# Development of a Sunflower Oil Expeller

A. Isaac Bamgboye[1] and A.O.D. Adejumo[2]
[1]Department of Agricultural and Environmental Engineering,
University of Ibadan, Ibadan
[2]Federal College of Agricultural, Institute of Agricultural
Research and Training, Ibadan.

Corresponding author: isaacbam22@yahoo.com

**ABSTRACT**

An expelling machine was developed for extracting oil from decorticated sunflower seeds. The expelling unit consists of an auger with decreasing pitches and the heating of seeds is achieved by generated steam, which heats the surrounding of seeds passage. The machine was tested at auger speeds of 30, 40, 50rpm respectively and three throughputs. Results showed that performance efficiencies increased with auger speed and throughput. Expelling efficiency of over 70% was obtained. The machine has expelling capacity of 24.4 litres/hr. of oil and throughput capacity of 502.64 kg/day.

**Keywords**: Sunflower, expelling machine, performance evaluation, efficiency, throughput, capacity, development, Nigeria

## 1. INTRODUCTION

Sunflower (Helinanthus annues L) is a plant of composite family belonging to large family of flowering plants that are mainly herbs and shrubs. Its tolerance to draught and great variety of soils accounts for its suitability to most areas of Nigeria. The seeds of sunflower are rich in oil (about 50 wt. %) and it is considered to be a potential source of proteins for human consumption. This is due to its high ratio of polyunsaturated/saturated fatty acids and the high content in linoleic acid (Ohlson, 1992; Isobe et al., 1992).

The oil extracted from sunflower seeds is a good source of vegetable oil for cooking, manufacturing of margarine, paints, soaps, and cosmetics. In addition to the oil, edible proteins can be obtained from the cake for human being consumption. At the local level, the cake can be boiled or fried for the table, or used in the preparation of edible cake called Kosei in Hausa, Akara in Yoruba, Moin-moin, Robo, soup ingredient etc. The cake is also a good source of protein in the manufacture of furfural in yeast, alcohol production and as fuel.

The increase in the population of developing countries is by far greater than the increase in food production. The calorie intake of most populace depends on cheap and easily available starch based food, as they could not afford the expensive animal based meal. Therefore, there is a need for a cheap source of nutrients (sunflower) to augment the shortage of protein and oil in the diets of large section of the population for proper growth and development. Hence, to meet the requirement of oil intake as recommended by the FAO, as well as meeting the demand of indigenous Agro-allied industries, extraction of oil from oil seeds such as sunflower is necessary. About 90% of sunflower seed produced is been utilized for oil extraction (Yoyock et al., 1988).

The most common method of extracting edible oil from oilseeds is mechanical pressing of oilseeds (Mrema and McNulty, 1985). This method ensures extraction of a non-contaminated, protein-rich low fat cake at a relatively low-cost. However, mechanical presses do not have high extraction efficiencies, about 8±14% of the available oil in the cake are left un-extracted (Srikantha, 1980). An estimated US$57 million worth annually of edible oil are left in the deoiled cake. Extraction efficiencies seldom exceed 80%, compared to over 98% achieved by solvent extraction methods (Bargale, 1997).

The oil content of sunflower is given as 35.45% (weight basis) and in the expression of oil by screw press, 60 to 70% of the oil from meal is recoverable Chakrauenty (1988). This is similar to the oil content of 36 to 45% obtained by Ogunremi (1988).

Considerable efforts have been made in the past to improve the oil extraction efficiency of screw presses. Most of them have focused on optimization of process variables such as applied pressure, pressing temperature and moisture conditioning of the fed samples (Ohlson, 1992).

Other methods that can be used in oil extraction include local method, which entails manual squeezing of ground sample by hand or on a hard smooth wooden platform (Ajibola et al., 1990). Weiss (1983), said that if an expeller is well maintained and handled skillfully, it is expected to process up to 13,000 and 26,000 liters per day of oil, reducing oil content of meal from 40-46% (Approximately). Khan and Hanna (1983) designed a screw press and found out that the pressure produced in screw rupture the oil cells and oil is expelled through slots between the cage lining bars. The capacity of screw press depends on the size of the cage, which holds the product (UNIFEM, 1987). Small expellers and power driven requiring about 3hp can process between 8 and 45kg per hour of raw materials, depending on the type of expeller (Kit, 1985).

Olayanju (1992) observed that the yield of oil from groundnut increases with a reduction in clearance. The expressing of the oil content from the seed can be done through solvent extraction, which involves the dissolution of condition seed in fluid and separated by flotation or by mechanical expression to press or squeeze the material. Adeeko and Ajibola (1990) investigated the effects of particle size, heating temperature, heating time, applied pressure and duration of pressing on the yield and quality of a mechanically expressed groundnut oil. They found an increase in the oil in the coarsely ground seed than that of finely ground sample. Heating breaks the oil bearing cells; allowing for easy flow of the oil (Lutanda ltd., 1988).

Machell and Chipital (1991), stated that sunflower provide acceptable edible oils in the unrefined state. Moreover, Zafforoni et al. (1978) found that sunflower, apart from the oil extracted from it for direct human consumption; it can also be used as a substitute for diesel oil in internal combustion engines.

Improvement in the mechanical extraction equipment and techniques through proper conditioning can raise oil recovery from 73% to 80% for rapeseed and groundnut (peanut) and from 60% to 65% for cotton seeds (Pathak et al., 1988). Efforts are been made to improve the performance of oil expellers through modifications in press design and by optimization. To increase production of oil from vegetable oils in developing countries, there is a need to develop more efficient mechanical screw presses.

## 2. MATERIALS AND METHODS

### 2.1 Design of the Sunflower Oil Expeller

#### 2.1.1 Description of the Sunflower oil Expeller

The main components of the oil expeller are frame, cake outlet, expeller housing, heating compartment, auger, hopper, auger pulley and shaft as shown in Figure 1. Various components of the oil expeller were designed using standard formula. The frame was constructed from 45x80x45mm channel and 45x45mm angle bar to give rigidity and stability that will withstand load and vibration. The cake outlet is located at the end of the expelling housing where the conditioned seeds are compressed and the oil content forced out through the oil outlet slots on the housing. The heating compartment, where the incoming steam heats up the seeds passing through enclosed passage is located close to the housing. The machine is powered by an electric motor or IC engine via pulley arrangement connected to the main shaft that turns the screw conveyor. The hopper into which the oil seed is fed is located at the top of the housing. The steam generator, which is constructed of thick pipe, imbedded in is electric heating element and coupled to the heating compartment by an inlet pipe and steam return pipe with water jacket to condense the steam.

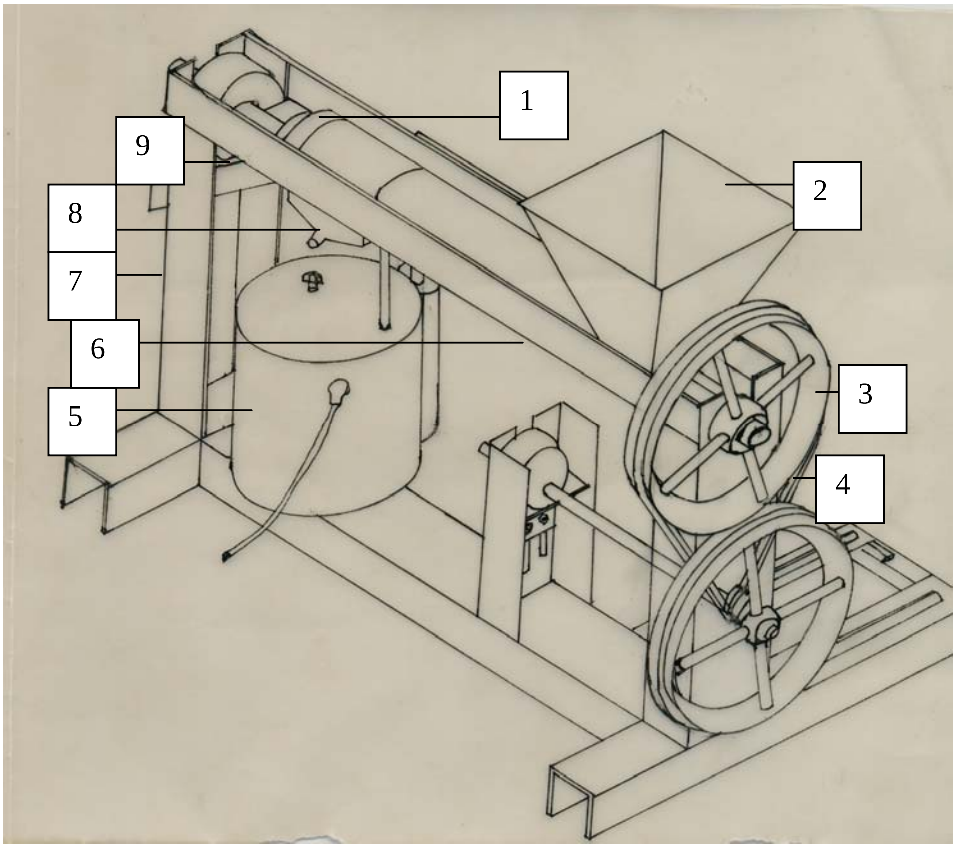


Fig. 1 Sunflower Oil Expeller

Legend: 1. Auger, 2. Hopper, 3. Auger pulley, 4. Pulley belt, 5. Heating compartment, 6. Expeller housing, 7. Frame, 8. Oil outlet, 9. Cake outlet.

**2.1. 2 Operation of the Oil Expeller**

The operation was based on the axial movement of the material in the screw press. 3hp electric motor was used to power the machine. The heating compartment is connected to electricity by a flexible cable and switch on to heat the seeds passage prior to the introduction of seed for some minutes. Then the oil seeds are fed from the hopper to the screw conveyor which rotates in an expeller housing. When the electric motor is switch on, the main shaft and the auger, which moves and packs the seed being heated along the passage to the far side, will start to rotate. The compression is achieved by decreasing pitch of the auger, designed to act as a screw press. The conditioned seeds are compressed and the oil content forced out through the slots on the housing. The heating of the seed along the passage, and high pressure generated at expeller housing due to drastic reduction in volume, ensured expelling of the oil content.

## 2.2 Evaluation Procedure

Sunflower (Oil type) collected from the Institute of Agricultural Research and Training (IAR&T), Ibadan, was used for evaluation of the machine. Evaluation of the machine was carried out at speeds 30, 40 and 50 rpm and on three levels of throughputs. The Sunflower seeds were decorticated and cleaned. Samples were then weighed to determine the weight before loading into the expelling machine. The weighed samples were allowed to pass through preheated chamber to roast the seeds as it moves in the screw conveyor along the seed passage before extracting the oil. The cake was also weighed after expelling to know the quantity of oil expelled; and the expected oil yield was calculated on 36% of samples weight (Ogunremi, 1988). Statistical analysis was carried out using ANOVA, linear and nonlinear regression, Ducan multiple range text

# 3. RESULTS AND DISCUSSION

Table1. Mean performance of the Sunflower Oil Expeller

| Speed(rpm) | Through put | Seed weight (g) | Oil Yield (g) | Cake Yield (g) | Expected Oil Yield (g) | Expelling Efficiency (%) |
|---|---|---|---|---|---|---|
| 30 | 1 | 104.40 | 24.12 | 80.28 | 37.58 | 64.18 e |
| | 2 | 105.32 | 24.12 | 81.19 | 37.91 | 63.62 e |
| | 3 | 106.52 | 24.15 | 82.37 | 38.35 | 62.98 e |
| 40 | 1 | 104.34 | 25.11 | 79.24 | 37.56 | 66.84 d |
| | 2 | 105.30 | 25.93 | 79.37 | 37.91 | 66.39 c |
| | 3 | 106.11 | 26.35 | 79.76 | 38.20 | 68.98 c |
| 50 | 1 | 104.47 | 26.05 | 78.42 | 37.61 | 69.27 c |
| | 2 | 105.22 | 27.01 | 78.21 | 37.88 | 71.31 b |
| | 3 | 106.42 | 28.00 | 78.42 | 38.31 | 73.08 a |

Total mean = 67.63 Standard Error= 0.400

Table 1 is the summary of the results of the performance of the developed screw press oil expeller with sunflower samples at different speeds. Oil yield was observed to increase with an increase in speed and throughput. The same pattern was observed in the efficiency from 63.59 % at speed 30 rpm to 71.21% at speed 50 rpm (Table 2).

Table 2 Mean Effects of Speed and Throughput on Expelling Efficiency.

| Speed | Mean | Standard Error | 95% Confidence Lower Bound | Interval Upper Bound |
|---|---|---|---|---|
| 1 | 63.592 c | 0.231 | 63.070 | 64.114 |
| 2 | 68.070 b | 0.231 | 67.547 | 68.592 |
| 3 | 71.2179 | 0231 | 70.694 | 71.739 |
| Through put | | | | |
| 1 | 66.761 b | 0.231 | 66.239 | 67.283 |
| 2 | 67.772 a | 0.231 | 67.250 | 68.294 |
| 3 | 68.345 a | 0.231 | 67.822 | 68.867 |

The results suggest that the performance of the machine is highly depended on auger speed and quantity of material passing through the machine (Through put); with expelling operation probably at its peak of just over 70% at 50 rpm. Analyses of variance indicated significant differences at 5% level of significant in oil yield and efficiency due to speed and throughput.
Preliminary test carried out on the machine without heating of the seeds gave no oil yield; only paste was observed through the cake outlets. This result suggests that for oil to be extracted from sunflower seed, heating is inevitable. When the seed was roasted before extracting oil from it, oil was produced because of the breaking of oil bearing cells during heating (Lutanda Ltd, 1988). The highest expelling efficiency of 62 - 73% is within the range of 60 to 70% obtained by Chakraventy (1988) with screw press, but lower than 94.7% obtained from palm kernel (Akinoso, et al., 2006).

## 4. CONCLUSION

A sunflower oil expeller with a capacity of 24.43l/hr. was developed. Evaluation of the machine on sunflower gave an expelling efficiency of 70% at the speed of 50 rpm. However, improvement in the design of the auger and the heating device is expected to greatly improve the performance efficiency of the machine. The power requirement of the machine is 3hp and is designed to expel oil from sunflower and can be adapted to expel oil from most oil seed varieties.

## 5. REFERENCES

Adeeko, K. A. and Ajibola, O.O. (1980). "*Processing Factors Affecting Yield and Quality of Mechanically Expressed Groundnut Oil*". Journal of British Society of Research in Agricultural Engineering. Vol.45. No. 1. pp31

Ajibola, O.O., Eniyemo, S.E, Fasina, O.O and Adeeko, K.A. (1990). *Mechanical Expression of Oil from Melon Seeds*. Journal of British Society of Research in Agricultural Engineering. Vol.45. No. 1. pp 45.

Akinoso, R., Igbeka, J.C., Olayanju, T. and Bankole, L. (2006). "Modeling of Oil Expression from Palm Kernel ( *Elaeis guineensis* Jacq.)". Agricultural Engineering International: the CIGR Ejournal. Manuscript FP 05 016. Vol. VIII. October, 2006.

Bargale, P. C. (1997). *Mechanical oil expression from selected oilseeds under uniaxial compression*. PhD Thesis, Department of Agricultural & Bioresource Engineering, University of Saskatchewan, Saskatoon, Canada.

Chakraventy, A. (1988). "*Post Harvest Technology of Cereals Pulses and Oil Seeds.*" Oxford and IBH Publishing Co. PVT Ltd. New Delhi. Pp. 258-266

Khan, L.M and Hanna, M.A. (1983). Expression of Oil from Oilseeds – A Review. Journal of Agricultural Engineering Research. Vol. 28. pp.495-503.

Kit, A. (1985). "*Make Your Own Oil*". Royal Tropical Institute Magazine. Vol. 63. Amsterdam, Netherlands.

Luthanda Limited (1988). *Sunflower Processing in Zambia (manual)*. Lusaka, Zambia. Machell, K and Chipikas, A. (1991). No 1 Rural Production of Cooking Oil in Zimbabwe, Using the Tinytech Oil Mill (Investment Prospectus) pp.13-17.

Mrema, G. C. and McNulty, P. B. (1985). *Mathematical model of mechanical oil expression from oilseeds*. Journal of Agricultural Engineering Research, 31(5), 361}370

Ogunremi, E.A (1988). *Sunflower in Nigeria from Planting to Processing.* Research Bulletin. Institute of Agricultural Research and Training, Ibadan. No. 17, pp.1-16.

Olayanju, T.M. (1992). "*Design, Development and Evaluation of a Manually Operated Groundnut Oil Expeller*. A project report submitted to the Dept. of Agric. Engineering, university of Ibadan.

Ohlson, I. S. R. (1992). *Modern processing of rapeseed*. Journal of the American Oil Chemists' Society, 69, 195-198.

Pathak, B. S., Singh, A., Singh, D., & Verma, R. N. (1988). *Performance of oil milling technologies in India*. Agricultural Mechanism in Asia, Africa and Latin America, 19 (4), 68-72.

Srikantha, P. V. R. (1980). *A search for an appropriate technology for village oil industry*. AIDA: Lucknow (India) Publications.

UNIFEM (1987). *Oil Extraction for Cycle Technology*. Handbook of United Nations Development Fund for Women. New York.

Weiss,E.A. (1983). *Oilseed Crops*. Longman. London, U.K.

Yoyock, J.Y, Lombia, G and Owonubi, J.J. (1988). "*Crop Science and Production in Warm Climates*. General Edition. Macmillan Intermediate Agricultural Series, London.

Zaffaroni, E, Kaufman, K.R and Pratt, G.L. (1987). "*Vegetables Oil as Substitutes for Diesel Oil in Brazil"*. Applied Engineering in Agriculture. Vol. 3, no. 2, pp.266.