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COEFFICIENT OF STATIC FRICTION OF BENISEED FOR MILD STEEL, PLYWOOD, CONCRETE AND GLASS STRUCTURAL SURFACES

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ABSTRACT

In developing processing machines for plant materials, the frictional property of the seed on structural surfaces of Mild steel (MS), Plywood (PW), Concrete (CC) and Glass (GL) is a parameter which needs to be measured. In this study, the static coefficient of friction of two Nigerian beniseed accessions (Yandev-55 and E8) were determined at moisture content levels of 5.3, 10.6, 16.1 and 22.4 per cent (wet basis). These were used as inputs into designing a beniseed oil expeller. A - 2 x 4 factorial experiment in completely randomized was used for the study. The static coefficients of friction between beniseed and the four structural surfaces increased curvilinearly with increase in moisture content irrespective of the surface employed. The result showed that glass has the least value of 0.32 while for mild steel, plywood and concrete, frictional coefficients with beniseed were between 0.39 to 0.59 within the 5.3 and 22.4% moisture content levels. The effect of moisture content is highly significant on the coefficient of frictions of all the tested surfaces..

Keywords: Coefficient of friction, Beniseed, Structural surface, Moisture content.

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1. INTRODUCTION

Peleg and Bagly (1982) have defined the physical properties of agricultural materials as those properties that lend themselves to description and quantification by physical means. These properties include the linear dimensions, size, shape, bulk and true densiities, porosity, weight and volume. Others are angle of repose, specific gravity,colur and coefficient of friction. The knowledge of these physical properties constitutes an essential engineering data in the design of machines, structures, processes and control, in analysing the performance and the efficiency of a machine, as well as in developing new consumer products (Mohsenin, 1986).

Mohsenin, op. cit. used a technique, which related the volume of a set of specimens of pebbles to the axial dimensions of 50 kernels, dry shelled corn by measuring the major, minor and intermediate axes as well as weight and specific gravity of each kernel. The volume of the kernel was taken as one of the parameters defining the shape of the kernel and the three mutually perpendicular axes were taken as a measure of the size of the kernels. Tracings of shape and designation of the three intercepts for seeds and grains obtained by a photographic enlarger were presented. He stated that the sphericity of most agricultural particles is within the range of 0.32 to 1.00. The criteria used for describing shapes and size include charted standards, roundness, sphericity, measurement of axial dimensions, resemblance to geometric bodies and average project area.

In developing a processing plant for grains, the frictional property of the seed is a parameter which needs to be investigated. The methods used by various investigators to determine static and dynamic coefficient of friction of agricultural materials have usually been designed to suit the particular conditions of the materials. The usual method of inclined plane has been used for rough rice, cereal grains and karinga seeds (Suther and Das, 1996) while a horizontal table was employed for that of grains on various surfaces (Syndy et al., 1967 as reported by Mijinyawa and Falayi, 2000). This paper discusses the result of an investigation carried out on the coefficient of friction between beniseed and four structural surfaces namely mild steel, plywood, concrete and glass.

2. MATERIALS & EXPERIMENTAL PROCEDURES

One kilogram, each of the two commonly grown beniseed accessions - Yandev 55 and E8 were obtained from the National Cereal Research Institute (NCRI) Badeggi in Niger State, Nigeria. These were conveyed to the experimental site in wet jute bags in order to prevent dehydration. The seeds were cleaned using a specific gravity separator to remove dust, sand, dry leaves and empty capsules. The moisture contents of the samples of the two beniseed accessions were determined by the oven drying method [2]. Methods described by in previous researches [3-8] were used to adjust seeds to the desired moisture content. The static coefficient of frictions of the two accessions was obtained on four structural surfaces namely mild steel, plywood, concrete and glass. In the case of plywood the direction of movement was parallel to the grain. A tilting table constructed at the Engineering Drawing Office of FIIRO [9] was used. The surface to be tested was fixed on the tilting table and the beniseeds were poured into a cardboard paper ring of diameter 10cm by 2cm deep until the ring was full. Care was taken to raise the ring slightly so that it did not touch the surface. The table was then slowly tilted by a gentle screwing device until movement of the seeds down mounted against the edge of the tilting table. The tangent of the angle of friction is the coefficient of friction.

A-2 x 4 factorial in CRD experimental design with a total of 24 observations (2 accessions x 4 moisture content levels x 3 replications) was utilized. Tables 1 and 2 gave the measured and descriptive statistics. Figures 1 and 2 shows the interactions between moisture contents and the measured parameters.

2.1. Statistical Analysis

The analysis of variance (ANOVA) was used to analyze the data obtained in this study.

3. RESULTS AND DISCUSSION

The coefficient of friction for the two beniseed accessions on four structural surfaces and at different moisture contents are summarized in Table 1.

Table 1 Coefficient of Static Friction of two Beniseed Accessions with respect to Different Structural Surfaces

Material	MC	MS	PW	CC	GL
Yandev-55	5.3	0.5095	0.4706	0.5704	0.3672
	10.6	0.4621	0.4473	0.5140	0.3477
	16.1	0.4797	0.4586	0.5217	0.3524
	22.4	0.5392	0.5236	0.5872	0.3805
E8	5.3	0.4625	0.4142	0.5498	0.3424
	10.6	0.4157	0.3904	0.4932	0.3226
	16.1	0.4326	0.4017	0.5011	0.3273
	22.4	0.4925	0.4667	0.5665	0.3554

Key: MC: Moisture Content % (wb); MS: Mild Steel (Normal Surface Finish); PW: Plywood (Normal Surface Finish); CC: Concrete (Normal Surface Finish); GL: Glass (Plain)

The analysis of variance (ANOVA) is summarized in Table 2 while the regression equations in the moisture content range of 5.3 –22.4% are represented in Table 3.

Table 2 Regression Equations for Static Coefficient of Friction in the Moisture Content Range of 5.3 to 22.4% wb

Property	Beniseed	Linear Regression	R– Square	Correlation Accession	Equation Coefficient
Mild Steel	Yandev 55	0.972	- 0.0165MC	0.0647	-0.254
Mild Steel	E8	0.423	+ 0.002MC	0.196	0.443
Plywood	Yandev 55	0.432	+ 0.003MC	0.465	0.682
Plywood	E8	0.376	+ 0.003MC	0.458	0.677
Concrete	Yandev 55	0.532	+ 0.001MC	0.061	0.247
Concrete	E8	0.511	+ 0.001MC	0.061	0.246
Glass	Yandev 55	0.350	+ 0.001MC	0.179	0.423
Glass	E8	0.325	+ 0.001MC	0.172	0.414

Table 3a Analysis of Variance (ANOVA) for the Coefficient of Static Friction at 5% Significance Level (Mild Steel)

Source of Variation	Degree of Freedom, DF	Sum of Squares, SS	Mean Squares, MS	F-value
Accession (A)	1	0.004	0.004	2.00 NS
Moisture Content (M)	3	0.007	0.002	66.67**
Interaction (A X M)	3	0.0001	0.00003	0.015 NS
Total	7	0.011	0.002	

*Significant Difference; **Highly Significant Difference; NS Non Significant

Table 3b Analysis of Variance (ANOVA) for the Coefficient of Static Friction at 5% Significance Level (Plywood)

Source of Variation	Degree of Freedom, DF	Sum of Squares, SS	Mean Squares, MS	F-value
Accession (A)	1	0.006	0.006	3.00 NS
Moisture Content (M)	3	0.007	0.002	66.67**
Interaction (A X M)	3	0.0001	0.00003	0.015 NS
Total	7	0.013	0.002	

Table 3c Analysis of Variance (ANOVA) for the Coefficient of Static Friction at 5% Significance Level (Concrete)

Source of Variation	Degree of Freedom, DF	Sum of Squares, SS	Mean Squares, MS	F-value
Accession (A)	1	0.001	0.001	0.333 NS
Moisture Content (MC)	3	0.008	0.003	100.00**
Interaction (A X MC)	3	0.0001	0.00003	0.030 NS
Total	7	0.009	0.001	

Table 3d Analysis of Variance (ANOVA) for the Coefficient of Static Friction at 5% Significance Level (Glass)

Source of Variation	Degree of Freedom, DF	Sum of Squares, SS	Mean Squares, MS	F-value
Accession (A)	1	0.001	0.001	0.333 NS
Moisture Content (M)	3	0.001	0.0003	10.00*
Interaction (A X M)	3	0.0001	0.00003	0.069 NS
Total	7	0.003	0.0004	

Figures 1and 2 show the effect of moisture content on the coefficient of friction on different structural surfaces for the two beniseed accessions. It was observed that the coefficient of friction decreased from 0.5095 at 5.3% moisture content to 0.4621 at 10.6% moisture content and increased to 0.5392 with a further increase in moisture content to 22.4% for mild steel (normal surface finish). Similar trends were observed for plywood (normal surface finish), concrete (normal surface finish) and glass (plain surface). The coefficient of friction on all the studied surfaces decreased with increase in moisture content from 5.3% to 10.6% and then increased with a further increase in moisture content to 28.3%. Glass has the least values of 0.345 for Yandev-55 and 0.323 for E8 at 10.6% moisture content. The values of coefficient of friction for beniseed on mild steel, plywood and concrete do not differ significantly from each other and they are not significantly affected by moisture content. Their values lie between the ranges 0.41 to 0.58.

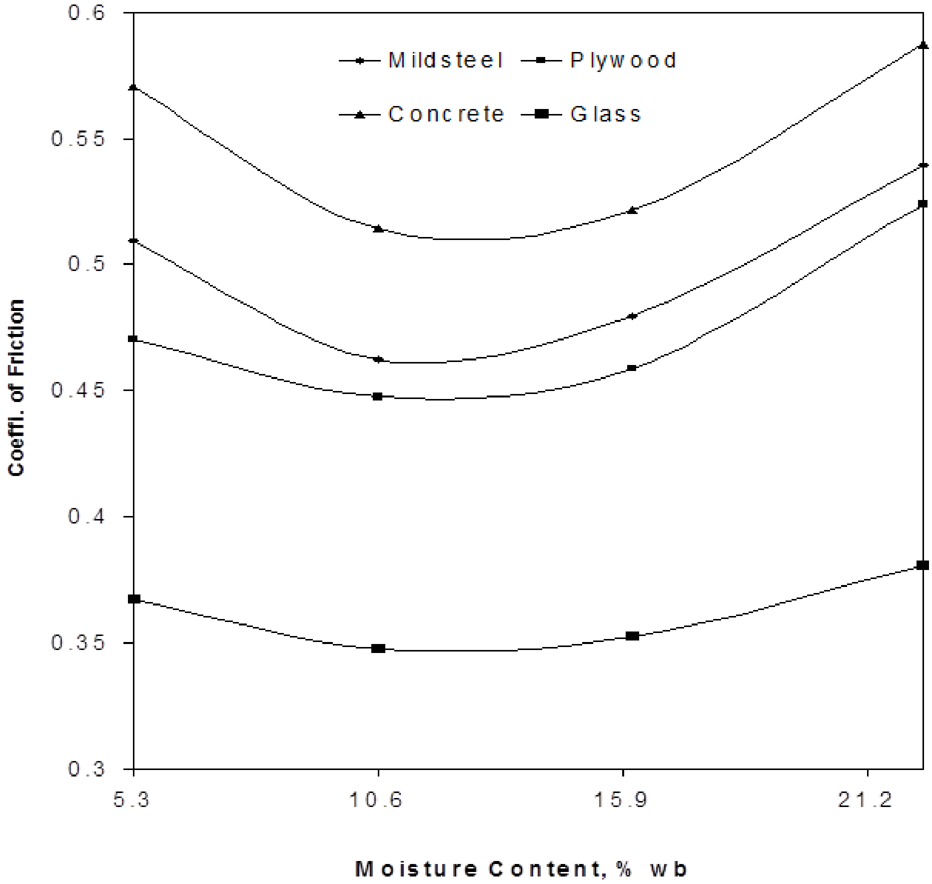

Figure 1 Effect of Moisture Content on the Coefficient of Friction of Yandev 55 Beniseed Accession

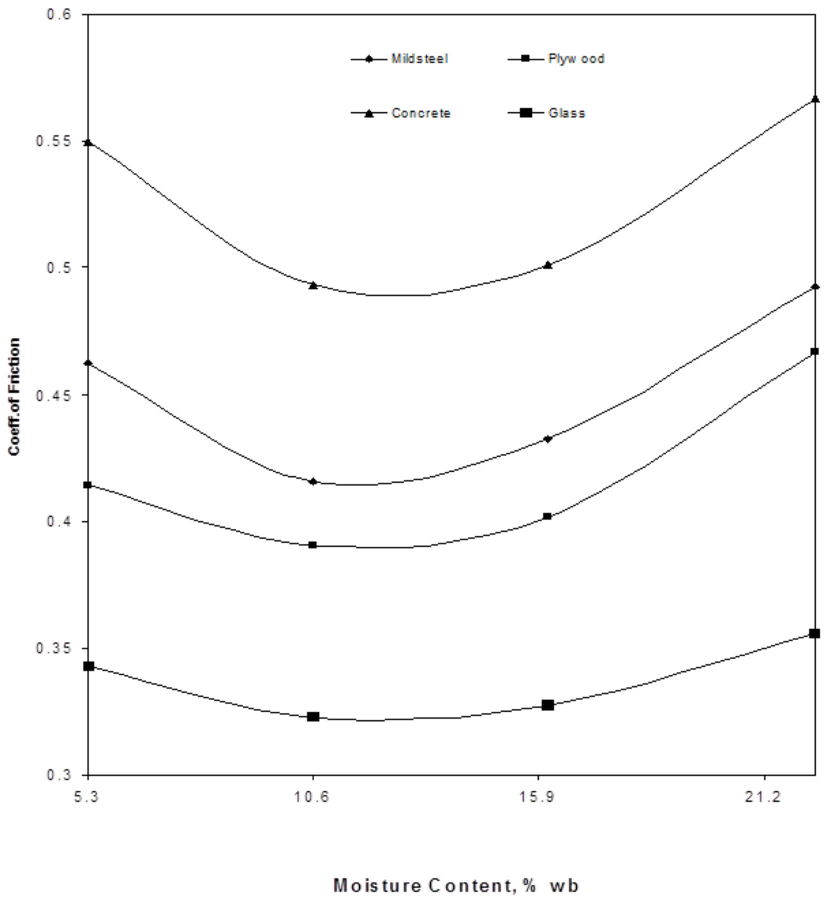

Figure 2 Effect of Moisture Content on the Coefficient of Friction of E8 Beniseed Accession

These values are within the range of values specified for other seeds and grains as summarized by Mohsenin (1986). This is expected as the seeds have very smooth surfaces. The analysis of variance shows a highly significance difference between the moisture content means for all the structural surfaces but the effects of accession and its interaction with moisture content is not significant.

4. CONCLUSION

Vital numeric values of the coefficient of friction of beniseed on different structural surfaces of concrete, wood, glass and mild steel had been established. The mean coefficient of friction between beniseed and glass is 0.32 while that on other structural surface lies between 0.45 to 0.59. From the study, the effect of moisture content is highly significant on the coefficient of frictions of all the tested surfaces.

REFERENCES

[1] ASAE, (1998). Moisture Measurement Unground Grains and Seeds, American Society of Agricultural Engineering Standards, S352.2 DEC 97: 551.

[2] Lucas EB, Olayanju TMA. Effect of moisture content on some physical properties of two beniseed accessions. J Appl Sci Eng Technol. 2003 3(1): 7–12.

[3] Akinoso R, Olayanju TA, Idehai JO, Igbeka J. The effects of varieties and moisture content on some physical and aerodynamic properties of Sesame seeds (Sesamum indicum L) as related to cleaning. Int'l J Food Eng. 2008 DOI: https://doi.org/10.2202/1556-3758.1303.

[4] Ahn JY, Kil1 DY, Kong C, Kim BG. Comparison of oven-drying methods for determination of moisture content in feed ingredient. Asian Australas J Anim Sci. 2014 27 (11): 1615-1622..

[5] Olayanju TMA. Effect of wormshaft speed and moisture content on oil and cake qualities of expelled sesame seed Trop Sci. 2003 43(4): 181-183.

[6] Olayanju TMA, Lucas EB. Mechanical behaviour of two beniseed (Sesamum indicum L.) cultivars under compression loading J Food Sci Technol. 2004 41(6): 686-689

[7] Udoh JE, Olayanju TMA,, Dairo OU, Alonge AF. Effect of Moisture Content on the Mechanical and Oil Properties of Soursop Seeds Chem Eng Trans. 2017 58(1): 361-366

[8] Peleg, M. and E.B. Bagly, 1982: Physical Properties of Foods. AVI Publishing Co. Inc. West Port Connectiut.

[9] Udoh JE, Alonge AF, Olayanju TMA, Dairo OU. Physical Characteristics of Soursop Seeds as affected by Moisture Content, ASABE Annual Int'l Meeting 2017, 1700946.(doi:10.13031/aim.201700946).