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Full Length Research Paper

Use of alternative raw materials for yoghurt production

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Soymilk and maize steep water were used as alternative raw materials to cow milk and commercial starter, respectively, for production of yoghurt. The cow milk used was both Fresh milk and dried powdered milk (DANO). The cost of production of the yoghurt samples as well as their chemical, microbial and organoleptic properties was compared with that of the commercially available yoghurt (FAN MILK). There was no significant difference (P<0.05) in the protein content of soymilk yoghurt (either fermented with commercial starter or maize steep water) and that of the dried powdered milk yoghurt fermented with maize steep water. Soymilk yoghurt fermented with commercial starter contained the highest moisture, the least carbohydrate and the least total solid, 94.07%, 0.81% and 5.89 g/100 g, respectively. The commercial yoghurt recorded the highest phosphorous and calcium 59.09 and 49.60 ppm, respectively. There was no significant difference (p<0.05) in the total viable count of soymilk yoghurt fermented with commercial starter and soymilk yoghurt fermented with maize steep water. Soymilk yoghurt fermented with maize steep water compares well with the other yoghurt samples organoleptically and costs less to produce.

Key words: Cow milk yoghurt, soymilk yoghurt, commercial yoghurt, commercial starter, maize steep water, chemical, microbial and organoleptic properties.

INTRODUCTION

Fermented milk products are sour tasting milk which has been made by either fermenting the milk naturally or by the use of starter culture to produce the desirable milk products. Examples of fermented milk in Africa, Syria, India, America and Nepal are Cheese, nono, buttermilk, yoghurt, irgo, kadam, laban, shenineh, dahi, shirkand, mahi, etc. (Ajayi, 2006). Yoghurt is a tasty fermented drink, nutritious and easily digestible. It has become an important dairy product in Nigeria (Akinnubi, 1998). Conventionally, yoghurt is produced from cow milk and commercial starter.

Soybean (*Glycine max*), a plant protein which is cheaper could serve as an alternative to cow milk. Soybean is richer in protein than most animal milk. It contains up` to 40% protein compared with 1.0% to 5.6% protein content of most animal milk (Burton, 1985). Soymilk is processed from soybean. Intake of fermented soymilk improves the ecosystem in the intestinal tract by increasing the amount of probiotics (Chang et al., 2005). This study aims at using maize steep water as an alternative to the expensive commercial starter for inoculation of milk for fermentation. Maize steep water has been found to contain lactic acid bacteria (Adegoke, 2004). Pinthong et al. (1980) reported that yoghurt could be produced from soymilk supplemented with glucose and yeast extract through fermentation by lactic acid bacteria. But no work has been reported on the use of maize steep water as an inoculant for yogurt production.

The objective of this study is to use soymilk as an alternative to the expensive cow milk and maize steep water as an alternative to the expensive commercial starter to produce yoghurt and to compare its nutritional composition, microbial safety, sensory qualities and production cost with those of fresh cow milk yoghurt, dried powdered milk yoghurt and the commercial yoghurt.

MATERIALS AND METHODS

Source of materials

Fresh cow milk was purchased from a local dairy at Omi-Adio,

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Ibadan, Nigeria. Soymilk of a mixed variety was purchased at Oja Oba, Ibadan, Nigeria. Commercial starter culture (CHRHANSEN) was purchased at Ola Oluwa chemical store, Ilasamaja, Lagos, Nigeria. Maize steep water (MSW) was obtained from already fermented maize porridge (omi ogi). Dried powdered milk (DANO) was purchased at Crown supermarket Ibadan, Nigeria.

Sample processing

The milk (fresh cow milk or soymilk) was pasteurized at 60℃ for 30 min. Dried powdered milk (DANO) 500 g was reconstituted to make up 1000 ml and was also pasteurized. The pasteurized milk was cooled down to 40 – 45℃ after which the milk was inoculated with either commercial starter (pure culture of mixed strain of *Lactobacillus bulgaricus* and *Streptococcus thermophillus*; 0.5 g of the culture was used to inoculate 1000 ml of milk to initiate fermentation) or maize steep water (70 ml was used to inoculate 1000 ml of milk). The milk was incubated in a tight fitted warmer container and placed in a warm place for 10 h, during which the characteristic yoghurt flavour was produced, and curd formed. The curd was mixed with mechanical blender (Margic blender Petunjuk pengggunaam, Nakai, Japan) to get stirred yoghurt. Pineapple fruit juice (10) ml was added, sugar was also added to taste. The yoghurt was filled into sterile plastic bottles, corked and stored in refrigerator at 5^{o}C for subsequent analysis (Figure 1).

Production cost

After the initial fixed cost of acquiring simple machines and utensils such as blender, pots fermenting containers, mixer, muslin cloth, thermometer, water bath, measuring cylinder, plastic and aluminium containers, the production cost of 2 L of yoghurt from each source of milk and each type of coagulant was compared, taking into consideration the cost of the raw milk, the coagulant, sugar and fruit flavour added, packaging bottle and labour.

Sample analysis

The crude protein, fat, ash, moisture, carbohydrate, total solid and minerals were determined using the method (AOAC, 1995). Determination of pH and Titratable acidity was determined using the method of Ikenebomeh (1989). All determinations were done on wet basis.

Microbial determination

Microbial load of the yoghurt samples was determined using the method of Uzeh et al. (2006). Nutrient agar was used to plate for total viable count, Man, Rogsa and Sharpe (MRS) (DeMan et al, 1960) medium was used to plate for lactic acid bacteria, Macconkey agar was used to plate for *coliform*, Manitol salt was used to plate for *Staphilococcus*, while acidified potato dextrose agar was used to plate for yeast .The plates were incubated at 37℃ for 48 h for the growth of bacteria and 25℃ for 72 h for that of yeasts.

Isolation and identification of bacteria in the yoghurt samples were done using the method of Buchanan and Gibbons (1974), while yeasts were isolated and identified following the method of Talbot (1971) and Bryce (1992).

Sensory evaluation

Freshly prepared cow milk yoghurt, soymilk yoghurt, dried powdered milk yoghurt (fermented with either the commercial starter or maize steep water) as well as the commercial yoghurt were presented to 10 trained yoghurt consumers who evaluated the samples for colour, sourness, flavour, mouthfeel, aftertaste and overall acceptability using 9 point hedonic scale, where 9 = like extremely and 1= dislike extremely (Larmond, 1977).

Statistical analysis

The results were analysed using Analysis of variance (SAS, 1985). Means were separated by Duncan multiple range Test (Duncan, 1955).

RESULTS AND DISCUSSION

The results of the proximate composition of the yoghurt samples are shown in Table 1. The protein content of soymilk yoghurt fermented with maize steep water was significantly higher ($p<0.05$) than that of the commercial yoghurt. There was no significant difference ($p < 0.05$) in the protein content of soymilk yoghurt fermented with commercial starter and soymilk yoghurt fermented with maize steep water. Fat was least in dried powdered milk yoghurt fermented with commercial starter (0.48 ± 0.01%); this could be due to the fact that the milk might have been defatted as it is a commercial product and most commercial milk are deffated. soymilk yoghurt fermented with maize steep water was significantly low ($p<0.5$) in fat content (1.41 ± 0.05%) compared with fresh cow milk yoghurt fermented with maize steep water (3.60 ± 0.02%). There was no significant difference ($p< 0.05$) in the ash content of fresh cow milk yoghurt fermented with commercial starter, soymilk yoghurt fermented with commercial starter and commercial yoghurt. Moisture was highest in soymilk yoghurt fermented with commercial starter and subsequently the total solid was least in this same sample. The total solid could be improved by adding soybean flour to the soymilk before fermentation. Increasing the total solid increases the nutritive value of the product. The total solid determined was significantly high ($p< 0.05$) in the commercial yoghurt. This could be attributed to the fact that processing of yoghurt industrially involves reducing the fat content and increasing the total solid (Tamine et al., 1991). The total solid of the commercial yoghurt is similar to that reported by Obatolu et al. (2007). Soymilk yoghurt fermented with commercial starter was significantly low ($p< 0.05$) in carbohydrate compared with all the other yoghurt samples. The highest carbohydrate was recorded in dried powdered milk yoghurt fermented with commercial starter, (11.95±0.05%).

The mineral composition of the yoghurt samples is shown in Table 2. Calcium and phosphorous were highest in commercial yoghurt (54.09 ± 0.12 and 46.60 ± 0.52 ppm, respectively), probably because the milk used has been fortified with minerals. Soymilk yoghurt either fermented with maize steep water or commercial starter were significantly low ($P< 0.05$) in calcium and phosphorous. Soybean has been reported to be a poor source

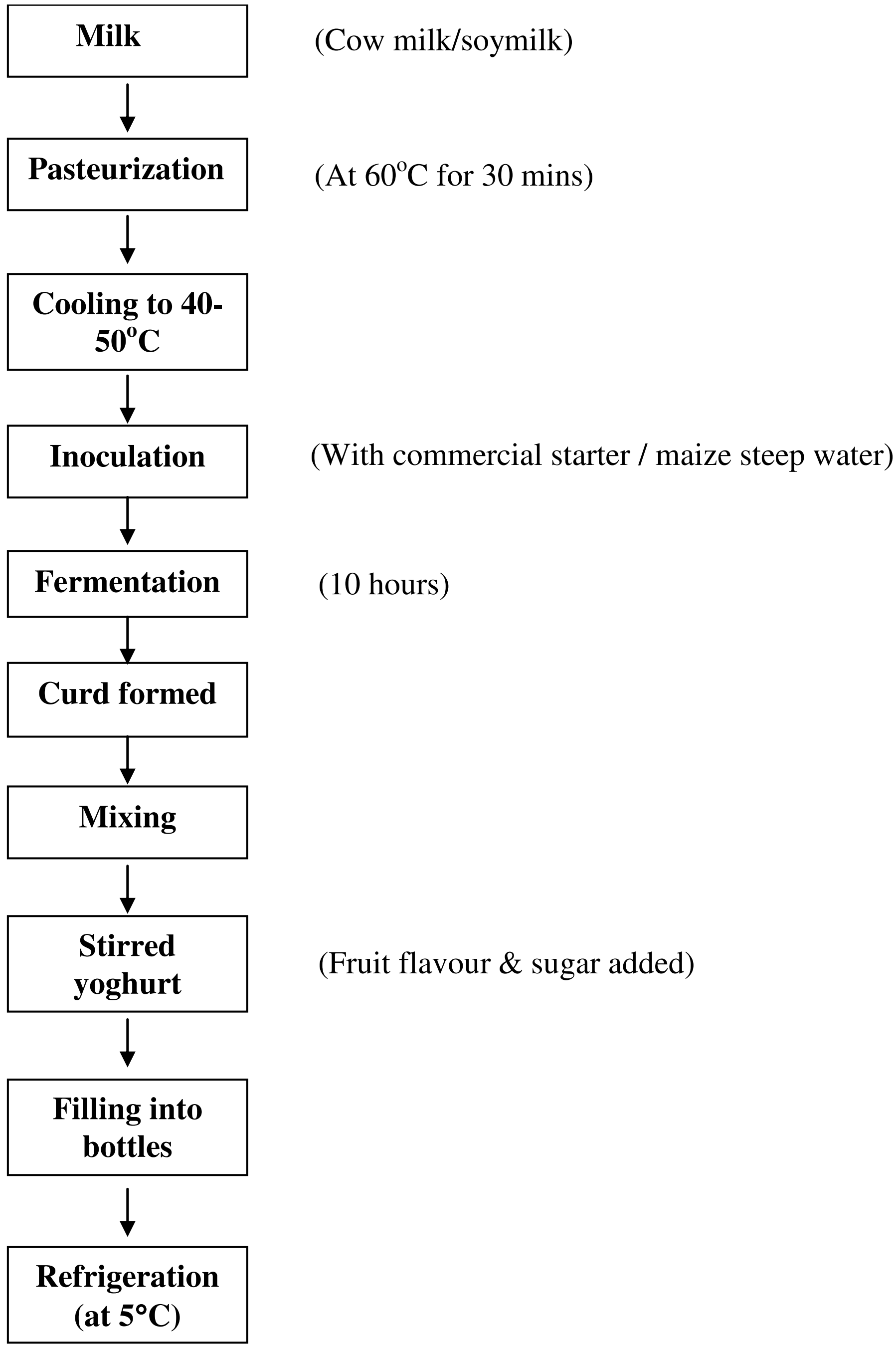

Figure 1. Flow chart for processing of yoghurt with soymilk and fermented maize water.

of mineral (Sigh et al., 1989), although its consumption will still increase the mineral intake of the body.

The pH and titratable acidity of the yoghurt samples are shown in Table 3. The pH ranged from 4.62 in commercial yoghurt to 5.80 in soymilk yoghurt fermented with maize steep water. There was no significant difference ($P < 0.05$) in the titratable acidity of soymilk yoghurt fermented with commercial starter and soymilk yoghurt fermented with maize steep water. Titratable acidity was least in the commercial yoghurt (0.14 g/100 g).

The microbial count of the yoghurt samples and the maize steep water is shown in Table 4. Maize steep water recorded the least total viable count (1.61 cfu/ml), this is expected to serve as blank since it was not one of the yoghurt samples. Dried powdered milk yoghurt fermented with commercial starter was significantly high ($P < 0.05$) in total viable count. There was no significant difference ($P < 0.05$) in the total viable count of soymilk yoghurt fermented with commercial starter and soymilk yoghurt fermented with maize steep water. Fresh cow

Table 1. Proximate composition of the yoghurt samples (%).

Sample	Protein (%)	Fat (%)	Ash (%)	Moisture (%)	Carbohydrate (%)	Total solid (g/100 g)
FCMY(CS)	4.62±0.09^{a}	3.47±0.2^{b}	0.63±0.04^{c}	86.81±0.56^{c}	4.47±0.09^{ab}	13.17±0.05^{c}
FCMY(MSW)	3.61±0.08^{b}	3.60±0.02^{a}	0.55±0.01^{a}	86.48±0.46^{c}	5.76±0.01^{c}	12.25±0.56^{d}
SMY(CS)	3.25±0.01^{c}	1.21±0.05^{c}	0.63±0.04^{c}	94.07±0.07^{a}	0.81±0.03b^{c}	5.89±0.01^{e}
SMY(MSW)	3.33±0.19^{c}	1.41±0.05^{d}	0.56±0.04^{a}	93.09±1.62^{b}	1.61±0.02^{d}	7.09±0.01^{de}
DPMY(CS)	3.04±0.03^{de}	0.61±0.04^{e}	0.72±0.10^{b}	83.68±0.83^{d}	11.95±0.05^{a}	16.35±0.04^{b}
DPMY(MSW)	3.21±0.03^{e}	0.48±0.01^{e}	0.73±0.03^{b}	85.06±0.64^{d}	10.52±0.12^{b}	15.62±0.02^{b}
CY	3.08±0.02^{d}	3.43±0.03^{b}	0.61±0.03^{c}	81.03±0.96^{d}	11.85±0.90^{a}	18.94±0.96^{a}

Means with the same superscript letter within a column are not significantly different (P<0.05).
FCMY(CS) = Fresh cow milk yoghurt fermented with commercial starter; FCMY(MSW) = fresh cow milk yoghurt fermented with maize steep water; SMY(CS) = soymilk yoghurt fermented with commercial starter; SMY(MSW) = soymilk yoghurt fermented with maize steep water; DPMY(CS) = dried powdered milk yoghurt fermented with commercial starter; DPMY(MSW) = dried powdered milk yoghurt fermented with maize steep water; CY = commercial yoghurt.

Table 2. Mineral composition of the yoghurt samples (ppm).

Sample	Phosphorus	Calcium	Magnesium
FCMY(CS)	41.53±0.52^{b}	49.60±0.52^{a}	11.19±0.97^{a}
FCMY(MSW)	39.95±0.01^{c}	20.90±0.00^{e}	54.43±0.06^{e}
SMY(CS)	20.26±0.10^{d}	10.88±0.77^{be}	39.10±0.17^{c}
SMY(MSW)	18.34±0.11^{e}	16.70±0.08^{d}	39.00±0.13^{c}
DPMY(CS)	39.05±0.84^{be}	41.45±0.30^{b}	11.11±0.89^{d}
DPMY(MSW)	32.07±0.94^{bc}	40.90±0.74^{b}	11.45±0.05^{d}
CY	54.09±0.12^{a}	49.60±0.52^{a}	49.03±0.14^{b}

Means with the same superscript letter within a column are not significantly different (p<0.05).
FCMY(CS) = Fresh cow milk yoghurt fermented with commercial starter; FCMY(MSW) = fresh cow milk yoghurt fermented with maize steep water; SMY(CS) = soymilk yoghurt fermented with commercial starter; SMY(MSW) = soymilk yoghurt fermented with maize steep water; DPMY(CS) = dried powdered milk yoghurt fermented with commercial starter; DPMY(MSW) = dried powdered milk yoghurt fermented with maize steep water; CY = commercial yoghurt.

Table 3. pH and titratable acidity of the yoghurt samples.

Samples	pH	TTA (g/100 g)
FCMY(CS)	4.91±0.86^{b}	0.17±0.01^{c}
FCMY(MSW)	4.90±0.17^{b}	0.16±0.01^{c}
SMY(CS)	5.67±0.10^{a}	0.19±0.01^{a}
SMY(MSW)	5.80±0.00^{a}	0.22±0.03^{a}
DPMY(CS)	4.88±0.14^{b}	0.20±0.03^{b}
DPMY(MSW)	4.83±0.04^{b}	0,20±0.01^{b}
CY	4.62±0.00^{ab}	0.14±0.14^{bc}

Means with the same superscript letter within a column are not significantly different (P<0.05).
FCMY(CS) = Fresh cow milk yoghurt fermented with commercial starter; FCMY(MSW) = fresh cow milk yoghurt fermented with maize steep water; SMY(CS) = soymilk yoghurt fermented with commercial starter; SMY(MSW) = soymilk yoghurt fermented with maize steep water; DPMY(CS) = dried powdered milk yoghurt fermented with commercial starter; DPMY(MSW) = dried powdered milk yoghurt fermented with maize steep water; CY = commercial yoghurt.

milk yoghurt fermented with commercial starter contain the highest lactic acid bacteria count (6.07 cfu/ml) while the least lactic acid bacteria count was found in maize steep water. There was no significant difference in the lactic acid bacteria count of soymilk yoghurt fermented with maize steep water and commercial yoghurt. Mould was nil in all the yoghurt samples. There was no yeast found in the fresh cow milk yoghurt fermented with commercial starter. The commercial yoghurt was significantly low (P<0.05) in yeast count compared to all the other yoghurt samples. Maize steep water was also very low in yeast count (0.6 cfu/ml).

The pattern of occurrence of occurrence of isolates in the yoghurt samples is shown in Table 5. *L. plantarum* was found in fresh cow milk yoghurt fermented with maize steep water, soymilk yoghurt fermented with maize steep water and maize steep water. *S. aureus* was present in fresh cow milk yoghurt fermented with maize steep water, commercial yoghurt and maize steep water. The *Staphylococcus* count in each of these samples was negligible, less than the standard set by FAO/WHO Expert Consultation on microbiological specification for minimum *Staphylococcus* count in frozen foods (Frazier

Table 4. Microbial count of the yoghurt samples and maize steep water (log_{10} cfu/ml).

Sample	Total Viable	Lactic acid bacteria	Mould	Yeast
FCMY (CS)	5.79±0.35[b]	6.07±0.46[a]	NIL	NIL
FCMY(MSW)	3.98±0.55[c]	3.89±0.44[b]	NIL	3.43±0.14[c]
SMY(CS)	5.15±0.24[b]	3.20±1.00[a]	NIL	4.25±0.20[b]
SMY(MSW)	5.12±0.22[b]	2.61±0.24[c]	NIL	3.32±0.20[c]
DPMY(CS)	7.14±0.10[a]	6.13±0.40[a]	NIL	4.81±0.11[a]
DPMY(SMW)	3.83±0.22[c]	2.89±0.20[b]	NIL	3.52±0.20[c]
CY	3.30±2.10[c]	2.07±1.00[c]	NIL	1.27±0.00[d]
MSW	1.61±100[d]	0.69±0.00[d]	NIL	0.60±0.00[e]

Means with the same superscript letter within a column are not significantly different (P<0.05).
FCMY(CS) = Fresh cow milk yoghurt fermented with commercial starter; FCMY(MSW) = fresh cow milk yoghurt fermented with maize steep water; SMY(CS) = soymilk yoghurt fermented with commercial starter; SMY(MSW) = soymilk yoghurt fermented with maize steep water; DPMY(CS) = dried powdered milk yoghurt fermented with commercial starter; DPMY(MSW) = dried powdered milk yoghurt fermented with maize steep water; CY = commercial yoghurt.

Table 5. Pattern of occurrence of isolates in the yoghurt samples.

Sample	*Lactobacillus plantarum*	*Staphylococcus aureus*	*Lactobacillus bulgaricus*	*Streptococcus thermoplillus*	*Saccharomyces rouxii*	*Saccharomyces cerevisiae*
FCMY(CS)	-	-	+	+	+	-
FCMY(MSW)	+	+	+	-	+	-
SMY(CS)	-	-	+	+	+	-
SMY(MSW)	+	-	-	-	+	+
DPMY(CS)	-	-	+	+	+	+
DPMY(MSW)	-	-	+	+	+	+
CY	-	+	+	+	+	-
MSW	+	+	-	-	+	+

+ = Present; - = absent
FCMY(CS) = Fresh cow milk yoghurt fermented with commercial starter; FCMY(MSW) = fresh cow milk yoghurt fermented with maize steep water; SMY(CS) = soymilk yoghurt fermented with commercial starter; SMY(MSW) = soymilk yoghurt fermented with maize steep water; DPMY(CS) = dried powdered milk yoghurt fermented with commercial starter; DPMY(MSW) = dried powdered milk yoghurt fermented with maize steep water; CY = commercial yoghurt.

and Westhoff, 1998) and as such the product is safe for consumption. *Lactobacllus bulgaricus* and *Streptococcus thermophilus* were present in all the milk samples inoculated with commercial starter as well as the commercial yoghurt. *Sacharomyces rouxii* was found in all the yoghurt samples

The result of the sensory evaluation of the yoghurt samples is shown in Table 6. Apart from fresh cow milk yoghurt fermented with commercial starter and commercial yoghurt, all the other yoghurt samples were significantly different (P< 0.05) from each other in terms of colour. The commercial yoghurt was significantly different (P< 0.05) in terms of sourness from all the other yoghurt samples. There was no significant difference (p< 0.05) in the flavour of all the yoghurt samples with the exception of soymilk yoghurt fermented with commercial starter. There was no significant difference in the after-taste of soymilk yoghurt fermented with commercial starter and soymilk yoghurt fermented with maize steep water. In overall acceptability, soymilk yoghurt fermented with commercial starter and soymilk yoghurt fermented with maize steep water were accepted by the panelist but the commercial yoghurt was most preferred.

The result of the cost of producing yoghurt from each source of milk using commercial starter/maize steep water as coagulant is shown in Table 7. The cost of producing 6 bottles (2000 ml) of soymilk yoghurt from soymilk fermented with maize steep water was least (N280), while the cost of producing 6 bottles (2000 ml) of cow milk yoghurt from cow milk fermented with commercial starter was highest (N750).

Conclusion and recommendation

Yoghurt can be processed from soymilk (a plant protein) and maize steep water which are readily available and accessible to the rural people at affordable production

Table 6. Sensory evaluation of the yoghurt samples.

Attribute	FCMY(CS)	FCMY(MSW)	SMY(CS)	SMY(MSW)	DPMY(CS)	DPMY(MSW)	CY
Colour	6.70±0.89[b]	4.40±1.83[bc]	5.30±1.49[c]	6.10±1.63[ab]	7.10±0.82[a]	7.00±1.41[a]	6.30±2.11[b]
Sourness	5.20±2.34[b]	4.40±1.71[ab]	6.00±1.88[b]	5.40±1.50[b]	5.80±1.68[b]	5.30±1.94[b]	7.00±1.49[a]
Flavour	5.70±2.31[a]	5.50±1.96[a]	5.60±1.57[c]	5.70±1.41[a]	6.40±1.50[a]	5.80±1.93[a]	7.30±1.42[a]
Mouth feel	6.50±1.64[b]	5.00±0.94[b]	5.40±1.43[b]	5.40±1.43[b]	5.50±1.64 [b]	5.70±1.68[b]	8.00±0.47[a]
After taste	5.70±2.16[ab]	5.30±1.26[b]	5.40±1.71[b]	5.50±1.23[b]	6.20±1.68[ab]	6.10±1.66[ab]	7.40±2.01[a]
Overall acceptability	5.60±2.22[ab]	4.40±1.43[b]	5.30±1.88[ab]	5.90±0.87[bc]	6.10±1.52[c]	6.00±1.63[c]	6.90±1.76[a]

Means of each attribute followed by the same letter in superscript within a row are not significantly different (P<0.05).
FCMY(CS) = Fresh cow milk yoghurt fermented with commercial starter; FCMY(MSW) = fresh cow milk yoghurt fermented with maize steep water; SMY(CS) = soymilk yoghurt fermented with commercial starter; SMY(MSW) = soymilk yoghurt fermented with maize steep water; DPMY(CS) = dried powdered milk yoghurt fermented with commercial starter; DPMY(MSW) = dried powdered milk yoghurt fermented with maize steep water; CY = commercial yoghurt.

Table 7. Cost of production of the yoghurt samples.

Materials	Fresh cow milk yoghurt	Dried Powdered milk yoghurt	Soymilk yoghurt
Milk	N400	N200	N50
Sugar	N40	N40	N40
Fruit flavour	N20	N20	N20
Commercial Starter	N120	N120	N120
Maize Steep Water	-	-	-
Packaging bottle(6)	N90	N90	N90
Labour	N100	N100	N100
Total cost for producing 6 bottles using commercial starter	N750	N550	N400
Total cost for producing 6 bottles using maize steep water	N630	N430	N280

cost and with simple processing technology. Yoghurt processed from soymilk and maize steep water compares well with yoghurt processed from cow milk in terms of nutrient composition and sensory evaluation.

There is need for further research to improve the values of soy yoghurt fermented with maize steep water in terms of colour and taste. Soy yoghurt fermented with maize steep water can be fortified with minerals most especially with natural fruit juices to meet the mineral requirement of consumers.

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