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Quality Comparison of Flavoured and Non-flavoured Yoghurts from Animal and Vegetable Milk Sources

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Abstract
In this study, the physico-chemical, microbiological and organoleptic properties of flavoured and non-flavoured yoghurt samples made from powdered whole milk (PWM) and soymilk (SYM), were comparatively evaluated using standard methods. The results were significantly ($p<0.01$) different and showed that PWM yoghurt samples contained higher moisture (77.8 ± 0.025-78.21 ± 0.48%); lactose (1.02 ± 0.01-1.86 ±0.03%); crude fat (3.29 ± 0.10- 3.30 ±0.10%); TTA (total titratable acidity: 0.21 ±0.02- 0.25 ±0.01%) and pH (4.17 ±0.12-4.40±0.02) while SYM yoghurt samples recorded higher total solids (13.05 ± 2.01- 13.11 ±0.64%); ash (0.76 ± 0.02-0.79 ±0.04%); crude protein (3.35 ± 0.09 – 4.76 ±0.12%); crude fibre (0.81 ± 0.02 – 0.88 ± 0.01%) and specific gravity (0.82 ± 0.01-0.84 ±0.00). No lactose was detected in SYM yoghurt. There was significant ($p<0.01$) difference in the total microbial count of the two samples while some other non-identified growths were observed. Blind organoleptic evaluation results of the flavoured yoghurt samples showed significant ($p<0.01$) differences in the sensory attributes measured with PWM2 yoghurt being more generally acceptable than SYM2. However, no significant ($p<0.01$) effect of flavourings on general acceptability of the yoghurt samples was established.

Keywords: Milk, soymilk, yoghurt, microbiology, flavour, quality.

INTRODUCTION

Yoghurt is a fermented dairy product popular across the world. Among the various cultured dairy products, yoghurt is unique with the presence of acetaldehyde which is relatively high in concentration and desirable as an essential flavour component [1]. This uniqueness is attributable to the synergistic and symbiotic fermentative processes of a specific mixed-starter culture of *Lactobacillus delbruekii subsp. bulgaricus* and *Streptococcus salivarius subsp. thermophilus* during its production process [2]. During this process, lactic, acetic and formic acids, together with acetaldehyde and diacetyl give yoghurt its characteristic smooth texture, tart flavour and aroma [3]. In recent years, its associated health benefits were elucidated,established and brought to the fore by a new trend in nutrition towards healthy living through functional foods, nutraceuticals, probiotics and prebiotics [4 - 10]. This led to an increase in yoghurt consumption since the last decade [2].

Animal milk is the traditional raw material for making yoghurt [11 - 13]. In developing countries the twin challenges of continuous population growth and malnutrition have made the cost of animal milk /its products highly prohibitive with gross inadequate supply [11 & 13; 14 - 16]. This has led to populations in the developing world not being able to meet their average daily protein requirements.

In order to ameliorate these short-comings and meet the protein demands in these countries, research efforts are geared towards finding alternative sources of protein from plants [14 & 17]. It must be stressed as well that as a result of recent trends in nutrition, there is an increasing concern about fat, cholesterol and lactose intolerance associated with animal milk as well as the issue of a wider choice for vegetarians [11 & 13]. These factors have made vegetable milk and its products to become highly favoured. The production of yoghurt from these alternative milk sources like soymilk, tigernut milk, and coconut milk has been reported [12 - 13; 18 - 21]. Of all the alternative vegetable milk sources, only soymilk has been extensively investigated [22 - 23]. However, the main objections to soybean products are intrinsic off-flavours which have been described as beany or astringent [11]. Lactic acid fermentation has been reported to reduce anti-nutritional factors [24] and flatulent sugars namely starchyose and raffinose [25]. It has been reported that decreased phytic acid as a result of the action of phytase synthesized by micro-organisms increased bioavailability of minerals in legume grains [26].

With this background, it is expected that the modification of processing methods [11] including the use of sweetners and flavours [27] will enhance the quality and wider acceptability of soymilk yoghurt compared to powdered whole milk yoghurt. This strategy is primary in improving the quality and status of nutrition of developing countries.

The objective of this study, therefore, is to comparatively evaluate the physico-chemical, microbiological and organoleptic properties of flavoured and non-flavoured yoghurt samples produced from soymilk and powdered whole milk.

MATERIALS AND METHODS

Materials and samples

The materials used for this study which included Powdered whole milk (NANA brand); Mixed-starter culture of *Lactobacillus delbruekii subsp. bulgaricus* and *Streptococcus salivarius subsp. thermophilus*; Rayner's Vanilla Flavouring Essence; Sucrose and Treated water were supplied by the Quality Control Department of Wimbig Food Industries, Etinan in Akwa Ibom State, South-South Nigeria (a local yoghurt manufacturing outfit). The soymilk powder was purchased from the Central Supermarket, Uyo. All chemicals and reagents used for the analyses were of analytical grades and

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were provided by the Quality Control Unit of Wimbig Food Industries, Etinan, Nigeria. The method described by Farinde et al [12] was adapted and modified to produce the two yoghurt samples (Figure 1).

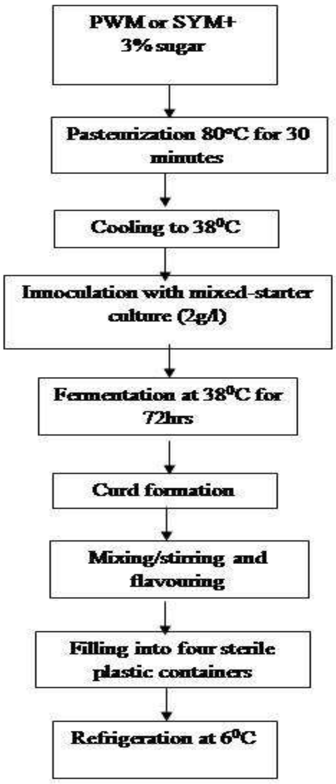

Figure 1: Flow chart for yoghurt processing. (Adapted and modified from Farinde et al [12]). Key: PWM = Powdered whole milk, SYM = Soymilk

Sample processing

Five kilograms each of powdered whole milk (PWM) and soymilk powder (SYM) were reconstituted according to their manufacturers' recommendations and used as base materials. The modification of the Farinde et al [12] method was as follows: the milk types were fortified with 3% (w/v) sucrose before being pasteurized (at 80 °C for 30 minutes), cooling (to 38 °C), inoculated (at the rate of 2g of innoculum/litre of each milk type) and fermented (at 38 °C for 72 hours). The samples were split as lots and flavoured with vanilla at the rate of 2ml/kg to the samples: PWM1 (non-flavoured whole-powdered milk yoghurt), PWM2 (flavoured whole-powdered milk yoghurt), SYM1 (non-flavoured soymilk yoghurt) and SYM2 (flavoured soymilk yoghurt). Samples were subsequently packaged in four sterile containers and refrigerated at 6^{o}C through out their evaluation period.

Physico-chemical analysis

Samples were analysed for moisture content; total solids; ash; lactose; crude protein; crude fat; crude fibre; SG (specific gravity); TTA (total titratable acidity) and pH using standard methods [28].

Microbiological analysis

The PWM and SYM yoghurt samples were examined for viable counts of bacteria, *Esherichia coli*, yeast and moulds using Nutrient Agar, Eosin Methylene Blue Agar and Potato Dextrose Agar, respectively. The pour plate technique was used to enumerate the total number of viable microbes in all yoghurt samples. Serial dilution was done using normal saline to 10^{-7} dilution and 1 ml of 10^{-7} dilution was added into each petri dish. Cooled sterilized molten nutrient agar was added into the plates, allowed to solidify and incubated in aerobic conditions at 38°C for 24 hours [28]. The number of colonies counted on the plates was recorded taking into consideration the dilution factor and used to calculate colony forming units (cfu). The presence of *E. coli* was determined by plating yoghurt samples on Eosin Methylene Blue Agar and incubating at 38°C for 18 hours [29]. The presence of yeasts and molds were enumerated by plating serially diluted samples of PWM and SYM yoghurts on potato dextrose agar. The plates were incubated at 25°C for 3-4 days [30].

Organoleptic analysis

A *blind* organoleptic test was carried out for the PWM2 and SYM2 yoghurt samples to evaluate their sensory attributes according to Ihekoronye and Ngoddy [31]. A randomly numbered panel of five untrained judges (all of whom were familiar with yoghurt and used it daily) rated and ranked the sensory characteristics of the samples on a nine-point hedonic scale for colour, aroma, taste, and general acceptability.

Experimental design

The experiment was conducted in a randomized complete block design (RCBD). with incubation temperature (38^{0}C), innoculum concentration (2g/l) and each of the two base materials (PWM and SYM) split into three blocks and each of the two treatments replicated three times to give thirty-six experimental units.

Statistical analysis

All determinations were carried out in triplicate and mean values and standard deviations (S.D) calculated. Analysis of variance (ANOVA) was used to determine differences among mean values of data obtained from the physico-chemical and microbiological analysis. The Student t-test was applied to statistically compare the organoleptic analysis data of the yoghurt samples. Significant differences were accepted at $p<0.01$ [32; 33].

RESULTS AND DISCUSSION

Physico-chemical composition

The physical and chemical composition of the yoghurt samples are presented in Table 1. The result revealed that the composition of samples were significantly ($p<0.01$) different. The values were within range and are comparable with those reported by Muhammed et al [34]; Osundahunsi et al [11] and Mayunzu et al [35] for whole cow milk and soymilk yoghurts, respectively. Farinde et al [12] also reported that soymilk contains more protein than most animal milk, although, Shilpa et al [36] observed that their amino acid profile differ. No lactose was detected in SYM yoghurt confirming the report of Buono et al [25] that soybeans contained some other sugar profile such as raffinose and starchyose. The fortification of SYM with sucrose may have contributed to improved lactic acid fermentation by the mixed-starter culture observed in its yoghurt samples. However, the differences in the pH levels of the PWM and SYM yoghurt samples (and by implication the titratable acidity) might, apparently, be a reflection of the ability of the mixed-starter culture to grow in the various samples and ferment the carbohydrates they contained which is in concordance with the observation of Tuitemwong and Tuitemwong [37] that lactic acid bacteria (LAB) from different sources are quite different in their efficiencies in yoghurt fermentation. However, it was noticed that soymilk does not support the growth of micro-organisms including bifidobacteria and lactobacilli [38]. This may have had some effect on the flavour of SYM2 yoghurt sample.

Table 1. Proximate composition of whole-powdered milk and soymilk yoghurt samples*

Sample	Moisture Content (%)	Total Solids (%)	Ash (%)	Lactose (%)	Crude Protein (%)	Crude fat (%)	Crude fibre (%)	S.G.	TTA (%)	pH
PWM1	78.21 ±0.25^{b}	12.50 ±1.24^{j}	0.46 ±0.01^{f}	1.86 ±0.03^{d}	3.20 ±0.15^{g}	3.29 ±0.10^{a}	0.20 ±0.00^{h}	0.71 ±0.01^{d}	0.25 ±0.01^{e}	4.40 ±0.01^{bc}
PWM2	77.80 ±0.40^{b}	12.76 ±1.08^{j}	0.45 ±0.01^{f}	1.02 ±0.01^{d}	3.04 ±0.10^{g}	3.30 ±0.10^{a}	0.20 ±0.01^{h}	0.71 ±0.01^{d}	0.21 ±0.02^{e}	4.17 ±0.01^{bc}
SYM1	51.40 ±0.12^{a}	13.05 ±2.01^{c}	0.76 ±0.02^{e}	ND -	4.76 ±0.12^{bc}	2.11 ±0.01^{c}	0.81 ±0.02^{i}	0.82 ±0.01^{k}	0.18 ±0.02^{b}	4.09 ±0.12^{m}
SYM2	52.10 ±0.28^{a}	13.11 ±0.64^{c}	0.79 ±0.04^{e}	ND -	3.35 ±0.09^{bc}	2.08 ±0.01^{c}	0.88 ±0.01^{i}	0.84 ±0.00^{k}	0.17 ±0.01^{b}	4.00 ±0.02^{m}

*Values are means of triplicate determinations ± S.D. ND - Not Detected.
abcMeans with different superscripts on the same column are significantly different at p<0.01.

Microbiological analysis

The microbial load of PWM and SYM yoghurt samples are shown in Table 2. The microbiological analysis was done to evaluate the survival of the mixed-starter culture microorganisms (which confers some functional health benefits on yoghurt) and the presence of spoilage and pathogenic organisms. Mean total count for PWM yoghurt was 6.76x10^{7} and 2.15x10^{4} for SYM yoghurt. These results were significantly (p<0.01) different and in line with average total viable count of 4.04 ± 0.93 x 10^{8} and 4.6 ± 1.22 × 10^{8} reported for *Mondia whytei* and vanilla yogurts respectively [35]. Lopez et al [39] also reported a log aerobic mesophilic count from < 1.0-5.38 and from 4.87-6.67 per ml in natural yogurt. The colony features of the growths were moist, smooth, opaque and creamy, without pigmentation. The growth of PWM yoghurt sample was sharp and distinct unlike that of SYM yoghurt which was sluggish and non distinct. When viewed under the microscope, they were rod shaped and in short chains. They were also catalase negative and stained purple with Gram stain. This indicated that some of the starter culture organisms survived the arrest of the process through cooling although their actions may have been slowed down. There was no growth of *E. coli* recorded which confirmed that all the samples were free from faecal contamination. However, some other forms of growths with different colourations (Table 2) were observed which were suspected to be molds and/or yeasts. However, their identification was beyond the scope of this study.

Table 2. Total microbial count of whole-powdered milk and soymilk yoghurt samples

Sample *	Total count (cfu/ml)	E.coli (cfu/ml)	Colours of other growths
PWM1	6.76×10^{7}±0.62^{a}	NG	White¹
√	-	-	Dark-green²
√	-	-	Greenish²
SYM1	2.15×10^{4}±0.71^{c}	NG	White¹
√	-	-	Blue-green²
√	-	-	Dark-brown²

*Values are means of triplicate determinations ± S.D.
abcMeans with different superscript on the same column are significantly different at p<0.01. NG – No Growth. ¹Yeast suspected. ²Mold suspected.

Organoleptic analysis

The result of the organoleptic analysis showed that PWM2 yoghurt sample was preferred to SYM2 yoghurt in all the sensory attributes measured (Figure 2). Mean scores of the attributes for the two samples were significantly (p<0.01) different. Overall, PWM2 yoghurt was more generally acceptable to the panellists than the SYM2 yoghurt. This result is in line with those of Muhammad et al [34] who worked with whole cow milk, powdered milk and soymilk yoghurts but differed from the findings of Farinde et al [12] who reported overall acceptability of soymilk yoghurt fermented with commercial starter and soymilk yoghurt fermented with maize steep water over the commercial yoghurt. However, no significant (p<0.01) effect of flavourings on general acceptability of the yoghurt samples was established. This agrees with the result reported by Muhammad et al [34] and Trachoo & Mistry [40].

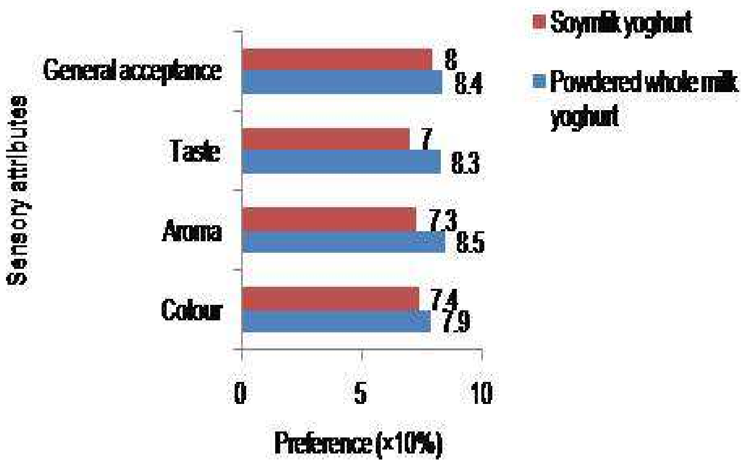

Figure 2: Sensory evaluation of yoghurt samples

CONCLUSION

In this study, the physico-chemical, microbiological and organoleptic properties of flavoured and non-flavoured yoghurt samples made from powdered whole milk (PWM) and soymilk (SYM) were comparatively evaluated. Despite comparative quality and organoleptic properties, the PWM2 yoghurt was more generally acceptable than SYM2 yoghurt. The discovery of cheaper proteins in vegetables as alternatives to costly animal proteins could solve increased protein demand in developing countries considering their comparative nutritional benefits. However, some characters such as off-flavours, astringency and anti-nutritional factors need to be eliminated to enhance wider acceptability of their products.

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