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Quality Evaluation and Acceptability of Soy-yoghurt with Different Colours and Fruit Flavours

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Abstract: The effects of different flavouring/colouring agents and fruits on the quality and acceptability of stirred soy-yoghurt were studied. Soy-yoghurts flavoured with strawberry, vanilla, orange, orange fruit, pineapple fruit and pawpaw fruit were compared for protein, pH, percentage lactic acid, soluble solids, percentage syneresis, total solids and microbial count with plain soy-yoghurt. Sensory evaluation was conducted in order to determine the acceptability of the samples. The pH and percent lactic acid ranged from 4.4-4.7 and 0.9-1.08%, respectively on the first day of storage while the values were 4.1-4.3 and 1.44-1.71%, respectively on the eighth day of storage at 6°C. Soluble solids of yoghurt samples ranged from 18.4-27.9% on the first day and were between 18.4-25.4% on the eight day of storage. The average percent syneresis of flavoured and fruit soy-yoghurts were 42.03 and 46.3%, respectively. The values increased with increasing storage days. The average protein content of fruit Soy-yoghurts was 5.01% while the average for flavoured soy-yoghurts was 3.93%. The total solids of plain yoghurt was 14.5%, flavoured soy-yoghurt was 13.5% and fruit soy-yoghurts was 12.5%. Microbiological examination revealed that the samples were within the acceptable minimum standards. The sensory evaluation showed that there was no significant difference in taste among all the samples. However, there were significant difference in the colour, aroma, consistency and overall acceptability of soy-yoghurts samples. The sensory evaluation revealed that there was preference for strawberry, vanilla, plain, orange flavoured, pineapple fruit flavoured yoghurts relative to pawpaw and orange fruit flavoured-yoghurts.

Key words: Soy-yoghurt, fruit flavours, acceptability

INTRODUCTION

Yoghurt is usually made from animal milk. It is acidic in flavour and has a fine smooth texture. Among the various cultured dairy products, yoghurt is unique with presence of acetaldehyde which is relatively high in concentration and desirable as an essential flavour component (Vedamuthu, 1982). The continuous increase in population and inadequate supply of protein has in advertently increased the occurrence of malnutrition in developing countries (Siddhuraju *et al*., 1996). To meet the protein demands in developing countries, where animal protein is also grossly inadequate and relatively expensive, research effort is geared towards finding alternative sources of protein from legume seeds (Nsofor and Maduako, 1992). The increasing concern about fat and cholesterol content of animal milk is another factor promoting the selection of vegetable substitute for animal milk. Unsaturated fatty acid in the diet is recommended to reduce the incidence of cardiovascular disease (Lee *et al*., 1990). Consumption of vegetable milk may also be beneficial in cases of lactose intolerance (PAG, 1972).

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Efforts have been devoted to exploiting soybean and soybean products for the manufacture of palatable food products. Enrichment of cereal-based traditional weaning food by complementing with soybean tempe has been reported (Osundahunsi and Aworh, 2003). The main objections to soybean products by some consumers are the associated intrinsic flavour which has been described as beany or astringent and phenomenon of flatulence. Fermentation has been reported to reduce antinutritional factors (Paredes-Lopez and Harry, 1989). Lopez *et al*. (1983) reported increase in bioavailability of minerals in grain legumes by decreasing phytic acid as a result of the action of phytase synthesized by micro-organism. However, it has been reported that acceptability of soybean products has been enhanced by modification of processing methods. Some of the modifications of cold-water extraction of soymilk include application of heat, soaking of soybean in ethanol or alkali and acid grinding. Reduction in the objectionable flavour and flatulent sugars namely starchyose and raffinose occur after fermentation by Lactic acid bacteria (Buono *et al*., 1990). The increase in the consumption of yoghurt in the United States of America is attributed to the addition of fruits, flavours and sweetners to plain yoghurt (Vedamuthu, 1982). Natural flavourants have been used to improve acceptability of soymilk (Iwe and Agu, 1993). Although soy-yoghurt flavoured with flavour essence has been introduced into the market in Nigeria, there is dearth of information on response of consumers to fruit flavoured soy-yoghurt.

The objectives of this research were to evaluate some chemical quality attributes of soy-yoghurt and assess the effect of different fruits, flavours and colours on the storage and acceptability of soy-yoghurt.

MATERIALS AND METHODS

Materials

Soybean (*Glycine max* Merr) was provided by Dr. Maziya-Dixon of the International Institute of Tropical Agriculture Ibadan, Nigeria. Freeze dried Roselle yoghurt culture was obtained courtesy Roselle California, U.S.A. Flavour and colour essence were obtained from Roche, Nigeria (Givaudan, Switzerland). Peak milk powder (Holland), gelation, granulated sugar and fruits were obtained locally. All chemical used were of analytical grade.

Methods of Analysis

Preparation of Soymilk

Cleaned soybean seeds were soaked in 0.05% $NaHCO_3$ (25°C, 20 min), boiled for 5minutes and rinsed. The blanched soybeans were ground in a warring blender Hamilton Beach (model 909-220). The slurry was filtered at ratio 7:1 of water to slurry through cheese cloth and filtrate simmered for 20minites to obtain soymilk (Nsofor and Maduako, 1992).

Preparation of Mother Culture

Cowmilk powder was reconstituted by dissolving 18 g in 190 mL of water as recommended by the manufacturer. The whole milk was heated to 82°C for 30 min, then cooled rapidly to 48°C and inoculated with 2% (w/v) of freeze-dried culture. The inoculated mix was incubated for 4 h at 40-45°C to develop proper acidity, then cooled and stored at 6°C.

Preparation of Colour Flavoured, Fruit Flavoured and Plain Soy-yoghurt

The colour/flavour solution was obtained by adding 2.0 g of the powdered colour/flavour into 10 mL of sterilized distilled water. One milliliter of the solution obtained was then added to 9 mL of sterilized distilled water to give a concentration of 0.002%.

Into freshly prepared soymilk, 0.3% gelatin, 1% glucose, 0.104% calcium sulphate and 3% sucrose were added. The mix was pasteurized at 82°C for 30 min, then rapidly cooled to 48°C and inoculated with 15% (w/v) mother culture. The inoculated mix was stirred and weighed into lots. Two milliliter of colour/flavour of choice was added to each lot. A batch without flavour served as a

control, which was the plain soy-yoghurt. The lots were incubated at 40-45°C for 8 h and then cooled rapidly to 15°C. Each lot was stirred, poured into cups and stored at refrigeration temperature for 8 days. To the samples for fruit flavour were added 5% of different mashed fruit chunks (pineapple, pawpaw and orange).

Chemical Analysis

Proximate Composition

The analysis of the samples for protein, moisture, lipid total solids and ash content were carried out in triplicate using standard methods (AOAC, 1990). The carbohydrate content was determined as the weight difference using moisture, crude protein, lipid and ash content data.

Lactic Acid Content Determination

The lactic acid content of soymilk and soy-yoghurt samples were determined according to the AOAC (1990) technique. Twenty grams of well homogenized sample was placed in beaker and was titrated against O.IN NaOH with phenolphthalein as indicator. Titratable acidity was expressed as percent lactic acid.

pH Determination

The pH of the soymilk and soy-yoghurt samples were measured directly using PYE UNICAM Model 292 MK2 The pH meter was standardized with pH 4.0, 7.0 and 9.0 buffer solution.

Determination of Soluble Solids

Soluble solids were determined on some drops of samples using Bausch and Lomb Abbe refractometer.

Percentage Syneresis

Syneresis was determined according to Shirai *et al*. (1992). A sample of 30 g was centrifuged (1535 x g, 20 min) and the whey was drained for 1 min. The weight of the drained whey expressed as a percentage of the weight of the yoghurt gives percentage of syneresis.

Microbiological Examination

Soymilk and soy-yoghurt samples, were examined for viable count of bacteria, *Esherichia coli*, yeast and moulds using plate count Agar, Eosin Methylene Blue agar and Potato Dextrose Agar, respectively.

The pour plate method was used to enumerate the total number of viable microorganisms in the soymilk and the various yoghurt samples. Serial dilution was done using normal saline to 10^{-6} dilution and 1 mL of 10^{-6} dilution was added into each sterile petri dish. Molten plate count agar was added into the plates, agitated, allowed to solidify and incubated at 28 and 37°C for 48 h. The number of colonies counted on the plates taken into consideration the dilution factor.

The presence of *E. coli* was determined by inoculating soymilk and the soy-yoghurt samples on Eosin methylene Blue Agar and incubating at 37°C for 18 h (Anderson and Holbrook, 1980). The presence of yeasts and moulds were enumerated by inoculating serial dilution of soymilk and soy-yoghurt samples on potato Dextrose Agar. The plates were incubated at 25°C for 3-4 days (Harrigan and McCance, 1976).

Sensory Evaluation

A total of 16 untrained assessors drawn from University of Ibadan, Ibadan assessed the sensory quality of yoghurt samples. The extent of the differences between the soy-yoghurt samples for each

sensory quality was measured on a standard nine-point hedonic scale. The assessors rated the yoghurt samples for colour, Aroma, taste, consistency and overall acceptability successively on a scale varying from 1 = dislike extremely to 9 = like extremely.

Statistical Analysis

All results in this study are reported as mean of three replicate analyses. One-way analysis of variance (ANOVA) was use to determine differences between the mean scores. Differences between means obtained from the ANOVA were ascertained using Duncan's Mutiple range tests. Significance was accepted at $p<0.05$ (SAS, 1990).

RESULTS AND DISCUSSION

The chemical composition and gross energy values of the soybean, soymilk and soy-yoghurt are presented in Table 1. The crude protein was 3.5 g/100 g in soymilk and 39.4 g/100 g in soybean. Generally the trend was observed in ether-extract which was 4.5 and 2.7 g 100 g^{-1} in soy-yoghurt and soymilk, respectively, but 20.6 g 100 g^{-1} in soybean. The protein content reported is within the range of 30 to 40% reported by Ogundipe and Oguntunde (1990). The fat content is also comparable. The moisture content (8.4%) of soybean is within the range reported by Weingartner (1987). This will enhance good keeping qualities, decrease insect infestation and increase the shelf life. The freshly prepared soymilk protein is comparable to 3.58% reported by STS (1987). Total solids of soymilk used for the production of soy-yoghurt was expected to range between 9 to 12%.

Davis (1981) recommended lactic acid of 0.1% in yoghurt. The value reported in this study is considered satisfactory. The pH value reported for cowmilk ranged between pH 6.6 and 6.7 according to (Sheron, 1988). Whereas the pH value of the freshly prepared soymilk was 7.2 (Table 2). Table 3

Table 1: Chemical composition of soybean, soymilk and soy-yoghurt [A]

Parameter (%)	Soybean	Soymilk	Soy-yoghurt
Moisture	8.4±0.24	89.6±0.12	87.8±0.01
Protein	39.4±0.27	3.5±0.16	3.75±0.13
Fat	20.6±0.16	2.7±0.33	4.5.8±0.18
Ash	4.8±0.35	0.27±0.22	0.52±0.23
Total Solids[B]	91.6±0.12	10.4±0.16	14.5±0.21
Carbohydrate[C]	27.1±0.13	3.93±0.50	3.43±0.62
pH[D]	6.4±0.15	7.2±0.10	4.7±0.10
Gross energy[E]	451.4	54.02	69.22

[A]Result is on wet weight basis, [B]results are mean±SD of samples in Triplicate, [C]carbohydrate by difference of 100-(moisture+crude protein+fat+ash), [D]pH meter readings, [E]Atwater factor of (Protein x 4+Carbohydrate x 4+Fat x 9) as Kcal/100 g

Table 2: pH and Lactic acid content of freshly prepared and inoculated soymilk

Samples	pH	Lactic acid (%)
Soymilk (freshly prepared)	7.2	0.01
Soymilk (inoculated)	6.4	0.25

Table 3: pH value, lactic acid content (%) and soluble solids of soy-yoghurt samples on the 1st and 8th day [a]

	1st day			8th day		
Samples*	pH	Lactic acid (%)	Soluble solids	pH	Lactic acid (%)	Soluble solids
Strawberry soy-yoghurt	4.6	0.9	26.4	4.2	1.60	25.4
Vanilla soy-yoghurt	4.7	0.7	23.9	4.3	1.44	22.4
Plain soy-yoghurt	4.7	0.8	18.4	4.3	1.47	18.4
Orange soy-yoghurt	4.7	0.8	22.4	4.2	1.58	21.4
Orange fruit soy-yoghurt	4.4	1.08	25.9	4.1	1.71	21.4
Pineapple fruit soy-yoghurt	4.4	1.08	27.9	4.1	1.60	21.4
Pawpaw fruit soy-yoghurt	4.4	1.06	26.3	4.1	1.71	22.4

[a]Mean of three determinations in each of three replicate samples, *Refrigerated soy-yoghurts stored at 6°C

Table 4: pH values and solids of fruits

Fruit samples	pH	Soluble solids
Orange	4.0	8.34
Pawpaw	5.7	11.35
Pineapple	4.1	14.35

Table 5: Percentage syneresis of soy-yoghurt samples[a]

Samples	1st day	8th day
Strawberry soy-yoghurt	41.3	43.50
Vanilla soy-yoghurt	43.9	45.00
Plain soy-yoghurt	44.5	45.90
Orange soy-yoghurt	40.9	42.60
Orange fruit soy-yoghurt	46.2	52.20
Pineapple fruit soy-yoghurt	47.0	50.90
Pawpaw fruit soy-yoghurt	45.6	52.70

[a]Mean of three determination in each of three replicate samples

Table 6: Protein and total solids contents of soy-yoghurt samples[a]

Samples	Protein (%)	Total solid (%)
Strawberry soy-yoghurt	3.95	13.5
Vanilla soy-yoghurt	3.99	14.0
Plain soy-yoghurt	3.75	14.5
Orange soy-yoghurt	3.85	13.0
Orange fruit soy-yoghurt	5.42	12.6
Pineapple fruit soy-yoghurt	4.55	12.4
Pawpaw fruit soy-yoghurt	5.07	12.6

[a]Mean of three determination in each of three replicate samples

shows the pH value, lactic acid content and soluble solids of soy-yoghurt samples on the first and the 8th day of storage. The lactic acid content increased with decreasing values in pH during storage at 6°C (Refrigeration). The change in pH and lactic acid content indicated that the activity of the starter culture was not completely arrested though markedly decreased. It was shown that the pH values and lactic acid content of fruit soy-yoghurts (4.4) were lower than (4.7) recorded for flavoured soy-yoghurts. The decrease in pH value and concomitant increase in lactic acid may be attributed to the low pH values of the fruit added to soy-yoghurt as shown in Table 4. These values for soy-yoghurt samples were comparable to those reported by Lee *et al*. (1990) and Chang *et al*. (1990). The ranges for pH and lactic acid content of soy-yoghurt were 3.94-4.00 and 1.00-1.99%, respectively. However, Mital and Steinkraus (1974) reported a pH range of 4.7-4.26. The soluble solids of fruit soy-yoghurts (Table 3) were higher than that of flavoured soy-yoghurts. The high sugar content of fruits added to soy-yoghurts might have contributed to the higher soluble solids recorded. It was observed that the soluble solids of all soy-yoghurt samples decreased during storage at 6°C. It would appear that decrease in soluble solids was due to metabolism of sugars by lactic acid culture under storage condition. The sugars converted to glucose was metabolised to pyruvate via Embdem Meyerhof Parnas pathway. The pyruvate was later converted to lactic acid by lactate dehydrogenase (Tamine and Robinson, 1989).

The percentage syneresis ranged between 40.9 to 47.0% on the first day and 42.6 to 52.7% on the 8th day (Table 5). Shirai *et al*. (1992) reported an average of 52.6% syneresis in soy-yoghurt fortified with 0.104% calcium sulphate. Montano-ortega *et al*. (1991) reported an average of 31.5% syneresis in Mexican plain yoghurts. However, with the addition of 0.3% gelatin and 0.104% calcium sulphate (Paolieolo *et al*., 1987) a range from 42.06 to 46.3% syneresis was obtained for flavoured soy-yoghurt. In comparison with flavoured soy-yoghurts, higher percentage of syneresis was reported for fruit soy-yoghurts. The percentage also increased with increasing length of storage. Based on the values, a very good stability to wheying-off of the fermented mixed substrate could be expected.

The protein and total solids content of yoghurt samples are shown in Table 6. Protein content ranged between 3.7 to 5. 42% while total solids were between 12.4 and 14.5%. Fermentation has led

Table 7: Microbiological evaluation of soy-yoghurt samples after eight days of storage

Samples	Total count (cfu mL^{-1})	*E. coli* (cfu mL^{-1})	Yeast and mould (cfu mL^{-1})
Strawberry soy-yoghurt	302×10^6	-	-
Vanilla soy-yoghurt	288×10^6	-	-
Plain soy-yoghurt	290×10^6	-	-
Orange soy-yoghurt	308×10^6	-	-
Orange fruit soy-yoghurt	313×10^6	-	-
Pineapple fruit soy-yoghurt	346×10^6	-	-
Pawpaw fruit soy-yoghurt	290×10^6	-	2
Commercial yoghurt	290×10^6	-	-

-: Not found

Table 8: Mean ranks for quality attributes of soy-yoghurt samples

	Flavours/Fruits						
Attributes	Strawberry flavour	Vanilla	Orange flavour	Orange flavour	Pawpaw fruit	Pineapple fruit	Plair fruit
Colour	8.50^{a}	7.38^{b}	7.50^{b}	6.81^{b}	6.75^{b}	7.06^{b}	7.13^{b}
Aroma	7.94^{a}	7.13^{bc}	7.56^{c}	6.56^{c}	6.75^{bc}	7.44^{ab}	6.94^{bc}
Taste	7.5^{a}	7.0^{a}	7.06^{a}	6.56^{a}	6.50^{a}	7.31^{a}	6.88^{a}
Consistency	7.38^{ab}	7.31^{abc}	7.19^{abc}	6.56^{bc}	6.37^{c}	6.81^{abc}	7.68^{a}
Overall acceptability	7.69^{a}	7.44^{a}	7.06^{ab}	6.19^{c}	6.56^{bc}	7.25^{ab}	7.38^{a}

Values in the same row with the same superscript are not significantly different ($p<0.05$) by Duncan Multiple Range test

to increase in protein content than obtainable in soymilk. Yoghurt starter cultures bring about proteolysis during fermentation, resulting in changes in the nitrogenous compounds in yoghurt. Tamine and Deeth (1985) reported the capacity of *S. thermophilus* to increase the level of ammonia nitrogen in cultured milk by splitting urea. It was reported that there is an increase in the level of soluble nitrogenous compounds like peptides and amino acids. The protein contents obtained are comparable to those reported by Robinson and Tamine (1990) containing 3.9 and 5.0% for full-fat and fruit yoghurts, respectively.

The microbial populations of soy-yoghurt samples are shown in Table 7. The microbiological examination was to evaluate the finished product on the survival of starter organisms as well as the presence of undesirable spoilage and pathogenic organisms. Total count was between 288×10^6 and 354×10^6 while there was no count for *E. coli* and 2 cfu mL^{-1} was reported for yeast and mould for pawpaw soy-yoghurt. The count could be due to the microorganisms present in the inoculum. In commercially available plain yoghurt, there was no growth for coliform and fungi count with variable amount for total count. The microbial status of the soy-yoghurt samples conforms to the accepted standard. The absence of *E. coli* signifies that all the samples were free from feacal contamination.

The mean scores for quality attributes of the soy-yoghurt samples are shown in Table 8. The results show that there was no significant difference for taste among the treatments.

Strawberry soy-yoghurt was the most preferred by the sensory panelist with respect to all quality attributes except consistency. The consistency of plain soy-yoghurt was the most preferred. The decrease in consistency in fruit-flavored yoghurts may be due to the diluting effect of the flavouring agent and stirring. Strawberry and pineapple yoghurts were significantly different from each other in colour, whereas there was no significant difference between them in other quality attributes.

In terms of colour there was no significant difference in soy-yoghurt samples except for strawberry yoghurt which was significantly different from other soy-yoghurt samples. Orange flavour and orange fruit soy-yoghurt were similar in all quality attributes except for consistency. In terms of overall acceptability strawberry soy-yoghurt received the highest score followed by vanilla soy-yoghurt. Orange fruit and pawpaw fruit received the lowest mean scores for all quality attributes. It is possible that the panelists are more familiar with flavoured yoghurt than with fruit-flavoured yoghurts.

CONCLUSIONS

The increase in protein demand in developing countries led to effort in finding alternative sources of protein in legume seeds. Incidence of cardiovascular disease and lactose intolerance are other contributing factors. However, flatulence factor and objectionable flavour in soybean products must be reduced or eliminated to enhance acceptability.

In this study, flavouring agents and fruits were incorporated into soy-yogurt. There was no appreciable difference in the chemical composition of the yoghurts. Microbiologically the samples were free from feacal contamination. The choice of appropriate flavour or fruit would enhance acceptability. This in turn would increase the use of legumes and improve the overall nutritional status of the populace in developing countries.

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