

Evaluation of Proximate, Carbohydrate and Fatty Acid Composition of Milk Formula Prepared from Soy Beans and Plantain Flour

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ABSTRACT

Background and Objective: Plant-based milk is derived from the aqueous extraction of plants, which could help individuals who are lactose intolerant and also suitable for vegans. This study evaluated the proximate, carbohydrate and fatty acid composition in milk formula prepared from soybeans and plantain flour. **Materials and Methods:** The samples were prepared in a 1:1 ratio of soybeans and plantain flour. The proximate composition (moisture, ash, carbohydrate, crude protein and fat content) was determined using standard methods, carbohydrate composition was analysed using High-Performance Liquid Chromatography while fatty acid composition was measured using Gas Chromatography-Mass Spectroscopy. Statistical analysis was done using ANOVA of the SPSS package, a $p < 0.05$ was shown as significantly different. **Results:** The proximate composition revealed the presence of carbohydrates at 62.49%, crude protein at 15.27% and crude fibre at 2.025%. The carbohydrate composition of monosaccharide revealed that glucose had the highest value (71.0552 g/100 g). For the disaccharides, sucrose (68.8410 g/100 g) had the highest value while cellobiose (11.7959 g) had the lowest value. Fatty acid composition had oleic acid (38.93%) as the highest value. **Conclusion:** This result indicates the milk formula prepared from soy beans and plantain flour has some nutrients which have important for human health.

KEYWORDS

Soy-beans, plantain flour, plant-based milk, vegans, lactose intolerant

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INTRODUCTION

A variety of nutrients, some of which are especially crucial at different stages of life, can be found in milk and dairy products. Early dietary intake of nutrients has a significant impact on the development of chronic diseases later in life. For young children to acquire bone mass and experience longitudinal bone growth, milk is necessary, which lowers their risk of stunting¹. Milk can be obtained from animals as well as plant-based. Plant-based milk can be obtained from soy-beans, cashews, oats, almonds, coconut and rice. This milk alone may not give all the necessary nutrients required by children, hence fortification with other food is important². Since plant-based food fortification reduces childhood malnutrition in underdeveloped nations³.



Soy beans (*Glycine max*) is an annual legume crop that belongs to the family Leguminosae. Soy beans is an excellent source of protein. Soy milk, an aqueous extract of soy-beans maybe made from soybeans and has been demonstrated to prevent oxidative stress in type 2 diabetes mellitus⁴. Baby formula made from soybeans has been used to treat infants who are allergic or intolerant to cow's milk. According to Vandenpals *et al.*⁵ soy infant formula is regarded as a safe, nutritious substitute for infant formula made from cow's milk. Due to how inexpensive soy bean formula is, it has also been accepted for infant use⁶.

Plantain (*Musa paradisiaca*) is a tree-like perennial crop that belongs to the Musaceae family⁷. Due to their high nutritious content, plantains are a popular staple crop in Nigerian cuisine. It is rich in carbohydrates and a starchy food⁸. Plantain can reduce cholesterol levels, ease constipation and even prevent colon cancer due to its high fiber content⁹. Plantains can be preserved from spoiling by processing them into plantain flour¹⁰. According to Givens¹ the flour can be reconstituted in boiling water to form amala, which is consumed with any Nigerian soup. It is also used in a variety of traditional foods such as akara, ukpo ogede and baked goods.

Plant-based food sources consumed in high quantities can result in lower levels of cholesterol and saturated fat. They also contain high amounts of dietary fibre, phytochemicals and antioxidants, all of which are beneficial to human nutrition and health⁵. Hence a plant-based milk source that is rich in carbohydrates and also protein could help to alleviate malnutrition and undernutrition. Therefore, this study looked at the proximate, carbohydrate and fatty acid composition of milk formula prepared from soybean and plantain flour.

MATERIALS AND METHODS

Study area: This research was carried out at the Department of Biochemistry Laboratory, Rivers State University, Port Harcourt. It started from September 2022 to November 2022.

Sample collection and preparation: Soybeans (*Glycine max*) and unripe plantain (*Musa paradisiaca*) with vanilla flavor were purchased from Mile 3 Main Market Port Harcourt, Rivers State.

Ten fingers of plantain were peeled and sliced into tiny sizes and placed on trays to dry using adequate sunlight for a maximum of 3 days. Seven cups of soybeans were measured and placed into a cooking pot and water was added to the pot. It was placed on heat to cook for about 5 min. The soybeans were filtered out from the pot using a sieve. It was immediately spread on trays to dry using sunlight for a maximum of 6 days. The dried plantain was grinded using an electric blender (SC-1589 Silver Crest blender, India) to a powdered form. The dried soybean was grinded into a powdered form using a blender. This was mixed thoroughly in a ratio of 1:1 of soy-bean (100 g) and plantain flour (100 g) and vanilla flavor was added to make the milk.

Chemical analysis: Proximate composition (moisture, ash, crude protein, crude fiber and fat) of the milk sample according to standard methods. Carbohydrate content was calculated by difference. The carbohydrate composition of the different monosaccharides and disaccharides was analyzed using High Performance Liquid Chromatography (N2000 Chromatography Data System, China). The fatty acid composition was determined using a Gas Chromatography-Mass Spectroscopy.

Statistical analysis: Values are expressed as Mean±STD. The ANOVA was used for the SPSS package and a $p < 0.05$ was seen as significantly different.

RESULTS

The proximate composition of milk prepared from soybeans and plantain flour is displayed in Table 1. The moisture content was 14.245%, ash content 2.70%, fiber 2.025%, crude protein 15.275%, crude fat 3.285% and carbohydrate content 62.49%.

Table 1: Proximate composition of milk formula prepared from soy beans and plantain flour

Parameter (s)	Concentration (100 %)
Crude fibre	2.025±0.045 ^a
Ash	2.70±0.05 ^b
Crude fat	3.285±0.105 ^c
Moisture	14.245±0.545 ^d
Crude protein	15.275±0.475 ^d
Carbohydrate	62.49±0.78 ^e

Values are expressed as Mean±STD and values with different alphabetic letters show significant difference at p<0.05

Table 2: Monosaccharide composition of milk formula prepared from soy beans and plantain flour

Monosaccharide	Concentration (g/100 g)
Fructose	0.6053
Fucose	1.2031
Raffinose	2.5948
Arabinose	5.1772
Mannose	6.8435
Xylose	7.7771
Glucose	71.0552

Table 3: Fatty acid composition of milk prepared from soy beans and plantain flour

Fatty acid	Concentration (%)
Myristic acid	11.15
Palmitic acid	19.04
Stearic acid	16.28
Oleic acid	38.93
Linoleic acid 18:2	1.90
Linolenic acid 18:3	4.78
Arachidic acid	1.58
Eicosenoic acid	1.91
Eicosadienoic acid	4.38
Total saturated	48.10
Total unsaturated	51.90
Omega-3	4.78
Omega-6	6.28

Table 2 presents the monosaccharide composition of milk formula prepared from soybeans and plantain flour. The concentration(mg/100 g) was as follows: Glucose (71.0552)>xylose (7.7771)>mannose (6.8435)>arabonse (5.1772)>raffinose (2.5948)>fucose (1.2031)>fructose (0.6053). This indicates that the plant-based milk had more of glucose and would be used as energy related food. The disaccharide composition of milk formula prepared from soy beans and plantain flour had sucrose (68.8410 g/100 g) as the highest concentration followed by trehalose (18.6074) and then cellobiose (11.7959).

The concentration of fatty acid of milk made from soy beans and plantain flour is shown on Table 3. The concentration (%) was as follows: Oleic acid 38.93>palmitic acid 19.04>stearic acid 16.28>myristic acid 11.15>linolenic acid 4.78>eicosadienoic acid 4.38>eicosenoic acid1.91>linoleic acid 1.90>arachidic acid 1.58. The total unsaturated fatty acid was 51.90% while that of saturated was 48.10%. This study had omega-3 fatty acid concentration of 4.78%.

DISCUSSION

The study looked at the proximate, carbohydrate and fatty acid composition of milk prepared from soybean and plantain flour. The study observed a very high carbohydrate content, followed by the protein content. The fibre and ash content had the lowest values. Also, from the study, the monosaccharide with the highest value was glucose, also found was xylose and raffinose. For the disaccharide concentration, sucrose, trehalose and cellobiose were present. The fatty acid concentration of this study had oleic, palmitic and stearic acid as the highest values while arachidic acid had the lowest value.

Plant based milk is an aqueous liquid that is made from plant extract and has a similar consistency to animal milk¹². The proximate composition is used to assess the nutritional value of the macronutrients such as the moisture, ash, carbohydrate, crude fibre, fat and crude protein content of a food sample¹³. Protein is important for tissue replacement and growth. The ash content of a food can serve as an index for determining the mineral contents of food. Additionally, carbohydrates are important for energy metabolism and fibre aids in food digestion¹⁴. The result showed that the milk is rich in carbohydrates and protein. This investigation displayed a lower protein content than those of Edema *et al.*¹⁵ and Eshun¹⁶. The carbohydrate content of this research was higher than Obasi *et al.*¹⁷, when they supplemented soybean with wheat to make bread. The amount of crude fibre in this study was similar to those of Davy *et al.*¹⁸ when the soymilk by-product was used in making white wheat bread.

Carbohydrates are essential for human nutrition because they aid in the production of energy in cells and tissues. Glucose helps the brain function by giving it enough energy¹⁹. Cellobiose is used within a wide variety of foodstuffs and functional foods as a low-calorie bulking agent and also has a lower glycemic index than sucrose²⁰. This result was consistent with recent investigations that found sucrose, fructose and glucose present in soy milk². Similar studies by Smith *et al.*²¹ and Felberg *et al.*²² also observed sucrose being present in soy-based beverages/milk. These findings suggest that the milk formula offers consumers excellent nutritional value due to its high carbohydrate content.

Fatty acids are major metabolic fuel, essential component of membrane and precursors of powerful locally acting metabolites (eicosanoids). The result of this study differed from those of Peñalvo *et al.*²³ who had higher linoleic acid and linolenic acid concentration (%) for soybeans, okara and soymilk and lower values of oleic acid of soybeans, okara and soymilk. This indicates the milk formula might have some fatty acid that is of importance to nutrition and help in possibly diabetes and cardiovascular disease, since high saturated fatty acids could result to the aforementioned diseases² and this study had less when compared to the unsaturated fatty acids. The study was able to show that the plant based milk had a good carbohydrate content at a 1:1 ratio. It could be used to compound milk formula for infants and children at a low cost to ease malnutrition.

CONCLUSION

This study evaluated the proximate, carbohydrate and fatty acid composition of milk prepared from soybeans and plantain flour. The research work from the proximate composition showed that carbohydrate content had the highest concentration followed by protein content. The carbohydrate composition of the milk from soybeans and plantain flour revealed the presence of glucose, sucrose and cellobiose. The fatty acid composition showed the presence of omega-3 fatty acid and a higher concentration of unsaturated fatty acid when compared to the saturated one. In conclusion, this result indicates the milk formula prepared from soybeans and plantain flour had high carbohydrate content and considerably higher amounts of unsaturated fatty acids which could impact greatly the health of individuals.

SIGNIFICANCE STATEMENT

Malnutrition and undernutrition deprive children of their full potential, with negative consequences. Insufficient intake of carbohydrates could lead to malnutrition; hence the purpose of the study was to evaluate the proximate, carbohydrate and fatty acid composition of milk prepared from soybeans and plantain flour. The study was able to reveal that the milk formula had a high percentage of carbohydrates and protein. Glucose and sucrose were also found in moderate amounts. Although the study didn't look at different ratios of the soybeans and plantain flour, to see which could give a better nutritional value. A possible rationing could be looked at, to get a better nutritional value of this milk formula.

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