Original Research Article

Physical and Engineering Parameter of Garlic Clove

ABSTRACT

Garlic is nature's most versatile medicinal plant and it is primarily used as a flavoring agent in cooking. It is the second most important spice after the onion. The physical parameter of garlic performs a crucial role in context designing of conveying systems and metering units. The prime aim of study was to evaluate the physical and engineering parameters of garlic cloves. The physical parameters garlic cloves found in terms of average length, width, thickness, Geometric mean diameter, sphericity and bulk density were 27.78 mm, 11.60 mm, 9.26 mm, 14.23 mm , 0.52 and 554 to 592 kg/m^3. Angle of repose for garlic clove was found as 45.6 and 36.8^o for wood and G.I. sheet.

Keywords: *Garlic clove, Physical and Engineering parameter, Bulk density.*

1. INTRODUCTION

Garlic (Allium Sativum) can rightfully be called one of nature's wonderful plants with healing power. The most profitable species of the Allium genus and a significant vegetable crop world-wide is garlic (Allium sativum L.). Garlic's medicinal value has been known since 3000 B.C., when it was used primarily for the treatment of cardiac disorders, arthritic disease, lung complaints, abdominal growths (particularly uterine), infections of the lungs, skin diseases, signs of ageing, vomiting, headaches, bites, worms, wounds, mouth ulcers, and tumours. Other ancient civilizations that used the garlic included the Egyptians, Babylonians, Greeks, Indians, Romans, and Chinese (Rahman et. al. 2007). Garlic is considered as a functional spice because of its diverse array of nutritional constituents, phytochemicals, and fiber. It contains high levels of potassium, phosphorus zinc, and sulfur, moderate levels of selenium, calcium, magnesium, manganese, iron, and low levels of sodium, vitamin A and C and B-complex. The garlic has sulfur containing compounds such as alliin, allicin, ajoene, allylpropyl disulfide, and enzymes such as allinase, peroxidase, myrosinase), and other compounds, such as β-phellandrene, phellandrene, citral, linalool, and geraniol. (Ansary *et.al.*, 2020).

FOA reports that the total world garlic production in 2020 reached 28 million tons that were harvested from 1.6 million hectares area. India stands second in area and production of garlic in

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the world and area covered under the garlic cultivation was 0.352 Million ha and production was 2925 MT in 2019-20 (Anon, 2021). In the production of garlic, Madhya Pradesh, Rajasthan, Uttar Pradesh, Gujarat, Punjab and Assam had a major share and accounted for 63.92, 14.23, 7.11, 3.23, 3.17 and 2.31% of the total production, respectively in 2019-20 (NHB, 2021).

Garlic is a perennial plant of the Liliaceae family and vegetatively propagated using clove. The garlic crop has great impacts on the profitability of farmers. Today, the area under garlic cultivation has declined due to many reasons. A holistic comparison of decadal growth of the area of garlic, in 1990-91 to 1999-00, 2000-01 to 2009- 10 and 2010-11 to 2016-17 it was positive i.e. 4.29, 9.69 and 5.92 %, respectively. But, in production, all the decadal growth of the garlic was positive. In case of yield, the decadal growth 1990-91 to 1999-00 and 2000-01 to 2009-10 was positive but in 2010-11 to 2016- 17 it was negative (Sachin et al. 2019). The decadal growth rate decreases but profit margin from the crop has been discouraging to farmers. In past decades, the contribution of agricultural labor in total power availability declined from 14.7 % to 4.6% in 1960-61 to 2013-14, respectively (Singh et. al. 2014). The garlic cultivation had increased, it increased the labor requirement. The labour hiring charges increase during the peak of period planting. The manual planting of garlic consumes a major share of cost of production. These challenges are discouraging the farmers, therefore they need the mechanization in garlic cultivation along with appropriate planting methods.

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The physical properties of a crop can be used as a basis to support the development of agricultural machinery. It was useful to design the suitable metering device and the proper hopper dimensions of the garlic planting machine. Also, the operational parameters of planting machines such as forward speed and clove failing height relate with garlic clove properties. It is responsible for the simulation and discharging of clove for planting. To reduce the rates of missing plants and multiple plants, an optimal design that considers the performance index of the metering device is necessary. In the attempt to mechanize garlic planting, research has been conducted to characterize the physical properties of garlic clove.

The physical and engineering parameters have a key role in designing of conveying systems into the processing industry, supply chain management and material handling. To mitigate these challenges, the investigation was conducted for physical and engineering parameters.

2. MATERIALS AND METHODS

The physical parameter of the garlic clove tends to be influenced by the variety of garlic. Its physical and engineering parameters had been determined in terms of the bulk density, linear dimension, Geometric mean diameter, sphericity and angle of repose.

Experiment side

The experiment was conducted in the department of Farm Machinery and Power Engineering, Vaugh Institution Agricultural Engineering and Technology, SHUATS, U.P. The physical and engineering parameters of garlic clove had been determined. The variety used for the determined parameter was Yamuna Safed-3 (G-282). The garlic variety is most suitable for the north and central parts of India, including Punjab, Haryana, Uttarakhand and Uttar Pradesh as per commendation of ICAR.

2.1 Linear dimension

The Linear dimensions (length, width and thickness) of hundred garlic cloves per replication were determined using a vernier caliper with an accuracy of 0.02 mm (Mohsenin, 1970 and Bahnasawy, 2007).

2.2 Geometric mean diameter

The geometric mean diameter (D_g) of the garlic cloves was calculated using Equation Geometric mean diameter, (Mohsenin,1986 and Bahnasawy, 2007)

$$(D_g) = (D_e\, D_p\, T)^{0.333}$$

Where, D_g = Geometric mean diameter, (cm)

D_e = Equatorial diameter, cm

D_p = polar diameter, cm

2.3 Sphericity

The sphericity of the garlic cloves was calculated using following Equation (Bakhtiari, 2015)

$$\text{Sphericity} = \frac{Dg}{L} = \frac{(LMT)^{1/3}}{L}$$

2.4 Angle of repose

It is an angle of friction taken up by garlic clove to slide itself. A wooden 250 x 250 x 250 mm box with a removable front panel was used to estimate it. The box was filled with garlic cloves and mounted at the tilting top of the drafting table. The front panel was removed, and the tabletop was gradually tilted until the garlic clove began to move and leave the inclined surface. The repose angle was measured as the angle between the base and inclined frame for the sample. It was measured for wood and iron sheet surfaces for sample (Mohsenin, 1986 Olajide *et al.* 2000 Tabatabaeefar, 2003, and Mohsen, *et.al.* , 2014)

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2.5 Bulk density

The bulk density is a ratio of mass of the sample to its volume. It was measured using the acrylic cylinder. It completely filled up with garlic cloves and weighed it using weighing balance with least of count 0.01gm. The mean of three replications were considered as bulk density of garlic.

$$\text{Bulk density} = \frac{M_c}{V}$$

Fig. 1 Garlic cloves

3. RESULTS AND DISCUSSION

3.1 Physical parameters of garlic

The engineering parameter of garlic clove is playing a crucial role in the design of planting machinery for sowing of garlic. The properties of garlic clove are as linear dimensions, geometric mean diameter, arithmetic mean diameter, shape index and angle of repose. The linear dimension includes the length, width and thickness of garlic clove. The number of the garlic cloves was 100 selected for measurement.

3. 2. Bulk Density for Garlic Clove

The bulk density of the garlic clove was determined as per the methodology used. The average bulk density of the garlic cloves was found as 554 to 592 kg/m^3.

Physical properties of garlic

The length of garlic clove ranged from 2 0 to 38.6 mm with mean value of 27.78 mm. The SD and CV were calculated to be 4.09 to 14.28, respectively. The width of garlic cloves ranged from 7.5 to 17.2 mm along with a mean value of 11.60 mm. The SD and coefficient of variation was calculated to be 1.81 and 15.59, respectively. The thickness of garlic cloves ranged from 6.6 to 17.8 mm with mean value of 9.26 mm. The SD and coefficient of variation was calculated to be 1.55 to 16.95, respectively. The geometric mean diameter of garlic clove ranged from 10.59 to 19.21 mm along with a mean value of 14.23 mm. The SD and coefficient of variation was 1.90 to 13.39, respectively.

The sphericity of garlic cloves ranged from 0.44 to 0.83 along with a mean value 0.52 for an average of 100 garlic cloves. The SD and coefficient of variation were calculated to be 0.05 and 9.27, respectively.

Table 1 Physical properties of garlic

	Length, mm	**Width, mm**	**Thickness, mm**	**Linear Dimension, mm**	**Geometric mean Diameter, mm**	**Spericity**
Min	16.8	7.5	6.6	10.34	10.59	0.44
Range (Max)	36.8	17.2	13.8	18.66	19.21	0.83
Mean	27.54	11.6	9.13	13.85	14.23	0.52
SD	4.09	1.81	1.55	1.84	1.90	0.05
CV %	14.84	15.59	16.95	13.25	13.39	9.27

Angle of repose

The experimental result reveals the angle of repose for garlic clove with varying the two surfaces as wood and G.I. sheet. It was found as 45.6 and 36.8^o for wood and G.I. sheet respectively.

The various properties that are measured will be useful in the design of equipment and processes, which will help to increase the product's yield and quality.

4. CONCLUSIONS

The goal of the research was to measure the physical and engineering parameter of garlic clove, it is directly responsible for singulation of seed during the metering process. Design and construct the appropriate metering unit for planting machines. The metering unit is called the heart of the planter.

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