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Physico-chemical characteristics of pan and pita bread supplemented with the products of goat oggt

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Abstract

Oggt products (raw, defatted and isolated protein) were used for partial substitution of wheat flour (75% Extraction) for the preparation of pan and pita bread. Each oggt product was added to wheat flour at 3%, 5% and 7%. We studied the influence of this substitution on chemical and physical properties and nutritive value of the bread. We found that the protein content was highest in isolated oggt (60.00%), defatted oggt (43.44%) and raw oggt (35.83%). The protein content in oggt bread, was higher than in the controls. Pan bread contained higher percentages of fat, ash and fibre than other samples. The calcium and phosphorus content increased by increasing the levels of oggt. Oggt products contained the highest amounts of essential amino acids (AAs) Lysine was the most limited AA in raw oggt. It was evident that the essential AAs increased by increasing the levels of supplementation bread in comparison with the control. In addition, deficient amounts of leucine and tryptophan were recorded in the pan control. However, the pan bread sample with 3% raw oggt had lower tryptophan content as compared with other samples.The values of in-vitro protein digestibility as well as calculated protein efficiency ratio (c-PER) of oggt products are similar to that in casein because of to their high essential AA content. High protein digestibility has been identified in bread supplemented with oggt protein as compared to those with raw or defatted samples. However, pita bread showed a slightly higher protein digestibility than of pan bread. In comparison to controls, the bread supplemented with raw, defatted or isolated oggt protein showed increased the c-PER values. The lowest protein solubility of raw, defatted or isolated protein was at pH 5 and the highest solubility was at pH 9 and 10.

Introduction

At present, there is a growing demand for a new generation of healthier food products which are required to have an excellent nutritional quality (Marina *et al*., 2013). Bread has always been one of the most popular and appealing food products because of its superior nutritional, sensual and textural characteristics, ready to eat convenience as well as cost competitiveness. The current emphasis is on healthy bread with a low glycaemic index and high protein content, leading to an increased dietary fibre and high starch intake (Giannou and Tzia, 2007).

Bread is the main cereal-based staple food for majority of the population, and is the cereal providing most of the calories and protein consumed by an average person. Lysine is the most limited (AA) in cereal flour. Furthermore, the tryptophan, threonine and methionine contents in this flour are lower when compared to the values given by the Food and Agriculture Organization of the United Nations (FAO) standard (FAO, 1973). Fortification with essential AAs has become a common method used to improve the nutritional quality of wheat products (Vaseen *et al*., 1991).

To obtain bread with enhanced nutritional quality, different additive products have been used, such as soybean, sesame, legume flours, sweet potato flours and isolated protein of oggt or defatted oggt flour. All these ingredients impart characteristic colours, texture and nutritional value which may be favourable in bakery products, recipes and other food products (Pãucean and Man, 2014).

Goat milk plays an important role in various parts of the world. In Saudi Arabia, the goat population of 2.3 million (International Trade Centre UNCTAD/GAT, 1984) ranks third highest, the first two being that of sheep and cattle, in the indigenous total animal population. Goat milk production in Saudi Arabia in 1981 accounted for approximately 30% of the total milk production i.e. 80,744 metric tonnes/y. However, most of the goat milk is consumed by the pastoral community, and little is available in the market. Commercially, it is in form of goat milk

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products such as madeer (dried cheese) and Ghee (Al-Saleh, 1967).

The importance of fermented milk products is that it helps to increase lactose digestion, thereby avoiding symptoms in people showing lactose intolerance (Verse *et al*., 2001). Yoghurt and other fermented milk products are additionally reported to have other health benefits, including blood cholesterol reduction and possible cancer prevention (Guo, 2003). The nutritive value of a fermented milk product depends on the type of milk or butter milk utilised; most fermented dairy products contain lactic acid bacteria which stimulate the immune system (Gatesoupe, 2008).

Jameed is a dried milk product that is widely used as a common traditional food in several Mediterranean countries, including Jordan, Syria, Saudi Arabia, Iraq and Egypt. Several names have been given to Jameed in Jordan and Syria as well as Kishk in Egypt. Jameed is mainly used in the preparation of popular traditional dishes. It has a high nutritive value, with protein, fat and ash content of approximately 48%–54%, 18%–22% and 12%–13%, respectively, and is characterised by a long shelf life (Al-Omari *et al*., 2008; Mazahreh *et al*., 2008).

Oggt is a dried fermented milk product prepared using goat, camel or sheep milk by Bedouins in the Arabian Peninsula, particularly in the northern Saudi Arabia (Sawaya *et al*., 1984; Al-Ruqia, 1987). Oggt is known for its pleasant organoleptic properties, high protein and calcium content and low fat content (Al-Mohizea *et al*., 1988).

Thus, the aim of the current study was to determine the effect of partial substitution of wheat flour with oggt products (raw, defatted and isolated protein) on the chemical composition and protein digestibility of produced pita and pan bread, aiming to improve the nutritional quality of produced bread as a healthier food product.

Materials and Methods

Materials

The oggt powder (made using goat milk) was purchased from a local market in Riyadh City in the Kingdom of Saudi Arabia and milled and placed into polyethylene bags for storage at 4°C until use. Raw oggt powder, defatted oggt and isolated oggt protein as well as pan and pita bread where prepared as reported previously (AlFaris *et al*., 2014). Each sample was dried at 50°C, ground then placed in plastic bags for analysis.

Within the chemical analysis, the moisture, crude protein, crude fibre, fat and ash contents were determined according to the methods of the Association of Official Agricultural Chemists (AOAC, 2000). Total carbohydrates were calculated by difference.

Calcium and phosphorus content was determined according to the methods described by AOAC (2000) using a pye-unicam SP/900 atomic absorption spectrophotometer and spectronic-20-colorimeter, respectively.

AAs were determined after hydrolysing with 6 N HCL for 22 h at 110°C according to the method reported by AOAC (2000) using a high performance liquid chromatograph (Shimadzu LC-10 AD corporation, Kyoto). The AA score (AAS) was calculated according to the method reported by the FAO/World Health Organisation (WHO, 1985).

In-vitro protein digestibility was determined using the analysed enzymes of protein obtained from Sigma Chemical Co., St. Louis Mo, according to the method described by AOAC (1995).

The pH of each sample was determined using a digital pH-metre (Jenway, Model 3020 Dunnow, Essex, UK) at room temperature (25°C).

Protein solubility was determined according to the method reported by Were *et al.* (1997) with some modifications. A sample mass of 1 g was mixed with 100 ml distilled water and stirred for 30 min. A pH between 2–12 was obtained by adding sodium hydroxide or HCl, stirring by a magnetic stirrer for 2 h at room temperature, centrifuging (3,000 rpm) for 20 min at 4°C and then the protein content of the supernatant was determined as according to the method of AOAC (1995). The determination of protein solubility was as according to the following equation:

Protein solubility = (protein in supernatant/protein of sample) × 100 (1)

The water and oil holding capacity of the oggt protein were determined according to the method described by Beuchat (1977).

The emulsion activity of oggt protein was estimated according to the method reported by Yasumatsu *et al*. (1972) using the following equation:

Activity of emulsion (%) = (volume of emulsion layer before the centrifugation/volume of emulsion after centrifugation) × 100.

Statistical analysis

The obtained data were statistically analysed as mean ± standard deviation using SAS (1990). Analysis of variance was used. Duncan's New Multiple Rang test was used at $P < 0.05$.

Table 1. Chemical composition and mineral contents of raw oggt(R), defatted oggt(D) and isolated protein(I) of oggt and pan and pita breads

Samples	Chemical composition (%)						Mineral Content	
	Moisture	Protein	Fat	Fibre	Ash	Carbohydrates	Phosphorus (%)	Calcium (ppm)
Oggt								
Raw oggt (R)	15.01 ± 0.09	35.83 ± 0.14	11.45 ± 0.01	0.57 ± 0.09	7.10 ± 0.09	30.04 ± 0.08	0.893 ± 0.01	11450.00 ± 50.00
Defatted oggt (D)	15.33 ± 0.13	43.44 ± 0.50	1.94 ± 0.20	0.00 ± 0.00	5.82 ± 0.10	33.47 ± 0.18	1.013 ± 0.01	13450.00 ± 150.00
Isolated Protein of oggt (I)	13.14 ± 0.35	60.00 ± 0.35	0.37 ± 0.03	0.00 ± 0.00	5.37 ± 0.13	21.12 ± 0.17	0.623 ± 0.01	5250.00 ± 150.00
Control pan bread	8.48 ± 0.09	13.83 ± 0.00	2.28 ± 0.04	1.99 ± 0.02	2.85 ± 0.08	70.57 ± 0.05	0.170 ± 0.01	355.00 ± 5.00
Pan bread with 3% R	7.04 ± 0.08	14.63 ± 0.17	2.58 ± 0.02	2.56 ± 0.01	3.01 ± 0.05	70.18 ± 0.06	0.190 ± 0.01	6.29.67 ± 9.50
Pan bread with5% R	6.98 ± 0.03	15.10 ± 0.03	2.80 ± 0.01	2.40 ± 0.06	3.18 ± 0.03	69.54 ± 0.03	0.200 ± 0.01	816.00 ± 12.00
Pan bread with 7% R	6.95 ± 0.12	15.46 ± 0.13	3.22 ± 0.01	2.25 ± 0.06	3.31 ± 0.02	68.81 ± 0.06	0.213 ± 0.01	979.67 ± 4.51
Pan bread with 3% D	8.00 ± 0.10	14.80 ± 0.01	2.59 ± 0.01	2.30 ± 0.01	2.99 ± 0.01	69.32 ± 0.03	0.190 ± 0.01	702.00 ± 7.00
Pan bread with 5% D	7.85 ± 0.07	15.16 ± 0.09	2.45 ± 0.04	2.48 ± 0.02	3.15 ± 0.04	68.91 ± 0.07	0.210 ± 0.01	860.00 ± 5.66
Pan bread with 7% D	7.74 ± 0.06	15.77 ± 0.06	2.25 ± 0.26	2.32 ± 0.08	3.21 ± 0.00	68.71 ± 0.09	0.223 ± 0.01	1044.33 ± 11.01
Pan bread with 3% I	7.06 ± 0.00	15.08 ± 0.06	2.08 ± 0.06	2.11 ± 0.01	3.02 ± 0.09	70.65 ± 0.04	0.175 ± 0.01	478.00 ± 5.00
Pan bread with 5% I	7.28 ± 0.12	15.86 ± 0.11	1.23 ± 0.06	0.49 ± 0.05	3.19 ± 0.02	71.95 ± 0.07	0.180 ± 0.00	578.00 ± 6.00
Pan bread with 7% I	7.24 ± 0.15	16.29 ± 0.06	2.45 ± 0.06	0.70 ± 0.11	3.35 ± 0.08	69.97 ± 0.09	0.190 ± 0.00	679.00 ± 7.00
Control Pita bread	7.91 ± 0.01	14.10 ± 0.04	0.32 ± 0.01	0.41 ± 0.03	2.06 ± 0.03	75.20 ± 0.02	0.170 ± 0.00	327.33 ± 7.50
Pita bread with 3% R	7.04 ± 0.03	14.80 ± 0.14	0.28 ± 0.04	0.32 ± 0.02	2.23 ± 0.04	75.33 ± 0.05	0.200 ± 0.00	632.67 ± 3.00
Pita bread with 5% R	7.22 ± 0.22	15.53 ± 0.06	0.30 ± 0.03	0.38 ± 0.04	2.37 ± 0.08	74.20 ± 0.09	0.203 ± 0.01	799.00 ± 3.00
Pita bread with 7% R	7.32 ± 0.10	15.65 ± 0.02	0.31 ± 0.10	0.43 ± 0.02	2.39 ± 0.14	73.90 ± 0.08	0.213 ± 0.01	952.33 ± 10.06
Pita bread with 3% D	8.74 ± 0.01	14.66 ± 0.05	0.19 ± 0.03	0.50 ± 0.04	2.14 ± 0.00	73.77 ± 0.03	0.189 ± 0.00	648.33 ± 9.50
Pita bread with 5% D	9.13 ± 0.03	15.61 ± 0.31	0.22 ± 0.01	0.40 ± 0.06	2.30 ± 0.08	72.34 ± 0.10	0.200 ± 0.00	860.00 ± 10.00
Pita bread with 7% D	9.26 ± 0.03	15.82 ± 0.19	0.16 ± 0.04	0.55 ± 0.18	2.63 ± 0.33	71.58 ± 0.15	0.213 ± 0.01	1092.33 ± 5.51
Pita bread with 3% I	7.81 ± 0.03	15.42 ± 0.02	0.63 ± 0.02	0.13 ± 0.01	2.20 ± 0.08	73.81 ± 0.03	0.180 ± 0.00	486.33 ± 6.51
Pita bread with 5% I	7.91 ± 0.01	15.93 ± 0.06	0.35 ± 0.01	0.08 ± 0.11	2.34 ± 0.00	73.39 ± 0.04	0.190 ± 0.00	481.33 ± 1.53
Pita bread with 7% I	7.81 ± 0.03	16.65 ± 0.01	0.30 ± 0.11	0.09 ± 0.02	2.57 ± 0.04	72.58 ± 0.04	0.190 ± 0.01	661.67 ± 2.52

Results and Discussion

Chemical composition

Raw and defatted oggt contained the highest percentage of moisture, followed by isolated protein of oggt (Table 1). However, the control sample of pan bread recorded the highest moisture content than those samples supplemented with raw, defatted or isolated oggt at different levels (3%, 5% and 7%). On the other hand, the control sample of the pita bread had lower moisture content than those samples supplemented with 3%, 5% or 7% defatted oggt.

JSS (1997) accordingly indicated that from a quality point of view, Jameed should not contain less than 15% moisture to minimise microbial spoilage and prevent any unwanted physical and chemical changes from occurring during storage (Koc *et al*., 2008). The highest percentages of protein content were found in isolated protein of oggt followed by defatted oggt then raw oggt (60.00, 43.44 and 35.83%, respectively). The supplementation with raw, defatted or isolated protein of oggt at different levels (3%, 5% and 7% of each) for pan or pita breads increased their protein contents as compared to their controls (Table 1). In addition, the highest percentages of protein were observed in both pan and pita bread supplemented with isolated protein. This may be attributed to the high protein content of oggt; therefore, the addition of oggt not only improved the quality attributes but also the nutritional value of bread. Accordingly, JSS (1997) illustrated that Jameed has an excellent nutritional value because of its high protein (57.07%) content. Raw oggt recorded the highest percentages of fat (11.45%) and ash (7.10%) in comparison with defatted and isolated protein of oggt.

Raw oggt contained a very low percentage of fibre, in contrast to defatted and isolated protein of oggt. The pan bread samples contained high percentages of fat, fibre and ash in comparison with their controls (Table 1). The comparison was similar in case of the pita bread samples and their control. This may be attributed to the added ingredients to formulas for preparing the breads. Reasonable amounts of carbohydrates were noticed in the three oggt samples. However, the highest percentages of carbohydrates were found in all samples of pan or pita bread. In this regards, El-Erian (1979) indicated that oggt had a high protein and low fat content as well as good quality characteristics. In addition, Al-Omari *et al*. (2008) and Mazahreh *et al*. (2008) showed that Jameed had a protein content of approximately 48%–54% and fat content of 18%–22% with a high nutritive value.

Results in the Table 1 show that the oggt products are characterised by a high calcium and phosphorus content. The highest phosphorus (P) and calcium (Ca) contents were in defatted oggt samples followed by raw samples, and lastly isolated protein samples. The supplementation with the aforementioned oggt

Table 2. Amino acids contents and chemical score of oggt products (g/16gN)

Amino Acids	Raw oggt	Defatted oggt	Isolated Protein of oggt	FAO/WHO pattern (1985)
Essential amino acids				
Lysine	5.17 ± 0.021	6.15 ± 0.113	6.11 ± 0.000	5.80
Threonine	7.11 ± 0.304	6.49 ± 0.191	5.99 ± 0.000	3.40
Valine	8.42 ± 0.014	8.29 ± 0.071	4.91 ± 0.000	3.50
Methionine + Cystine	2.63 ± 0.035	3.48 ± 0.064	3.24 ± 0.332	2.50
Isoleucine	5.36 ± 0.021	4.88 ± 0.085	3.89 ± 0.239	2.80
Leucine	10.23 ± 0.035	9.14 ± 0.156	10.28 ± 0.057	6.60
Phenylalanine + Tyrosine	6.46 ± 0.014	6.47 ± 0.062	10.02 ± 0.461	6.30
Tryptophan	1.13 ± 0.000	1.63 ± 0.000	2.01 ± 0.014	1.10
Histidine	3.32 ± 0.057	3.35 ± 0.071	4.65 ± 0.071	1.90
Chemical Score				
Lysine	89.14[a]	106.03	105.35	
Threonine	209.12	190.88	176.18	
Valine	240.57	236.86	140.29	
Methionine + Cystine	102.20	139.20	129.60	
Isoleucine	191.43	174.29	138.93	
Leucine	155.00	138.48	155.76	
Phenylalanine + Tyrosine	102.54	102.70	159.05	
Tryptophan	102.73	148.18	183.00	
Histidine	174.74	176.32	244.74	

[a.] The most limited amino acid.
*$p<0.05$(Duncan's New Multiple Rang test).

products for pan or pita breads showed an increase in their amounts of P and Ca in comparison with their controls. It could be concluded that both P and Ca contents increased with the increasing supplementation levels of oggt products. In this respect, El-Erian (1979) illustrated that oggt had a high calcium content. In addition, Salji (1986) revealed that the oggt products had contributed to 64% of the recommended daily allowances of Ca, 49% of P and 30% of protein.

The essential AAs content

Results of essential AAs are summarised in Table 2 in which the data indicate that the oggt products (raw, defatted and isolated protein) contained the highest amounts of all essential AAs except the essential AA lysine in raw oggt, which was low in comparison with that in the FAO/WHO (1985) reference pattern. Therefore, the essential AA content of oggt products meets or exceeds the National Academy of Sciences pattern of high quality protein for human consumption, except for the AA lysine of raw oggt.

On the basis of the values presented in Table 2 as compared to those reported in the FAO/WHO reference pattern, lysine was the most limited AA in raw oggt. It could be concluded that the oggt products showed a good and high protein quality. All other essential AAs were in amounts exceeding those reported in the FAO/WHO AA reference pattern. In this regard, Sawaya *et al*. (1984) showed that goat milk contained a high amount of lysine. The AA content and chemical score of pan breads supplemented with oggt products are given in Table 3. The results reveal that the essential AA content of pan bread supplemented with raw, defatted or isolated protein of oggt by 3%, 5% and 7% were relatively higher than those of the control. This may be attributed to the high nutritional value of oggt, which led to an increase in the content of majority of the essential AAs in bread.

On the basis of the essential AA values presented in Table 3 with reference to the FAO/WHO reference pattern (1985), lysine was the most limited AA in the control as well as the prepared pan bread samples, followed by sulphur AAs in the control and finally by bread with raw oggt. Meanwhile, tryptophan was the third most limited AA in the control and pan bread samples supplemented with 3% raw oggt. However, leucine was deficient in the pan bread control in comparison with the supplemented samples.

As a matter of fact, the nutritive value of protein for humans would mostly depend on its AA profile in general and the qualities of the essential AAs in particular. Thus, the supplementation with oggt products is important for improving the quality of AAs of bread, which is considered to be the staple food for most people who live in the Middle East countries (Lorimer *et al*., 1991 and El-Akel, 1993). In addition, lysine is the most limited AA in cereal flour.

Table 3. Essential amino acids content and chemical score of pan bread and pita bread supplemented with oggt products

Amino Acids	Control Sample	supplemented with									FAO/WHO Reference Pattern1985
		Raw oggt			Defatted oggt			Isolated protein of oggt			
		3%	5%	7%	3%	5%	7%	3%	5%	7%	
Essential amino acids											
pan bread											
Lysine	1.17 ± 0.000	1.92 ± 0.092	2.03 ± 0.000	2.15 ± 0.092	3.08 ± 0.00	3.43 ± 0.283	3.77 ± 0.042	4.09 ± 0.042	4.32 ± 0.28	4.59 ± 0.042	5.80
Threonine	4.27 ± 0.000	4.36 ± 0.000	4.32 ± 0.099	4.77 ± 0.226	4.26 ± 0.233	4.73 ± 0.191	4.36 ± 0.311	4.40 ± 0.141	4.33 ± 0.219	4.72 ± 0.219	3.40
Valine	4.28 ± 0.000	5.02 ± 0.000	5.40 ± 0.0141	5.37 ± 0.269	5.22 ± 0.092	5.94 ± 0.325	5.17 ± 0.049	4.91 ± 0.141	5.29 ± 0.042	5.83 ± 0.042	3.50
Methionine + Cystine	1.58 ± 0.226	2.41 ± 0.099	2.46 ± 0.000	2.49 ± 0.134	2.66 ± 0.566	2.68 ± 0.276	2.70 ± 0.332	2.99 ± 0.064	3.12 ± 0.580	3.17 ± 0.000	2.50
Iso leucine	3.63 ± 0.000	3.90 ± 0.000	3.99 ± 0.099	4.33 ± 0.22	3.60 ± 0.049	4.36 ± 0.417	4.49 ± 0.049	3.85 ± 0.000	4.17 ± 0.085	4.35 ± 0.042	2.80
Leucine	6.38 ± 0.000	6.87 ± 0.000	7.59 ± 0.184	7.68 ± 0.318	7.20 ± 0.092	7.48 ± 0.000	7.92 ± 0.085	7.19 ± 0.000	7.32 ± 0.085	7.80 ± 0.042	6.60
Phenylalanine + Tyrosine	8.21 ± 0.056	11.76 ± 0.322	12.04 ± 0.173	11.91 ± 0.266	11.42 ± 0.041	10.87 ± 0.415	9.72 ± 0.252	10.89 ± 0.213	12.07 ± 0.056	11.59 ± 0.298	6.30
Tryptophan	1.08 ± 0.000	1.06 ± 0.000	1.24 ± 0.000	1.30 ± 0.049	1.19 ± 0.00	1.20 ± 0.049	1.22 ± 0.000	1.29 ± 0.000	1.32 ± 0.000	1.59 ± 0.042	1.10
Histidine	3.37 ± 0.049	3.12 ± 0.396	2.95 ± 0.092	2.88 ± 0.143	2.27 ± 0.00	2.93 ± 0.417	3.62 ± 0.481	2.63 ± 0.000	3.63 ± 0.042	3.33 ± 0.608	1.90
pita bread											
Lysine	2.55 ± 0.000	2.77 ± 0.049	2.82 ± 0.092	2.95 ± 0.000	2.58 ± 0.00	2.74 ± 0.049	2.80 ± 0.042	7.29 ± 0.000	3.31 ± 0.000	3.35 ± 0.000	5.80
Threonine	4.53 ± 0.000	4.44 ± 0.049	4.49 ± 0.042	4.60 ± 0.084	4.41 ± 0.00	3.92 ± 0.049	4.47 ± 0.000	4.40 ± 0.325	4.33 ± 0.311	4.46 ± 0.000	3.40
Valine	5.24 ± 0.000	5.27 ± 0.000	5.41 ± 0.042	5.47 ± 0.049	5.15 ± 0.00	5.40 ± 0.000	5.48 ± 0.085	5.44 ± 0.000	5.25 ± 0.000	5.46 ± 0.000	3.50
Methionine + Cystine	1.48 ± 0.000	1.90 ± 0.000	2.02 ± 0.064	2.44 ± 0.070	2.45 ± 0.290	2.52 ± 0.148	2.55 ± 0.071	2.77 ± 0.063	2.90 ± 0.000	2.96 ± 0.000	2.50
Iso leucine	4.04 ± 0.000	3.60 ± 0.00	4.03 ± 0.042	4.00 ± 0.134	3.32 ± 0.00	4.16 ± 0.000	4.03 ± 0.000	3.83 ± 0.141	4.05 ± 0.354	3.69 ± 0.000	2.80
Leucine	6.24 ± 0.049	6.66 ± 0.049	6.76 ± 0.092	6.91 ± 0.092	6.66 ± 0.00	7.04 ± 0.049	6.74 ± 0.000	7.63 ± 0.042	7.50 ± 0.139	7.49 ± 0.382	6.60
Phenylalanine + Tyrosine	11.48 ± .755	11.54 ± 0.46	10.92 ± 0.62	10.55 ± 0.092	11.47 ± 0.341	12.06 ± 0.536	10.96 ± 0.042	9.44 ± 0.795	9.11 ± 0.843	9.01 ± 0.754	6.30
Tryptophan	1.28 ± 0.00	1.17 ± 0.049	2.33 ± 0.141	1.21 ± 0.000	1.15 ± 0.000	1.18 ± 0.000	1.17 ± 0.049	1.184 ± 0.000	1.14 ± 0.000	1.95 ± 0.000	1.10
Histidine	2.34 ± 0.00	2.24 ± 0.049	2.18 ± 0.00	2.34 ± 0.268	2.54 ± 0.141	2.71 ± 0.586	2.33 ± 0.184	2.75 ± 0.184	2.88 ± 0.488	3.09 ± 0.000	1.90
Chemical Score											
pan bread											
Lysine	20.17	33.10	35.00	37.10	53.10	55.14	65.00	70.53	74.50	80.34	
Threonine	125.59	128.24	127.10	140.30	125.30	139.12	128.24	129.41	127.35	138.82	
Valine	122.29	143.43	154.28	153.43	149.14	169.71	147.71	140.29	151.14	166.57	
Methionine + Cystine	63.20	96.40	98.40	99.6	106.4	107.20	108.00	119.6	124.80	126.80	
Iso leucine	129.44	139.29	142.50	154.64	128.57	155.71	160.35	137.50	149.00	155.36	
Leucine	96.67	104.10	115.00	116.36	109.10	113.33	120.00	108.94	111.00	118.18	
Phenylalanine + Tyrosine	130.32	186.67	191.11	189.05	181.27	172.54	154.29	172.868	191.59	184.00	
Tryptophan	98.18	96.36	112.73	118.18	108.18	109.10	110.21	117.30	120.00	144.55	
Histidine	177.37	164.21	155.26	151.58	119.47	154.21	190.53	138.42	191.10	175.26	
pita bread											
Lysine	43.69[a]	47.76 [a]	48.62 [a]	50.86 [a]	44.48 [a]	47.24 [a]	48.28 [a]	56.72 [a]	57.10 [a]	57.76 [a]	
Threonine	132.49	130.59	132.10	135.29	129.71	115.29	131.47	129.41	127.35	131.20	
Valine	149.71	150.57	154.57	156.29	147.14	154.28	156.57	155.43	150.00	156.00	
Methionine + Cystine	59.20 [b]	76.00 [b]	80.80 [b]	97.60 [b]	98.00 [b]	100.80	102.00	110.80	116.00	118.00	
Iso leucine	144.29	128. 57	143.93	142.86	118.57	148.57	143.93	136.79	144.64	131.79	
Leucine	95.00 [c]	180.91	102.42	104.96	100.91	106.76	102.12	115.61	113.64	113.48	
Phenylalanine + Tyrosine	182.22	183.17	173.33	167.46	182.10	797.43	174.00	149.84	144.60	143.02	
Tryptophan	116.36	106.36	211.81	110.00	105.00	107.27	106.36	107.27	103.64	177.30	
Histidine	123.16	118.10	114.74	123.16	133.68	142.63	122.63	144.74	151.57	162.63	

[a].Lysine was the most limited amino acid

[b].Methionine + Cystine were the second most limited amino acids.

[c].Tryptophan was the third most limited amino acid.

*$p<0.05$(Duncan's New Multiple Rang test).

Furthermore, tryptophan, threonine and methionine contents were low as compared to the FAO standard (FAO, 1973). Fortification with essential AAs has become a common method for improving the nutritional quality of wheat products (Yaseen *et al*., 1991).

It could be concluded that the supplementation with oggt products increased the nutritive value of bread by increasing the amounts of essential AAs, which led to the high quality of bread. Thus, the higher levels of bread supplemented with oggt products must be recommended as these products contributed the greatest amounts of AAs in all fortified bread. Therefore, supplementation of wheat flour with oggt products improves quality, since the higher contents of essential AAs in oggt complement the lower content of AAs in wheat flour.

The results in Table 3 show the essential AAs and their chemical score within pita bread supplemented with oggt products. It was evident that the essential AAs increased with the increasing levels of supplementation of pita bread with oggt products in comparison with their controls. The control bread was found to be limited in lysine, methionine, cysteine and leucine. Therefore, the fortification of bread with oggt products should improve protein quality because the higher content of essential AAs in oggt products substitutes for the deficiency of the AAs in wheat flour. The chemical score of each essential AA in the investigated pita bread was interpreted and the obtained data (Table 3) showed that all the predicted values for the protein quality of bread were higher than those for the quality of control. Moreover, all pita bread samples contained higher amounts of all AAs, except lysine, whereas methionine was low in samples supplemented with raw oggt and 3% defatted oggt as compared to their corresponding amounts reported in the FAO/WHO pattern (1985). The deficiency of the aforementioned AA could be attributed to the processes of defatting or isolating protein. Thus, lysine was the most limited AA in all samples, followed by sulphur AAs. In this respect, Lindell and Walker (1984) found that the protein quality and quantity of chapati bread were improved when they were prepared using a soy flour blend.

In vitro *protein digestibility and protein C-Efficiency ratio*

Data in Table 4 show that the values of in vitro protein digestibility of oggt products were near to those in casein. This may be attributed to the high amounts of essential AAs in raw, defatted or isolated

Table 4. *In vitro* protein digestibility and calculated protein efficiency ratio (C-PER) of produced pan and pita bread

Samples	*In vitro* protein digestibility	C-PER
Casein	89.42 ± 0.658	2.50
Oggt		
Raw oggt (R)	89.38 ± 0.601	2.32
Defatted oggt (D)	87.01 ± 0.594	2.33
Isolated Protein of oggt (I)	89.20 ± 0.198	2.50
Control pan bread	77.52 ± 0.990	0.50
Pan bread with 3% R	79.52 ± 0.990	0.50
Pan bread with5% R	81.57 ± 0.608	0.51
Pan bread with 7% R	81.71 ± 0.156	0.61
Pan bread with 3% D	81.50 ± 0.608	0.52
Pan bread with 5% D	81.63 ± 0.403	0.94
Pan bread with 7% D	81.84 ± 0.000	0.94
Pan bread with 3% I	82.61 ± 1.796	0.61
Pan bread with 5% I	83.35 ± 0.438	0.99
Pan bread with 7% I	83.88 ± 1.987	1.09
Control Pita bread	78.34 ± 0.000	0.60
Pita bread with 3% R	81.63 ± 0.000	1.02
Pita bread with 5% R	81.22 ± 0.184	1.50
Pita bread with 7% R	81.48 ± 0.198	1.60
Pita bread with 3% D	81.20 ± 0.198	1.04
Pita bread with 5% D	81.63 ± 0.403	1.15
Pita bread with 7% D	83.65 ± 0.325	1.27
Pita bread with 3% I	83.09 ± 2.390	1.16
Pita bread with 5% I	84.73 ± 2.390	1.62
Pita bread with 7% I	84.78 ± 2.319	1.85

oggt protein. It was evident that the digestibilities of pan breads were higher than their control. The highest protein digestibility in comparison with those in raw and defatted pan bread was observed in the pan bread supplemented with isolated protein. A similar trend was additionally detected in pita bread. On the other hand, the protein digestibility of pan bread was lower than that of pita bread supplemented with isolated protein. Generally, the supplementation with oggt products led to an increase in the protein digestibility of both pan and pita bread, particularly in the case of the supplementation with isolated protein of oggt.

Results in Table 4 indicate that the c-PER of the three oggt products were similar to that of casein (2.32, 2.33, 2.50 and 2.50 for raw, defatted and isolated protein of oggt and casein, respectively). The higher values of PER for the products could be because of its higher content of sulphur AAs, which were considered to be limited in milk, in addition to the high lysine content. Slightly higher c-PER values of pita bread were observed in comparison with those of pan bread. However, the above mentioned two types of bread showed a decrease in PER values in comparison with those of oggt products. This could be because of the low amounts of some AAs, particularly lysine in the bread samples. It could be concluded that the addition of oggt products to bread increased the PER values in comparison with their control samples.

In this respect, Sawaya et al. (1984) revealed that the higher value of PER for goat milk could be because of its higher sulphur AA content. They additionally found that goat's milk is nutritionally adequate and is at par with cow's milk. In addition, Badria et al. (2013) indicated that it was necessary to encourage oggt production and promote its human consumption for its good nutritive value rather than its taste. In conclusion, the deficiency of essential AAs in wheat flour could be corrected, and the metabolic utilisation of bread protein might be improved by combining with products containing high AAs.

Physical properties of oggt products

The water holding capacity values of the three oggt products were similar (Fig 1). In addition, the values of oil holding capacity were the same. Furthermore, the same trend was detected in the values of emulsion activity of the raw, defatted and

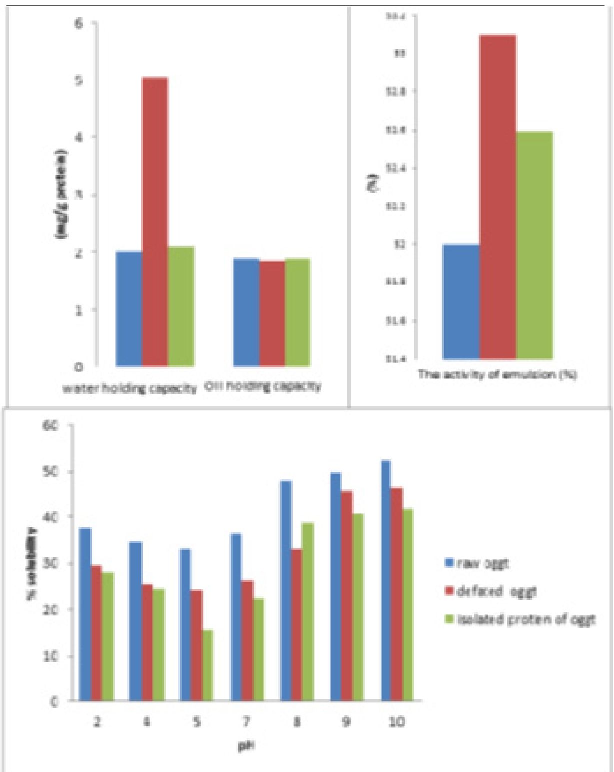

Figure 1. The physical properties, protein solubility and the values of solubility of protein in raw, defatted and isolated protein of oggt

isolated protein of oggt (52.0%, 53.1% and 52.6%, respectively). In this respect, Al-Hindi *et al.* (2015) indicated that the oggt products had good storage quality at ambient temperature because of to low aw and low pH (4.0).

The values of solubility of protein in raw, defatted and isolated protein of oggt are shown in Figure 1. Data showed that the lowest solubility of protein was at pH 5 (33.02 ± 0.125, 24.29 ± 0.275 and 15.61 ± 0.921 for raw, defatted and isolated oggt, respectively). Meanwhile, the highest solubility was at pH 9 and 10. It could be observed that at pH 2, the protein solubility was high, following which it decreased with increasing pH values. In this respect, Mizubuti *et al.* (2000) found that the solubility of the isolated protein of peas was high at a pH higher than 6.7 and lower than pH 3.5.

Conclusion

The results showed that oggt products have high protein contents compared to other samples, addition of oggt products to pan samples resulted in an increase in protein content in these samples. The study revealed that oggt products contain fair amounts of all essentials amino acids resembling that of reference protein. While bread sample, were deficient in lysine, methionine + cystein leucine and tryptophan and lysine being the first limiting amino acid. Valves of protein digestibility and calculated protein efficiency ratio (c-per) of breads samples were mildly increased when oggt products were added to them.

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References

Al-Abdulkarim, B. O., Osman, M. S. and EL-Nadeef, M. A. 2013. Determination of chemical composition and storage on dried fermented goat milk product (oggt). Journal of the Saudi Society of Agricultural Sciences 12(2): 161-166.

AL-Faris, N.A., AL-Jobair, M.O., Saif Eldein, B. A. and Idriss, S. A. S. 2014. Rheological and Sensory evaluation of wheat doughs and breads supplemented with oggt product. Journal of the Saudi Society of Food and Nutrition 9(1): 28-47.

Al-Hindi, R.R., Abde El Ghani, S. and Fayza, A. 2015. Physico-chemical composition and Microbiological quality of oggt: Saudi Arabian Traditional Dried fermented milk. American Journal of Food Technology 10(5): 195-205.

Al-Mohizea, I.S., Abu-Lehia, I.H. and El-Behery, M.M. 1988. Acceptability of Laboratory made oggt using different types of milk. Cultural Dairy Products Journal 4: 20-33.

Al-Omari A., Quasem, J.M. and Mazahreh, A.S. 2008. Microbiological analysis of solar and freeze-dried jameed produced from Cow and Sheap milk with addition of carrageenan mix to the jameed paste. Pakistan Journal of Nutrition 7(6): 726-729.

Al-Ruqaie, I.M., EL-Nakhal, H.M. and Wahdan A.N. 1987. Improvement in the quality of the dried fermented milk product, oggt. Journal of dairy Research 54: 429-435.

AL-Saleh, N.O. 1976. Some problems and development possibilities of the livestock sector in Saudi Arabia: A case study in livestock development in arid areas. England: Durham University, PHD thesis.

AOAC (Association of Analytical Chemists). 1995. Official method of analysis of AOAC International. 16th ed. Washington, DC: AOAC.

AOAC. 2000. Official method of analysis of AOAC International. 17th ed. Washington, DC: AOAC.

Beuchat, L. R. 1977. Functional and electrophoretic characteristics of succinylated peanut flour protein. Journal of Agricultural and Food Chemistry 25(2): 258-261.

de Escalada Pla M., Rojas, A.M. and Gerschenson, L.M.

2013. Effect of butter nut (*Cucurbita moschata* Duchesne ex poiret) fibers on bread aking, quality and staling. Food Bioprocess Technology 6(3): 828-838.

EL-Akel, A. T. 1993. Production and evaluation of some food mixtures by extrusion-cooking. Egyptian Journal of Food Science 8(3): 62-82.

EL-Erian, A. F. 1979. Studies on oggt. In: EL-Erian, A. F. Proceedings of the 3rd conference Biological Aspects of Saudi Biological Society, p.7-13. AL-Hassa, Saudi Arabia: King Saud University.

FAO(Food and Agricultural Organization). 1973. Energy and protein requirements. Report of a joint FAO/WHO (World Health Organization) Ad Hoc. Expert. Committee. Italy: FAO.

FAO/WHO/UNU. 1985.. Energy and protein requirement technical. Report of FAO/WHO/UNU Joint expert consultation series No. 724. Geneva, Switzerland: WHO.

Gatesoupe, F. J. 2008. Updating the importance of lactic acid bacteria in fish farming natural occurrence and probiotic treatments. Journal of Molecular Microbiology and Biotechnology 14(1-3): 107-114.

Giannou, V. and Tzia, C. 2007. Frozen dough bread: Quality and textural behavior during prolonged storage. Prediction of final product characteristics. Journal of Food Engineering 79(3): 929-934.

Guo, M. 2003. Goat milk. In B. Caballero, L. Trugo,. P. Finglas, (Eds). Encyclopedia of Food Sciences and Nutrition, p.2944-2949. London, UK: Academic Press.

Hassan, E. M, EL-Akel, A. T. and Abdel El-Magied, M. M. 1993. Nutritional evaluation of cookies supplemented with pigeon pea and sorghum blends. Minia Journal of Agricultural Research and Development 15(2): 397-411.

International Trade Centre UNCTAD/GAT. 1984. Animal Feed Ingredients: A Study of Selected Markets. Geneva: International Trade Centre, UNCTAD, GATT.

JSS (Jordanian Standards Institution).1997. Jordanian standard no 462 for Jameed. Amman, Jordan: JSS.

Koç, B., Eren, I., Ertekin, F.K. 2008. Modelling bulk density, porosity and shrinkage of quince during drying: The effect of drying method. Journal of Food Engineering 85: 340–349.

Lindell, M. J. and Walker, C. E. 1984. Soy enrichment of chapaties made from wheat and non-wheat flours. Cereal Chemistry 61(5): 435-438.

Lorimer, N. L., Zabik, M. E., Harte, J. B., Stachiw, N. C. and Uebersax, M. A. 1991. Navy bean flour fractions in composite doughs: effect of bean grade on rheology parameters and microstructure of wheat dough. Cereal Chemistry (USA) 68(6): 636-641.

Mazahreh, A. S., Al-Shawabkeh, A. F. and Quasem, J. M. 2008. Evaluation of the chemical and sensory attributes of solar and freeze-dried Jameed produced from cow and sheep milk with the addition of carrageenan mix to the Jameed paste. American Journal of Agriculture and Biological Science 3(3): 627-632.

Pãucean, A. and Man, S. 2014. Physico-chemical and sensory evaluations of wheat bread with pumpkin *(Cucurbita maxima)* pulp incorporated. Journal of Agroalimentary Processes and Technologes 20(1): 26-32.

Salji, J. P. 1986. Contribution of dairy products to nutrient intake in Saudi Arabia. Nutrition Report International 34(4): 673-676.

Sawaya, W. N., Saljl, J. P., Ayaz, M. and Khalil, J. K. 1984. The chemical composition and nutritive value of madeer. Ecology of Food and Nutrition 15(1): 29-37.

Statistical Analysis System Institute. 1990. Statistical Analysis System User's Guide: statistics. Cary, the United States of America: Statistical Analysis System Institute.

Vrese, M., Steglmann, A., Richter, B., Fenselaws, L. C. and Schrezenmeir, J. 2001. Probiotics-Compensation for lactose insufficiency. American Journal of Chemical Nutrition 73: 4215-4295.

Were, L., Hettiarachchy, N. S. and Kalapathy, U. 1997. Modified soy proteins with improved foaming and water hydration properties. Journal of Food Science 62(4): 821-824.

Yaseen, A. A. E., El-Din, M. H. A. and EL-Latif, A. R. 1991. Fortification of balady bread with tomato seed meal. Cereal Chemistry 68(2): 159-161.

Yasumatsu, K., Sawada, K., Moritaka, S., Misaki, M., Toda, J., Wada, T. and Ishii, K. 1972. Whipping and emulsifying properties of soybean products. Agricultural and Biological Chemistry 36(5): 719-772.