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NUTRITIONAL AND SENSORY EVALUATION OF HOME-MADE SOY YOGURT

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ABSTRACT
Soybean yogurt is a plant-based alternative to traditional dairy yogurt. The purpose of this research was to assess the soy-based yogurt's sensory properties and nutritional composition. The nutritional composition of each sample was determined using standard methods. Panelists of 20 healthy individuals were enrolled for the sensory evaluation, comprised of 10 females and 10 males. . The sample was evaluated for acceptability, taste, color, appearance and mouth feel. The findings showed that Store Bought Yogurt (SBY) had a larger energy (68.54%) and carbohydrate value (14.22%) than Produced Soy Yogurt (PSY). The PSY had the highest contents of moisture (92.47%), protein (2.73%), fat (0.80%), and ash content (0.99%). Both PSY and SBY had no difference in phosphorus content (0.03 %). PSY had higher content of sodium (0.56 %). Outcome of the sensory evaluation showed that the produced soy yogurt was acceptable. It was found that Produced Soy Yogurt was better than Store-Bought Yogurt in terms of acceptability, color, mouthfeel, and taste. But SBY's appearance was better compared to PSY. Our findings suggest that Produced Soy Yogurt (PSY) has the potential to be a healthy source of protein and non-dairy products for those looking for an alternative to dairy products.

Keywords: Soy yogurt, non-dairy yogurt, soya bean, lactose intolerance.

INTRODUCTION

Soybean (*Glycine max*) is a legume native to East Asia perhaps in North and Central China. It belongs to the family *Leguminacea* (Sinclair *et al*., 2014; Gobana and Geleta, 2022). Soybean has been recognized as one of the premier agricultural crops today, thus it is the best source of plant protein and oil. Hence, it can serves as a potential supplementary source of nutritious food (Afolabi *et al*., 2021). It has been found to substitute other sources of good quality protein such as milk, meat and fish. Therefore, it has become a very suitable replacement for other protein sources that are scarce or too expensive to afford (Ikrang *et al*., 2020). Soybean has been found to have different uses; for example in food industry, soybean is used for flour, oil, cookies, candy, milk, vegetable cheese, and many other products (Miransari, 2016).

Soybean protein is considered complete, because it supplies sufficient amounts of the types of amino acids that are required by the body for building and repair of tissues (Afolabi *et al*., 2021). Essential amino acids found in soybean are methionine, isoleucine, lysine, cystine, phenylalanine, tyrosine, theonine, tryphophan as well as valine (Ikrang *et al*., 2020). Amino acids are used in the formation of protoplasm, the site for cell division and therefore facilitate plant growth and development (Farag *et al*., 2022).The shortage of industrial and food grade oils and of protein for animal feeds during World War II further encouraged the processing of domestic soybeans. During this same period, the cultivation of soybeans spread from the Carolinas to Illinois and surrounding states (Sinclair *et al*., 2014).The oil was used mostly to manufacture soap and the cake or meal for feeding dairy cattle (Sinclair *et al*., 2014).

Soymilk is a liquid extract made from soybeans, which are a type of grain legume and one of the earliest known food to human. It has high-quality ingredients for pharmaceuticals, food, feed, and other industrial uses (Miransari, 2016; Gobana and Geleta, 2022). The soybean's edible portion has approximately 40% protein, 27% complex carbohydrates, 20% oil, 8% moisture, and 5% minerals (Zaefarian and Rezvani, 2016). Low cost, high nutritional content and compatibility for those with lactose intolerance are some of the unique qualities of soymilk. It can be used to feed infants and young children, and also serve as dietary supplement for adults and the elderly (Twinomuhwezi *et al.,* 2020).
The term 'yogurt' originated from Turkey. Its production began among the early cultures of nomadic herdsman of Asia, Southern and Eastern Europe (Makanjuola, 2012; Sinclair *et al*., 2014). Raw materials for yogurt production include milk, culture of acid-forming/fermenting bacteria (such as *Streptococcus thermophilus* and *Lactobacillus bulgaricus*), sugar like fructose, glucose, honey or raw sugar (Ikrang *et al.,* 2020; Farag *et al*., 2022). Yogurt can also be produced using soy or corn milk and the same microorganisms involved in the fermentation process (Makanjuola, 2012)
Recently, there has been an increase in the consumption of soymilk due to a growing awareness of its health benefits and its potential to alleviate certain illnesses (Osundahuns *et al*., 2007; Gobana and Geleta, 2022). However, some consumers may find the beany flavor of soymilk unappealing, which is caused by the presence of lipoxygenase enzymes in soybeans (Kong *et al*., 2022). Source of animal protein is expensive in Nigeria. Some of the available yogurts contain sweetener and preservative that are not healthy for consumption and some individuals are lactose intolerance (Kong *et al*., 2022). Traditionally, studies have shown that the beany flavor in soy beans can be controlled or minimized by activating the enzymes through heating and fermenting soy milk into soy yogurt (Osundahuns *et al*., 2007; Makanjuola, 2012). However, soy yogurt is still at the indigenous level of fermentation, with no standard procedure, as in yogurt. Therefore, there is need for researchers to exploit the production of soy yogurt and also to evaluate the nutritional composition, which was the objective of this research.

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MATERIALS AND METHODS

Study area

This study was carried out in the Department of Biochemistry and Biotechnology Laboratory, Ibrahim Badamasi Babangida University Lapai, Niger state, Nigeria. The laboratory specializes in standard food safety.

Production of Yogurt from Soybeans

Dried soybeans were purchased at Lapai market, Niger State, Nigeria. It was kept in a clean plastic bag at room temperature. The soybeans were sorted to remove the spoilt ones and other foreign materials. The good soybeans was run into a grinding machine to remove the shaft then winnowed. It was soaked and blended immediately. Before then, about 4 liters of water was heated on fire and the blended mixture was poured into the boiling water to boil for 30 minutes, while the mixture was continuously stirred to avoid foaming and spillage. The mixture was removed from heat after 30 mins of boiling and allowed to cool for 10 min. After 10 min the mixture was sieved into a bowl and the filtrate was covered and allowed to ferment for about 15-20 hours at room temperature (25-30^{o}C). After the fermentation, the water at the top was decanted and re-sieved, and that was the Produced Soy yogurt. The PSY was stored at 4^{o}C until sensory evaluation was carried out.

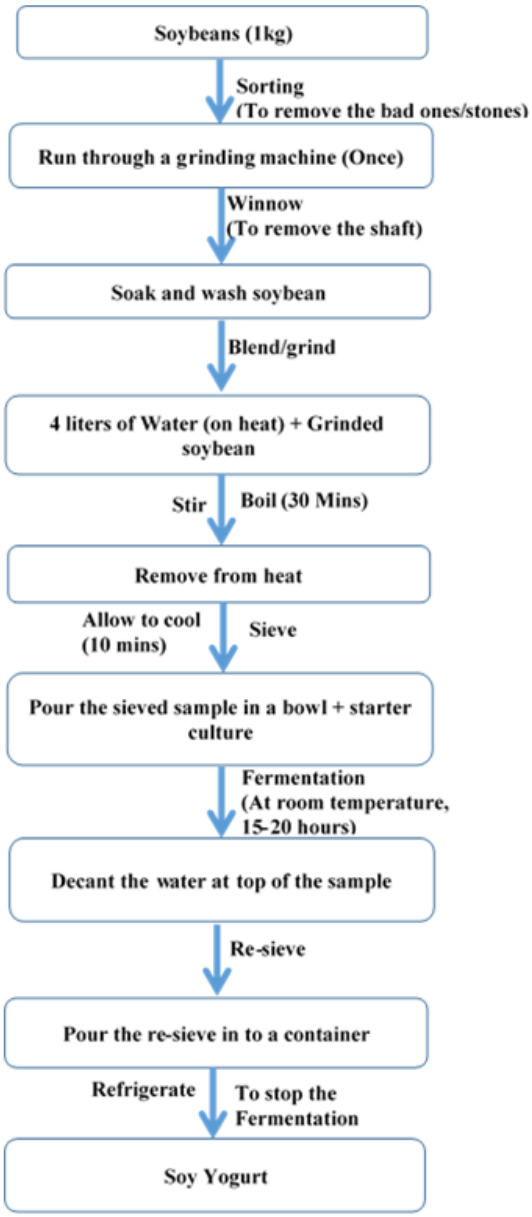

Figure 1: Flow chart of Soy yogurt production

Proximate and pH analyses of the yogurt samples

The moisture content of the samples were determined using the oven drying method as described in method No.945.38 by AOAC (2012). Lipid content of the samples were gotten using AOAC (2012) method no 920.39. The protein content was determined using method No. 955.04C (AOAC, 2012) called the Kjeldahl method. The ash content was determined using AOAC (2012) method no 942.05. The pH was measured using pH meter after standardization with pH 4, 10 and 7 buffers. The carbohydrate content of the samples were obtained by estimation, that is, as the difference between the total summation of percentage moisture, fat, protein, ash and 100%, and was gotten thus;

% Carbohydrate = 100% – (% moisture + % fat % protein + % ash)

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Minerals and Vitamins Determination
The calcium, phosphorus, sodium, and magnesium contents of the samples were determined by absorption spectrometer according to AOAC, (2012). The vitamin content was determined using the method described by Bates (1997).

Sensory evaluation
The sensory evaluation was carried out using a 20 semi-trained panelist of 10 males and 10 females. The panelists were instructed to indicate their preferences of the sample. A nine point Hedonic scale was used, where 9 was 'extremely like' and 1 was 'extremely dislike'. The sample was evaluated for acceptability, taste, color appearance, texture and mouth feel.

Statistical Analysis
Data were analyzed using Statistical Package for Social Science (SPSS 23) and the Means data were compared using Analysis of Variance (ANOVA) and Tukey Posthoc Test.

RESULTS

Proximate analysis of Produced Soy Yogurt (PSY) and Store Bought Yogurt (SBY)
Table 1 shows the percentage proximate and pH composition of the PSY and SBY. The result reveals that the PSY had the highest amount of moisture, protein, fat and ash contents than SBY with the following values (92.47, 2.73, 0.80, and 0.99% respectively) that differ significantly across the column at *p<0.05* respectively. The carbohydrate (14.22%) and energy value (68.54) were however higher in SBY than PSY and were significantly different. The pH of PSY was 4.62 which slightly lower than SBY (4.90). However, the pH values were not significantly different.

Table 1: Proximate composition and pH of Yogurt samples

	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fiber (%)	CHO (%)	pH	Energy value (Kcal/100g)
PSY	92.47±0.12^b	2.73±0.11^b	0.80±0.13^b	0.99±0.12^b	0.66±0.05^b	2.35±0.12^a	4.62±0.13^a	30.15^a
SBY	82.98±0.15^a	1.79±0.12^a	0.39±0.11^a	0.37±0.11^a	0.25±0.02^a	14.22±0.16^b	4.90±0.14^a	68.54^b

***PSY= Produced Soybean Yogurt *SBY= Stored Bought Yogurt. Values are presented as Mean ±SD. Values with the same superscript letters are not significantly different at *p<0.05*.**

Mineral Composition
Table 2 shows mineral contents of the PSY and SBY. Mineral contents of the soy yogurt were comparable with those of the SBY. The calcium recorded in both PSY and SBY were 0.38±0.03 and 0.35±0.01 respectively. The calcium content does not show a significant difference (*p<0.05*) in both PSY and SBY. The sodium content was higher in PSY than SBY and indicated a significant difference while magnesium and potassium were significantly higher in SBY than in PSY. The Phosphorus contents are not significantly different and both PSY and SBY (0.03±0.01)

Table 2: Mineral contents of yogurt samples in percentage

Minerals	Calcium (%)	Magnesium (%)	Sodium (%)	Potassium (%)	Phosphorus (%)
PSY	0.38±0.03^a	0.52±0.02^a	0.56±0.01^b	0.66±0.01^a	0.03±0.01^a
SBY	0.35±0.01^a	1.18±0.04^b	0.02±0.00^a	1.69±0.03^b	0.03±0.02^a

***PSY= Produced Soybean Yogurt *SBY= Stored Bought Yogurt. Values are presented as Mean ±SD. Values with the same superscript letters are not significantly different at *p<0.05*.**

Vitamin Concentration
Table 3 shows the vitamins analyzed (retinol (A), riboflavin (B2), ascorbic acid (C), pyridoxine (B6) and thiamine (B1)). The value recorded for vitamin A is greater in SBY (14.18±0.15) than the one recorded for PSY (11.12±0.12). There was a significant difference (*p<0.05*) in the value of Vitamin A. The Vitamin B2 recorded in SBY (3.68±0.10) is significantly higher than those recorded for PSY (2.88±0.11). The value of Vitamin C, Vitamin B6, Vitamin B1 and Total Antioxidant were 213.20±0.13, 2.14±0.12, 8.03±0.10 and 353.91±0.10 in PSY while that of SBY were 128.80±0.15, 1.47±0.12, 6.40±0.11 and 213.78±0.12 respectively. The Vitamins and Total Antioxidant exhibited significant difference in their content in PSY and SBY.

Table 3: Vitamins Concentration of yogurt samples

Samples	Vitamin A (mg/100ml)	VitaminB2 (mg/100ml)	Vitamin C (mg/100ml)	Vitamin B6 (µg/ml)	Vitamin B1 (µg/ml)	Total Antioxidant (mg/100ml)
PSY	11.12±0.12^a	2.88±0.11^a	213.20±0.13^b	2.14±0.12^a	8.03±0.10^b	353.91^b
SBY	14.18±0.15^b	3.68±0.10^b	128.80±0.15^a	1.47±0.12^a	6.40±0.11^a	213.78^a

Key: **A- Retinol, B2- Riboflavin, C- Ascorbic acid, B6- Pyridoxine and B1- Thiamine. *PSY= Produced Soybean Yogurt *SBY= Stored Bought Yogurt. Values are presented as Mean ±SD. Values with the same superscript letters are not significantly different at *p<0.05*.**

Sensory Analysis
Table 4 shows the sensory evaluation scores for appearance, color, mouth feel, taste and overall acceptability of PSY and SBY by the panelists ranged from 7.15-9.01, all above the mean score of 5 for the 9 points hedonic scale used. Thus, the PSY samples were acceptable by the panelists. PSY was significantly (P<0.05) preferred to SBY in terms of color (7.15), mouth feel (9.01), and overall acceptability (7.98). However, there was no significant difference in the taste of both samples. The appearance of SBY was preferred to Soy yogurt.

Table 4: Sensory evaluation of samples

	Sample code	
Sensory attributes	**PSY**	**SBY**
Appearance	7.23±0.12[a]	8.98±013[b]
Color	7.15±0.11[b]	6.12±0.10[a]
Mouth feel	9.01±0.16[b]	6.70±0.11[a]
Taste	7.22±0.12[a]	7.20±0.11[a]
Overall acceptability	7.98±0.13[b]	6.99±0.12[a]

PSY= Produced Soybean Yogurt *SBY= Stored Bought Yogurt. Values with the same superscript letters are not significantly different at *p<0.05.

DISCUSSION

The results in Table 1 show the proximate compositions and pH of the yogurt samples. The fat content of PSY sample was 0.80% compared to SBY (0.39%). Higher fat content of the PSY is possible from the usual high fat content in soybeans and also a good source of cooking oil (Vij *et al.*, 2011; D'Andrea *et al.*, 2023). Also, soy fat is plant fat and composed of mainly unsaturated fats which are of high health benefit to human (Mehaya *et al.*, 2023). SBY fat is animal fat, which on the other hand is composed mainly of saturated fats which are likely to predispose consumers to heart related disease (Vij *et al.*, 2011; Mehaya *et al.*, 2023;). High ash content implied high minerals in the sample. The high protein and minerals in the PSY suggested to higher quality than the SBY. In contrast, a study by Miransari (2016); Gobana and Geleta (2022) examine early to late maturing soybean varieties, found that delayed planting (first half of June) reduced oil content but had no effect on protein content (Miransari, 2016).

The mineral content of the yogurt samples were reported in Table 2. PSY is slightly high in calcium and most mineral, while SBY is comparatively low in the minerals. Minerals play important metabolic and physiologic roles in living cells. Calcium, magnesium, sodium and potassium are known to prevent many degenerative diseases, including muscle degeneration, growth retardation and bleeding disorder (Vij *et al.*, 2011; Ogundipe *et al.*, 2021). Mineral help to build our bones, influencing muscle and nerve functions and regulating the body's water balance. They are also component of hormones and enzymes and other biologically active compounds (Zaefarian and Rezvani, 2016).

Table 3 shows the vitamin content of the yogurt samples. The vitamins shows that riboflavin could be synthesized and isolated form a traditional sourdough (Vij *et al.*, 2011). However, the increase in vitamin B1concentration in PSY could be attributed to the production pathway in fermentation (Mehaya *et al.*, 2023).The high level of A and B2 in SBY could be due fortification of the store bought yogurt with some of this vitamins (Mehaya *et al.*, 2023). However, the high level of antioxidant exhibited by PSY could be as a result of high vitamin C content in PSY.

The result of sensory evaluation of the yogurt sample is presented on Table 4. The properties evaluated by the panelists include color, taste, mouth feel, appearance and overall acceptability. Sample SBY was rated low in color. There was no significant difference in taste for both samples. This can be compared to reports by Makanjuola (2012); Obiora *et al.* (2020). In term of mouth feel, sample PSY was most preferred. However, PSY was generally accepted compared to SBY.

Conclusion

It is evident that, yogurt can be produced from soybeans as a plant source. Produced Soy Yogurt (PSY) has the potentials of giving an equal measure of nutritive and sensory value as would be obtained from an animal source having realized some incremental average values of the various properties analyzed. Using soybeans as a possible product in the manufacture of yogurt so as to impact on the nutritive spectrum of consumers showed a relatively acceptable result. The production of soy yogurt serve the same purpose as animal base yogurt to people who are lactose intolerant and also individuals looking for low calorie diets.

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