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Effect of Arabic Gum (AG) on Physical Characteristics of yoghurt

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Abstract

The main objective of this study was to evaluate the effect of Arabic Gum (AG) on physical characteristics of yoghurt. Cow's milk was collected from Khartoum University Farm in clean and sterilized ice containers, filtered, pasteurized at 85^{o}C for 30sec and then cooled to 42^{o}C. Yoghurt samples were formulated with 0%, 0.1%, 0.3% and 0.5% Arabic Gum. Starter culture MIX505LYODCU (*Streptococcus thermophilus* and *Lactobacillus bulgaricus* SSP.). Danisco, France was added at the level of 3% then, samples were incubated at 42^{o}C for four hours. After setting, yoghurt samples were then kept refrigerated at 4^{o}C for 24hrs. Physicochemical analysis of cow's milk and AG powder were done, then, physicochemical characteristics of the product were determined using the standard analytical procedures. Statistically, Completely Randomized Design (CRD) in 2x2x3 factorial arrangement was used. The data collected were subjected to (ANOVA) using SAS software. The results revealed that, Arabic Gum had moisture, protein ash and fiber content of 7.00%, 2.55%, 1.38% and 1.26%, respectively. As gum level increased, pH values of yoghurt significantly (P≤0.05). decreased. Whying-off of yoghurt significantly (P≤0.05) affected by the gum level. It worth mentioning that, all treated samples were synerisis free. Viscosity increased as gum concentration increased. Control sample reported the lowest viscosity 1215cp. While, samples stabilized with 0.1%, 0.3% and 0.5% AG had viscosity of 1263.42. 1328.25 and 1400.50cp,

Regarding storage period, pH- value of yoghurt was significantly (P≤0.05) influenced throughout the storage period. Whying-off of yoghurt significantly (P≤0.05) affected by storage period progress. It detected at 5th and 7th day of storage. There was significant (P≤0.05) reduction

in viscosity during storage period. Viscosity was 1373.17cp at zero time, whereas, it reached 1230.58cp at the end of storage period

Key: Arabic Gum (AG), Yoghurt, viscosity and synerises

Introduction

Livestock is the main agricultural resource in Sudan. It's population is 100 million heads, distributed throughout the country according to the climatic conditions (MLFR, 2020). However, milk production from these animals was estimated more than 4391.000 tons (MLFR, 2020). The growing awareness of the relationship between diet and health has led to an increased demand for food products that support health above and beyond providing basic nutrition. One of these products is yoghurt (Vedamuthu, 1993). Milk is considered as a nearly complete food since it is a good source for protein, fat and major minerals (Sarkar, 2010). Yoghurt is a fermented dairy product obtained through anaerobic fermentation of lactose milk by relevant microorganisms (Tull, 1996). Lactose is converted into lactic acid by a symbiotic bacterial culture of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* growing at temperatures in the range of 40-45^{o}C (Wood, 1985). Yoghurt is a good dietary source of calcium, magnesium, phosphorus and zinc (Flynn and Cashman, 1997). However, it is difficult to provide a universal make-procedure for yoghurt to suit every variation in the final product marketed by the industry and whatever procedure is used, it is essential that the final product conforms to the requirements of the code of federal and state regulation, is safe for public consumption, has a satisfactory shelf-life and meets consumer demands with respect to body, texture and flavor characteristics (Badreldin *et al.*, 2008). A major concern of the yoghurt industry is the production and maintenance of a product with optimum consistency and stability. The factors known to improve consistency are increasing total solids, manipulation of processing variables, and characteristics of starter culture, (Omer, 2003). Syneresis is considering the one of yoghurt defect and it can be reduced by adding stabilizers interact with the casein network. The viscosity of yoghurt is affected by homogenisation, pH, processing parameters (stirred or set yoghurt) and heat treatment. One approach to reduce syneresis and improvement the yoghurt quality using of stabilizer. Gum Arabic is considering the one of common stabilizer in food industry. Gum Arabic (GA) or *Acacia* gum is an edible biopolymer obtained as exudates of mature trees of *Acacia Senegal* and *Acacia seyal* which grow principally in the African region of Sahelin Sudan (Abdul-Hadi *et al.*, 2010). Gum Arabic is a

branched-chain, complex polysaccharide, either neutral or slightly acidic, found as mixed calcium, magnesium and potassium salt of a poly saccharidic acid (Arabic acid) Badreldin *et al.*, (2008); Abdul-Hadi *et al.*,(2010). Various studies have been reported the use of gums to improve some characteristics of yoghurt (Ertan *et al.*, 2009). Therefore, this study was undertaken to study the effect of Arabic Gum on physical attributes of yoghurt.

Objectives:

1- To determine the physicochemical attributes of Arabic Gum (AG).

2- To study the effect of Arabic Gum (AG) on physical attributes of yoghurt.

2. MATERIALS AND METHODS

2.1 Materials

Fresh cow's milk sample were obtained from Khartoum university farm and transferred immediately in sterilized container in an ice box to the Animal Products Department laboratory, National Food Research Center (NFRC), Shambatt. Starter culture MIX505LYODCU, freeze-dried form, Danisco France was obtained from a domestic dairy factory at Khartoum State. Arabic Gum (AG) was purchased from Arabic Gum Company. Chemicals and reagents used were obtained from the Lab line company-Khartoum. All the chemical and reagents were of analytical grades.

2.2 Methods

2.2.1 Preparation method

2.2.1.1 Arabic Gum preparation

Gum Arabic, provided by Arabic Gum Company. Gum samples were dried at room temperature and cleaned by hand to remove foreign particles and adhering bark. The samples were then ground using a mortar and piston, sieved through sieve No. 4 and kept in glass containers.

2.2.1.2 Yoghurt manufacture

Fresh milk was filtered through a sterilized cloth sheet, then it was analyzed for moisture, total solids, protein, fat, lactose, ash, pH and acidity (Table 1). Samples were pasteurized at 85˚C for 30 seconds and left to cool down to 42^{o}C. The different treatment was added. Starter culture Yo-MIX505LYODCU was added at the level of 3% (w/v) containing a mixture of (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*) at ratio of 1:1, then samples were incubated at 42^{o}C for about four hours. Samples were then kept refrigerated at 4^{o}C until needed.

2.2.2 Analytical method

2.2.2.1 Physical analysis

The physical analysis carried out according to A.O.A.C (2005).

2.2.2.2 Statistical analysis

The data collected from the different treatments were subjected to Completely Randomize Design (CRD) in 2×2×3 factorial arrangement using analysis of variance (ANOVA) and Duncan's Multiple Range test was employed (Steel and Torrie, 1980). The SAS program (SAS, 2002), was used.

3-DESCUTION

3.1 Chemical composition of raw materials

3.1.1 Chemical composition of fresh cow's milk

Table 1, shows the proximate analysis of the fresh cow's milk. Cow's milk had moisture content of 88.67%. Similar moisture content of fresh cow's milk of 87.60%, was found by Eissa (2008). Lee and Lucey (2010) reported that, cow's milk is composed of 88% water content. Fresh cow's milk had 12.56% total solids. Bano *et al.*, (2011) found that, the total solids of cow's milk were 12.30%. Cow's milk had protein content of 3.30%. Similar protein content 3.30%, of fresh cow's milk was reported by Bano *et al.*, (2011). The present result was supported with that reported by Eissa (2008) who stated that, milk is considering rich protein source. Fat content of the sample was 4.13%. Eissa (2008) reported that, fresh cow's milk had fat content of 3.67%. Tamime and Robinson (2007) reported that, milk fat is important to give milk its rich-creamy taste and to act as the transporter of the fat soluble vitamins. Mohammed (2014) reported that, cow's milk had lactose content of 4.60%. Turner (1978) reported that, lactose is the major sugar presents in milk and it plays a significant role in the solubility of milk powders. Ash content of milk was 0.80%. Bano *et al.*, (2011) stated that, cow's milk was 0.77% ash content. Eissa (2008) who found that, milk contains 0.7% of ash with calcium and potassium being the major constituents. The pH value of the sample was 6.57. Cow's milk had titratable acidity of 0.16%. DF (2004) stated that, milk mineral salts are chlorides, phosphates and citrates of sodium, calcium and magnesium. SSMO (2008) stated that, acidity of milk must be 0.16%-0.20%. Generally, milk composition is affected by: genetic factors, breed, stage of lactation, season and nutrition system Dabora, (2016).

Table 1: Chemical composition of fresh cow's milk

Item	Fresh cow's milk
Moisture %	88.67 (±0.02)
Total solids %	12.56 (±0.00)
Protein %	3.30 (±0.02)
Fat %	4.13 (±0.02)
Lactose %	4.40 (±0.01)
Ash %	0.80 (±0.22)
pH Value	6.57 (±0.02)
Acidity %	0.16 (±0.42)

Values are means ± SD.

3.1.2 Chemical composition of Arabic gum (AG)

Table 2, revealed that, Arabic Gum (*Acacia senegal*) had moisture content of 7.00%. Higher moisture content was found by Omer (2012) who reported that AG had moisture content of 13%. El Amin (1990) found that, moisture content of AG was 8.5%. Elhassan (2017) reported that, gums can get dissolved in water in a concentration of 50% w/v, forming a fluid solution with acidic properties. Arabic gum had protein content of 2.55%. The current result of protein content ranged between 1.5 to 2.60%. Wadoud and El Fatih, (2010) reported that, Arabic gum had 1.6% protein content. The current results were supported by that reported by Elhassan (2017) who stated that, chemically, gum is considered a complex mixture of macromolecules of different size and composition (mainly carbohydrates and small quantity of proteins). Fiber content of Arabic Gum was 1.26%. Slightly higher fiber content 1.30% of gum Arabic was reported by Ali *et al.*, (2008). Ash content of Arabic gum was 2.38%. Elhassan (2017) stated that, gums are a complex mixture of calcium, magnesium and potassium salts. Omer (2012) reported that, AG had ash content of 2%. AG had pH- value of 5.26. The current result was not far from that obtained by Omer (2012) who reported that, Gum is composed of the sugars such as; galactose, rhamnose and galacturonic acid as reported by Elhassan (2017). Wadoud and El Fatih (2010) mentioned

that, characteristics of gums affect by: geographical origin, age of the trees, climatic conditions, soil environment and even the place of exudation on the tree.

Table 2: Physicochemical characteristics of Gum Arabic (GA)

Item	Gum Arabic (GA)
Moisture %	7.00 (±0.02)
Protein %	2.55 (±0.26)
Ash %	1.38 (±0.16)
Fiber %	1.26 (±0.02)
pH Value	5.26 (±0.06)

Values are means ± SD.

3.2 Physical attributes of yoghurt stabilized with gum Arabic throughout the storage period

3.2.1 pH- values

Table 3, revealed that, pH- value significantly (P≤0.05) influenced by gum level and storage period. Control sample reported the highest pH value 4.36, while, sample stabilized with 0.5% Arabic gum reported the lowest pH - value 4.24. Obviously, as gum level increased, pH values of yoghurt decreased. This could be attributed to the present of organic acid of Arabic Gum as stated by El Elhassan (2017). Osman *et al.*, (1993) stated that, higher amount of arabinose and methyl glucuronic acid present in AG. Similar observation was reported by Hussein (2006) who noticed that, addition of AG reduced pH value of yoghurt, and found that, samples formulated with 0.1%, 0.3% and 0.5% had pH- values of 4.57, 4.40 and 4.30, respectively. Omer (2012) found that, untreated yoghurt sample registered the highest pH value 4.57. Whereas, the yoghurt sample treated with 0.5% gum Arabic registered the lowest one 4.22.

Regardless of the treatments the pH of yoghurt significantly decreased progressively (P≤0.05) with the increase in the storage period. This could due to the presence of lactic acid bacteria. Hamad *et al.*, (2016) reported that, there was reduction in pH values of rob enriched with gum Arabic during storage period. Codex (2003) mentioned that the maximum pH value of

yoghurt is (4.50) in order to prevent the growth of any pathogenic microorganisms. In addition, Hegenbart (1991) stated that, the pH has a direct influence on the flavor perception of the dairy products.

Table 3: Effect of Arabic Gum (AG) and storage period on pH- value of yoghurt

Treatment	Storage period (days)				Overall
	0	4	8	12	
Control	4.40^{a} ±0.00	4.38^{ab} ±0.02	4.29^{cde} ±0.00	4.35^{ab} ±0.01	4.36^{A}
0.1% (AG)	4.40^{a} ±0.00	4.37^{ab} ±0.06	4.28^{def} ±0.09	4.19^{g} ±0.02	4.31^{B}
0.3% (AG)	4.33^{bc} ±0.03	4.27^{def} ±0.03	4.26^{def} ±0.04	4.20^{g} ±0.03	4.27^{C}
0.5% (AG)	4.30^{cd} ±0.00	4.24^{fg} ±0.01	4.20^{g} ±0.00	4.24^{efg} ±0.00	4.24^{D}
Overall	4.36^{A}	4.31^{AB}	4.26^{C}	4.25^{C}	
$Lsd_{0.05}$	0.05259**				

Values are means ± SD.

*Means in the same column for the same parameter bearing the same superscript small letters are not significantly different (P≥0.05).

* *Means in the same row for the same parameter bearing different superscript capital letters are significantly different (P≤0.05).

3.2.2 Whying-0ff

Table 4, shows that, whying -off of yoghurt significantly (P≤0.05) affected by the gum level. Obviously, control sample had whying-off of 0.175%. It worth mentioning that, all treated samples were synerisis free. Hematyar *et al.,* (2012) noticed that, control sample reported the highest whying-off when compared to the treated one. Abdelgadir (2018) reported that, whying-off of yoghurt reduced as gum level increased. This could be attributed to the fact that, syneresis can be reduced by adding stabilizers that interact with the casein network.

Concerning storage period, whying-off was detected at day five and day twelve. These could be attributed to the fact that, spontaneous syneresis is the result of the breakage of many protein strands and structural rearrangements, which result in the expulsion of whey as stated by Serra *et al.,* (2009). The reason behind the increase in syneresis of yoghurts during storage may be closely related to whey release caused by gel network rearrangements triggered by decrease in pH values. Abdelgadir (2018) concluded that, syneresis increased with increasing of storage time. Masoud *et al.,* (2013) and Macit and Bakirci (2017). Abdelgadir (2018) stated that,

syneresis is one of the basic defects of yoghurt, which is observed in the form of accumulation of serum or whey on yoghurt surface.

Table 4: Effect of Arabic Gum and storage period on whying-off of yoghurt

Treatment	Storage period (days)				Overall
	0	4	8	12	
Control	0.00^{c} (±0.00)	0.00^{c} (±0.00)	0.20^{b} (±0.00)	0.50^{a} (±0.00)	0.175^{A}
0.1% (AG)	0.00^{c} (±0.00)	0.00^{c} (±0.00)	0.00^{c} (±0.00)	0.00^{c} (±0.00)	0.00^{B}
0.3% (AG)	0.00^{c} (±0.00)	0.00^{c} (±0.00)	0.00^{c} (±0.00)	0.00^{c} (±0.00)	0.00^{B}
0.5% (AG)	0.00^{c} (±0.00)	0.00^{c} (±0.00)	0.00^{c} (±0.00)	0.00^{c} (±0.00)	0.00^{B}
Overall	0.00^{C}	0.00^{C}	0.050^{B}	0.125^{A}	
$Lsd_{0.05}$	0.05259^{*}				

Values are means ± SD.

*Means in the same column for the same parameter bearing the same superscript small letters are not significantly different (P≥0.05).

* *Means in the same row for the same parameter bearing different superscript capital letters are significantly different (P≤0.05).

3.2.3 Viscosity

Viscosity is an important characteristic as it is required for achieving desirable whipping ability and retaining of air bubbles Tarkashvand (2005). Table 5 revealed that, viscosity was significantly (P≤ 0.05) affected by AG concentration. It was clear that, viscosity increased as gum concentration increased. Untreated sample reported the lowest viscosity 1215cp. While, samples stabilized with 0.1%, 0.3% and 0.5% AG had viscosity of 1263.42. 1328.25 and 1400.50cp, respectively. Abdelgadir (2018) found that, there was significant (P≤0.05) increment in viscosity index as gum level increased. Dickinson *et al.*, (1992) stated that, stabilizer absorbing maximum water of the medium resulting in an increase in viscosity of yoghurts. Stabilizers have water-holding capacity and can influence the rheological properties of ice cream mix as stated by Guinard *et al.*, (1994).

Concerning storage period, there was significant (P≤ 0.05) reduction in viscosity during storage period. Viscosity was 1373.17cp at zero time, whereas, it reached 1230.58cp at the end of storage period. This may be attributed to the fact that, change of pH values, as well as activity

of lactic acid bacteria in yoghurt which may cause changes in the micro-structure of the media and hence affecting viscosity as stated by Park *et al.*, (2007). In contrast, Sahan *et al.*, (2008) reported that apparent viscosity can increase over time due to the rearrangement of protein and protein-protein contacts. Ritzoulis and Rhoades (2013) mentioned that, viscosity is the resistance to flow.

Table 5: Effect of Arabic Gum and storage period on viscosity of yoghurt

Treatment	Storage period (days)				Overall
	0	4	8	12	
Control	1292.00^{g} (±5.00)	1217.00^{i} (±1.00)	1190.00^{k} (±8.54)	1161.00^{l} (±1.0)	1215.00^{D}
0.1% (AG)	1376.00^{d} (±5.00)	1277.00^{h} (±3.51)	1206.00^{ij} (±5.00)	1194.00^{jk} (±6.51)	1263.42^{C}
0.3% (AG)	1411.00^{c} (±10.00)	1326.00^{e} (±5.00)	1308.00^{f} (±11.00)	1268.00^{h} (±9.54)	1328.25^{B}
0.5% (AG)	1494.00^{a} (±10.97)	1476.00^{b} (±5.00)	1333.33^{e} (±7.51)	1299.00^{fg} (±2.01)	1400.50^{A}
Overall	1393.17^{A}	1324.08^{B}	1259.33^{C}	1230.58^{D}	
$Lsd_{0.05}$	12.10^{**}				

Values are means ± SD.

*Means in the same column for the same parameter bearing the same superscript small letters are not significantly different (P≥0.05).

* *Means in the same row for the same parameter bearing different superscript capital letters are significantly different (P≤0.05).

Conclusion and Recommendation

Conclusion

- Arabic Gum had moisture, protein ash and fiber content of 7.00%, 2.55%, 1.38% and 1.26%, respectively.
- All treated samples were synerisis free.
- Viscosity increased as gum concentration increased.
- pH- value of yoghurt was significantly (P≤0.05) influenced throughout the storage period.
- All treated sample was free of Synreris
- There was significant (P≤0.05) reduction in viscosity during the storage period, in contrast, to synresis.

Recommendation

- Further research must be needed to study the quality attributes of treated yoghurt

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