INFLUENCE OF GRADED LEVELS OF GUM ARABIC ON YOGHURT STABILITY UNDER STORAGE

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ABSTRACT
The study was carried out to evaluate the effect of Arabic Gum (AG) on the physical properties of yoghurt made from powdered milk. Reconstituted powdered milk was pasteurized at 85oC for 30 minutes and then fast-cooled to 42oC. Starter culture MIX505LYODCU (Streptococcus thermophiles and Lactobacillus bulgaricus SSP.) was added at 3% inclusion level, and the mixtures were incubated at 42oC for four hours. Yoghurt samples were formulated with 0%, 5%, 10% and 15% Arabic Gum in a Completely Randomized Design (CRD). After setting, the yoghurt was kept refrigerated at 10oC for 24hrs. Standard analytical procedures were used to determine the physicochemical properties of the product. . Results showed that, powdered milk contained 3.5% moisture, 24.43% protein, 25.66% fat, 28.45% lactose, 3.65% ash, 6.57 pH and acidity of 0.14. Gum Arabic had moisture, protein, ash, and fibre contents of 7.00%, 2.55%, 1.38%, and 1.26% respectively. Increasing the gum level, led to a significant (P≤0.05) decrease in the pH values of the yoghurt, while wheying-offWheyingwas significantly (P<0.05) affected by the gum arabic level. All treated samples were synerisis free. Viscosity increased as gum concentration increasedwith the control sample having the the lowest viscosity of 1213cp, and samples stabilized with 5%, 10% and 15% Gum Arabic (GA) had viscosities of 1260.42. 1326.25 and 1402.50cp respectively. Regarding storage period, the pH- value of yoghurt was significantly (P<0.05)as well as wheying-off of yoghurt and there was significant (P<0.05) reduction in viscosity during storage period.
Keywords: Gum Arabic , Yoghurt, Viscosity and Synerises

INTRODUCTION

Milk is an important animal product with an estimated figure of more than 4391.000 tons Codex Standard (2003). Milk is considered a nearly complete food since it is a good source of protein, fat, and major minerals (Sarkar, 2010). The nutritional benefit of milk and the growing awareness of the relationship between diet and health has led to an increased demand for food products with high nutritional and health benefits to support human health through the anaerobic fermentation of lactose milk by relevant microorganisms (Tull, 1996). 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 in terms of texture and flavour 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 (Omer, 2003). Syneresis is considered the one of yoghurt's defect and it can be reduced by adding stabilizers that interact with the casein network. One approach to reduce syneresis and improve the yoghurt quality is by the use of stabilizer. Gum Arabic is considered as one of the common stabilizers in the 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 Sahel in Sudan (Bakhoum, *et al.,* 2018). 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) Bakhoum, *et al.,* (2018). Various studies have reported the use of gums to improve some characteristics of yoghurt (Ertan et al., 2009). Therefore, this study was undertaken to evaluate the effect of Gum Arabic on the physical attributes and storage potentials of yoghurt.

MATERIALS AND METHODS

The study was carried out at the Product and Processing unit of the Deparment of Animal Science, Federal University DutsinMa. Dutsin-Ma is located in the Northwestern Nigeria in latitude $12^0$27''18' North and $7^0$29''29' East and 605 meters above sea level. The average rainfall ranges between 700mm and 900mm occurring annually with a distinct wet season between May and September and dry season between October and April (Ati *et al.,* 2019).

Experimental design

Yoghurt samples containing 0%, 5%, 10% and 15% Gum Arabic were prepared. Three replicates of the samples were compared for physical and chemical properties using a completely randomized design (CRD).

Sample preparation

Powdered milk was reconstituted and heated for to 83^{o}C for 30 minutes then fast-cold for 5 minutes to 42^{o}c after which a starter culture was added 3% and then incubated for 8hours at 42^{o}c.Three hundred (300) liters of yoghurt samples was made and two hundred (200) liters was collected and separated in to four plastic containers with fifty liters each and proportions of prepared Gum Arabic (GA) powder were added at 0%, 5%, 10% and 15% for each sample respectively. These samples were then refrigerated at 10^{o}C until needed

Data collection and Data analysis

Physical which includes and chemical properties data were obtained in accordance to A.O.A.C (2005). All data obtained were analyzed using general linear model multivariate procedures of the SPSS version (2021). The means were separated using the Turkey Range Test.

RESULTS AND DISCUSSION

Table 1 shows the chemical composition of reconstituted powdered milk used in the production of the experimental yoghurt.

Table 1: Chemical composition of reconstituted powdered milk used for the experimental yoghurt

Parameters	Nutrient composition (%)
Moisture	3.50
Protein	24.43
Fat	25.66
Lactose	28.45
Ash	3.65
pH	6.57
Acidity	0.14

Table 1, shows the proximate analysis of the powdered milk. Powdered milk had a moisture content of 3.7% which is expected since it is powder milk not fresh milk that has 88% moisture in-fact it is reported that fresh cow's milk contains 87.60% moisture Eissa (2010) while Lee and Lucey (2010) reported that, cow's milk is composed of 88% water content. The powdered milk contains 24.43% protein implying that the protein is highly concentrated since water has been extracted, unlike the fresh cow milk with a protein content of 3.30% as reported by Bano *et al.,* (2011). The result indicates that powdered milk is a rich source of protein (Eissa, 2010). The fat, lactose and ash content of the powdered milk were relatively higher (25.66%, 28.45% and 3.65%). Lower fat and lactose were reported in fresh milk due to dilution effects. Mohammed (2014) reported that fresh milk had lactose content of 4.60%. 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.

Chemical composition of Arabic gum (AG)

The result of proximate composition of Gum Arabic (GA) is presented in Table 2.

Table 2: Physicochemical characteristics of Gum Arabic (GA)

Parameters	Nutrient composition (%)
Moisture	7.00
Protein	2.55
Fiber	1.29
Ash	1.76
pH Value	5.26

Gum Arabic (*Acacia senegal*) had a moisture content of 7.00%, which was lower than moisture content of 13% reported by Omer (2012) but similar to that of El Amin (1990), who reported a moisture content of 8.5%. The protein content fell within the expected range for gum with a range of 1.5 to 2.60% reported by Wadoud and El Fatih, (2010). The fiber content of 1.29% was similar to the fiber content of 1.30% reported by Ali *et al.,* (2008). The ash content of 1.76% was slightly lower than the 2.38% reported by Elhassan (2017), which may be attributed to the complexity of gums and the mixture of calcium, magnesium and potassium salts.

Physical attributes of yoghurt stabilized with gum Arabic throughout the storage Period

Table 3 shows the effect of GA inclusion levels and storage on the pH value of yoghurt.

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

GA concentrations	Storage period (days)				Overall
	0	5	10	15	
0(%)	4.40^{a}	4.38^{ab}	4.29^{cde}	4.35^{ab}	4.36^{a}
5(%)	4.40^{a}	4.37^{ab}	4.28^{def}	4.19^{g}	4.31^{b}
10(%)	4.33^{bc}	4.27^{def}	4.26^{def}	4.20^{g}	4.27^{c}
15(%)	4.30^{cd}	4.27^{def}	4.20^{g}	4.24^{efg}	4.24^{d}
Overall	4.36^{a}	4.31^{ab}	4.26^{c}	4.25^{c}	
SE	0.05259**				

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).

pH- values

The acidity of the yoghurt were highly significant (P < 0.05) across all the GA inclusion levels and as well as the storage intervals. The pH value was significantly (P≤0.05) influenced by gum concentration level and storage period. Control sample reported the highest pH value 4.36, while, sample stabilized with 15% gum arabic reported the lowest pH value of 4.24. Obviously, as the gum level increased, pH values of Yoghurt decreased. This could be attributed to the presence of organic acid of gum arabic (El Elhassan, 2017). Osman *et al.,* (1993) stated that higher amount of arabinose and methyl glucuronic acid is present in GA. Similar observation was reported by Hussein (2006) who noticed that the addition of GA reduced pH value of yoghurt, and found that, samples formulated with 2%, 4% and 6% had pH values of 4.57, 4.40 and 4.30, respectively. Omer (2012) found that untreated yoghurt samples recorded the highest pH value of 4.57 whereas, the yoghurt sample treated with 4% gum Arabic had the lowest value of 4.22. Regardless of the treatments, the pH of yoghurt significantly (P≤0.05) decreased progressively with increase in the storage period. This could be due to the presence of lactic acid bacteria which activities might have slowed down as a result of the storage condition. Hamad *et al.,* (2016) reported that there was reduction in pH values of robs 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.

Wheying-off

The effect of GA inclusion levels on the wheying-off of yoghurt at storage intervals. The wheying of the yoghurt were not significant (P > 0.05) across all the GA inclusion levels and the storage intervals except for the 10th and 15th days.

Table 4, showed that wheying-off of yoghurt was significantly (P < 0.05) affected by the gum level. Control sample had wheying-off of 0.175. It worth mentioning that, all treated samples were synerisis free. Hematyar *et al.,* (2012) noticed that the control samples had the highest wheying-off when compared to the treated one. Abdelgadir (2018) reported that wheying-off of yoghurt reduced with increase in gum concentration level. This could be attributed to the fact that syneresis can be reduced by adding stabilizers that interact with the casein network Masoud *et al.,* (2013) and Macit and Bakirci (2017).

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

Treatment	Storage period (days)				Overall
	0	5	10	15	
0(%)	0.00^{c}	0.00^{c}	0.31^{b}	0.550^{a}	0.183^{a}
5(%)	0.00^{c}	0.00^{c}	0.00^{c}	0.00^{c}	0.00^{b}
10(%)	0.00^{c}	0.00^{c}	0.00^{c}	0.00^{c}	0.00^{b}
15(%)	0.00^{c}	0.00^{c}	0.00^{c}	0.00^{c}	0.00^{b}
Overall	0.00^{c}	0.00^{c}	0.050^{b}	0.125^{a}	
SE			0.05259*		

* abc = Means bearing different Superscripts along the same column differ (P < 0.05)
* * abc = Mean bearing difference superscript along the same raw differs (P < 0.05)

Concerning storage period, wheying-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 *etal.,* (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.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 5 indicates that, viscosity was significantly (P < 0.05) affected by GA concentration. Ritzoulis and Rhoades (2013) mentioned that, viscosity is the resistance to flow. Viscosity is an important characteristic as it is required for achieving desirable whipping ability and retaining of air bubbles (Tarkashvand, 2005).

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

Treatment	Storage period (days)				Overall
	0	5	10	15	
0(%)	1292.00^{g}	1217.00^{i}	1190.00^{k}	1161.00^{l}	1213.00^{d}
5(%)	1376.00^{d}	1277.00^{h}	1206.00^{ij}	1194.00^{jk}	1260.42^{c}
10(%)	1411.00^{c}	1326.00^{e}	1308.00^{f}	1268.00^{h}	1326.25^{b}
15(%)	1494.00^{a}	1476.00^{b}	1333.33^{e}	1299.00^{fg}	1402.50^{a}
Overall	1393.17^{a}	1324.08^{b}	1259.33^{c}	1232.58^{d}	
SE			12.10**		

* abc = Means bearing different Superscripts along the same column differ (P < 0.05)
* * abc = Mean bearing difference superscript along the same raw differs (P < 0.05)

The result shows that viscosity increased with increase in gum concentration. The untreated sample reported the lowest viscosity of 1213cp while samples stabilized with 5%, 10% and 15% AG had a viscosity of 1260.42, 1326.25 and 1402.50cp, respectively. Abdelgadir (2018) found that, there was a significant (P<0.05) increase in viscosity index as gum level increased. Dickinson *et al.,* (1992) stated that stabilizer absorbs maximum water of the medium which increased the viscosity of yoghurts.

Stabilizers have water-holding capacity and can influence the rheological properties of ice cream mix (Guinard *et al.,* 1994).

Yoghurt viscosity was significantly affected ($P < 0.05$) causing a reduction in viscosity during the storage period. Initially, viscosity was 1373.17cp, decreasing to 1230.58cp by the end of the storage period. This reduction may be attributed to the changes in pH values and the activity of lactic acid bacteria, which can alter the micro-structure of the media and consequently impact viscosity as noted by Park *et al.* (2007). In contrast, Sahan *et al.* (2008) reported that apparent viscosity can increase over time due to the rearrangement of proteins and protein-protein contacts.

CONCLUSION

Gum Arabic had moisture, protein, ash and fiber content of 7.00%, 2.55%, 1.76% and 1.29%, respectively. All treated samples exhibited synerisis. Viscosity showed a notable increase with higher gum concentration. The pH value of yoghurt was significantly ($P < 0.05$) influenced throughout the storage period. Interestingly, there was a significant ($P < 0.05$) reduction viscosity during the storage period, contrasting with syneresis.

RECOMMENDATION

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

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