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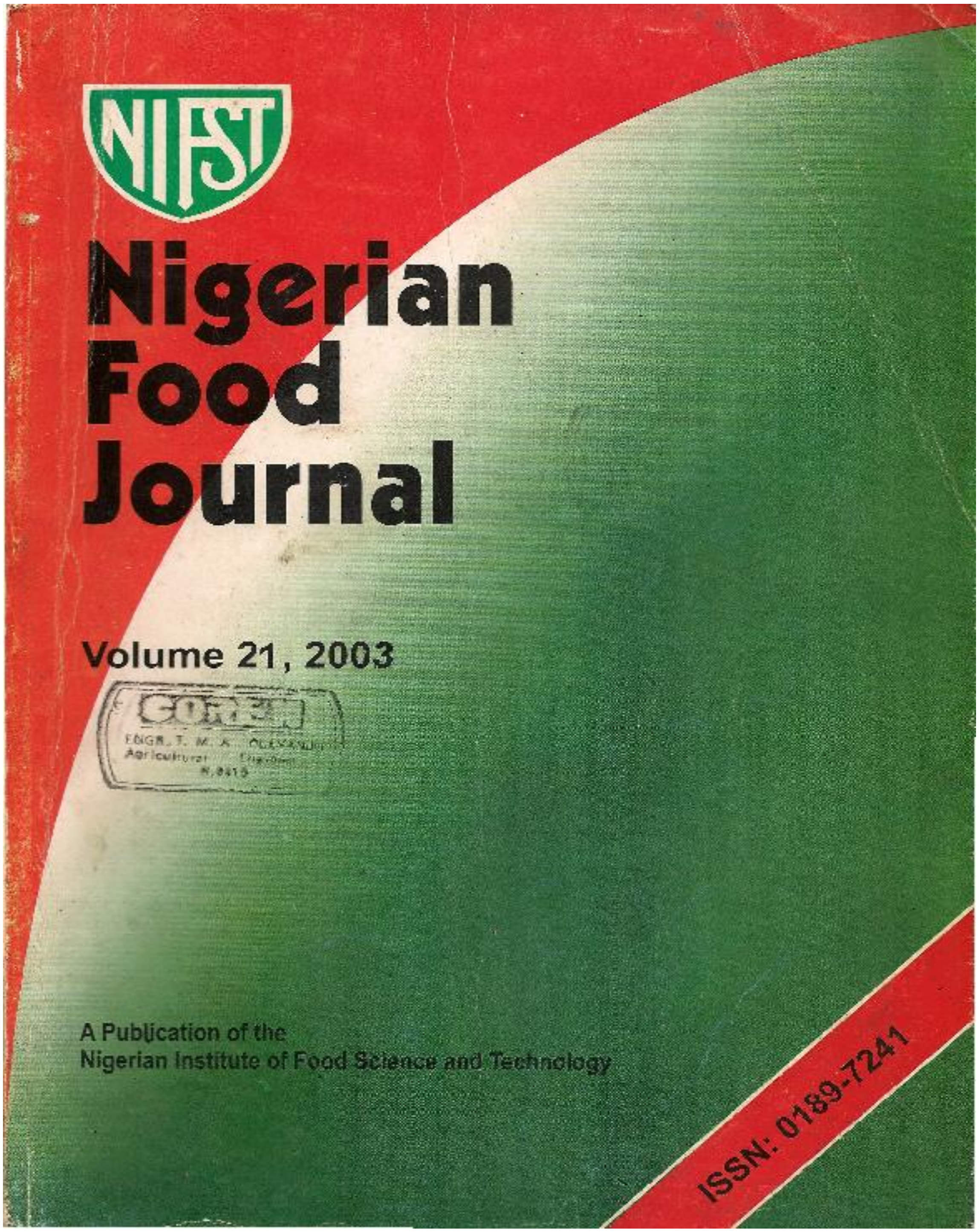

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EFFECT OF WORMSHAFT SPEED AND MOISTURE CONTENT ON THE CAPACITY OF A BENISSED OIL EXPELLER

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ABSTRACT

The effect of machine wormshaft speed and seed moisture content on the capacity of a cottage - scale oil expeller was studied using two beniseed accessions Yandev 55 and E8. The expeller has a barrel of 60mm diameter and a special wormshaft of 600mm length and was powered by a 0.75kW electric gear reduction motor. The machine capacity increased from 9.98 to 11.88kg/h and 8.91 to 11.52kg/h, respectively, for the two accessions as the moisture content increased from 4.1 to 5.3% wet basis at wormshaft speed of 30rpm. A further increase in moisture content to 10.3 % decreased the capacities to 10.50 and 9.65kg/h, respectively. This was a general trend for all the wormshaft speeds (45, 60, and 75rpm).

The capacity of the expeller was highly affected by wormshaft speed, moisture content and seed accessions. It was found to be greater at lower levels of wormshaft speed and moisture content. The maximum capacities of 13.22 and 12.08kg/h were obtained at wormshaft speed of 60rpm and 5.3% moisture content for Yandev 55 and E8, respectively.

Keywords: Beniseed, Expeller, Capacity, Wormshaft speed, Moisture content

Introduction

Mechanical expression of oil from oilseeds can be accomplished majorly by using a plate press, an hydraulic press or an expeller. According to Oresanya and Koleoso (1990), NCRI (1995) and Tunde-Akintunde (2000), plate and hydraulic presses are of low capacities, time consuming and less effective. Therefore, an oil expeller, which expresses oil more efficiently is preferred.

Oil expeller has been described by UNIFEM (1987) as an equipment having a horizontal rotating metal screw, which feeds oil -bearing raw materials into a barrel-shaped outer casing with perforated wall. Most small expellers are power driven requiring about 3kW and are able to process between 10 to 50 kg per hour of oilseed depending on the type of expeller used. Bigger units processing greater quantities are available for use in large mills. Some expellers have supplementary heaters fitted to the barrel to improve oil yield. The expressed cake has 5 18% (w/w) residual oil, depending on the type of oilseed and operating conditions (Rosedown, 1990 and Desai, 1998).

The effect of processing and operational parameters on expeller capacity, oil recovery and residual oil – in – cake of different oilseeds had been studied by several investigators. Khan and Hanna (1983) reviewed the expression of oilseed in an expeller and their result indicates that pressure, temperature, pressing time and moisture content are the factors that affect expression of oil from oilseed. Sivakumaran and Goodrum (1987) on the other hand, reported that peanut feed rate, oil expression rate, meal oil content and expression efficiency can be controlled in a small screw press by varying the internal pressure of the screw press. They stated that a reduction in internal pressure led to the increased peanut feed rate and increased meal oil extraction rate in the initial stages, increased cake oil content and lowered oil expression efficiency.

Vadke and Sasulski (1988) studied the effect of wormshaft speed, choke opening and seed pre-treatment, i.e., moisture conditioning, flaking and preheating of canola seed in a small screw press. With reduction of choke opening and shaft speed, maximum pressure increased and both press throughput and residual oil in the cake decreased. When either the whole seed or flakes were preheated in the range of 40 to 100 °C, the pressure and throughput increased and residual oil in the cake decreased. The press throughput and oil output were maximum at 5% moisture content (wet basis) while the residual oil showed a continuous rise with increasing moisture content. From the foregoing, its important that optimum processing and operational conditions for the expression of oil from beniseed be identified for higher oil yield and improve cake quality at minimum production cost. Therefore, the objective of this work was to study the effect of wormshaft speed and moisture content on the capacity of a specially developed beniseed oil expeller with a view to maximising its operation.

Materials and Methods

Machine Specifications

Most of the oil expellers available in this country could not perform effectively with beniseed because of its small size. Therefore, a functional power - operated expeller containing a special wormshaft rotating in cylindrical barrel with perforations was developed based on the application of parameters obtained from the determined physical and mechanical properties of the seed (Olayanju, 2002). The machine specifications are as follow:

Length of chamber, L (mm) = 300
Diameter of Chamber, D (mm) = 60
Length of Wormshaft, L_1 (mm) = 600
Number of worms, n = 6
Worm pitches, P (mm) = 2 x 25, 37.5, 37.5, 37.5, 37.5, 37.5
Depth of worm, H (mm) = 6.25
Thickness of worm, e (mm) = 6.25
Helix angle, a (degree) = 10
Mean diameter of screw, D_m = 54
Speed of rotation, N (rpm) = 45
Power requirement, P (kW) = 0.75
Speed of electric gear reduction motor, N_m (rpm) = 180

Experimental

Three experiments involving an interactive study of the three independent variables viz: wormshaft speed, moisture content and beniseed accession were carried out to evaluate the capacity of the fabricated oil expeller. Four levels of wormshaft speed, four levels of moisture content and two levels of beniseed accession were employed. The wormshaft speed was considered as the main-plot, while the moisture content and beniseed accession were considered as the sub-plot and sub-sub plot respectively. Fifty kilograms, each of the two common beniseed accessions – Yandev 55 and E8 were procured from Afri Agric. Products Ltd., Apapa, Lagos. The seeds were cleaned using a specific gravity separator to remove dust, sand, dry leaves and empty capsules. The moisture contents of the two beniseed accessions were determined by the oven drying method (ASAE, 1998). Methods described by Kachru *et al.* (1994) were used to adjust seeds to the desired moisture content. Dehulled beniseed samples were prepared by using FIIRO established method (Olayanju *et. al.*, 2000). Two kilograms, each of the dehulled beniseed samples was poured into the feeding hopper of the expeller. The speed was adjusted with the aid of a belt/pulley arrangement to the first speed. When a constant speed was indicated by the tachometer attached to the wormshaft, the feed control gate was opened for the seed to pass onto the expression chamber where the seed was crushed and compressed. The crushing time was noted. The capacity of the expeller was determined as the ratio of the crushed material to the crushing time.

Results and Discussion

Table 1 gives the data on the machine capacity from the samples at different wormshaft speeds and moisture content levels. Figures 1 and 2 show that there was an increase in the capacity as the wormshaft speed increased from 30 to 75 rpm at all the moisture content levels of 4.1, 5.3, 7.7 and 10.3% wb. Figures 3 and 4 show the effect of moisture content on the machine throughput. It was observed that the capacity increased as the moisture content increased from 4.1 to 5.3%. Further increase in moisture content to 10.32% led to a decrease in the press capacity. This was a general trend for all the wormshaft speeds (30, 45, 60 and 75rpm) and for the two beniseed accessions. The maximum machine capacities of 12.99 and 12.08kg/hour were obtained at wormshaft speed of 60 rpm and 5.3% moisture content for Yandev 55 and E8, respectively. Similar result had been reported by Tikko *et al.* (1985) while evaluating the performance of a baby oil expeller for oil recovery and energy consumption in relation to seed moisture and wormshaft speed. They observed that as the wormshaft speed and choke opening increased, the press throughput also increased. They further stated that the maximum press throughput was obtained at 5% seed moisture content. The observation in the present study may be due to the fact that as the wormshaft rotates, the beniseed material at 4.1 and 5.3% moisture contents wet basis which were very dried, offered least resistance to the wormshaft movement, thereby leading to an increase in press throughput as the wormshaft speed increased. However, at 10.3% moisture content, the material was relatively wet, thereby creating a resistant effect on the wormshaft movement and thus leading to a decrease in machine capacity.

Conclusion

The following conclusions are drawn from this research: The statistical analysis for machine capacity showed that the third level of wormshaft speed (60 rpm), the second level of moisture content (5.3%, wb) and Yandev-55 accession were the optimum experimental levels at 13.22kg/h throughput. The machine throughput was highly affected by wormshaft speed, moisture content and seed accessions and were found to be greater at lower levels of moisture content and wormshaft speed.

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Mr. H. Crowbar, the Managing Director of the Afri Agric. Products Ltd., Apapa, Lagos, provided the beniseed accessions used for the study. Mrs. M. O. Oresanya of the Chemical and Fibre Technology Division, FIIRO assisted in dehulling the seeds.

Table 1: Effect of wormshaft speed and moisture content of two beniseed accessions on machine capacity

S/N	Wormshaft speed (rpm)	Mositure content (%, wb)	Crushing time (minute)		Machine throughput (kg/h)	
			Yandev 55	E8.	Yandev 55	E8
1	30	4.1	12.03	13.44	9.98	8.91
2	30	5.3	10.10	10.42	11.88	11.52
3	30	7.7	11.30	11.83	10.62	10.14
4	30	10.3	11.43	12.43	10.50	9.65
5	45	4.1	10.58	12.23	11.34	9.81
6	45	5.3	9.37	10.03	2.81	1.96
7	45	7.7	10.25	10.43	11.71	11.51
8	45	10.3	10.32	11.12	11.63	10.79
9	60	4.1	10.35	11.17	11.59	10.74
10	60	5.3	9.08	9.93	13.22	12.08
11	60	7.7	10.13	10.40	11.85	11.54
12	60	10.3	10.28	10.58	11.67	11.34
13	75	4.1	10.20	10.77	11.76	11.14
14	75	5.3	9.23	10.28	13.00	11.67
15	75	7.7	10.02	10.43	11.98	11.51
16	75	10.3	10.08	10.73	11.90	11.18

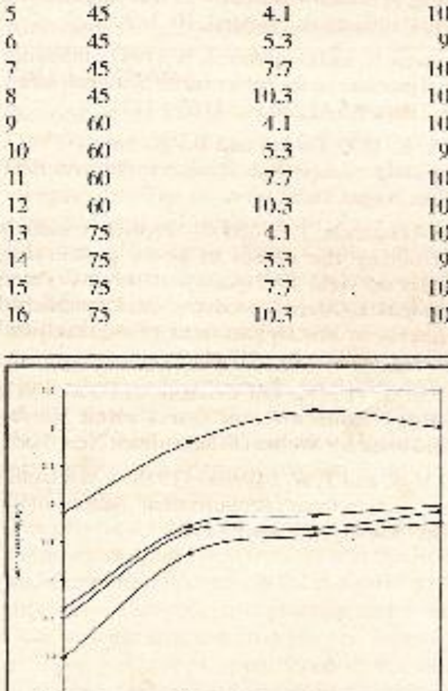

Figure 1: Effect of wormshaft speed on machine capacity using Yandev 55 beniseed accession at different moisture contents of 4.1%, 5.3%, 7.7% and 10.3%

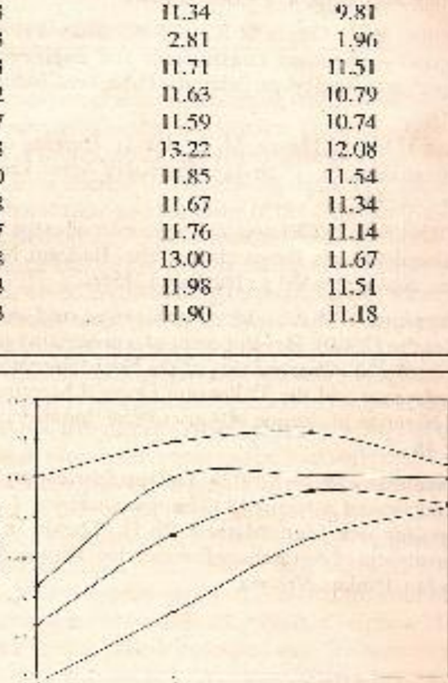

Figure 2: Effect of wormshaft speed on machine capacity using E8 beniseed accession at different moisture contents of 4.1%, 5.3%, 7.7% and 10.3%

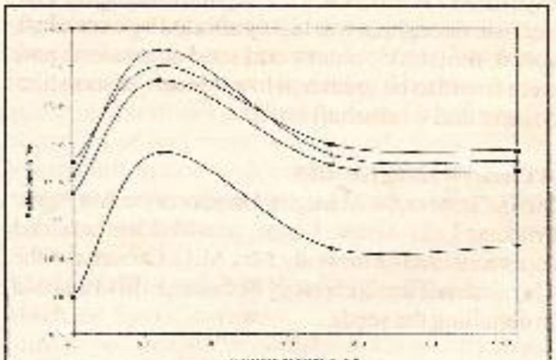

Figure 3: Effect of wormshaft speed on [illegible] using Yandev 55 beniseed accession at different moisture contents of [illegible]

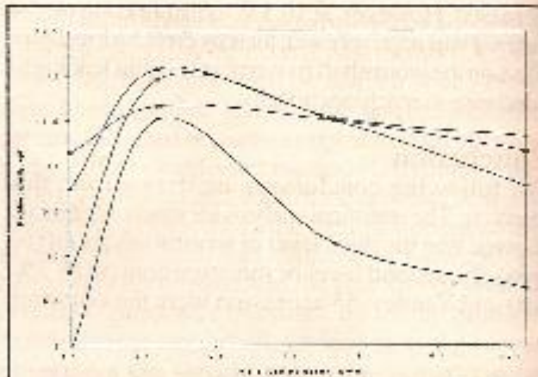

Figure 4: Effect of wormshaft speed on machine capacity using E8 beniseed accession at different moisture contents of [illegible] 45 [illegible] 60 per cent [illegible] 75 [illegible]

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