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The Effect of Arabic Gum on Physicochemical and Sensory Properties of Camel Milk, Yogurt

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Abstract

This study was conducted to investigate the effect of adding different percentages of Arabic Gum (AG) on the characteristics of yogurt for camel milk regarding to chemical composition and sensory properties during the storage period. This study was conducted at Tikrit University, Faculty of Agriculture, Food Science Department, from 8/11/2016 to 7/5/2017. The first treatment, yogurt was produced without the addition of Arabic gum. In the second treatment, Arabic gum was added by 1%. With the third treatment, Arabic gum was added by 2%. After addition the culture of (*Streptococcus salivarius Sub sp. thermophilus and Lactobacillus delbrueckii Sub sp.bulgaricu* 1:1)and incubated at a temperature of 42 C°, 3 hours and then the samples were stored at 5 C° for ten days and conducted chemical analysis and sensory evaluation on the first day and the fifth day and the tenth day. The results of the statistical analysis showed that the addition of Arabic gum at a concentration of 2% to increase the ability to retain water and decrease the ability to separate the whey's. Increasing the concentration of total solid materials on comparison samples, adding gum increased the viscosity higher than the comparison samples. Addition of gum improved the texture and sensory properties of yogurt of camel milk without affecting general acceptance.

Introduction

The camels is widely used to produce high nutritional quality of milk for a longer periods than other species in an environment that may be rightly termed as hostile regarding to extreme temperature, drought and lack of pasture ***[1]***. In the general the camel's milk is an opaque white color and has a faint sweetish odor with sharp and salty taste ***[2]***. However, camels milk has a white color due to homogenized fats in the milk. whereas, test changes is caused by fodder and water availability ***[3]***. The composition of camels milk has physiochemical properties such as density 1.026-1.035 and the pH 6.2-6.5 both are lower than the cow's milk with buffering capacity of skim milk is at pH 4.95 ***[4]***. The average amount of camel milk composition take, lactose 4.4%; protein 3.4%, ash 0.79%,; fat 3.5%; while water covers 87% ***[5]***. There are 23.9 million camels in the world. In India, there are about 0.45 million camels which are 1.9% of the total world camel population [6]. Sudan has 4.623 million heads ***[7]*** , In Pakistan 0.8 million heads ***[8]***. According to statistical data FAO, (2008) ***[9]***, camel milk production in the world amounts to about 5.3 million tons annually.

It has been reported that some problems occur during yogurt production from camel milk during fermentation and that the viscosity of the product does not change during gelation ***[10]***. These problems were

associated with the high antimicrobial content of camel milk ***[11]***, antimicrobial enzymes such as lacto peroxidase ***[12]***, Lactoferrin ***[13]*** and Lysozymes ***[14]***.

Stabilizers are sometimes referred to as [hydrocolloids**,** and their mode of action in yogurt includes the binding of water and promotion of an increase in viscosity. Texture is one of the most important characteristics that define the quality of yogurt and affects its appearance, mouth-feel and overall acceptability. The most frequent defects related to yogurt texture, which may lead to consumer rejection, are apparent viscosity variations and the occurrence of syneresis ***[15]***. Arabic Gum (AG) or *Acacia* gum is an edible polymer obtained as exudates of mature trees of *Acacia Senegal* and *Acacia seyal* which grow principally in the African region of the Sahel in Sudan. The exudate is a non-viscous liquid, rich in soluble fibers ***[16]***. AG is considered as a probiotic**,** stabilizer, a thickener and an emulsifier ***[17] and [18]***. Also**,** Arabic gum has some biological properties as an antioxidant ***[19]***. There are several studies conducted using the gum Arabic as a stabilizer in a wide variety of dairy products including ice cream, ice milk, sherbets, ice pops, water ices, chocolate milk drink, pudding, cottage cheese, cream cheese spread, processed cheese and yogurt. The main reason for the use of Arabic gum in these products is water-absorbing capacities ***[20]***. AG is a polyelectrolyte, the solution viscosity decreases in the presence of electrolytes due to charge screening and at low pH when the carboxyl groups become undissociated. The other major functional characteristic of AG is its ability to act as an emulsifier for essential oils and flavors. It has been found that the protein rich components adsorb preferentially onto the surface of the oil droplets ***[21]***. The aim of this study was to study the effect of Arabic Gum on physicochemical and sensory properties of camel milk yogurt.

Materials and Methods:

Camel Milk**:** The samples were collected from camels on period of November, 2016 to April, 2017; Camels milk samples transfer to clean plastic and then to laboratory for experiences, physical and chemical composition analysis as follows: Fat, Protein, Total solids, Lactose and Ash.

Starter culture and yogurt cups**:** The starter culture *Streptococcus salivarius Sub sp. thermophilus and Lactobacillus delbrueckii Sub sp.bulgaricu*(1:1) were obtained from Khartoum Dairy Products Company Ltd. Plastic cups (100 ml size) were purchased from the local market.

Arabic Gum**:** Arabic gum (*Acacia* Senegal) was obtained from the local markets of Tikrit city.

Manufacture of Yogurt:

Milk was heat treated at 85 C˚ for 30 min. As described by Robinson & Tamime(1994) [22] and cooled to 42 C˚. The camel milk, divided into three treatments: The first treatment contains 0% AG, the second treatment contains 1% AG, and the third treatment contains 2% AG; Then the starter culture of *Streptococcus salivarius* Sub sp. *thermophilus* and *Lactobacillus delbrueckii Sub sp.bulgaricus* the rate of 20 gm added for each treatment and blended thoroughly, measured and mixed, then the amount of the whole sample packed in plastic cups (100ml capacity) for analysis and incubated at 42 ^{O}C for 3 hours. Then the yogurt transferred to a refrigerator at 5 ± 2 C˚ for 10 days. The yogurt samples were analyzed and sensory evaluation was done.

Physicochemical analysis:

Total solids, Fat, titration acidity and protein according to AOAC (2005) ***[23]***. Lactose determined according to Tamime *et al*., (1987) ***[24]***, pH value using digital pH meter model A00567 H. Germany.

Rheological properties:

1- *Water Holding Capacity (WHC)*

The water-holding capacity (WHC) of yogurt was determined as described by Doleyres et al., (2005) ***[25]***. Briefly, 10 g of yogurt was centrifuged at 2555×g for 25 min at 5°C. The resulting supernatant was carefully weighed to determine the amount of excluded water (% wt/wt).

2- *Wheying–off*: Wheying–off was measured by sucking the water on the surface of the curd and pouring in a graduated cylinder,

Spontaneous whey separation analysis

Spontaneous whey separation was determined according to the procedure described by Doleyres et al., (2006) ***[26]***. A cup of set fermented skim milk was removed from refrigerator at 4°C, weighed and kept at approximately 45°C to allow the whey on the surface to be collected on the side of the cup. A needle connected to a syringe was used to withdraw the liquid whey from the surface of the sample, and the cup of fermented milk was weighed again. The process lasted for less than 10 s to avoid further leakage of whey from the curd. The syneresis was expressed as the percentage weight of the whey over the initial weight of the fermented milk sample.

3- ***Viscosity***: The viscosity determined by using a digital Hakke viscometer.

Sensory Evaluation

Ten members semi-trained panel from the staff of food sciences department, College of agriculture. The panel were evaluate the sensory of samples depended on color, taste, odor, texture and appearance according to Hekoronye and Ngoddy, (1985) ***[27]***. Sensory evaluation of each parameters take minimum number (4) for strongly acceptable and the highest number (10) for non-acceptable.

Statistical analysis: Data were analyzed using analysis of variance (ANOVA) followed by Duncan's Multiple Range Test with $P \leq 0.05$ to determine the significant differences in results using SAS software [28].

Results and Discussion

The results presented in table 1 revealed non-significant increase (0.05) titratable acidity (%lactic acid), pH, fat% and protein % at Storage periods except titratable acidity of camel milk, yogurt (AG 2%), The results revealed a significant decrease (0.5) compared with the control group. Fat content in Gum Arabic in this study showed increase on the both concentration (AG 1%) and(AG 2%) these was higher than reported from Omar (2012) [29] who reported 4%. Therefore, the observed variations may result from the analytical methods used. The result of The pH of Arabic Gum was 4.56 and 4.66 to (AG 1% and AG 2%) respectively to 1 day storage, and for 5 days storage the result take decrease 4.45 and 4.54 respectively, and for a long period storage 10 days the result were recorded 4.36 and 4.44 respectively these was higher than Omer (2012) [29] who reported 3.3 % this different is due to soil and climate. The protein content in AG 1% and AG 2% were (3.31%,3.32)% for 1 day period storage and (3.36%,3.36)% for 5 days period storage and (3.14, 3.15)% for 10 days period storage respectively and these were lower than Khadiga et al., (2016) ***[30]*** reported that the protein content in yoghurt was 3.99%. This difference may be due to effect of Arabic gum on yoghurt properties. The total solid content in AG 1 % and AG 2% were (14.60, 14,89)% for 1 day period storage and (15.32,15.90)% for 5 days period storage and (15.60, 15.83)% for 10 days period storage respectively this result is higher than Khadiga et al.,(2016) [30] reported that total solid content 14.5% , this is due to contain the samples of Arabic gum. The results showed a significant increase (0.05) on total solids (1 day) at both concentrations (AG 1%) and (AG 1%) were 14.6 % and 14.89% respectively compared with the control group (14.18%). This agreed with results of Guler-Akin and Akin, (2007) ***[31]*** work on goat's milk yogurts and cow's milk yogurts ***[32]***. There were no significant differences in pH between control yogurt and all of the camel milk yogurts at the end of the storage. The stable of pH value may be due to increasing the viscosity which can be inactivated water activity of lactic bacteria ***[33]***. In this study the yogurts was produced by using culture of *Streptococcus salivarius* Sub sp. *thermophilus* and *Lactobacillus delbrueckii Sub sp.bulgaricus* which given post fermentation of acidification in yogurt during storage time compared with starter cultures which are devoid of Lactobacillus bulgaricus stable of pH value may be due to control the contribution of the acidity with fermentation by the lactic acid bacteria of adding stabilizers due to antibacterial properties of Arabic gum. Changes in the protein, solids and fat these parameters, especially total solids and fat content may affect certain other physicochemical properties, but in this study

the result showed no any changes in the content of these parameters, that's can be returned to Arabic gum properties to maintain of camel milk compounds from the changes by bacteria during to storage periods ***[34]***.

Table-1**:** Effect of Arabic Gum on some chemical properties of camel milk yogurt at different storage periods.

Properties (Parameter)	***Storage periods (day)***	***Cont.***	***Camel Milk, Yogurt (AG 1%)***	***Camel Milk, Yogurt (AG 2%)***
Titratable acidity (%lactic acid)	*1*	*0.81 a*	*0.83 a*	*0.5 b*
	5	*0.83 a*	*0.89 a*	*0.88 a*
	10	*0.94 a*	*0.92 a*	*0.93 a*
pH	*1*	*4.46 a*	*4.57 a*	*4.66 a*
	5	*4.40 a*	*4.45 a*	*4.54 a*
	10	*4.30 a*	*4.36 a*	*4.33 a*
Fat%	*1*	*3.14 a*	*3.15 a*	*3.18 a*
	5	*3.12 a*	*3.14 a*	*3.16 a*
	10	*3.19 a*	*3.12 a*	*3.15 a*
Protein %	*1*	*3.35 a*	*3.31 a*	*3.32 a*
	5	*3.4 a*	*3.36 a*	*3.36 a*
	10	*3.45 a*	*3.14 a*	*3.14 a*
Total solids (%)	*1*	*14.18 b*	*14.6 ab*	*14.89 ab*
	5	*15.16 ab*	*15.32 ab*	*15.9 ab*
	10	*15.2 ab*	*15.6 ab*	*16.83 a*

The different letters in column refer to significant differences at 0.05.

The results in table 2. Were shown the effect of Gum Arabic on some rheological properties of camel milk yogurt at different storage periods, The results showed a significant decrease in Wheying off at both concentrations (G A 1%) and (G A 2%) were (10.13 and 7.45), (11.6 and 8.35), (12.12 and 9.55) ml respectively, compare with control group were 38.14, 41.25 and 42.3 ml respectively. The result of Whey off content not agreement with Faroog and Haque , (1992) ***[35]*** who reported the result (0)% that's due to addition of Arabic gum. A result showed a significant increase in the values of WHC at different storage periods were (67.54 and 86.61), (65.1 and 83.76), (62.79 and 81.22 ml) for each of G A 1% and GA 2% concentrations respectively. As well as a significant increase in viscosity at 1day , 5 days and 10 days were (982, 1207 and 1300 cps) and (1306, 1415 and 1594 cps) respectively Compare with the control group. Increased the viscosity result by the use of Arabic gum could be associated with the reduction in serum separation in camel milk yogurt. When the samples containing high concentration of Arabic gum compared with the control, the increase in viscosity is much greater with GA1% and GA2% and this reflects to the serum separation levels ***[36]***. The interactions between casein particles and gums can be contribute to the reduction in serum separation in addition to the effect of increased viscosity. When the concentration of camel milk yogurt were increased to effect might be enhanced completely immobilizing the particles and preventing serum separation. The effect of Arabic gum up to 1.0% in the reduction of serum separation can be explained similarly to gelatin and modified starch. Rheological and stability properties of yogurt can be modified by fortifying the milk with dairy based ingredients, non-dairy ingredients or a combination of both to heat treatment and acidification ***[37]***.

Table- 2: Effect of Gum Arabic on some rheological properties of camel milkyogurt at different storage periods.

Properties (Parameter)	*Storage period (day)*	*Cont.*	*Camel Milk, Yogurt (AG 1%)*	*Camel Milk, Yogurt (AG 2%)*
	1	*38.14 b*	*10.13 de*	*7.45 f*
Wheying off (ml)	*5*	*41.25 a*	*11.6 cd*	*8.35 ef*
	10	*42.3 a*	*12.12 c*	*9.55 e*
	1	*42.73 c*	*67.54 b*	*86.61 a*
WHC (% wt/wt)	*5*	*41.2 c*	*65.1 b*	*83.76 a*
	10	*40 c*	*62.79 b*	*81.22 a*
	1	*424 e*	*982 d*	*1306 bc*
Viscosity (cps)	*5*	*457 e*	*12.07 c*	*1415 b*
	10	*470 e*	*1300 bc*	*1594 a*

The different letters in column refer to significant differences at 0.05.

High concentrations of stabilizers were necessary to prevent the serum separation in camel milk yogurt modified by Arabic gam. However, in the preliminary of sensory assessments, the high concentrations of stabilizers was found to adversely affect to taste of yogurt samples lead to providing a foreign taste of samples. Therefore, yogurt with medium and low concentrations of stabilizers was presented to the sensory panel. Stabilizers were found to have a significant effect on, odor and texture consistency ($p \leq 0.05$). On the other hand, panelists had find differences in the texture of yogurt samples ($p \leq 0.05$) meaning the textures of the samples with stabilizers particulate material The results in table 3. showed the effect of Gum Arabic on sensory evaluations of camel milk yogurt at different storage periods. The results showed that adding of Gum Arabic caused in significant reduction ($P<0.05$) in the values of Color at GA 2% concentration were (8.02 and 7.59) for 5 days and 10 days respectively compared with the control group. The results showed no significant increase in Taste at GA 2% concentration were 7.5, 7.2 and 7.06 Compared with control 8.18, 8.5 and 7.1 respectively. While noting a significant increase in Texture and Appearance in addition, both concentrations of GA with Camel Milk Yogurt.

Table- 3: Effect of Gum Arabic on sensory evaluations of camel milk, yogurt at different storage periods.

Properties (Parameter)	*Storage periods (day)*	*Cont.*	*Camel Milk, Yogurt (AG 1%)*	*Camel Milk, Yogurt (AG 2%)*	*Total*
	1	*7.43 a*	*7.5 a*	*8.19 a*	*7.70 a*
Color	*5*	*6.18 bc*	*7.03 ab*	*8.02 a*	*7.07 a*
	10	*5.3 c*	*6.11 bc*	*7.59 a*	*6.33 a*
	1	*8.18 a*	*8.13 a*	*7.5 a*	*7.93 a*
Taste	*5*	*8.5 a*	*8.33 a*	*7.2 a*	*8.1 a*
	10	*7.1 a*	*7.1 a*	*7.06 a*	*7.08 a*
	1	*8.41 a*	*7.55 b*	*7.51 b*	*7.82 ab*
Odor	*5*	*7.62 ab*	*7.33 b*	*7.21 b*	*7.38 ab*
	10	*5.42 c*	*6.13 c*	*6.25 c*	*5.94 c*
	1	*5.45 cd*	*7.16 ab*	*8.6 a*	*7.07 a*
Texture	*5*	*5.6 cd*	*6.65 bc*	*8.07 ab*	*6.77 ab*
	10	*4.4 d*	*5.45 cd*	*7.13 ab*	*5.66 ab*
	1	*5.67 bc*	*7.22 ab*	*8.54 a*	*7.14 ab*
Appearance	*5*	*5.78 bc*	*6.45 b*	*7.11 ab*	*6.44 ab*
	10	*4.07 c*	*5.4 bc*	*7.2 ab*	*5.55 ab*

The different letters in column refer to significant differences at 0.05. Sensory evaluation of each parameters take minimum number (4) for strongly acceptable and the highest number (10) for non-acceptable.

Conclusions:

The obtained results might be a guide to the selection of Camel Milk Yogurt (AG 2%) samples which scored the highest score of overall acceptability compared with control samples. In addition, of Arabic gum in concentration of AG1, and AG2 did not appear effects on Physiochemical properties of camel milk. Even though the two concentration of Arabic gum have provided the highest viscosity in camel milk yogurt. The treatment of Arabic gum with camel milk yogurt at a concentration of AG1% is recommended for camel milk yogurt to stabilize the texture without affecting the flavor of the product.

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