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Research Paper :

Studies on engineering properties of different varieties of sunflower (*Helianthus annuus* L.)

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ABSTRACT

An experiment "Studies on engineering properties of different varieties of sunflower was carried out in the Department of Agricultural Engineering at GKVK Campus of the University of Agricultural Sciences, Bangalore. Among the varieties of sunflower seeds studied for their engineering properties minimum and maximum length of 10.28 mm and 11.80 mm was observed in Sandoz-275 and ITC-104 varieties, respectively. Similarly, minimum and maximum breadth was observed in SHS-909 (4.18 mm) and ITC-104 (5.46 mm) varieties. Varieties Jaikisan and KBSH-44 recorded minimum and maximum seed thickness of 3.22 and 3.95, respectively. Single seed weight was maximum in KBSH-44 (0.075 g) and minimum in Sandoz-275 (0.050 g). Minimum and maximum size was observed in KBSH-41 (5.656 mm) and PASH-553 (6.291 mm) varieties. Pod sphericity was minimum and maximum in ITC-104 (0.462 mm) and PASH-553 (0.584 mm) varieties, respectively. Similar trend was also followed in bulk density. Maximum surface area was with PASH-553 (124.31 mm^2) and minimum was in SHS-909 (99.90 mm^2).

Key words : Sunflower varieties, Engineering properties, Bulk density, Moisture content

The Sunflower (*Helianthus annuus* L.) belongs to family Compositae, a large and successful family of flowering plants occurring throughout the world. Its wider adoptability, day neutral nature and responsiveness to better management practices have played a significant role in its cultivation across varied agro-climatic zones within a span of three decades of its introduction in the country as a important oil seed crop.

India accounts for 3.9 per cent of sunflower oil and 4.4 per cent of the sunflower meal production in the world. Currently, the important sunflower growing states in India are Karnataka, Maharashtra, Andhra Pradesh, Haryana, Tamil Nadu, Punjab and Uttar Pradesh.

Karnataka is the largest sunflower producing state in the country which accounts for half of the total area under the crop and 30 per cent of total output (Anonymous, 2003). It is an important oil seed crop cultivated for its premier oil and manifold uses of both industrial and pharmaceutical importance. The most important commercial products produced from the sunflower are seed, seed oil and sunflower extractions. Sunflower oil has become major economic importance worldwide. The oil is used as cooking and salad oil and also used as a lubricant and illuminant. It is also used for manufacturing paints and varnishes, soaps, detergents and vanaspathy.

A number of research stations in the country are engaged in the cultivation of sunflower. Despite the extensive search, no published literature was found on the detailed physical and engineering properties of sunflower seeds and their dependence on size grading which would be useful for design of processing equipment and machinery. The seeds of sunflower are subjected to various mechanical forces during threshing and post production operations. Physical properties of seeds such as size, shape, specific gravity and sphericity are required for design of various types of cleaning, grading and separation equipment. In design of an air screen cleaner, the shape and size of grain determine the shape and size of screen openings, angle of inclination, vibration amplitude and frequency of screens. The density of grain decides the size of screening surface. The shape of product is used for design of conveying equipment and calculating various cooling and heating loads of food materials. Frictional co-efficient of grains are needed for design and prediction of the motion of material in harvesting and handling equipment. Physical properties like density, size and shape are also required in calculating the terminal velocity of an object in the fluid which is useful for the design of air conveying or pneumatic separation equipment.

Moisture content of oil seeds was determined by placing 25-30 g of seed sample in hot air oven at 130^0C for 72 hours (Hall, 1957). Physical and engineering properties of seeds are considered to be necessary for the proper design of equipment for handling, conveying, separating, cleaning, de-hulling, drying, mechanical expression of oil, storage and other processing operations (Kachru *et al.*, 1993).

Physical properties of sunflower seeds and kernels were evaluated as a function of moisture content. The average length, width, thickness, equivalent diameter and sphericity of the seed and kernel were determined. The bulk density of rewetted seeds decreased while true density, porosity and terminal velocity increased with moisture content (Gupta and Das, 1997).

The dependence of physical properties of gram on moisture content was determined. The average 1000 grain weight, mean surface area, sphericity and roundness were determined. The bulk density and true density decreased with an increase in moisture content (Dutta *et al.*, 1988).

Some of the physical properties of oil bean seed relevant to de-hulling were measured. Major diameter, thickness, average sphericity and roundness, density, co-efficient of friction and angle of repose were determined. Hardness, crushing energy and specific heat capacity were also determined (Oje and Ugbro, 1991).

Chowdegowda *et al.* (1993) have determined the frequency distribution of eight varieties of pigeon pea seeds. The observations indicated that physical dimensions and weight of the seeds were crowded around the central values.

Despite these ever increasing applications, little is known about the basic physical characteristics and properties of these materials. The knowledge of these properties constitute important and essential engineering data in design of machines, structures, processes and controls; in analyzing and determining the efficiency of a machine over or an operation; in developing new consumer products and in evaluating and retaining the quality of the final product. There is an apparent lack of information on engineering properties of the seeds of sunflower varieties grown under different agro-climatic conditions of Karnataka. Keeping all these in view and importance in the design of sunflower seed processing, a study was undertaken with the following to establish the engineering properties and their dependence on size grading of the important sunflower cultivars of Karnataka with the following objectives: to study the engineering properties namely, shape, density of identified sunflower seeds and to analyze the dependence of engineering properties on size grading.

METHODOLOGY

The study was carried out in the Department of Agricultural Engineering at G.K.V.K. Campus of the University of Agricultural Sciences, Bangalore. Sunflower seed samples of nine promising varieties *viz.*, KBSH-1, KBSH-41, KBSH-44, MFSH-17, PASH-553, Jaikissan, Sandoz-275, SHS-909 and ITC-104 were selected for this study. Bulk samples of each variety consisting of 5 kg of seeds were procured from the National Seed Project, GKVK, UAS, Bangalore. These seeds were cleaned manually for foreign matter, broken and immature seeds. The moisture content of seed was found to vary between 6.46 and 8.35 per cent (d. b.). The seeds were packed in double layered low density polyethylene bags of 90 μ thickness, sealed and stored before starting the experiment. For each test the required quantity of seeds were taken out and allowed to warm up for about 2 hours.

The properties such as physical dimensions, 1000 seed weight, bulk density, specific gravity were determined using standard techniques.

RESULTS AND DISCUSSION

Engineering properties of nine varieties of sunflower studies indicated that the seed moisture range varied from 6.46 per cent to 8.35 per cent (Table 1). Actual dimensions of the seed vary according to the moisture content present in the seed. This may be due to actual arrangement of cells in the kernal and increased cavity between the cotyledons.

Length, breadth, thickness and weight of the seeds were also varied among the nine varieties of sunflower (Table 1). Minimum seed length ranged from 9.14 mm to 10.28 mm whereas, maximum seed length ranged from 11.34 to 13.68 mm among the nine varieties studied. Minimum seed length was recorded in the seed lot of Sandoz 275 and maximum seed lenth in ITC 104, respectively. However, an average seed length differed significantly among the varieties and ITC 104 seeds recorded significantly superior average seed length of 11.80 mm compared to other varieties except KBSH-41 (11.53 mm), Jiakisan (11.40 mm) and SHS (11.77 mm) which was comparable in average seed length (Table 1). Minimum seed breadth was recorded in SHS 909 and Minimum and maximum seed breadth recorded was in PASH-553 (Table 1). An average seed breadth of 5.52 mm was recorded in PASH 553 seeds which was significantly superior to rest of the varieties. However, KBSH-41 (5.38 mm), KBSH-44 (5.37 mm), MSFH-17 (5.45 mm) and ITC 104 (5.46 mm) recorded comparable average seed breadth. Minimum thickness was recorded in Sandoz 275 (2.23 mm) and maximum thickness of 4.81 mm was obtained in SHS-909. However, mean seed thickness differed significantly among the varieties studied. KBSH-44 recorded significantly superior average thickness of 3.95 mm and rest of the varieties recorded comparable average thickness except Jaikisan (3.22 mm)

Table 1: Physical dimensions and single seed weight of sunflower

Variety	Moisture content % (db)	Length (mm)			Breadth (mm)			Thickness (mm)			Weight of single seed (g)		
		Min.	Max.	Average	Min.	Max.	Average	Min.	Max.	Average	Min.	Max.	Average
KBSH-1	6.72	10.10	12.82	11.17	4.16	6.31	5.23	2.26	4.26	3.36	0.03	0.11	0.057
KBSH-41	7.84	9.34	12.86	11.53	4.21	6.42	5.38	2.54	4.41	3.69	0.02	0.09	0.058
KBSH-44	7.21	9.67	12.28	10.97	4.18	6.39	5.37	3.18	4.76	3.95	0.04	0.10	0.075
MSFH-17	6.46	10.15	11.84	11.89	4.26	6.36	5.45	2.84	4.54	3.86	0.04	0.11	0.073
PASH-553	8.35	9.29	12.13	10.56	4.29	6.58	5.52	2.63	4.41	3.49	0.03	0.08	0.052
Jai Kisan	6.92	10.28	12.08	11.40	4.36	6.35	4.98	2.28	4.27	3.22	0.02	0.09	0.054
Sandoz-275	7.38	9.14	11.34	10.28	4.13	6.27	5.29	2.23	4.26	3.31	0.03	0.07	0.050
SHS-909	8.23	10.26	13.32	11.77	4.06	6.18	4.18	2.46	4.81	3.61	0.04	0.10	0.064
ITC-104	6.81	10.28	13.68	11.8	4.23	6.53	5.46	2.26	4.23	3.47	0.03	0.11	0.064
F test	**			NS			**			**			**
C. D. (P=0.05)	0.584			0.213			0.635			0.181			0.007
S. EM ±	0.224			0.080			0.235			0.064			0.002
C. V. %	3.496			0.831			.187			2.226			5.542

and Sandoz (3.31 mm) which recorded the least average thickness (Table 1).

Range of minimum seed weight was from 0.02 to 0.04 g and maximum was 0.07 to 0.11 g per seed (Table 1). There was significant variation with respect to average seed weight among the varieties. KBSH-44 recorded significantly superior average seed weight per seed (0.075 g/seed) when compared to the weight of other varieties except MSFH-17 which was comparable in its weight (0.073 g/seed). Variation of physical dimension and single seed weight among the varieties may be due to varietal characteristics and environmental conditions under which the crop was grown (Chowdegowda *et al*., 1993).

There was no significant difference among the varieties with respect to the equivalent diameter. However, equivalent diameter ranged from 6.29 to 5.64 mm in PASH-553 and SHS-909, respectively. Length to breadth ratio of seeds varied significantly among the varieties. ITC 104 recorded significantly higher length to breadth ratio of 2.408 compared to rest of the varieties except KBSH-1 (2.14), KBSH-41 (2.12) and KBSH-44 (2.15). ITC 104 registered significantly superior breadth to thickness ratio of 1.74 compared to other varieties (Table 2). Elongation ratios represent seed shape. More the elongation ratio the seed shape is oblong and lesser seed, shape is spherical. More the flatness ratio, the seed shape will be ovate.

From the data it is evident that KBSH-1, KBSH-41,

Table 2 : Elongation and flatness ratios

Variety	Equivalent diameter (D_e) mm	Sphericity (S)	L/B Ratio	B/T Ratio	Thousand seed weight (g)	Surface area (mm^2)	Bulk density (g/cc)	Specific gravity
KBSH-1	5.814	0.555	2.141	1.266	57.2	106.17	0.47	0.918
KBSH-41	5.656	0.519	2.120	1.573	58.2	100.48	0.49	0.930
KBSH-44	5.959	0.542	2.150	1.348	75.1	111.53	0.49	0.929
MSFH-17	5.701	0.541	2.066	1.462	73.3	102.08	0.52	0.946
PASH-553	6.291	0.584	1.784	1.562	52.9	124.31	0.47	0.902
Jai Kisan	6.064	0.556	1.939	1.535	54.4	115.50	0.46	0.911
Sandoz-275	6.048	0.553	1.902	1.616	50.9	114.89	0.47	0.900
SHS-909	5.641	0.551	1.984	1.501	64.4	99.94	0.47	0.918
ITC-104	5.7	0.462	2.408	1.735	64.8	102.05	0.47	0.917
F test	*	*	*	*	*	*	NS	*
C. D. (P=0.05)	5.65	0.462	0.340	0.262	7.230	10.380	0.503	0.232
S. EM ±	2.025	0.174	0.133	0.101	2.749	3.916	0.194	0.081
C. V. %	5.125	3.962	4.320	4.631	2.326	4.694	3.268	4.524

KBSH-44 and MSFH-17 had oblonged shape than rest of the varieties and had comparatively less pod sphericity which is according to Bal and Mishra (1988). Varieties differed significantly with respect to 1000 seed weight. KBSH-44 registered significantly higher 1000 seed weight of 75.10 g and MSFH-17 registered comparable 1000 seed weight of 73.30 g (Table 2).

Bulk density did not vary significantly among the varieties studied. It is clear from the table the relatively round seeds of less elongation ratio have comparatively higher bulk density than slender seeds. Also round seeds have more weight than slender seeds. Similar relationships were reported by Datta *et al*. (1988) and Deshpande *et al*. (1993). Surface area of the seeds varied significantly among the varieties. PASH-553 registered significantly higher surface area of 124.31 mm^2 when compared to rest of the varieties, whereas Jaikisan and Sandoz 275 registered comparable surface area of 115.50 and 114.89 mm^2, respectively (Table 2). Seed which has higher size had more surface area. PASH-553 had higher surface area of 124.31 mm^2 which is bolder compared to other varieties. Variation in the surface area among the varieties may be due to varietal and genetical difference (Deshpande *et al.*, 1993).

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REFERENCES

Anonymous (2003). Directorate of Oil Seeds Research (ICAR), Hyderabad.

Bal, S. and Mishra, H.N. (1988). Engineering properties of soybean. Proc. National seminar on soybean processing and cultivation in India. pp. 146-165.

Chodegowda, M., Ramaiah, R. and Banakar, A.S. (1993). Frequency distribution of pigeon pea seeds. . *Mysore J. agric. Sci.*, **27**: 281-284.

Deshpande, S. D., Bal, S. and Ojha, T.P. (1993). Physical properties of soybean. *J. agric. Engg. Res.*, **56**: 89-98.

Dutta, S. K., Nema, V. K. and Bhardwaj, R. K. (1988). Physical properties of gram. *J. agric. Engg. Res.*, **39**: 259-268.

Gupta, R.K. and Das, S.K. (1997). Physical properties of sunflower seeds. *J. agric. Engg. Res.*, **66**: 1-8.

Hall, C.W. (1957). *Drying farm crops.* Lyall book Depot, Ludian.

Kachru, R. P. and Rai, D.R. (1993). Physical constituents and some engineering properties of peanut pods. *J. Oil Seed Res.,* **10**: 145-153.

Oje, K. and Ugbro, E. C. (1991). Some physical properties of oil-bean seed. *J. agric. Res.*, **50**: 305-313.

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