

Technologies for Oil Extraction: A Review

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Abstract— This paper is designed for people who have little or no technical background or earlier knowledge of oil extraction processing. It provides a vital introduction to both traditional and improved methods for the extraction of vegetable oil from oilseeds. Comparisons are made between different improved technologies aim to show under what circumstances they may be technically appropriate or inappropriate.

The improved method include; Mechanical Extraction (oil expeller, motorized screw press) and solvent extraction (chemical extraction). Also problems associated with each method and the needs for more research for the improvement of the methods are analyzed. It has been shown that for any developing country to effectively adopt modern methods in the production of edible vegetable oils, improvement on the existing traditional methods, environmental factors need to be studied. This can be achieved through more research in the recommended area of need. Also oil expression technology in order to create an interest and awareness of the technology, which may help improving the rural development as wealth and self-employment.

Keywords— oil extraction, oil bearing agricultural products, Vegetable oil extraction.

I. INTRODUCTION

India is one of the largest producers of oil seeds in the world and Maharashtra is one of the major oil seed producing and edible oil producing state in India [2]. Expelling operations have come a long way since its inception many centuries ago. From the simple rural 'Ghanis' that were time-intensive and low in capacity, expelling equipment manufactured today, including in India, boasts of high capacity, high workmanship and operational efficiency, and, low power consumption. India has always been blessed with a richness of agricultural produce. Expelling has been an operation prevalent in India for several centuries and still continues to support rural households. The agricultural products are classified into oil-seeds (cotton, castor, sunflower, etc), nuts (coconut, groundnut, sheanut, etc) and mesocarps or fruits (oil palm). Plants bearing these agricultural products have greatly contributed to the economic development of many countries.

The oil serves as a major source of vegetable oil that constitutes a good percentage of meal in the diets of common people. The oil as well as the by-products are also very useful as food and non-food materials for the production of snacks, cake, margarine, biscuit, cosmetics, detergent, plastics, etc. Until the eighteenth century, technology for oil extraction was limited to combined leverage and the use of animal power. In the eighteenth century, wind and water power largely replaced animal power to assist in oil extraction. Oil production is important not only among small-to-medium scale industrialists, but also to rural populace, employing quite a substantial workforce serving as a source of income to many communities engaging in the exercise.[3].

II. TYPES OF OIL EXTRACTION METHOD

Extraction of oil from oil-bearing products could be done in two major ways. I) Traditional Methods II) Improved Methods. The traditional method is usually a manual process and involves preliminary processing and hand pressing. The improved method consists of chemical extraction and mechanical expression. [4]

III. TRADITIONAL METHODS

Traditional oil expellers are simple mechanical devices that are hand/animal operated. These equipments work on the principle of mechanical compression and require no electricity or fuel for operation. They are fabricated using inexpensive components that can often be manufactured locally. Non-motorized expellers are used in rural settlements for domestic crushing of oilseeds, such as copra (dried coconut meal), mustard, groundnut, soybean etc. Being hand operated, these devices have low expelling capacities of about 2 - 5 kg/hr, or 20 - 30kg/day.

Types of Traditional Expellers

- I. Indigenous method (Traditional Domestic Methods)
- II. Ghanis (Granite Ghani. Wooden Ghani, Bengal Ghani etc.)
- III. Presses (Plate Presses and Ram Presses)
- IV. Screw Presses
- V. Hydraulic Press

I) Indigenous method (Traditional Domestic Methods)

Hot water floatation is probably the simplest method and is still used in many rural areas. Seeds are ground manually unless a local mill is both accessible and affordable. The paste is heated, alone at first, and then with boiling water. The mixture is stirred and brought to the boil. After boiling, the mixture is allowed to cool during which time the oil gathers at the top and is scooped off. In traditional methods of processing oil seeds the extraction efficiency is about 40% .(extraction efficiency refers to the percentage of oil extracted based on the total theoretical content, which of course is never in practice obtained) (TDRI, Private Communication) The extraction efficiency is generally low, and problems often occur with the formation of oil-water emulsions which makes the final separation difficult. In some cases salt is used to break such emulsions. It can be used to process oil seeds at the village level as: groundnuts, sunflower seed, palm kernels, coconuts, sesame seed, rape- seed, castor seed and sheanuts.

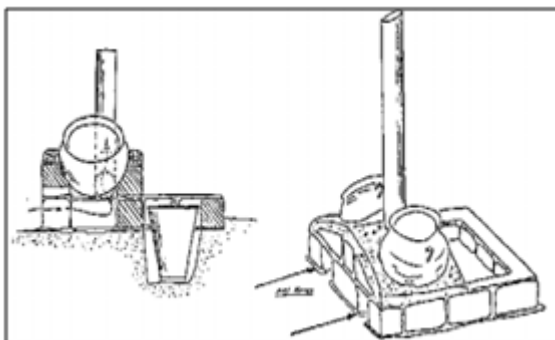


Fig.1: Heating Oven (KIT)

II) Ghanis (Granite Ghani. Wooden Ghani, Bengal Ghani etc.)

p Ghanis originated in India where they are primarily used to express oil from mustard and sesame seeds, although in some cases they can be used for coconut and groundnut processing. Traditionally ghanis (Fig.2) are operated by animals and can be manufactured locally. They consist of a wooden mortar and wood or stone pestle. The mortar is fixed to the ground while the pestle, driven by one or a pair of bullocks or draught animals is located in the mortar where the seeds are crushed by friction and pressure. Depending on the size of mortar and type of seeds, an animal – powered ghani can express about 10 kg of seeds every two hours (TDRI, Private Communication). The ghani process requires much mechanical energy. A ghani operated by one bullock (the equivalent of 0.35 kW) can process 5 kg oilseed in about one hour. Hence, 0.3515 or 0.07 kWh is required to process 1 kg of an oilseed into oil. This energy consumption is about equal to the maximum amount of energy required by small oil expellers.



Fig.2: Animal Powered Extraction (Ghani)

III) Presses

a) Plate Presses

Many different types of mechanical press are in use but they fall into two basic types, plate presses and rams presses. In the first type a plate or piston is forced into a perforated cylinder containing the oil bearing material by means of a worm. In some cases hydraulic jacks have been used, care is needed to make sure there is no leakage of hydraulic fluid that might contaminate the edible oil.



Fig.3: Plate Presses

b) Ram Presses

The ram press is a manually operated mechanical (Fig.4) press capable of pressing a range of oil-seeds including sunflower, sesame and groundnuts, as well as seeds from pumpkin, rape, watermelon, mustard, and *Jatropha Curcas*. The ram press can be operated continuously without the need to remove cake. The capacity of the press is 14 litres of oil for an eight-hour shift, which approximately amounts to pressing a 55-kg bag of seeds, although the capacity would depend on the type oilseed and its temperature at the time of pressing. Operation of the press is very simple and therefore an operator can be trained to use the equipment in about one hour. Maintenance is limited to simple routine cleaning and general checks.

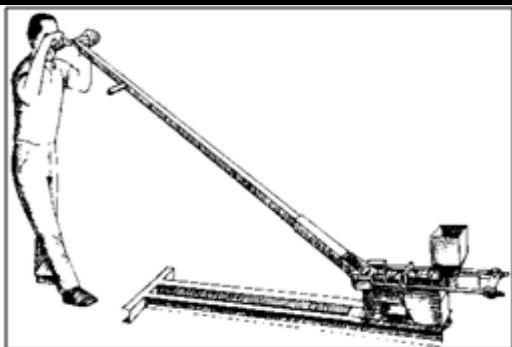


Fig. 4: Ram Presses

IV) Screw press

In screw press (Fig.5) that is manually operated the substance from which the oil is to be expressed is pressed slowly and with maximum pressure by plunger (round steel plate), forced down by a screw, and into a cylinder with a large number of small holes.

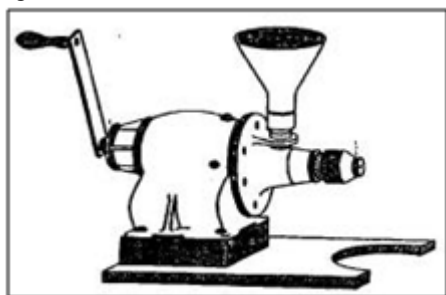


Fig.5: Screw press

V) Hydraulic Press

In hydraulic press that can be manually or power operated, pressure is exerted by hydraulic device such as a lorry jack. They require a heavy, rigid frame structure. Because of the weight of such a structure the press must be stationary and cannot be moved as easily as a screw press. Hydraulic presses can process mesocarp (fruits), oil-seeds and nuts as they generate greater pressure than a screw essential to ensure that hydraulic fluid, which may be toxic, does not come into contact with the food stuff.

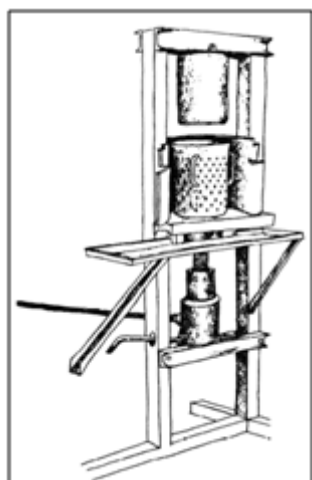


Fig.6: Kit spindle press

IV. Improved Methods.

a) Chemical Extraction

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The chemical extraction method requires the use of organic solvents to recover the oil from the products. Solvent extraction method involves the use of organic solvents such as straight chain hydrocarbons, chlorinated hydrocarbons, alcohols and ketones to recover the oil from the sources. The process for solvent extraction of nut (groundnut) is similar to that of seeds (soybean, cotton, etc). Solvent extraction is capable of removing nearly all the available oil from oil-seeds or nuts. About 98% of the oil is being extracted by solvent method. [9]. In addition to the high yield of oil, the method produces oil with better qualities, and a higher protein meal [10]. The method generally requires more capital expenditure, and refining the oil before use. There is also possibilities of toxicity from the solvent used and danger of fire explosion from the use of volatile organic solvent.

b) Mechanical Extraction

All headings Mechanical method involves the application of pressure to already pre-treated oil-bearing products. The essential components of a typical small-scale expeller are shown in Figure 7. The expeller is driven either by an electric motor or by a diesel engine. At the heart of the machine is a powered worm shaft which rotates inside a closely fitting cage. The oilseed is fed continuously into the press through a hopper and is crushed as it is transported through the cage by the worm shaft. Pressure is exerted on the system by restricting the gap at the end of the cage through which the oil cake is discharged from the press. The expelled oil drains out of the cage through small gaps.

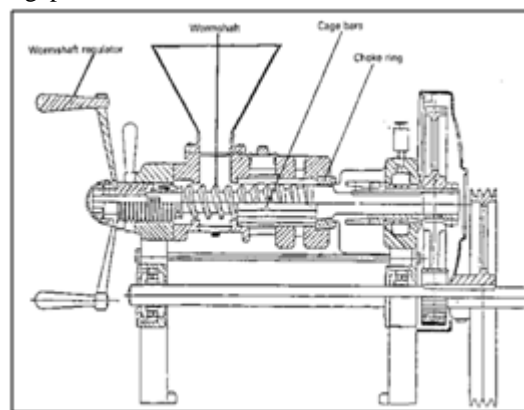


Fig.7: Mechanical Extraction

V. Comparison

All although processing of oil-seeds, nuts, and fruits for oil production is achieved by both traditional and improved techniques, oil extraction techniques have not changed significantly over the years as the bulk of this trade is still in the hands of rural women employing traditional systems only. Apart from discouraging many oil producers from continuing with the trade especially at old age, this difficult task also limits the capacity and oil yields of those determined to continue with the trade.

Accessibility to modern equipment and spare parts, degree of complexity of the equipment, maintenance, and the availability of power source constitute other major setbacks [8].

In most of the developing countries, there has been a steady rise in the demand of edible oil both for domestic and industrial uses. Therefore, continuous review of existing methods of oil expression or extraction from oil-bearing agricultural products will no doubt continue to reveal the current state of the art especially on aspects that require further improvement.

The different methods that are used to extract oil from oil-bearing seeds are listed in Table. All these technologies have been applied in Eastern and Southern Africa for seeds including cottonseed, soybean, sunflower and groundnuts. [5, 6, 7]

Table 1: Oil-Seed Processing Technologies

Technology	Description	Capacity
Solvent Method	Industrial technology; oil-seeds rolled to reduce them to flakes, which are dissolved in a solvent that extracts the oil.	120 tons/day
Intermediate (screw expellers) technology	Power-driven technology, oil-seeds continuously fed, pre-heated, crashed and pressed to expel oil as it passes through the machine.	90 kg/h
Oil-plate method	Plunger/cylinder presses, either screw operated or hydraulically operated	15 kg/batch
Indigenous methods	Traditional domestic method; pounding, boiling and skimming.	Few kg per day
Lever-operated Ram Presses	Manually operated mechanical press, seeds are fed continuously, and oil separates from cake	55kg/shift

Out of the five methods, the ram press technology is the most adaptable to small-scale rural activity. The ram press technology is based on a manually operated machine but allows for continues feed of the seeds with no need for stopping the pressing in order to feed the seeds. It is less efficient than the industrial-based methods (solvent extraction and using screw expellers) that require special and expensive machinery electrically powered and strict hygienic conditions that are cannot be easily obtained at the small-scale rural level. Indigenous methods on the other hand are not efficient; some of them (like hot water extraction) are very laborious and time consuming.

VI. CONCLUSION

The vital introduction to both traditional and improved methods for the extraction of vegetable oil from oilseeds has been reviewed. In introducing new technologies it is important to make comparisons between the proposed improved technology and traditional methods. In some cases, it was found that the improved technology was no better than the traditional method and in fact increased the labor requirements and time inputs or resulted in an excess demand for raw materials. The availability of inputs such as animal power and human power need to be assessed.

However, some aspects of oil expression technology in order to create an interest and awareness of the technology, which may help improving the rural development as wealth and self-employment. The adoption of these simple machines will no doubt develop the capacity of local artisans in the oil extraction business who are quite talented but hardly diversify due to lack of new and adaptable technologies. So that develop a new machine powered by human powered which has tremendous utility in energizing many rural places where reliability of availability of electric energy is much low. Also machine Adoption of simple machines by small oil producers needs more attention for jobs are generated.

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