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Influence of Stabilizers on Composition, Sensory Properties and Microbial Load of Yoghurt Made from Zebu Milk

O.A. Olorunnisomo, T.O. Ososanya and A.Y. Adedeji
Department of Animal Science, University of Ibadan, Ibadan, Nigeria

Corresponding Author: O.A. Olorunnisomo, Department of Animal Science, University of Ibadan, Ibadan, Nigeria

ABSTRACT

Yoghurt is a popular dairy product with wide consumer acceptance around the world. The use of stabilizers to improve the sensory attributes of yoghurt and enhance profitability in yoghurt-making has become common practice. In this study, the effects of Corn Starch (CS), Milk Powder (MP) and Baobab Fruit pulp (BF) as stabilizers in the yoghurt mix was evaluated. Raw zebu milk was homogenized, pasteurized at 75°C for 20 min and incubated at 43°C for 6-8 h until a gel was formed. Milk powder was added to the milk prior to homogenization while corn starch and baobab fruit pulp were added to yoghurt after incubation. Chemical composition, sensory attributes and microbial load of yoghurts formed were determined. Results show that the use of different stabilizers influenced the chemical composition, sensory attributes and microbial load of the yoghurt formed. Total solids varied from 14.34-16.70%, protein from 3.57-5.50% and fat from 4.33-5.30% in the yoghurts. Total solids increased with addition of stabilizers while protein and fat content increased only in MP and reduced in CS. The use of BF did not significantly alter the protein and fat content of yoghurts. With the exception of BF, addition of stabilizers generally improved sensory attributes and overall acceptability of yoghurt. Sensory scores shows that acceptance of the yoghurts was in the order, MP>CS>control>BF. The microbial load of the yoghurt increased with the addition of stabilizers. Coliform, fungal and total viable counts varied from 0.1-2.4×10^2, 0.1-1.8×10^2 and 0.2-2.5×10^3, respectively and was in the order, MP>BF>CS>control. While, addition of stabilizers to yoghurt may be desirable, high hygienic standards must be adopted in the production of stabilizers in order to avoid microbial contamination of yoghurt.

Key words: Yoghurt, corn starch, milk powder, baobab fruit pulp, physico-chemical properties, microbial counts

INTRODUCTION

Yoghurt is one of the most popular fermented milk products worldwide and has gained widespread consumer acceptance as a healthy food (McKinley, 2005). In recent years, yoghurt has become one of the fastest growing products in the frozen dessert market (Opadahl and Baer, 1991; Guinard *et al.*, 1994). It is more nutritious than many other fermented milk products because it contains a high level of milk solids in addition to nutrients developed during the fermentation process. A major concern in the yoghurt industry is the production and maintenance of a product with optimum consistency and stability. Omer (2003) reported that the factors known to improve consistency include; increased total solids, manipulation of processing variables and characteristics of the starter culture. Stabilizers prevent the separation of whey from the yoghurt, a problem known as syneresis. The addition of stabilizers improves the body, texture, appearance, mouthfeel and retards syneresis of yoghurts (El-Sayed *et al*., 2002; Jawalekar *et al*., 1993; Khalafalla and Roushdy, 1997; Tayar *et al*., 1995). Stabilizers are important in several manufactured products including yoghurt (Awan, 1995). However, different stabilizers have been used to overcome the problem of syneresis and create the desired texture and stability during processing and storage of yoghurt. Substances used as stabilizers include vegetable gums, gelatin, starch and pectin (Walstra, 1998). Airan and Desai (1954) highlighted the presence of organic acids in the baobab fruit pulp. These are citric, tartaric, malic, succinic and ascorbic acid. Nour *et al*. (1980) confirmed that the baobab fruit pulp contain water soluble pectin, ascorbic acid and tartaric acid. The inclusion of stabilizers improves yoghurt quality, create new brands of yoghurt and modulate perception of consumers (Karagul-Yuceer *et al*., 1999; Iwalokun and Shittu, 2007). This study was therefore designed to evaluate the use of Corn Starch (CS), Milk Powder (MP) and Baobab Fruit pulp (BF) as stabilizers in yoghurt and their effect on chemical composition, sensory properties and microbial load of yoghurt made from zebu milk.

MATERIALS AND METHODS

Yoghurt preparation: Raw milk was collected from lactating White Fulani cows and clarified manually using a muslin cloth. The milk was heated to 60°C and homogenized using a high speed mixer (10000-13000 rpm; Qlink^R, Shangai, China). The milk was subjected to modified low temperature-long time pasteurization by heating through a water bath to a temperature of 75°C for 20 min and cooled to 45°C prior to inoculation. The milk was divided into four portions to correspond to the following treatments:

- No stabilizer
- Addition of milk powder at 2% inclusion
- Addition of corn starch at 2% inclusion
- Addition of baobab fruit pulp at 2% inclusion

Milk powder was added to the milk prior to homogenization while corn starch and baobab fruit pulp (which were made into a gel) were added to yoghurt after incubation. A freeze-dried commercial starter culture (Yogourmet, Lyo-San Inc., Canada) containing a mixture of *Streptococcus thermophillus*, *Lactobacillus bulgaricus* and *Lactobacillus acidophilus* was used to inoculate the milk at 2% inclusion for incubation. Each of the treatments was placed inside an incubator set at 43°C for 6-8 h until a gel was formed. After incubation, 5% of sucrose was added to the formed yoghurt (corn starch and baobab slurry were added to CS and BF, respectively, at this point), stirred, cooled and refrigerated at 4°C for further analysis.

pH of yoghurt samples: The pH of yoghurt samples was determined at 25°C using an electronic pH meter (PHS-3C, TBT, Jiangsu, China) which was calibrated with buffer standards of 4 and 10 prior to use.

Chemical analysis: Total solids in raw milk and yoghurt was determined by drying in an oven at 105°C to constant weight, protein was determined by Kjeldahl method (N×6.38), ash was determined using a muffled furnace and fat by a modified Rose Gottlieb method following the general procedures of AOAC (2005). The carbohydrate fraction of the samples was determined as the difference between the total solids and other milk solids (protein, fat and ash).

Sensory evaluation: All the samples were evaluated for sensory characteristics and overall acceptability by a 10 man semi-trained panel drawn from the Department of Animal Science, University of Ibadan, Nigeria. Yoghurt samples were identified by three-digit random numbers and presented to the panel in a random manner. A nine-point hedonic scale ranging from 9 (highest score) to 1 (lowest score) was used (Iwe, 2002). Sensory characteristics evaluated include: colour, aroma, taste and texture. Overall acceptability of yoghurt was determined as the average score for sensory characteristics.

Microbiological analysis: The pour plate technique (Adegoke, 2000) was used for the microbiological examination of the various yoghurt samples.

Statistical analysis: The experimental design adopted for the study was the Completely Randomized Design. All data obtained was subjected to one-way analysis of variance using procedures of SAS. (1995). Means were separated at 5% level of significance using Duncan's multiple range test.

RESULTS

The chemical composition of yoghurt samples with different stabilizers is presented in Table 1. This result shows that there were significant differences ($p<0.05$) in chemical composition of yoghurts with different stabilizers. Total solids of yoghurt varied from 14.34-16.70%, with MP having the highest value and control, the least. Addition of stabilizers increased the total solids content of yoghurt. Protein content of yoghurts varied between 3.57 and 5.50%. The highest protein content was recorded for MP and the least for CS. Protein content of BF and control were intermediate between MP and CS. Fat content of yoghurts followed the same trend with protein. The highest fat content was recorded for MP, least for CS and intermediate for BF and control. There were however, no significant differences ($p>0.05$) in ash content of yoghurts stabilized with different ingredients in this study. The carbohydrate fraction of yoghurts varied from 4.17-5.33% and increased with addition of stabilizers. The highest carbohydrate fraction was recorded for CS and least for control. The pH value of yoghurts varied from 3.80-4.60. The highest pH was recorded for control and the least for BF and CS.

Table 2 shows the sensory properties and scores of yoghurt produced with different stabilizers on a hedonic scale of 1-9. The highest scores for colour were recorded for CS, MP and control while the least colour score was recorded for BF. The highest aroma scores were recorded for MP and BF while the least were recorded for control and CS. There were no significant differences ($p>0.05$) in taste scores for yoghurts with different stabilizers. Texture scores showed that MP and CS had the best mouthfeel among the yoghurts while, BF and control had the least. Overall acceptability of yoghurts, which was determined as the average of other sensory scores showed that MP was the most accepted by panelists, followed closely by CS while, control and BF were the least accepted.

Table 1: Chemical composition of yoghurt with different stabilizers

Parameters (%)	Control	CS	MP	BF	SEM
Total solids	14.34^{c}	14.86^{bc}	16.70^{a}	15.05^{b}	0.17
Protein	4.20^{b}	3.57^{c}	5.50^{a}	4.20^{b}	0.06
Fat	4.50^{b}	4.33^{b}	5.30^{a}	4.60^{b}	0.09
Ash	1.37	1.63	1.70	1.65	0.06
Carbohydrate	4.17^{b}	5.33^{a}	4.20^{b}	4.60^{b}	0.04
pH	4.60^{a}	3.88^{b}	4.50^{a}	3.80^{b}	0.02

^{abc}Means with different superscripts along the same row are significant ($p<0.05$), CS: Corn starch, MP: Milk powder, BF: Baobab fruit pulp, SEM: Standard error of the mean

Table 2: Sensory properties and scores for yoghurt stabilized with different materials

Parameters	Control	CS	MP	BF	SEM
Colour	7.60^{a}	7.90^{a}	7.73^{a}	6.45^{b}	0.10
Aroma	6.60^{b}	6.30^{b}	7.47^{a}	7.00^{ab}	0.10
Taste	7.00	7.30	7.37	7.27	0.10
Texture	6.30^{b}	6.90^{ab}	7.33^{a}	6.55^{b}	0.12
Overall acceptability	6.86^{b}	7.10^{ab}	7.48^{a}	6.82^{b}	0.09

^{ab}Means with different superscripts along the same row are significant ($p<0.05$), CS: Corn starch, MP: Milk powder, BF: Baobab fruit pulp, SEM: Standard error of the mean

Table 3: Microbial load of yoghurt samples produced with different stabilizers

Microbial count (CFU g^{-1})	Control	CS	MP	BF	SEM
Total viable count	0.2×10^{2d}	0.9×10^{3c}	2.5×10^{3a}	1.9×10^{3b}	23.75
Coliform count	0.1×10^{2d}	1.2×10^{2c}	2.4×10^{2a}	1.8×10^{2b}	20.54
Fungal count	0.1×10^{2d}	0.6×10^{2c}	1.8×10^{2a}	1.3×10^{2b}	18.65

^{abcd}Means with different superscripts along the same row are significant ($p<0.05$), CS: Corn starch, MP: Milk powder, BF: Baobab fruit pulp, SEM: Standard error of the mean

The microbial load of yoghurt samples produced with different stabilizers is presented in Table 3. Total viable count, coliform and fungal count varied significantly among the treatments. In this study, total viable count, coliform and fungal count followed a similar trend and showed that the addition of stabilizers generally increased the microbial load of the yoghurts. The observed trends in microbial load of yoghurt in this study was MP>BF>CS>control.

DISCUSSION

The chemical composition of yoghurts in this study shows that addition of stabilizers increased the total solids in the yoghurt. This was due to the high solid contents of the stabilizers compared to fresh milk from which the yoghurt was made. This result agrees with the findings of Monay (1987) and Mehanna and Mehanna (1989), who also reported increase in solid contents of yoghurt with addition of stabilizers. The very high solid content in yoghurt stabilized with milk powder duly reflects the dry nature of the added milk powder.

The high protein content in yoghurt stabilized with milk powder is a reflection of the protein and dry matter content of the milk powder while the low protein content in yoghurt stabilized with corn starch is a reflection of the low protein content in corn starch. This shows that milk powder had a concentrating effect on protein of yoghurt while corn starch had a diluting effect. Similar effects were observed in fat content of yoghurt with addition of milk powder and corn starch. This implies that use of milk powder as a stabilizer in yoghurt would also enhance the nutritive value of this food, particularly for children and pregnant women. The addition of baobab fruit pulp had little effect on protein and fat content of yoghurt in this study. This may have resulted from the dilution effect of the water used in making the baobab slurry prior to addition in the yoghurt.

Although, the ash content of stabilized yoghurts did not vary significantly from the control, there is indication that the high ascorbic acid content (vitamin C) in baobab fruit pulp enhanced the nutritive value of the yoghurt. Vitamin C is an extremely important nutritional element and supplement. It prevents many degenerative diseases such as cataract formation, cardiovascular risks, arteriosclerosis and scurvy (Weber *et al*., 1996). Baobab fruit pulp is an excellent source of vitamin C (Nour *et al*., 1980; Vertuani *et al*., 2002; Wilkinson, 2006). Baobab fruit is also a source of carbohydrate and protein (Odetokun, 1996). The reduction in pH value for BF may be attributed to high organic acids content in baobab fruit pulp (Airan and Desai, 1954; Nour *et al*., 1980).

The high protein, minerals, fat and carbohydrate content in the milk powder used for stabilization explains the high increase in these nutrients from yoghurts so stabilized. This agrees with the findings of Ihekoronye and Ngoddy (1985).

Appearance is one of the most important attributes of a food and is directly related to consumer acceptance and product quality (Pomeranz and Meloan, 1990; Redlinger, 1993; Hendrick *et al*., 1994). The addition of BF significantly ($p>0.05$) lowered the colour scores within the treatment. The high sensory scores and overall acceptability of yoghurt stabilized with milk powder has to do with its high compatibility with fresh milk from which yoghurt is made. This is in agreement with the report of Early (1998), who also affirmed that milk powder gave yoghurt a firm body, better consistency and unique flavor.

The high microbial load of the yoghurt produced may be attributed to the high microbial load of the stabilizers added. Improper sterilization and handling of these stabilizers prior to yoghurt manufacture could be a source of microbial contamination to yoghurt in this study.

CONCLUSION

Use of stabilizers in this study influenced the composition, sensory attributes and microbial load of yoghurt formed. Solids content and carbohydrate fraction of yoghurt increased with addition of stabilizers. Protein content of yoghurt increased when milk powder was used as stabilizer and reduced when corn starch was used. Except for yoghurt with baobab fruit pulp, addition of stabilizers generally improved the sensory properties and overall acceptability of yoghurt. However, the use of stabilizers in this study increased the microbial load of the yoghurt; hence greater hygienic precautions should be observed in the preparation of the different stabilizers. Since, colour was the main factor that reduced the sensory score of yoghurt with baobab fruit pulp, the use of appropriate coloring agent is recommended to enhance consumer acceptance of this yoghurt.

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