American Journal of Food Science and Technology, 2017, Vol. 5, No. 1, 1-5
Available online at http://pubs.sciepub.com/ajfst/5/1/1

DOI:10.12691/ajfst-5-1-1

Preparation of Semi-dairy Yoghurt from Soy bean

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Abstract The study was undertaken to have soymilk used as an alternative low cost plant protein product in the production of yoghurt. It was in effect to also address the allergy phenomenon of some sections of vegetarianism and minimize post-harvest losses of soybean which has been underutilized. Semi-dairy yoghurts of cow-soymilk were produced to evaluate its proximate composition and consumer acceptability. Soybean was purchased from the central and Bantama markets and the soy and cow milks prepared at Boadi farms, KNUST. Four different yoghurt products; SDY01 (100%CM), SDY02 (80%CM: 20%SM), SDY03 (60%CM: 40%SM) and SDY04 (40%CM: 60%SM). Samples were examined proximately according to AACC 2000 standard of analysis while sensory evaluation was performed according to the 7 points score hedonic scale. Excel database was used to analysis result at 5% level of significance. Average proximate values for moisture 20.00±0.76; Ash 2.36±0.10; crude fat 4.00±0.29 and carbohydrate 75.92±1.35 contents were highest for sample SDY01 and least for SDY04. Crude fibre and protein were however, higher for SDY04, 2.25±0.81 and 23.00±2.85 respectively. That is, soymilk could contribute considerable amount of fibre and protein to the nutritive spectrum of diets. Nonetheless, there were no significant differences at $P < 0.05$ between mean values. Sensory analysis according to the hedonic scale inference showed that the four semi-dairy yoghurt under the food characteristics evaluated were fairly "moderately liked" and "liked very much" by the range 5.12 to 6.24, in the exception of SDY02 that recorded 4.94 implying a "neither liked nor disliked" assertion for thickness and sourness food characteristics. No significant difference existed between these values for all the samples. Per this study, soymilk could possibly be used as a composite raw material in the production of yoghurt and thus to ensure for better and greater utilization of the soybean.

Keywords: *cow-soymilk composite/semi-dairy yoghurt, proximate characteristics, sensory characteristics, consumer acceptability*

Cite This Article: Sampson Gilbert Owiah, Duah Naomi, Gyima Vida, and Alhassan Martha, "Preparation of Semi-dairy Yoghurt from Soy bean." *American Journal of Food Science and Technology*, vol. 5, no. 1 (2017): 1-5. doi: 10.12691/ajfst-5-1-1.

1. Introduction

Yoghurt is a fermented dairy product obtained through anaerobic fermentation of lactose in milk by relevant microorganisms most of which are classified as pro-biotic [1]. Lactose in evaporated whole milk, skimmed milk or fresh cow's milk is converted into lactic acid by a symbiotic bacterial culture of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* growing at temperatures in the range of 40– 45°C [2]. Since the 1960s there has been worldwide increase and development in the production of yoghurt. In 2001, more than 9 million tons of yoghurt were produced, mostly in Europe (6.6million tons).

However, it is becoming more popular in other parts of the world including Africa; especially because of the prevailing instance of lactose intolerance. Several factors account for the success of yoghurt: the fact that it is a natural drink, has good organoleptic characteristics (fresh, acidulated taste and characteristic flavour) and good nutritional value. It also has prophylactic and therapeutic properties [3]. The health promoting properties of live lactic acid bacteria in yoghurt include protection against gastrointestinal upsets, enhancing digestion of lactose by maldigesters, decreasing risk of cancer, lowering blood cholesterol and improving immune response and helping the body to assimilate protein, calcium and iron [4].

Yoghurt is a good dietary source of calcium, magnesium, phosphorus and zinc which are important in physiological processes and their contribution to total phosphorus intake has been reported as 30-45% in western countries [5]. Essential minerals such as calcium, phosphorus, iron, etc, are present in dairy products at various levels depending on the type of milk used, the technological treatments during production of dairy products and the accuracy of analysis.

Many researchers have advocated the consumption of some cultured dairy products such as yoghurt in the prevention and treatment of several diseases: prophylaxis against the treatment of gastrointestinal infection, management of lactose intolerance and of hypercholesterolaemia, the prevention of neoplastic disease [6,7] and treatment of antibiotic associated colitis [8]. For these reasons probiotic organisms are increasingly incorporated into food as dietary adjuncts to help maintain a healthy microbial

gastrointestinal balance and their availability in yoghurt has made it increasingly popular in many parts of the world.

Like any other food product, the quality of yoghurt is a key to its acceptability and marketability. One important aspect of the quality of yoghurt relates with the physical properties of the yoghurt gel which should possess a smooth textural character in the mouth during consumption, as well as a low tendency to serum separation during storage [9].

Soybean (*Glycine max*), belonging to the family leguminousae and sub-family, papilionoideaeis the most annual grain legume crop in the world. The cultivated form is used in human food and livestock feeds. Soybean contains approximately 21% oil. It also contains 40% protein calculated on a dry weight basis, which is the highest protein yield of all crops. It is therefore, expected to be used as a weapon against world hunger.

There is a great need for high protein and caloric preparations of foods by low income people all over the world. Soymilk contains virtually a high amount of proteins as compared to cow milk and is free of cholesterol. Unlike cow milk, Soymilk is lactose-free and therefore very ideal for persons who are allergic to lactose in milk products. Cereals given to babies lack most of the amino acids they need, and it is not surprising that protein calorie malnutrition is the second major cause of death in children between day old and 6years children.

Low protein intake has become a major challenge affecting the populace in developing countries of which Ghana is no exception. This is primarily due the high cost of animal protein in the market for which has become unaffordable to the low income earner to consistently purchase.

The reason to have the needs of vegetarian satisfied also has been an outcry. Vegetarians who are intolerant to animal products must have diversified product in the market that will serve their nutritive values in forms of snacks for which yoghurt is an example. Also, post-harvest losses of most Agricultural produce has become a predominant phenomenon that has devastating consequences on the issue of food security in the country.

Regardless the beautiful flavor and anti-nutritive factors associated with the soybean, its utilization is limited, comparatively to its low cost. It is therefore worth considering soybean as an alternative for solving the high incidence of Protein Energy Malnutrition (PEM) problem on the rise in low income earning groups in Ghana daily. Increasing production, storage, methods of processing and marketing the raw state of soybean and finished products has become very paramount to further promote it judicious utilization aside the traditionally use of preparing palaver sauce and weaning-mix.

Hence this study to assess the nutritive value of prepared yoghurt from cow-soymilk composites to serve as substitute to cow milk and evaluate its acceptability.

2. Material and Methods

2.1. Materials

Soya milk, cow milk powder were used as the main ingredients for the semi-dairy cow-soymilk yoghurt. Included were; Sugar, sweetener, vanilla essence, starter culture and sodium benezolate, purchased from Kumasi Central market, Boadi Farm KNUST and Bantama market as well.

2.2. Product Formulation

Four (4) different yoghurt formulations, namely, SDY01, SDY01, SDY03 and SDY04 respectively was prepared with the incorporation of cow milk fractions represented in percentage wise of the cow milk/Soybean milk combinations with other ingredients as shown in Table 1 below.

Table 1. Percentage composition of product samples

Test Sample	Quantity of other Ingredients			
	Substrate (%)		Sugar (g)	Starter culture (mL)
	CM	SM		
SDY01	100	0	20	30
SDY02	80	20	20	30
SDY03	60	40	20	30
SDY04	40	60	20	30

SDY01 = Control (100% CM) SDY02 = (80% CM: 20% SM) SDY03 = (60% CM: 40% SM) SDY04 = (40% CM: 60% SM); CM = Cow milk SM = Soy milk.

2.3. Preparation of the Soy Yoghurt Samples

Varying volumes of milk powder and soy milk was measured using scale and measuring cylinder, respectively as shown in Table 1. Composited soy yoghurt was boiled at 95°C in water bath and held there for 8 minutes and rapidly cooled to 40°C and inoculated with 3% single starter culture. The mixture was incubated at 37°C in an air oven till the pH dropped to 3.5. The soy yoghurt samples as well as the control sample (100% CM) were stored in the refrigerator at 4°C for further analysis.

2.4. Measure of Physiochemical Parameters

Proximate analysis was employed to determine the essential chemical constituents of the various product samples that were prepared. The 'Weende System of Analysis' was adopted, being the most widely used method for determining the composition of feedstuffs. The system partitions a feedstuff into 6 fractions: water, ash, crude protein, ether extract (fat), crude fibre and nitrogen-free extract (carbohydrates). This was conducted according to international standard [10].

2.5. Sensory Evaluation

A panel of fifty semi-trained judges from Ramseyer Vocational Technical Institute was employed for the sensory analysis based on a hedonic scale of 1-7; where 1 = Dislike extremely, 4 = neither like nor dislike and 7 = like extremely [11]; under the following criteria: colour, flavour, taste, texture, sourness, overall acceptance.

2.6. Statistical Analysis

Data obtained in triplicates and was analyzed with the aid of Microsoft Excel 2010 software for windows. Results were calculated and expressed as Mean ± Standard Deviation using the software graphpad Insat 2000. Level of significance among means was determined at $P<0.05$.

3. Results

3.1. Proximate Analysis

Table 2. Analyzed average percentage values of the nutritive constituents of the samples

Test Sample	Constituent food values					
	Moisture (%)	Ash (%)	Crude fat (%)	Crude fibre (%)	Protein (%)	Carbohydrate (NFE) %
SDY01	20.00^{a}±0.76	2.36^{a}±0.10	4.00^{a}±0.29	0.30^{a}±0.02	16.00^{a}±2.08	57.92^{a}±1.31
SDY02	18.60^{a}±0.06	2.24^{a}±0.14	3.68^{a}±0.03	0.35^{b}±0.81	16.44^{a}±1.99	57.82^{a}±1.29
SDY03	18.20^{a}±0.41	2.19^{a}±0.17	3.31^{a}±0.20	0.50^{c}±0.09	20.00^{a}±2.00	55.79^{a}±1.88
SDY04	18.12^{a}±0.22	2.07^{a}±0.11	3.29^{a}±0.19	2.25^{d}±0.87	23.00^{b}±2.11	54.75^{a}±1.35
CV%	4.72	7.89	10.49	110.40	17.46	2.77
LSD	1.91	0.38	0.81	0.03	4.12	3.38

Numbers in rows followed by a different superscript are significantly different at P<0.05
SDY01 = Control (100% CM) SDY02 = (80% CM: 20% SM)
SDY03 = (60% CM: 40% SM) SDY04 = (40% CM: 60% SM); CM = Cow milk SM = Soy milk.

3.1.1. Moisture

From Table 2, the percentage moisture content of the samples ranged between 18.12 and 20.00 with SDY01 recording the highest while SDY04 recorded the least moisture content. Generally there was a decrease in moisture content with increasing soymilk though soymilk is reported to have high moisture content compared to cow milk [12] however there was no significant difference among the samples investigated. Thus, the non-significance of the treatment means per this study, so attest to this fact made by [12].

3.1.2. Ash

The ash content represents the inorganic content in the samples. Ash content decreased correspondingly with increasing percentage proportion of soymilk component. It was highest (2.36%) for sample SDY01 yogurt (100% cow milk) used as the control treatment and least for sample SDY04 (3.29 %). However, no significant difference existed between the treatment means at 95% confidence interval.

3.1.3. Crude Fat

The crude fat content ranged between 3.29 to 4.00 % with the control sample recording the highest while SDY04 recorded the least as shown in Table 1. The decrease in fat content could be attributed to the partial replacement of the cow milk which is documented to have high fat content. Similarly, there was no significant difference at $P < 0.05$ according to the ANOVA.

3.1.4. Crude Fibre

The fibre content of the treatment samples increased with increasing percentage proportion of soymilk in the semi-dairy yoghurt produced as recorded in Table 1 above. According to literature, food with high crude fibre content helps to reduce blood cholesterol levels, accelerate the transit of chyme in the gut as well as increasing faecal weight. Such foods are very helpful in weight management especially in obesity and diabetes cases. The increasing crude fibre content could be attributed to the high water soluble fibre in most legumes and as such as the proportion of soymilk increased it reflected in the total crude fibre content in the product. This resulted in significant differences among the samples as shown in Table 1 above.

3.1.5. Protein

Parman [13] stated that, properly defatted soybean flour will contain 50% or more of protein. As a fortification material, soybean stands a greater importance of increasing the protein value of food. From Table 1, the average percentage values of protein increased with increased proportions of soymilk component; that is sample SDY04 recording the highest value of 23.00% compared to SDY01 (16.00%), SDY02 (16.44%) and SDY03 (20.00%) respectively. This statistical difference however, infers no significant difference between SDY01 and SDY02 however these were significantly different from SDY03 and SDY04 at 95% confidence interval.

3.1.6. Carbohydrate

The carbohydrate nutritive value as analyzed under this study also inferred no significant difference between the means of the samples though the highest carbohydrate value was recorded for sample SDY01 (100% cow milk yogurt). Though according [12] stating that cow milk has high carbohydrate value than soymilk, the low carbohydrate nutritive value recorded for sample SDY04 with the highest soymilk proportion will give the same carbohydrate value compared to the other samples as statistically proven by the ANOVA.

3.2. Sensory Analysis

Table 3. Average score of sensory evaluation of formulations

Product	Food attributes					
	Colour	Taste	Flavour	Thickness	Sourness	Overall acceptance
SDY01	6.44^{c}±0.15	6.71^{c}±0.04	5.76^{d}±0.09	6.82^{d}±0.11	6.65^{c}±0.09	5.95^{d}±0.10
SDY02	5.88^{b}±0.11	3.12^{b}±0.13	2.95^{c}±0.11	5.94^{c}±0.28	4.94^{b}±0.14	4.24^{c}±0.16
SDY03	4.88^{a}±0.16	2.59^{a}±0.24	2.29^{b}±0.14	3.35^{b}±0.09	2.29^{a}±0.34	2.76^{b}±0.08
SDY04	3.94^{a}±0.10	2.71^{a}±0.29	1.59^{a}±0.06	1.24^{a}±0.06	2.14^{a}±0.29	1.65^{a}±0.14
CV%	3.66	5.83	4.57	9.45	7.15	4.94
LSD	0.47	0.69	0.54	1.16	0.81	0.59

Numbers in rows followed by a different superscript are significantly different at P<0.05
SDY01 = Control (100% CM) SDY02 = (80% CM: 20% SM)
SDY03 = (60% CM: 40% SM) SDY04 = (40% CM: 60% SM); CM = Cow milk SM = Soy milk.

3.2.1. Colour

The mean color rating for the samples ranged between 3.94 to 6.44 representing 'dislike moderately to like very much' on the 7-point hedonic scale. Sample SDY04 recorded the least mean rating while SDY01 (control) recorded the highest mean score. Statistically there was no significant difference ($p>0.05$) between SDY03 and SDY04 however they two were significantly different from the control sample and the 20% replaced soy yoghurt. From the hedonic scale, it was evident that the panelist preferred the colour of the control sample and the SDY02 but disliked the appearance of SDY04 and this could be due to the presence of soybean.

3.2.2. Taste

Taste refers to sensation perceived by the tongue which includes sweet, salty, sourness and bitterness [14]. This however could be influenced by the quality of the raw materials used in the processing of the yoghurt as well as the chemical reactions that might occur during the sequence of fermentation of the cultures used. With respect to the taste of the control and composite yoghurts, the mean ratings ranged from 2.71 to 6.71 indicating dislike moderately to like very much. The 100% CM was the most preferred while SDY04 was the least preferred by the panelists due to the high percentage composition of soy milk. Soy yoghurts produced from 20 and 40% soy milk did not show significant difference in taste ($p>0.05$).

3.2.3. Flavour

Flavor is often expressed as a combined sensation perceived through the chemical senses of taste and aroma as well as chemical irritation in the bucal cavity. Based on the hedonic scale, the mean values ranged between 1.59 to 5.76 indicating dislike very much to like very much. Control sample was the most accepted product while soy yoghurt with 60% soymilk was the least accepted with respect to their flavor. Possibly the unpalatable beany flavour associated with soy bean imparted in the products and thus accounting for its relatively lower rating compared to the 100% cow milk yoghurt. All samples were significantly different from each other.

3.2.4. Thickness

Thickness which could be termed as viscosity is likely to be influenced by the protein building blocks of the yoghurt gel network against the effect of fermentation time as well as the starter culture metabolism [15]. Several researches reported that, products with greater viscosity and firmer texture have increased protein content [15,16,17]. The mean scores for thickness ranged from 1.24 to 6.82 indicating dislike very much to like extremely. The most preferred sample was the control followed by composite yoghurt with 20% soy milk. Significant differences existed in the thickness for all four samples ($p<0.05$).

3.2.5. Sourness

The evaluation of sourness as a sensory attribute of yoghurt samples ranged from 2.14 to 6.65 which indicate dislike very much to like extremely. The most preferred product for this attribute was the control sample (100% CM) followed by SDY02 (80% CM: 20%SM) with panelists rating SDY04 as the least. There were significant differences ($p<0.05$) in the mean values for all samples however SDY03 and SDY04 did not show significant differences ($p>0.05$). This could be attributed to the effect of fermentation reactions as well as the starter culture metabolism.

3.2.6. Overall Acceptance

Based on the overall mean values of the sensory attributes, the most accepted product was the control sample (100% CM) with a mean score of 5.95 representing like very much. Product SDY02 (80: 20) was the second most accepted product by the panelists with an overall mean of 4.24 which remained a neutral product with panelists completely rejecting product SDY04 (40: 60). There were significant differences ($p<0.05$) in the overall mean values of the products.

4. Conclusion

Using soymilk as a possible product in the manufacture of yoghurt so as to impact on the nutritive spectrum of consumers showed a relatively acceptable results. It was evident that, soymilk has the potential of giving an equal measure of nutritive and sensory value as would be obtained from an animal source having realised some incremental average values of the various food characteristics analysed and in comparison to the pure (100%) cow milk yoghurt. Though per this study it was established that no significant difference ($P < 0.05$) existed between the mean values of the samples with respect to the proximate composition, soy milk can be used to partially replace cow milk up to 20% in composite yoghurt without a possible organoleptic defect notwithstanding its nutritional and health benefits.

Acknowledgement

The authors are grateful to all the students who volunteered to be part of the sensory evaluation as well as the laboratory technicians at KNUST who analyzed the samples.

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