SENSORY AND CHEMICAL EVALUATION OF YOGHURT FORTIFIED WITH PINEAPPLE JUICE

Olusola O. O.,[*] Durosinmi Comfort O.,[#] Ajibade J. F.[*] and Ajayi D.A..[#]
[*]: Department of Animal Science, University of Ibadan. Ibadan, Oyo State. Nigeria.
[#]: Animal Genetic Resources Department, National Centre for Genetic Resources and Biotechnology. Moor Plantation, Ibadan. Oyo State. Nigeria

ABSTRACT
Yoghurt is a coagulated milk product obtained by controlled fermentation of lactose in milk by the action of Lactobacillus bulgaricus and Streptococcus thermophiles. Improvement of the sensory characteristics of yoghurt has been accessed with sucrose to enhance sweetness, cream to provide smoother texture with limited information on the use of fruit juices. This study was therefore carried out to access the effect of fruit (pineapple juice) on the taste and flavor of yoghurt. Yoghurt was prepared with ripe cayenne pineapple juice incorporated at different levels; T1: 0% (Plain yoghurt), T2: 0% (2% synthetic flavour), T3: 5%, T4: 10% and T5: 15%. Yoghurt samples were analyzed for proximate and nutritional composition as well as sensory properties. Yoghurt with 15% pineapple juice had the lowest fat (5.19%) and pH (4.05) values and was significantly different (p< 0.05) from other treatments. There were significant differences (p< 0.05) in the mean values of crude protein, fats and ash of the yoghurt samples. Crude protein, fats and ash values were significantly different (p< 0.05). Crude fibre values for 5, 10 and 15% were not significantly different (p>0.05) from each other but 15% pineapple juice yoghurt had the highest crude fibre value (0.19%). There was no significant difference (P>0.05) in the mean values for odour, colour and texture of yoghurt samples while 15% pineapple juice yoghurt had the highest score for taste (5.10). Graded levels of pineapple juice had an impact on the proximate and nutritional compositions, and also the sensory properties of yoghurt.
Keywords: Pineapple Juice, Sensory, Taste, Texture, Yoghurt.

INTRODUCTION

Yoghurt is a coagulated milk product which is obtained by fermentation of lactose in milk the use of *Lactobacillus bulgaricus* and *Streptococcus thermophiles* (Pelczar *et al*., 1986). The fermentation process converts lactose to lactic acid, thereby causing the characteristic curd. The lactic acid lowers the pH, makes it tart, causes the milk protein to thicken and act as a preservative since pathogenic bacteria cannot grow in an acid condition (Sharar, 2013). The partial digestion of the milk when these bacteria ferment the milk makes yoghurt easily digestible (David, 2003) and hence more suitable for young children and lactose intolerant adults.

To modify certain properties of yoghurt, various food additives may be added for instance, to sweeten yoghurt, sucrose may be added, and cream could also be added to provide texture. The consistency and shelf stability of the yoghurt could be improved by adding stabilizers such as food starch, gelatin, locust bean gum, guar gum and pectin. To improve taste and flavor, many kinds of fruits may be added (Tamine and Robinson, 1986). However, the harmful effects of food additives may be immediate or in the long run if one has constant exposure or accumulations. Immediate effects may include headaches, change in energy level, and alterations in mental concentration, behavior, or immune response (Pandey and Upadhyay, 2012). Some modern synthetic preservatives have become controversial because they have been implicated to cause respiratory or other health problems (Pandey and Upadhyay, 2012).

The association between the diet rich in fruits and vegetables and a decreased risk of cardiovascular diseases and certain forms of cancer is supported by considerable epidemiological evidence (Riboli and Norat, 2003). Phenolic and other phytochemical antioxidants found in fruits and vegetables are capable of neutralizing free radicals present in human organs which cause oxidative damages to lipids, proteins and nucleic acids that eventually lead to degenerative diseases. (Kaur and Kapoor, 2001). Since the rate of increase in incidences of life-threatening diseases like cancer, kidney diseases, and liver diseases has been traced to the accumulated use of synthetic materials in food production, there is a need to provide safer alternatives from natural products such as fruits.

Pineapple is known as the queen of fruits due to its excellent flavour and taste (Baruwa, 2013). It is the third most important tropical fruit in the world after Banana and Citrus (Bartholomew, 2003). Pineapple contains a considerable amount of calcium, potassium, vitamin C, carbohydrates, crude fibre, water and different minerals that are good for the digestive system, and helps in maintaining ideal weight and balanced nutrition (Md. Farid *et al.,* 2015).
The objective of this study is to provide healthy alternatives to the use of synthetic flavorants in yoghurt production.

Materials and methods
The study was carried out in the Animal Products and Processing Laboratory of the Department of Animal Science. University of Ibadan, Ibadan. Nigeria. Fresh milk was obtained from Akinyele cattle market, Ibadan, Nigeria. Fresh pineapples, (cayenne variety), sugar and synthetic pineapple flavour were bought in Bodija market, Ibadan, Nigeria. Mother culture (unsweetened plain yoghurt) was obtained from a leading yoghurt brand in Ibadan, Nigeria. Preparation of yoghurt was done in a controlled, well-sanitized environment. The raw milk was physically examined for physical contaminants and pasteurized at 77ºC. On attaining 77ºC, it was cooled to 45ºC and inoculated with 3% volume/volume (v/v) starter culture. Afterwards, the milk was incubated at 43ºC for three hours to form the curd. Following incubation, the curd was broken and stirred till a smooth consistency was achieved. Sugar was added at 3% (weight/volume) inclusion rate and stirred till it was completely mixed. Cayenne variety of pineapple was used for the study. The pineapples were thoroughly washed to reduce contamination of the juice, and peeled. The peeled pineapples were diced to smaller cuts for easy extraction of juice. Extraction was done using a Master Chef juicer (Model: MC-JBL2102). The juice was also pasteurized before mixing with yoghurt. Samples of the pineapple juice were analyzed for bromelain and ascorbic acid contents. The yoghurt was divided into five transparent containers which represented each treatment as follows: Treatment 1: Sweetened plain yoghurt, Treatment 2: Synthetic flavoured (2% v/v) yoghurt, Treatment 3: 5% (v/v) pineapple juice yoghurt, Treatment 4: 10% (v/v) pineapple juice yoghurt, Treatment 5: 15% (v/v) pineapple juice yoghurt. Each treatment was replicated thrice
The product for this study were subjected to proximate analysis which was carried out according to AOAC, (2005). Sensory analysis was carried out using a 10-man taste panel for evaluation of flavour, taste, appearance, consistency, and overall acceptability on a 7-point hedonic scale. Panelists were trained and provided with crackers biscuit with water to rinse their mouths after evaluating each sample to give an accurate evaluation of each treatment sample.
All data collected were subjected to One-Way Analysis of Variance using the completely randomized design of the Statistical Analysis System software version 9.2 (SAS, 2011) and means were separated using Duncan multiple range test.

RESULTS AND DISCUSSION
Table 1: Proximate analysis of yoghurt samples

Variables (%)	**Treatment 1**	**Treatment 2**	**Treatment 3**	**Treatment 4**	**Treatment 5**	**SEM**
Moisture	77.88^{c}	79.47^{a}	78.40^{b}	77.61^{d}	77.62^{d}	0.00
Dry matter	22.12^{b}	20.53^{d}	21.60^{c}	22.39^{a}	22.38^{a}	0.00
Crude protein	29.73^{a}	28.35^{b}	26.52^{c}	22.38^{d}	28.35^{b}	0.01
Crude fibre	0.02^{b}	0.02^{b}	0.17^{a}	0.12^{a}	0.19^{a}	0.01
Fats	8.17^{a}	7.97^{b}	6.36^{c}	5.96^{d}	5.19^{e}	0.02
Ash	0.81^{a}	0.43^{d}	0.43^{d}	0.57^{b}	0.49^{c}	0.00

^{abcde}- means with different superscripts on the same row are significantly different (P< 0.05)
SEM- Standard error of mean 1: Plain yoghurt 2: 2%Synthetic pineapple flavoured yoghurt 3: 5% pineapple juice yoghurt 4: 10% pineapple juice yoghurt 5: 15% pineapple juice yoghurt

Proximate analysis, which is the estimation and determination of how much of the major food components, (Moisture, CHO, Lipids, Proteins, Ash, Crude Fibre), exist in a given food, is presented in table 1. Moisture content results shows that there is a significant difference (P<0.05) among the treatments. However, treatments 4 (77.61%) and 5 (77.62%) are not different from each other with the

least values of moisture content. Treatment 2 (79.47%) has the highest value for moisture content. From the results, moisture content decreased with addition of pineapple juice and dry matter content increased with addition of pineapple juice. This may be attributed to the total solids content which was observed to increase with addition of pineapple juice. This result is similar to the result of a similar experiment carried out with orange juice, strawberry and grape juice by Hossain *et al.* (2012). Crude protein (CP) values ranged from 26.52% to 29.73%. The highest CP was recorded by plain yoghurt and the least by 5% and 10% pineapple juice yoghurt. The reduction in CP values may be attributed to the low protein content of pineapple juice as reported as Nnam and Njoku, (2005).

For crude fiber content, treatments 3 (0.17%), 4 (0.12%) and 5 (0.12%) were significantly different ($P<0.05$) from treatments 1 and 2 (0.02%). Crude fibre values are lowest in plain yoghurt and synthetic flavoured yoghurt because milk do not contain fibre according to Aliyu *et al.* (2015). So, the increase in fibre content in 5%, 10% and 15% pineapple juice yoghurt could be as a result of the fibre content of pineapple juice. Crude fibre is important in proper and efficient functioning of the digestive system.

Fats results reveals that all treatments were significantly different from each other ($P<0.05$). Treatment 1 (8.17%) had the highest fat content. Treatment 1 had the highest ash value (0.81) which was significantly different from other treatments. Fat content values are reduced with addition of fruit juice. This may be due to the low-fat content in pineapple juice. Plain yoghurt recorded the highest fat content value. This result is in accordance with the result of Amal *et al.* (2016) who observed that there were slight decreases in the fat content of the yoghurt which contained fruit.

For ash, values ranged from 0.49% to 0.81%. Plain yoghurt recorded highest ash value while lower values were recorded in the pineapple juice flavoured yoghurt. USDA (2013) reported that pineapple juice is low in ash and this may be the reason for the reduced ash value in the pineapple juice flavoured yoghurt. This result agrees with a similar experiment result carried out by Njoya *et al.* (2016).

Table 2: Nutritional Composition of fortified yoghurt samples

Variables	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	SEM
Lactose (%)	4.31^{b}	4.40^{a}	4.10^{e}	4.16^{d}	4.25^{c}	0.00
Ascorbic acid(mg/g)	0.87^{b}	0.88^{a}	0.84^{e}	0.85^{d}	0.86^{c}	0.00
Calcium (%)	0.18^{b}	0.19^{a}	0.16^{e}	0.17^{d}	0.18^{c}	0.00
Phosphorus(%)	0.25^{b}	0.26^{a}	0.22^{e}	0.23^{d}	0.24^{c}	0.00

abcde: means with different superscripts on the same row are significantly different ($P< 0.05$)

SEM: Standard error of means 1: Plain yoghurt 2: Synthetic pineapple flavoured yoghurt 3: 5% pineapple juice yoghurt 4: 10% pineapple juice yoghurt 5: 15% pineapple juice yoghurt

Lactose content, ascorbic acid, phosphorus and calcium contents of pineapple yoghurt are shown in Table 2. There were significant differences ($P<0.05$) in the lactose, ascorbic acid, calcium and phosphorus values of the yoghurt samples. The highest values were recorded by treatment 2 (4.40, 0.88, 0.19 and 0.26%) and the least by treatment 3 (4.10%, 0.84, 0.16%, 0.22%) for lactose, ascorbic acid, calcium and phosphorus.

Lactose content, ascorbic acid, phosphorus and calcium contents of pineapple yoghurt increased with increasing volume of pineapple juice. However, these values are lower than plain yoghurt and synthetic pineapple flavoured yoghurt. The cause of decrease in lactose value in pineapple juice yoghurt may be because of rapid conversion of lactose to lactic acid due to the availability of soluble sugar present in pineapple juice available to the lactic acid bacteria as a source of energy. This result agrees with those reported by Njoya *et al.* (2016). The lower ascorbic acid result in pineapple juice yoghurt may be due to the heat treatment given to pineapple before being incorporated into the yoghurt as vitamins are easily denatured by heat. However, 15% pineapple yoghurt has the highest ascorbic acid content which is an indication that pineapple is a source of ascorbic acid (Joy, 2010) and increase in the inclusion rate of pineapple in yoghurt increased ascorbic acid content.

Pineapple juice is a poor source of calcium and phosphorus according to Joy. (2010). This may explain why the calcium and phosphorus values were lower in pineapple yoghurts compared to plain

yoghurt and synthetic flavoured yoghurt. However, increasing the inclusion rate of pineapple juice in yoghurt can increase the calcium and phosphorus contents of yoghurt.

Table 3: Sensory analysis of fortified yoghurt samples

Variables	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5	SEM
Appearance	5.10	4.60	4.90	5.30	5.20	0.24
Aroma	3.00	2.80	3.20	3.10	2.70	0.28
Texture	4.50	4.80	4.00	4.80	4.60	0.23
Taste	4.40^{b}	4.60^{ab}	4.20^{b}	4.40^{b}	5.10^{a}	0.17
Overall acceptability	4.80	4.30	4.80	4.50	5.30	0.26

[ab]: means with different superscripts on the same row are significantly different (P< 0.05)
SEM: Standard error of means 1: Plain yoghurt 2: Synthetic pineapple flavoured yoghurt 3: 5% pineapple juice yoghurt 4: 10% pineapple juice yoghurt 5: 15% pineapple juice yoghurt

There was no significant difference (P>0.05) among the entire sample in terms of aroma, appearance, texture and overall acceptability. The results are shown in Table 3. However, for taste, 15% pineapple juice had highest score (5.10) which may be attributed to the increased volume of pineapple juice in the treatment. This confirms the report of Cakmakcı *et al.* (2012) that the use of different fruits in fruit yoghurt production has been found to improve the nutritional and sensory properties. This result also agrees with the result of Duangrutai (2014).

REFERENCES

Aliyu, Y., Abdullahi, I., Whong, C., Anumiri, C., Bwala, J., and Esimi, S. (2019). The Proximate Composition of Fresh and Fermented Milk in Parts of Nasarawa State, Nigeria. Asian Food Science Journal. 1-12. 10.9734/afsj/2019/v10i430047.

Amal, A.M., Eman, A.M.M. and Zidan, N.S. (2016). Fruit Flavored Yoghurt: Chemical, Functional and Rheological Properties. *International Journal of Environmental and Agriculture Research,* 2(5) ,57–66.

AOAC (2005) Association of Official Analytical Chemist, Official Methods of Analysis. 18th Edition, AOAC International, Suite 500, 481 North Frederick Avenue, Gaithersburg, Maryland 20877-2417, USA

Baruwa, O. I. 2013. Profitability and constraints of pineapple production in Osun State, Nigeria. *Journal of Horticultural Research.* 21(2): 59-64.

Cakmakci, S., Cetin, Y., Turgut, T., Gurses, M. and Erdoğan, A. (2012). Probiotic properties, sensory qualities, and storage stability of probiotic banana yogurts. *Turk. J. Vet. Anim. Sci.*36(3): 231-237

David, B. F. 2003. Yoghurt making illustration. In; Biology and Chemistry,Clermont Science College, Batavia. pp.45 - 103.

Duangrutai, T. 2014. Effect of Thai fruits on Sensory properties of Fruit Yogurt and Survival of Yoghurt Starter Culture added with Probiotic Strains in Fruit Yoghurt. *Research Journal of Pharmacological Biological and Chemical Science.* 5.3: 283-290.

Hossain, M. N., Fakruddin, M. and Islam M. N. 2012. Development of Fruit Dahi (Yoghurt) Fortified with Strawberry, Orange and Grapes Juice. *American Journal of Food Technology.*7.9: 562-570

Joy, P. P. 2010. Benefits and uses of pineapple. Pineapple Research Station, Kerala Agricultural University, Kerala, India. [http://www.kau.edu/prsvkm/Html/BenefitsofPA.htm]

Kaur C and Kapoor HC. 2001. Antioxidants in fruits and vegetables – the millennium‘s health. Int J Food Sci. and Technol. 36:703-725.

Md. Farid H, Shaheen A and Mustafa A. 2015. Nutritional Value and Medicinal Benefits of Pineapple. *International Journal of Nutrition and Food Sciences.* Vol. 4, No. 1, pp. 84-88. doi: 10.11648/j.ijnfs.20150401.22

Njoya, M. A., Nain, C. W., Mahbou, P. Y. and Imele, H. 2016. Physicochemical, microbiological and sensory properties of pineapple (Ananascomosus (L.) Merr.) flavoured yoghurt. *International Journal of Agriculture Innovations and Research* 4.6; 1154-1158

Nnam N. M. and Njoku I. E. 2005. Production and evaluation of nutrient and sensory properties of juices made from citrus fruits. *Nigerian Journal of Nutrition Science,* 26 (2) 62-66

Pandey, R. M. and Upadhyay, S. K., 2012. Food Additive. Prof. Yehia El-Samragy (Ed.), ISBN: 978-953-51-0067-6

Pelczar, M.J., Chan E.C.S. and N.R. Krieg, 1986. Microbiology. McGraw-Hill, Inc., New York, pp: 635-639.

Riboli E. and Norat T. 2003. Epidemiologic evidence of the protective effect of fruit and vegetables on cancer risk. American Clinical Nutrition. 78: 559–569.

Sharar, N. S. 2013. Lactic acid fermentation of pasteurized and powdered milk and optimizing the factors affecting the fermentation process. A project submitted to the Department of Microbiology, Brac University.

Tamine, A. Y. and Robinson, R. K. 1986. Yoghurt Science and Technology. Pergamon press limited, Oxford. pp.431

U.S. Department of Agriculture (USDA), National Nutrient Database for Standard Reference, Release 26, 2013. Published online at: http://ndb.nal.usda.gov/ (assessed April 07, 2014).