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Engineering properties of finger millet (*Eleusine coracana* L.) grains

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ABSTRACT : Some physical properties of finger millet (*Eleusine coracana*) grains were determined at the moisture content of 14.16 per cent (d.b.). The size, sphericity, surface area, mass of 1000 grains, volume of 1000 grains, true density, bulk density and porosity were 1.13 mm, 0.98, 4.15 mm^2, 2.87 g, 2171 mm^3, 1293 kg m^3, 803 kg/m^3 and 37.79 per cent, respectively. The frictional properties of the finger millet grains *viz.*, angle of repose, coefficient of internal friction and coefficient of external friction were also determined and the values were 29.09^o, 0.63 and 0.48, respectively. The terminal velocity of the grains was 2.94 ms^{-1}.

KEY WORDS : Finger millet, Friction, Porosity, Terminal, Velocity

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Finger millet (*Eleusine coracana* L.) is also known as African millet, Koracan, Ragi (in India), Bulo (Uganda), Wimbi (Swahili) and Telebun (Sudan). It is an important cereal crop for subsistence agriculture in the dry areas of Eastern Africa, India and Srilanka. India is one among the major cereal producing countries in the world. The finger millet production is 4.5 million tonnes in the world. In India, it is cultivated over an area of 2.65 million ha with total production of about 2.9 million tonnes. It is widely grown in Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Gujarat and Maharashtra and in the hilly regions of Uttar Pradesh, Sikkim and Himachal Pradesh.

Finger millet has outstanding properties as subsistence food crop. Its small seeds can be stored safely for many years without insect damage. Finger millet especially valuables as it contains essential amino acid methionine which lacking in the diets of hundreds of millions of the poor who live on starchy staples such as cassava plantain, polished rice or maize as a meal. The presence of all the required nutrients in millet make them suitable for large scale utilization in the manufacture of baby food, snack foods, dietary food etc. from grain, kernel and flour (Subramanium and Viswanathan, 2007).

Physical and engineering properties are important in many problems associated with the design of machines and the analysis of the behaviour of the product during agricultural process operations such as handling, planting, harvesting, threshing, cleaning, sorting and drying. Solutions to problems in these processes involve knowledge of their physical and engineering properties (Irtawange, 2000).

Bulk density, true density, and porosity (the ratio of inter granular space to the total space occupied by the grain) can be useful in sizing grain hoppers and storage facilities; they can affect the rate of heat and mass transfer of moisture during aeration and drying processes. Grain bed with low porosity will have greater resistance to water vapour escape during the drying process, which may lead to higher power to drive the aeration fans. Cereal grain kernel densities have been of interest in breakage susceptibility and hardness studies (Ghasemi *et al*., 2008). Flow ability of agricultural grains is usually measured using the angle of repose. This is a measure of the internal friction between grains and can be useful in hopper design, since the hopper wall's inclination angle should be greater than the angle of repose to ensure the continuous flow of the materials by gravity. The static coefficient of friction is used to determine the angle at which chutes must be positioned in order to achieve consistent flow of materials through the chute. Such information is useful in sizing motor requirements for grain transportation and handling (Ghasemi *et al*., 2008). Many researchers have been determined the properties of different agricultural produces like millet (Baryeh, 2002; Subramanium and Viswanathan, 2007), moth gram (Nimkar *et al*., 2005), sesame seed (Akintunde and Akintunde, 2004), sunflower seed (Gupta *et al*., 2007), Baryeh (2002) studied about the properties of pearl millet, Subramanium and