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Research Application Summary

Physico-chemical, microbiological and sensory qualities of probotic yoghurt enriched with baobab pulp

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Abstract

Yoghurt is a healthy food as it contributes to alleviation of Lactose intolerance, protection against gastrointestinal infection, anti-carcinogenic effect and immune system stimulation. Integrating yoghurt with baobab pulp was hypothesised to enhance its health benefits through enrichment with baobab pulp nutrients including dietary fibre. The objective of this study was to determine the effect of baobab pulp on the physicochemical, microbiological and sensory properties of probiotic yoghurt. Yoghurts were prepared and blended with pasteurized baobab pulp at the rate of 0%, 10%, 20%, 30% and 40%. In 28 days of storage, all yoghurt samples revealed a significant ($p<0.05$) decrease in pH value and an increase in titratable acidity, viscosity and total soluble solids. Microbiologically, yoghurts were stable and with satisfactory sanitary conditions for consumption. Acceptability tests sensory analysis tests showed that yoghurts enriched with 10% baobab pulp showed the greatest acceptance by consumers. From this study, it may thus be concluded that yoghurt enriched with baobab pulp is a good food alternative, because it has benefits to the health of consumers.

Keywords: Acidity, baobab, immune system, physicochemical property, sensory properties, vitamin C

Résumé

Le yaourt est un aliment sain car il contribue à soulager l'intolérance au lactose, la protection contre l'infection gastro-intestinale, l'effet anti-cancérogène et la stimulation du système immunitaire. L'intégration du yaourt avec de la pulpe de baobab a été évoquée pour améliorer ses bienfaits pour la santé grâce à l'enrichissement en éléments nutritifs de la pulpe de baobab, y compris les fibres alimentaires. L'objectif de cette étude était de déterminer l'effet de la pulpe de baobab sur les propriétés physico-chimiques, microbiologiques et sensorielles du yaourt probiotique. Les yaourts ont été préparés et mélangés avec de la pulpe de baobab pasteurisée à un taux de 0%, 10%, 20%, 30% et 40%. Dans 28 jours de stockage, tous les échantillons de yaourt ont révélé une diminution significative ($p<0,05$) de la valeur du pH et une augmentation de l'acidité titrable, de la viscosité et des solides solubles totaux. Microbiologiquement, les yaourts étaient stables et avec des conditions sanitaires satisfaisantes pour la consommation. Les tests d'acceptabilité et les tests d'analyse sensorielle ont montré que les yaourts enrichis avec 10% de pulpe de baobab ont montré une plus grande acceptation des consommateurs. A partir de cette étude, on peut donc conclure que le yaourt enrichi en pulpe de baobab est une bonne alternative alimentaire, car il a des avantages pour la santé des consommateurs.

Mots-clés: Acidité, baobab, système immunitaire, propriété physico-chimique, propriétés sensorielles, vitamine C

Background

Yoghurt is cultured milk produced through a fermentation process (Amanze, 2011). Yoghurt evolved empirically centuries ago by allowing naturally contaminated milk to sour at a warm temperature, in the range of 40-50^{O}C. The micro-organisms which are used conventionally in this process are referred to as "starter culture. Yoghurt is essential in alleviation of Lactose intolerance, protection against gastrointestinal infection, has anticarcinogenic effect, stimulates the immune system, has antihypertensive activity, has antiallergenic qualities and alleviaties of constipation (McKinley, 2005 and Panesar, 2011).

Yoghurt promises greater nutritional benefit when enriched with other fruits such as carrots (Aly *et al.*, 2004; Madora *et al.,* 2016), phytosterols (plant sterols) (Izadi*et al.*, 2014), coconut (Ndife, *et al.,* 2014) and pineapple and ginger (Ihemeje *et al.,* 2015). Fruits have gained a central place among dieticians and nutritionists due to their wide array of benefits that they confer particularly in the preparation of high energy value and dietetics food including yoghurt, flour for babies, jams, and marmalades (Amellal *et al.,* 2011).

Enrichment with baobab pulp increases the nutritional content of yoghurt, including minerals and vitamins such as Vitamin C, pectin, riboflavin, niacin (Besco *et al.*, 2007). Several amino acids such as alanine, arginine, glycine, lysine, methionine, proline, serine, valine and minerals especially Calcium, Magnesium, Potassium and Sodium (Kamatou *et al.*, 2011). Moreover baobab fruit pulp exhibits higher antioxidant properties hence have the higher ability of combating the formation of free radicals (Ojotu *et al.,* 2013). According to Osman (2004) baobab fruit pulp contains high amount of carbohydrate (76.2%), low protein (8.2%), very low fat (0.3%), metabolizable energy of 320 Kcal/100 g and crude fiber content of 5.4 percent. The acceptance of baobab fruit pulp as food ingredient by the European Union (EC 2008) and the US Food and Drug Administration (FDA, 2009) has pushed the demand and utilization of baobab in food production. It is now used in industrial production process particularly in enrichment of products including yoghurt. Baobab pulp has been utilized in several food formulations including jam (Ndabikunze *et al.,* 2011).

Baobab pulp can be used in the yoghurt processing as it blends well with probiotics bacteria that make up the natural flora of our gastrial intestinal system. Lactic acid bacteria (LAB) and bifidobacteria, as are normal components of the intestinal microbiota and have a long tradition of safe application within the food industry (Siró *et al.*, 2008). However, there is a dearth of information regarding physico-chemical, microbiological and sensory quality of probotic yoghurt enriched with baobab pulp. The absence of this information limits the level with which baobab can adequately be integrated in yoghurt production as an enrichment. This study sought to determine the physiochemical, microbial and sensory properties of the probiotic yoghurt enriched with baobab pulp in order to promote and increase the utilization and consumption of underutilized baobab fruits.

Study description

This study was conducted at Jomo Kenyatta University of Agriculture and Technology in Kenya from September 2015 to June 2016. The fruits were collected from Makuyuni area, Arusha-Tanzania in their original pod. The hard woody shells of the fruits were opened by hand to obtain seeds, embedded in a whitish powdery soft pulp and grounded by pestle and mortar to separate the pulp from the seeds. The mixture was sieved through a 0.09 micron sieve to obtain a fine powder, according to the procedure from Ndabikunze *et al.* (2011).

Fresh milk purchased from local suppliers in Juja, Kenya was used. Starter culture containing *Streptococcus salivarius* subsp. *thermophillus* and probiotics *Bifidobacterium* spp and *Lactobacillus acidophilus* was used. The milk was heated to about 85°C to kill any undesirable bacteria and to partially break down the milk proteins. The sample was then cooled to about 44°C. Commercial probiotic culture of *Bifidobacterium* spp, *Lactobacillus acidophilus* and *S. thermophillus* was added. This active culture was used to inoculate the litre of milk. The temperature of milk at inoculation was 44°C and was maintained for 6 hours to allow for fermentation and the rapid production of Lactic-acid by the inoculated bacteria.

The baobab pulp was made into a slurry/gel and pasteurized at 85°C for 15 minutes and was blended with yoghurt at various levels ranging from of 0%, 10%, 20%, 30% and 40%. The baobab enriched yoghurts were subjected to physicochemical tests which included titratable acidity, pH, viscocity and total soluble solids. Microbial tests included yeast, moulds and coliform counts after 1, 7, 14, 21 and 28 days of storage. Sensory evaluation test was conducted using 9-hedonic point scale.

Statistical analyses were performed by applying one-way analyses of variance (ANOVA) to determine the significance at the 95% confidence interval using SPSS version 20. The mean differences were analyzed by Least Significance Difference test.

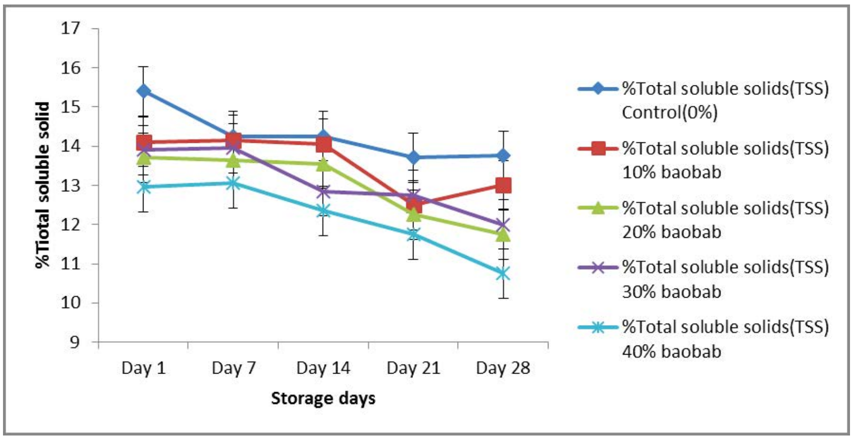

Figure 1: Changes in Total soluble solid of yoghurt product during storage

Results

Percentage soluble solid content decreased throughout the days of monitoring for both control and baobab enriched yoghurt in yoghurt (Fig. 1). On day 28, TSS in yoghurt with 40%, 30%, 20% and 10% baobab pulp added had decreased from 12.95% to 10.75%, 13.9% to 12%, 13.7% to 11.75% and 14.1% to 13%, respectively. The control sample decreased from 15.4% to 13.75%, therefore the highest decrease was in yoghurt with 40% baobab. The results for pH for different yoghurt samples are presented in Fig. 2. They indicate a decrease in pH as the days increased.

From day one, the yoghurt having 40 % of baobab had low pH value of 3.45±0.05 while the control is showed high pH value of 4.56±0.01.The decrease in pH on the 28th day was 4. 2±0.2, 3.9±0.1, 3.7±0.2, 3.57±0.03 and 3.45±0.05 for control, 10%, 20%, 30% and 40% baobab added yoghurt, respectively. All results were significant at a p value of $p<0.05$.

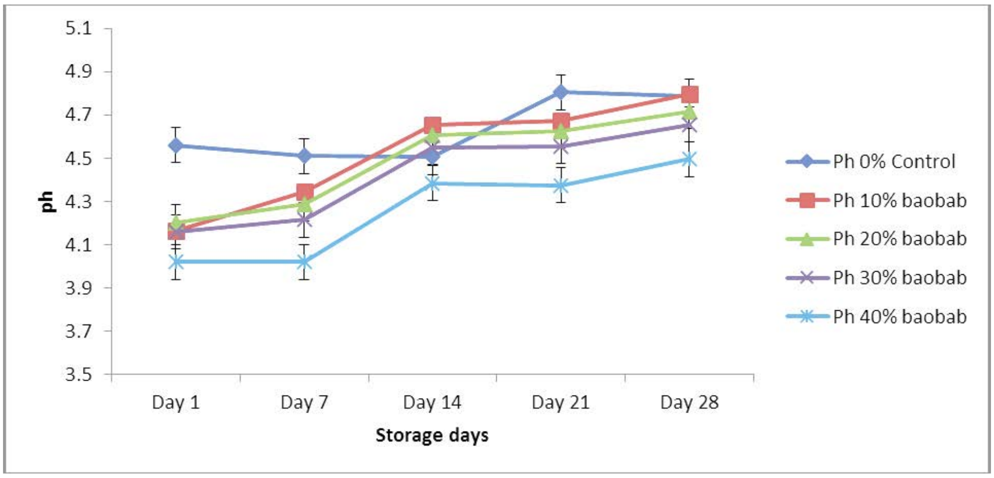

Figure 2: Changes in pH for yoghurt products during storage

The viscosity of the samples as shown on Fig. 3 indicates a decrease with days. On day one, the control (yoghurt) was less viscous with value of 3.57 (cP). This increased to 4.79(cP) on day (seven), then to 4.93cP on day 14 and decreased to 4.24 cP on day 28.

The baobab added yoghurt had a unique viscosity trend. Viscosity increased on day 7 and 14 for 10% and 20% yoghurt while for 30% and 40% yoghurt , viscosity decreased on day 14. Yoghurt with 10% baobab added was more viscous with 5.77(cP) on day 14. The low viscosity on day 28 was reported on the control (yoghurt) with significantly ($P<0.05$) lower value of 3.6p (cP).

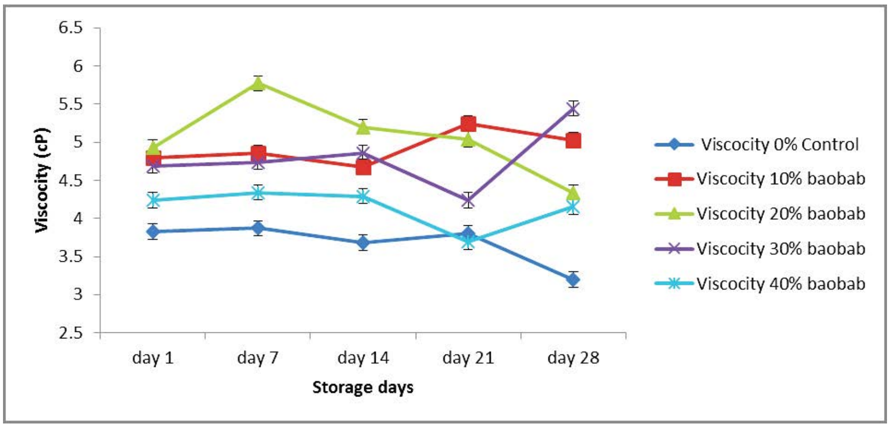

Figure 3: Changes in viscosity of yoghurt products during storage

Figure 4 shows the values of % TTA of yoghurt samples from day one (1) to day twenty eight (0.88%) . Results shows slight decrease for the control (yoghurt), 10% baobab and 30% baobab, and extreme increase for 40% baobab on day 28.

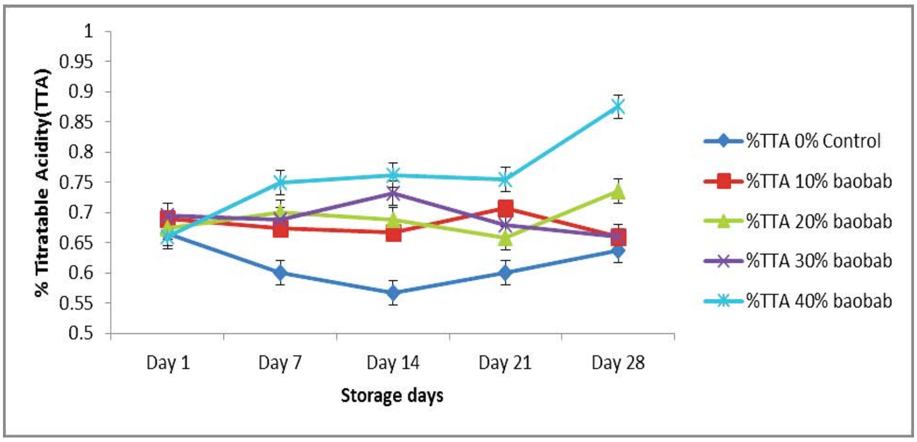

Figure 4: Changes in tritatable acidity of the yoghurt product during storage

The microbial populations of different yoghurt samples at day one and after seven days of cold storage at 4ºC were enumerated to evaluate quality of the finished product with respect to presence of undesirable spoilage and pathogenic organisms. The total viable counts for freshly prepared control ranged from 1×102 CFU. ml^{-1} to 5×10^2 $CFUml^{-1}$ at 4ºC. On the other hand the total viable counts for the control and enriched yogurts on day one to day seven of storage were zero but on day 14 increased (1×10^1) $CFUml^{-1}$ for 30% baobab pulp yoghurt (Table 1). Coliform, *Escherichia coli* and *Salmonella* spp were not detected in control and baobab pulp enriched yogurts throughout the 28 day storage period. However, yeasts and molds count detected on day 14 of storage were 17×10^2 CFU. ml^{-1}, 2×10^2 CFU. ml^{-1} and 2×10^3CFU. ml^{-1} for 0%, 30% and 40%, respectively, except for 20% and 10% for the counts on day 21 and 28, respectively.

Table 1: Microbial count of yoghurt products during storage

	Storage days	Treatment 0% baobab	10% baobab	20% baobab	30% baobab	40% baobab
Total count(cfu)	1	0	0	0	0	0
	7	0	0	0	0	0
	14	0	0	0	$1x10^1$	0
	21	$1x10^2$	$1x10^2$	0	$1x10^2$	0
	28	$5x10^2$	$55x10^1$	$1x10^2$	$2x10^2$	$40x10^1$
Yeast/Moulds(cfu)	1	0	0	0	0	0
	7	0	0	0	0	0
	14	$17x10^2$	0	0	$2x10^2$	$2x10^3$
	21	$27x10^2$	0	$1x10^3$	$4x10^2$	$4x10^3$
	28	$34x10^2$	$46x10^2$	$22x10^2$	$24x10^2$	$47x10^2$
Coliform	1	Negative	Negative	Negative	Negative	Negative
	7	Negative	Negative	Negative	Negative	Negative
	14	Negative	Negative	Negative	Negative	Negative
	21	Negative	Negative	Negative	Negative	Negative
	28	Negative	Negative	Negative	Negative	Negative

Values are means of three readings.

Sensory properties. The sensory evaluation results of probiotic yoghurt enriched with baobab pulp are presented in Fig. 5 at different concentrations. The nine point hedonic scale was used, where 1= like extremely and 9= dislike extremely. The results for aroma showed the enriched yoghurt with 10% baobab pulp had higher mean score of 7.15, 40% baobab pulp yoghurt had higher mean score of 6.70 while 10% and 20% baobab pulp yoghurt had a similar mean score of 6.35.

Appearance for 20% baobab pulp yoghurt had higher mean score of 7.05, and in the case of gel thickness and firmnesss the results showed 20% baobab pulp had higher mean score of 7.45 and 7.40, respectively. For overall acceptability, 10% baobab pulp added had the highest acceptability mean score of 7.15.

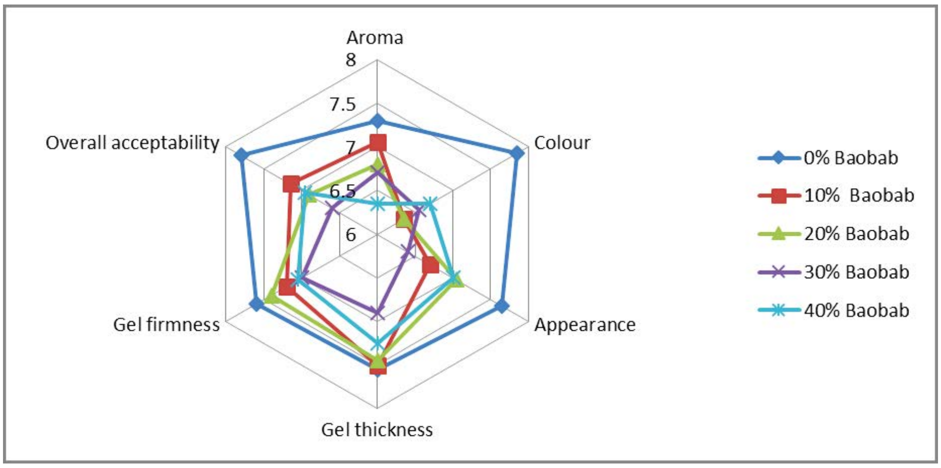

Figure 5: Effect of Baobab pulp concentration on sensory evaluation of probiotic yoghurt

Discussion

The content % TSS is reasonably lower compared to the findings of Igbabul *et al.* (2014) who reported the range of 18.4% to 21.41%. However our results are within the range reported by Ndife *et al.* (2014). Lactic acid bacteria ferment lactose to produce lactic acid thus lowering the pH (Ndife *et al.,* 2014). However, baobab is rich in organic acid such as citric, tartaric, malic, succinic and ascorbic acid (Kamatou *et al.,* 2011) and yeast could be a contributing factor for having low pH for the baobab added yoghurt (Larsson, 2009). Generally pH shows a steady decline throughout storage time.

Viscosity is affected by the strength and number of bonds between casein micelles in yoghurt, as well as their structure and spatial distribution (Izadi *et al.,* 2014). Yoghurt is a gel/matrix of casein micelles with entrapped water. Adding baobab pulp interrupts the gel structure. It was reported that the apparent viscosity of yoghurt during storage time decreased. However, the viscocity may increase over time due to the rearrangement of protein and protein-protein contacts (Izadi *et al.,* 2014).

Titratable acidity values were within the average of 0.6% acidity recommended for plain yoghurt (Ndife *et al*., 2014). According to Sengupta *et al.* (2013), microbial count for yeast and mould keep increasing as days progressed. An increase in acidity or reduction in potential oxygen during fermentation process may provide suitable conditions for growth of yeasts and molds. The absence of *Escherichia coli* signifies that all the yogurt samples were free from fecal contamination. Overall acceptability of enriched yoghurt having baobab pulp of 10% showed high score indicating that it is more acceptable by consumers compared with other enriched yoghurt.

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