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FORTIFICATION OF TAPIOCA WITH TURMERIC POWDERS AND ASSESSMENT OF ITS ACCEPTABILITY BY CONSUMERS

BY

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ABSTRACT

This present work is an attempts to enhance the nutritional status of tapioca meal by fortifying with turmeric powder. Fortification of cassava starch in the production of tapioca at different substitutional levels was carried out using standard analytical methods. Proximate analysis revealed that the protein content ranged from 6.12 to 9.02 %, ash varied from 0.92 to 2.22 %, crude fibre ranged from 2.16 to 3.0 % and fat varied from 0.07 to 2.91 % while carbohydrate content ranged from 72.71 to 79.12 % for all the samples. It was generally observed that protein, ash, fibre and fat increased with increase in the level of substitution with turmeric powder. Selected functional properties viz bulk density, swelling power, solubility index and pH from 0.46 to 0.69 g/ml; 8.74 to 9.67 %; 7.36 to 8.81% and 8.80 to 9.20 respectively for all the tapioca samples indicating the functionality of turmeric in food systems. All the fortified tapioca samples were generally liked by the panelists, with tapioca produced from 100% cassava starch most acceptable. Therefore, fortifying cassava starch in the production is a good vehicle for nutritional improvement of the product (Tapioca).

Keywords: Fortification, Tapioca, Turmeric powder, Assessment, Consumer Acceptability.

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INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is a source of food and nutrition for over 500 million people in the tropical world, and the third largest sources of carbohydrate for humankind, with Nigeria being its largest producer (Okwuonu *et al*., 2021). One of the main meals in tropical and sub-tropical nations is cassava, also known as Brazilian arrowroot, manioc, or yucca, and it is a member of the Euphorbiaceae family (Phanghal *et al*., 2019; Alve, 2002). The primary storage organ of the cassava plant is the root, which also contains 3% of other materials, such as minerals, 70% moisture, 24% starch, 2% fibre, and 1% protein (Phanghal, 2019; Tonukari, 2004). In comparison to most staples, the caloric value of cassava products ranged from 11.70 to 14.51MJ/Kg, according to Kuforiji *et al*. (2016). According to the Food and

Agriculture Organisation (FAO, 2013), cassava provides 800 million people with the nutrition they need and a means of subsistence, which is important for millions of business players worldwide.

The perennial herb turmeric (*Curcuma longa*) is known by many names, including Curcum in the Arabic region, Indian Saffron, Haridra (Sanskrit, Ayurvedic), Jianghuang (Yellow ginger in Chinesse), Kyoo or Ukon (Japanese), and its bright yellow colour and peppery flavour, which are perhaps its main characteristics. Turmeric has been shown to have anti-inflammatory properties and aid in wound healing (Ogunbusola and Lashore, 2021; Lantz and Timmermann, 2005). Turmuric, the ingredient that gives curry powder its characteristic yellow colour, is derived from dried *Curcuma longa*.

Turmeric (*Curcuma longa*) native to Asian countries is widely used in form of rhizome powder to impart yellow colour (Abd El-Hack *et al*., 2021) such as in curry powder. The rhizomes, when not used fresh are usually boiled in water for 30-40 minutes, dried in hot oven and then ground into a deep orange yellow powder commonly used as a colouring and flavouring agents (Ahmed *et al*., 2020)

Cassava grit, a staple product of cassava, is one of the least expensive sources of calories for human nutrition (Aruma *et al*., 2021). Tapioca, a partially gelatinised irregular starch-grit made from cassava, is essentially a flavourless starchy ingredient or food that is typically consumed as a snack, thickened soups or sweetened baked goods. It is typically consumed as milk pudding in many parts of Africa.

A lot of researchers have studied the fortification of cassava products in order to enhance the nutritional components of the foods. For instance, Ogunbusola and Lashore (2021) investigated the nutritional, phenolic, and sensory qualities of tapioca made from blends of cocoyam, plantain, turmeric, and date fruits, whereas Samuel *et al*. (2006) documented the chemical analysis and consumer acceptability of tapioca enhanced with soybeans. Lantz and Timmermann (2005) examined the impact of turmeric extracts on inflammatory mediators, while Alvares *et al*. (2024) investigated the optimal concentration of turmeric to be added to artisanal cassava flour based on consumer preferences. Thus, the purpose of this study is to assess the nutritional qualities of tapioca that has been fortified with turmeric powders as well as the product's acceptability among consumers.

MATERIALS AND METHODS

Source of Materials

Fresh cassava tubers of superior quality were purchased from a nearby farm settlement in Ilaro town, and turmeric rhizomes were procured from the Botanical Garden of the Department of Science Laboratory Technology of the Federal Polytechnic, Ilaro. The materials were then transported to the Food Technology Laboratories at the Federal Polytechnic, Ilaro, Nigeria, for preparation and further analysis. The chemicals and reagents used were of analytical-grade.

Production of Turmeric Powder

Turmeric powder was made using the process outlined by Ogunsusola and Lashore (2021). After thoroughly washing the roots in clean portable water, the roots were boiled for approximately 45 minutes to soften and eliminate their raw odor. The roots were then cut into smaller pieces to aid in drying, and they were then dried at 50^0C in a hot oven (Model HS60, Czechoslovakia) before being ground into fine powder using a Marlex Electroline Blender (Dabhel, Daman CUT) and sieved through a 250 µm mesh size sieve.

Production of Cassava Starch

Twenty kilograms of recently harvested cassava roots were cleaned with potable water, peeled with stainless steel knives, cleaned once more, and then grated using a mechanical grater powered by a diesel engine (action zone made of 3mm stainless steel). The pulp that was produced was immediately suspended in thirty liters of water after being sieved through a screen. This made it possible to separate the starch pulp from fibrous and other coarse root material. After five hours of settling, the starch pulp was decanted. Coarse-grained moist starch was created by pressing and screening the thick starch cake at the bowl's bottom (20 mesh size).

Formulation and Production of Various Blends of Fortified Tapioca

Different proportions of cassava starch and turmeric powders were combined to create blends of fortified tapioca. The different blend formulations are displayed in Table 1. An electrically powered rotary dryer was used to roast the fortified cassava starch for 20 minutes at 100^0C. A suction fan in the dryer draws out the steam produced during roasting. To achieve partial gelatinization, the fan was turned off for the first ten minutes after the starch flour was loaded into the dryer. The partially gelatinized starch granules were then dried off by turning on the fan (Sanni *et al*., 2004).

Table 1: Formulation of Fortified Tapioca

Sample	Cassava tapioca (%)	Turmeric
A	100	-
B	95	5
C	90	10
D	85	15
E	80	20

Key:

A – 100% Cassava starch

B – 95% Cassava starch + 5% turmeric powder

C - 90% Cassava starch + 10% turmeric powder

D - 85% Cassava starch + 15% turmeric powder

E - 80% Cassava starch + 20% turmeric powder

Chemical Analysis

The proximate analysis of fortified tapioca was carried out using standard methods of AOAC (2010). Bulk density and water absorption capacity were determined by the method of AOAC (2017), swelling power by Kusumayanti et al. (2015), Solubility index by Otondi et al. (2020) and pH using pH meter.

Thirty semi-trained panelists were chosen based on their familiarity with tapioca and their consistent scoring to assess the sensory qualities of tapioca enriched with mixes of turmeric powder. A Hedonic scale with nine points—from "like" to "dislike"—was employed. Color, texture, taste, and general acceptability were assessed for the samples.

Statistical Analysis

Every determination was made in triplicate, and the data produced was examined using the SPSS 21 computer program's Analysis of Variance (ANOVA) and means separated by the New Duncan Multiple Range Test. At the five percent probability level, significance difference was evaluated.

RESULTS AND DISCUSSION

Results

Table 2: Proximate Composition of Tapioca Fortified with Turmeric

Sample	Moisture Content (%)	Protein (%)	Carbohydrate (%)	Ash (%)	Crude fibre (%)	Fat (%)
A	11.61±0.01^{a}	6.12±0.01^{d}	79.12±0.01^{a}	0.92±0.02^{e}	2.16±0.01^{d}	0.07±0.01^{d}
B	10.88±0.01^{b}	7.63±0.02^{c}	77.45±0.01^{b}	1.23±0.01^{d}	2.65±0.01^{c}	0.16±0.01^{c}
C	10.66±0.02^{b}	8.14±0.02^{b}	74.37±0.01^{c}	1.85±0.01^{c}	2.92±0.01^{ab}	2.10±0.01^{b}
D	10.34±0.01^{c}	8.92±0.01^{ab}	72.90±0.02^{d}	2.01±0.01^{b}	2.97±0.01^{ab}	2.86±0.01^{a}
E	10.13±0.01^{c}	9.02±0.01^{a}	72.71±0.01^{d}	2.22±0.02^{a}	3.01±0.01^{a}	2.91±0.01^{a}

Each value represent means of triplicate value; mean ± standard deviation. Values with same superscripts are not significantly different at 5% probability level ($P \geq 0.05$).

Key:

A – 100% Cassava starch

B – 95% Cassava starch + 5% turmeric powder

C - 90% Cassava starch + 10% turmeric powder

D - 85% Cassava starch + 15% turmeric powder

E - 80% Cassava starch + 20% turmeric powder

Table 3: Selected Functional Properties of Tapioca Fortified with Turmeric

Sample	Bulk Density (%)	Swelling power (%)	Solubility Index (%)	pH
A	0.69±0.02^{a}	9.67±0.01^{a}	8.21±0.01^{b}	9.20±0.01^{a}
B	0.58±0.01^{b}	8.93±0.01^{b}	8.32±0.01^{b}	9.02±0.01^{b}

C	0.54±0.01[b]	8.74±0.01[b]	8.81±0.01[a]	9.01±0.01[b]
D	0.51±0.01[bc]	8.83±0.01[b]	7.45±0.01[c]	8.90±0.01[c]
E	0.46±0.02[c]	9.21±0.01[a]	7.36±0.01[c]	8.80±0.01[c]

Each value represent means of triplicate value; mean ± standard deviation. Values with same superscripts are not significantly different at 5% probability level (P ≥ 0.05).

Key:

A – 100% Cassava starch

B – 95% Cassava starch + 5% turmeric powder

C - 90% Cassava starch + 10% turmeric powder

D - 85% Cassava starch + 15% turmeric powder

E - 80% Cassava starch + 20% turmeric powder

Table 4: Sensory Characteristics of Tapioca Fortified with Turmeric

Samples	Colour	Texture	Taste	Overall Acceptability
A	8.63±0.01[a]	8.13±0.01[a]	8.13±0.01[a]	8.38±0.01[a]
B	7.50±0.01[ab]	7.63±0.01[a]	7.13±0.01[a]	7.75±0.01[b]
C	7.50±0.01[ab]	7.63±0.01[a]	7.50±0.01[b]	7.75±0.01[b]
D	7.38±0.01[b]	7.38±0.01[a]	7.38±0.01[b]	7.50±0.01[b]
E	7.13±0.01[b]	7.63±0.01[a]	7.38±0.01[b]	7.25±0.01[b]

Each value represent average score with mean± standard deviation. Values with same superscripts are not significantly different at 5% probability level (P ≥ 0.05).

Key:

A – 100% Cassava starch

B – 95% Cassava starch + 5% turmeric powder

C - 90% Cassava starch + 10% turmeric powder

D - 85% Cassava starch + 15% turmeric powder

E - 80% Cassava starch + 20% turmeric powder

DISCUSSION

Proximate Composition

The result of the proximate composition of tapioca fortified with turmeric powder is as shown in Table 2. The proximate composition evaluated varied considerably (P≤0.05). The moisture content ranged from 10.13 to 11.61% for all the samples. The control (Sample A), 100% tapioca made from cassava flour has

the highest value (11.61%) while tapioca fortified at 20% turmeric level had the least value (10.13%). there was a slight difference in the moisture content obtained by a similar work carried out by Sanni *et al*. (2008), where the moisture content ranged from 7.2 to 10.5%. However, the lower the moisture content, the more the improvement in the storability of the product. The protein contents obtained were 6.12%, 7.63%, 8.14%, 8.92% and 9.02% respectively for the sample, that is control and substitution carried out at 5%, 10%, 15%, and 20% with turmeric powders. As the amount of turmeric substituted increased, so did the protein content. The outcome is consistent with research by Olatidoye *et al*. (2010), who found that when "Agidi," a fermented cereal product, was produced, the protein content increased in proportion to the amount of soy flour supplemented in maize flour. There were notable variations ($P \leq 0.05$) in the samples' carbohydrate contents. For the samples, it ranged from 72.71 to 79.02%. According to a related study by Adebowale *et al.* (2008), tapioca is basically a starch product made from wet cassava starch, which explains why the carbohydrate levels of all the tapioca samples were fairly high (72.71 to 79.02%). The ash contents ranged from 0.92 to 2.22% for all the tapioca samples under consideration. The ash contents showed increased amounts as the level of substitution increases. Turmeric plants have an appreciable amounts of ash (about 2.85%). Ash residue is typically modest (less than 1% of the food) and is typically thought of as a measure of the mineral contents of the food (Adejuyitan *et al.* 2009). The crude fibre and fat content also revealed significant differences ($P \leq 0.05$) among the samples. Crude fibre varied from 2.16 to 3.01% while fat ranged from 0.07 to 2.91 %. there were increase in the amounts of both crude fibre and fat contents as the level of substitution increases.

Functional Properties

Selected functional properties of fortified tapioca are depicted in Table 3. All of the tapioca samples had bulk densities ranging from 0.46 to 0.69 g/ml, which is the ratio of flour weight to volume in grams per milliliter (Subramania and Viswanathan, 2007). Adejuyitan *et al*. (2009) state that bulk density, a measurement of flour weight, is a crucial factor in determining whether a flour is suitable for the packaging and transportation of particle food (Shittu *et al*., 2005). The control sample (sample 100% cassava tapioca) had the highest value of 0.69 g/ml. Swelling power (%) obtained for the tapioca samples varied from 8.74 to 9.67%. Swelling power has been described as the expansion accompanying spontaneous uptake of solvent (Omueti *et al.*, 2009). it was however observed that tapioca produced from 100% starch had the highest value (9.67%) with tapioca substituted with 10% turmeric having the lowest value (8.74%). The solubility index, which measures the amount of water soluble solids per unit weight of the sample, varied from 7.36 to 8.21% for the tapioca samples. In the literature, solubility is a measure of protein functionality, including denaturation and its potential applications (Adebowale *et al.*, 2008).The pH of the tapioca samples ranged from 8.80 to 9.20, indicating a progressive decrease in pH as the level of substitution increases.

Sensory Attributes of Tapioca Fortified with Turmeric Powder

The result of sensory evaluation test is as shown in Table 4. The results computed for colour attributes showed that sample A (100% cassava starch) is significantly more attractive than the other four samples due to its bright, whitish colour. Also, it showed that there is no significant different ($P \geq 0.05$) between samples B and C (sample substituted with 5% and 10% turmeric). Similar trend was shown between sample D and E (15% and 20% substitutional levels). The textural attributes revealed that there is significant differences ($P \leq 0.05$) among all the samples. This may be due to the same roasting temperature and time ($P \geq 0.05$) among samples and this may be due to the fortification carried out the tapioca samples. However, sample A which is 100% cassava starch was generally acceptable in all the quality attribute evaluated.

Conclusion

It is evident from this present work that fortification of tapioca with turmeric powder has led to increase in the nutritional value of the product, with increase in protein, ash, crude fibre and fat and corresponding

decrease in the amount of carbohydrate content. Fortification also affected the functional properties of the product while consumers still preferred tapioca produced from 100% cassava starch.

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References

Abd EL-hack, M. E., EL-Saadony, M. T., Swelum, A. A., Arif, M., AboGhannima, M. M., Shukry, A. N., Noreldin, A., Taho, A. E., and El- Tarabily, K. A. (2021). Curcumin, the Active Sustance of Turmeric: Its Effect on Health and Ways to improve its Bioavailability. *Journal of the Science of Food and Agriculture,* 101(14):574-762

Adebowale, A.A., Sanni, L. O. and Onitilo, M. O. (2008b). Chemical Composition and Pasting Properties of tapioca grits from Different Cassava Varieties and Roasting Methods. *African Journal of Food Science,* 2(7):077-082

Adejuyitan, J. A., Otunola, E. T., Akande, E. A., Bolarinwa, I.F.,and Oladokun, F. M. (2009). Some Physicochemical Properties of Flour Obtained from Fermentation of Tigernut (*Cyperus esculentus*) sourced from a market in Ogbomoso, Nigeria. *African Journal of Food Science,* 3:51-55

Ahmed, M., Srivastava, U., and Gupta, C. (2020). Turmeric: Biological Operations and Medicinal Applications. *Ethnopharmacological Investigation of Indian,* 163-172

Alves, A. A. C. (2002). Cassava Botany and Physiology. In: R. J. Hillocks, J. M. Thresh and A. C. Bellotti eds. Cassava: Biology, Production and Utilization. New York, NY: CABI Publishing, 67-69

Alvares, V. S., Reis, R. C., Souza, J. M. L., Lambertucci, D. M., and Santiago, A. C. C. (2024). Ideal Concentration of Turmeric To Be Added to Artisanal Cassava Flour According to Consumer Perference. *Food Science and Technology, 44:1-3*

Aruna, T. E., Bolarinwa, I. F., Raji, A. O., Baolgun, M. A., Sanni, M., Akintayo, O. A., and Kolawole, O. O. (2021). Evaluation of Nutritional Value and Sensory Properties of *Moringa oleifera* Seed Powder Fortified with Sakada (A cassava-based Snack). *Journal of Food Chemistry and Nanotechnology, 7(3): 54-59*

AOAC (2010). Association of Official Analytical Chemist. Official Methods of Analysis. I7th Edition, Washington, D. C.

AOAC (2017). Association of Official Analytical Chemist. Official Methods of Analysis. I8th Edition, Washington, D. C.

FAO (2013). Save and Grow: Cassava Root: Food and Agriculture Organization for United Nations.

Goel, A, Kunnumakkara, A. B., and Aggarval, B. B. (2008). Curcurmin As “Curecumin” from Kitchen to Clinic. *Biochemical Pharmacology, 75(4): 787-809*

Kusumayanti, H., Handayani, N. A., and Santosa, H. (2015). Swelling Power and Water Solubility of Cassava and Sweet Potatoes Flour. *Procedia Environmental Sciences, 23: 164-167*

Kuforiji, O. O., Agunbiade, J. A., Awojobi, H. A., & Eniolorunda, O. O. (2016). Feeding value of cassava products supplemented with earthworm meal in diets of growing rabbits. *Tropical Agriculture*, *93*(3).

Lantz, R. C., and Timmermann, B. N. (2005). The Effect of Turmeric Extracts on Inflammatory Mediator Production. *Phytomedicine, 12(67): 445-452*

Ogunbusola, E. M., and Lashore, O. S. (2021). Nutritional, Phenolic and Sensory Properties of Tapioca Produced from Blends of Cocoyam, Plantain, Turmeric and Date Fruits. *FUOYE Journal of Agriculture and Human Ecology, 5(1): 31-38*

Okwuonu, I. C., Narayanan, N. N., Egesi, C. N., and Taylor, N. J. (2021). Opportunities and Challenges for Biofortification of Cassava to Address Iron and Zinc Deficiency in Nigeria. *Global Food Security. 28:100-478*

Olatidoye, O. P., Sobowale, S. S., Adeleke, A. E., and Adegbite, S. A. (2010). Effect of soy-fortification in the Nutritional and Physicochemical Properties of Cassava Flour. *International Journal of Food Science and Technology. 2(1)85-97*

Omueti, O., Otegbayo, B., Jaiyeola, O., and Afolabi, O. (2009). Functional Properties of Complementary Diet Developed from Soybean (*Glycine max*), Groundnut (*Arachis hypogea*) and Crayfish (*Macrobroichim spp*). *Electronic Journal of Environmental Agricultural and Food Chemistry, 563-573*

Otondi, E. A., Nduko, J. M., and Omwamba, M. (2020). Physicochemical Properties of Extruded Cassava-Chia Seed Instant Flour. *Journal of Agriculture and Food Research. 2:58-64*

Phanghal, A., Munezero, C., Sharma, P. and Chhikara, N. (2019). Cassava Toxicity, Detoxification and its Food Applications: A Review. *Toxins Reviews,* DOI:10.1080/15569543.2018.1560334

Samuel, F. O., Ayoola, E. O., and Adina, F. O. (2006). Chemical Analysis and Consumer Acceptability of Tapioca Enriched with Soybeans. *International Journal of Food and Agricultural Research, 3:1-5*

Sanni, L., Onitilo, M., Oyewole, O. O., Keiths, T and Westby, A. (2004). Studies into the production and Qualities of Cassava Grits (Tapioca) in Nigeria. In sixth International Scientific meeting of Cassava Biotechnology Network. Pp:8-14

Sanni, M. O., Achi, O. T. and Adegoke, G. O. (2008). Mechanization of Nigerian Cassava Production and Processing: Research Needs and Interest. *The Agricultural Engineer, 31(1):20-23*

Shittu, T. A., Sanni, L. O., Awonorin, S. O., Maziya-Dixon, B., and Dixon, A. (2005). Use of Multivariate techniques in Studing Flour Making Characteristics of Some Cassava Mosaic Disease Resistance Cassava Clones. African Crop Science Conference Proceedings,7:621-630

Subramania, S., and Viswanathan, R. (2007). Bulk density and Friction Co-efficient of Selected Minor Millet Grains and Flours. *Journal of Food Engineering, 81:118-126*

Torukari, N. J. (2004). Cassava and the Future of Starch. Biotechnology Issues for Developing Countries. 7:5-8