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Research Application Summary

Gastro-intestinal viability of probiotics in baobab enriched yoghourt

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Abstract

A study was conducted to assess the viability of probiotics in the simulated gastro intestinal tract, vitamin C and mineral contents in probiotic yoghurt. Various concentrations of baobab enriched yoghourts were prepared. Results showed that probiotics used in yoghurt had survival rates of 22% - 52% after passing through simulated gastric juice and duodenum. The effect of baobab was significant ($p > 0.05$) for vitamin C and magnesium but insignificant for calcium and zinc. Probiotic yoghurt enriched with baobab pulp not only had a higher nutrient content than plain yoghourt but also a higher survival rate in the gastro intestinal tract (GIT). This is an important finding because yoghourt supports growth and metabolic activities of beneficial micro-organism in the GIT.

Key words: Baobab pulp, calcium, probiotic yoghurt, survival rate, vitamin C, zinc

Résumé

Une étude a été menée pour évaluer la viabilité des probiotiques dans le tractus gastro-intestinal simulé, la teneur en vitamine C et en minéraux du yaourt probiotique. Différentes concentrations de yaourts enrichis au baobab ont été préparées. Les résultats ont montré que les probiotiques utilisés dans le yaourt avaient des taux de survie de 22% à 52% après avoir traversé le suc gastrique et le duodénum simulés. L'effet du baobab était significatif ($p < 0,05$) pour la vitamine C et le magnésium, mais insignifiant pour le calcium et le zinc. Le yaourt probiotique enrichi en pulpe de baobab avait non seulement une teneur en nutriments plus élevée que le yaourt nature, mais aussi un taux de survie plus élevé dans le tractus gastro-intestinal (TGI). Ceci reste une découverte importante parce que le yaourt soutient la croissance et les activités métaboliques des micro-organismes dans le TGI.

Mots clés: pulpe de baobab, calcium, yaourt probiotique, taux de survie, vitamine C, zinc

Background

Yoghurt is the most widely used fermented milk product and its consumption has increased tremendously. The regular consumption of probiotic foods like yoghurt can provide health benefits to human beings, not only on the nutritive value of milk from which it is made, but also from the beneficial effect of intestinal microflora, improved lactose tolerance and protection against gastrointestinal infections, effective treatment for specific types of diarrhoea, improved immunity, cholesterol reduction and protection against cancer (Fadela *et al*., 2009; Ghalem and Zouaoui, 2013; Lollo *et al*., 2013; Hassanein *et al*., 2014).

Yoghurt and particularly probiotic yoghurts contribute to human health by providing natural nutrients and by enrichment of the intestinal microbiota with lactic acid bacteria and probiotic cultures. They provide several benefits for humans. Among them are better resistance to infections, stimulation of the immune system (Bahrami *et al*.,2013) and better absorption of minerals and lactose (Fadaei, 2013). The probiotic activity of some strains with the ability to colonize the intestinal epithelium strengthening to stabilize the intestinal microflora, especially after antibiotic treatment, has been well described in previous studies (Mazahreh *et al*., 2009).

Interest for probiotics has arisen in recent years especially in relation to addition of *Bifidobacterium* spp*, Lactobacillus acidophilus, Lactobacillus rhamnosus, Lactobacillus casei* and *Lactobacillus reuteri* to the fermented dairy products such as yoghurt (Fadaei, 2013). After ingestion, these probiotic cultures are believed to play a significant role in the intestinal system against some of the pathogenic microorganisms such as *Helicobacter pylori, Salmonella typhi* and *Yersinia enterocolitica* (Fadaei, 2013; Abd El-Gawad *et al*., 2014). To develop expected therapeutic benefits, a sufficient number of viable microorganisms must be present in the product (Fadaei, 2013).

Fruit yoghurt is a product which is made by adding fruit to yoghurt. Adding fruits such as baobab requires no preservatives, maintain their natural colour and flavour and have an acceptable texture. Furthermore, when such fruits or dried pieces are added to yoghurt, they have the tendency to absorb some of the free or unbound water from the yoghurt gel (Sarmin *et al*., 2014), and also improvement of the nutritional value.

Therefore, a study was under taken to develop probiotic yoghurt enriched with baobab pulp and to establish the viability of probiotics in a simulated gastrointestinal tract and nutritional component (vitamin C and minerals).

Study description

This study was conducted at Jomo Kenyatta University of Agriculture and Technology in Kenya from September 2015 to June 2016. The baobab fruits were collected from Makuyuni area, Arusha-Tanzania in their original pods. 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 Ndabikunze *et al*. (2011). Fresh milk purchased from local suppliers in Juja, Kenya was used. A 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. A commercial probiotic culture of *Bifidobacterium* spp., *Lactobacillus acidophilus* and *S. thermophillus* was added. The temperature of milk at inoculation was 44°C and was maintained for six 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 survival of the microorganisms in the simulated gastric and duodenal fluids, vitamin C and mineral content (calcium, zinc and magnesium). 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. Significant treatment means were separated using the Least Significance Difference (LSD) test.

Results

The probiotic used for making yoghurt were tested in simulated gastric and duodenum fluid for survival. All samples showed probiotic survival rates that ranged from 22% -52% after three hours in the gastric juice and duodenum (Table 1). Yoghurt blended with 30% baobab pulp exhibited higher survival rate of 52% where the initial count was 8.45 log10 (cfu/ml).

Vitamin C content was significantly ($P<0.05$) influenced by baobab concentration. It was lowest in the control (0.60±0.04 mg/100g) yoghurt and highest (7.07±0.10mg/100g) in the 40% baobab treatment (Table 2). Results for mineral analysis of plain yoghurt (mg/100g) for calcium, magnesium and zinc are shown in Table 2. Zinc and calcium contents were not significantly influenced by baobab concentration ($P = 0.05$).

Table 1. Survival rates of probiotics (LACTOBACILLUS and BIFIDOBACTERIA) in baobab blended yoghurt in simulated gastric and duodenum fluid

Sample	Initial count	Gastric log 10CFU/ml			Duodenum log 10 CFU/ml		
		1 h	2h	3h	4 h	5h	6h
0% baobab	7.3	3(41)	2.78(38)	2.6(36)	2.78(38)	2(27)	0
10% baobab	7.48	3.41(46)	3.20 (43)	3(40)	3.68(49)	3.32(44)	2.30(31)
20% baobab	8.38	3.89(46)	3.51(42)	3.44(41)	3.83(46)	3.58(43)	2.30((27)
30% baobab	8.45	4.39(52)	4.2(50)	4(47)	3.90(46)	3.68(44)	2.85(34)
40% baobab	8.95	2.69(30)	3(34)	3.08(34)	2.78(31)	2(22)	2(22)

Figures in brackets represent the survival rate; h= hours

Discussion

Results from the study suggest that probiotics in yoghurt can tolerate gastro intestinal tract conditions. Results also show that addition of baobab pulp to yoghurt support probiotics growth. The reason for higher survival rates for probiotics could be that baobab pulp has soluble fiber (25%) which stimulates growth and metabolic activities of beneficial organisms (Abdalla *et al*., 2010). Moreover, products attained a the minimum recommended bacterial population of 106 cfu (6 log10 cfu) (Cencic and Chingwaru, 2010; Granato *et al*., 2010) fulfil the aim of compensating the possible reduction in

the number of probiotic micro-organisms during passage through the gut.The results also support findings of Ihemeje *et al*. (2015) that yoghurt is a very good source of essential minerals needed for human metabolism or functionality of cells. Addition of baobab pulp caused an increase in calcium, magnesium and zinc. A similar increase of minerals was also observed when carrot, pineapple, ginger and pepper fruit were used (Ihemeje *et al*., 2015). Baobab pulp is also rich in calcium (302mg/100g) and magnesium (195mg/100g). This may have caused the observed increase in mineral values of the products.

Table 2. Vitamin C and mineral contents of yoghurt blended with different amounts of baobab in simulated gastric and duodenum fluid

Samples	Vitamin C (mg/100g)	Calcium (mg/100g)	Magnesium (mg/100g)	Zinc (mg/100g)
0% Baobab pulp	0.60±0.04a	64.12±6.69a	12.05±2.36a	0.83±0.19a
10% Baobab Pulp	2.75±0.22b	65.89±8.18a	21.56±1.84b	0.85±0.19a
20% Baobab Pulp	2.95±0.02c	67.86±17.57a	21.87±1.58b	0.86±0.17a
30% Baobab Pulp	3.35±0.03d	85.87±26.19a	22.05±6.79b	1.01±0.12a
40% Baobab Pulp	7.07±0.10f	88.47±6.65a	31.03±3.98c	1.59±1.42a
P-value	<.001	0.207	0.002	0.585

Each value in average of three replicates. Values are Mean ±Standard deviation. Means in the same column followed by the same superscript are not significantly different at $p<0.05$

Conclusion

This study showed that the baobab enriched yoghurt was highly nutritious and superior in most quality attributes than conventional yoghurt. The viability on simulated gastro intestinal tract showed higher survival rates in yoghurt enriched with baobab pulp, hence supporting growth of probiotics. Thus, baobab pulp can be used to produce symbiotic functional yoghurt with acceptable probiotic and prebiotic properties. Fortifying yoghurt or dairy products with baobab pulp is of great interest in improving the functionality of foods with health benefits. The addition of baobab pulp to yoghurt would complement its healthy characteristics. The results showed that the nutritional quality of plain yoghurt was improved by addition of baobab pulp especially for vitamins and minerals. This implies that the therapeutic potency of yoghurt could be improved because consumption of foods with high vitamin C can aid in combating deficiency diseases like scurvy. An adequate supply of minerals improves functionality of cells and also supports immunity of the body.

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References

Abd El-Gawad, I., El-Sayed, E., El-Zeini, H., Hafez, S. and Saleh, F. 2014. Antibacterial activity of probiotic yoghurt and soy-yoghurt against *Escherichia coli* and *Staphylococcus aureus*. *Nutrition*

and Food Sciences 4 (5): 1–6. http://doi.org/10.4172/2155-9600.1000303

Abdalla, A.A., Mohammed, M.A. and Mudawi, H.A. 2010. Production and quality qssessment of instant baobab (*Adansonia digitata* L .). *Advanced Journal of Food Science and Technology* 2 (2):125–133.

Bahrami, M., Ahmadi, D., Alizadeh, M. and Hosseini, F. 2013. Physicochemical and sensorial properties of probiotic yogurt as affected by additions of different types of hydrocolloid. *Food Science of Animal Resources* 33 (3): 363-368.

Cencic, A. and Chingwaru, W. 2010. The role of functional foods, nutraceuticals, and food supplements in intestinal health. *Nutrients* 2(6):611–625. http://doi.org/10.3390/nu2060611

Fadaei, V. 2013. Influence of *Spirulina platensis* powder on the starter culture viability in probiotic yoghurt containing spinach during cold storage. *European Journal of Experimental Biology* 3 (3): 389–393.

Fadela, C., Abderrahim, C. and Ahmed, B. 2009. Sensorial and physico-chemical characteristics of yoghurt manufactured with ewe's and skim milk. *World Journal of Dairy & Food Sciences* 4 (2): 136–140.

Ghalem, B.R. and Zouaoui, B. 2013. Microbiological, physico-chemical and sensory quality aspects of yoghurt enriched with Rosmarinus officinalis oil. *African Journal of Biotechnology* 12 (2): 192–198. http://doi.org/10.5897/AJB12.1257

Granato, D., Branco, G.F., Cruz, A.G., Faria, J. de A. F. and Shah, N.P. 2010. Probiotic dairy products as functional foods. *Comprehensive Reviews in Food Science and Food Safety* 9 (5):455–470. http://doi.org/10.1111/j.1541-4337.2010.00120.x

Hassanein, A.M., Tawfic, E.A. and El-Shazly, H.A.M. 2014. Effect of concentrated pomegranate on probiotic yoghurt. *World Applied Sciences Journal* 30 (5): 567–574. http://doi.org/10.5829/idosi.wasj.2014.30.05.14103

Ibrahima, C., Didier, M., Max, R., Pascal, D., Benjamin, Y. and Renaud, B. 2013. Biochemical and nutritional properties of baobab pulp from endemic species of Madagascar and the African mainland. *African Journal of Agricultural* 8 (47): 6046–6054. http://doi.org/ 10.5897/AJAR12.1231

Ihemeje, A.C.N. and Nwachuku, C.C.E. 2015. Production and quality evaluation of flavoured yoghurts using carrot, pineapple, and spiced yoghurts using ginger and pepper fruit. *African Journal of Food Science* 9 (3): 163–169. http://doi.org/10.5897/AJFS2014.124.

Lollo, P.C.B., De Moura, C.S., Morato, P.N., Cruz, A.G., Castro, W. de F., Betim, C.B. and Amaya-Farfan, J. 2013. Probiotic yogurt offers higher immune-protection than probiotic whey beverage. *Food Research International* 54 (1): 118–124. http://doi.org/10.1016/ j.foodres.2013.06.003

Malgorzata, Z. and Dorota, Z. 2010. Viability of microflora of market fermented milk products in simulated conditions of gastric and duodenum. *Acta Sci.Pol. Technol. Aliment* 9 (2): 227–236.

Mazahreh, A.S., Turki, O. and Ershidat, M. 2009. The benefits of lactic acid bacteria in yogurt on the gastrointestinal function and health. *Pakistan Journal of Nutrition* 8 (9): 1404–1410.

Ndabikunze, B.K., Masambu, B.N. and Tiisekwa, B.P.M. 2011. The production of jam from indigenous fruits using baobab (*Adansonia digitata* L.) powder as a substitute for commercial pectin. *African Journal of Food Science* 5: 168–175.

Ndife, J., Idoko, F. and Garba, R. 2014. Production and quality assessment of functional yoghurt enriched with coconut. *International Journal of Nutrition and Food Sciences* 3 (6): 545–550. http://doi.org/10.11648/j.ijnfs.20140306.19

Sarmin, N.S. 2014. Development of a ripened jack (*Artocarpus heterophyllus*) fruit incorporated set yoghurt. Proceedings of Jaffina International Research Conference. pp. 14–21.

Stapleton, P. 2015. Characterizing baobab, the nutritious African "Tree of Life". Biodiversity International. pp. 1–2.

Vikram, V.B., Ramesh, M.N. and Prapulla, S.G. 2005. Thermal degradation kinetics of nutrients in

orange juice heated by electromagnetic and conventional methods. *Journal of Food Engineering* 69 (1): 31–40. http://doi.org/10.1016/j.jfoodeng.2004.07.013