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Proximate Analysis and Nutritional Fortification of Tapioca with *Phoenix dactylifera*, *Cocos nucifera* and *Glycine max* Flour

[1]*Chinyere Imoisi,* [2]*Julius Uche Iyasele,* [2]*Edoghogho Naomi Igbenosa,* [2]*Agbita Nathaniel Efemena,* [2]*Oghenefejiro Okwoma and* [3]*Maryam Sa'ad*

[1]*Department of Industrial Chemistry, Mewar International University, KM 21, Abuja-Keffi, Expressway, Masaka, Nasarawa, Nigeria*

[2]*Department of Chemistry, University of Benin, Benin, Nigeria*

[3]*Department of Chemistry, Kaduna State University, Kaduna, Nigeria*

ABSTRACT

Background and Objective: A balanced diet with all necessary nutrients is crucial for everyone, regardless of age or physical condition. Dietary fiber plays a vital role in maintaining a healthy digestive system. Unlike other nutrients, fiber is not broken down or absorbed by the body. Instead, it travels through the digestive tract to the colon and rectum, adding bulk to waste products as they exit the body. This study aimed to investigate the effect of dietary fibre of tapioca (kpokpo garri) after it had been fortified with date (*Phoenix dactylifera*), soybean (*Glycine max*) and coconut (*Cocos nucifera*) on gut health. **Materials and Methods:** Composite flours were prepared by blending wheat flour and watermelon flour in the ratios of 100:0 (AB1), 90:10 (AB2), 80:20 (AB3), 70:30 (AB4), 60:40 (AB5) and 50:50 (AB6), respectively. The blends were analyzed for proximate properties using standard methods. **Results:** Proximate results indicated increased levels of protein, fibre, fat/oil, ash and decreased level of moisture for the tapioca-date, tapioca-soybean and tapioca-coconut respectively. The fibre content for each blend increased from 2.70% (AB1) to 4.30% (AB6) for tapioca-date, 2.70-5.50% for tapioca-soybean and 2.70-4.35% for tapioca-coconut. **Conclusion:** Date, soybean and coconut can be used as a fortifier in tapioca which improves gut health.

KEYWORDS

Cassava, date, tapioca, soybean, coconut, proximate composition

INTRODUCTION

When cassava is peeled, chopped and cooked, it loses a significant amount of vitamins, minerals, fibre and resistant starch. Still, cooking the root before consumption is necessary to avoid side effects. The processing of cassava into processed product e.g. garri, tapioca, etc, is the sole reason cassava loses most of its nutritional value. These processes include peeling, washing, chopping, grinding, squeezing to remove 90% of water, mechanical drying or sun drying and then frying[1-5].

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Dietary fiber, an essential component of a healthy diet, is widely recognized for its numerous health benefits, including promoting digestive health and preventing various chronic diseases[6-8]. Despite its importance, dietary fiber intake remains below recommended levels in many populations[9-11]. One approach to addressing this deficiency is through the fortification of staple foods with high-fiber ingredients[12,13].

This study focuses on enhancing the dietary fiber content of tapioca, a staple food derived from cassava, by fortifying it with date, coconut and soybean flour. These ingredients were chosen for their high fiber content and nutritional value. Dates are rich in dietary fiber and antioxidants, making them beneficial for digestive health[13,14]. Coconut is known for its high fiber content and potential benefits in managing blood cholesterol levels[11,15]. Soybeans, being a good source of both soluble and insoluble fiber, contribute to improved gastrointestinal health and reduced risk of cardiovascular diseases[16]. This study lies in the need to improve the nutritional profile of tapioca, a widely consumed carbohydrate source, by incorporating high-fiber ingredients. This fortification aims to provide a more balanced diet, especially in regions where tapioca is a dietary staple. Additionally, the study explores the potential for these fortified tapioca products to offer additional health benefits, such as enhanced gut health and reduced risk of chronic diseases[17,18].

The objective of this study is to evaluate the effects of incorporating date, coconut and soybean flour into tapioca on its dietary fiber content and overall nutritional value. The study also aims to determine the optimal proportions of these ingredients to maximize the health benefits of the fortified tapioca.

MATERIALS AND METHODS

Study area and sites: This study was conducted at Benin City, Edo State, Nigeria. It is located at 6.34°N Latitude and 5.63°E Longitude and it is situated at elevation of 88 m above sea level. The population of Benin City is 1,125,058, making it the most populous city in Edo State[19].

Sample collection and analysis: Date, coconut and soybean were purchased from Uselu and new Benin local market, Benin City; 7 kg date, coconut and soybean, respectively were weighed with a weighing balance in the laboratory and washed severally before soaking with 7 L of water overnight, thereafter, the date, coconut and soybean were grinded with a grinder and subsequently sieved with a soft cloth. The sieved date, coconut and soybean were sun-dried for seven days thereafter it was grinded again and subsequently sieved with a smaller sieve to obtain a fine date, coconut and soybean flour. Mature cassava roots, weighing 45 kg and aged over eleven months, as shown in Fig. 1 were purchased from Sapele Town Delta State, peeled with a knife and washed with water to remove contaminants, it was grated into a coarse particle and washed with water repeatedly to remove the starch content which was observed until the wash water become clear. This study spanned from October, 2021 to November, 2022.

Fig. 1: Unprocessed cassava tubers

Table 1: Incorporation of cassava flour with fortifier (date, coconut and soybean flour)

Sample code	Classification
AB1	Control (100 g cassava flour)
AB2	90% cassava flour+10% fortifier
AB3	80% cassava flour+20% fortifier
AB4	70% cassava flour+30% fortifier
AB5	60% cassava flour+40% fortifier
AB6	50% cassava flour+50% fortifier

Preparation of tapioca and incorporation with fortifiers (date, coconut and soybean flour): Tapioca (kpokpo garri) was produced using the straight dough process described by Imoisi *et al.*[20]. Baking was carried out under laboratory conditions to optimize baking conditions. A laboratory scale was used to weigh cassava flour, date, coconut and soybean flour. In a mixer, dough was mixed for 1 min at a low speed of 85 rpm until it reached optimum consistency. Cassava flour was substituted by date, coconut and soybean flour in AB1, AB2, AB3, AB4, AB5 and AB6 to the extent of 0, 10, 20, 30, 40 and 50%, respectively (Table 1). The mixed cream was then put into medium size round calibrated pan. The tapioca was oven baked for 10 min at 100°C.

The grounded dates and cassava (cassava was in a wet state) were mixed in the proportions as shown in Table 1 before being processed in a pan to form tapioca.

Tools and equipment manufacturers: The meter balance, desiccator, Soxhlet extractor and other tools and equipment used in this study were procured from manufacturers including Thermo Fisher Scientific (Waltham, Massachusetts, USA), Toledo (Columbus, Ohio, USA), Hanna Instruments (Woonsocket, Rhode Island, USA) and Mettler among others.

Proximate analysis of the composite cassava flour: The proximate composition was assessed according to the methods outlined by Imoisi *et al.*[21]. The functionality of cassava flours, influenced by their starch and protein content, significantly impacts the formulation and characteristics of the final product. Hence, the flours were evaluated for their functional properties, which are essential for creating value-added composite bakery products. Protein content was determined using the micro-Kjeldahl method (N×6.25) and fat content was measured via solvent extraction. Carbohydrate content was calculated using the subtraction method[22].

Determination of moisture content: The moisture content was measured using the oven-drying method. Initially, clean and dry Petri dishes were weighed (W1) using a balance. Approximately 5 g of the sample was placed into the dishes (W2) and spread evenly. These dishes were then placed in an oven set at 105°C and dried for about 3 hrs. After drying, the dishes were cooled in a desiccator and weighed again. This process was repeated until a constant weight (W3) was achieved. The percentage of weight loss during drying was considered the percentage moisture content, calculated using the equation provided by Imoisi and Michael[23]:

$$\text{Moisture (\%)} = \frac{\text{Loss in weight}}{\text{Weight of sample before drying}} \times 100$$

$$\frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where:

W_1 = Initial weight of empty crucible
W_2 = Weight of empty crucible+sample before drying
W_3 = Final weight of empty crucible+sample after drying

Ash determination: Approximately 1 g of finely ground sample was placed into clean, dried, pre-weighed crucibles with lids (W1). The organic matter was initially burned off with an open flame until the sample became charred. The crucibles, with lids removed, were then placed in a muffle furnace set to 550°C until a light grey or white ash was formed. The ash content was then calculated using the equation provided by Imoisi and Michael[23].

The crucibles were then cooled in a desiccator and weighed (W_2):

$$\text{Ash (\%)} = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100$$

Where:
W_2 = Weight of crucible+ash
W_1 = Weight of empty crucible

Crude fat determination: Cleaned and dried thimble was weighed as (W_1) and 5 g oven-dried sample was added and reweighed (W_2). Round bottom flask was filled with petroleum ether (b.pt 40-60°C) up to ¾ of the flask. Soxhlet extractor was fixed with a reflux condenser and adjusted the heat source so that the solvent boiled gently. The thimble plus the sample were inserted into the Soxhlet apparatus and extraction under reflux was carried out with petroleum ether (40-60°C) for over 6 hrs. The thimble was then removed and taken into the oven at 100°C for 1 hr and later cooled in the desiccator and weighed again (W_3). The percentage fat content was calculated using the following equation as cited by Imoisi and Michael[23]:

$$\text{Fat (\%)} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

$$\frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where:
W_1 = Initial weight of the empty thimble
W_2 = Weight of the thimble plus sample before extraction
W_3 = Weight of the thimble plus sample after extraction

Crude protein determination: Approximately 1 g of the sample was placed into a micro Kjeldahl digestion flask. One selenium catalyst tablet and 15 mL of concentrated H_2SO_4 were added. The mixture was then digested on an electro-thermal heater inside a fume cupboard until a clear solution was obtained. After cooling, the solution was diluted with distilled water to 50 mL. A 5 mL portion of this solution was transferred into a distillation apparatus and 5 mL of 2% boric acid was pipetted into a 100 mL conical flask (receiver flask) with four drops of screened methyl red indicator. The 50% NaOH was gradually added to the digested sample until it became cloudy, indicating alkalinity. Distillation was performed into the acid solution in the receiver flask, with the delivery tube submerged below the acid level. As distillation proceeded, the pink solution in the receiver flask turned blue, indicating ammonia presence. Distillation continued until the round bottom flask contained approximately 50 mL of solution, after which the condenser's delivery tube was rinsed with distilled water. The resulting solution in the conical flask was then titrated with 0.1 M HCl. The protein content percentage was calculated using the method cited by Imoisi and Michael[23]:

$$\text{Nitrogen (wet \%)} = \frac{A - B \times 1.4007}{\text{Weight (g) of sample}} \times 100$$

Where:

A = Vol (mL) Std HCl×normality of Std HCl

B = Vol (mL) Std NaOH×normality of Std NaOH

$$\text{Nitrogen (dry \%)} = \frac{\text{Nitrogen (wet \%)}}{100 - \text{Moisture (\%)}}$$

$$\text{Protein (\%)} = \text{Nitrogen (dry \%)} \times 6.25 \text{ (protein nitrogen conversion factor)}$$

Crude fibre determination: The 2.0 g (W1) of the sample was defatted using petroleum ether in a separating funnel and placed into a 1 L conical flask. To this, 200 mL of boiling 1.25% H_2SO_4 was added and the mixture was gently boiled for 30 min. After boiling, the mixture was filtered through muslin cloth and rinsed thoroughly with hot distilled water. The residue was then transferred back into the flask using a spatula and 200 mL of boiling 1.25% NaOH was added. This mixture was boiled gently for another 30 min. It was filtered again through muslin cloth, washed thoroughly with hot distilled water and then rinsed once with 10% HCl, twice with industrial methylated spirit. The residue was then scraped into a crucible, dried in an oven at 105°C, cooled in a desiccator and weighed (W2). The residue was ashed at 550°C for 90 min in a muffle furnace, cooled in a desiccator and weighed again (W3). The percentage of crude fiber content was calculated using the equation cited by Imoisi and Michael[23]:

$$\text{Crude fibre (\%)} = \frac{W_2 - W_3}{W_1} \times 100$$

Where:

W_1 = Weight of sample used

W_2 = Weight of crucible+oven dried sample

W_3 = Weight of crucible+ash

Determination of carbohydrate content: The percentage of carbohydrate content was calculated using the following equation as cited by Ajenu *et al.*[24]:

$$\text{Carbohydrate (\%)} = 100 - (\text{protein} + \text{fat} + \text{fibre} + \text{ash} + \text{moisture content (\%)})$$

Statistical analysis: The statistical analysis was performed using the BMDP 2R program for stepwise multiple regression. Results were expressed as the mean of triplicate analyses[25-27]. The results of the proximate composition analysis of the tapioca-date, tapioca-soybean and tapioca-coconut blends were obtained at a significance level of $p<0.05$.

RESULTS AND DISCUSSION

Table 2 presents the proximate composition of different samples of a tapioca-date blend. The parameters measured include moisture, protein, fat/oil, ash, fiber, carbohydrate content and energy (kcal/100 g).

Table 3 presents the proximate analysis of different samples of tapioca-soybean blends, showing the composition of moisture, protein, fat/oil, ash, fiber, carbohydrate content and energy (kcal/100 g).

Table 4 presents the proximate analysis of different samples of tapioca-coconut blends, showing the composition of moisture, protein, fat and oil, ash, fiber, carbohydrate content and energy (kcal/100 g).

Food fortification is the process whereby nutrients are added to food to maintain or improve the quality of the diet of a group, community, or population. Due to the consumption of processed foods, vitamins and minerals are insufficiently absorbed[28].

Table 2: Proximate composition of tapioca-date blend

Sample	Moisture (%)	Protein (%)	Fat/oil (%)	Ash (%)	Fibre (%)	Carbohydrate (%)	Energy (kcal/100 g)
AB6	9.60	1.18	1.60	1.45	4.30	81.87	349.60
AB5	9.60	1.23	1.60	1.85	4.20	81.52	348.40
AB4	10.60	1.28	1.60	2.15	4.00	80.37	344.00
AB3	12.40	1.39	1.50	2.15	3.90	78.66	336.70
AB2	13.00	1.54	1.50	2.35	3.25	78.36	336.70
AB1	12.80	1.10	1.60	0.90	2.70	80.90	342.40

Table 3: Proximate analysis of tapioca-soybean blends

Sample	Moisture (%)	Protein (%)	Fat/oil (%)	Ash (%)	Fibre (%)	Carbohydrate (%)	Energy (kcal/100 g)
AB1	12.80	1.10	1.60	1.10	2.70	80.90	342.40
AB2	10.80	6.25	3.60	2.40	2.85	73.83	353.80
AB3	11.20	9.76	5.20	2.95	3.00	67.89	357.40
AB4	11.40	12.78	8.90	3.65	3.60	59.67	369.90
AB5	9.40	16.33	11.80	4.10	4.60	53.77	386.60
AB6	11.00	20.49	15.20	4.55	5.50	43.26	391.80

Table 4: Proximate analysis of tapioca-coconut blends

Sample	Moisture (%)	Protein (%)	Fat/oil (%)	Ash (%)	Fibre (%)	Carbohydrate (%)	Energy (kcal/100 g)
AB6	13.80	8.61	33.10	2.35	4.35	37.79	483.50
AB5	10.20	5.43	25.30	2.15	3.91	52.67	462.80
AB4	10.60	3.30	18.30	1.80	3.20	62.80	429.10
AB3	12.00	2.79	10.40	1.70	2.85	70.26	385.80
AB2	12.60	1.40	6.20	1.50	2.85	75.36	363.20
AB1	12.80	1.10	1.60	0.90	2.70	80.90	342.40

During processing, commercial food fortification involves the addition of small quantities of micronutrients to foods, which assists consumers in meeting their dietary micronutrient needs. One well-known example is the fortification of table salt with iodine, a sustainable and cost-effective public health measure. Approximately 71% of the global population now has access to iodized salt and the number of countries with iodine deficiency has decreased from 54 to 32 since 2003. Other fortification efforts include adding B-group vitamins, iron and zinc to wheat flour, as well as fortifying cooking oil with vitamin A. However, fortification is generally more effective for urban consumers who regularly purchase commercially processed and fortified foods. In contrast, rural consumers often face challenges in accessing these fortified products. Food fortification also has its limitations, such as consumer resistance, potential alterations in cooking properties, difficulties in determining appropriate micronutrient concentrations and reduced bioavailability of nutrients. Therefore, effective and sustainable food fortification strategies require active collaboration among stakeholders, including policymakers, researchers and economists[29].

Tapioca fortified with date (*Phoenix dactylifera*) had a moisture content ranging from 9.60-13.00%, with sample AB6 having the lowest value and sample AB2 having the highest as shown in Table 2. As a result, the sample with a lower moisture content will have a longer shelf life than the sample with a higher moisture content. Sample AB1 had the lowest fibre content and sample AB6 had the highest, ranging from 2.70 to 4.30%. Fibre content increased due to the addition of date fibre to tapioca, as more date was added the fibre content increased. Sample AB1 (100% tapioca from cassava mash) was significantly different and less nutritious from the fortified tapioca samples. Sample AB4 is the best sample to prepare this blend due to its moderate moisture and fibre contentand it is also crunchy as shown in Table 2.

Food moisture content is important for food quality, shipping costs and convenience, legal standards and uniformity of other analytical determinations (i.e. dry weight basis)[30]. As shown in Table 3, the moisture content of the five samples of tapioca-soy formulation, ranged from 9.40 to 12.80 %. A low moisture content in a food product can contribute to its extended shelf life because moisture is essential for the growth of microorganisms. This finding aligned with the research of Bouaziz *et al.*[31], who observed prolonged shelf life in cassava strips with comparable moisture content levels. Ash, on the other hand, represents the inorganic residue remaining after the complete oxidation of organic material in a food product. It serves as an initial step in preparing food samples for mineral analysis as part of proximate nutritional evaluation. Typically, ash content in foods is determined using dry, wet, or microwave ashing methods[31].

As shown in Table 3, the ash content of the five samples of tapioca-soy formulation ranged from 1.10 to 4.55 % with slight differences existing among all the five formulations. This suggested that soybean is cereal rich in mineral contents. These results agree with a previous study conducted by Macagnan *et al.*[32] who reported an increase (0.45 to 2.9%) in ash content of cassava and soy protein concentrate blend. Total carbohydrate content is important for nutrition labeling and for laboratory samples. The content of specific carbohydrates or groups of carbohydrates, however, may be more useful in developing food products and ensuring their quality. Mono- and oligosaccharides content in foods can be determined by enzymatic assays or high-performance liquid chromatography (HPLC). Enzymes are used to determine starch and total dietary fibre contents of food[33].

As shown in Table 3, among all formulations, there was a huge variation in carbohydrate content. When cassava is substituted with soybean, the carbohydrate content of the cassava-soy product decreases. Compared to the control (AB1), the most substituted formulation sample AB6 was reduced by almost 50%. Among all the roots, cassava is known to have the highest content of carbohydrate in the form of starch[33,34]. Results of the present study disagreed with Yaich *et al.*[35] who reported that the carbohydrate content of the most preferred sample was 64.15%, which was higher than the most preferred sample of the cassava-soybean product of 52.28%. The main components of dietary fiber consist of cellulose, lignin, hemicellulose, pectins and hydrocolloids. These components vary in solubility in water, with some being soluble and others insoluble. To determine total dietary fiber, these constituents are quantified using an enzymatic-gravimetric method. Initially, a dried and defatted sample undergoes enzymatic digestion using α-amylase, amyloglucosidase and protease enzymes to eliminate starch and protein. Soluble fiber components are then precipitated by the addition of ethanol. Following filtration, both soluble and insoluble fiber residues are collected. The weight of the dried residue, adjusted for ash and protein contents (determined through dry ashing and the Kjeldahl method, respectively), is used to calculate the dietary fiber content. There were significant differences in the fibre contents of tapioca-soybean blend which ranged from 2.70 to 5.50%. According to the proximate results, soybean had 2.04 times the fibre content of tapioca AB1. Therefore, this suggested that fibre content also increased with increased substitution of cassava with soybean. Dietary fibre is important in nutrition as it increases water holding capacity of stool. As a result, stool bulk and softness are increased and transit time is reduced which reduces constipation, diverticular diseases and probably other diseases of lower gastro-intestinal tract[36-40].

According to the most preferred sample AB6, which has 5.50% dietary fibre, the results are higher than those reported by Yaich *et al.*[35] who noted 3.34% of dietary fibre in the most preferred sample of a complementary feeding food by weaning mothers that used similar raw materials. A protein analysis is important for nutrition labelling, nutrient assessment and protein isolation and purification. As shown in Table 3, the protein content of the five samples of tapioca-soybean blend ranged from 1.10-20.49%, indicating an increase in the nutritional value of tapioca-soybean blend; among all the five formulations, AB1 has the lowest protein content which indicated poor nutritional value of tapioca[41-43]. Yang *et al.*[44] reported an increase in protein content from 7.7-12.3% in soybean-fortified gari and from 6.5-16.4% in soybean-fortified maize tortillas. The energy content of tapioca-soybean blends ranged from 342.40-391.80 kcal/100g, with all samples demonstrating higher levels compared to the control. This means that substitution of cassava with soybean plays a major role in the energy content of a food ration. It is important to have a good energy balance between different nutritional components in a food[45,46].

The chemical properties of "kpokpo" garri enriched with coconut, indicated that moisture content ranged from 10.20 to 13.80%; sample AB5 had the lowest value of moisture content and sample AB6 had the highest (Table 4). Moisture content is important in the storage of cassava products. Moisture content greater than 12% allows microbial growth which reduces shelf life. There was a high moisture content in most of the samples, so they are likely to have a short shelf life. Protein content ranged from 1.10- 8.61%; sample AB1 had the lowest value of protein content and sample AB6 had the highest, a positive increase in protein was recorded. Fat content ranged from 6.20-33.10%; sample AB1 had the lowest value of fat content and sample AB6 had the highest, as more coconut was added to kpokpo garri, the fat content increased significantly, creating a high possibility of rancidity. Ash content ranged from 1.50-2.35%; sample AB1 had the lowest value of ash content and sample AB6 had the highest, the ash content also increased as more coconut was added to kpokpo garri, proving that the samples with coconut had higher mineral content than that of only kpokpo garri. Carbohydrate ranged from 75.36-37.79%; sample AB1 had the highest value of carbohydrate and sample AB6 had the lowest as shown in Table 4.

Decrease in carbohydrates is due to the variation in other parameters (protein, fibre, fat, ash and moisture). Fibre content ranged from 2.70-4.35%; sample AB1 had the lowest value of fibre content and sample AB6 the had the highest. The increase in fibre content was due to the coconut chaff that was added to the kpokpo garri, the fibre continued to increase as more coconut was added to it. Sample AB1 (100% kpokpo garri from cassava mash) was significantly different from the enriched kpokpo garri samples. The proximate composition of foods includes the contents of its macro components, specifically moisture, ash, lipid, protein and carbohydrate[47-50]. The study demonstrates that fortifying tapioca with date, soybean and coconut can significantly enhance its nutritional profile, addressing dietary deficiencies in populations reliant on tapioca. The increased dietary fiber content in the fortified blends can improve gut health and alleviate digestive issues like constipation. Additionally, the lower moisture content in some samples suggests longer shelf stability, which is crucial for storage and distribution. The findings can be utilized by the food industry to develop new, fortified tapioca products with improved nutritional benefits, appealing to health-conscious consumers and those with specific dietary needs. The fortified tapioca blends can also be integrated into public health nutrition programs to combat malnutrition, especially in regions where tapioca is a dietary staple. Moreover, the dietary fiber from tapioca can be used in various food products, including beverages and animal feeds, to enhance their nutritional quality. The study does not address the sensory properties (taste, texture, etc.) of the fortified tapioca blends, which could affect consumer acceptance and marketability. Additionally, while the study shows positive results on a small scale, further research is needed to determine the feasibility and cost-effectiveness of scaling up the fortification process for commercial production. The bioavailability of the added nutrients is also not explored, which is crucial to ensure that the fortified nutrients are effectively absorbed and utilized by the body. Date, soybean and coconut can be effectively used to enhance the dietary fiber content of tapioca, improving its nutritional value and health benefits. The study's results indicate that the tapioca-date, tapioca-soybean and tapioca-coconut blends are rich in essential nutrients, making them valuable for human consumption and addressing health issues like constipation due to their high dietary fiber content. For optimal nutritional balance and longer shelf life, sample AB4 of the tapioca-date blend is recommended. With moderate moisture (10.60%), fiber (4.00%) and carbohydrate content (80.37%), it provides a good energy value (344.00 kcal/100 g) and is suitable for a nutritious diet. This blend offers a balanced source of energy, fiber and essential nutrients, making it an excellent choice for enhancing overall dietary quality. Additionally, the lower moisture content in AB4 helps in prolonging its shelf life, making it more practical for storage and consumption.

CONCLUSION AND RECOMMENDATIONS

The study concluded that tapioca-date, tapioca-soybean and tapioca-coconut blends are rich in nutritional qualities especially dietary value. Date, soybean and coconut can be used to increase the dietary fibre content of tapioca which will help improve gut health. The utilization of dietary fibre is possible in a variety of foods like tapioca, beverages and animal products. Therefore, the consumption of this food product will provide nutritional value to humans, as well as solve health problems such as constipation because of its dietary fibre value. For optimal nutritional balance and longer shelf life, sample AB4 of the tapioca-date blend is recommended. This blend offers a balanced source of energy, fiber and essential nutrients, making it an excellent choice for enhancing overall dietary quality. Additionally, the lower moisture content in AB4 helps in prolonging its shelf life, making it more practical for storage and consumption.

SIGNIFICANCE STATEMENT

This study, conducted in Benin City, Nigeria, exploring the enhancement of dietary fiber in tapioca (kpokpo garri) by fortifying it with dates, coconut and soybean. Samples of these fortifiers were processed into fine flour and mixed with cassava flour in varying proportions. The fortified tapioca samples were then analyzed for moisture, protein, fat, ash, fiber and carbohydrate content using standard methods. The results showed significant improvements in nutritional value, particularly in fiber and protein content, across the fortified samples. The findings suggest that using dates, coconut and soybean as fortifiers can enhance the nutritional quality of traditional Nigerian foods like tapioca, offering a potential strategy for improving dietary intake in the region.

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