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Some Properties of Ginger Crop for a Digger Development

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Abstract Some physical engineering properties of ginger crop were determined for designing of a digger. The moisture content of ginger varieties vary between 81.4 to 85.11%. The sample was selected for determination of linear dimensions, geometric mean diameter, bulk density, surface area and sphericity and load required for crushing and cutting of ginger crop. The mean length of 69.38, 75.67 and 106.22 mm; mean width of 41.1, 44.04 and 58.4 mm; and thickness of 19.2, 23.13 and 28.64 mm was found to be for variety Suruchi, Mahima and Suprabha, respectively. The mean of the GMD and sphericity for these varieties was found to be of 36.62, 40.99 and 54 mm; and 0.55, 0.55 and 0.51, respectively. The average load required for crushing and cutting of the ginger crop was 540.75 and 96.96 N for Suruchi, 565.73 and 101.62 for Mahima and 602.93 and 104.3 N for Suprabha variety, respectively.

Keywords Length, Width, Variety, Crushing resistance, Cutting resistance.

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Introduction

India is konwn as The home of spices. In the world, India is one of the countries that produce so many kinds of spices in different climates. The climate of the country is suitable for almost all type of spices. In agricultural commodities, spices constitute an important group of which are virtually indispensable in the culinary art. In India, spices are used from both domestic consumption and export point of view. Besides, huge quantities of spices are also being consumed with the country for flavoring foods and are also used in an medicine, pharmaceutical, perfumery, cosmetics and several other industries. Among the spices, ginger is an important crop grown in India. Ginger is also an important foreign exchange earning crop. Ginger is one of the earliest known oriental spices and is being cultivated in India both as a fresh vegetable and as a dried spice since time immemorial. It is used in different forms such as raw ginger, dry ginger and processed ginger. Ginger is spice and medicinal plant gaining attention in the pharmaceutical, food and chemical industries. A remarkable increase in the use of medicinal plant and their products has been observed in the past decade. Due to their properties, medicinal plants are used as primary health care aid among 80% of the World's population in the form of plant extracts or their active

components (WHO 2008). In India the production of ginger crop was found to be 107 million tonne with an area of 0.168 million hectare (NHB 2017) .

The harvesting of ginger depends upon maturity and the ultimate use. In ginger, lifting up the clumps carefully with the help of a digging fork or a spade or even with bare hands does harvesting, and the rhizomes are separated from the dried up leaves. Mechanical harvesting has been introduced in many countries. To introduce the proper mechanical harvesting for ginger crop, the study of some engineering properties are necessary. Based on these properties, the soil separating unit and other part of digger was design and developed for harvesting of ginger crop timely.

Materials and Methods

The present study was conducted in year 2016 at Department of Farm Machinery and Power Engineering, JNKVV, Jabalpur, Madhya Pradesh. In this study 3 variety viz, Suruchi, Mahima and Suprabha of ginger crop was selected. The engineering properties of ginger crop like physical properties (length, width and thickness), shape, size, color, volume, bulk density, sphericity, weight, surface area, moisture content, coefficient of static friction and crushing and cutting resistance were deternined. For each property, 25 samples wewre selected.

Dimensions, of ginger rhizome

Twenty five pieces of ginger rhizome was randomly chosen for measuring dimensions viz. length, width and thickness. Each rhizome was measured using vernier caliper (least count 0.01 cm). The observations were made to get average values of length,width and thickness of the ginger rhizome.

Bulk density

Bulk density of ginger rhizomes was calculated by ratio of the weight of ginger rhizomes on its estimated volume. The volume was measured using a density iron box having the dimensions of 3723.87 cm^3 in which the bulk ginger rhizome was put in the box,20 replications were taken to measure the bulk density.

Moisture content

Moisture content was determined on wet basis (w.b). The ginger crop was cut in thin slices of 3-4 mm and weighted on electronic balance to a precision of 0.01 g, then dried in oven to a constant weight at 60 ± 2^0C (AOAC 1999).

Geometric mean diameter (GMD)

The geometric mean diameter for the 25 rhizomes was determined by measuring the dimensions of length (L), width (W) and thickness (T) (Mohsenin 1986). The equation is given below :

$$\text{Geometric mean diameter (GMD)} = (LWT)^{1/3} \quad .....1$$

Sphericity (S) is defined as the ratio of the surface area of a sphere having the same volume as the rhizome to the surface area of the rhizome. The shape of a food material is usually expressed in terms of its sphericity. It is an important property used in fluid flow and heat and mass transfer calculations. Sphericity was determined using the measured geometric dimensions (Eqn 2).

$$\text{Sphericity} = \frac{GMD}{L} \quad .....2$$

Surface area and volume are measured by using the geometric mean diameter (GMD), the surface area and volume of ginger rhizome were calculated as given in the following equations 3 and 4.

$$\text{Surface area} = \pi\, GMD^2 \quad .....3$$

$$\text{Volume} = \frac{\pi}{6}\, GMD^3 \quad ..... 4$$

Coefficient of static friction

The coefficient of static friction (μ_S) of ginger was determined by inclined plane method. The samples were filled in a container of dimension 15× 15 × 15 cm and placed on the different test surface. The test surfaces viz. mild steel, stainless steel, plywood, aluminum and GI iron sheet used were used for the study. The horizontal surface was tilted up until the samples begin to slide downward on the surface. The angle of inclination of test surface with the ground

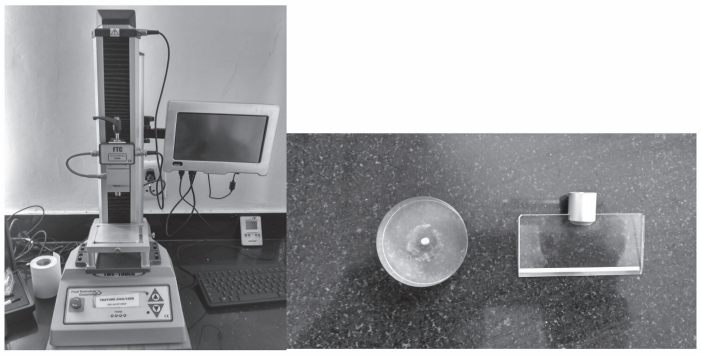

Fig. 1. Texture analyzer with cutting and crushing probe.

surface was measured by a protractor and considers it as an angle of internal friction. The tangent of angle was taken as coefficient of friction between surface and sample (Ghaffari et al. 2013).

$$\mu_S = \tan \theta$$

Where, μ_S = Coefficient of static friction and θ = Angle of inclination of material surface, degrees.

Measurement of crushing and cutting resistance of ginger crop

It was analyzed by measuring peak force (N) required to overcome the resistance to the compression/cutting, imposed by the sample to the cylindrical metalprobe with test speed of 1 mm/s. The crushing strength of fresh products (approximate samedimension piece) was determined in replicated trials for each sample.

The texture analyzer (The TMS-Touch texture nalyzer) consisted of a crushing and cutting probe, Fig.1 fixed at the lower end of the load cell. There is a base plate, fixed at the lower end of the texture analyzer. The ginger crop was kept horizontally on the base plate such that the point of crushing and cutting was on the center of the sample. The rupture distance was kept as 10 mm and force was measured in cutting and compression. After setting the machine, the crop sample was kept on the base plate; the crushing probe moved in the downward direction and crushed at center of sample. The peak force was obtained with the help of computer attached to the texture analyzer. The experiment was repeated 10 times for cutting and crushing of the crop and average value was calculated.

Results and Discussion

Physical properties of ginger crop

Table 1 shows the physical properties of turmeric crop of 3 varieties of which samples were used in the laboratory and evaluated for development of a digger.

Linear dimension

The length range of variety Suruchi, Mahima and Suprabha was found to be 37.31-115.2, 42.71-107.6 and 76.89-145.28 mm; and for width the range of 22.33-66.21, 24.16-63.28 and 41.72-78.49 mm and for thickness the range of 15.37-24.5, 16.35-29.13 and 21.38-36.75 mm with the mean for length of 69.38, 75.67 and 106.22 mm; and for width of 41.1, 44.04 and 58.4 mm; and for thickness of 19.2, 23.13 and 28.64 mm, respectively. The standard deviation (SD) and coefficient of variance (CV) for variety Suruchi, Mahima and Suprabha was found to be 23.41, 18.72 and 16.85; and 33.74, 24.74 and 15.86 for length and 11.22, 10.39 and 9.21; and 27.3, 23.59 and 15.77 for width and 2.68, 3.92 and 3.83; and 13.97, 16.93 and 13.37 for thickness, respectively.

Geometric mean diameter

The range of the geometric mean diameter for variety Suruchi, Mahima and Suprabha was found to be

Table 1. Physical properties of ginger crop.

Particulars	Variety	Length,mm	Width,mm	Thickness, mm	Geometric mean diameter, mm	Sphericity	Surface area, mm^2	Bulk density kg/m^3
	Suruchi	37.31-115.20	22.33-66.21	15.37-24.50	24.10-53.58	0.43-0.88	1823.76-9013.67	391.26-431.14
Range	Mahima	42.71-107.60	24.16-63.28	16.35-29.13	29.22-55.57	0.45-0.68	2680.88-9596.58	384.28-419.99
	Suprabha	76.89-145.28	41.72-78.49	21.38-36.75	43.48-64.54	0.43-0.58	5936.28-13080.63	380.52-412.74
	Suruchi	69.38	41.10	19.20	36.62	0.55	4315.36	410.77
Mean	Mahima	75.67	44.04	23.13	40.99	0.55	5339.57	402.48
	Suprabha	106.22	58.40	28.64	54.00	0.51	9156.94	395.05
	Suruchi	23.41	11.22	2.68	7.95	0.1	1919.55	10.29
SD	Mahima	18.72	10.39	3.92	7.23	0.06	1892.87	10.47
	Suprabha	16.85	9.21	3.83	5.72	0.04	1928.17	12.00
	Suruchi	33.74	27.3	13.97	21.7	19.02	1716.93	2.50
	Mahima	24.74	23.59	16.93	17.63	11.06	1823.82	2.60
CV%	Suprabha	15.86	15.77	13.37	10.60	7.47	1894.75	3.04

24.1-53.58, 29.22-55.57 and 43.48-64.54 mm with the mean of 36.62, 40.99 and 54 mm, respectively. The standard deviation (SD) and coefficient of variance (CV) was 7.95, 7.23 and 5.72; and 21.7, 17.63 and 10.6 for variety Suruchi, Mahima and Suprabha, respectively.

Sphericity

The range of the sphericity of variety Suruchi, Mahima, and Suprabha was found to be 0.43=0.88, 0.45-0.68 and 0.43—0.58 with the mean of 0.55, 0.55 and 0.51, respectively. The standard deviation (SD) and coefficient of variance (CV) of sphericity was found to be 7.95, 7.23 and 5.72 and 21.7, 17.63 and 10.6 for the variety Suruchi, Mahima and Suprabha, respectively.

Surface area

The range of the surface area of variety Suruchi, Mahima and Suprabha was found to be 1823.76-9013.67, 2680.88-9596.58 and 5936.28-13080.63 mm^{-2} with the mean of 4315.36, 5339.57 and 9156.94 mm^{-2}, respectively. The standard deviation (SD) and coefficient of variance (CV) of surface are was found to be 1919.55, 1892.87 and 1928.17; and 1716.93, 1823.82 and 1894.75 for the variety Suruchi, Mahima and Suprabha, respectively.

Bulk density

The range of the bulk density of variety Suruchi, Mahima and Suprabha was found to be 391.26-43.14, 384.28-419.99 and 380.52-412.74 kg m^{-3} with the mean of 4315.36, 5339.57 and 9156.94, respectively. The standard deviation (SD) and coefficient of variance (CV) of bulk density was found to be 10.29, 10.47 and 12; and 2.5, 2.6 and 3.04 for the variety Suruchi, Mahima and Suprabha, respectively.

Crushing and cutting resistance

The crushing and cutting resistance of 3 varieties was measured by crushing and cutting probe as shown in Fig. 1. The mean of crushing and cutting load was found to be 540.75, 565.73 and 602.93 N as shown in Table 2 for varieties Suruchi, Mahima and Suprabha, respectively.

Table 2. The crushing and cutting resistance of different varieties.

Particulars	Variety	Crushing resistance, N	Cutting resistance, N
	Suruchi	249.4-727.9	78.3-126.6
Range	Mahima	269.9-749.6	83.9-117.2
	Suprabha	296.9-817.9	86.7-125.0
	Suruchi	540.75	96.96
Mean	Mahima	565.73	101.62
	Suprabha	602.93	104.30
	Suruchi	165.63	15.45
SD	Mahima	162.42	11.56
	Suprabha	195.98	13.91
	Suruchi	30.63	15.94
CV%	Mahima	28.71	11.38
	Suprabha	32.50	13.34

Coefficient of static friction

The coefficient of static friction for plywood, mild steel (MS), aluminium, galvanized iron (GI) and stainless steel was found to be 0.39, 0.53, 0.40, 0.49 and 0.37 for Suruchi variety; 0.37, 0.56, 0.38, 0.45 and 0.35 for Mahima variety and 0.32, 0.54, 0.36, 0.44 and 0.33 for Suprabha variety, respectively.

References

AOAC (1999) Official Methods of Analysis of the Association of Official Analytical Chemists Washington DC, pp 211.

Ghaffari H, Marghoub N, Sheikhdarabadi MS, Hakimi A, Abbasi F (2013) Physical properties of 3 Iranian onion varieties. Int Res J Appl Basic Sci 7 (9) : 587—593.

Mohsenin RN (1986) Physical Properties and Animal Materials. Gordon and Breach Science Publishers, New York.

World Health Organization (2008) Traditional medicine.

NHB (2017) Indian Horticulture Data Base 2017. Min of Agric, Govt of India, Gurgaon.