INTRODUCTION

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Position of Vegetable Oil Industry in India

India is the third largest producer of oil seeds in the world, average annual production during the period 1951-1954, being 6.4 million tons or 10% of the total world production, compared with 17 million tons by China and 15 million tons by U.S.A. (84). The present position of five major oil seeds in India is summarised in the table below (56 & 77).

	Year 1954-55			Year 1960-61 (End of Second Five Year Plan)	
Seed	Acreage, Thousand Acres.	Production of seeds. *Lakh tons.	Production of Oil. Lakh tons	Production of seed Lakh tons	Production of Oil Lakh tons
Groundnut	12,647	38.23	9.38	47.00	10.67
Sesamum	6,460	5.92	1.84	6.51	2.02
Rape and Mustard	5,665	9.62	2.91	10.60	3.23
Linseed	3,290	3.88	1.14	4.28	1.26
Castor Seed	1,273	1.12	0.39	1.61	0.56
Total		58.77	15.66	70.00	17.74
Other Oils			1.94		3.40
Grand Total			17.60		21.14

Other Oil Seeds

In addition to the 5 major oil seeds stated above, there are various other oil seeds from which appreciable amounts of oils are extracted, e.g., Coconut and Cotton seed, and non-edible oil seeds like Karanja, Neem, Kusum, Punsi, Polang, Nageswar, Kamala seed, Mahua and Khakhan or Pilu Oil.

* 1 Lakh = 100,000.

In 1954-55, Cotton plantation was done in 18.35 million acres of land and production of cotton seed was 5 million tons. But extraction of cotton seed oil was not considered an economic proposition and most of the seed is used as cattle fodder. Production of cotton seed oil was 5000 tons in 1950-51 and 9000 tons in 1955-56. Second Five Year Plan envisages production of 5.5 million bales of raw cotton by 1960-61, which will provide 1.8 million tons of cotton seed, from which 1.8 lakh tons of oil can be extracted. Against this huge potentiality, the target of production in 1960-61 has been fixed at only 30,000 tons of cotton seed oil. This would need only 2.5 lakh tons of cotton seed or only 11% of the total supply available. There would be simultaneous production of 20 million lbs., of linters for meeting the requirements of cellulose acetate and nitro-cellulose industries. This colossal waste of national wealth can not be stopped, unless an economic method of cotton seed oil extraction can be found out. The Planning Commission of the Govt. of India have strongly emphasised about the adoption of solvent extraction method for extraction of more cottom seed oil.

Coconut is cultivated in 1.5 million acres of land. Both in respect of area and production, India ranks second among the coconut growing countries, first being Philippines. Current produstion of coconut is 3800 million nuts and coconut oil is 1.3 lakh tons. Target of production of coconut oil in 1960-61 is 2.1 lakh tons. India imports some coconut oil, chiefly from Ceylon, Singapore and Malaya and in 1954 22,900 tons valued at Rs. 3.58 crores were imported. In the same year India exported

1.52 lakh tons of vegetable oils, valued at Rs.18.98 Crores.

Consumption of Oil

The utilisation of oil for different purposes is as follows (90) :-

Purpose	Quantity in lakh tons (1954-55)	Quantity in lakh tons (1960-61)
1. Edible purposes	11.39	11.92
2. Vanaspati manufacture	2.59	4.30
3. Industrial purposes (Soap, paints & Varnishes, Lubrication, hair dressing and miscellaneous)	2.24	2.78
4. Export	1.38	2.14
Total	17.60	21.14

Per capita consumption of oils and fats in India in 1954-55 was only 11.5 lbs. per annum.

Oil-Mills

In 1951 there were about 174 large scale of oil mills in India, with an annual rated capacity of 5.8 lakh tons oil. There are at present 2097 oil mills registered under Factories Act and total number of power driven mills is 3200, with a total crushing capacity of 56 lakh tons seed per annum. In addition there are about 4 lakh village ghanis with an annual crushing capacity of 7 lakh tons bringing the total crushing capacity to 63 lakh tons. The actual out put is 50 to 55 lakh tons per annum.

The capital invested in 1955 (for registered factories in 1952) was 24.33 Crores, giving employment to 43,500 persons. In addition about 3.5 lakh persons are employed in small scale production of oil. For the development of small scale and village industries, more stress has been laid on crushing of seeds in ghani, for which Rs. 6.7 crores have been sanctioned in Second Five Year Plan. The Oil Seeds Crushing Enquiry Committee (63) have also advocated the encouragement of ghani crushing even if there is a slight loss of vegetable oil.

Methods of Oil Extraction

Two methods of oil extraction are universally prevalent all over the world -

A) By application of pressure

B) By solvent

Numerous attempts have been made to introduce a third process - aqueous extraction of oil, but it has not met commercial success. A brief review of the different methods now follows.

Extraction by Pressure

Before pressing, the seeds are subjected to a mechanical pretreatment which consists of :

i) Decorticating, by which treatment the hulls are removed. Decorticating is necessary in the case of groundnut, cotton seed etc. Cotton seed also requires delinting.

ii) Preliminary crushing to break the oil cells, which is usually done in roll mills. In case of Copra and Palm Kernel oil, a disintegrator may be used.

iii) Heat treatment or "Cooking". The seeds are heated usually to 50-60°C and in some cases to 110°C. This is done by cooking the seeds in steam jacketted vessels. During cooking, a definite proportion of water or steam is also added to the seeds, where by the albumin is coagulated. By this treatment the flow of oil, which depends on the temperature and moisture content of the seeds, becomes easier. The different methods of applying pressure are :

A) Hydraulic Press

i) Open or Plate type

ii) Closed or Cage type

B) Expeller or Screw Press

In the plate press the seeds are wrapped in cloth bags, placed between horizontal iron plates and a pressure of $1\frac{1}{2}$ - 2 tons per Sq.in., is applied for a period of 10-40 minutes. In the cage press the seeds are directly pressed between horizontal plates, without using any cloth bag. The plates are enclosed in a perforated casing, through which oil can flow but the solids are retained. A pressure of 3-4 tons per Sq.in., is usually applied. The cage press offers more advantage than the plate-press. In both the plate and cage type presses, the pressure is usually applied in two stages. Initially a pressure of $\frac{1}{4}$ - $\frac{3}{4}$ ton per Sq.in., is used when the best quality oil comes out and the seeds are then subjected to the maximum pressure. Usually a single pressing is enough for oil extraction, but if the oil content of the seed is more e.g., groundnut, copra etc., after the first pressing the oil cake is broken up and the seeds are then subjected to a second pressing.

An expeller or screw press is a continuous process, where the seeds are pressed by a screw through a narrow annulus between a conical head piece and a perforated cage, whereby an extremely high pressure of 7-10 tons per Sq.in., is applied. The expeller offers more advantage than hydraulic pressing, is more economical and is widely used in industry. Seeds very rich in oil content are subjected to expeller pressing and after reducing the oil content to the desired figure, the oil cake is obtained in a form, which is highly suitable for solvent extraction process.

Average capacity of an expeller or rotary ghani in India is 5-6 tons per day of 24 hours, hydraulic press 2½ tons and country ghani 20 seers * in 4 batches at the rate of 5 seers per batch. The number of working days in the year is about 250. (58)

Solvent Extraction of Oil

This technique has been developed mostly in Germany and has been practised all over Europe since a long time. For extraction of oil from seeds containing a low or medium percentage of oil e.g. cotton seed , soy bean etc., this process can be applied directly. For seeds containing a high percentage of oil, like groundnut, copra, castor seed etc., the seeds are subjected to cold and moderate pressing, whereby the finest and best flavoured oils are obtained. The prepressed seeds are subjected to solvent extraction for maximum recovery of oil. Anderson Exsolex process as reported by Hunt Moor (33), consists of extraction in a pre-expeller followed by solvent extraction of the cake. The process claims to be more economic.

The modern trend in oil extraction in the whole world is in favour of solvent extraction process as is evident from large number of plants which are in operation. During the year ending 1953, in U.S.A. 86% of soy bean was treated by solvent extraction,

* 1 seer = 2 lbs. approx.

as compared with 28% in 1945-46. Solvent extraction process has been increasingly adopted for cotton seed in the past 5 years (22). The process has been applied to groundnut, flax, rice-bran etc., and even to oil cakes in recent years.

A brief outline of the process of solvent extraction of oils is given below :-

Preliminary treatment of Seeds

The seeds are cleaned and then decorticated and delinted, where necessary. The meat is sent through a flaking machine, which consists of a series of roll mills. Proper flaking depends on the moisture content and temperature. The flakes must be as thin and arched as possible and should have enough mechanical strength to retain their shape during extraction. Usually oil seeds are flaked but oil cakes are not, prior to extraction.

Batch Extraction

An extractor for the batch process usually consists of a cylindrical steam jacketted kettle with a large ratio of diameter to depth. It is fitted with a reflux condenser, a vertical agitator and a perforated steam coil for direct injection of steam into the meal.

A number of such extractors, varying from 3 to 8 in number forms a battery which is operated on strict counter current principle. Fresh solvent is introduced into the extractor which contains the most nearly exhausted meal, flows through the extractors in series and is finally withdrawn as a concentrated miscella from the tank, which contains freshly charged seeds. The ratio of solvent to oil is about 3 : 1.

The exhausted meal is then steamed. The solvent and steam after being condensed, are separated by continuous decantation. A batch extraction plant can be run economically with a daily capacity of as little as 3 tons of seed*.

<u>Continuous Extractors</u>

The first continuous extractor was introduced in Europe on a commercial basis in the early 1920's. The continuous process is used for handling huge tonnage of materials with minimum economic size of the plant as 50-100 tons per day, the largest plant in the world in operation having a capacity of 800 tons.

The most widely used continuous extractors are of German origin and of various types of extractors installed all over the world, the following are in the order of total installed capacity Bollman, Hildebrandt and Fauth. Some American extractors e.g., Allis-Chalmers, Bonotto, French, Bohm, Miag etc., are now being installed.

The Bollman extractor looks more or less like a bucket elevator, in which the bucket or buckets are moved very slowly, on an endless chain through an enclosed extractor. The buckets which are charged with seeds are perforated. Fresh solvent is sprayed continuously on the bucket which is going to discharge the exhausted meal. The solvent percolates from bucket to bucket and a concentrated miscella is obtained.

In the Hildebrandt type, the extraction is carried out in a large U-tube, through which the seeds are conveyed by perforated screens against a counter flow of solvent.

In the Fauth type, the extraction is carried out by conveying the seeds by means of a moving conveyor belt of filter cloth, through the solvent and miscella is squeezed from the seed mass in a number of stages. The Fauth extractor is successfully used for peanuts and copra, which have got high oil content and which are liable to disintegrate during the treatment .

The Allis-Chalmer extractor consists of a tall cylindrical tank, which is divided into a series of sections, separated by slotted plates with a central shaft and revolving paddles above each plate. The seeds are conveyed below from plate to plate by the revolving paddles against an upward flow of solvent.

Other extractors are more or less modifications of the above types and for detailed descriptions reference may be made to Bailey (5, p 492).

Treatment of Miscella

The oil solvent mixture, called miscella contains about 20 to 30% oil. It is filtered to remove fine particles. The miscella is then concentrated to 50 to 60% oil in atmospheric evaporators, followed by further concentration to about 90% oil in vacuum evaporators. The solvent recovered is sent to storage tank for re-use. The highly concentrated miscella is now fed to the top of a vacuum stripping column heated by direct steam. The solvent is collected from the top and the oil now entirely stripped of the solvent is continuously discharged from the bottom of the tower. Care should be taken to see that at no stage of concentration, temperature exceeds 200-212°F.

The Meal

The exhausted oil seeds, remaining after extraction of the oil by pressure is called oil cake, whereas that left after solvent extraction is termed meal. The meal which contains about 35% solvent, 7% water and 0.5% oil, is first steamed and then sent to the dryer. The meal drying system consists of a number of screw conveyors, connected in a series and heated by direct and indirect steam. The vapours of the solvent are recovered by condensation and the dried meal, if meant for cattle feeding is conditioned by baking in a toaster and sent to storage.

Merits and Demerits of Solvent Extraction Process

a) The chief advantage of the solvent extraction process is that maximum amount of oil can be extracted from the seeds. While the oil content of the cakes after most efficient mechanical processing is about 4-7%, that in the meal is only 1% or less.

b) Solvent extraction process can be more easily applied on seeds which form thin and firm flakes, like soybean and cotton seeds. For seeds like groundnut which are liable to disintegration, more mechanical difficulties have to be encountered in the solvent extraction process.

c) One argument which is frequently put forward against solvent extraction process is that, while the oil cake because of its high oil content, is a valuable cattle fodder particularly for milch cows, the oil meal is not. Goss (28), states "The meal from the solvent extracted cotton seed is claimed to be excellent cattle food, with superior nutritional value". However this point is controversial. The meal has got a greater value as a manure than the oil cake.

d) In a solvent extraction plant there is always the danger of fire hazards, which is non existent in mechanical crushing plant.

e) The process requires huge capital investment.

Present Position of Solvent Extraction Plants in India

The first solvent extraction plant was started in India in 1905, but it was an economic failure. According to Parekh (74, p-148), at present (till May, 1957), 9 units having a combined total capacity of 400 tons cake per day, are working in India, mostly with groundnut cake. Seven units having a total capacity of 300 tons cake per day, are under erection and they are expected to be completed by the end of 1957. Twenty seven units for solvent extraction have been registered. At present of the total vegetable oil produced in India, only 0.1% is obtained by solvent extraction and the rest 99.9% by pressure. The target for solvent extraction for First Five Year Plan was fixed at 4 lakh tons of oil cake. The target for Second Five Year Plan is 8 lakh tons of oil cake, per annum.

Future Possibility of Solvent Extraction in India

Parekh (74, p-24) states that although groundnut cake is mostly used in India for solvent extraction, 6 million tons of other oil bearing materials as stated below are available locally.

Name of Material	Quantity in thousand tons.
Edible oil cake (after deducting 0.65 million tons for animal fodder)	1,750
Half the cotton seed production (other half to be mixed with de-oiled cake)	700
Non edible oil seeds	500
Rice-bran	2,500
Other oil seeds and oil bearing materials (estimated)	550
Total -	6,000

The above raw materials will require 400 solvent extraction plants, each of the capacity of 50 tons per day; and that working 300 days in a year, they are expected to recover 0.6 million tons of oil (with 10% recovery), valued at 60 crores of rupees. The capital investment will be Rs. 50 - 60 crores and additional jobs created will be 40,000.

In addition to the above raw materials for solvent extraction, 4 lakh country ghanis are expected to produce another 18 lakh tons of oil cake, which can augment another 18 crores of rupees to our national income on 10% recovery basis. In order to transform the inefficient ghanis to efficient ones and to stop the national waste, the Govt. of India, Planning Commission (77) advices the working of a 25 tons per day solvent extraction plant on a co-operative basis, with 756 ghanis lying within a radius of 10 miles.

The progress of the solvent extraction though very slow at present, is likely to assume an enormous possibility in coming years with the availability of suitable solvent and proper market for de-oiled cake.

Parekh after a critical study of the solvent extraction plants in India, estimated that under Indian conditions, the cost of a continuous type, 50 tons per day plant, will be more suitable and it will cost Rs. 7 lakhs (74, p-27 & 135) and that solvent loss will come to about 13.5% on the total cost or 2 Imperial gallons per ton of material entering the plant. Kumaraswamy (45) discusses the prospect of solvent extraction in Hyderabad State and states that 6,500 - 7,000 tons of additional oil, giving a profit of Rs. 76 lakhs can be obtained, if solvent extraction of oil cake is practised with alcohol.

The most important factors, which stand in the way of economic development of this process are :

a) High cost of solvents in India

b) High solvent loss, because of hot climate and installation of costly refregeration system to keep down the solvent losses.

c) Non availability of suitable solvents

d) High cost of machinery and difficulty in getting foreign exchange for purchase of machinery.

<u>Position of solvents in India</u>

Parekh (74, p.p-114, 115 & 118), has analysed the position of different solvents in India and shown that some of the petroleum cuts can be obtained at following prices :

Solvents	Price per Imperial gallon
S.B.P. 62°/82°C	Rs. 2-14-6 *
S.B.P. 60°/120°C	Rs. 1- 8-9
Hexane	Rs. 3-12-0
Heptane	Rs. 3-12-0

The price of trichloroethylene is Rs.10- 5-3 per gallon against other solvents obtained at Rs.2-12-0 per gallon. The requirement of solvent for Second Five Year Plan period is 2 million gallons. Though ethyl alcohol is a good solvent for solvent extraction, yet the vast quantity of solvent required for the purpose and predrying of the seeds below 3% moisture content, make this uneconomic for India. However the process of solvent extraction has got a bright future, if the de-oiled cake can be used for some other new industries, such as human food, synthetic fibres, plastics etc.

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* At present Re.1/- = 100 Naye Paise & 1 anna = 6 Naye Paise

Miscellaneous Methods of Oil Extraction

A few methods introducing newer ideas for oil extraction are briefly discussed below :

A process for removing oil bearing seeds, by bacterial action has been patented and described by Beckman (8) & (9). The seeds are ground and mixed with water to produce a mash. Calcium carbonate is added to maintain a near neutral pH and the mixture is inoculated with B. delbrueckii, which is obtained from brewer's malt. The mixture is allowed to stand for 5 or 6 days at 50°C, when lactic acid attacks the protein cells and the released oil floats to the surface. Although fair yields are obtained with copra and a few other oleaginous materials, but Horovitz-Vlassova and Novotelnov (31), could not repeat the findings with cotton seed, linseed, corn germs and similar materials. Any way, due to the technical difficulties and popular dislike against fermentation, the process ultimately lost its importance.

David and Felizat (16) patented a method for extracting oil, by beating the finely ground oil seeds with water and floating out the oil. In their method, the comminuted materials are mixed with an alkaline solution, and celliulosic materials are removed by successive washing on a screen. The filtrate contains starch granules in suspension, proteins in a peptized form and emulsified oil. The starch is removed by mild centrifugal treatment and oil by high speed centrifuge. The protein is removed by acid precipitation.

The use of a pulp beater for the same purposes has been recommended by Freise (23) &(24). The slurry is fed at 5 to 8%

concentration at 40°C, and the yield is claimed to be 95% of the oil in soy beans, with less than 2 kilowatt hour current consumed., per bushel.

Methods of Processing Oil seeds in Russia

According to Gavarilenko and Bezuglov (26) and Chernov (14) oil extractions are mainly based on prepressing in "FP" presses and subsequent solvent extraction of cakes with benzene. The "FP" press expeller consists of a shaft containing four stages of diameter. The diameter is large at the inlet and smallest in the next stage, followed by two stages of increasing diameters.

A single stage pressing of the ground seeds i.e., soy bean and sunflower and uninterrupted solvent extraction is reported by M.A.Minasyau and E.Z.Plyushkin (55), where Kernels of above seeds (containing 1.7 - 3.9% husk), are ground and pressed at 100 - 105°C at 12 r.p.m. The yeild is 83.8%. The cake with 5 - 5.7% moisture and 13 - 14% oil is ground again and extracted with ligorine. The residual oil content of the cake is 0.46 - 0.5%. It is claimed that it gives better results than single extraction or two stage pressing.

New Developments in Solvent Extraction and Other Methods

Kulkarni, Graci and Vix (44) describe a filtration extraction process for continuous solvent extraction of oleaginous materials and gives an operational flow sheet for cotton seed oil. In this process, the seed after cooking is crisped before making slurry with a solvent, filtered under vacuum and oil is finally separated from the solvent. Filtration extraction differs from direct and prepress extraction process in that it uses a slurrying step (temperature 125 - 135°F and time 30 - 45 mins) to replace the counter current diffusion extraction employed by other extraction processes.

Spadaro & Vix (92) recently published a data on a new process - solvent cooking - that combines cooking, crisping and slurrying in a single step. The new process claimed to possess 3 advantages

a) Simplification of operational steps

b) Greater control of gossypol content in cotton seed or meal

c) Better control of agglemeration and extractability of solvent cooked meal.

Pominiskii et al (78) report the fruitful application of filtration extraction process to groundnut seed also. The elemination of prepressing and cooking etc., is possible if the raw flakes are mixed with extracted meal in 4 : 3 ratio.

Knoepfler et al (42) report that solubility of mucilage of flax seed in solvent can be avoided by mild cooking and crisping by means of evaporative cooling. The moisture content before crisping is 17 - 24% and after the operation 8 - 10%. Gastrock et al (25) report the application of this process to rice-bran.

Lipovatz (46) has developed a process for extraction of oleaginous material at high temperature and pressure.

Solvent extraction of neutral fat from acid materials like olive pomace is possible by grinding it with soda ash before extracting it with carbondisulphide (80).

Roy Chaudhuri & Nandi developed a pulverization extraction process for cotton seed.(88)

A Spanish patent reports the extraction of oil from the dry fermentation residues using solvent in the vapour phase (53).

Putambekar (31) discusses the economic extraction of fatty oils from low oil content seed Kernels. In this method the Kernel is ground with twice the quantity of noncongealable oil in an edge runner. The paste is heated to 100 - 110°C and centrifuged. On cooling the filtrate to 0 - 5°C the oil is separated from noncongealable oil.

Aqueous Extraction of Oil

Skipin Process :

A survey of literature, shows that Skipin (5, p-467), first stated that 50% or more of the oil from the oil seeds can be obtained by treating with water at a critical temperature and critical moisture content, under which condition there is a selective wetting of the seed surfaces by water in preference to oil.

The operating conditions of the seeds are as follows :-

Seed	% moisture	% hulls in meal	Temperature (0°C) for Oil Separation	
			Initial	Final
Castor, whole	14.5-19.0	23-24	60	82
Castor hulled	11.5-16.0	2- 3	60	82
Cotton	14.5-20.0	5- 6	70	72
Peanut	16.0-20.0	2- 3	35	37
Sesame	16.0-20.0	1- 2	35	37

In the Skipin process rolled seeds are mixed with optimum quantity of water, quickly heated in 5-6 minutes to the proper temperature and maintained at the proper temperature when about half of the oil is separated. The residual oil cake is then subjected to pressure in the conventional way, for further extraction of oil from the cake. This process increases the mill capacity by 50 - 100% without increasing the recovery of oil from the seed.

Other Processes.

Another Russian process, proposed by Iljin (as reported in 51, p-165) is based on the principle of moistening seed for displacing the oil. The Iljin process is employed to obtain a greater yield of oil from linseed, sesame, sunflower etc. The material is treated with steam in such a way, that 80% of the oil can be removed by prepressing at relatively low pressure and at relatively high moisture content, without undue oozing or flowing of the cake. The residual cakes are broken up, treated with superheated steam and repressed in the usual way. This process gives higher oil yield but does not increase the mill capacity.

Bailey (5, p-498) describes the action of steam in the extraction of Palm Kernel oil. Here the seeds are steamed under slight pressure and subsequently the oil is taken out either by centrifuge or by hydraulic pressure.

A British patent (12) describes the aqueous extraction of oleaginous meats of seeds, by first making a slurry with water and next by centrifuging the product. The slurry is separated into a cream phase and water phase without fermentation. It is suddenly cooled to 0°C and finally heated to 50°C during 6 - 8 hours. The oil is next separated by centrifuging.

A French patent (82) describes the treatment of oleaginous material with boiling water, containing a non-emulsifying wetting agent. The oil is obtained in a pure state by centrifuging.

Pai (73) while making a survey of recent inventions on fats and fatty oils describes (a) Canadian invention dealing with extraction of animal oil, grease and tallow by grinding in a hammer mill with one part of material and 5 - 6 parts of water. The other processes developed are :-

i) The oil bearing material is subjected to the treatment at elevated temperature in an aqueous medium in presence of a foaming or wetting agent.

ii) Recovery of oils from the spent absorbent material used for oil refining by treating it with an alkali or an alkaline metal salt and recovering the separated oil from mixture.

iii) Recovery of wool grease from wool scouring liquors with a critical amount of ionizable salt to break the emulsion.

Verma (98) describes a method in which slightly roasted castor seed is crushed and kept with 5 - 10% sodium chloride and water containing 0.1 - 0.5% lime on the weight of seed meal is added followed by potassium nitrate 0.2% on the weight of the seed meal and finally hot water is added. Free oil is liberated and removed. The remainder of the oil is obtained by adding successive amount of hot water as an emulsion. The emulsion is broken by adding 3% sodium chloride solution.

In the second method proposed by him, 500 gms. seed are roasted for 15 minutes, crushed and mixed with common salt and 250 c.c. hot water. The slurry is then heated to 50 - 100°C for 30 minutes. 0.1 - 1% surfactant in 250 c.c. hot water is then added and the mass is blown with steam for 1½ hours. The emulsion is separated and residual meal is repeatedly washed with 3% saline solution for further extraction of oil. The emulsion is broken by heating to 120°C or by centrifuging. The total yield is 80% of original oil.

In the third method proposed by the same author, wetting agents like zephiran, aerosol etc. are used. 500 gms. seed are roasted and crushed. The meal is treated with 50 c.c. water at 80 - 90°C for 30 minutes. Next 1.5 c.c. of 10% zephiran and 90% inert material in 500 c.c. water are added and contents steamed for 1½ hours. The emulsion is separated and more emulsion is obtained from the meal by adding 1.5 gms. aerosol and washing with 3% saline water. Sastry (89) tried these methods insa bigger scale with groundnut seed. The yield is claimed to be 92% of the total oil. But any industrial applications of the above processes are not known, perhaps due to technical difficulties or economic reasons.

Simultaneous recovery of Protein and Oil

In view of growing importance of vegetable proteins for food and industrial use, Sugarman (94) patented a process for recovery of protein and oil simultaneously from peanut and other oil bearing materials, where Kernel is ground with water under optimum conditions of pH and temperature and dispersion is separated into oil rich emulsion and protein sloution. The oil is obtained by de-emulsification while the protein is recovered by pH control. A similar process at low temperature is reported by Subrahmanyam et al (93) for groundnut seed. The recovery of oil is about 85% of the total oil

Importance of Moisture for Oil Extraction

For extraction of oil from seeds by the application of pressure, it is essential to add a little moisture to the seeds. Oil cannot be extracted from bone dry seeds by pressing. Prior to extraction in a hydraulic press or expeller, the seeds are cooked by adding the requisite quantity of moisture to the seeds. For extraction of oil in a ghani, cooking is not done but the moisture is added while crushing is going on in the ghani. By addition of moisture the albumin is coagulated and flow of oil becomes easier. The amount of moisture to be added depends on the type of oil seed and varies from about 3 to 10%.

Scope of Present Investigation

Although India is one of the most important producers of oil seeds, the extraction of oil is highly inefficient, as will be evident from the table below (85)

Type of Mill	Approx. recovery of oil %	% Residual Oil Content Linseed cake	Mustard cake	Sesame cake
Bullock driven ghani	35-40	12.6-14.6	11.2-15.2	12.5-14.2
Power driven ghani	42	11	10.5-11	11 - 12
Expellers	45	7.8	8	9
Hydraulic press	44 - 45	8.9	9	8

Whereas in Western countries, the oil content of expeller cake is 4.5 to 5%, in India it is 8 to 9%, and by country made ghani high as 15% or more.

It is evident that the extraction of oil in India is an extremely wasteful process, which is mainly due to inefficient equipments and lack of technical knowledge. Moreover very little oil is extracted from cotton seed and various other nonedible seeds because of low oil content and unknown physical properties.

In order to stop this colossal wastage of national wealth, it is absolutely essential to carry out research investigations in order to find out better methods of oil extraction. Of course solvent extraction process must be developed and given a fair trial, but two important factors which stand in the way of development of this process are :

a) High cost of solvent and

b) High solvent losses, because of the climate of India.

If it is possible to get better extraction of oil by pre-treatment of the seeds or cakes with water along with small quantities of cheap salts and acids, followed by pressing, the process will be more economic.

It is with this object in view that the present work has been started.

Experiments have been carried out with seven major seeds, viz., Cotton seed, Mahaua, Mustard, Sesame, Groundnut, Linseed and Coconut.