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Evaluation and Analysis of Tapioca Fortified with Soy Beans

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Abstract:
Production and evaluation of soy-Fortified Tapioca is a project work carried out to: Determine the best level of soybean addition that will retain the quality characteristics of Tapioca, analyze the product samples obtained and carryout sensory analysis on the products and determine which of the samples will be generally acceptable.
The soy- fortified tapioca was subjected to proximately analysis and sensory evaluation. The protein content of soy-fortified tapioca samples ranges from 1.19% to 2.27%.Moisture content ranges from 56.4% to 69.8%. Fat content ranges from 0.40% to 0.80%.
Crude fiber of the samples ranges from 1.10% to 1.18%. HCN (mg/100g) of the samples ranges from 1.46 to 1.61, Ash content of the samples ranges from 0.86% to 0.98%.
Carbohydrate content of the samples ranges from 25.09% to 39.60%. Also the water absorption capacity of the samples ranges from 65.7% to 113.2%. The bulk density of the samples at loose stat ranges from 0.33 to 0.45 and at packed state ranges from 0.41 to 0.50
Sensory evaluation showed that there is significant difference in terms of colour, taste, texture, odour and overall acceptability.

Keywords: *Tapioca, soy-fortified, soy bean, sensory, samples*

1. Introduction

Tapioca is prepared from pure starch, a product made from cassava. It is available in pearls and flakes. The starch meant for use, should have very low fibre content and should also be free microbial contamination. The main quality factors are colour, particles size (fineness) Freedom from foreign particles such as soils insect etc.
A good tapioca contain not more than 12.5% moisture, 5% pulp and fibrous material, and 0.35% ash (Ayinde F.A. (2002)). Tapioca like ogi can be enriched with any of the legumes to make it more nutritious since it contains more of carbohydrates, it can also be enriched with cow milk. It can also be used as food puddings and pies directly or after partial conversion into "minute tapioca".
Soy flour is a product of soy beans which is a legume. It has the best nutritutional value of all the legumes. Also it has a high grade vegetable protein and it iso of great value as regards animal and human foods. Soy beans are better body builder than other vegetable proteins because it contains all the eight essential amino acid required by the body for proper functioning of the body. In the raw form, it contains some toxins including trysin inhibitors that interfere with the digestive enzymes. It can be toxic if not well cooked. The toxins can be removed by heat treatment and fermentation.
Soyabeans is low in starch and glutten. It is difficult to bind so it is mixed with other flours or pastes in preparing dishes. Its low carbohydrates content makes it suitable for babies / children foods and for people who avoid animal protein due to illness or religious practices. (Mariam Abacha, 1987/88 & 1989).
Economically, it is cheaper than other sources of proteins. Soyabeans has 40% crude protein. It also contain more protein of higher biological value; 70% more than the other sources. (Abacha (1987/88 & 1989).

2. Materials / Methodology

2.1. Materials

Fresh Cassava tubers, Matured soyabeans, Knife, Sieve, Frying vat, Muslin cloth, Trays, Pot, Colander, Water, Stove, Grinding machine and Milling machine.

2.2. Production of Tapioca Starch

Fresh cassava tubers were brought from Ogun State Agricutural Development Project (OGADEP) Imowo, Ijebu Ode, Ogun State. The variety used was sweet cassava (manihot palmate) known as "Dalejero" "rogo and Nwaiwa". The Cassava roots were freshly harvested and processed with 24hours to tapioca. The cassava tubers (freh) were washed to remove the soil debris, peeled and washed with clean wate, grated, filtered to separate starch from fibrous materials. The starch solution was allowed to stand and settled. After settling, the water was decanted and was strained using a muslin cloth to reduce the water contents which is will be gelatinized under low heat in an oiled frying vat. The produced tapioca was sundried until hardened and then packed in moisture.

2.3. Producing Soyabean Flour

Raw soyabeans of good variety (TGS 1838) was bought from IITA, Ibadan. It was cleaned by removing the stones, dirt and broken seeds after which it was washed and soaked in water for one hour. The water was drained (i.e. soaked) with a colander. It was then brought to boil for 20minutes, after which the beans were drained of water, dehulled, dried, ground, sieved to obtain the soyflour.

2.4. Producing the Soybean Fortified Tapioca

The soy-fortified tapioca was formulated in the proportions shown in table 1 below. The soyabean flour was added to the wet cassava starch in wet from before gelatinizing.

Tapioca	100%	95%	90%	85%	80%	75%
Soyflour	0%	5%	10%	15%	20%	25%

Table 1: Formulation of Soy-fortified Tapioca

3. Analysis of the Tapioca Samples

The following analysis was carried out on the tapioca samples:

Bulk density, protein content, fat content, ash content, crude – fibre, moisture content, carbohydrate content (by difference), HCN, Sensory Evaluation.

3.1. Physical Analysis Procedures

3.1.1. Swelling Index

The swelling index of the tapioca determined by the method of Leach et al (1959), 1 g of each of the tapioca was hydrated with 15 ml of distilled water and shake for 5 minutes at low speed in a 100 ml conical flask. This was then transferred into water bath, heated for 40 minutes at a temperature between 80 ^{o}C – 85 ^{o}C with constant stirring. It was then transferred to a pro-weighed centrifuge tube and 7.5 ml of distilled water was added and centrifuged at 2200 rpm for 20 minutes.

The supernatant was decanted to pre-weighed can and dried at 100 e to a constant weight, the residue in the centrifuge tube was also weighed. The index is calculated from the expression:

$$Swelling\ index = \frac{weight\ of\ sediment}{sample\ weight - weight\ soluble}$$

3.1.2. Bulk Density Determination

This was determined by the method of Harper (1981), a 250 ml graduated cylinder was tarred and gently filled with grounded tapioca. The bottom of the cylinder was repeatedly tapped gently on a laboratory bench until there was no further reduction of the sample volume. Bulk density was calcultated as the weight of samples unit volume (ml). Each product was determined in triplicate.

$$Bulk\ density\left(\frac{g}{ml} or \frac{g}{cm^3}\right) = \frac{weight\ of\ sample}{vol\ of\ sample\ after\ tapping}$$

3.1.3. Water Absorption Capacity

This is the amount of water absorbed per unit weight of sample. It was determined on the tapioca by the method of Feillet (1975). 5 g of the tapioca was weighed and hydrated with 100 ml of distilled water at 25 ^{o}C for 1 hr with manual string at 10 minutes excess water was drained with a whatman number 2 filter paper with slight suction. Water Absorption Capacity (Index) was calculated as:

$$Wa\% = \frac{weight\ gain\ upon\ hydration}{dry\ weight\ of\ sample}\ x\ 100$$

3.1.4. Determination of Mositure Content

A cleam petri-dish was dried in the oven and cool in a desicadtor. The cooled dish was weighed (W1) and Sg of ssmple was spread into the dish and weighed (W2). The dish was transferred into the oven at 110 ^{o}C to dry for 4 hrs it was then removed from the oven and cooled after which it was weighed (W3). The process was repeated until a constant weight was obtained and calculated as:

$$\%\ Moisture = \frac{W2 - W3}{W2 - W1}\ x\ 100$$

3.1.5. Determination of Ash Content

The ash content of ground sample was determined by AOAC method (1980). The crucible was cleaned, dried and cooled in a desiccator and weighed accurately into the Dish (W2).

The crucible with the samples is put in the furnace at 660^{o}C for 6hours. It was thereafter cooled to room temperature in a dessicator and weighed (W3). The ash content was calculated by the relations:

$$\%Ash = \frac{W3 - W1}{W2}\ x\ 100$$

3.1.6. Determination of Protein Content

The protein cotent of the samples was determined by the method in procedures manual systems for food, feed and breverages analysis procedures (1990).

0.29 of the sample was weighed into 100ml volumetric flask; 3.0 ml of concentrated sulfuric acid was added to the digestion flask. Water was turned to the aspiration and there was no suction to the fractionating column, the flask was placed followed by th fractionating column with funned on the flask these were heated at 335 – 440 ^{o}C (825 ^{o}F), refluxing sulphuric acid was visible) for 3 – 5 miutes, (the sample was not boiled to dryness).

10ml of 50% Hydrogen Peroxide was added to the channel sample via the capillary funnel on the fractionating column.

Execess hydrogen peroxide was boiled off by heating for one minute after adddiion of hydrogen peroxide was completed, the flask was taken off the heater, cooled and the fractionating column was removed from the digestion flask, it was again cooled to room temperature and diluted to the mark with demonized water, this was inverted several times to mix.

The digest was now ready for colorimetric analysis (sample was filtered because it looks turbid).

The colorimetric analysis was carried out by pipetting 1 ml of the digest into a 250 ml mixing graduated cylinder, 1 drop of 7 KN indicator was added and drops of 8 N potassium hydroxide standard solution was also added until blue colour was formed. This was diluted (about 20 ml) with de-mineralized water. 3 drops of mineral stabilizer was added to the mixing cylinder containing the sample and inverted several tires to mix, three drops of polyvinyl alcohol dispersing agent was added to each cylinder, and inverted several times to mix. Each cylinder was filled to the 25 ml mark with demonized water, stopper and was inverted to mix. 1 ml of Nesslerreagent (Cat No.: 21194-49) was added to each cylinder, stopper nd inverted several times to mix, the solution was clear.

The blank was prepared by adding 1 ml of distilled water, three drops of mineral stabilizer, PVA dispering agent, Nessler Reagent into 25 ml graduated cylinder, the blank and the sample was poured into the sample cells in the spectrophotometer. The measurement was taken in not later than 5 minutes after adding Nesseler Reagent. The smple cell containing deionized water blank was place into the cell holder, set to zero concentration point and the myth total KjeldahlNitorgen (N) from the display was read.

The calculation of Actual Total Kjeldahl Nitrogen is:

$$\%N = \frac{Conc.x\ 0.0075\ x\ 6.75}{Weight\ of\ sample}$$

3.1.7. Determination of Crude Fibre

The method of AOAC (modified 1993) was used. 2g of the grounded sample was weighed (W1) into a round bottom flask and 100 cm^3 of the digesion reagent was added and refluxed for 40 minutes. After cooling, the digest were washed with 10 ml ethanol and dried in the oven at 105 ^{o}C (W3). After drying, it was put into a pre-weighed crucible and the weight ws taken as (W2). The residue was then weighed, preheated an ashed. The weight was taken as (W4) which was used to calculate the crude fibre:

$$Crude\ Fibre\ (\%) = \frac{W3 - W4}{W1}\ x\ 100$$

All other quality test carried out includes the determination of fat content, carbohydrate content, HCN content and the sensory evaluation. The values obtained from the sensory evaluation were used to evaluate the statistical analysis.

4. Results & Discussion

Tables 2 and 3 shows the results of chemical and physical characteristics of soy-fortified tapioca samples in different proportions.

Samples	Moisture (%)	Protein (N_2 x 6.25) %	Fat (%)	Crude (%)	HCN (mg/100)	Ash (%)	Carbohydrate (%)
AB	67	1.19	0.40	1.16	1.6	0.96	29.29
CDE	56.8	1.43	48	1.18	1.60	0.98	39.13
FGH	56.4	1.42	0.52	1.10	1.16	0.96	39.60
IJK	63.8	2.1	0.54	1.16	1.52	0.86	31.54
LMN	63.6	2.19	0.66	1.18	1.55	0.88	31.49
OPQ	68.0	2.22	0.74	1.10	1.49	0.98	26.91
RST	69.8	2.27	0.80	1.15	1.46	0.94	25.09

Table 2: Chemical Analysis of Soy-fortified tapioca samples in different proportions

Samples	WAC (%)	Bulk Density (Loose)	Bulk Density (Packed)
AB	113.2	0.36	0.5
CDE	92.3	0.33	0.45
FGH	67.6	0.42	0.5
IJK	96.5	0.44	0.45
LMN	65.7	0.45	0.48
OPQ	99.4	0.38	0.44
RST	97.2	0.36	0.41

Table 3: Physical characteristics of Soy-fortified tapioca samples

4.1. Discussion

Considering the results obtained from the chemical analysis showed that samples OPQ and RST has the highest moisture content of 68 % and 69.8 %. The moisture content obtained from the various tapioca produced agrees with the observation made by Amwa-Amwa, 2006, Ojewole, (1990b).

Low moisture content as observed in the tapioca will help to ensure shelter shelve stability of the product sample and prevent spoilage. The moisture content is the measure of the waer content in a product sample (Pearson, 1994).

Also sample CDE and OPQ has the highest percentage of ash 0.98 % and 0.98 % while other samples are a bit lower. The ash content in all the tapioca samples was to enhance probably as a result of processing of the starch with the rate of fortification.

The results of crude fibre showed that samples CDE and LMN has the highest crude fibre content in the tapioca is probably as a result of processing of the cassava starch. Nutritionally, crude fibre is important in helping to increase the bulk of the food and to add water to the food during digestion.

The percentage carbohydrate is high in sample CDE and FGH with 39.13 % and 39.60 %. These tapioca samples had high carbohydrate content when compared to other as a result of the loss in moistre during drying.

Nutritionally, carbohydrate provides energy to the body during thir metabolic activities. Vacuole of the cytoplasm. Chronic poisioning has a direct implication in the aetiology of several endermicdisease such as goiter, tropical ataxic neutropaty and vitamin Bp deficiency (FAO, 1991, Bokanga, 1996). From the results all the result had cyanide content that were above consumable level. According to Ahmazan, 1986, Akinrele et al 2002, more than.

1.0 mgHCN/100g is usually regarded as being dangerously poisonous. The cyanic acid of tapioca samples as shown in tables 3 are in very small concentrations that is within the consumable levels without causing any harm to the health. As a gurdle cassava products with 3.0 mgHCN/100g was regarded as saf by Akindele, 2002, and Almazan(1996). However, Standard Organization of Nigeria (SON), 2003, recommended a lower limits of 2.0 mgHCN/100g as safe for cassava consumed products.

Protein content in the tapioca produced as shown in Table 2 revealed that OPQ and RST had the highest protein content and the least is HPT. The ones with high protein content are with 2.27 % and 2.22 % while the least is with 1.19 %. Also the table shows that the protein content in the tapioca samples that are high was due to the level of fortification using soy flour.

The nutitionalsiginificance of protein cannot be over emphastically help in the (Gaman and Sherrington, 2006).

Fat content of the various tapioca samples as shown in tables 3 were found to be high in tapioca fortified with soy flour than plain tapioca.

Differences in the fat content was probably due to the level of fortification. The tapioca sample RST had the highest fat content while AB had the least. Nutritionally, fat is important due to their ability to produce heat for body activation.

Water absorption capacity of the samples as shown in table 3 were found to be high in sample AB and least in sample LMN. This is done to know the level of water absorbed by the sample.

The bulk desntiy in loose state of the sample as shown in table 3 was high in sample LM and the least in sample CDE. Also the bulk density in packed state is high in sample AB and FGH and the least is sample RST.

Samples	Colour	Taste	Odour	Texture	Overall Acceptabilty
AB	7.4	7.3	6.8	7.4	7.3
CDE	6.9	7.0	5.9	6.9	6.9
FGH	6.9	5.0	6.3	6.9	6.9
IJK	5.0	6.2	6.9	5.9	5.9
LMN	6.3	6.5	6.9	6.3	6.3
OPQ	5.9	6.1	6.3	5.9	6.1
RST	5.9	5.3	5.9	5.9	5.9

Table 4: Means Scores for Sensory Evaluation of Soy-Fortified Tapioca Samples in Diff. Proportions

Parameter	Feal.	1 %	5 %	Comments
Colour	2.39	3.22	2.30	There is significant diff.
Odour	2.48	3.22	2.30	There is significant diff.
Taste	2.49	3.22	2.30	There is significant diff.
Overall Acceptability	2.69	3.22	2.30	There is significant diff.

Table 5: F. Tablulated

5. Conclusion

Studies carried out revealed that cassava contains a high level of cyanide which however tends to vary as the product is being fortified with soyflour. Processing of the tapioca also shows that the nutiritve composition of the prouct is increased when fortified with soy flour and a drastic reduction in the cyanide content to an appreciable and acceptable level.

Based on these findings, the production of tapioca starch fortified with soy beans flour an aneconomicl source of protein for he fortification of other food stuff that lack protein such as tapioca starch which is commonly taken by Lagosians in Nigeria. Modifications can also be carried out on it for infants and animal feeds as the third world population is lacking in proteneous foods.

5.1. Sensory Evaluation Result

Judges	AB	CDE	FGH	IJK	LMN	OPQ	RST	TOTAL
1	8	7	6	7	6	7	6	47
2	7	7	7	2	5	6	5	39
3	9	7	6	5	6	2	7	42
4	8	7	7	8	9	3	8	56
5	7	7	7	7	5	5	6	44
6	7	6	6	3	5	6	4	39
7	6	7	7	7	7	7	5	46
8	7	7	8	7	6	7	5	47
9	8	6	7	4	8	7	4	47
TOTAL	67	62	62	53	57	53	53	407
MEAN	7.4	6.9	6.9	5.9	6.3	5.9	5.9	

Table 6: Colour

Judges	AB	CDE	FGH	IJK	LMN	OPQ	RST	TOTAL
1	8	8	6	6	8	7	5	48
2	7	7	7	6	6	7	6	46
3	7	9	2	1	6	6	4	37
4	7	8	8	8	9	9	7	57
5	9	6	6	9	7	8	6	48
6	6	6	8	7	6	2	4	39
7	7	4	4	4	4	4	4	28
8	7	7	2	8	4	6	5	39
9	8	8	2	7	9	6	7	47
TOTAL	66	63	45	56	59	55	48	392
MEAN	7.3	7.0	5.0	6.2	6.5	6.1	5.3	

Table 7: Taste

Judges	AB	CDE	FGH	IJK	LMN	OPQ	RST	TOTAL
1	8	7	6	7	6	7	6	47
2	7	7	7	2	5	6	5	49
3	9	7	6	5	6	2	7	42
4	8	4	4	8	9	9	8	56
5	7	7	7	7	5	5	6	44
6	7	6	6	3	5	6	4	39
7	6	7	7	7	7	7	5	46
8	7	7	8	7	6	7	5	47
9	8	6	7	4	8	7	4	47
TOTAL	67	62	62	53	57	53	53	407
MEAN	7.4	6.9	6.9	5.9	6.3	5.9	5.9	

Table 8: Texture

Judges	AB	CDE	FGH	IJK	LMN	OPQ	RST	TOTAL
1	7	7	6	6	7	6	7	46
2	7	2	5	7	7	5	6	39
3	7	5	6	6	7	7	2	40
4	7	8	9	7	7	8	9	55
5	7	7	5	7	7	6	5	44
6	7	3	5	7	7	4	6	39
7	7	7	7	7	7	7	2	48
8	6	7	6	8	7	7	7	48
9	6	7	4	7	6	7	8	45
TOTAL	61	53	57	62	62	57	53	405
MEAN	6.8	5.9	6.3	6.9	6.9	6.3	5.9	

Table 9: Odour

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