than other samples and lower in Pyridoxine (B_6) (0.33) in completely in other grains. These results agree with result obtained by FAO [26].

Amino Acids for different grains cultivars and kishk powder used in this study are given in Table (2), Arginine of different grains ranged from (4.79 to 6.90) for all studied samples. Oats had the highest value while Wheat had lowest value among all samples. As regards Cystine, Wheat had the highest value (2.19%) while Barley (2.17%) had the lowest value. On other hand Lysine ranged from 2.82% (Wheat) to 4.20% (Oats). Additionally Wheat was lower in Methionine (1.29) than other samples and lower in Histidine (2.04) in completely in other grain. However, highest Aspartic was observed in (Oats) (8.90%). The results of Tryptophan showed that Barley had significant highest value (1.97%) while Wheat had lowest value (1.24). These results agree with result obtained by FAO [26].

The nutritive value of plant proteins is known to be lower than that of animal protein. With the addition of the yogurt to grain helps to increase the nutritional value by raising the level of amino acids at the kishk powder. The amino acids in kishk powder were the approximately increase in proteolytic activities during fermentation and added to yoghurt.

Mycotoxins content of different grains cultivars (Table 3). It can be noticed that all samples had low aflatoxin content before storing under detection limit (0.5ppb) for aflatoxin, ochratoxin, zearalenone, fumonisin. Thus, it can be concluded that all samples (Barley, Oats and Wheat) content of aflatoxins were under detection limit (0.5ppb) of the standard Egyptian maximum (B1=10ppb and total aflatoxin =20 ppb).

In Table (4), the chemical composition of the kishk made from oats contained the highest values of moisture and ash compared with products made from barley and wheat. These values are seen to be ranged as reported for kishk by Tamime *et al.* [9].

The microbiological quality of Kishk is shown in Table (4). Total aerobic bacterial counts (TAB) ranged between $2.14X10^4$ to $3.70X10^4$ cfu/ml. Nearest to the counts were observed, the total count (i.e. 2.8×10^2 to 1.3×10^6 cfu/ml) including Kishk samples refer to Tamime and Mcblulty [27]. It was found that lactic acid bacterial counts (LAB) of kishk were $2.35X10^3$, $2.61X10^3$ and $3.01X10^3$ cfu/ml for wheat, barley and oats, respectively. In addition, No coliform or yeasts and moulds were recovered from any of the Kishk samples (i.e. 10^{-1} dilution).

Table 1: Chemical analysis for different grains cultivars

	Grains		
Chemical composition	Barley	Oats	Wheat
Moisture%	10.2^{b}±0.5	13.30^{a}±0.1	10.40^{b}±0.1
Protein%	12.30^{a}±0.1	11.30^{b}±1.0	12.20^{a}±1.0
Fat %	2.30^{a}±0.01	5.80^{b}±0.01	1.90^{c}±1.0
Ash%	3.00^{a}±0.1	3.20^{a}±0.1	1.70^{b}±0.1
Fiber%	8.50^{a}±0.01	11.90^{b}±0.01	1.90^{c}±0.1
NFE%	73.90^{a}±0.01	68.80^{b}±0.01	82.30^{c}±0.1
Total caloric values%	365.50^{a}±0.01	372.60^{b}±0.01	395.90^{c}±0.1
Minerals			
Mg µg/g	1410	45	480
Zn ppm	23.6	82.8	4.4
Fe ppm	36.7	108.0	6.0
Vitamins			
Thiamine (B_1)	0.57±0.5	0.77±0.1	9.90±0.1
Riboflavin (B_2)	0.22±0.1	0.14±1.0	3.10±1.0
Niacin (B_3)	6.40±0.01	0.97±0.01	48.3±1.0
Pantothenic (B_5)	0.73±0.1	1.36±0.1	9.1±0.1
Pyridoxine (B_6)	0.33±0.01	11.90±0.01	4.7±0.1

NFE = Nitrogen free extracts

Table 2: Amino Acids contents of different grains cultivars and kishk powder (g/100g protein)

	Grains			Kishk powder		
Amino Acids	Barley	Oats	Wheat	Barley	Oats	Wheat
Aspartic	5.82^{b}±0.1	8.90^{a}±0.1	5.46^{b}±0.1	11.5^{a}±0.1	9.0^{c}±0.1	10.5^{b}±0.1
Arginine	4.83^{b}±0.01	6.90^{a}±0.01	4.79^{b}±1.0	6.6^{a}±1.0	5.2^{b}±0.01	5.0^{b}±0.01
Cystine	2.17±0.1	-	2.19±0.1	2.9±0.1	2.8±1.0	2.5±0.1
Glutamic	27.02^{b}±0.01	23.90^{c}±0.01	31.25^{a}±0.1	24.7^{c}±0.1	29.0^{b}±0.01	32.8^{a}±0.01
Glycine	3.35^{c}±0.01	4.90^{b}±0.01	6.11^{a}±0.1	6.1±0.1	5.5±0.01	5.7±0.01
Leucine	6.90^{b}±0.01	7.4^{a}±0.01	6.71^{c}±0.1	9.9^{b}±0.1	9.3^{b}±0.01	11.1^{a}±0.01
Lysine	3.35^{b}±0.5	4.20^{a}±0.1	2.82^{c}±0.1	6.3^{a}±0.1	4.5^{c}±0.1	5.9^{b}±0.5
Methionine	1.68^{b}±0.1	2.50^{a}±1.0	1.29^{c}±1.0	1.6±1.0	1.5±1.0	1.9±0.1
Histidine	2.37^{a}±0.1	2.20^{a}±1.0	2.04^{b}±1.0	3.5^{b}±1.0	3.8^{b}±1.0	4.1^{a}±0.1
Isoleucine	3.65c±0.01	3.90^{b}±0.01	4.34^{a}±1.0	5.5^{b}±1.0	5.3^{b}±0.01	6.2^{a}±0.01
Phenylalanine	5.23^{b}±0.1	5.30^{b}±0.1	4.94^{a}±0.1	5.7^{c}±0.1	6.3^{b}±0.1	8.1^{a}±0.1
Proline	12.03^{a}±0.01	4.70^{c}±0.01	10.44^{b}±0.1	7.3^{c}±0.1	12.1^{b}±0.01	16.2^{a}±0.01
Alanine	-	5.0±0.01	-	6.5^{a}±1.0	5.5^{b}±0.01	6.3^{a}±0.1
Serine	4.54±0.01	4.20±0.01	4.61±0.1	6.0^{b}±0.1	5.0^{c}±0.01	6.7^{a}±0.01
Threonine	3.55^{a}±0.5	3.30^{b}±0.1	2.88^{c}±0.1	4.8^{b}±0.1	4.2^{c}±0.1	5.6^{a}±0.5
Tyrosine	2.96^{c}±0.01	3.10^{b}±0.01	3.74^{a}±1.0	3.7^{b}±1.0	4.5^{a}±0.01	4.8^{a}±0.01
Valine	4.93^{b}±0.1	5.30^{a}±0.1	4.63^{c}±0.1	7.4^{b}±0.1	6.8^{c}±0.1	8.3^{a}±0.1

(-) = Not determined

Table 3: Mold count and mycotoxins content in different grains cultivars

Isolated Species			Barley	Oats	Wheat
Total Mold Count log cfu/g			3.0	2.50	2.40
	Mycotoxins ppb				
	Ochratoxin		*	*	*
	Zearalenone		*	*	*
	Fumonisin		*	*	*
Aflatoxin		B1	*	*	*
		B2	*	*	*
		G1	*	*	*
		G2	*	*	*
		Total	*	*	*

Grains columns: Barley, Oats, Wheat.

*= Under detection limit (0.50ppb)

Table 4: Chemical composition and microbiological counts of camel milk, yoghurt camel milk and kishk with different grains

			Kishk		
	Milk	Yoghurt	Barley	Oats	Wheat
% Moisture			8.45	9.10	8.01
% Protein	3.84	3.85	13.90	12.85	14.20
% Fat	3.50	3.55	2.65	5.00	2.25
% Ash	0.869	0.871	5.68	6.41	5.34
Total solid	11.60	11.63			
Carbohydrate*	3.391	3.359			
% Fiber			2.24	2.54	1.95
% NFE			67.08	64.10	68.25
The microbial counts CFU/ml					
TAB	-	6.5X10^5	2.55X10^4	3.70X10^4	2.14X10^4
LAB			2.61X10^3	3.01X10^3	2.35X10^3

* Calculated by the difference

NFE = Nitrogen free extracts=100-(fat +fiber +moisture +protein +ash),

Converted to protein content using a factor of 6.25

The chemical characteristics of the kishk powder samples are presented in Table 5. Significant differences in protein, ash and crude fiber contents were found among kishk powder camel samples. The highest moisture value was obtained from kishk powder of oats 6.96%. The moisture values of the samples changed in a wide range. It was previously reported that the variation in moisture content of kishk powder samples was due to the properties of ingredients used in the formulation and the drying method [19, 28].

The ash content of the samples was 8.974, 9.69±0.124 and 8.61%.from kishk powder of barley, oats and wheat respectively. Ash content of kishk powder had a trend similar to crude fiber content because the flour in formulation contributes to the ash content of kishk powder. This could be explained because the original dietary fiber content of oats was the highest (2.93%) that of the barley and wheat flour (2.66 and 2.14% respectively). it due to high amounts of non-starch polysaccharides and these are the main constituents of dietary fiber [29].

The lowest protein content (14.45%) belonged to kishk powder of oats. Since the type and amount of yoghurt samples used in this research were the same for all kishk powder samples, it can be concluded that the reason for the variation of protein contents is the type of flour samples used in kishk powder preparation. On the other hand, Kishk powder is considered to be a useful high-protein dietary supplement with average 15% protein content [10].

Kishk powder of oats had the highest crude fat content of 5.80%. The observed differences in fat contents of kishk powder samples are probably due to the different fat contents of flour samples used in the formula.

pH and acidity values of kishk powder were significantly affected ($P<0.05$). The acidity values of kishk powder samples were between 2.34 and 2.76. Oats kishk powder had the lowest acidity value whereas wheat kishk powder had the highest one. Kishk powder samples used in this research had pH values between 5.46 and 5.58. From the results it was concluded, that the pH value and acidity of the kishk powder, affected by production of acids by lactic acid bacteria of yoghurt in the formulation during fermentation was the main reason of pH reduction in kishk powder samples [30].

Mineral contents of kishk powder samples are shown in Table 5, mineral composition of kishk powder barley was the richest oats and wheat flour. The kishk powder samples contained various minerals since it was produced from grains flours, yoghurt, vegetable and spices. Kishk powder is a good source of calcium, iron and zinc as well as some other minerals [10].

Iron content of kishk powder samples was 36, 30 and 35 ppm to barley, oats and wheat, respectively. While, zinc content is 29.4, 22.7 and 16.6 ppm to barley, oats and wheat, respectively. The results obtained in the research showed considerable similarity with these findings. In literature, Fe and Zn contents of kishk powder ranged between 21 - 59 ppm and 8 - 32 ppm, respectively [10]. This rate depends on amount of flour and its extraction rate used in production. Also, Availability of kishk powder minerals is very high, because phytates were mostly decomposed during fermentation. Fermentation provides optimum pH conditions for enzymatic degradation of phytates which is presented in cereals in the form of complexes with divalent cations such as iron, zinc, calcium and magnesium [31].

Table 5: Chemical composition and microbiology counts of kishk powder

	Barley	Oats	Wheat
% Moisture	6.42	6.96	6.25
% Protein	15.84	14.45	16.95
% Fat	4.87	5.80	3.88
% Ash	$8.97^{b}\pm0.124$	$9.69^{a}\pm0.124$	$8.61^{b}\pm0.124$
% Fiber	2.66	2.93	2.14
% NFE	61.6	60.17	61.81
Acidity	$2.44^{a}\pm0.051$	$2.34^{a}\pm0.051$	$2.76^{b}\pm0.051$
pH	$5.46^{a}\pm0.009$	$5.58^{b}\pm0.009$	$5.65^{c}\pm0.009$
Minerals ppm			
Fe	36.0	30.0	35.0
Zn	29.4	22.7	16.6
Se	1.733	1.109	1.113
The microbial counts CFU/ml			
TAB	$2.95X10^{6}$	$3.7X10^{6}$	$1.8X10^{6}$
LAB	$1.5X10^{4}$	$3.5X10^{4}$	$1.0X10^{4}$
Vitamins %			
Thiamine (B_1)	0.86±0.5	1.08±0.1	14.85±0.1
Riboflavin (B_2)	0.31±0.1	0.21±1.0	4.34±1.0
Niacin	7.04±0.01	1.06±0.01	57.96±1.0
Pyridoxine (B_6)	0.43±0.01	14.28±0.01	7.05±0.1

NFE = Nitrogen free extracts=100-(fat +fiber +moisture +protein +ash), Converted to protein content using a factor of 6.25

The results of microbial analysis done on the dried and ground kishk powder samples are given in Table 5. The lowest count of TAB and LAB were detected in kishk powder camel wheat ($1.8X10^6$ and $1.0X10^4$ CFU/ml, respectively) because of low water binding capacity of the sample (Table 8), compared to kishk powder camel barley and oats ($2.95X10^6$, $1.5X10^4$ and $3.7X10^6$, $3.5X10^4$ CFU/ml, respectively). Similar results were founded in the previous work [31].

Yeast, moulds and coliform bacteria were not found from any research samples within the first dilution analysis, this indicating no contamination in raw materials or during the manufacturing process.

Vitamins of different kishk powder used in this study are given in Table (5) that Thiamine (B_1) of kishk powder ranged from (0.86 to 14.85) for all studied samples. Wheat had the highest value while Barley had lowest value among all samples. As regards Riboflavin (B_2), Wheat had the highest (B_2) (4.34%) followed by Barley (0.31%), while Oats (0.21%) had the lowest (B_2). On other hand Niacin (B_3) % ranged from 1.06% (Oats) to 57.96% (Wheat). Additionally Barley was lower in Pyridoxine (B_6) (0.40) than other samples in completely in other kishk powder. These results agree with result obtained by FAO [26].

Functional properties of kishk powder samples are summarized in Table 6. The kishk powder produced to camel's milk containing of oat and barley were characterized with the highest viscosity values during increasing heat treatment as compared with containing of wheat. A high significant ($P \leq 0.05$) value of viscosity was obtained for kishk powder of oats (12600 cp/s) compared to that of other kishk powder of wheat or barley (3400 or 3000 cp/s respectively). Yilmaz *et al.* [32] determined that the viscosity of kishk powder camel was decreased with increasing heat treatments. Svihusa *et al.* [33] also reported that the viscosity of different samples of wheat, barley and oats vary considerably and that the viscosity values are affected by heat treatment, these due to pointed out that there is a relationship between the water binding capacity, heat treatment and the viscosity of the product of processed flour [34].

Also, Caprita and Caprita [35] explained the reason for arabinoxylans and β-glucans are the two most important water-extractable dietary fiber polysaccharides in cereal food products and they determined their physical properties like viscosity, extractability, solubility and gelling behavior, as well as nutritional properties. While, Pednekar *et al.* [34] pointed out that there is a relationship between the water binding capacity and the viscosity of the product of processed flour.

As seen in Table 6, water binding capacity of kishk powder samples were significant ($P \leq 0.05$). Kishk powder wheat and barley banded lowest amount of water (1.507 and 1.508 g/gp, respectively) while kishk powder oats exhibit significantly different water binding capacity (1.579 g/gp). However, the decrease in water binding capacity with the increase in ionic strength can be attributed to can be attributed to low the moisture of the flour whereas most of the water molecules get bind to salt ions [36].

Table 6: Functional properties and viscosity of kishk powder

	Barley	Oats	Wheat
Viscosity Cp/s			
20°C	3000	12600	3400
40°C	2200	8600	2800
60°C	1800	7600	2000
Binding capacity			
Water	1.508^{a}±0.0137	1.579^{b}±0.0137	1.507^{a}±0.0137
Oil	1.540±0.0129	1.547±0.0129	1.531±0.0129
Color			
L*	74.20^{a}±0.004	71.88^{b}±0.004	69.63^{c}±0.004
a*	-14.78^{a}±0.077	-10.42^{b}±0.077	-10.24^{b}±0.077
b*	12.63^{a}±0.016	19.41^{b}±0.016	21.54^{c}±0.016
Hue	-0.71^{a}±0.003	-1.08^{b}±0.003	-1.13^{c}±0.003
Chrome	19.45^{a} ±0.052	22.04^{b}±0.052	23.85^{c}±0.052

The oil binding capacity of kishk powder samples were not significantly (P>0.05). The oil binding capacity of kishk powder was kishk powder of oats (1.547g/gp), which is higher compared to kishk powder of barley and wheat (1.540 and 1.531 g/gp respectively). This result is due to the possibility that the presence of different polar and non-polar side chains that binds to water or to hydrocarbon side chains of oil might possibly cause the variation in water and oil holding capacity [34].

The CIE color values (L*, a*, b*) of the raw and thermally treated flours are presented in Table 6. Among the kishk powder dried studied, the kishk powder of barley showed the highest L* parameter value, 74.20, indicating the kishk powder of barley's lighter color compared to the other kishk powder. All the products showed negative a* values. Significantly lower a* value (-14.78), was obtained for the kishk powder of barley, indicating its greener hue compared to all the other samples. The highest a* value (-10.24) was obtained for kishk powder wheat, indicating its redder hue. The kishk powder wheat had the highest b* value, which was significantly different from the values observed for the other kishk powder, indicating its yellower hue compared to the other flours. On the other hand, the intensity of the color indicated by chrome value is higher in the kishk powder of wheat (23.85), indicating it's brighter. This sample also had highest a* and b* values compared to all the samples, as well as the lowest whiteness (L* = 74.20). Erbas *et al.* [31] and Rodríguez *et al.* [37] have been mentioned that the differences in color could also be due to the formation of Maillard reaction products during the drying process and phenolic compounds that influence the color of vegetable food products. Free minerals like Fe, Cu and Sn catalyzed some non enzymatic browning reactions which lower the color values of kishk powder [38].

Table 7: The sensory evaluation of kishk powder soups

	Color	Taste	Odor	Mouth feel	Overall
Barley	7.6^{a}	8.4^{a}	8.8	7.8^{a}	8.4^{a}
Oats	8.6^{b}	9.0^{a}	8.8	8.8^{b}	8.8^{a}
Wheat	7.0^{a}	6.4^{b}	8.8	6.8^{c}	7.2^{b}
±se	±0.27	±0.27	±0.20	±0.20	±0.28

Different letters within the same column are significantly different (P ≤ 0.05)

Sensory evaluation of kishk powder samples had significant differences (p<0.05) were observed in color, taste, mouth feel and overall acceptability (Table 7). While, the effects of different flours on the odor of kishk powder soups was not statistically significant (P>0.05). Kishk powder of oats had the highest score by the panelists. The results of the overall sensory analysis showed that utilization of oats flour in kishk powder preparation resulted in acceptable soup properties in terms of most of the sensory properties to compare barley or wheat. The color, taste, mouth feel and overall acceptability of oats kishk powder soups were nearly comparable to that of barley kishk powder soup except wheat kishk powder soup. The highly acceptability with the health benefits of oats products and sensory quality of soups prepared from oats flour can be benefits increase future studies (the product will be biological evaluated in another study).

CONCLUSIONS

Kishk/ kishk powder is a good source of protein, minerals, organic acids, free amino acids and other nutritional compounds and systems which make kishk powder healthy for the healthy child, adult, the elderly and medical patients. Use of grains and fermented camel milk in the ingredients used in kishk or kishk powder production contributed to the production of high-quality food, nutritional value food and health product. Cereal fermentation can thus be helped effective to modify composition cereal and also increase nutritional benefits. The more important of the two major components of kishk powder are flour and yoghurt. While the former plays a significant role in the texture formation of the soup or other product texture and the latter is important mostly for the development of kishk powder flavor. This was evident in the high viscosity of the product made from oats due to the highest β-glucan content compared to other product made from barley or wheat. Thus we recommend producing this product as healthy and cheap nutraceutical product.

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