Journal of Animal and Veterinary Sciences
2019; 6(2): 24-30
http://www.openscienceonline.com/journal/javs

Effect of the Addition of Different Levels of Starch and Skim Milk on Physicochemical Properties of Sudanese Camel Milk Set Type Yoghurt

Maria Gadalla Osman Elnazier[1], Adam Ismail Ahmed[2], Sallam Abdelfadeil Bakheit[3]

[1]Department of Biology, Faculty of Education, University of West Kordofan, Elnohoud, Sudan

[2]Department of Food Science and Technology, University of Kordofan, El-Obeid, Sudan

[3]Department of Animal Production, Faculty of Natural Resources and Environmental Studies, University of Kordofan, Elobeid, Sudan

Email address

adamalgnana62@yahoo.com (A. I. Ahmed)

To cite this article

Maria Gadalla Osman Elnazier, Adam Ismail Ahmed, Sallam Abdelfadeil Bakheit. Effect of the Addition of Different Levels of Starch and Skim Milk on Physicochemical Properties of Sudanese Camel Milk Set Type Yoghurt. *Journal of Animal and Veterinary Sciences.* Vol. 6, No. 2, 2019, pp. 24-30.

Received: February 14, 2019; **Accepted**: May 19, 2019; **Published**: June 25, 2019

Abstract

This study was carried out in the laboratory of Dal group for food, department of quality andnew product development (NPD), Khartoum, Sudan, to assess thee ffects of fortifying camel milk (fresh camel milk was brought from the nomads in Buttana plains area) with 4% milk protein, 1% gum Arabic and some additives such as skim milk powder and modified starch either individually or combined with different levels on the physicochemical propertiesof yoghurt produced, then to compare theseproperties of camel milk set type yoghurt processed with stabilizer to that without stabilizer. The results indicatedthat the highesttotal solid, lactose, fat, glucose and titratable acidity was found in camel milk set yoghurt supplemented with 3% skim milk (SMP), while the yoghurt supplemented with 3% SMP + 3%stabilizer had the highest ($P<0.05$) protein and sucrose content, on the other hand, the camel milk set-yoghurts fortifiedwith 2%starch +1%skim milk +3%stabilizer had the highest ($p<0.05$) viscosity andwater holding capacity values whencompared with other treatments. The investigation also showed that the combined used of skim milk with modified starch improved the physicochemical properties more than the used of starch only. Statistical analysis pointed out that there were no significant differences in physicochemical properties between camel milk yoghurt with or without stabilizer addition in this study. However, more research is needed as recommended point of view to evaluate the microbiology, quality of camel milk set yoghurt fortified with various ingredients.

Keywords

Set Type Yoghurt, Modified Starch, Physicochemical Properties, Camel Milk, Sudan

1. Introduction

Fermented milk products such as yoghurts were originally developed simply as a means of preserving the nutrients in milk, which fermented by different microorganisms, an opportunity existed to develop a wide range of products with different flavors, textures, consistencies and health attributes [1]. Yoghurt is a product of the lactic acid fermentation of milk by adding of a starter culture containing *Streptococcus thermophilus*spp and *Lactobacillus delbrueckii ssp. bulgaricus*. In some countries less traditional microorganisms such as *Lactobacillus helveticusssp* and *Lactobacillus delbrueckii lactic ssp*, at sometimes mixed with the starter culture [1]. Making yoghurt from cows' milk is a usual practice however sheep, camel and goat milks are not used on commercial level to produce yoghurt. These three species under disciplined management are a profitable way of marketing marginal natural resources without endangering the environment. In Sudan camel is usually kept by nomads who did not pay attention to processing and marketing of their milk. Therefore, in Sudan traditional yoghurt is mainly a fermented cow milk product, preparation of yogurt from camel milk is almost absent [2]. Flavor and texture are the most pronounced factors that influence the quality and acceptance of yoghurt and related fermented milks [3].

Textural attributes, including the desired oral viscosity, are important criteria for quality and consumer acceptance of yoghurt [4]. Consumer acceptance of yogurts is based on physical attributes like lack of syneresis and perceived viscosity [5]. However, yoghurt produced from camel milk (with no additives) was reported to have a thin, flowable and very soft texture [6]. The producers attempt to put off syneresis and make sure texture by increasing total solids constituents of camel milk, therefore, one of the most important steps in the production of camel yogurts is to increase the total solids content of the yoghurt mixes by the addition of a source of milk proteins. The added milk protein assists in providing a firmer body and reduces whey separation [7]. Whey protein concentrate modifies the texture profile, water holding capacity, buffering capacity and fermentation time, as compared to yoghurts containing only skim milk powder, atthesame level of protein addition [8 and 9]. Nevertheless, fortification with these ingredients affects production costs. Therefore, starch is one of the most used thickeners in dairy products due to improve mouth feel, prevent syneresis and low cost when compared with other hydrocolloids [10]. However, gum Arabic (GA) is a dietary fiber has potentials to be used in several food applications and could be good alternative to dairy ingredients to their different beneficial characteristic.

Alaa and Khalifa demonstrated that the add 1% GA to yogurt product led to improve the nutritional value through increasing the percentage of total solids, protein, fat and carbohydrates [11]. Therefore, the chemical composition of yogurt with 1% GA was (86.97, 3.88, 3.21, 0.79 and 5.15)% for moisture, protein, fat, ash and carbohydrates, respectively. After one day of fermentation, pH values decreased to 4.52, while the total acidity was 0.91%.

In order to obtain up to date information about the supplementation or fortification camel milk with Gum Arabic and milk protein and their effects on quality of set yogurt, the present research work was undertaken to realize the following objectives:

1 To determine the possibility of manufacturing setyoghurt from camel milk fortified with 4% (milk protein +whey protein) and 1% Gum Arabicand it enhanced by adding skim milk powder and starch.
2 To evaluate the effect of adding Starch and skim milk powder to fortified camel's milk different levels of 3%, 2%, 1.5% and 1% on the physicochemical properties 2. Materials and Methods

2. Materials and Methods

2.1. Camel Milk

The fresh camel (*Camelusdromedarius*) milk was brought from the nomads in Butana plains area. 30 liter of camel milk were collected in sterile containers immediately cooled to 4°C and kept at $4\pm1^{\circ}$C to preserve quality during transportation to the laboratory of Dal Food, Quality and New productdevelopment (NPD) Department. For camel milk fortification, the experiment incorporated four main ingredients were used to improve texture and sensory quality of set type yogurt produced from camel milk as follows:

2.2. Skim Milk Powder (Low Heat)

Made in the Canada (*Gay lea brand*), the chemical composition as per manufacturers data was fat (0.8%), protein (32.4-36.7%), lactose (51%), ash (7.90%), moisture (4%), pH in 10% solution (6.55-6.80%) and total acidity (0.15% lactic acid%).

2.3. Milk Protein and Whey Protein (*jogustab51 HG 3033*)

Made in Newzealand it was contained approximately 51.0% protein (N × 6.38), 2.0% milk fat, 39.0% lactose, 15.0% ash and 14.0% moisture according tomanufacturers data.

2.4. Food Modified Starch

Acetylated di- starch adipate (E1422), waxy maize basis, has 1.5 - 2.1% Acetyl viscosity and 13% loss on drying with about composition of 0.35% protein, 0.2% ash and pH4.5-2.1.

2.5. Gum Arabic (*Acacia Senegal*)

The used Gum Arabic has a high emulsion capacity, 100 viscosity (25%w/v soln, cps), 4.5 pH, 95% complex carbohydrates, 2.61%Crude protein and>85soluble dietary fiber. All this ingredients were obtained from Dal Food, Quality and New product development (NDP) Department, Khartoum, Sudan,

2.6. Stabilizer *(BNILE YSYS1)*

This stabilizer was composed of Milk protein, pectin (E440), Mono-and diglycerides of fatty acids (E471), sodium phosphate (E339) and standardized with sugar (sucrose/ or dextrose). It has 19% protein *(Kjeledehl/ factor 6.25)*, 18% fat, 6.5% ash and 6.0% moisture according to manufacturers data.

2.7. Starter Culture

Thermophilic yoghurt culture name (YO-FLEX EXPRESS 3.0) composed of *Streptococcus thermophilus* and *lactobacillusbulgaricus* were used as starter cultures, obtained from Dal Food, Quality and NDP Department, Khartoum, Sudan.

2.8. Preparation and Manufactured of Camel Milk Set Yoghurt

Before fresh camel milk was prepared to yogurt, initial quality of milk was estimated. The chemical analysis was shown in table 1. A total of 60 litre of camel milk were preheated at 65C for 30 minutes for pasteurization to preserve milk before supplementation or during processing into yoghurt, and thencamel milk was fortified with 4% w/v). Milk protein and whey protein (*jogustab 51 HG 3033*) and 1% (w/v) gum Arabic. Thus was increased the total solid of camel milk to 14% then the mixture was divided into two parts;

Part 1: was homogenized at 160 bars with 3% stabilizer.

Part 2: was homogenizedat 160 barswithout stabilizer.

Sample from part 2 was taken and usedas thecontrol sample, then themixture inboth parts were divided into 5 equal parts; The 1st t part was supplemented with only 3% (w/v) modified starch (sch), the2nd part was supplementedwith 2% Sch + 1%skim milk powder (SMP), the 3rd part was supplementedwith 1.5%Sch + 1.5% SMP, the4thpart was supplementedwith 1% Sch + 2% SMP and 5th part was supplementedwith only 3% (w/v) SMP. All samples in both treatments andthe control was heated to 90°C for 5 minutes for pasteurization, then cooled to reduced the temperature to 43°C, when the temperaturereached 43°C the mixturewas inoculated with 2% of commercial yoghurt culture and packed into plastic cups (200g capacity) in 50 replicates for each treatment. Then the inoculated milk was incubated at 42°C until a pH of 4.6 was attained in approximately 13 - 14 h (the pH end point). When the pH end point was achieved, the yoghurts were cooled at 5°C and stored at the same temperature during all period of post-acidification prior to analysis.

Table 1. *The fresh camel milk proximate composition.*

Fat	Total solids	Protein	Lactose	Specific gravity	pH	Antibiotics test
3.29	11.02	2.71	4.05	1.028	6.5	-Ve

2.9. Analysis of Samples

All camel milk set type yoghurt samples were subject to physiochemical analyses for fat, protein, total solids, lactose, pH, titratable acidity, water holding capacity and viscosity.

2.10. Statistical Analysis

Statistical Package for Social Sciences (SPPS version 20 software) was used for analyses, and then Duncan's multiple range tests was used for mean separation between the treatments at 0.05 level of significant.

3. Results and Discussions

3.1. Effect of the Addition of Different Level of Starch and Skim Milk on Chemical Property of Camel Milk Set Yoghurt

The chemical composition of set type yoghurts produced from camel (*Camelusdromedarius*) milk with 4%whey protein and 1% Gum Arabic which was supplemented with modified starch and skim milk powder, at five levels concentrations with and without addition 3% stabilizers (ys-ys) are displayed in table 2.

3.1.1. Protein Content

The mean protein content of camel milk set type yoghurt samples was found to be 4.30%.

The protein content of camel yoghurt with or without stabilizer was significantly ($P<0.05$) higher than the control which was recorded lowest protein content (3.38%). Therefore, highest protein content (5.07%) and (4.77%) was observed by $Y_{3\%\ SMP\ (b)}$ and $Y_{3\%\ SMP\ (a)}$, respectively,

In general the results indicated that the additional of 3% skim milk powder to camel milk yoghurt with or without resulted in the highest protein content as compared to other yoghurt samples, which was higher than the findings of Kavas and Kavas who indicated lower value of protein content (3.54%) for yoghurt made from camel milk with9% skimmed milk powder ($Y_{9\%SMP}$), while Ibrahim reported higher value of protein content (7.18%, 7.17% and 5.49%) for camel milk bioyoghurts enriched with 4% whey protein concentrate (WPC), 4% sodium caseinate (SCN) and 4% skim milk powder SMP, respectively, these differences may be attributed to several factors can be responsible include the nature of ingredients used in the camel milk-making process and the protein content of the raw material used [12, 15]. It is also evident from the results that combing skim milk powder and modified starch improved protein content more than unaccompanied modified starch that can be compatible with Okoth et al. who reported that the skimmed milk powder with modified corn starch implemented to produce high quality and profitable yoghurt [13].

3.1.2. Fat Content

The mean fat content of camel milk set type yoghurt samples was found to be 3.34%. The addition of skim milk powder and modified starch has significantly ($P\leq 0.05$) increased the levels of fat content in all samples of set yoghurt compared to the control there for e samples $Y_{3\%\ SMP\ (a)}$, $Y_{1\%sch+2\%smp\ (a)}$, $Y_{1\%sch+2\%smp\ (b)}$and $Y_{3\%\ SMP)\ b}$ were showed the highest values of fat contents3.47%, 3.46%, 3.46% and 3.45%, respectively, compared with the control yoghurts which resulted lower value (3.09%), this may be due to the low fat content in the composition of milk protein (2.0%).1n a comparison with results have been reported by several authors for camel milk yogurts. Higher values off at content (3.73%), (3.71%) and (3.53%) were reported by Kavas and Kavas who reported $Y_{4.5\%SMP+4.5\%NRF}$, $Y_{9\%SMP}$ and Y_{NR}, respectively, while Nazan found lower fat value (2.82%) for camel milk yogurts produced with 3% (w/v) traditional samphire molasses +0.05% (w/v) xanthan gum (Y_{TSMX}), this variations in the fat content may be due to differences in the types of materials added to camel milk [12, 14].

3.1.3. Lactose Content

The mean lactose content of camel milk set type yoghurt samples was found to be 4.14%. The addition of skim milk powder and modified starch has significantly ($P\leq 0.05$) higher levels of lactose content in all samples of set yoghurt compared to the control. The highest lactose content (4.45%)

by sample $Y_{3\%\ SMP\ (a)}$ and the lowest (3.58%) by the control yoghurt sample, while the other samples ranked in intermediate positions (p≤0.05) these findings were lower than lactose content (5.59 and 4.61%) observed for yoghurt made from camel milk enriched with9% skimmed milk powder ($Y_{9\%SMP}$) and that enriched with4.5% skimmed milk powder +4.5 native rice flour ($Y_{4.5\%SMP+4.5\%NRF}$), respectively which found [12]. According to thepresent findingswe can claimed that unaccompanied skim milk powder and accompanied skim milk powder with modified starch with or without stabilizer achieved highest values oflactose than unaccompanied modified starch, that maybe due to the high lactose content in the composition of skim milk powder (51%).

3.1.4. Total Solids

The mean total solid of camel milk set type yoghurt samples was found to be 17.15%. Significant difference (P<0.05) in total solid were observed between the control yoghurt and all samples of the camel milk yoghurt. The total solids of the control sample expressed the lowest value being (15.04%), while the highest (18.10%) was obtained by sample $Y_{3\%\ SMP\ (a)}$, which were higher than the findings of Ibrahim; Kavas and Kavas, this may be due to addition rate of skim milk and starch or affected by the heating of camel milk at 95°C for 5 minutes, our present results were in agreement with Akhtar et al. who reported that total solids content increased after boiling [15, 12, 16].

In concluded remarks, the results indicated that there were nosignificant differences (p>0.05) between yoghurt made from camel milk with or without stabilizer intotal solids, protein, fat, lactose means. However, camel milk yoghurt with stabilizer was found to have the highest protein, fat and lactose, while that without stabilizer was found to have the highest totalsolid.

3.2. Effect of Addition Different Level of Starch and Skim Milk on Sucrose and Glucose of Set Camel Milk Yoghurt

The sucrose and glucose contents of set camel milk yoghurt samples are detailed in Table 3. The sucrose and glucose content of camel milk yoghurt were significantly (P≤0.05) affected by type and quantity of ingredients used. Addition of skim milk powder and modified starch with or without stabilizers increased sucrose and glucose content of camel milk yoghurt compared to the control.

The relationship between the sucrose and glucose content and the fortification type/ratio was found to be significant (p> 0.05) in some yoghurt samples. Therefore, lower value of sucrose (0.40) was reported for the control samples, while higher value of sucrose (0.61) was reported for yoghurt sample enriched with 3% SMP + 3% sterilizer ($Y_{3\%\ SMP\ (b)}$) it was significantly (P≤ 0.05) different from other samples. The increase of sucrose content in ($Y_{3\%\ SMP\ (b)}$) was considered to be related with the interaction between (sucrose) in stabilizer and complex carbohydrates content in the Gum Arabic composition (95%).

On other hand yoghurt sample enriched with 3%smp ($Y_{3\%\ SMP\ (a)}$) had higher glucosecontent (0.49) and significantly (P≤ 0.05) different from othertreatments, while the controlsamplehad the lowest value ofglucose (0.27). The values of glucose in this work is higher than that (0.42) given by Abdelrahmanwho studied the glucose of camel milk fermented by yoghurt starter cultures, these variationsmay be due to differences in the types of materialsadded [17]. The increase of glucose in ($Y_{3\%\ SMP\ (a)}$) likely due to the high levels of lactose in the skim milk powder, therefore Lactose may be hydrolyzed to its components (glucose and galactose) by enzymes (p- galactosidases, commonly called lactase) or by acids, leading toincreaseglucose content in the yoghurt samples.

Generally the results indicated that there were nosignificant differences (p>0.05) (p>0.05) between yoghurt made from camel milk with or without stabilizer in sucrose and glucose means. However, camel milk yoghurt with stabilizer was found to have the highestsucrose.

Table 2. *Effect of addition different level of starch and skim milk on chemical properties of set camel milk yoghurt.*

Parameter	Control	Treatment (A)				
		$Y_{3\%Sch\ (a)}$	$Y_{2\%sch+1\%smp\ (a)}$	$Y_{1.5sch+1.5\%smp\ (a)}$	$Y_{1\%sch+2\%smp\ (a)}$	$Y_{3\%\ SMP\ (a)}$
Protein	$(3.38)^{h}$±.111	$(3.62)^{g}$±.170	$(4.11)^{e}$±.546	$(4.50)^{c}$±.308	$4.69)^{b}$±.171	$(4.77)^{b}$±.159
Total solid	$(15.04)^{d}$±.474	$(17.09)^{bc}$±.89	$(17.47)^{ab}$±.83	$(17.85)^{a}$±.824	$(18.08)^{a}$±1.00	$(18.10)^{a}$±.818
Fat	$(3.09)^{f}$±.080	$(3.19)^{e}$±.080	$(3.26)^{d}$±.122	$(3.36)^{c}$±.135	$(3.46)^{a}$±.066	$(3.47)^{a}$±.115
Lactose	$(3.58)^{d}$±.544	$(3.86)^{bd}$±.506	$(3.85)^{bd}$±.546	$(4.29)^{a}$±.307	$(4.20)^{ab}$±.503	$(4.45)^{a}$±.281

Table 2. *Continued.*

Parameter	Control	Treatment (B)					Mean effect
		$Y_{3\%Sch\ (b)}$	$Y_{2\%sch+1\%smp\ (b)}$	$Y_{1.5sch+1.5\%smp\ (b)}$	$Y_{1\%sch+2\%smp\ (b)}$	$Y_{3\%\ SMP\ (b)}$	
Protein	$(3.38)^{h}$±.111	$(3.77)^{f}$±.202	$(4.26)^{d}$±.183	$(4.44)^{c}$±.203	$(4.73)^{b}$±.249	$(5.07)^{a}$±.294	(4.30) ±.570
Total solid	$(15.04)^{d}$±.474	$(16.63)^{c}$±.970	$(16.53)^{c}$±.701	$(16.89)^{bc}$±.665	$(17.16)^{bc}$±1.0	$(17.86)^{a}$±.769	(17.15) ±1.180
Fat	$(3.09)^{f}$±.080	$(3.17)^{e}$±.075	$(3.37)^{c}$±.075	$(3.40)^{abc}$±.058	$(3.46)^{a}$±.038	$(3.45)^{a}$±.085	(3.34) ±.155
Lactose	$(3.58)^{d}$±.544	$(3.91)^{bc}$±.406	$(4.38)^{a}$±.132	$(4.34)^{a}$±.382	$(4.41)^{a}$±.207	$(4.31)^{a}$±.581	(4.14) ±.498

Mean (±SE). a, b, c Values in the same row having different superscripts differ significantly (p<0.05).

Treatment A=camel milk yoghurt prose a without stabilizer used.

Treatment B=camel milk yoghurt prose a with stabilizer used.

$Y_{3\%Sch}$=camel milk yoghurt prose a with 3% starch, $Y_{2\%sch+1\%smp}$= camel milk yoghurt prose a with 2% starch+1% skim milk, $Y_{1.5sch+1.5\%smp}$=camel milk yoghurt prose a with 1,5% starch+1.5%skim milk, $Y_{1\%sch+2\%sm}$= camel milk yoghurt prose a with 1% starch+2% skim milk and $Y_{3\%\ SMP}$= camel milk yoghurt prose a with 3% skim milk.

***Table 3.** Effect of addition different level of starch and skim milk on sucrose and glucose of set camel milk yoghurt.*

Parameters	Control	Treatment (A)				
		$Y_{3\%Sch\ (a)}$	$Y_{2\%sch+1\%smp\ (a)}$	$Y_{1.5sch+1.5\%smp\ (a)}$	$Y_{1\%sch+2\%smp\ (a)}$	$Y_{3\%\ SMP\ (a)}$
Sucrose	$(.40)^{c}\pm.123$	$(.47)^{bc}\pm.141$	$(.56)^{ab}\pm.180$	$(.57)^{ab}\pm.159$	$(.47)^{bc}\pm.141$	$(.55)^{ab}\pm.154$
Glucose	$(.27)^{bc}\pm.110$	$(.34)^{bc\pm}.121$	$(.42)^{ab}\pm.117$	$(.42)^{ab}\pm.106$	$(.41)^{ab}\pm.134$	$(.49)^{a}\pm.142$

***Table 3.** Continued.*

Parameters	Control	Treatment (B)					Mean effect
		$Y_{3\%Sch\ (b)}$	$Y_{2\%sch+1\%smp\ (b)}$	$Y_{1.5sch+1.5\%smp\ (b)}$	$Y_{1\%sch+2\%smp\ (b)}$	$Y_{3\%\ SMP\ (b)}$	
Sucrose	$(.40)^{c}\pm.123$	$(.58)^{ab}\pm.211$	$(.59)^{ab}\pm.114$	$(.45)^{bc}\pm.091$	$(.59)^{ab}\pm.143$	$(.61)^{a}\pm.141$	$(.54)\pm.158$
Glucose	$(.27)^{bc}\pm.110$	$(.45)^{a}\pm.055$	$(.31)^{bc}\pm.054$	$(.43)^{a}\pm.091$	$(.47)^{a}\pm.091$	$(.45)^{a}\pm.122$	$(.41)\pm.124$

Mean (±SE). a, b, c Values in the same row having different superscripts differ significantly ($p<0.05$).
Treatment A=camel milk yoghurt prossea without stabilizer used.
Treatment B= camel milk yoghurt prossea without stabilizer used.
$Y_{3\%Sch=}$camel milk yoghurt prosseawith3%starch, $Y_{2\%sch+1\%smp=}$ camel milk yoghurt prosseawith2%starch+1%skim milk, $Y_{1.5sch+1.5\%smp(=}$camel milk yoghurt prosseawih1,5%starch+1.5%skim milk, $Y_{1\%sch+2\%sm=}$ camel milk yoghurt prosseawih1%starch+2%skim milk and $Y_{3\%\ SMP=}$ camel milk yoghurt prosseawith3%skim milk.

3.3. Effect of Addition Different Level of Starch and Skim Milk on physical Properties of the Set Type Camel Milk Yoghurt

3.3.1. pH Value

pH value of the all yoghurt samples was significantly ($P\leq0.05$) not affected by the addition of skim milk powder and modified starch (Table 4). The mean pH value of camel milk set type yoghurt samples was found to be 4.38%. Yoghurt enriched with 2% modified starch+ 1% skim milk powder ($Y_{2\%sch+1\%smp\ (b)}$) had higher pH values (4.40), while yoghurt enriched with 1.5% modified starch+1.5% skim milk powder ($Y_{1.5sch+1.5\%smp}$) and yoghurt enriched with 3% modified starch ($Y_{3\%Sch}$) had the lowest pH value (4.36). In the present findings the pH values were found to be lower than 4.65, 4.62 and 4.48, respectively [18, 15, 12].

3.3.2. Titratable Acidity%

Titratable acidity% of the all yoghurt samples was significantly ($P\leq0.05$) affected by the addition of skim milk powder and modified starch. The titratable acidity% of all treated camel milk yoghurt with or without stabilizers was increased titratable acidity % compared to the control, therefore camelmilk yoghurt enriched with 3% skim milk powder ($Y_{3\%\ SMP}$) had higher acidity 1.21%, while yoghurt enriched with3% modified starch and the control yoghurt had the lowest value 1.08% and 1.02%, respectively, and that may be due to nutrients provided by skim milk powder may, or factors that stimulate the starter culture, which promotes higher acidity.

The titratable acidity% found in the present study for camel milk yoghurt made by using 3% skim milk powder ($Y_{3\%\ SMP}$) was found to be higher as compared to1.12reportedfor camel milk yoghurt made by using4.5% skimmed milk powder +4.5 native rice flour ($Y_{4.5\%SMP+4.5\%NRF}$) and that (1, 15) reported for bioyoghurt made from camel milk using 4%whey protein concentration (WPC) [12, 15].

3.3.3. Water Holding Capacity

Water holding capacity (WHC)% of some yoghurt samples was significantly ($P\leq0.05$) affected by the addition of skim milk powder and modified starch. Yoghurt enriched with 2% starch + 1% skim milk powder+ 3%stabilizer ($Y_{2\%sch+1\%smp\ (b)}$) had higher WHC (50.33%), while yoghurt enriched with3% modified starch and the control yoghurt had the lowest values of 42.73% and 38.47%, respectively, These differences might be attributed to the properties of the different proteins present in them. Wu et al. demonstrated that the water holding capacity was related to the ability of the proteins to retain water within the yoghurt structure [19]. These researchers further suggested that fat globules in the milk may also play an important role in retaining water. In this study, yoghurts with or without added stabilizers demonstrated significantly higher water holding capacity compared to control yoghurts, possibly reflecting the higher protein and fat content of the treated yoghurt compared to the control yoghurt.

The results indicated that camel milk yoghurt with added stabilizers had higher water capacity than that without added stabilizers this finding was in agreement with finding of Alaa and Khalifa who reported higher WHC (74.18) for camel milk yoghurt made using different stabilizers as compared to the control yoghurt [18]. That might be contributing to the functions of stabilizers in yoghurt i.e. the binding of water and improvement in texture [20]. Stabilizers bind with water to reduce water flow in the matrix space and some may interact with protein in the food matrix, further increase hydration behavior [21].

3.3.4. Viscosity

Viscosity of yoghurt was significantly ($P\leq0.05$) affected by addition of skim milk powder (smp) and modified starch (sch). Yoghurt enriched with 2%sch +1%smp+ 3% stabilizer ($Y_{2\%sch+1\%smp\ (b)}$) had higher viscosity (3.67cp), while yoghurt enriched with 3% sch +3% stabilizer ($Y_{3\%Sch\ (a)}$) and the control yoghurt were observed lowest values of 1.79and 1.52 cps, respectively. The results indicated that the combing skim milk powder and modified starch improved viscosity more than unaccompanied modified starch or skim milk. The increase in viscosity in current study was considered to be related to the interaction between starch ratio (2% w/v) and stabilizer, thus contributing a strong gel. The interaction between starch ratio (2% w/v) and stabilizer also contribute to the reduction in serum separation in addition to the effect of increased viscosity. According to Phillip sand Williams the use of modified starch at a level of 1.5% reduced syneresis, but did not prevent serum separation in yogurts [22].

No significant differences ($P< 0.05$) were observed in pH, acidity, viscosity and water holding capacity. However, viscosity and water holding capacity were found to be higher in yoghurt with stabilizers compared to that without stabilizers, while, titrable acidity was found to be higher in camel milk yoghurt without stabilizers yoghurt samples than yoghurts with stabilizers.

Table 4. *Effect of addition different level of starch and skim milk on physical properties of camel milk set yoghurt.*

Parameter	Control	Treatment (A)				
		$Y_{3\%Sch\ (a)}$	$Y_{2\%sch+1\%smp\ (a)}$	$Y_{1.5sch+1.5\%smp\ (a)}$	$Y_{1\%sch+2\%smp\ (a)}$	$Y_{3\%\ SMP\ (a)}$
pH	$(4.37)^{a}\pm.117.$	$(4.36)^{a}\pm .086$	$(4.39)^{a}\pm.074$	$(4.38)^{a}\pm.091$	$(4.39)^{a}\pm.069$	$(4.38)^{a}\pm.079$
Titratable acidity	$(1.02)^{d}\pm.084.$	$(1.08)^{cd}\pm..104$	$(1.19)^{ab}\pm..109$	$(1.12)^{bc}\pm.104$	$(1.18)^{ab}\pm..089$	$(1.21)^{a}\pm.114$
WHC	$(38.47)^{d}\pm.2.60$	$(42.73)^{c}\pm.3.11$	$(49.26)^{a}\pm.6.60$	$(43.04)^{c}\pm.4.18$	$(42.90)^{c}\pm.6.41$	$(43.63)^{bc}\pm.6.31$
Viscosity	$(1.52)^{d}\pm.101$	$(1.79)^{cd}\pm.246$	$(3.11)^{ab}\pm.267$	$(2.45)^{bc}\pm.241$	$(1.86)^{cd}\pm.115$	$(2.39)^{bc}\pm .201$

Table 4. *Continued.*

Parameter	Control	Treatment (B)					Mean effect
		$Y_{3\%Sch\ (b)}$	$Y_{2\%sch+1\%smp\ (b)}$	$Y_{1.5sch+1.5\%smp\ (b)}$	$Y_{1\%sch+2\%smp\ (b)}$	$Y_{3\%\ SMP\ (b)}$	
pH	$(4.37)^{a}\pm.117.$	$(4.37)^{a}\pm.071$	$(4.40)^{a}\pm.082$	$(4.36)^{a}\pm.090$	$(4.39)^{a}\pm.078$	$(4.38)^{a}\pm.086$	$(4.38)\pm .083$
Titratable acidity	$(1.02)^{d}\pm.084.$	$(1.08)^{cd}\pm.163$	$(1.16)^{abc}\pm..09$	$(1.19)^{ab}\pm.131.$	$(1.10)^{bc}\pm..0649$	$(1.10)^{bc}\pm.1006$	$(1.13)\pm .119$
WHC	$(38.47)^{d}\pm.2.60$	$(44.20)^{bc}\pm.7.05$	$(50.33)^{a}\pm.8.02$	$(48.66)^{a}\pm.5.98$	$(46.20)^{abc}\pm.2.86$	$(47.62)^{ab}\pm.4.18$	$(45.19\pm).6.33$
Viscosity	$(1.52)^{d}\pm.101$	$(2.01)^{cd}\pm.268$	$(3.67)^{a}3\pm.26$	$(3.21)^{ab}\pm.231$	$(2.50)^{bc}\pm.427$	$(3.13)^{ab}\pm.228$	$(2.67\pm)2.31$

Mean (±SE). a, b, c Values in the same row having different superscripts differ significantly ($p < 0.05$).
Treatment A=camel milk yoghurt prossea without stabilizer used
Treatment B= camel milk yoghurt prossea without stabilizer used
$Y_{3\%Sch=}$camel milk yoghurt prosseawith3%starch, $Y_{2\%sch+1\%smp=}$ camel milk yoghurt prossea with 2%starch+1%skim milk, $Y_{1.5sch+1.5\%smp(=}$camel milk yoghurt prosseawith1,5%starch+1.5%skim milk, $Y_{1\%sch+2\%sm=}$ camel milk yoghurt prosseawih1%starch+2%skim milk and $Y_{3\%\ SMP=}$ camel milk yoghurt prosseawith3%skim milk

4. Conclusion

The study concluded that fortification of camel's yoghurts with gum Arabic and milk protein enhanced by addition of modified starch and skim milk powder improved the viscosity of camel milk yoghurts, the combined used of skim milk with starch are also able to increase the gel of camel yoghurt but not as effectively as the fortification with skim milk also improved viscosity and water holding capacity more than control and starch yoghurt, while the addition of stabilizer to fortified camel milk not significantly affected in the all physicochemical characteristics except titratable acidity, viscosity and water holding capacity. Evaluation and compare micro textural of the camel's milk set yoghurts prepared from skim milk, milk protein and gum Arabic to confirm these results including industrial trials and also evaluation the microbiology and quality of camel milk yoghurt is needed in future work as recommended point of view.

References

[1] McKinley, M. C (2005). The nutrition and health benefits of yoghurt, *International Journal of Dairy Technology, 58 (1): 1-12.*

[2] Eissa, E. A; Babiker, E. E and Yagoub, E. A (2011). Physicochemical, microbiological and sensory properties of Sudanese yoghurt (*zabadi*) made from goat's milk, *Animal Production Science, 51: 53-59.*

[3] Labropoulos, A. E; Lopez, A and Palmer, J. K (1981). Apparent viscosity of milk and cultured yogurt thermally treated by UHT and vat systems; *J. Food Prot. 44: 874-876.*

[4] Walstra, P (1998). Relation between structure and texture of cultured milk products. In texture of Fermented Milk Products and Dairy Desserts, Special Issue 9802, International Dairy Federation, Brussels. pp. 9-15.

[5] Lee, W. J and Lucey, J. A (2010): Formation and physical properties of yogurt, *Asian-Australian Journal of Animal Sciences, 23 (9): 1127-1136.*

[6] Hashim, I. B; Khalil, A. H and Habib, H (2008). Quality and acceptability of a set-type yogurt made from camel milk, *Journal of Dairy Science, 92: 857-862*.

[7] Mistry, V. V and Hassan, H. N (1992). Manufacture of nonfat yogurt from a high milk protein powder, *J. Dairy Sci., 75, 947–57.*

[8] Antunes, A. E. C; Antunes, A. J and Cardello, H. M. A. B (2004). Chemical, physical, microstructural and sensory properties of set fat-free yoghurts stabilized with whey protein concentrate. *Milchwissenshaft, 59: 161-165.*

[9] Damin, M. R; Eimy, M; Alcântara, M. R and Oliveira, M. N (2008). Effect of cold storage on culture viability and some rheological properties of fermented milk prepared with yoghurt and probiotic bacteria, *Journal of Texture Studies, 39: 40–55.*

[10] AOAC (1995). Official Methods of Analysis, 16th edn. Association of official analytical chemists, Washington, D. C.

[11] Alaa, H. I and Khalifa, S. A (2015). The effects of various stabilizers on physiochemical properties of camel's milk yoghurt, *Journal of American Science, 11 (1).*

[12] Kavas, N and Kavas, G (2016). Some properties of set type yoghurts produced from camel (*CamelusDromedarius*) milk enriched with native rice flour and skim milk powder.

[13] Okoth, E. M; Kinyanjui, P. K; Kinyuru, J. N and Juma, F. O (2011). Effects of substituting skimmed milk powder with modified starch in yoghurt production, *Jomo Kenyatta Uni. of Agric. and Technol., 13, 25-32.*

[14] Nazan, K (2015). Yoghurt production from camel (*Camelusdromedarius*) milk fortified with samphire molasses and different colloids, *Mljekarstvo, 66 (1): 34-47.*

[15] Ibrahim, A. H and Khalifa, S. A (2015). The effects of various stabilizers on physiochemical properties of camel milk yoghurt, *Journal of American Science, 11 (1): 15-24.*

[16] Akhtar, D; Hashmi, H. S and Sattar, A (1990). Effect of post-bailins, cooling and refrigeration on microbial and physio-chemical quality of milk marketed through milk men. College of Home Economic University of Peshawar, Pakistan, Sarhad, *Journal of Agriculture, 6 (1): 13-19.*

[17] Abdelrahman, I. E (2007). Biochemical changes in camel milk fermented by bacterial starter cultures, PhD Thesis, Department of Botany and Agricultural Biotechnology, Faculty of Agriculture, University of Khartoum, Sudan.

[18] Alaa, H. I and Khalifa, S. A (2015). The effects of various stabilizers on physiochemical properties of camel's milk yoghurt, *Journal of American Science, 11 (1).*

[19] Wu, H; Hulbert, G. J and Mount, J. R (2001). Effects of ultrasound on milk homogenization and fermentation with yogurt starter, *Innovative Food Science and Emerging Technologies, 1: 211–218.*

[20] Thaiudom, S and Goff, H. D (2003). Effect of kcarrageenan on milk protein polysaccharide mixtures, *Int. Dairy J., 13, 763–771.*

[21] Duboc, P and Mollet, B (2001). Application of exopolysaccharides in the dairy industry, *Int. Dairy Journal, 11: 759–768.*

[22] Phillips, G. O and Williams, P. A (2009). Handbook of hydrocolloids, 2^{end} edition, Woodhead Publishing India Private Limited, G-2, Vardaan House, 7/28 Ansari Road, Daryaganj, New Delhi -110002, India properties in milk fermented with ropy strains of lactic acid bacteria, *International Dairy Protection, 43: 939-977.*