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Production and Evaluation of Enriched Tapioca Gruel

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Abstract Enriched Tapioca product was made from cassava tubers (TMS 30572). Soya milk was added to the tapioca to improve the flavor, color and more importantly the nutritional content. The Tapioca gruels were further enriched with strawberry flavorant and carmoisine and quinolene colorants, granulated, tossed at 60°C and dried in the oven at 55°C. Five samples A (100g of cassava starch + 0ml of soymilk), B (90g of cassava starch + 10ml of soymilk), C (80g of cassava starch + 20ml of soymilk), D (70g of cassava starch + 30ml of soymilk) and E (60g of cassava starch + 40ml of soymilk) were produced in all. Proximate and sensory analyses were carried out to ascertain the chemical composition and consumer acceptance of the product. The samples were also subjected to chemical and to functional analysis. The proximate composition of the samples significantly (p=0.05) increased with increasing level of soya milk. The only exceptions were carbohydrate and crude fiber. The Ash content increased from 0.8 to 5.00% while the fat increased from 4.78 to 5.10% with the Total titratable acidity decreasing from 0.490 to 0.0099% as soya milk level increased. The water absorption capacity increased from 2.5 to 3.3% with a decrease in solubility from 3 to 1%. Judges confirmed that the favored sample was the 40% soymilk enriched.

Keywords: *tapioca gruel, physico-chemical, sensory, soymilk*

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1. Introduction

Tapioca is a foodstuff obtained from partially gelatinized cassava starch and it is prepared and consumed in rural and urban villages around Lagos in Nigeria, Benin Republic, Togo and Ghana [1]. Tapioca is eaten as a breakfast porridge or pudding and can be termed a breakfast cereal or a snack food, though it has nothing in common with the cereal grains such as wheat, maize and rice which are converted into ready-eat-breakfast cereals. This was developed by food technologists as the beginning of the twentieth century. The first breakfast cereal to be made and sold as convenience food was cornflakes and some existing ones are wheat flakes, oat meal, Kellogg's bran, maize gruel and custard. These breakfast cereals are always eaten with milk [2,3,4]. Cereal grains are deficient in proteins, fats (with the exception of oat and maize), calcium, though they contain iron which is unavailable because of the presence of phytates present in the bran and germ. Cereals have no vitamin A, Ascorbic acid nor vitamin D but they contain the B-class of vitamins; thiamine. riboflavin, nicotinic acid and vitamin E. Tapioca made from cassava is often classed with the cereals though agriculturally and botanically they come from plants utterly unlike the cereals. Tapioca consists mainly of cassava starch from cassava roots [5,6]. Tapioca is a product of cassava (*Maniho tesculenta crantz*) known as "Manioc", in "Mandioca" in Portuguese and Brazil, "Tapioca" in Latin America and "Yucca" in Spanish [1]. In Nigeria, it is called in different regions as "Akpu" in Ibo, "rago" in Hausa, "ege" or "gbanuda" in Yoruba [7] lafun, tapioca, fufu and farinha de mandioca and a number of cassava based snack foods in Nigeria. Cassava is identified as a staple food for most people in Nigeria and serves as important low cost source of carbohydrate and energy calories for people in Nigeria. Tapioca gruel being a product of cassava starch is a rich source of energy but is low in protein and is also deficient in some micro-nutrients essential for growth, development, repair of body tissues and control of body processes [5]. As a result of its nutrient deficient problem, there is need to enrich tapioca gruel with protein-rich low cost legume such as soyabeans to prevent protein malnutrition among Nigerians who depend on the consumption of Tapioca. Soya bean has been used in a variety of food products in its flour or meal forms, isolates, concentrates and diary-likeform (soyamilk) in products like casoy biscuits, cassava soya flour breads and other varieties of soy enriched products like specialty breads, cakes and cake mixes, doughnuts, breakfast cereals, pasta products, miscellaneous baking and food products and alsoin cassava-soya bean infant food formula [8,9,10,11]. The use of soybeans in these products has proved to be of good nutritional quality and improved functional improved functional properties of the products. This project research aims to improve the nutrition quality

of Tapioca breakfast food with the objective of finding most suitable legume for the enrichment of Tapioca will increase the nutritional protein status of low income Nigeria. This will in turn reduce malnutrition among Tapioca consumers and advancement in the use of cassava is in line with the Nigerian government initiative programme.

2. Materials and Methods

The raw materials for the processing of tapioca was purchased at Ekeonunwa market in Owerri and they include soyabean [2kg].Strawberry flavor, carmoisine [E122] and Quinolene [E104] food colors, charcoal, muslin cloth and wooden stirrer. Cassava tubers [50kg] of TMS 30572variety was purchased from National Root Crops Research Institute Umudike. Umuahia.

2.1. Tapioca Processing

2.1.1. Starch Extraction

Fifty kilograms of cassava tubers were harvested, weighed and manually peeled with knife. The peeled cassava tubers were washed and weighed again. The tubers were manually grated with stainless steel grater to obtain slurry and the mash slurry was sieved in a white plastic bucket tied with muslin cloth using clean water. The starch was allowed to sediment and the fruit water was dewatered while the fibrous portion was disposed. The starch was washed two more times and finally allowed to settle and form starch cake.

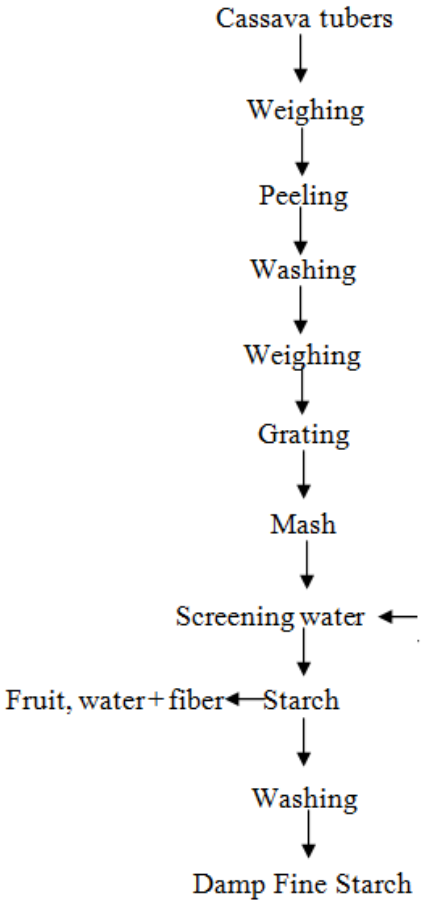

Figure 1. Flow diagram for starch extraction

2.1.2. Extraction For Soymilk

Soybeans (900g) were soaked in cold clean water five folds of its weight for twelve hours and were dehulled, washed and cooked in hot water for twenty minutes. The dehulled soybeans were milled in an electric grinder into slurry. The soybean slurry was mixed with 2700milk clean water for milk extraction and was sieved with a muslin cloth. Soymilk (with 9% total solids) was obtained using a hand refractometer and the milk was boiled for three minutes in a stainless pot, removed from fire and allowed to cool to 27°C.

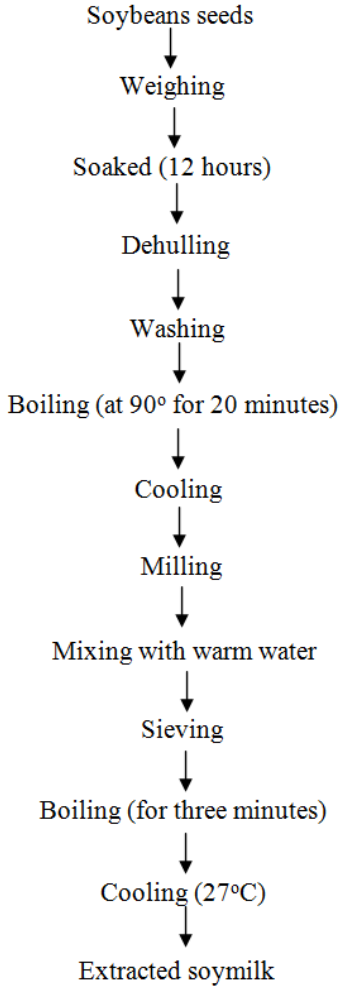

Figure 2. Flow diagram for extraction of Soymilk

2.1.3. Production of Tapioca Gruel

Damp cassava starch of measured weight 100g, 90g, 80g, 70g and 60g were put in five different stainless steel bowls and mixed with 0, 20, 30 and 40 ml of soymilk, respectively, mixture of carmoisine (E122) and quinolene yellow (E 104) (in the ratio of 1:0.5 w/w) of 0.5ml was introduced into each of the bowl containing starch and soymilk with the exception of the 100g: 0ml sample strawberry flavor of [14ml] each was also put into the five different samples. The tapioca samples were individually granulated and toasted on a frying pan smeared with little vegetable oil over a burning charcoal stand for five minutes at 60°C until the starch was partially gelatinzed. The tapioca samples were cooled to 27°C, oven dried at 55°C for 18hours to a dry crispy flake like product. They were cooled and filled in a plastic container until use.

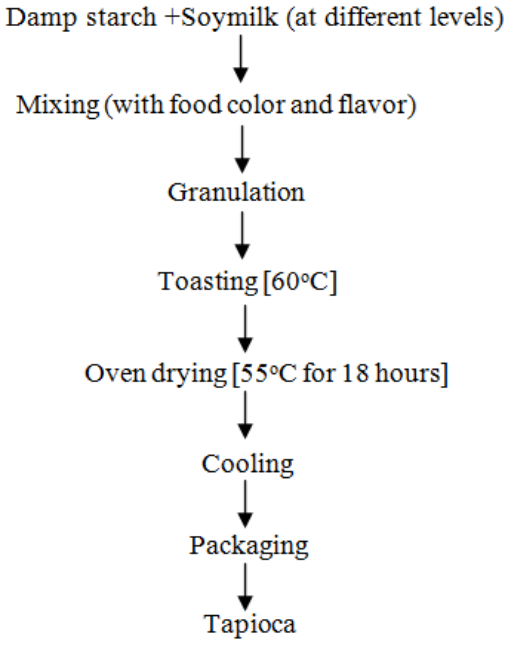

Figure 3. Production of Tapioca

2.2. Sample Analysis

Determination of carbohydrate, protein, moisture content, ash, crude fibre and fat content were conducted using the standard method [12]. Details of the method are given below:

2.2.1. Moisture Content Determination

A sample of 5gof tapioca were weighed into dried moisture cans of known weight, placed into the oven at 105°C for 3hours, cooled in a desiccator, removed and weighed. The samples were reheated, cooled and reweighted until a constant mass is obtained. The differences in weight before and after were recorded and the percentage moisture was calculated:

$$\%\,\text{moisture}=\frac{\text{loss in weight}}{\text{Weight of sample}}\text{x}\frac{100}{1}.$$

2.2.2. Crude Fiber Determination

Tapioca samples [2g] were weighed into 600ml beaker with 200ml of 1.25% sulphuric acid solution and boiled for 30minutes in a cool finger condenser. The boiled sample was washed with hot water using two folds muslin cloth to retain the particles and was carefully returned to the flask and boiled again in a 200ml of 1.25% sodium hydroxide solution. It was washed with hot water and allowed to dry by draining before transferred to a clean, dry porcelain crucible. The samples were dried in the oven at 105°C to constant weights, taken into the furnace, reduced to ash, cooled in a desiccator and reweighed. The percentage crude fiber is calculated as:

$$\%\,\text{crude fibre}==\frac{\text{Loss in weight on ignition}}{\text{Weight of sample}}\text{x}\frac{100}{1}.$$

2.2.3. Ash Determination

Each (2g) of the tapioca samples were weighed in dried, cooled in crucibles of known weight and heated in the muffle furnace at 550°C for 3 hours to burn to carbon free white ash. The ashed samples were cooled in a desiccator to room temperature and weight. The percentage ash was calculated as:

$$\%\,\text{Ash}=\frac{\text{weight of fat}}{\text{Weight of sample}}\text{x}\frac{100}{1}.$$

2.2.4. Crude Protein Determination

Each [0.5g] of the Tapioca samples were put in a micro- kjeldahl flask. One tablet of selenium catalyst was added into each flask moistened with distilled water and mixed with 10ml of concentrated sulphuric for 2 hours until clear solutions were obtained. The digest were transferred to a 100ml volumetric flask and diluted to mark by distilled water. An aliquot of the digest [10ml] was mixed with equal volume of 45% sodium hydroxide solution in selenium micro–Kjeldahi distillation apparatus. The mixtures were distilled and collected in 10ml of 2% boric acid solution containing 3drops of methyl red indicator and then titrated with 0.02N sulphuric acid solution. The above distillation processes were also carried out on the blank sample. The titer value of the blank was subtracted from that of the samples and the difference was used to calculate crude protein. The percentage nitrogen content was calculated as:
Calculation: Percent Nitrogen (N)

$$\%\text{N}\,(\text{DM basis})=\begin{bmatrix}(\text{VHCl x NHCl})\\-\,(\text{VBK x NNaOH})\\-(\text{VNaOH x NNaOH})\end{bmatrix}/1.4007\text{ X W X Lab DM}/100$$

Where

- VNaOH = mL standard NaOH needed to titrate sample
- VHCl = mL standard HCl pipetted into titrating flask for sample
- NNaOH = Normality of NaOH
- NHCl = Normality of HCl
- VBK = mL standard NaOH needed to titrate 1 mL standard HCl minus B
- B = mL standard NaOH needed to titrate reagent blank carried through method and distilled into 1 mL standard HCl
- 1.4007 = milliequivalent weight of nitrogen x 100
- W = sample weight in grams

Calculation: Percent Crude Protein (CP)

$$\text{CP}\,(\text{DM basis})=\%\,\text{N}\,(\text{DM basis})\text{ X F}$$

- F = 6.25 for all forages and feeds except wheat grains
- F = 5.70 for wheat grains

2.2.5. Carbohydrate Determination

This was determined by difference and was calculated by deducting the sum of the measured moisture (%MC), Ash (%A), Protein (%P), fat (%F) and crude fiber (%CF) = The total mass of 100%.

Therefore, %carbohydrate

$$=100\% - (\%MC+\%A+\%F+\%CF+\%CP).$$

2.3. Physico – Chemical Analysis

2.3.1. PH Determination

A 1%(M/V dry mater base) sample suspension was prepared and allowed to settle at room temperature (27+1°C) for 15minutes with the meter switched on and allowed to stabilize chemically with buffer solution of $_{P}H$ 7. The $_{P}H$ electrode sample as well as plain water was also determined.

2.3.2. Total Titratable Acidity (TTA)

Acidity was determined [13], where 5g of Tapioca samples were made into a thin smooth paste in recently boiled distilled water, so that the total water used and cooled was approximately 40 -50ml. Several drops of phenolphthalein (0.5% in ethanol) was added and titrated with 0.05M sodium hydroxide until a faint pink color appeared which did not fade on stirring for half a minute. The acidity was calculated as potassium dihydrogen phosphate KH_2P0_4. One milliliter of 0.0068g KH_2PO_4 being equivalent to 0.0068g KH_2PO_4.

2.3.3. Water Absorption Capacity

Two grams of tapioca were weighed into centrifuge tubes and 20ml of distilled water was added. The tubes were shacked by hand and allowed to stand at room temperature (25°C) for 30minutes. The samples were centrifuge for 30 minutes at 200RCF. Excess water was decanted by inverting the tubes. The weights of water are determined by difference.

2.3.4. Solubility Determination

Tapioca sample dispersions were prepared with each of the sample by dispersing 1g of Tapioca in little plain water and making it up to 10ml. They were allowed to stand for 10minutes. It is then allowed to settle for 60 minutes while it was stirred every 10minutes. They are allowed to settle for 15 minutes after which 2ml of the supernatant were pipette into a weighed dry petri dish, evaporated to dryness and re-weighed. The differences in weight are the total soluble solid. Solubility was calculated as:

$$\text{Solubility}-\text{TSS}\,(\%) = (\text{Vs}/\,2\text{Ms})\,(\text{Mc}-\text{Md})\ \text{X}\ 100$$

Where
Vs = Total supernatants / filtrate
Md = Mass of empty petri dish
Mc = mass of petri dish + residual solids
Ms = maws of flour sample used in the preparation of the dispersion.

2.4. Sensory analysis of Tapioca

The sample A, B, C, D and E were prepared into puddings by adding 100ml of water in 100g of the dried Tapioca and cooking in a pot until a required consistency is obtained, sugar and milk are added into the cooked Tapioca to taste. Sensory analyses were carried out to determine consumer preferences. The sensory panel was made up by ten consumer panelist and was assessed using a nine point hedonic scale [14].

9 – Like extremely
8 – Like much
7 – Like moderately
6 – Like slightly
5 – Neither Like nor dislike
4 – Dislike slightly
3 – Dislike moderately
2 – Dislike much
1 –Dislike extremely.

3. Results and Discussion

3.1. Proximate Composition of Tapioca Samples

The moisture content of the tapioca samples (A to E) increased as the level of soymilk increased. It increased from 10.00, 12.50, 15.009, 15.09 and 16.32% from sample A to E, respectively (Table 1). The A Tapioca samples were found to be free from fiber due to the low fiber content of cassava starch [15]. The Tapioca sample with100% cassava starch has the lowest ash content of 0.80% which signifies poor mineral availability while sample E, D, C and B have their ash content in the level of 5, 4, 3 and 2.5%, respectively. Sample E has the highest ash content of Tapioca sample. It was increased with increasing proportion of soymilk and this suggests possible fat supplementation of the product [16,17]. Sample E has the fat content of 15.02%, D 8.25% C, 4%, B 1.58% and A O. 16% (Table 1). Sample E has more protein than sample D, C, B and the least was sample A with 2.68%. There was a significant difference as the proportion of soymilk increased from 86.36, 80.41, 73.53, 67.03, and 53.98% from sample A to E, respectively, and significant differences existed among the means at p=0.05.

3.2. Physico-Chemical Properties of Tapioca Samples

The pH of the samples was slightly acidic in the range of 4. 78 to 5.10 as the proportion of soymilk increased (Table 2). This implies that the acid present in the samples was diluted to neutrality with a base from the protein in the soymilk [17]. The total titratable acidity decreased with increasing the soymilk level. The water absorption capacity of the samples increased from 2.5, 2.8, 3.05, 3.2 and 3.35% in the sample A, B, C, D, and E samples, respectively. The samples showed no solubility at temperature of 25°C, poor solubility at 45°C and the solubility was increased at 55°C and 75°C. Sample E has the least solubility followed by sample D, C and B in relative to sample A which having the greatest solubility. This might have been contributed by the denaturation of protein during toasting process.

3.3. Sensory Quality Attribute of Tapioca Samples

Anova analysis of the sensory data indicated that the samples were significantly the same at p=0.05 in terms of taste and aroma. So for appearance, samples B, C, D and E were the most acceptable. Taste panel judges did not

appreciate the color of sample A. This implies that the addition of soymilk increased and improved the color of the tapioca sample. For taste and aroma, no statistical differences existed among the samples. This may be because of the equal quantity of flavor used. In terms of mouthfeel and overall acceptance, there were no statistical difference at (p=0.05) among sample B and E with means that the sample are statistically similar. Samples A, D and C were not statistically different at p=0.05 though they scored lower than the rest of the samples. From the result, it does appear that sample E, B, and D were more accepted than sample A and C. sample E was rated most.

Table 1. Proximate Composition (%) Of Tapioca Samples.

Sample	Moisture	Ash	Crude	Crude fat	Crude protein	Carbohydrate
A	10.00^{b}±0.27	0.80^{e} ±0.05	0.00^{a}	0.16^{e} ±0.02	2.68^{e} ±0.02	86.36^{b}±0.27
B	12.50^{b}±0.01	2.50^{d}±0.11	0.00^{a}	1.58^{d}±0.03	3.01^{d}±0.04	80.41^{b}±0.30
C	15.00^{a}±0.47	3.00^{c}±0.02	0.00^{a}	4.00^{c}±0.01	4.47^{c}±0.04	73.53^{c}±0.50
D	15.09^{a}±0.33	4.00^{b}±0.05	0.00^{a}	8.25^{b}±0.09	5.63^{b}±0.08	67.03^{d}±0.18
E	16.32^{a}±0.02	5.00^{a} ±0.05	0.00^{a}	15.02^{a} ±0.04	6.68^{a} ±0.06	56.98^{e} ±0.53
LSD	2.92	0.10	0.00	0.06	0.05	0.69

Carbohydrate was obtained by difference.
The values are means of triplicate determination ± SD
Keys:
Sample A = 100g of cassava starch + 0ml of soymilk
Sample B = 90g of cassava starch + 10ml of soymilk
Sample C = 80g of cassava starch + 20ml of soymilk
Sample D = 70g of cassava starch +30ml of soymilk
Sample E = 60g of cassava starch + 40ml of soymilk
Values, within the same column, followed by the same letter is not significant difference at 0.05 level.

Table 2. Physico-Chemical Properties Of Tapioca Samples

PHYSICO-CHEMICAL PROPERTIES				
Sample	PH	Total titratable acidity (%)	Water absorption capacity (ml/g)	Solubility (%)
A	4.78^{e} ±0..01	0.490^{a} ±0.06	2.50^{d}±0.00	3.30^{a}
B	4.81^{d}±0.02	0.0303^{b}±0.04	2.80^{c}±0.00	3.00^{a}
C	4.89^{c}±0.10	0.0235^{c}±0.03	3.05^{b}±0.07	2.20^{a}
D	4.98^{b}±0.02	0.0145^{d}±0.02	3.20^{a}±0.14	1.00^{b}
E	5.10^{a}±0.01a	0.0099^{e}±0.01	3.35^{a}±0.07	1.00^{b}
LSD	0.09	0.005	0.24	1.28

Keys:
Sample A = 100g of cassava + 0ml of soymilk
Sample B = 90g of cassava starch +10ml of soymilk
Sample C = 80g of cassava starch +20ml of soymilk
Sample D = 70g of cassava starch +30ml of soymilk
Sample E = 60g of cassava starch +40ml of soymilk
The values are means of triplicate determination ± SD
Values, within the same column, followed by the same letter is not significant difference at 0.05 level.

Table 3. Sensory attribute value for tapioca samples.

Parameter	**SAMPLE**					
	A	**B**	**C**	**D**	**E**	**LSD(p=0.05)**
Appearance	3.2^{b}±2.04	6.5^{a}±1.96	5.4^{a}±1.78	5.2^{a}±2.04	5.3^{a}±1.70	1.68
Taste	6.0^{a}±1.94	6.1^{a}±1.60	5.4^{a}±1.20	5.7^{a}±1.78	6.1^{a}±2.13	1.32
Aroma	5.2^{a}±1.69	6.1^{a}±1.73	5.4^{a}±0.97	5.7^{a}±1.95	6.2^{a}±1.75	1.47
Mouth feel	5.1^{b}±2.23	6.0^{a}±1.41	5.3^{b}±1.57	5.6^{b}±1.51	6.7^{a}±1.16	1.26
Overall acceptance	5.1^{b}±2.23	6.0^{a}±1.4	5.2^{b}±1.69	5.4^{a}±1.58	6.7^{a}±1.16	1.41

Keys:
Sample A = 100g of cassava starch + 0ml soymilk
Sample B= 90g of cassava starch + 10ml of soymilk
Sample C = 80g of cassava starch + 20ml of soymilk
Sample D = 70g of cassava starch +30ml of soymilk
Sample E = 60g of cassava starch + 40ml of soymilk
The values are means of triplicate determination ± SD
Values, within the same column, followed by the same letter is not significant difference at 0.05 level.

4. Conclusion

The enrichment process increased the nutritive value and the sensory qualities of the Tapioca product. The enriched samples were accepted more compared with the unenriched sample though there was no appreciable change in physico-chemical properties of the unenriched and enriched samples. The possibility of enriching tapioca gruel for the improved health of common consumers needs to be explored further.

5. Recommendation

The use of enriched tapioca gruel will boost the nutritional status of consumers and do away with the problem of malnutrition among tapioca consumers.

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