

## EFFECT OF MOISTURE CONTENT ON PHYSICAL PROPERTIES OF SUNFLOWER SEEDS

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### ABSTRACT

A study was conducted to determine the effect of moisture content on physical properties of sunflower seeds (cv. Kironi). Four levels of moisture content ranging from 7.5 to 30.0 percent (wb) were considered for this study. Length, width, thickness, diameter of equivalent sphere, surface area, volume, porosity and angle of repose increased linearly with the increase of moisture content. But bulk density and kernel density decreased with the increase of moisture. A small linear increase of roundness and sphericity were observed with the increase of moisture content. Regression equations were developed to describe the physical properties of the sunflower seeds with the variation of moisture content.

### INTRODUCTION

Sunflower (*Helianthus annuus*) is the second most important oil seed crop in the world and a potential oil crop of Bangladesh (Anon, 1994; Kromer, 1974). Kironi is the only recommended variety of sunflower cultivated throughout the country. Oil content of sunflower seed varies from 25-50%. The quality of oil is good for edible purpose, as the content of oleic acid and linoleic acid are fairly high (Kaul and Dash, 1986).

Recently scientists have directed great efforts in evaluating basic physical properties of agricultural materials and have pointed out their practical utility in machine and structural design and in process and control engineering (Waziri and Mittal, 1983). Although the recent scientific development have improved the handling and processing of bio-materials through mechanical, thermal, electrical, optical and other techniques, a little is known about the basic physical characteristics of materials. Such basic information is important not only to engineers but also to food scientists, processors, plant breeders and other scientists who may find new uses (Mohsenin, 1970).

Rataj (1990) worked on physical and mechanical properties of sunflower seeds and confined his study at 15 percent moisture.

Kaleemullah (1992) reported that moisture content of oil seeds influences its physical properties to a great extent. Seeds of sunflower often ranges a high moisture content (25-30%) at harvest and down to a 7-9% for safe storage (Kaul and Dash, 1986; Alam *et al.*, 1984). In this study, the design related physical properties of sunflower seeds were determined at different moisture levels ranging from 7.5 to 30.0% (wb).

### MATERIALS AND METHODS

The study was conducted at Bangladesh Agricultural University, Mymensingh during 1995. Uniform and healthy seeds of sunflower (cv. Kironi) were used for the study. Four levels of moisture contents *viz.* 7.5, 15.0, 22.5 and 30.0 % (wb) were subjected to study. The samples were weighed by an electric balance and kept in an oven at 100°C for 96 hours (Brooker *et al.*, 1975). Cooling in a desiccator, the dried samples were weighed and moisture content on wet basis (wb) were determined by using the formula.

Percent moisture content

$$(wb) = 100(W_1 - W_2) / W_1 \dots \dots \dots (1)$$

Where,  $W_1$  = weight of moist seeds

$W_2$  = weight of dry seeds.

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The seed samples of desired moisture levels were prepared by adding calculated amount of water and sealing them in polyethylene bags. The samples were kept at 0°C in a refrigerator for 5 days to ensure uniform absorption of water as performed by Kaleemullah (1992). For each experiment, the required quantity of seeds were taken from the refrigerator and was allowed to warm up to room temperature. The seed size was determined by picking 100 seeds randomly and measuring their length, width and thickness. The dimensions were measured by a vernier calliper of least count 0.01 mm. For determining the surface area and volume of seeds, assuming them as cono-elliptical cylinders as well as cono-circular cylinders an empirical relation has been established by Murthy *et al.* (1986) in terms of length (L), width (W) and thickness (T).

$$\text{Surface area, } S = 13/11(W+T)L \dots\dots\dots(2)$$

$$\text{Volume, } V = p/6.L.W.T \dots\dots\dots(3)$$

The diameter of equivalent sphere was calculated from 1000 grain weight ( $W_{1000}$ ) and kernel density ( $\rho_k$ ) defined by Pabis (1967) as,

Diameter of equivalent sphere,

$$d = 6W_{1000}/1000\rho_k \cdot \pi \dots\dots\dots(4)$$

The shape of seed may be expressed as roundness and sphericity. Roundness is a measure of the sharpness of corner in solid. Sphericity is a measure, how spherical the seed is. The seeds in three mutually perpendicular positions were placed on a graph paper sheet and the over head projector was focused to obtain the sharp boundary of the seeds. The area of shadows were measured by planimeter and diameter by compass and scale. The roundness and sphericity were calculated by using the formula given by Curray (1951).

$$\text{Roundness, } R = A_p/A_c \dots\dots\dots(5)$$

$$\text{Sphericity, } S = D_i/D_c \dots\dots\dots(6)$$

Where,

$A_p$  = Largest projected area

$A_c$  = Area of the smallest circumscribing circle

$D_i$  = Diameter of the largest inscribed circle

$D_c$  = The largest diameter of the seed.

The bulk density was determined by filling 500 ml beaker with seeds from a height of 15 cm and weighing the seeds as performed by Kaleemullah (1992).

The kernel density was determined by water displacement method. Five hundred ml water was taken in a 1000 ml graduated measuring cylinder and 20 g seeds were immersed in that water. The amount of displaced water was read from the graduated scale of the cylinder. The ratio of weight of seeds to the volume of displaced water gave the kernel density. Porosity was determined in terms of bulk density ( $\rho_b$ ) and kernel density ( $\rho_k$ ) by using the formula

$$\text{Percent porosity, } P = (1 - \rho_b/\rho_k) * 100 \dots\dots\dots(7)$$

The angle of repose was determined by using a topless and bottomless cylinder of 10 cm diameter and 15 cm height. The cylinder filled with seeds was placed on a table and raised slowly until it form a cone. The diameter (D) and height (H) of the cone were recorded. The angle of repose was calculated by using the formula as Kaleemullah (1992)

$$\text{Angle of repose, } \theta = \text{Tan}^{-1}(2H/D) \dots\dots\dots(8)$$

## RESULTS AND DISCUSSION

### Size

Due to increase of moisture content, the seed dimensions such as length, width, thickness, diameter of equivalent sphere, surface area and volume of seeds increased by 3.89, 3.35, 1.92, 8.94, 6.79 and 9.44 percent, respectively with their increase of moisture content (M) from 7.5 to 30.0 percent (wb). The following regression equations were developed for length (L), width (W), thickness (T), diameter of equivalent sphere (D), surface area (A) and volume (V).

$$L(\text{mm}) = 10.455 + 0.016M \quad (r=0.944)$$

$$W(\text{mm}) = 5.600 + 0.008M \quad (r=0.996)$$

$$T(\text{mm}) = 3.620 + 0.003M \quad (r=0.994)$$

$$D(\text{mm}) = 5.355 + 0.021M \quad (r=0.985)$$

$$S(\text{mm}^2) = 113.865 + 0.337M \quad (r=0.984)$$

$$V(\text{mm}^3) = 110.825 + 0.466M \quad (r=0.992)$$

Similar results were presented by Wali Ullah *et al.* (1992) for paddy grains, Nkanya and Thomson (1991) for coffee beans and Islam and Penderision (1987) for paddy and wheat grains.

### Shape

The shape of an object is expressed by roundness and sphericity and their values range from 0 to 1. The following regression equations were developed to represent roundness (R) and sphericity (S) in terms of percent moisture content (wb).

$$R = 0.400 + 0.002M \quad (r = 0.956)$$

$$S = 0.430 + 0.001M \quad (r = 0.923)$$

A small change of roundness and sphericity were found due to change in moisture content. Kaleemullah (1992) and Waziri and Mittal (1983) reported similar findings for groundnut kernels and sorghum grains, respectively.

### Bulk density and kernel density

Bulk density and kernel density decreased from 362.38 to 336.65 kg/m<sup>3</sup> and 631.18 to 617.54 kg/m<sup>3</sup>, respectively with the increase of moisture content from 7.5 to 30.0 percent. The regression equations of bulk density and kernel density in terms of percent moisture content (wb) are given below.

$$\rho_b = (\text{kg/m}^3) = 371.785 - 1.144M \quad (r = -0.996)$$

$$\rho_k = (\text{kg/m}^3) = 635.385 - 0.606M \quad (r = -0.997)$$

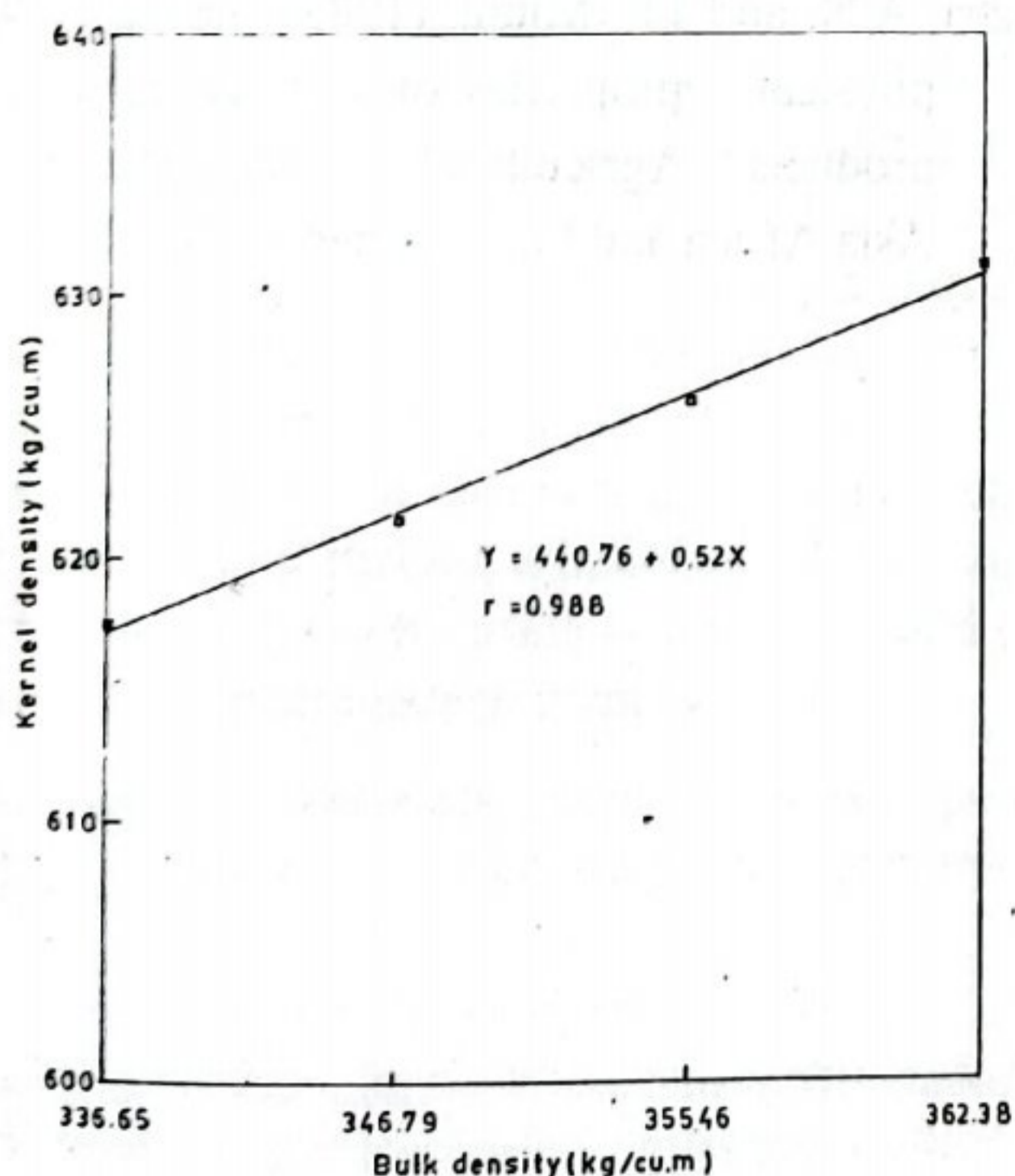


Fig. 1 Regression line of bulk density and kernel density.

Bulk density was found lower than kernel density at the same moisture content. The decrease of densities at high moisture content may be due to the greater swelling of seeds. The kernel density and bulk density corresponding to each moisture content results in  $\rho_k = 440.76 + 0.52\rho_b$ , with correlation coefficient of 0.988 (Fig.1). This result is in close agreement with the findings of Waziri and Mittal (1983) and Fraser *et al.*, (1978).

### Porosity and angle of repose

Porosity and angle of repose increased from 42.59 to 45.48% and 28.41 to 36.96°, respectively with increase of moisture content from 7.5 to 30.0 percent. Porosity (P) and angle of repose (A) vary linearly with moisture content and the following regression equations were developed.

$$P(\%) = 41.215 + 0.135M \quad (r = 0.959)$$

$$A^\circ = 27.520 + 0.355M \quad (r = 0.874)$$

It seemed that at higher moisture content, the cohesive force between the moisture component of individual seed increases. This results were also supported by Rataj (1990), Pierce *et al.* (1987) and Fraser *et al.* (1978).

### CONCLUSIONS

The size, shape, porosity and angle of repose of sunflower seeds were found linearly dependent on the moisture content. But bulk density and kernel density showed negative correlation with the moisture content. This study will provide the physical parameters of sunflower seeds with practical range of moisture content which may be useful for processing and handling purposes.

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