ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 14 No. 2
April 2014
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

SENSORY PROPERTIES AND CONSUMER ACCEPTANCE OF A STIRRED-TYPE YOGHURT PRODUCED FROM BAOBAB (*ADANSONIA DIGITATA*) PULP DURING REFRIGERATED STORAGE

Chipurura B*[1], Pswarayi F[1] and M Muchuweti[2]

Batsirai Chipurura

*Corresponding author email: bchipurura@science.uz.ac.zw

[1]Institute of Food, Nutrition and Family Sciences, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe

[2]Department of Biochemistry, University of Zimbabwe, P.O. Box MP 167 Mount Pleasant, Harare, Zimbabwe.

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 14 No. 2
April 2014
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

ABSTRACT

The baobab (*Adansonia digitata* L.) tree is widespread throughout the hot and drier regions of tropical Africa. The baobab pulp from the tree is an important source of nutrients in Africa as it is a rich source of amino acids, iron, vitamins C, A and E. In some African countries including Zimbabwe, the pulp is used traditionally to cure various ailments such as dysentery, inflamed gums and as an antidote to poison. Baobab pulp has many food uses and consequently the aim of the current study was to determine the sensory properties of the baobab flavoured yoghurt during storage and consumer acceptance of the yoghurt. A trained panelist evaluated the appearance, consistency on spoon, consistency in mouth, odour, flavour and overall acceptability of the yoghurt on days 1, 7, 14, 21 and 28 of storage. In all the sensory evaluations, plain yoghurt was used as a control. The consumer panelists (n = 150) evaluated taste, texture, colour, smell and aftertaste of the yoghurt. In general, the sensory scores of the baobab flavoured yoghurt and plain yoghurt decreased with storage time. The plain yoghurt had higher appearance scores from day 1 up to day 28 as compared to the baobab flavoured yoghurt and there was a significant difference ($p = 0.01$) in the scores of the yoghurts. On day 1 the consistency on spoon scores for both the baobab flavoured yoghurt and the plain yoghurt had the same value and from day 2 up to day 28, the plain yoghurt had the highest consistency on spoon scores as compared to the baobab flavoured yoghurt and the difference was significant ($p = 0.01$). The baobab flavoured yoghurt consistency in mouth scores were lower as compared to the plain yoghurt and the difference in the scores of the products was significant ($p = 0.01$). The odour and flavour scores of both the baobab flavoured yoghurt and plain yoghurt decreased throughout the storage period and the difference in the scores of the yoghurts was significant ($p = 0.05$). There was a significant difference ($p = 0.05$) in the overall acceptability scores of the baobab flavoured yoghurt and the plain yoghurt. Although the baobab flavoured yoghurt scores decreased with time of storage and the yoghurt had an astringent aftertaste, the consumer scores indicated that the baobab flavoured yoghurt was acceptable in terms of taste, texture, colour and smell.

Key words: Baobab, flavoured, yoghurt, sensory properties

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 14 No. 2
April 2014
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

INTRODUCTION

Yoghurt is a product of the lactic acid fermentation of milk and mainly produced from a starter culture containing *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*. In some countries microorganisms with known therapeutic properties, such as *Lactobacillus helveticus, Bifidobacterium infantis, Lactobacillus acidophilus, Lactobacillus casei, Lactobacillus rhamnosus, Lactobacillus reuteri, Lactobacillus plantarum* and *Lactobacillus delbrueckii* ssp. *Lactis* are sometimes mixed with the starter culture to produce probiotic yoghurt [1].

Yoghurt is amongst the mostly consumed fermented milk products worldwide and is accepted as a healthy food by most consumers especially in the developed countries [2]. Yoghurt is an excellent source of bioavailable proteins, minerals and vitamins [3]. In addition, yoghurt has many health benefits such as improved lactose tolerance and a variety of health aspects associated with probiotic bacteria [4, 5].

The baobab tree is widespread throughout the hot and drier regions of tropical Africa [6]. The baobab tree is an important source of nutrients in Africa as the pulp is a rich source of amino acids, iron, vitamins C, A and E [7]. In some African countries including Zimbabwe, the pulp is used traditionally to cure various ailments such as dysentery, inflamed gums and as an antidote to poison [8].

In Zimbabwe, exotic fruits and flavourants are mainly used to flavour yoghurts, and to the best of our knowledge, no studies have been done to investigate the use of baobab as yoghurt flavour. Manufacturing of the baobab flavoured yoghurts could increase the income of rural people who are involved in the harvest of the fruit and processing of the pulp. In addition, the baobab flavoured yoghurt would diversify the few exotic yoghurt flavours currently on the market and may also benefit the consumers nutritionally and pharmacologically as the baobab pulp is a rich source of micronutrients and phytochemicals. Hence the aim of the current study was to formulate baobab flavoured yoghurt and determine its acceptance and storage stability.

MATERIALS AND METHODS

Source of ingredients

Skim milk powder (SMP), sugar and baobab fruit pulp were purchased from a Spar retail outlet in Harare. The retail outlet sourced the pulp from a local company that purchases baobab fruits from rural communities. The Yo-Flex culture (Chr. Hansen, Horsholm, Denmark) containing strains of *L. delbrueckii* subsp. *bulgaricus* and *S. thermophilus* in a 1:1 ratio was purchased from a Kefalos retail outlet in Harare.

Production of experimental baobab yoghurt and plain yoghurt

Skim Milk Powder (SMP) was reconstituted to 12.5% (w/v) with warm distilled water and allowed to stand for 2 hrs. About 50 g sugar was added to 1 L of the reconstituted

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 14 No. 2
April 2014
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

milk. The mixture was heated to 90 °C for 30 min. After heating, the mixture was cooled to 43 ^{o}C. The cooled mixture was poured into a sterilised 2 L plastic container. The mixture in the plastic container was incubated at 43 ^{o}C until the yoghurt attained pH 4.6. After incubation, an in-house sensory evaluation team in the Institute of Food, Nutrition and Family sciences at the University of Zimbabwe arrived by consensus at the level of baobab pulp to be added to flavour the yoghurt. Consequently, 1 L of yoghurt was mixed with 36 g of baobab pulp using a stainless steel mixer for 30 min. About 0.2 g potassium sorbate was then added to the flavoured yoghurt and cooled to 4 ^{o}C. Plain yoghurt was formulated and used as a control in the subsequent analyses. All experimental yoghurts were divided into parts of approximately 150 g and stored at 4 ^{o}C for 28 days. The analyses were carried out after 1, 7, 14, 21 and 28 days of storage.

Sensory Analysis

The baobab flavoured and control yogurt samples were evaluated after 1, 7, 14, 21 and 28 days of storage by a 10-member trained sensory panel from the University of Zimbabwe, Institute of Food, Nutrition and Family Science. Panelists independently evaluated each sample for appearance, odor, consistency on the spoon and in the mouth, flavor and overall acceptability using a descriptive scale [9]. All the sensory scores ranged from 1 to 5. In brief, yoghurt that showed no signs of separation was given an appearance score of 5 and an appearance score of 1-3 was given to a product that had many cracks and showed signs of separation. A score of 5 for consistency on spoon was given to a product that was homogenous and thick and a score of 1-2 was given to a product that was free running. The criteria for consistency on spoon evaluation was also used by panelists to evaluate the consistency in mouth attribute. A product with a specific yoghurt odour was given a score of 5 and that one with a foreign odour was rated 1–2. Yoghurt with a normal yoghurt and baobab flavour was rated 5 and a score of 1–2 was given to yoghurt that was sour or having a bitter taste. Overall acceptability scores ranged from excellent with a score of 5 to very bad with a score of 1.

A consumer acceptance panel was conducted using the experimental yoghurt. Consumer panelists (n = 150) were chosen from consumers during the Zimbabwe International Trade Fair of 2012. Panelists scored on a 9 point hedonic scale on how they either liked or disliked the appearance, texture, colour, smell and aftertaste of the baobab flavoured yoghurt where 9 is like extremely and 1 is dislike extremely.

Selected physico-chemical properties of the baobab yoghurt

Selected properties of yoghurt that have got influence on the sensory attributes of the product were determined. The pH was measured using a pH meter (model WTW pH-340-A, Weilheim, Germany) fitted with a combined glass electrode. The total titratable acidity was determined as lactic acid by titration [10]. The total solid content was determined by the AOAC method [11]. The Water Holding Capacity was determined by a procedure adapted from Li and Guo [12]. A sample of about 20 g of

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 14 No. 2
April 2014
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

yoghurt (*Y*) was centrifuged for 10 min at 3000 x *g* at 4 ^{o}C. The expelled whey (*W*) was removed and weighed. The water-holding capacity (WHC) was calculated as: WHC (%) = (*Y* – *W*) / *Y* x 100.

Statistical analysis

Statistical analysis was done to compare the difference in the scores of the baobab flavoured yoghurt and plain after 1, 7, 14, 21 and 28 days and also to determine whether there were significant changes in sensory attributes of each yoghurt at day 1 when compared to day 28. The statistical tests were done using *t*-tests packaged in the Statistical Package for Social Sciences (SPSS) version 8.0.

RESULTS

The physico-chemical results of the baobab flavoured yoghurt and plain yoghurt are shown in Table 1**.** The baobab flavoured yoghurt had lower pH and higher total titratable acid when compared to the plain yoghurt. The plain yoghurt had higher water holding capacity and also total solids when compared to the baobab flavoured yoghurt.

In general, all sensory attributes of both baobab-flavoured yoghurt and plain yoghurt decreased with the storage time. The change in all the sensory attributes of each of the yoghurts with storage time was significant ($P < 0.05$) except for the flavour attribute of the baobab-flavoured yoghurt.

The appearance scores of both the baobab-flavoured yoghurt and plain yoghurt decreased throughout the storage period storage as shown in Figure 1. The plain yoghurt had higher appearance scores from day 1 up to day 28 when compared to the plain yoghurt and there was a significant difference ($p = 0.02$) in scores of the yoghurts throughout the storage period.

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 14 No. 2
April 2014
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

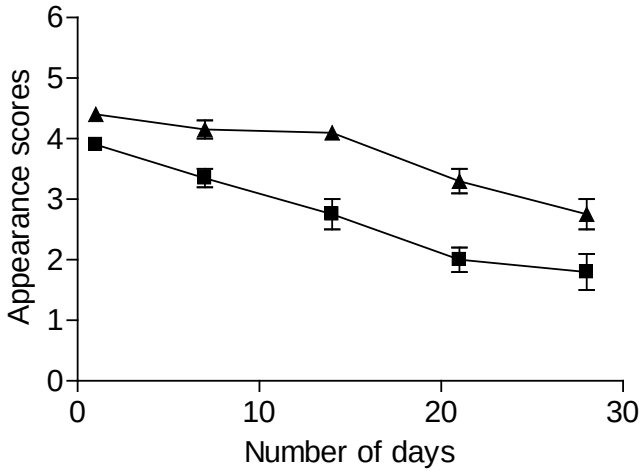

Figure 1: Appearance scores for the baobab-flavoured yoghurt (■) and control yoghurt (▲) during storage for 28 days at 4ºC in a refrigerator

The consistency on spoon scores of both the baobab-flavoured yoghurt and plain yoghurt decreased throughout the storage period storage as shown in Figure 2. On day 1 the consistency on spoon scores for both the baobab-flavoured yoghurt and the plain yoghurt had the same value. From day 7 up to day 28, the plain yoghurt had the highest scores when compared to the baobab-flavoured yoghurt and the difference in the scores was significant ($p = 0.05$) throughout the storage period.

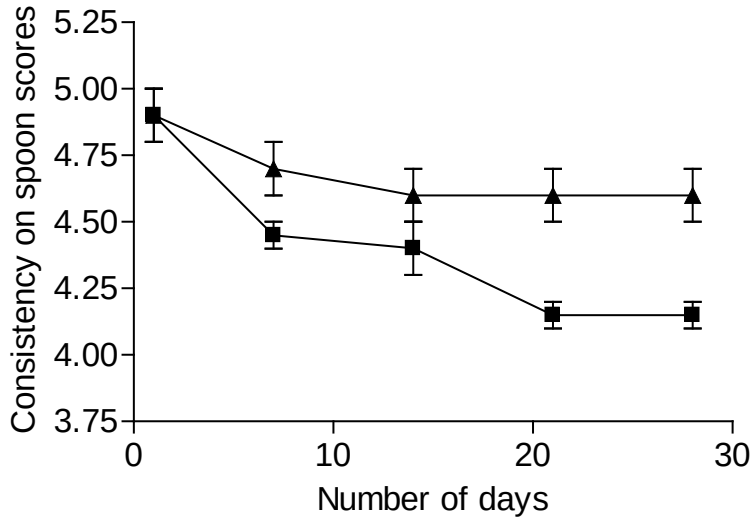

Figure 2: Consistency on spoon scores for the baobab-flavoured yoghurt (■) and control yoghurt (▲) during storage for 28 days at 4ºC in a refrigerator

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 14 No. 2
April 2014
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

The consistency in mouth scores of both the baobab-flavoured yoghurt and plain yoghurt decreased throughout the storage period storage as shown in Figure 3. The plain yoghurt had the highest consistency in mouth scores as compared to the baobab-flavoured yoghurt. There was a significant difference between the scores of the baobab-flavoured yoghurt and the plain yoghurt throughout the storage period.

The odour scores of both the baobab-flavoured yoghurt and plain yoghurt decreased throughout the storage period storage as shown in Figure 4. The baobab-flavoured yoghurt and the plain yoghurt had the same odour score on day 1. From day 7 the baobab-flavoured yoghurt had the highest odour scores when compared to the plain yoghurt and the difference in scores of the yoghurts was significant throughout the storage period ($p = 0.01$).

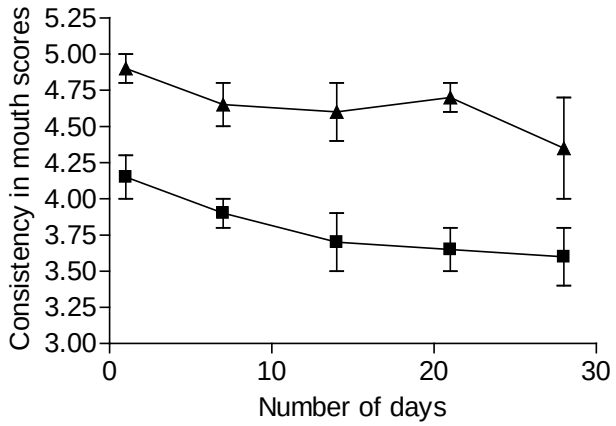

Figure 3: Consistency in mouth scores for the baobab-flavoured yoghurt (■) and control yoghurt (▲) during storage for 28 days at 4ºC in a refrigerator

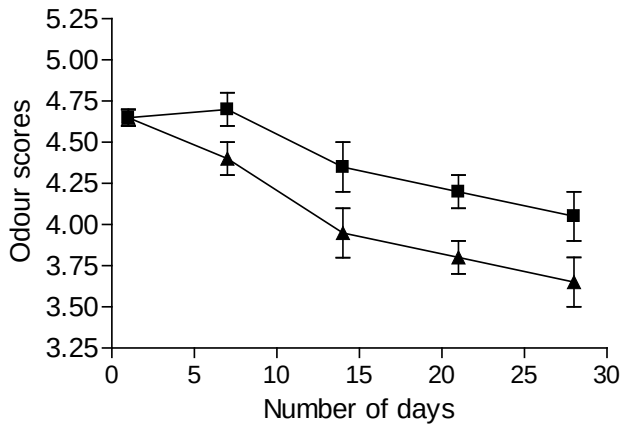

Figure 4: Odour scores for the baobab-flavoured yoghurt (■) and control yoghurt (▲) during storage for 28 days at 4ºC in a refrigerator.

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 14 No. 2
April 2014
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

The flavour scores of both the baobab-flavoured yoghurt and plain yoghurt decreased throughout the storage period as shown in Figure 5. The baobab-flavoured yoghurt had the highest scores throughout the storage period when compared to the plain yoghurt and the difference in the scores was significant (p = 0.05)

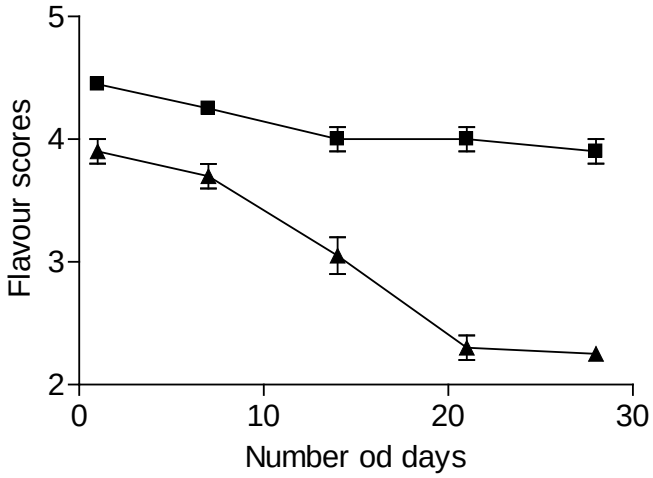

Figure 5: Flavour scores for the baobab-flavoured yoghurt (■) and control yoghurt (▲) during storage for 28 days at 4ºC in a refrigerator

The overall acceptability scores of both the baobab-flavoured yoghurt and plain yoghurt decreased throughout the storage period as shown in Figure 6. The plain yoghurt had the highest scores throughout the storage period when compared to the baobab-flavoured yoghurt and the difference in the scores of the yoghurts was significant (p = 0.01).

The taste, texture and smell sensory attributes as determined by the consumers had scores greater than 8.0 as shown in Figure 7. The colour of the baobab-flavoured yoghurt was the only sensory attribute with a score less than 8.0. The taste of the baobab-flavoured yoghurt had the highest score of 8.6 and the colour of the yoghurt had the lowest score of 7.6.

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 14 No. 2
April 2014
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

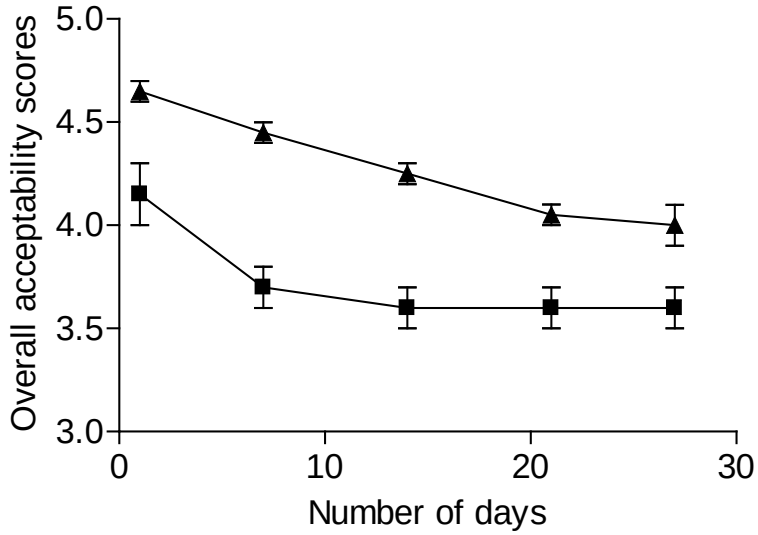

Figure 6: Overall acceptability scores for the baobab-flavoured yoghurt (■) and control yoghurt (▲) during storage for 28 days at 4ºC in a refrigerator

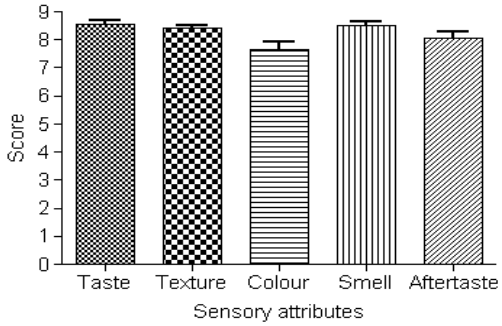

Figure 7: Consumer scores on the sensory attributes of the baobab-flavoured yoghurt

DISCUSSION

The decrease in all sensory scores with storage time might be attributed to the increase in total titratable acidity, yeasts and moulds of the yoghurts [9]. The inevitable change in acidity and microbial counts during refrigerated storage implies that yoghurts should not be stored for long periods of time [13].

The lower appearance scores of the baobab flavoured yoghurt throughout the storage period might be attributed to the observed low pH and high total titratable acid values of the baobab-flavoured yoghurt as compared to the plain yoghurt (Table 1). The

increased acidity may result in low pH values and consequently will have a negative effect on the properties of yoghurt [13, 14]. The low pH and high total titratable acid values might have caused separation of whey (syneresis) from the solids as observed in the baobab-flavoured yoghurt (Table 1). Syneresis is not acceptable as it may affect the texture of yoghurts as a result of the formation of a gel with poor consistency [15, 16]. The sensory evaluation results are in agreement with the water holding capacity results (Table 1) because the yoghurt was found to have low water holding capacity when compared to the plain yoghurt. Hence further trials should be done so as to come up with baobab-flavoured yoghurt with improved water holding capacity.

The low consistency on spoon and consistency in mouth scores of the baobab-flavoured yoghurt throughout the storage period when compared to the plain yoghurt might be attributed to the low water holding capacity (Table 1) of the baobab-flavoured yoghurt that gave a product with weak gel. The high total solids (Table 1) and subsequently the pectin content [17] of the baobab-flavoured yoghurt might also contribute to the low consistency scores. High total solids were used in the current formulation because low levels of pulp produced yoghurts that were not acceptable by the panelists in terms of taste. Consequently the baobab-flavoured yoghurt had lower overall acceptability scores when compared to the plain yoghurt because of the low appearance and consistency scores.

The high odour and flavour scores of the baobab-flavoured yoghurt were probably due to the presence of other volatiles in the pulp in addition to the diacetyl and acetaldehyde compounds produced during fermentation [18]. The decrease in odour and flavour scores of both the plain yoghurt and baobab-flavoured yoghurt throughout the storage period may be due to increases in organic acids production during storage as suggested by other studies [19]. As reported elsewhere, if the acid level becomes too high, the acid taste becomes offensive to a majority of consumers. In addition, the intense acid taste masks the other flavour and odour notes of the yoghurt [19].

The high taste, texture and smell sensory scores of the baobab-flavoured yoghurt by the consumers indicated that the yoghurt was liked very much by all the panelists. In general the consumers liked the flavour and taste of the baobab-flavoured yoghurt despite the astringent aftertaste reported when large quantities of the yoghurt are consumed. The problems observed by consumers included separation of whey from the yoghurt solids and the off white colour that was atypical of yoghurts.

CONCLUSION

The current study indicated that sensory attributes of the baobab-flavoured yoghurt and plain yoghurt decreased with time of storage. The plain yoghurt had higher appearance, consistency on spoon and consistency in mouth scores up to day 28 when compared to the baobab-flavoured yoghurt. In contrast the baobab-flavoured yoghurt had higher odour and flavour scores up to day 28 when compared to the plain yoghurt. The change in all the sensory attributes of each of the yoghurts with storage time was

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 14 No. 2
April 2014
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

significant ($P < 0.05$) except for the flavour attribute of the baobab-flavoured yoghurt. Although the yoghurt had an astringent aftertaste, the consumer scores indicated that the baobab-flavoured yoghurt was acceptable in terms of its taste, texture, colour and smell.

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 14 No. 2
April 2014
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 1: Physico-chemical parameters of the baobab-flavoured yoghurt and the plain yoghurt

Parameter	Baobab yoghurt	Plain yoghurt
pH	3.72	4.53
Total titratable acidity	0.72	0.70
Water holding capacity	65.79	71.21
Total solids	20.12	17.30

REFERENCES

1. **Fooks LJ and GR Gibson** Probiotics as modulators of the gut flora. *Br J Nutr.* 2002; **88:** S39–S49.

2. **Do not use et al here…Hjartåker A, Lagiou A, Slimani N, Lund E, Chirlaque MD, Vasilopoulou E, *et al*** Consumption of dairy products in the European Prospective Investigation into Cancer and Nutrition (EPIC) cohort: data from 35 955 24-hour dietary recalls in 10 European countries. *Public Health* Nutr. 2002; **5:**1259– 1271.

3. **Ballew C, Kuesters S and C Gillespie** Beverage choices affect adequacy of children's nutrient intakes. *Archives of Pediatrics and Adolescent Medicine.* 2000**; 154**: 1148– 1152.

4. **Ouwehand AC, Blanchi S, Salvadori B, Fondén R, Mogensen G, Salminen S and R Sellars** Health effects of probiotics and culture-containing dairy products in humans. *Bulletin of the International Dairy Federation.* 2003; **380:** 4–19.

5. **Sanders ME** Probiotics: considerations for human health. *Nutr rev.* 2003; **61**: 91–99.

6. **FAO.** Traditional food plants. *Food and Agriculture Organisation of the United Nations, Rome.* 1988; **24**: 63-67.

7. **Chadare FJ, Linnemann AR, Hounhouigan JD, Nout MJR and MAJS Van Boekel** Baobab Food Products: A Review on their Composition and Nutritional Value. *Crit. Rev.* Food *Sci. Nutr.* 2009; **49**: 254-274.

8. **Kaboré D, Sawadogo-Lingani H, Diawara B, Compaoré CS, Mamoudou H, Dicko MH and M Jakobsen** A review of baobab (*Adansonia digitata*) products: Effect of processing techniques, medicinal properties and uses. *AJFS.* 2011; **16**: 833-844.

9. **Tan G and F Korel** Quality of flavoured yoghurt containing added coffee and sugar. *J Food Quality***.** 2007**; 30:** 342–356.

10. **Kurt A, Cakmakci S and AA Caglar** Guide Book of Analysis Methods of Milk and Milk Products. Erzurum, Turkey: Atatürk University, Agricultural Faculty Pub. no18. 1996.

11. **AOAC**. Official methods of analysis of the association of official analytical chemist, 15th edition, Virginia 22201, Arlington. **1990**; 148-150.

12. **Li J and M Guo** Effects of polymerized whey proteins on consistency and water-holding properties of goat's milk yogurt. *J. Food Sci.* 2006; **71**: 34–38.

13. **Salvador A and SM Fiszman** Textural and sensory characteristics of whole and skimmed flavoured set-type yoghurt during long storage. *J. Dairy Sci.* 2004; **87:** 4033 – 4041.

14. **Sodoni I, Remufe F, Haddad S and G Corrieu** The relative effect of milk base, starter, and process on yoghurt culture: A review. *Crit. Rev.* Food *Sci. Nutr.* 2004; **44:** 113 – 137.

15. **Wacher-Rodarte C, Galvan MV, Farres A, Gallardo F, Marshall MVE and M Garcia-Garibay** Yoghurt production from reconstituted skim milk powders using different polymer and non polymer forming starter cultures. *J Dairy Res.* 1993; **60:** 247 -254.

16. **Ramaswamy HS and S Basak** Pectin and raspberry concentrate effects on the rheology of stirred commercial yoghurt. *J Food Sci.* 1992; **57:** 357-360.

17. **Ndabikunze BK, Masambu BN, Tiisekwa BPM and A Issa-Zacharia** The production of jam from indigenous fruits using baobab (*Adansonia digitata* L.) powder as a substitute for commercial pectin. *AJFS*. 2011; **5**: 168 – 175.

18. **Tribby D** Flavor Criticisms, Causes and Corrective Action for Cultured Dairy Products, Penn State University Cultured Products Short Course. 2001**.**

19. **Ryssad G and RK Abrahamsen** Formation of volatile aroma compounds and carbon dioxide in yoghurt starter grown in cows and goats milk. *J Dairy Res.* 1987; **54**: 257- 261.