COMPARATIVE EVALUATION OF DAIRY WITH VEGETABLE BASED (SESAME, GROUNDNUT AND SOYBEAN) YOGHURTS

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Abstract
Sesame, soybean and groundnut are important oil and protein rich seed. One important processing method to enhance their consumption is the production of vegetable based yoghurt. Fresh samples of sesame, soybean and groundnut were processed into their individual milk extract and inoculated to form respective vegetable yoghurt with addition of sweetener. The yoghurt samples were analyzed and compared with reconstituted full cream milk powder (FCMP) based yoghurt for their chemical composition, microbiological and sensory qualities using standard methods. The protein content of FCMP was 3.48% and vegetable based yoghurt ranged between 3.18 to 3.36% and there was no significant difference ($p< 0.05$) among them. The Carbohydrate content of FCMP was the lowest (3.19%), the value obtained for the vegetable yoghurt ranged between 4.99 and 6.44%. The fat content of FCMP (2.5%) was not significantly different ($p< 0.05$) from groundnut (2.38%) and sesame (2.4%) based yoghurt. The pH of the yoghurt varied between 4.08 in soybean to 4.34% in groundnut. The sensory evaluation also showed that there was no significant difference ($p< 0.05$) among the vegetable yoghurts in aroma, viscosity, taste and overall acceptability. Microbiological examination revealed that the yoghurt samples were within minimum acceptable standards

Keywords: Dairy, vegetable, Sesame, soybean, groundnut and yoghurt.

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1. INTRODUCTION
The basic raw material for all dairy products is milk. It is the normal secretion of the mammary glands of all mammals and provides the sole source of nourishment during the period directly after birth for a newborn mammal of the particular species of animal (Potter and Hotchkiss, 2006). The high nutritional value makes cow's milk not only a complete food for babies and young children but also an excellent and valuable food for adults (Potter and Hotchkiss, 2006; Oyeniyi *et al*. 2014). Despite the benefits of milk consumption, dairy subsector in Africa is still relegated to the category of subsistence system of production due to minor and peripheral status accorded the sector by various government policies. Allied with the above, are poor nutrition and genetic constitution of the Africa breeds of ruminants. The above problems lead to insufficient milk available to the people. This dramatic decrease in the consumption of milk and milk products stimulated in part the processing of milk from different seeds and nuts (Belewu and Belewu, 2007).Though undervalued in the past, milk from plant sources are key ingredient in the diet of African countries (Awonorin and Udeozor, 2014).

Recently, researchers have shown strong interest in vegetable milk and their products due to their high nutritional values and economic potentials. One major way of promoting the acceptability of vegetable milk is the production of yoghurt like product from it. Yoghurt is a fermented, dairy and nutrient-dense food produced with a starter culture consisting of Streptococcus thermophilus and Lactobacillus delbrueckii subsp. Bulgaricus in a 1:1 ratio. The symbiotic growth of the two organisms result in lactic, acetic and formic acids, together with acetaldehyde and diacetyl production which give yoghurt its characteristic smooth texture, sour flavor / aroma and certain beneficial health effects (Hutkins, 2006; Wiley *et al*., 2008).

Although soybean and groundnut have been accorded high attention for the investigation of milk substitutes but there is dearth of information on the comparative study of yoghurt from commonly utilized seed in Nigeria. The objective of this study was to comparatively evaluate the physicochemical, microbiological and sensory properties of yoghurt samples from sesame, groundnut and soybean seed, which are important oil and protein rich seed in Nigeria.

2. MATERIALS AND METHODS

Sample preparation

The materials used (sesame, soybean and groundnut seeds, full cream milk powder (FCMP), granulated sugar) were purchased from the local market in Ibadan, Oyo state, Nigeria. The seeds were cleaned to remove foreign materials and extraction of milk was carried out according to the method described by Oyeniyi *et al*. (2014). The total solid used was 14% for the seed (sesame, soybean and groundnut) and full cream milk powder reconstitution (FCMP). Commercial (YC-380) yoghurt culture composed of Streptococcus thermophilus and Lactobacillus delbrueckii subsp. bulgaricus was purchased from Ojota market in Lagos, Nigeria. The starter culture preparation and inoculation procedure were done according to the manufacturer recommendations (Chr. Hansen Denmark).

Yoghurt preparation

Milk samples and other ingredients were mixed, homogenized (in a blender), pasteurized at 85°C for 30minutes, cooled to 43°C (Fig. 1.), inoculated with starter culture (prepared according to the manufacturer instructions.) and incubated at 43°C for 9 hours, At the end of each incubation period, yoghurt samples were cooled to room temperature (28 ± 2 °C) and then refrigerated for 24 hours. Analyses were performed after 24 hours of refrigeration. The procedure was carried out at three replications.

Analysis of the yoghurt composition

Moisture content of the samples was determined by oven drying method at 103 ± 2˚C and left overnight (AOAC, 1990). Ash content was determined using a muffle furnace, (Gallenkamp model 3). Fat was determined in the soxhlet apparatus (AOAC, 1990) using petroleum ether as the solvent of extraction. The macro Kjeldahl procedure based on the AOAC (1990) method was used for nitrogen and the protein content of samples was calculated using 6.25 as the conversion factor. Crude fibre was based on the method of AOAC (1990).

Physicochemical analysis

The pH was determined using a digital pH meter (Model Equiptronic EQ-610, Japan). Titratable acidity (TTA) was determined according to AOAC (1990) method. Twenty (20) ml of the sample Twenty (20) ml of the sample was measured into a conical flask and 2 drops of 1% phenolphthalein indicator was added to the mixture and titrated with O.1N NaOH against a white background.

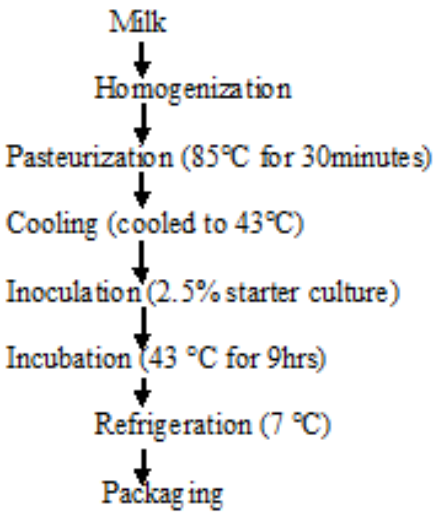

Figure 1. Production of yoghurt (Hutkin, 2006).

The result was recorded as soon as the first appearance of a pink color was observed. Titration continued until the color persisted. The result obtained were calculated as follows:

$$TTA(\%) = \frac{Number\ of\ ml\ of\ NaoH\ used}{Sample\ taken}$$

Sensory analysis
Samples were subjected to sensory evaluation using twenty trained panelists randomly selected from the student of the department of food technology, the Oke-ogun Polytechnic Saki, Oyo State, Nigeria. Panelists rated the products for overall acceptability and sensory attributes of taste, color, texture, flavor and appearance using 9-point hedonic scale.

Microbiological analysis
The sample media was prepared before carrying out the analyses. One milliliters of sample mixture was aseptically pipette into a test tube containing 9ml sterile distilled water and serial dilutions was made to 10^{-5} dilution. Growth media was prepared according to specifications on the containers. Total viable counts of bacteria (using nutrient agar) and Escherichia coli (using methylene blue agar) were determined according to the standard microbiological method (AOAC, 1990; Adegoke, 2000).

Statistical analysis
All analyses were carried out in triplicate for each sample and result. The data obtained were subjected to analysis of variance (ANOVA) significant relationships using SPSS software, version 16.0. Significant difference between means were determined at $p < 0.05$

3. RESULTS AND DISCUSSION

Proximate composition

Protein content
The protein content ranged between 3.18-3.48% (Table 1) with FCMP milk based yoghurt having the highest value. Among the three vegetable based yoghurts, the protein contents were not significantly different ($p > 0.05$) from each other but significantly different ($p < 0.05$) from the FCMP based yoghurt with the exception of groundnut based yoghurt. The results agreed with the findings of Kolapo and Olubamiwa (2012) and Belewu *et al*. (2010) who reported protein content of 3.62 and 3.13 % for sesame and soy-coconut milk based yoghurt respectively. The protein content in groundnut based yoghurt was however lowered than 5.60% reported by Elsamani *et al*. (2014) this may be due to varietal differences.

Carbohydrate content
The yoghurt samples analyzed had carbohydrate contents between 3.91 and 6.44%.The highest value of 6.44% obtained in Soybean based yoghurt was significantly different ($p < 0.05$) from other samples while there was no significant difference ($p > 0.05$) between sesame and groundnut based yoghurt. The FCMP had the lowest value of 3.9%. This may be due to suitability of lactose as the preferred substrate for fermenting organisms (Fellows, 2000; Martensson *et al*., 2001)

Fat content
The value obtained for the fat content was between 2.26 and 2.5%. Although FCMP yoghurt had the highest value of 2.5% followed by sesame, 2.4% and groundnut 2.38%. The three vegetable yoghurts, were not significantly different in their fat values ($p >0.05$). However, the lowest value obtained in soybean yoghurt (2.26%) was similar to the findings of Ogbonna *et al*. (2013).

Ash content
The ash content of the yoghurt ranged from 0.45 to 0.52%. Ash content is an indication of mineral element present in the sample of the food (Lawal *et al*., 2016).The highest value of 0.52% was found in soybean while the lowest value (0.45%) was found in sesame and FCMP based yoghurt. There were no significant difference ($p > 0.05$) in the ash content obtained for the four yoghurt samples.

Physicochemical properties of yoghurt samples

Total solid
The result of physicochemical properties of yoghurt samples are shown in Table 2. The mean total solid varied between 11.15 and 15.5%. The mean values of total solid obtained in sesame yoghurt (15.51%) was significantly higher ($p < 0.05$) than all other yoghurt samples in this study and 13.05% reported by Chima *et al*. (2013) in soy based yoghurt. FCMP had the Lowest value (11.15%) and was significantly ($p < 0.05$) different from

groundnut and soybean based samples. Generally, the result obtained in this study was similar to the work of Afaneh *et al*. (2011). All the yoghurts analyzed were significantly different ($p < 0.05$) from each other with the exception of groundnut and soybean based yoghurt.

Table 1: Proximate composition of the yoghurt samples

Yoghurt sample	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	Carbohydrate (%)
FCMP	3.48^{a}	2.5^{a}	0.45^{a}	0.25^{a}	3.91^{d}
Groundnut	3.36^{ab}	2.38^{abc}	0.48^{a}	0.20^{ab}	4.99^{c}
Soybean	3.18^{cbd}	2.26^{d}	0.52^{a}	0.18^{b}	6.44^{a}
Sesame	3.25^{bc}	2.4^{ab}	0.45^{a}	0.15^{b}	5.51^{bc}

Means with different superscript in each column are significantly different ($p < 0.05$). FCMP: full cream milk powder.

Table 2: Physicochemical properties of the yoghurt samples

Yoghurt sample	Total solid (%)	TTA (%)	pH
FCMP	11.15^{d}	1.24^{a}	4.23^{a}
Groundnut	12.64^{c}	1.34^{a}	4.34^{a}
Soybean	13.35^{bc}	1.28^{a}	4.08^{a}
Sesame	15.51^{a}	1.23^{a}	4.17^{a}

Means with different superscript in each column are significantly different ($p < 0.05$). FCMP: full cream milk powder. TTA: Titratable acidity

Acidity of the yoghurt samples

The pH of the yoghurt ranged between 4.08 and 4.34. The highest value was recorded in groundnut while the soybean based yoghurt had the lowest pH. The pH values of all the samples were lower than 4.67 reported by Balewu *et al*. (2010) in Bambara based yoghurt but higher than the range (3.70 - 3.90) reported in kunun- zaki (Locally fermented sorghum beverage) by Makinde and Oyeleke (2012). The differences in pH of the yoghurt samples might be due to ability of the mixed starter culture to grow in various samples and ferment the carbohydrate (Ott *et al*., 2000; Ogbonna *et al*., 2013). The titratable acid value ranged from 1.23 to 1.34%. Sesame based yoghurt had the lowest value (1.23%) and groundnut sample had the highest (1.34%). No significant difference ($p > 0.05$) existed in titratable acid value of the yoghurt samples. Yoghurt acidity are due to the presence of lactic acid bacteria during fermentation of milk to yoghurt. These bacteria are beneficial to human being (Reid *et al*., 2003; Ayo *et al*., 2004)

Microbiological analysis

The Mean total count of FCMP and vegetable yoghurts ranged between 2.24 and 2.57 $x10^{8}$ cfu/ml (Fig.2). Although, the groundnut based sample had higher total count (2.57 $x10^{8}$ cfu/ml) but there were no significant difference ($p > 0.05$) in the values recorded for all the samples. The result corroborates the findings of Mayunzu *et al*. (2011) who reported range 4.04 to 4.6 x 10^{8} cfu/ml total count for yoghurt. Oyeniyi *et al*. (2014) also reported total count in the range 2.10 to 3.80 10^{8} cfu/ml for different flavored soy yoghurt in Nigeria.

However, lower bacterial count had been reported in kunun- zaki (Ogbonna *et al.*, 2011), Soy yoghurt (Chima, *et al*., 2013), and fermented Tiger nut milk (Wakil *et al*., 2014) in Nigeria. There was no presence of E. coli in all the samples analyzed and this certified the products free of fecal contamination (Lopez *et al*., 1997; Olatoye and Lawal, 2016). Microbiological analysis of the yoghurt samples give information about the safety level for human consumption (presence of spoilage and pathogenic organisms) and presence of mixed started organisms which confers health benefits on yoghurt for the consumers (Hutkin, 2006).

Sensory evaluation

The mean scores for quality attributes of the yoghurt samples were presented in Table 3.

The yoghurt produced from FCMP had significantly higher ($p < 0.05$) viscosity and taste than all the vegetable based yoghurts. The rating obtained for aroma and colour in soy bean and groundnut were not different from FCMP yoghurt ($p > 0.05$). It appears that, the three vegetables based yoghurt were not significantly different ($p > 0.05$) from each other with respect to aroma, viscosity, taste and overall acceptability.

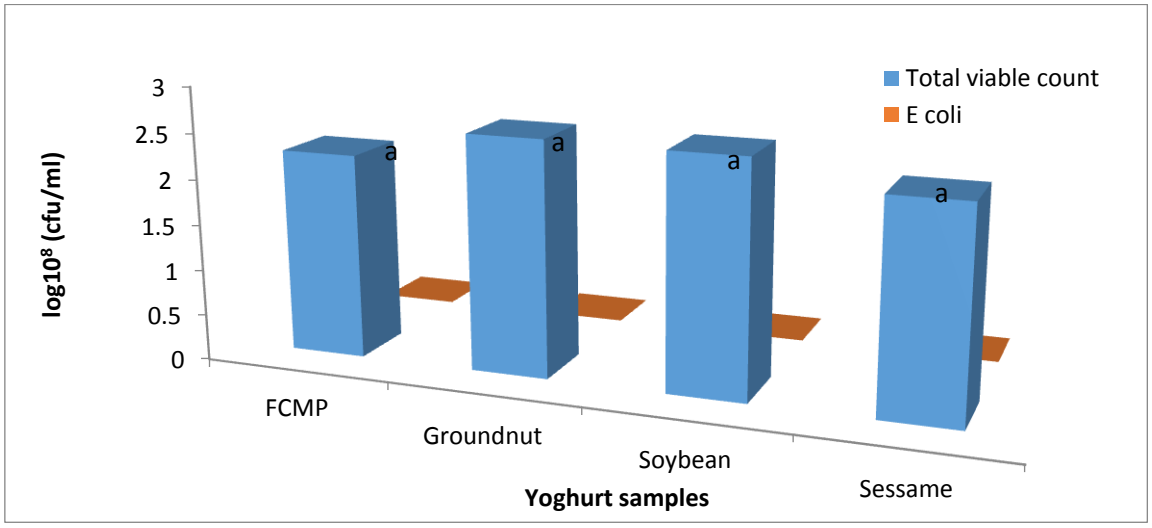

Figure 2. Total microbial count of yogurt samples.

Table 3: Sensory qualities yoghurt samples

Yoghurt sample	Aroma	Colour	Viscosity	Taste	Overall acceptability
FCMP	7.46^{a}	7.18^{a}	7.46^{a}	7.31^{a}	7.69^{a}
Groundnut	6.31^{d}	7.08^{a}	6.08^{b}	6.62^{b}	6.69^{b}
Soybean	6.46^{c}	6.38^{c}	5.92^{d}	6.08^{c}	5.62^{d}
Sessame	7.23^{b}	7.05^{b}	5.94^{c}	6.00^{d}	6.38^{c}

Means with different superscript in each column are significantly different ($p < 0.05$). FCMP: full cream milk powder.

The similarity noticed by the panelists may be partially due to activities of starter culture and vegetable fat in the seed. This agreed with the findings of Awonorin and Udeozor (2014) who reported that, the fat composition plays a vital role in determination of mouth feel in imitation milk based products.

4. CONCLUSION

The study revealed the inherent potential embedded in vegetable based yoghurt. Physicochemical, microbiological and sensory properties of yoghurt samples from sesame, groundnut and soybean seed were comparatively evaluated. It was found that the yoghurt made from the vegetable seeds were not appreciably different from the yoghurt made from full cream powder in terms of nutritional composition, physicochemical properties and microbiological analysis. Higher sensory properties were recorded in full cream powder yoghurt over other vegetable yoghurt samples. Finally, the production, utilization, and consumption of vegetable based yoghurt should be encouraged because such product will be helpful in providing nutritious, safe and wholesome food for the poor and malnourished populations in developing country.

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