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Full Length Research

Functional properties of turmeric (*Curcuma longa*) powder and physical properties of turmeric rhizomes grown in Ekiti State, Nigeria

Oladimeji O.*, Idowu-Adebayo F. and Falabake M. A.

Department of Food Science and Technology, Federal University Oye Ekiti, Ekiti State, Nigeria.

Corresponding Author: Email: segundimeji@yahoo.com

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ABSTRACT: Turmeric is a perennial herb possessing an ovate, orange and often short-branched rootstock that grows to about two feet in length. The study evaluated the physical and functional properties of powder of unpeeled (A) and peeled (B) turmeric rhizome grown in Ekiti State, Nigeria. Turmeric samples were obtained at selected local farms and market of Ekiti Central, Ekiti North and South, Nigeria. The results obtained for physical properties range from 0.44±10.02 to 0.62±11.01 g/cm^3, 0.45±0.10 to 0.63±0.10 g/cm^3, 1.59±0.10 to 2.22±0.09%, 5.50±0.04 to 8.00±0.04 mm, 1.60±0.03 to1.90±0.03 mm for bulk density, true density, porosity, length and breadth respectively. Also, the results of particle size analysis range from 71.72±0.10 to 87.37±0.10, 9.47±0.10 to 26.26±0.10 and 2.02±0.10 to 6.06±0.10 for sieve 425 micron (%RT), 180 micron (%RT) and 125 micron (%RT) respectively. The functional properties include the pH that ranged from 7.24±0.10 to 7.41±0.09 for A; 6.72±0.10 to 7.04±0.10 for B, water absorption capacity (WAC) ranged from 30.84±0.10 to 42.94±0.10 for A; 41.04±0.10 to 51.25±0.09 for B. The results of functional properties of turmeric powder range from 6.72±0.10 to 7.04±0.09 and 30.84±0.10 to 51.25±0.09 for pH and water absorption capacities (WAC) respectively. The data obtained for physical properties will aid in the design of appropriate machinery for processing of turmeric plant, while the functional properties are to ascertain the health benefits as well as the utilisability of turmeric as a substitute for artificially produced drugs.

Keywords: Functional properties, physical properties, processing methods, turmeric.

INTRODUCTION

Turmeric possesses both primary and secondary rhizomes that are available in various forms such as globular, slightly conical, hemispherical, and its observable characteristic. Physico-functional properties includes the length, breadth, bulk density, true density, porosity, particle size analysis, pH and water absorption capacity, all which are usually determined using various formulas and instruments (Balasubramanian and Viswanathan, 2010). It is also known as “Indian saffron”, as it was broadly used as a substitute to the costlier saffron spice (Tanzeela et al., 2015).

In Nigeria, turmeric is cultivated in the homestead gardens in about nineteen (19) states where they bear different names such as ‘‘Osun’’, ‘‘Ata-Ile’’ and it serves different purposes. In Ebonyi and Enugu States, it is used for treatment of malaria and circumcision. People of Benue State use fresh turmeric for marking of yams while Kastina State inhabitants use it for decoration. Ekiti State uses turmeric rhizome plants for curing ailments like malaria, thyphoid and yellow fever (Olojede, 2005).

Physico-functional properties of turmeric plants are important for any elaborate study, design or operation of the millers. Turmeric most times has irregular shapes and sizes, pretreatment such as peeling has proved to cause damage to the sample and as well caused wastage. In order to improve the operation of the existing millers by retrofit combustion system or to design a new system all together will need the physic-functional properties of the

rhizome plant as the basic data (Athmaselvi and Varadharaj, 2002). The physical properties will aid in the design of appropriate machinery for processing of *a* turmeric rhizome plant that will help minimize losses of the needed and useful components (peels and stem-bark) that could be of health benefit (functional properties), and as well function as a substitute for artificially produced drugs.

This study was conducted to determine the physical properties of turmeric rhizome grown in Ekiti state, evaluate the functional properties of turmeric powder and reveal the industrial applications of these properties.

MATERIALS AND METHODS

Plant materials

Samples were obtained from the three agricultural/senatorial districts, Ekiti Central (Ado Ekiti), Ekiti North (Ikole Ekiti) and Ekiti South (Omuo Ekiti) of Ekiti State, Nigeria. Selection of these areas is based on similarity in cultural practices and because turmeric is commonly grown, consumed and marketed in the selected areas. Analysis was carried out at the Department of Food Science and Technology Laboratory, Federal University Oye, Ekiti State, Nigeria.

Preparation of turmeric powder

The rhizome plant was sorted to remove unwanted contaminants like sands, dust, straws, stones and other unwanted foreign materials. The turmeric rhizome plant was then washed with water in a big clean container to further remove contaminants. The washed turmeric plant was passed over a sieve to remove droplets of water remaining in the wet samples. The already drained turmeric rhizome plant was oven dried at temperature of 60°C for 4 to 5 hours. The dried plant sample was milled using a blender (JTC Omniblend V, Model; TM 800) to communite it to coarse or fine particles usually in powdery form. The milled sample was passed through sieves to separate the coarse particles from the fine particles. Figures 1 and 2 show the flow diagrams for the preparation of unpeeled and peeled turmeric powder respectively from turmeric rhizome.

Physical properties of turmeric rhizome

Turmeric rhizome samples were measured with the aid of a vernier caliper as described by Giami and Bekebain (1992).

True density

The true/tapped density (ρt) of the turmeric rhizome plant is the ratio of the rhizome mass to its pure volume using

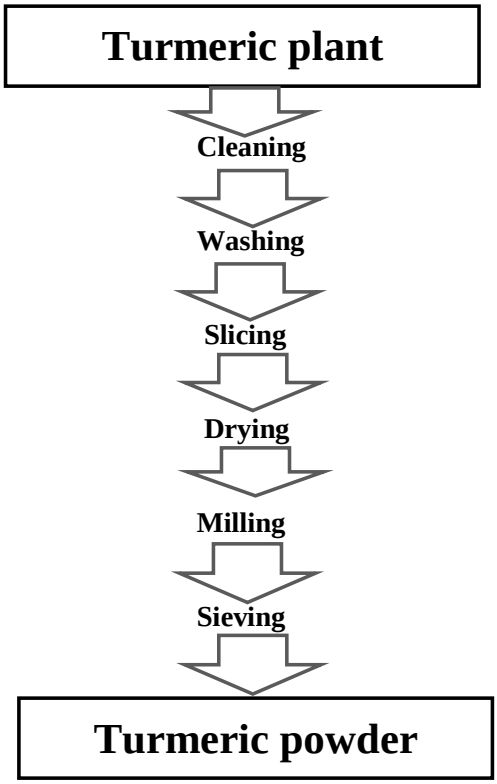

Figure 1. Flow chart for the production of unpeeled turmeric powder.

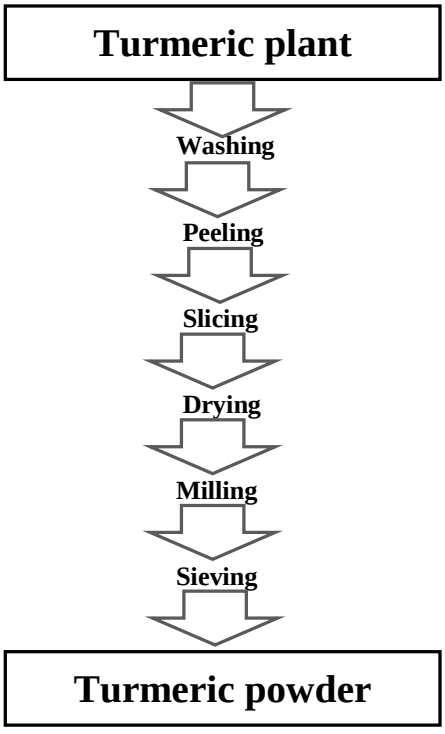

Figure 2. Flow chart for the production of peeled turmeric powder.

pycnometer (Hymipyc and make IQI, USA), and was determined by method of Balasubramanian and Viswanathan (2002)

Bulk density

Plant bulk density (ρb), which is the ratio of the mass to its bulk volume of the turmeric rhizome was determined by method described by AOAC (2005).

Porosity

Porosity is the percentage of volume of voids in the test sample at given moisture content. It was calculated as ratio of the difference in the true and bulk densities to true plant density and determined by the expression as reported by Sereno et al. (2007) as:

$$\text{Porosity } \% = 1 - \frac{\text{Bulk density}}{\text{True density}} \text{x} 100$$

Particle size analysis

The particle size determination analysis was carried out to obtain the total quantity of samples passing through each sieves and the quantity retained in the sieves, while expressed in percentage. The milled turmeric samples were passed through three different sieves of different mesh sizes of 425, 180 and 125 micron. These three sieves were shaken under a mechanical shaker that separated the milled samples into texture fraction in term of its finest and coarseness (British Pharmacopoeia).

$$\text{Total percentage retained} = \frac{\text{Total percentage passing through the sieves}}{\text{Total weight of the sample}} x100$$

Functional properties

Water absorption capacity (WAC)

Water absorption of the samples was determined by a modification of the method described by Tsai et al. (1998). A sample (2g) of milled turmeric powder was transferred into a weighed centrifuge tube and 10 ml of distilled water will be added. Using a glass stirring rod, the sample and water was mixed thoroughly for 30 s every 10 min over a period of 30 min. The flour particles that adhered to the side of the centrifuge tube were scrubbed down with the stirring rod to prevent it from drying. The suspension was centrifuged (MSE Harrier 15/80, Sanyo, UK) at 4500 g for 20 min. The supernatant was decanted, and the tubes were allowed to drain at a 45° angle for 10 min and then be weighed. Water absorption was expressed as percentage increase of the sample weight.

$$\%\text{WAC} = \frac{\text{Final weight of sample} - \text{Initial weight of sample}}{\text{Initial weight of sample}} \times 100$$

pH determination

pH values of the turmeric formulations was determined using a pH meter, the general rules for preparation (amrita.olabs.edu.in, 2013).

RESULT AND DISCUSSION

Table 1 shows the physical properties of turmeric rhizomes and functional properties of turmeric powder. The results obtained for physical properties range from 0.44±10.02 to 0.62±11.01 g/cm^3, 0.45±0.10 to 0.63±0.10 g/cm^3, 1.59±0.10 to 2.22±0.09%, 5.50±0.04 to 8.00±0.04 mm and 1.60±0.03 to 1.90±0.03 mm for bulk density, true density, porosity, length and breadth respectively. The average length of the turmeric samples grown and marketed in Ado Ekiti, Ikole Ekiti and Omuo Ekiti were 5.50±0.04 mm, 7.60 ± 0.04 mm and 8.00 ± 0.04 mm respectively.

According to Balasubramanian and Viswanathan (2010), the values obtained for the lengths of turmeric rhizome in India were 30.38±1.41, 40.57±1.79, 50.60±4.79 mm for three different grades of Grade I, Grade II and Grade III respectively. The results were high when compared to the values obtained for the length of turmeric stated. However, there is no much trend of difference in the breadth (1.60±0.03 mm) for sample from Ado Ekiti, sample (1.80±0.03 mm) obtained from Ikole Ekiti and sample (1.90±0.03 mm) obtained from Omuo Ekiti. The values obtained for the breadth of turmeric rhizome sample analyzed in India were 10.64±0.69 mm, 9.77±1.07 mm and 9.94±2.67 mm respectively as reported by Balasubramanian and Viswanathan (2010), these values were very high when compared to the values obtained in this study. This difference may be attributed to differences in the varieties studied and that reported by these authors.

The bulk density and true density for the unpeeled processed in Ado Ekiti, Ikole Ekiti and Omuo Ekiti were (0.44±10.02 g/cm^3, 0.52±10.00 g/cm^3, 0.47± 0.00 g/cm^3) and (0.45±0.10 g/cm^3, 0.53±0.09 g/cm^3, 0.48±0.10 g/cm^3) respectively and the peeled processed in Ado Ekiti, Ikole Ekiti and Omuo Ekiti were (0.50±10.01 g/cm^3, 0.62±11.01 g/cm^3, 0.53±10.00 g/cm^3) and (0.51±0.10 g/cm^3, 0.63±0.10 g/cm^3, 0.54±0.10 g/cm^3) respectively. The values for bulk density and true density as reported by Balasubramanian and Viswanathan (2010), were (0.348±6.30, 0.291±7.94, 0.260±5.11g/cm^3) and (1.354±7.89, 1.341±6.80, 1.349±5.47g/cm^3) respectively were in line with values obtained in this study. However, it should be noted that the bulk density and true density

Table 1. Physical properties of turmeric rhizomes and functional properties of turmeric powder.

Parameters	Ado Ekiti		Ikole Ekiti		Omuo Ekiti	
	Unpeeled	Peeled	Unpeeled	Peeled	Unpeeled	Peeled
Bulk density (g/cm^3)	0.44±10.02^b	0.50±10.01^a	0.52±10.00^b	0.62±11.01^a	0.47±10.00^b	0.53±10.00^a
True density (g/cm^3)	0.45±0.10^b	0.51±0.10^a	0.53±0.09^b	0.63±0.10^a	0.48±0.10^b	0.54±0.10^a
Porosity (%)	2.22±0.09^a	1.96±0.10^b	1.89±0.09^a	1.59±0.10^b	2.08±0.10^a	1.85±0.10^b
pH	7.36±0.10^a	7.04±0.10^a	7.41±0.09^a	6.72±0.10^b	7.24±0.10^a	6.93±0.11^b
WAC (%)	42.94±0.10^b	45.91±0.10^a	35.82±0.10^b	51.25±0.09^a	30.84±0.10^b	41.04±0.10^a
Sieve 425 mic (%RT)	87.37±0.10^a	82.11±0.10^b	71.72±0.10^b	82.83±0.10^a	77.78±0.10^b	81.44±0.10^a
Sieve 180 mic (%RT)	9.47±0.10^b	14.74±0.10^a	26.26±0.10^a	15.15±0.10^b	16.16±0.10^a	15.46±0.10^b
Sieve 125 mic (%RT)	3.16±0.10^a	3.16±0.10^a	2.02±0.10^a	2.02±0.10^a	6.06±0.10^a	3.09±0.10^b
Length (mm)	5.50±0.04	5.50±0.04	7.60±0.04	7.60±0.04	8.00±0.04	8.00±0.04
Breadth (mm)	1.60±0.03	1.60±0.03	1.80±0.03	1.80±0.03	1.90±0.03	1.90±0.03

Values are mean± SD of duplicate determinations. data with the same parenthesis are not significantly different (p>0.05).

differed with processing methods and locations. Peeled turmeric powder had high bulk density and true density values (0.62±10.00 and 0.63±0.10 cm^3) from samples grown at Ikole Ekiti.

Porosity value for the samples from different locations and the processing methods ranged from 1.59±0.10 to 2.22±0.10%. The values obtained were very low when compared to the values obtained for the three grades (74.53±0.64, 78.75±0.21, 80.93±0.42%) as reported by Balasubramanian and Viswanathan (2010). However, porosity of turmeric did not show any trend with dimension. The particle size determination was carried out using different sieves with different mesh sizes. Sieve A (425 micron) which had the largest mesh size had values ranging from 71.72±0.10 to 87.37±0.10% for the unpeeled processed in all the locations and also ranged from 81.44±0.10 to 82.11+0.10% for the peeled processed samples in all location. Sieve B (180 micron) had values ranging from 9.47±0.10 to 26.26±0.10% for unpeeled processed sample and as well ranged from 14.74±0.10 to 15.46±0.10% for peeled processed in all location. Sieve C (125 micron) which had the smallest mesh size, also had values ranging from 2.02±0.10 to 6.06±0.10% for unpeeled processed samples and ranging from 2.02±0.10 to 3.16±0.10% for processed samples. The percentage retained for each sieve accumulated to 100% for each processing method with different locations.

The pH value ranged from 6.72±0.10 to 7.41±0.09. The peeled processed sample grown in Ikole Ekiti had a pH value of 6.72±0.10 while the unpeeled processed had the pH value of 7.41±0.09. Samples grown in Ado Ekiti had pH values of 7.36±0.10 for unpeeled processed while the sample processed with the peels had pH value of 7.04±0.10. The sample grown in Omuo Ekiti had pH values of 7.24±0.10 for the unpeeled processed powder and the peeled processed powder had pH value of 6.93±0.11. These values were higher when compared to pH values for ginger spiced yoghurt (4.7), carrot flavored yoghurt (4.7), pineapple flavored yoghurt (4.5) and pepper fruit spiced (4.7) as reported by Ihemeje et al. (2015) because these were all fermented products.

Peeled processed turmeric powder grown at Ikole Ekiti had the highest water absorption capacity of (51.25±0.09) and unpeeled processed turmeric powder grown at Omuo Ekiti had the lowest value (30.84 ± 0.10). The results showed that the peeled samples from different location of Ado Ekiti (45.91±0.10), Ikole Ekiti (51.25±0.09) and Omuo Ekiti (41.04±0.10) had highest values of water absorption capacity which could probably be due to the texture of the milled particles and the soil type of the regions in which the turmeric plant was grown. This trend agrees with the report of Oladimeji (2007) on dikanut milled particles.

Conclusion

Turmeric rhizome has better physical properties and this could aid in the design of appropriate machinery for processing of rhizome plant and will help minimize losses to the needed and useful components (peels and stem-bark). The WAC of turmeric powder makes it useful as a health supplement through inclusion in snacks and other bakery products. It may also be suggested that the functional properties of this turmeric powder can also serve as substitute to artificially produced drugs.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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