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QUALITY EVALUATION OF YOGHURT PRODUCED FROM BLENDS OF WHOLE MILK AND SOYBEAN POWDER

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ABSTRACT

The study was conducted to evaluate and compare the quality of yoghurts produced from blends of whole milk and soybean powder. Soybean powder was prepared from ground soybean seeds. Four samples of yoghurt product were used, namely; 100% whole milk powder, 30:70, 50:50 and 70:30 (soybean powder: whole milk powder) and analysed for physicochemical, proximate, and sensory properties. The results of the physicochemical properties of the samples ranged as follows: pH,total solid and total titratable acidity expressed as percent lactic acid 4.40 – 4.70, 10.33 – 13.30 and 0.46 – 0.64, respectively. There was no appreciable difference (P>0.05) in the physicochemical properties of the samples. The proximate composition of all the yoghurt samples had different levels of protein content (3.24%, 3.41%, 3.59%, 3.76%) respectively. Fat content (2.90% - 3.60%), moisture content (88.10% - 88.70%), ash content (0.50% - 1.00%) and carbohydrate content (3.14% - 5.44%), with Sample D (70% soybean powder, 30% whole milk powder blend) having the highest values in protein, ash contents, moisture and carbohydrate contents. The sensory evaluation showed that there was no significant difference (P>0.05) in texture and overall acceptability of the samples. However, there were significant differences in appearance, taste and flavour of the samples. Results from this study have demonstrated a further way of enhancing soy yoghurt production and acceptability.

Keywords: Lactic acid bacteria, soybean, yoghurt, starter cultures, fermentation.

INTRODUCTION

Yoghurt is a dairy food, produced by lactic acid bacteria fermentation of milk. The fermentation of milk sugar (lactose) into lactic acid gives yoghurt its characteristic gel-like texture (Elson and Hass, 2005; Brainy Dictionary, 2005; Wikipedia, 2005). Between all milk fermented products, yoghurt is well-known than others and has more acceptability in the world (Caisson *et al.,* 2005).It is the oldest fermented milk product consumed by large segments of the world's populace either as a part of diet or as a refreshing beverage (Anu *et al.,* 2010) and is considered to have high nutritional values in protein and vitamins and is rich source of calcium with potential health benefits such as aiding digestion (Helferich and Westhoff, 1980). The yoghurts produced in Nigeria are primarily made from dry skim or whole milk powder that is often reconstituted with water instead of fresh milk as is the practice in other part of the world. However, the utilization of local raw materials such as soybean (*Glycine max*), a plant protein since it is affordable, available and nutritious could help the local food industry in terms of raw material selection and cost for the production of traditional dairy products. Use of soybean in dairy products like yoghurt could as well serve as an alternative to cow milk and also help boost economy.

In developing countries like Nigeria, protein intake is still far from the international standard (FAO, 1990). Soybean represents an excellent source of high quality protein with low content of saturated fat and a great amount of dietary fibre and bioactive components like the is of lavones. Soymilk and its fermented products constitute an alternative for lactose intolerant people. The major challenges limiting the wide spread consumption of soybean products are: (a) their 'beany' flavour; and (b) the presence of indigestible components, e.g. oligosaccharides, which can cause flatulence (Mital and Steinkraus, 1994). However, numerous processes including fermentation using lactic acid bacteria (LAB) have been used with the aim of removing the undesirable 'beany' flavour (Lee *et al.*, 1990; Chumchuere and Robinson, 1999). However, there is lack of detailed information in the literature about the physicochemical, proximate, and sensory properties of yoghurt produced by fermentation of soybean and whole milk powder. Therefore, the overall objective of this study is to evaluate such quality attributes of the yoghurt.

MATERIALS AND METHOD

Sources of samples

The soybean seeds were purchased from a local market (Meat Market) located in Abakaliki, Ebonyi State. The milk sample (Whole Milk Powder) and starter culture (Yoghurtment, containing *Streptococcus thermophiles, Lactobacillus bulgaricus* and *Lactobacillus acidophilus*) for the production of yoghurt was purchased from Confidence Supermarket, Abakaliki.

Processing of soybean samples

The soybean seeds were thoroughly sorted and cleaned with water to remove damaged seeds, metals, stones, chaffs etc., then boiled for 30mins and soaked for 8h. The tenderized seeds were subjected to dehulling (hand rubbing). Thereafter, were washed with water and oven dried. The dried seeds were milled using Local Attrition Mill and sieved with a wire mesh to achieve a uniform particle size. Then it was stored with a sterile glass bottle at room temperature until use. The flow chart for the processing of soybean powder is shown in figure 1 below;

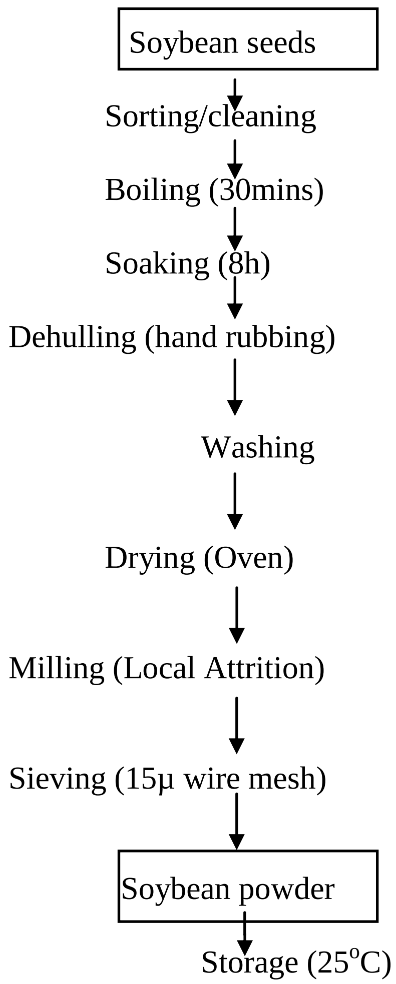

Figure 1: *flow chart for the processing of soybean powder*

Mixing of samples and yoghurt production

The yoghurt was produced according to the method of Tamime *et al*, (1989) with slight modification. The mixture had the following blends: Sample A 100% whole milk powder as control, while Sample B (30:70), Sample C (50:50), Sample D (70:30) of soybean and whole milk powder respectively to obtain four samples (A, B, C and D). The mixture was reconstituted with sterile water and homogenized. Then pasteurized at 85°C for 10mins, cooled to 43°C and inoculated with starter culture at the rate of 5g/litre of the solution. The inoculated blends were incubated at 43°C for 12h and the pH monitored. The blends were further cooled to 25°C after which fermentation was terminated. The resultant yoghurt was stirred and filled into sterile 50cl plastic containers for further analysis. The flow chart for the production of yoghurt is shown in figure 2 below;

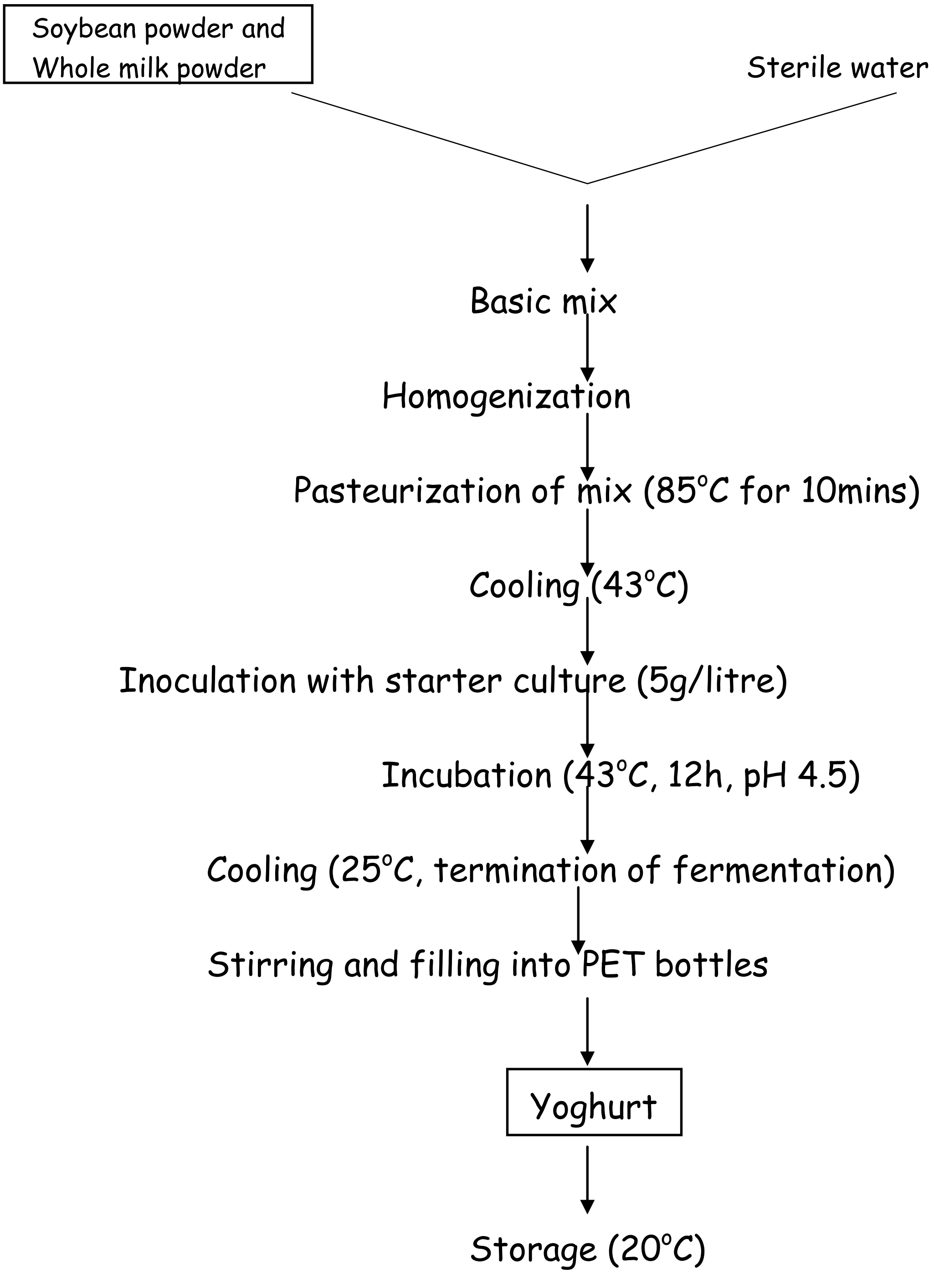

Figure 2: *Flow chart for the production of yoghurt*

Physicochemical Analysis

- **pH Determination**

The pH value of the yoghurt samples was measured in a 50ml beaker at a temperature of 20°C using a digital pH meter (Model 152k) after standardization at pH of 4.0 and 7.0.

- **Total Solids**

The total solid was determined according to the method described by AOAC (2002). About 4g of the samples was weighed into a metal dish and kept in a water bath for 30 min and thereafter heated in an oven at 100°C for 2.5h. The samples were further cooled in the desiccator for 30min and weighed. The sample was reheated in the oven for another 1h, cooled and reweighed. This was repeated until the weight loss between successive weightings became negligible (<0.5g). The percent total solid was then calculated from the formula:

$$TS\ (\%) = \frac{\text{Final wt of yoghurt sample} - \text{wt of dish}}{\text{Wt of sample}} \times \frac{100}{1}$$

- **Measurement of titratable acidity (% lactic acid)**

The titratable acidity of the yoghurt samples was determined as described by Egan *et al.* (1981). Approximately 1ml of phenolphthalein indicator was added to a conical flask containing 10ml yoghurt samples and titrated against 0.1M NaOH. The mixture was stirred continuously and titration was terminated when the colour of the mixture turned pink. The titratable acidity (% lactic acid) was calculated from the formula:

$$TTA\ (\%\ \text{lactic acid}) = \frac{\text{Titre value} \times \text{Molarity} \times 0.09}{\text{Vol. of sample (ml)}} \times \frac{100}{1}$$

Proximate Analysis of the Samples

The parameters determined were moisture content, ash, crude protein, crude fat and carbohydrates. These parameters were determined according to methods of AOAC (2002).

Sensory analysis

A twenty – member semi – trained panel were asked to rate the samples for flavour, appearance/colour, taste, texture/consistency and overall acceptability. The ratings were based on a hedonic scale ranging from 9 representing "Like extremely" to 1 representing "Dislike extremely" (Iwe, 2002), inviting comments on other observations.

RESULTS AND DISCUSSION

Physicochemical and Proximate Properties

The physicochemical and proximate properties of the yoghurts produced from blends of whole milk powder-soybean powder are contained in Table 1:

Table 1: Physicochemical and proximate properties of yoghurt samples

Samples	pH	TTA (% lactic acid)	Moisture	Ash	Fat	Protein	Carbohydrate
A (100%)	4.40^{a}	0.46^{b}	88.10^{b}	0.50^{a}	3.60^{a}	3.59^{b}	4.21^{a}
B (30:70)	4.51^{a}	0.64^{a}	89.67^{a}	0.75^{a}	3.20^{b}	3.24^{d}	3.14^{ab}
C (50:50)	4.63^{a}	0.64^{a}	88.51^{b}	0.75^{a}	2.90^{b}	3.41^{c}	4.43^{a}
D (70:30)	4.70^{a}	0.63^{a}	86.70^{c}	1.00^{a}	3.10^{b}	3.76^{a}	5.44^{a}
LSD	**--**	**0.096**	**1.06**	**--**	**0.35**	**0.122**	**1.43**

Results are Means of triplicate determinations and in Percentage (%)

Values in the same column having the same superscripts are not significantly different (P>0.05)
A = 100% Whole Milk Powder (control)
B = 30% Soybean Powder, 70% Whole Milk Powder blend
C = 50% Soybean Powder, 50% Whole Milk Powder blend
D = 70% Soybean Powder, 30% Whole Milk Powder blend

There was no significant different (P>0.05) in the effect of blends of whole milk powder and soybean powder on the pH, titratable acidity, ash, fat and carbohydrates of the yoghurt samples. The results revealed that as the percentage of the soybean powder increased in the blend, pH also increased. The pH of the samples ranged from 4.40 – 4.70 and is within the range (4.4-4.7) reported in literature (Osundahunsi *et al.,* 2007) for fruit flavoured soy yoghurt. Mital and Steinkraus (1994) reported a pH range of 4.26 – 4.70, and these results are in line with their findings. Though the pH of all the yoghurt blends decreased with fermentation time, the differences observed in the degree of pH decrease in the fermenting yoghurt blends may be a reflection of the ability of the yoghurt bacteria to grow in the blends and ferment the carbohydrates they contained. There was no significant difference (P>0.05) between the samples.

The titratable acidity which is an expression of the percentage lactic acid content (Lee, 1985) showed no significant difference (P>0.05), however, yoghurt made from 100% whole milk powder (control) differed significantly (P<0.05) from others. In 2004, Nigerian Industrial Standard

(NIS) recommended a maximum of 1.5% lactic acid in yoghurt and the range (0.46 – 0.64) recorded in this study is considered to be satisfactory. The lactic acid contents obtained in this study also compared favourably with the range (0.17 – 1.16%) reported by Olubamiwa and Kolapo (2010) for soy-yoghurt produced using soy-coconut milk premix. Acidity developed in the different soy yoghurts produced is dependent on the starter culture used and the formulation of the blends used for fermentation (Olubamiwa and Kolapo, 2010). Li and Yang (2010) reported titratable acidity between 0.75 and 0.80% for probiotic soy yoghurt prepared from germinated soybean. Therefore, all the samples produced in this study were in accordance with these research findings and is considered satisfactory.

The moisture contents of the yoghurt samples produced from whole milk powder and soybean powder blends are presented in Table 1. Sample B (30:70 soybean powder : whole milk powder) was the highest (89.67%) while sample D (70:30 soybean powder : whole milk powder) the lowest (86.70%) respectively. The high moisture content could be attributed to the fact that yoghurt is a liquid food product. The moisture content of the soy yoghurt samples in this study compared favourably with the value of 87.80% reported by Osundahunsi *et al.* (2007) but lower than the range (90.94 – 92.09%) reported by Olubamiwa and Kolapo (2010). There was a significant difference ($P<0.05$) between the moisture content of samples.

The ash content of the soy yoghurt blends in Table 1 showed that Sample D (70:30 soybean powder : whole milk powder) was the highest (1.00%) while sample A (100% whole milk powder) the lowest (0.50%) respectively. The result revealed that as the percentage of the soybean powder increased in the blend, ash content also increased. The high ash content of sample D could be due to its high total solid (Fig. 3). The quality of certain foods depends on the amount of ash left after burning or incineration. There was no significant difference between the samples (P>0.05) in terms of the ash content.

The results of the yoghurt samples in Table 1 showed that fat content decreased with increase in the proportion of soybean powder in the samples with sample C (50:50 soybean powder : whole milk powder) having the lowest (2.90%) and sample A (100% whole milk powder) having the highest (3.60%). Decrease in fat content of the samples with the proportion of soybean powder could be due to the removal of the germ in the seeds which contains the major oil portion before reconstitution with water. Statistically however, there was no significant difference (P>0.05) between the soy yoghurt samples but sample A (100% whole milk powder) was significantly different (P<0.05) from other samples.

The result of the yoghurt samples in Table 1 revealed that there was an increase in protein content with increase in the proportion of soybean powder with sample B (30:70 soybean powder : whole milk powder) having the lowest value (3.24%) and sample D (70:30 soybean powder : whole milk powder) having the highest protein content of 3.76%. Increase in protein content of samples with the proportion of soybean powder could be due to the high protein content of the leguminous seeds. Protein content is an important factor that affects the quality of acid coagulation of protein gel products

(Li and Yang, 2010). However, there was significant difference ($P<0.05$) in the protein content of the samples.
From Table 1, the result reveals that carbohydrate did not show a defined trend with the variation in percentage of soybean powder and whole milk powder blend in the samples. The carbohydrates increased with increase in the soybean powder proportions. There was no significant difference ($P>0.05$) among the samples.

Total Solid Content

The total solid content of the yoghurt samples is shown in Figure 3:

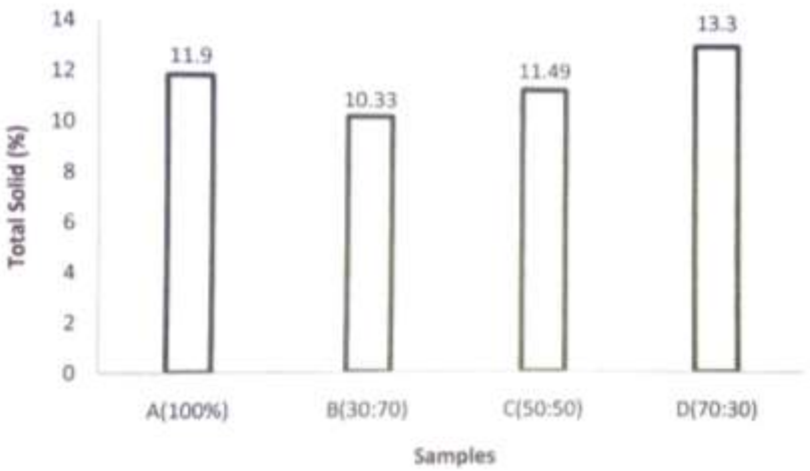

Figure 3: The total solid content of the yoghurt samples

Results are Means of triplicate determinations and in Percentage (%)
A = 100% Whole Milk Powder (control)
B = 30% Soybean Powder, 70% Whole Milk Powder blend
C = 50% Soybean Powder, 50% Whole Milk Powder blend
D = 70% Soybean Powder, 30% Whole Milk Powder blend

The total solid content of the yoghurt samples increased with increase in the soybean powder proportions (Fig.3). In this study, the highest total solid was observed in the yoghurt produced from 70% soybean powder and 30% whole milk powder blend (Sample D). Osundahunsi *et al.* (2007) reported total solid content of fruit flavoured soy yoghurt range of 12.4 – 14.5%. Obi *et al.* (2010) quoted British Standard for yoghurt to be 8 – 14% total solids. The values obtained in this study are in concordance with their findings. Shaker *et al.* (2000) indicated that the increase in viscosity of yoghurt with fat content may be due to increase of total solids of the milk which has a significant effect on the firmness of yoghurt gel and decreasing degree of syneresis. Samples with higher total solids have better textural properties than those with lower total solids (Mahdian and Tehrani, 2007).

Sensory Properties

The sensory attributes of the yoghurt samples are presented in Table 2

Table 2: Sensory Evaluation of yoghurt samples with different blend of soybean and milk powder

Samples	Appearance	Taste	Flavour	Texture/ Consistency	Overall Acceptability
A (100%)	8.60^{a}	7.80^{a}	7.55^{a}	8.00^{a}	8.35^{a}
B (30:70)	7.00^{bc}	6.15^{b}	6.25^{b}	7.05^{ab}	6.40^{b}
C (50:50)	5.95^{b}	4.95^{c}	4.70^{c}	6.30^{b}	5.55^{b}
D (70:30)	6.15^{b}	5.10^{bc}	5.20^{bc}	6.35^{b}	5.80^{b}
LSD	**0.56**	**1.12**	**1.23**	**0.97**	**1.01**

Values in the same column having the same superscripts are not significantly different (P>0.05)

A = 100% Whole Milk Powder (control)
B = 30% Soybean Powder, 70% Whole Milk Powder blend
C = 50% Soybean Powder, 50% Whole Milk Powder blend
D = 70% Soybean Powder, 30% Whole Milk Powder blend

From Table 2, Samples A, B and C were significantly different (P<0.05) from each other in appearance, whereas there was no significant different (P>0.05) between samples C and D. The result also showed that there was a significant different (P<0.05) for taste between sample A (control) and other samples, whereas there was no significant difference (P>0.05) between samples B and D, C and D respectively. Cuenca *et al.* (2005) found that soy yoghurt fermented with starter culture improved colour as well as taste and can be fortified with especially natural fruit juices to meet the requirement of consumers.

There was a significant difference (P<0.05) in flavour between sample A (control) and other samples. No significant difference (P>0.05) was recorded between the soy yoghurt samples except for sample B and C which showed a significant difference (P<0.05). Soy products have been known to possess a 'beany-flavour' usually regarded as 'unpleasant' (Pariyaporn and Robinson, 2005). Lactic acid fermentation reduced beany flavours in soybean products (Buono *et al.*, 1990).

It was observed that the texture of the samples improved with addition of soy powder in the blends. The result showed that there was a significant difference (P<0.05) between Samples A (control) and C, D respectively except for sample B. However, there was no significant difference (P>0.05) among the soy yoghurt samples. Lucey *et al.* (2000) found that stabilizersare commonly used in cultured products to control texture of soy yoghurt. In this study, no stabilizer was used because the texture/consistency of the soy yoghurt improved due to the appropriate quantity of soy powder added to the yoghurt blends.

In overall acceptability, there was a significant difference ($P<0.05$) between sample A (control) and other samples. However, there was no significant difference ($P>0.05$) among the other soy yoghurt samples. The result of the overall acceptability evaluation in this study has shown that soy yoghurt will become acceptable product in Nigeria when appropriate quantity of soy powder as was used in this study is added to yoghurt blends.

CONCLUSION

The increase in protein demand in developing countries led to effort in finding alternative sources of protein in legume seeds. However, data emanating from this study depicts that soy yoghurt could be helpful in meeting a significant portion of the daily needs of these nutrients. The results also have demonstrated a further way of enhancing soy yoghurt production and acceptability.

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