

Effect of Milk Type and Storage Period on Physiochemical Characteristics of Yoghurt

Sana Eltahir Osman Khir¹ and Nosiba Ahmed Ibrahim Hassan¹

¹Faculty of Animal Production, University of Sinnar, Sinnar -Sudan

Corresponding author email: osana9575@gmail.com

ABSTRACT

Milk and milk-products are important source of nutrients supply for mankind since immemorial time. In Sudan both cow's and camel's milk and their products are highly important in food security and nourishing people. This study was conducted at the department of animal production, Faculty of Agriculture, University of Sinnar as factorial experiments in completely randomized design (CRD) to investigate the effect of milk type (cows, camels milk and their mixtures) used for manufacturing yoghurt and the influence of storage time on physiochemical characteristics of yoghurt. Raw cows and camels milk were analyzed for nutrient contents and five types of yoghurt (Pure cow's milk yoghurt (A), pure Camel's milk yoghurt (B), yoghurt made of mixtures with a proportions of 1:1 (C), 1:2 (D) and 2:1 (E) Cow's to Camel's milk respectively) were made. Processing steps included milk heat treatment, incubation, cooling, and storage. All experimental yoghurt samples were analyzed at day one, seven and fifteen days. The Physiochemical properties of investigated yoghurt samples were significantly ($P<0.05$) lower in sample B during storage periods for titratable acidity with no differences between other samples. While the values were significantly ($P<0.05$) higher for total solids, fat content, solids not fat and protein for sample A in all storage periods compared to other tested samples. The study recommended that, milk mixtures with proportions of 1:1, 1:2 cow's to camel's milk respectively, could be used in commercial yoghurt production with reasonable nutritive value and consumer acceptance of the product.

Key words: Camel milk, Composition, Yoghurt

INTRODUCTION

Yoghurt is a product of the lactic acid fermentation of milk by addition of a starter culture. It provides milk proteins with a higher biological value and provides almost all the essential amino

acids necessary to maintain good health (Weerathilake *et al.*, 2014) and it can provide the body with significant amounts of calcium in a bio available form. Yoghurt is a popular fermented milk product that has especial importance on the human health because of its perceived nutritional benefits. In general, the overall properties of yoghurt, such as acidity level, free fatty acid content, as well as the sensory profile and nutritional value, are important traits of the product. These aspects are influenced by the chemical composition of the milk base, processing conditions, and the activity of starter culture during the incubation period (Bonczar *et al.*, 2003). Different types of milk can be used in the manufacture of yoghurt such as cow, goat, sheep and camel milk. Camel milk is an important component of the human diet in many parts of the world. It contains all the essential nutrients and the composition is similar to that of cow's milk (Yagil, 1982). Feed and water availability can affect the chemical composition and taste of camel milk, which contains 2.9 to 5.5 % fat, 2.5 to 4.5% protein, 2.9 to 5.8% lactose, 0.35 to 0.90% ash, 86.3 to 88.5% water, and 8.9 to 14.3% solid not fat (SNF). With relation to cattle, camel milk is rich in vitamin C (Kheraskov, 1961). Insulin, niacin and some unsaturated fatty acids are higher in camel than cattle, and lactose intolerance against camel milk does not exist (Wernery, 2007). The objectives of the study are to investigate the effects of milk types and storage period on different quality parameters such as chemical-composition (titratable acidity, total solids, solid not fat, fat, and protein).

Experimental site

The experiments conducted at the department of animal production, and department of biotechnology, faculty of agriculture, University of Sinnar.

Source of milk and starter culture

Cow's and camel's milk obtained from local market 30litres of milk use for each batch and starter culture obtained from local market.

Base Experiments

Five treatments were used in this study. The first treatment (A) is yoghurt made of cow's milk, the second treatment (B) is yoghurt made from camel's milk, the third treatment (C) is yoghurt made from a mixture of the two with a proportion of 1:1 cow's milk to camel's milk and treatment (D) is yoghurt made from a mixture of the two with a proportion of 1:2 Cow's milk to camel's milk and treatment (E) is yoghurt made of a mixture of the two with a proportion of 2:1

cow's milk to camel's milk. The yoghurt sample analyzed at day one, 7 and 15 intervals for chemical composition.

Yoghurt manufacture

The yoghurt was manufactured according to Lee and Lucey (2010) method. The main processing steps of yoghurt manufacturing include the milk heat treatment, incubation, cooling, and storage. In this method, milk was filtered from impurities and boiled to a temperature of (85°C) for 10 minutes and cooled for (45°C). Three percent starter culture was added to the milk and completely stirred. The product was packed in yoghurt packs and incubated at a temperature of (42°C). The coagulation time was recorded. The product was kept at room temperature for 20 minutes and stored in the fridge at 6-10°C.

Physiochemical analysis of milk and yoghurt

The characteristics measured in this study for physiochemical composition of milk and yoghurt included: titratable acidity, total solids, fat, solids not fat, and protein. The titratable acidity (Ten ml of milk and yoghurt each pipette into a clean porcelain dish and five drops of phenolphthalein indicator added and titrated against 0.1 N NaOH), total solids (using a forced draft oven at 100 °C for 3hrs. The total solids (T.S.) content was calculated as follows: T.S. % =W1/W2 X 100. Where: W1=Weight of sample after drying; W2=Weight of sample before drying) and protein (protein content was analyzed by kjeldehal method) of the yoghurt samples were determined according to the method described by AOAC (1990). The fat content determined by Garber method according to Bradly *et al.* (1992). However, the solids-non-fat (SNF) content was determined -from the following equation:

$$\text{SNF(\%)} = \text{TS\%} - \text{F\%}$$

Statistical analysis

Statistical analysis of data was subjected to analysis of variance by using Statistical Package for the Social Sciences (SPSS) program version 23. The significance of the differences among the groups has been determined by Duncan's multiple range tests (Petrie and Watson, 1999).

RESULTS AND DISCUSSION

Chemical composition of milk used for yoghurt making

The average chemical composition of the milk used for yoghurt making in this study was shown in table 1. The titratable acidity was 0.23 and 0.17%; total solids 11.74% and 6.19%; fat 3.82 and

1.43%; solid not fat 7.92 and 4.62%; protein 3.52 and 3.13% for cows and camel milk respectively. Cow milk was significantly higher in all components of milk compared to camel milk especially in total solids content. However, the lowest difference between the two types of milk observed in protein content 3.52% vs 3.13% for cow and camel milk respectively.

Table 1. Effect of milk type on physiochemical analysis of cow and camel's milk

Milk type	Acidity %	Total Solid%	Fat%	Solid Non Fat%	Protein%
Camel	0.17	6.19	1.43	4.62	3.13
Cow	0.23	11.74	3.82	7.92	3.52
SE	0.01	0.88	0.38	0.53	0.25
LS	*	**	**	*	**

SE: Standard error, LS: Level of significant, * Significant (P< 0.05), ** Highly significant (P< 0.01)

Effect of milk type and storage period on physiochemical analysis of yoghurt

Results in Table 2 showed significant difference (P<0.05) in titratable acidity, total solids, fat, solid not fat, and protein contents of the yoghurt as affected by milk type and storage period.

The titratable acidity

The titratable acidity of yoghurt (Table 1) increased significantly (P<0.05) in all samples as affected by time (Fig. 1) except the yoghurt made from pure camel milk and this might be due to the presence of antimicrobial agents in camel milk. The highest titratable acidity value (0.85) was obtained by the yoghurt made from cow and camel milk (1:1) at day one and seven, while the lowest one (0.66) was obtained in yoghurt made from camel milk during all storage period (day 1,7 and 15). These results of titratable acidity values increase from low to high levels which were in line with those of El-Agamy *et al.* (1992) who reported that during storage period, the pH value of yoghurt samples decreased progressively due to presence of lactic acid bacteria. Also the increase in titratable acidity refers to an increasing in lactic acids by starter culture (Gala *et al.*, 2004).

The total solids content

Generally, the total solids (TS) content of all studied samples were significantly ($P < 0.05$) decreased as affected by advance of time. The highest content value (12.02) was observed in the sample which made of pure cow's milk at first day. It was decreased to 11.45 at day 7 and 11.26 at day 15. While the lowest values was recorded in yoghurt made of pure camel milk (7.41, 7.46 and 7.16 at day 1, 7 and 15 respectively). It is observable that total solid in yoghurt made of pure camel was slightly increased at day 7 and then declined at day 15. The low content of total solid in yoghurt samples made of camel milk compared to those made of cow milk in all storage periods could be attributable to the low total solid percent of fresh camel milk before processing which affected the total solid of the end products (Dirar, 1993). Moreover, the composition of camel milk affected by many factors comprised; the water availability, stage of lactation and availability of green fodder as well as the differences in management of the animals (Farah, 1996; Bakheit, 1999).

It's appointed to mention that, the hybrid samples (made of different proportions of both cows and camel milk) generally had total solid contents in between compared to their native components and mostly their total solid content values tend to decrease with advance of time (Fig 2). The findings show that the total solids of all types of yoghurt were decreased as affected by advance in storage time; this is in agreement with Harding (1999) who reported that, during storage period there was a reduction in total solid due to the effect of fermentative organism.

The Fat content

The fat content of experimental yoghurt samples were shown in Table 2. All experimental samples were exhibited observable reduction in their fat contents as affected by advance of time except those obtained by yoghurt made of pure camel milk, in which fat content were increased slightly with advance of storage time which were found to be 2.11, 2.40 and 2.4 at day 1, 7 and 15 respectively. These results is in harmony with reports of Abdel Salam (1996) who report that, During storage period there was decrease in fat content and this might be due to the fat hydrolysis and liberation of free fatty acids that escape determination by Gerber method. However, camel milk which contain natural antimicrobial and antioxidant agents which acts as microbial inhibitors that slower the rate of fat hydrolysis and fermentation (Elagamy, 1992).

Table 2. Effect of milk type and storage period on physiochemical components of yoghurt

Yoghurt Type	Storage period (Day)	Titratable acidity %	Total solids %	Fat %	SNF%	Protein %
A	1	0.76 ^{ab}	12.02 ^a	3.58 ^a	8.44 ^a	4.36 ^a
	7	0.76 ^{ab}	11.45 ^{ab}	3.03 ^{abc}	8.41 ^a	3.54 ^{bcd}
	15	0.80 ^a	11.26 ^{abc}	2.86 ^{abcd}	8.39 ^a	3.87 ^{abc}
B	1	0.66 ^b	7.41 ^{hi}	2.11 ^d	5.28 ^{fgh}	2.51 ^f
	7	0.66 ^b	7.46 ^{hi}	2.40 ^{cd}	5.06 ^{gh}	4.18 ^{ab}
	15	0.66 ^b	7.16 ⁱ	2.41 ^{cd}	4.75 ^h	2.92 ^{def}
C	1	0.85 ^a	9.45 ^{ef}	2.86 ^{abcd}	6.58 ^{cd}	3.28 ^{cde}
	7	0.85 ^a	10.03 ^{def}	2.75 ^{bcd}	7.28 ^{bc}	3.88 ^{abc}
	15	0.80 ^a	9.46 ^{ef}	2.50 ^{bcd}	6.96 ^c	3.26 ^{cde}
D	1	0.75 ^{ab}	9.24 ^{fg}	2.80 ^{abcd}	6.44 ^{cde}	2.66 ^{ef}
	7	0.75 ^{ab}	9.06 ^{fg}	2.91 ^{abcd}	6.04 ^{def}	3.97 ^{abc}
	15	0.83 ^a	8.28 ^{gh}	2.60 ^{bcd}	5.68 ^{efg}	3.45 ^{bcd}
E	1	0.82 ^a	10.39 ^{cde}	3.25 ^{ab}	7.14 ^{bc}	3.30 ^{cde}
	7	0.82 ^a	10.67 ^{bcd}	2.75 ^{bcd}	7.92 ^{ab}	4.14 ^{ab}
	15	0.83 ^a	9.36 ^{ef}	2.50 ^{bcd}	6.86 ^{cd}	3.38 ^{cde}
SEM		0.33	0.34	0.24	0.28	0.23

* Means superscript by the same letter in a column are not significant ($P>0.05$), A: yoghurt made from cow's milk,

B: yoghurt made from camel milk, C: yoghurt made from a mixture of the two with a proportion of 1:1 Cow's milk to Camel's milk, D: yoghurt made from a mixture of the two with a proportion of 1:2 Cow's milk to Camel's milk

E: yoghurt made from a mixture of the two with a proportion of 2:1 Cow's milk to Camel's milk, SEM: Standard error of means.

The highest value of fat content (3.58%) was recorded for yoghurt sample made of pure cow's milk at day 1 while the lowest one (2.11%) was observed in yoghurt sample made of pure camel

milk at day 1 and that might be referred to the high fat content (3.82%) of cow's milk used to make yoghurt samples compared to (1.43%) in camel milk

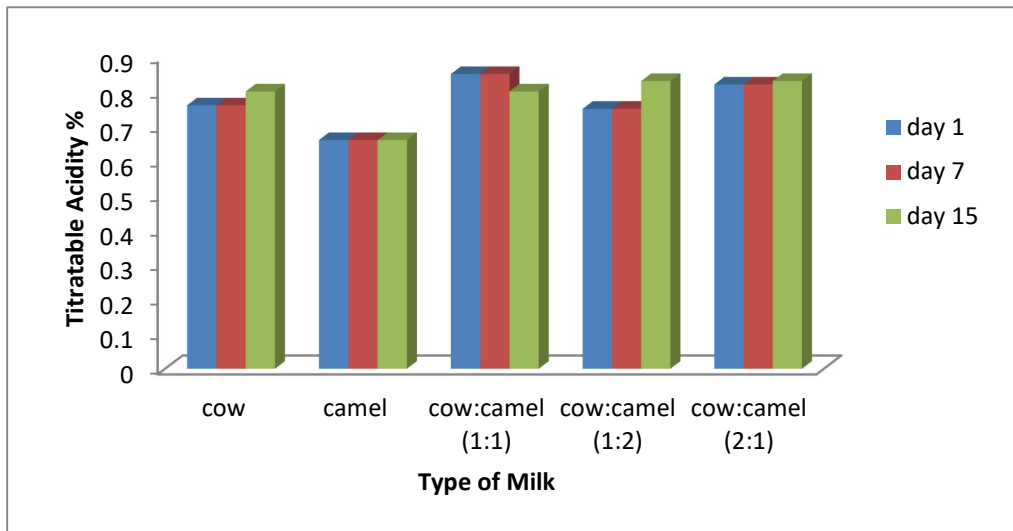


Figure 1. Effect of milk type and storage period on titratable acidity of yoghurt

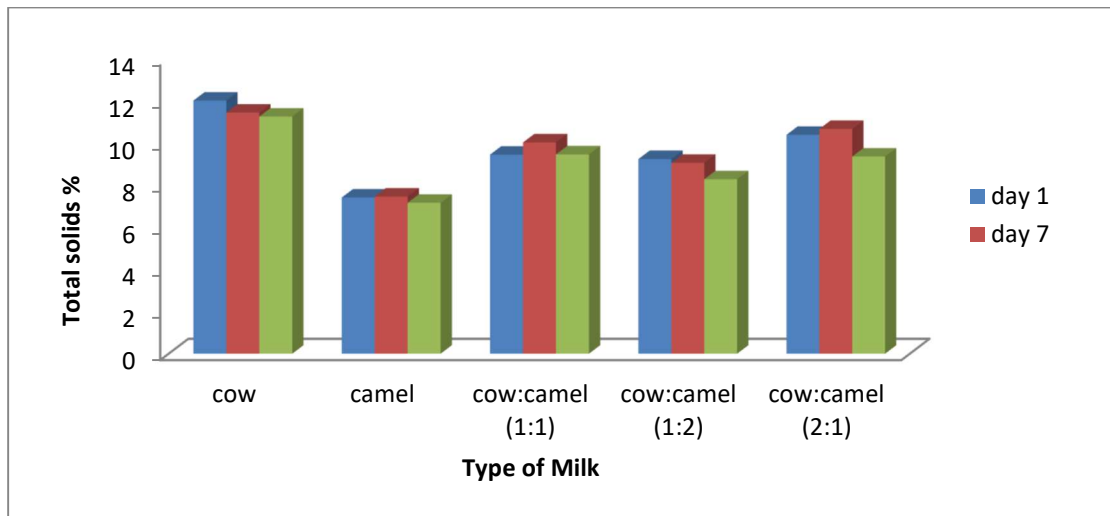


Figure 2. Effect of milk type and storage period on total solids content of yoghurt

In yoghurt samples made of mixtures of cows and camels milk there were fluctuations in the fat contents demonstrated initially and with advance of storage period (Fig. 3). This might be justified by the differences in their content of camel: cow milk. Additionally, in the camel milk during storage period the fat content revealed significant variation between its samples, due to the high content of lactic acid bacteria which have a lipase activity that influences the fatty acid pattern (Mirghani, 1994).

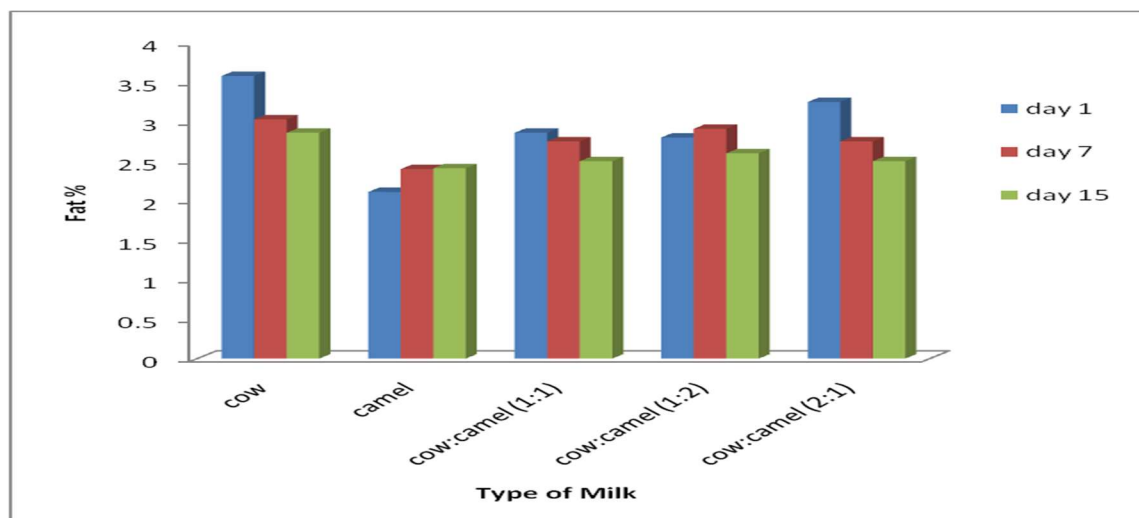


Figure 3. Effect of milk type and storage period on fat content of yoghurt

The solids not fat (SNF) content

The solids not fat contents were demonstrated in Table 2. Mostly, the solid not fat of experimental samples were significantly ($P < 0.05$) decline as affected with advance of storage time (Fig.4). The highest content of SNF was found in yoghurt made of pure cow's milk (8.44%) at day one. While, the lowest solid not fat content (4.75%) was obtained from camel milk yoghurt at day 15. Moreover, samples made of pure cow's milk, in all storage periods, were superior in their solid not fat content compared to solid not fat values of pure camel milk yoghurt. Solid not fat values of the other yoghurt samples tend to be in between the native components according to their ratios (Mohammed, 2015). It was observed that the solids not fat content of all types of yoghurt decreased progressively during storage period.

The protein content

The protein content were significantly ($P < 0.05$) different among the studied samples as affected by milk type and storage time. The higher value as (4.36%) was seen in pure cow milk yoghurt at day one while the lowest one as (2.51%) observed in pure camel milk yoghurt at day one. This might be refers to initial different between cow and camel milk in their protein content However,

this results are in harmony with findings of Dirar (1993) and Harding (1999) who stated that, type of milk used in the production of yoghurt which affect the protein percent of the end product.

The general trend of the protein content of yoghurt samples was to increase at day 7 and then decrease at day 15. Nevertheless, in pure cow milk yoghurt the protein contents was reduced at day 7 and slightly increased at day 15 (Fig. 5). Former results are comparable to findings of Eshraga Eissa *et al.* (2011) who observed some significant ($p < 0.05$) fluctuations protein contents of pure cow and camel milk yoghurt as affected by advance of storage period.

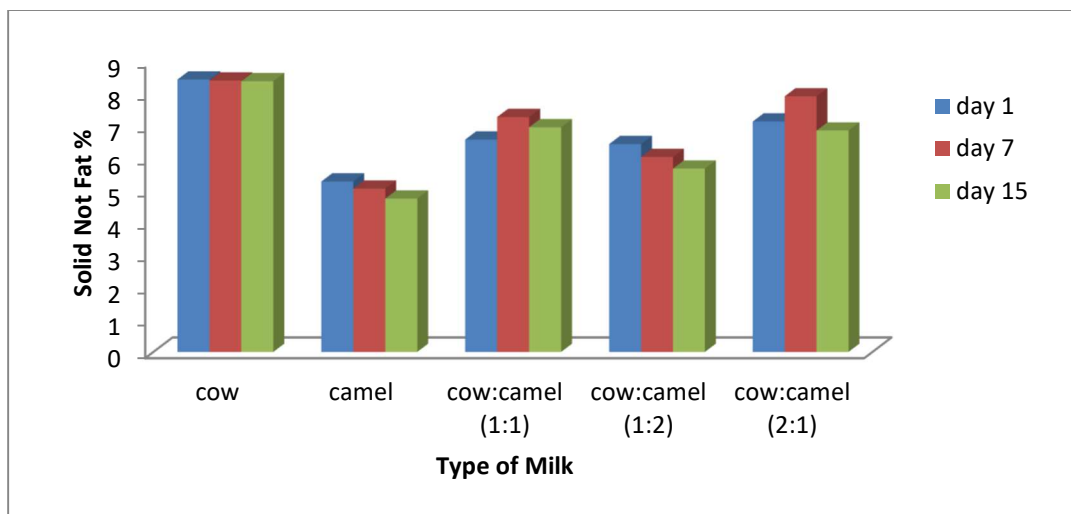


Figure 4. Effect of milk type and storage period on solid not fat content of yoghurt

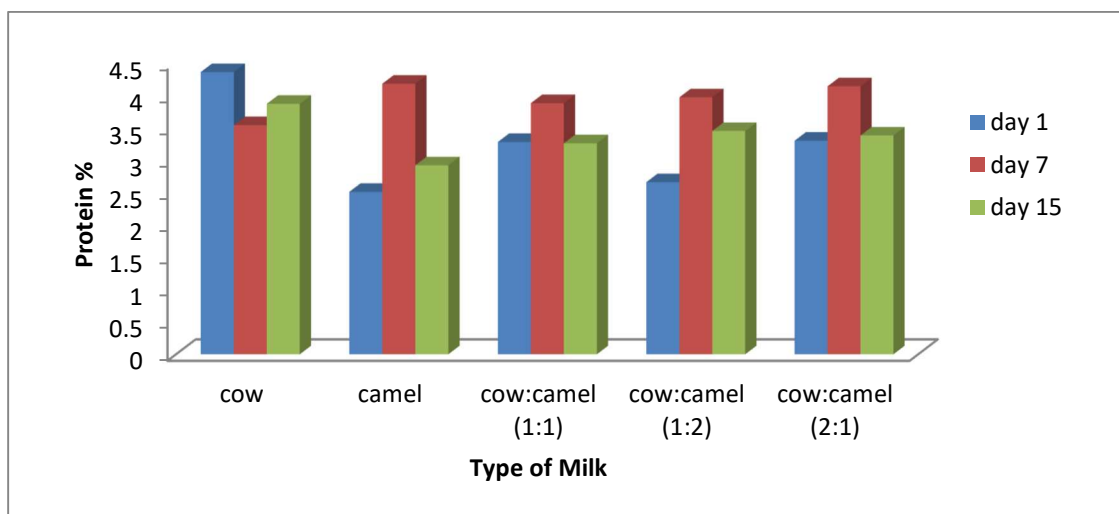


Figure 5. Effect of milk type and storage period on protein content of yoghurt

The study conclude that yoghurt made from a mixture of cow milk and camel milk has effect to chemical composition, the percentage of fat, protein and total solid increasing with the increase of cow's milk levels. So It is recommended to produce yoghurt from cow milk with camel milk at the level proportion of 1:1 and 2:1 Cow's milk to Camel's milk.

REFERENCES

- AOAC (1990). Official methods of analysis, 15thed., Association of Official Analytical Chemists, Washington, D.C, USA.
- Bakheit, S. A. (1999). Studies on milk production and composition of camel milk (*Camelus dromedarius*) under nomadic system. M.Sc. Thesis U. of K Sudan.
- Bonczar, G., M. Wszolek and Siuta, A. (2003). The effect of certain factors on the properties of yoghurt made from ewes milk. *Food Chem.*, 79:85-91.
- Bradly, J. R. R. L., Arnold, J. r. E., Barbano, D. M., Smith, D. E. and Vines, B. k. (1992). Chemical and physical methods. In:"standard Methods for the microbiological Examination of Dairy Products, 16th edition Edited by Marshall, T. R., American Public Health Association Washington D. C., USA.
- Dirar, H. A. (1993). Gariss. Dairy Products. In: The indigenous fermented foods of the Sudan and Nutrition. A Study in African food and Nutrition. First edition, University Pres, Cambridge.
- Elagamy, E. I., Rupanera, R., Ismail, A., Champagne, C. P. and Assaf, R. (1992). Antibacterial and antiviral activity of camel milk protective proteins. *J. Dairy Research*, 59(2):169-175.
- Eshraga Eissa A., Yagoub, A. A, Babiker, E. E. and Mohamed Ahmed, I. A. (2011). Physicochemical, Microbiological and Sensory Characteristics of Yoghurt

Produced from Camel Milk During Storage. *Electronic Journal of Environmental, Agricultural and Food Chemistry*. Issn:1579-4377.

Farah, Z. (1996). Camel milk properties and products. SKAT Swiss Centre for Developments Cooperation in Technology and Management.

Galal. E. A. and Salwa., Aly, A. and Neimat, Elewa, A. (2004). Carrot yoghurt: Sensory, chemical, microbiological properties. *Pakistan Journal of Nutrition* 3(6):322-330.

Harding, F. (1999). Milk Quality, First edition, Chapman and Hall Food Science Book. Aspen Publishers, Inc. Gaithersburg, Maryland.

Kheraskov, S. G. (1961). Composition, properties and nutritive value of camel milk. Vol. Pitan. 1961; 20: 69-72.

Lee, W. J. and Lucey, J. A. (2010). Formation and physical properties of yogurt. *Asian-Aust. J. Anim. Sci*, 23(9), 1127-1136.

Mirghani, A. A. (1994). Microbiological and biochemical properties fermented camel's milk (gariss). M.Sc. Thesis, U. of K.

Mohammed. M. E. (2015). Physio-Chemicals Characteristics of Yoghurt from Camel's Milk and Cow's Milk in Different Ratios. M.Sc. Thesis. Dept. of Animal Production. College of Agric. Sudan University of Science and Technology.

Petrie, A. and Watson, P. (1999). Statistics for Veterinary and Animal Science. Blackwell Sci., Malden, MA.

Weerathilake, W. A. D. V. Rasika, D. M. D. Ruwanmali, J. K. U. and Munasinghe M. A. D. D. (2014). The evolution, processing, varieties and health benefits of yoghurt. *International Journal of Scientific and Research Publications*, Volume 4, Issue 4, April 2014.

Wernery, V. (2007). Camel milk new observations. Camel Conf-Book. International-Camel Conference. Bikaner, India.

Yagil, R. (1982). Camels and Camel Milk. FAO Animal Production and Health Paper No. 26. Rome, Italy.

المخلص

تأثير نوع اللبن وفترة التخزين على الخصائص الفيزيائية والتركيب الكيميائي للزبادي المُصنع

الحليب ومنتجاته مصادر مهمة لإمداد الجنس البشري بالعناصر الغذائية منذ فجر التاريخ. في السودان كل من حليب الأبقار والإبل ومنتجاتهما ذو أهمية كبرى في الأمن الغذائي وتغذية السكان. أجريت الدراسة بقسم الإنتاج الحيواني، كلية الزراعة (جامعة سنار)، كتجارب عاملية على التصميم كامل العشوائية للتقصي عن أثر نوع الألبان (حليب الأبقار والإبل ومخاليطها) المستخدمة في صناعة الزبادي وكذلك تأثير فترة التخزين على الخصائص الكيميائية والفيزيائية. تم تحليل الحليب الخام للأبقار والإبل ومن ثم تصنيع خمس عينات من الزبادي (زبادي حليب الأبقار النقي (أ)، زبادي حليب الإبل النقي (ب) وزبادي خليط بالنسب 1:1 (ج)، 1:2 (د) و 2:1 (هـ) من حليب الأبقار: حليب الإبل على التوالي) شملت خطوات التصنيع المعاملة الحرارية والتحصين والتبريد والتخزين. كل عينات الزبادي التجريبية تم تحليلها في اليوم الأول والسابع والخامس عشر. بالنسبة للخواص الفيزيائية والكيميائية لعينات الزبادي فقد كانت عينة الزبادي (ب) هي الأقل ($P < 0.05$) من حيث الحموضة خلال فترة التخزين ولا توجد فروق معنوية بين بقية العينات. بينما كانت عينة الزبادي (أ) هي الأعلى معنوية ($P < 0.05$) من حيث: الجوامد الصلبة، المحتوى الدهني، الجوامد غير الدهنية والبروتين في كل فترات التخزين عند مقارنتها بالعينات الأخرى. توصي الدراسة بأنه يمكن استعمال مخاليط بنسبة 1:1 و 1:2 من حليب الأبقار: حليب الإبل في الإنتاج التجاري للزبادي والذي يكون معقولاً من حيث القيمة الغذائية وقبول المستهلك للمنتج.