Effect of Wormshaft Speed, Moisture Content and Variety on Oil Recovery from Expelled Beniseed

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ABSTRACT

The effect of machine wormshaft speed and seed moisture content on oil recovery from two beniseed accessions (Yandev 55 and E8) was studied in an oil expeller. The levels of moisture content of 4.1 to 10.3% wet basis and and wormshaft speed of 30 to 75 rpm were used. The oil recoveries from the two accessions increased from 37.56 to 70.62 and 33.70 to 64.85 respectively as the wormshaft speed increased from 30 to 45rpm at 4.1% moisture content. A further increase to 75 rpm decreased the respective oil recoveries to 40.23 and 38.79%. This was a general trend for all the studied moisture contents. The maximum filtered oil recoveries of 79.63 and 74.28% of the expressable oil were obtained for Yandev-55 and E8 respectively from a – one pass crushing. These values were obtained at 45 rpm and 5.3% m.c. The statistical analysis shows that wormshaft speed and its interaction with moisture content have significant effect on the oil recovery from the seed.

Keywords: Beniseed, expeller, oil recovery, wormshaft speed, moisture content

1. INTRODUCTION

Beniseed (Sesame seed) is a staple food of many ethnic groups in Nigeria and it is cultivated in most of the Local Government Areas of the Middle Belt and some Northern States of country. The seed oil content varies from 35% to 57% with 50 to 57% in the creamy white variety, 48% in the black variety and 46% in the brown variety (Tashiro et al., 1990). In quality, the best brands of beniseed oil are close to olive oil (Weiss 2000). It has no odour and after refining, it becomes straw-like in colour and tasty. The oil is widely employed as cooking oil and raw materials in the manufacture of margarine and pharmaceuticals (Sangha *et.al* 2004). After burning, it yields top-quality and black ink (Sudhir *et. al* 1996).

The usual method of beniseed oil extraction at domestic level involves pounding the seeds in a wooden mortar and treating the product with hot water. This method is slow with low oil yield and the oil produced has unpleasant odour and bitter taste (UNIFEM, 1987). Therefore, most commercial oil extractions are done with expeller. The performance of different oil expellers have been evaluated by several investigators by studying the effect of processing and operational parameters on the machine capacity, oil recovery and residual oil - in - cake.

Khan and Hanna (1984) reported the effects of pressure, temperature, pressing time and moisture content on oil yield from soybean during mechanical expression. They developed prediction equations for ground soybean with hulls, flakes with hulls and flakes without hulls. In general, their results showed that best oil yields were achieved by increasing the temperature, pressure and pressing time at moisture content of 9 – 10 per cent. The maximum oil yield of 85 per cent was obtained from soy flakes at a temperature of 60^{o}C, pressure of 35- 65MPa and moisture content of 9 – 10 per cent. The temperature, moisture and inter-action terms of moisture and temperature in the regression analysis were highly significant. The effect of pressing time on oil yield was not significant at 0.05 level. The soybean hulls play an important role in oil expression.

Shukla et al. (1992) reviewed the technology and equipment developed in India for oil expression from mustard oilseed. The result revealed that maximum oil recovery of 77.56 to 80.91 per cent was achievable at moisture content of 9.5 to 10 per cent (wb). Varma et al. (1993) reported the performance of an expeller with rapeseed based on oil recovery and energy consumption at moisture contnet of 6-15 per cent (wb). Maximum oil recovery of 82 per cent was reported at 9 – 9.5 per cent for oilseed without cooking, whereas, oil recovery of 84 per cent was obtained when rapeseed was cooked with steam at 0.1 MPa for 60 minute duration. The minimum specific energy consumption of 0.15kwh per kg oil was achieved for cooked oilseed as compared to 0.19kwh per kg oil at 10.0 per cent (wb) in cold expression.

From the foregoing, it is 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 is to study the effect of wormshaft speed and moisture content on beniseed oil recovery.using a specially designed oil expeller (Olayanju, 2002) with a view to maximising its operation. This is a continuation of an earlier work on the effect on capacity (Olayanju, 2003a) and on oil and cake qualities (Olayanju, 2003b)

2. MATERIALS AND METHODS

Fifty kilograms, each of the two beniseed accessions (Yandev 55 and E8) procured from the AfriAgric. Products Ltd., Apapa, Lagos, were cleaned using a specific gravity separator to remove dust, sand, dry leaves and empty capsules. The moisture contents of the seeds 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 using FIIRO (Federal Institute of Industrial Research Oshodi, Nigeria) established method (Olayanju, 2003b).

Three experiments involving an interactive study of the three independent variables viz: machine wormshaft speed, seed moisture content and beniseed accession were carried out to study their effect on oil recovery from beniseed. Two kilograms, each of the dehulled beniseed samples was expressed in an oil expeller with an average capacity of 10kg/h. It has an expression chamber of 60mm diameter and a – 600mm long wormshaft powered by a – 0.75kW electric gear reduction motor (Olayanju, 2003a).

The expressed oil was clarified using an oil filter press. The operation was repeated for the other samples. The volumes of the expressed and filtered oil were measured by using a graduated cylinder. The expression efficiency, E in terms of the oil recovery was evaluated as the ratio of the expressed and filtered oil to that of the expressable oil, which is equivalent to the initial oil content of the seed. The oil content of the seed was determined by soxhlet extraction apparatus with normal hexane as solvent.

3. RESULTS AND DISCUSSION

The results of the experiment are summarised in Table 1. The initial oil contents of Yandev – 55 and E8 Samples were determined to be 55.12 and 54.20% respectively.

Table 1: Effect of wormshaft speed and moisture content on oil recovery from beniseed

S/N	Wormshaft Speed rpm	Mositure Content %, wb	*Expressed Oil cm^3		Filtered Oil cm^3		**Oil Recovery, %	
			Yandev 55	E8	Yandev 55	E8	Yandev 55	E8
1	30	4.10	656	477	450	397	37.56	33.70
2	30	5.31	560	601	510	524	42.57	44.48
3	30	7.69	647	594	498	495	41.57	42.02
4	30	10.32	488	566	415	407	34.64	34.55
5	45	4.10	874	920	846	764	70.62	64.85
6	45	5.31	999	936	954	875	79.63	74.28
7	45	7.69	931	910	793	724	66.19	61.43
8	45	10.32	790	807	718	696	59.13	59.08
9	60	4.10	667	646	610	588	50.92	49.91
10	60	5.31	732	696	657	621	54.84	52.72
11	60	7.69	565	552	519	508	43.32	43.12
12	60	10.32	478	472	436	461	42.99	39.13
13	75	4.10	509	484	482	457	40.23	38.79
14	75	5.31	513	495	496	478	41.40	40.58
15	75	7.69	418	407	394	383	32.88	32.51
16	75	10.32	406	395	389	376	32.47	31.92

* Expressed oil was from each 2kg sample and on a – one pass / crushing basis.
** The initial oil content of Yandev – 55 and E8 Samples were determined to be 55.12 and 54.20% with an average relative density of 0.92. Thus, the respective volumes of expressable oil are 1198 and 1178cc respectively.

The analysis of variance for oil recovery is presented in Table 2. It shows that only the wormshaft speed and its interaction with moisture content are significantly different at the 0.05 level.

Table 2: Analysis of variance for oil recovery at 5% significance level

Source of variation	Degree of freedom (DF)	Sum of squares (SS)	Mean squares (MS)	Fvalue
Main effects: Accession (A)	1	24.308	24.308	0.117^{NS}
Moisture content (M)	3	624.571	208.190	0.136^{NS}
Wormshaft speed (N)	3	4599.917	1533.306	117.19**
2 – Way interactions (A X M)	3	4.586	1.529	0.297^{NS}
(A X N)	3	15.455	5.152	0.263^{NS}
(M X N)	9	176.213	19.579	9.209*
3 – Way interactions (AX M X N)	9	19.138	2.126	0.0121^{NS}
Total	31	5464.187	176.264	

*** -** Significant difference; ** - Highly significant difference; NS - Not significant

Figure 1 show that the oil recovery from Yandev 55 increased with increase in wormshaft speed from 30 to 45 rpm when the seed moisture content and accession were kept constant.

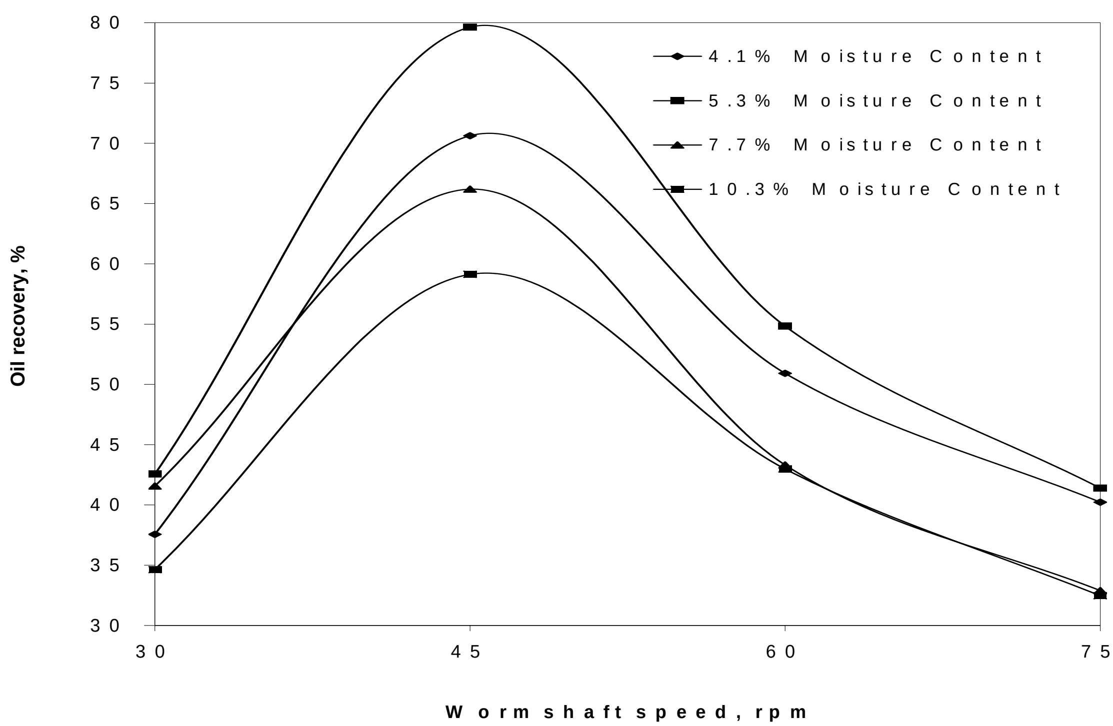

Figure 1: Wormshaft speed and oil recovery at different moisture contents (wb) using Yandev 55 beniseed accession

A further increase in wormshaft speed to 75 rpm led to a decrease in oil recovery. Moreover, at the initial level of moisture content (i.e. at 4.1%), the rate of increase in oil recovery with corresponding change in wormshaft speed was very sharp with curvilinear relationship indicated on the graph. Also, a sharp increase in oil recovery was observed between wormshaft speeds of 30 and 45 rpm at all the studied moisture contents.

The maximum oil recovery of 79.63% was observed at wormshaft speed of 45 rpm and 5.3% moisture content while the minimum of 32.47 was recorded at 75 rpm and 10.32% moisture content. The same trend was obtained for E8 accession with a maximum oil recovery of 74.28%. The moisture content affected oil recovery at all the studied wormshaft speeds for the two beniseed accessions as indicated in Figure 2.

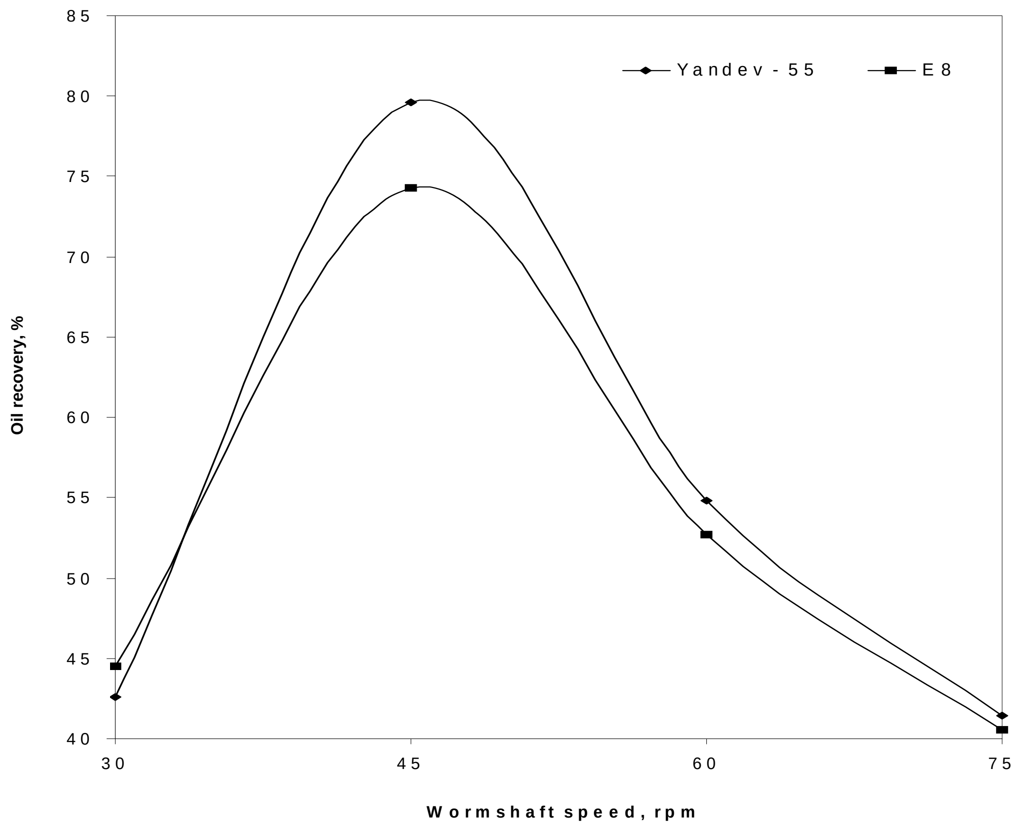

Figure 2: Wormshaft speed and oil recovery for the two beniseed accessions using moisture content of 5.3% wet basis

The obtained result is similar to that of an earlier study conducted by Shukla et al. (1992) where best oil recoveries of 55.11% at 5.13% moisture content (wb) was obtained for groundnut; 71.50% at 9% m.c for soydal; 74.29% at 9% m.c. for linseed; 77.56% at 9.5% m.c. for rapeseed; 81% at 9.4% m.c. for safflower; and 85.2% at 8.9% m.c. for sunflower.
In a related study, Varma et al. (1993) obtained maximum oil recoveries of 82 percent at 9-9.5% moisture content for cooked rapeseed and 84 per cent when the seed was steamed at 0.1 MPa for 60 minutes.

The result of the Duncan Multiple Range Test (DMRT) is presented in Table 3. It indicated that the oil recovery mean at wormshaft speed N_1 (38.9%) is not significantly different from the mean at N_4 (36.3%) level. However, both oil recovery means are significantly lower than that at N_3 (41.1%) which also significantly lower than that at N_2 (66.9%) level. The oil recovery means at all the moisture content levels are not significantly different. It was also observed that the second (45 rpm) level of wormshaft speed and the second (5.3%) level of seed moisture content produced the maximum oil recovery mean.

Table 3: Results of Duncan mean range test for oil recovery at 5% significant level*

Levels	Wormshaft Speed (N), rpm	Moisture Content (M), % wb
1	38.8862a	48.3225a
2	66.9012b	53.8125a
3	47.1188c	45.3800a
4	36.3475a	41.7388a

*Any two means with a common letter in the same column are not significantly different

The result may be attributed to the fact that at 5.3% moisture level, the shear and compression are relatively better than at the other moisture levels. This is because moisture works as heat transfer medium. So the total heat generated by wormshaft during pressing might be fully transferred to the individual fat globules, which results in breakdown of the emulsion form of the fat and helps in releasing more oil droplets. While low moisture causes britleness, higher moisture content causes plasticising effect, which reduces the level of compression and gives poor recovery.

4. CONCLUSIONS

The following conclusions are drawn from the research work:

- The machine wormshaft speed of 45 rpm; the seed moisture content of 5.3%, wb and Yandev-55 accession are the optimum experimental levels that yielded 79.63% oil recovery in one crushing.
- The oil recovery and residual oil - in - cake of the dehulled beniseeds were highly affected by wormshaft speed and its interaction with moisture content alone.

5. ACKNOWLEDGEMENTS

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