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Physicochemical and Functional Properties of Tapioca (*Manihont esculenta*) Flour

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ABSTRACT

The study was carried out to assess the physicochemical and functional qualities of tapioca flour. The results of physical characteristics of tapioca tuber namely length, width and weight were recorded as 26.24cm, 2.74cm at the proximal end, 3.21cm at the middle, 3.29cm at the distal end, and 273.40 kg. The tubers were sliced, blanched, dried and then milled into flour. The proximate composition of tapioca flour including moisture, protein, fat, ash, crude fiber, carbohydrate and energy were estimated as 10.77±0.22%, 2.10±0.10%, 0.91±0.08%, 1.60±0.38%, 1.40±0.32%, 83.17±0.78%, 349±4.00 Kcal, respectively. The functional properties of flour were found to be 20.25±1.05% swelling power, 59.08±2.53% flour dispersibility, 5.83±0.12cP viscosity, 0.836±0.045g/cm^3 bulk density, 38.30±1.02% percent solubility, 23.46±0.45% emulsification capacity, 10.12±0.14% gel capacity, 266.91±0.29% water absorption capacity and 88.46±1.14% oil absorption capacity. Tapioca is particularly high in carbohydrates, which makes it useful for persons with calorie deficiency and it also has a high functional value, so it may be used for home, commercial, and industrial purposes.

Key Words: Calorie, Deficiency, Flour, Proximate Composition, Properties, Tapioca,Value Addition.

INTRODUCTION

Tapioca is an underutilized root and tuber in Andhra Pradesh, which is available seasonally but not utilized to the extent that it should be. Manioc, yucca and cassava are the other common names for tapioca*(Manihot esculenta Crantz)*and karrapendalem is the local name used by the people of Andhra Pradesh, which belong to the family Euphorbiaceae. (Waisundara, 2018). It is regarded as Future Smart Food because to its tremendous potential for food, nutrition security, and adaptability. (Joshi *et al,* 2019). It is the most important food in the world and is also utilised as a feed plant. Tapioca ranks fourth in global production, after rice, maize, and wheat, with 16 crore tonnes produced per year. In the tropics, it has been a staple diet that supplies carbohydrates to billions of people. In contrast to other basic crops, tapioca grows more carbohydrates per hectare and may be farmed for a relatively low cost.(Ukwuru and Egbonu, 2013).The calorie source for around two-fifths of all Africans is cassava as it is a starchy tuber. For food security mostly people depend on cassava since its drought and climatic tolerance, high yield in poor soil and all-around-the-year availability.

Tapioca is a rich source of calcium, vitamin C, thiamine, riboflavin, dietary fibre, and carbohydrates. (Kanagasabapathi and Sakthivel, 2019). In addition to carbohydrates, tapioca is a good source of iron, zinc, B, C, and A vitamins. Moreover, because tapioca flour is gluten-free and acceptable for a variety of food products, it can entirely replace wheat in baking recipes for those with celiac disease (Marchini *et al,* 2022).In order to understand the functional properties and proximate composition of tapioca flour, the current investigation was carried out.

MATERIALS AND METHODS

The study was carried out in the Department of Food and Nutrition, College of Community Science, ANGRAU, Lam, Guntur, Andhra Pradesh in the year 2023. Tapioca roots used in the study was procured from Krishi Vigyan Kendra, Amadalavalasa, Srikakulam district, Andhra Pradesh, India. Physical parameters viz. length, width and weight of tapioca tubers were measured using Adetan *et al* (2003) method. Physical properties of twenty-five tubers were investigated at random. The length of the tubers was measured with a measuring tape, the breadth with

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vernier callipers, and the weight was recorded with an electronic weighing balance.

A.O.A.C (2000) technique was used to determine moisture, protein, fat, ash, crude fibre, carbohydrate, and energy. The following methods were used to evaluate the functional qualities of tapioca flour, which included swelling power (Schoch 1964 method), flour dispersibility, viscosity, bulk density (Narayana and Narasinga Rao, 1984), percent solubility (Schoch, 1964), emulsification capacity (Beuchat 1975 method), gel capacity (Abbey and Ibeh, 1988), water absorption capacity and oil absorption capacity (Beuchat *et al,* 1975).

Flour dispersibility was determined by putting 10g of tapioca flour sample to a 100ml measuring cylinder. 100ml of distilled water was added, rapidly agitated, and left to sit for three hours. The per cent dispersibility was calculated by deducting the volume of settled particles from 100 and reporting the result. The viscosity of tapioca flour was measured using a Viscometer at 100 rpm with spindle number two at 5% and 10% slurry concentrations (100ml). Statistical method mean, standard deviation and coefficient of variance were used.

Figure 1. a) Tapioca b) Tapioca flour

RESULTS AND DISCUSSION

Physical parameters of roots

Physical parameters of tapioca root namely, length(cm), width(cm) and weight(kg) were presented in the table 1.

Length of root

The length of the tapioca roots ranged from 9 cm to 48 cm with a mean length of 26.24 cm. Our reported value closely agrees with the mean value of 26.58cm reported by Oriola and Raji (2014) and 12-40 cm reported by Adetan *et al* (2003) but higher than the value of 3.0 cm reported by Lomchangkum *et al* (2020). The width of tapioca roots were observed at three tuber sections (proximal, middle and distal). The width ranged from 1.3 to 4.6 cm, 1.9 to 4.8 cm and 1.8 to 4.4 cm. The mean width of tubers was 2.74, 3.21 and 3.03 cm at the proximal, middle and distal of the root. These values were consistent with the values 37.32mm, 35.34mm and 26.05mm reported by Oriola and Raji (2014) and were lower than the values 37.32 mm and 35.34 mm for proximal and middle while higher than the value 26.05 mm at distal reported by Lomchangkum *et al* (2020). The weight of the tapioca roots ranged from 61 g to 739 g with a mean weight of 273.4 g which was in agreement with the values 0.3-1.0 kg and 59g to 722 g reported by Adetan *et al* (2003) and Oriola and Raji (2013) and but lower than the mean value441.10g by Oriola and Raji (2014) and 0.6 kg mentioned by Lomchangkum *et al* (2020). This disparity in physical characteristics may be due to variations in tuber age and tapioca cultivars used.

Proximate Composition of tapioca flour

One important aspect affecting food and product shelf life is moisture content. On a dry weight basis, tapioca flour had a moisture content of 10.77±0.22 percent. The important macronutrient and a functional ingredient in food formulations is protein. The protein value in this study was 2.10±0.10 percent,

Table 1. Physical parameters of Tapioca root

Sr.No	Length (cm)	Width (cm)			Weight (g)
		At Proximal	At Middle	At Distal	
1	44.0	1.7	3.5	3.8	208
2	32.5	3.5	4.5	2.5	378
3	33.0	3.0	4.8	3.8	739
4	28.5	3.8	3.5	3.6	228
5	29.0	1.5	4.0	3.5	439
6	19.0	2.0	3.0	5.0	69
7	11.0	2.2	2.3	2.0	77
8	18.0	2.5	3.6	3.0	464
9	15.0	1.3	3.4	4.1	564
10	12.0	3.5	3.2	3.2	96
11	26.5	2.4	3.3	3.6	231
12	16.5	2.4	2.6	2.3	102
13	9.0	1.6	2.1	2.5	99
14	42.0	2.8	2.5	2.3	144
15	37.0	2.6	2.4	1.85	197
16	22.0	2.2	1.9	1.8	210
17	19.5	1.5	2.1	1.9	61
18	16.0	2.1	2.3	2.4	74
19	19.5	4.0	4.8	4.4	236
20	24.0	3.6	3.2	3.0	354
21	48.0	3.2	3.6	3.7	450
22	38.0	3.9	3.5	2.3	435
23	36.0	4.6	3.7	2.9	410
24	28.5	3.7	4.2	2.9	250
25	31.5	3.1	4.3	3.4	320
Range	9.0-48.0	1.3-4.6	1.9-4.8	1.8-4.4	69-739
Mean	26.24	2.74	3.21	3.29	273.40
SD	14.21	0.91	0.80	0.86	177.21
CV	52.96	33.321	0.00249	0.00026	64.81

the value 23.51 percent reported by Obueh and Kolawole (2016) deviated from the findings of this study which explains that the fermentation process enhance the protein content, essential amino acids, and protein quality of cassava flour (Nilusha *et al*, 2021). Higher fat determines the stability of the flour. If the flour had a higher amount of fat will lead to rancidity and prone to oxidation and there will be the chance to the microbial growth (Verma *et al*, 2022). The fat content of tapioca flour was observed to be 0.91±0.08%. These values are similar to the finding of Verma *et al* (2022), Katunzi-Kilewela *et al* (2021), Okwunodulu *et al* (2022) and Banwo *et al* (2020). The difference in the values might be due to the variety, climatic conditions and processing technique (Nilusha *et al*, 2021).

Ash content shows the presence of mineral content which is used as a measurement of the quality of flours in the food industry (Verma *et al*., 2022). The ash content of studied tapioca flour was1.60±0.38 percent. The fiber content was found to be 1.40±0.32 percent, Verma *et al* (2022) described that fibre content increases with the increase in the age of the plant while protein and lipids decrease and the differences may be attributed to geographical location, maturity stage and environmental conditions (Chisenga *et al*, 2019). Carbohydrate is a chief source of energy that is required for human consumption. The present study revealed that the carbohydrate content of the tapioca flour was 83.17±0.78 percent and the calorific value of tapioca flour was 349±4.00 Kcal. Previous studies by Oyeyinka *et al* (2023), Oluwaniyi and Oladipo (2017), Olorode and Sobowale (2021) reported similar values as of this study.

Functional properties of tapioca flour

Swelling power

The swelling power in this study valued at 20.25±1.05 percent. Swelling power differs among the flours due to the variation in amylose content, particle size distribution, size of the starch granules, number of interactions between amorphous and crystalline regions, and the molecular structure of amylose and amylopectin. (Agbemafle 2019; Raya *et al*, 2022; Oyeyinka *et al*, 2023). The flour dispersity is an indication of particle suspensibility in water, move apart from water molecules and shows its hydrophobic interaction (Oyeyinka *et al*, 2023) and their ability to produce smooth and consistent dough (Yves *et al*., 2017). The flour dispersity of tapioca flour was 59.08±2.53 percent. Viscosity of tapioca flour was 5.83±0.12cP. Nzuta *et al* (2022), reported the viscosity values ranged from 5.40 to 7.25 cP in three different varieties of tapioca. The weak intermolecular network that may allow the flour granules to disintegrate when gelatinized in hot water and create a paste with relatively low viscosity might be the source of the variation in viscosity.

Bulk density

The bulk density measures the compactness or heaviness of flour produced which helps to determine the porosity of a product (Agbemafle, 2019; Geetha *et al*, 2021). It is a qualitative attribute that is dependent on the interaction of several components, including the number of contact sites, interparticle forces, and particle sizes. Tapioca flour had a bulk density of 0.83±0.04 g/cm^3. High bulk density flours may be desirable in some products as in infant formulas and used as a thickening agent in food products. The tapioca flour might be utilized as a thickener and binder in food product preparations like soups, gravies, meat sausages etc. High emulsion capacity is an indication that the flour samples could be an excellent emulsifier in various foods (Maruatona *et al,* 2010). In the study, tapioca flour had an emulsification capacity of 23.46±0.45 percent. The gel capacity value of tapioca flour was observed to be 10.12±0.14 percent. These values were in accordance with the values reported by Nwabueze and Anoruuoh (2011) and Praise *et al* (2022).

Water absorption capacity

The is an essential property that determines the quantity of water stored by the sample owing to hydrophilic sites in molecular chains and water contact via hydrogen bonding. It aids in measuring the sample's capacity to observe the water and increases the swelling of granule size to preserve the homogeneity of the sample. The water absorption capacity of tapioca flour was 266.91±0.29 percent at room temperature which depicts a good tendency to bind with water. The amount of water that a flour sample may absorb depends on its molecular structure, protein concentration, interactions with water, hydrophilic groups, configuration features, grinding level, and amounts of protein, carbohydrates, and damaged starch. (Kaushal *et al*, 2012). The potential of the product to hold water when processing dough and paste is an indicator of water absorption capacity. Oil absorption capacity is attributed mainly to the physical entrapment of oils. It indicates the rate at which protein binds to fat in food formulations. In this study, the oil absorption capacity of flour was 88.46±1.14 percent. Oil absorption capacity increased in processed flours which may be due to denaturing and separation of protein molecules when subjected to heat which unmasks the non-polar residues from the interior of the protein molecule. The values reported by Agbemafle (2019) and Katunzi-Kilewela *et al* (2021) were in consistent with the value of the present study.

CONCLUSION

Tapioca is exceptionally high in carbohydrate, which makes it useful for persons with calorie deficiency. The functional properties of processed tapioca flour are enormous, making it useful for developing new food products or substituting in current food products to add value in the domestic, commercial, and industrial sectors.

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