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F. B. LACHLE

2,325,327

OIL EXTRACTION

Filed June 18, 1940

FIG. 1

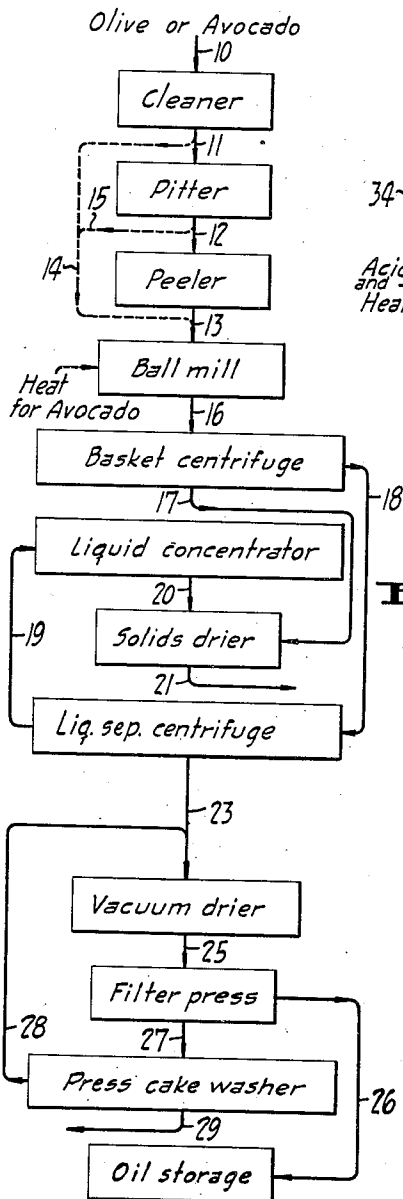


FIG. 2

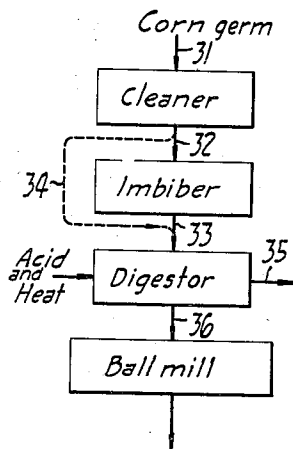


FIG. 3

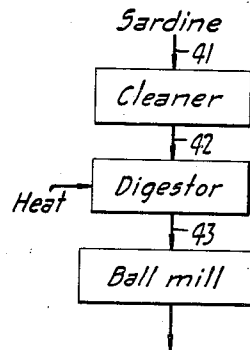


FIG. 4

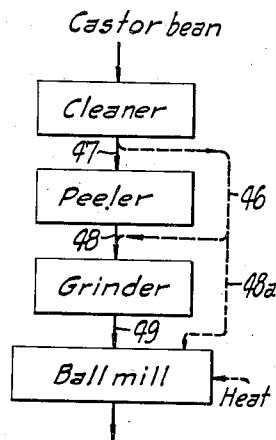


FIG. 5

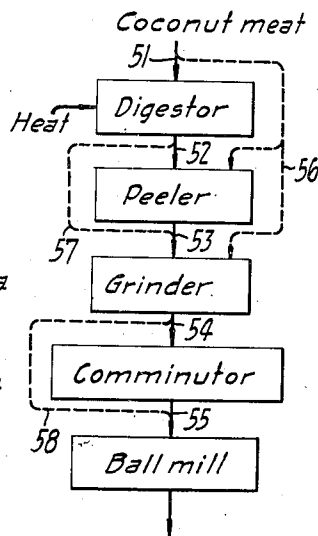
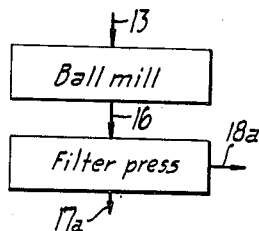


FIG. 6



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OIL EXTRACTION

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5 Claims. (Cl. 260—412)

This invention relates to the field of oil extraction, and is concerned more particularly with the provision of a new oil extracting process of wide application which enables improved results both quantitatively and qualitatively with vegetable and animal oils.

It is a general object of the invention to provide a new process of extracting oil from oil-bearing materials, such as vegetable and animal matter.

Another object of the invention is to provide a process of the character referred to which is of a flexible nature so as to be readily adapted and modified for extracting oil from a wide variety of oil bearing materials in an efficient manner which provides improved results both in the quantity and quality of the extracted oil.

Another object of the invention is to provide a novel oil extracting process which affords an approach to absolute oil recovery in that the oil can be liberated from virtually all of the oil cells.

Another object of the invention is to provide an oil extraction process in which the crude oil obtained in some applications of the process is of an unusually pure character so as to approximate refined oil in certain respects and therefore be capable of use in certain fields without further treatment.

Another object of the invention is to provide an oil extraction process in which the material can be treated at a selected one of a wide range of temperatures in accordance with the particular characteristics of the product being treated and the attributes desired in the oil produced.

Another object of the invention is to provide a process for extracting oil from materials such as corn germs, wheat germs, cotton seed, peanuts, and other similar materials.

Another object of the invention is to provide an oil extraction process which can be employed with fleshy fruits and nuts, such as olives, avocados, and coconuts.

Another object of the invention is to provide an oil extraction process which can be employed in extracting oil from fish, such as sardines, and other animal matter with or without subjecting the material to heat.

Another object of the invention is to provide an oil extraction process which is economical and can be carried out with relatively inexpensive equipment.

Other objects and advantages of the invention will be apparent from the following description of certain preferred forms of the process as

employed with particular types of oil bearing materials.

In the drawing:

Figure 1 is a flow diagram of a complete oil extraction and recovery process carrying out my invention.

Figure 2 is a fragmentary flow diagram illustrating the process as employed with corn germ.

Figure 3 is a fragmentary flow diagram illustrating the process as employed with fish, such as sardines.

Figure 4 is a fragmentary flow diagram illustrating the process as employed with castor beans.

Figure 5 is a fragmentary flow diagram illustrating the process as employed with coconut.

Figure 6 is a fragmentary flow diagram illustrating a modified process for recovering the oil which has been liberated in the slurry.

The present invention, as explained above, provides an oil extraction process of a new and novel character and as distinguished from prior methods which may be classified generally as mass pressure extraction methods, solvent extraction methods, and heat rendering methods. Known methods by their own limitations preclude the practical recovery of the greatest percentage of oil possible from certain oil bearing materials because they do not provide for the individual treatment of each oil-bearing cell to effect liberation of the oil.

In contrast to known methods, the process of the instant invention contemplates the dispersion of the material in a liquid medium so that the individual cells are separated to provide for wetting of each cell by the medium as it is separated and to provide for individual treatment of each cell whereby it is crushed or ruptured to have the oil displaced therefrom, or whereby the oil is expelled or expressed through the natural pores of the cells. To effect this result, point pressure is applied to each of the individual oil cells or oil cell groups in the presence of a non-oil-soluble oil-carrying medium, such as water or an aqueous solution. The result preferably is obtained by providing a treating zone filled or partly filled with a displacing medium in which a multitude of point pressure effects are provided repeatedly and successively so that after a period of treatment the mass of material is delaminated to free the individual cells or cell groups and each individual oil cell is free for separate treatment. The point pressure referred to is that provided by surfaces having multitudinous minute asperities of such dimensions as to allow the asper-

ities to practically or actually touch or rub each other so that the oil cell is pressed, cut, broken, squeezed or crushed between pressure surfaces having dimensions in the order of, or less than, the oil cell dimensions. Various surfaces providing a satisfactory type of asperity are referred to hereinafter. The point pressure effect is continued for a period of time sufficient to eliminate or substantially eliminate the oil cell groups and provide a slurry or puree containing individual oil cells and the oil-displacing medium. The same point pressure effect used for delamination is also used to rupture or macerate the oil cells to liberate the oil and allow it to be carried away by the oil-carrying medium or to effect displacement of the oil through the pores of the cells by the application of pressure to the individual cell.

In this way, substantially all of the oil-bearing cells can be treated, and the percentage of oil recovery from various substances can be materially increased. At the same time the process lends itself to the direct production of a crude oil having certain or substantially all of the characteristics of refined oil. In many instances, the crude oil recovered in accordance with this invention needs only certain finishing steps, such as deodorization or clarification, to compare favorably with refined oils which are treated by known processes.

Generally it is desirable that the oil bearing vegetables have a sufficient moisture content to activate the oil plasma which is believed to cause coalescence of the oil by virtue of the hydrophobic character of the oil plasma. With some vegetables this is the natural state of the oil plasma in the ripe condition, while with others the activation must be effected by the imbibition of a suitable activating medium, such as water. For example, usually the vegetables and nuts of the fleshy type such as olives, avocados and coconut contain a sufficient amount of moisture content when ripe and before dehydration to require no imbibition step. Other vegetable materials do not have a sufficient amount of moisture so that they require an imbibition step to properly condition the oil plasma for the extraction step.

In materials where an imbibition step is required, the oil is believed to exist in the form of an oil plasma wherein the oil is distributed throughout the oil cells in very small particle size, some of which may be ultra-microscopic. The oil plasma is believed generally to be in the form of a fine oil emulsion which is hydrophobic in character. With this type of materials, it is desirable to precede the actual extraction step with a period of imbibition wherein the material is permitted to pick up moisture. This imbibition step may be performed by applying a non-oil-soluble liquid as generally classified, for example, by soaking the material in water or by application of steam, or both, to condition the oil plasma for the extraction operation by causing coalescence of the oil into droplets of a size to permit separation.

The imbibition is preferably effected with the material in its whole state, although with some materials it may be desirable to effect imbibition during or after a comminution step where comminution of the material is desirable.

With certain of the materials, for example materials like corn germs, it is desirable to perform a starch reduction step either after or simultaneously with the imbibition step. In the reducing step the material is subjected to the action of a suitable weak acid, such as sulphuric

acid or hydrochloric acid, to reduce the starch content to sugar, so that it will be dissolved from the kernel and will not be able to act as an emulsifying agent. The dissolving of the starch from the kernel also serves to expose the germ itself for subsequent treatment. Preferably the reduction step would be carried out with the material in a whole state, although it may be carried out by effecting either a wet or dry comminution of the material followed by application of the acid.

In some materials the imbibition and reduction steps should be effected successively, so that the imbibition step will serve to condition the material for the reduction step. In this way the reduction step may be performed more rapidly or with weaker acid to reduce the possibility of injury to the oil from the acid used in the reduction step and decrease the expense of operation.

After the pre-treatment is completed, where required, the oil-bearing material is placed in a treating chamber which contains a non-oil-soluble oil-carrying medium, such as water, and means for first delaminating or disintegrating the material to individual cells or cell groups to provide a dispersion of the individual cells or cell groups in the medium and then for treating the cells individually or while in a layer of approximately cellular thickness. Both the delamination and the subsequent pressure treatment of the cells is preferably effected by means of a multitudinous point pressure effect. Throughout the reduction and treatment, the non-oil-soluble oil-carrying medium should be present in at least sufficient quantity to wet all of the solids of the oil-bearing material in all portions of the treating chamber and not in excess of the amount required for efficient operation. The desired amount of medium provides a complete dispersion of the oil-bearing material in the medium so that the individual cells or cell groups composed of two or more cells are completely surrounded and wetted by the medium. After the treatment is finished the oil-solids-water slurry or puree is usually of the consistency of cream.

With certain materials, it may be desirable to perform a comminuting step of either a fine or coarse nature or both prior to the reduction of the material into cellular or small, multi-cellular particles.

Generally, it may be stated that the treatment of the material in cellular or small multi-cellular particles in a dispersed form in a non-oil-soluble oil-carrying medium is of a character to extract some of the oil by actual rupturing or breaking of the cells to liberate the oil in the medium; some of the oil may be displaced by osmosis; and other portions of the oil will be liberated by complete or partial collapse of the cell walls without rupture. The combined effect of the various types of extraction is to recover a high percentage of the oil present in the material.

The liberation of oil from the individual cells as explained may be carried out at "cold" temperatures, i. e. temperatures in the neighborhood of ordinary room temperature (60° F.) or lower, where this is desirable to provide a high quality oil, otherwise higher temperatures tend to hasten the process. Also, the oil liberation is preferably effected in an acid mixture to minimize the formation of emulsifying agents such as soap. However, extraction may be performed in an alkaline medium.

The means for providing a multitudinous point pressure effect in the treating chamber may take the form of usual surfaces available, such as

metal or porcelain, which have a character of minute roughness (even though they may be apparently smooth) to approximate cellular dimensions. Preferably, the pressure surfaces are provided on a plurality of small pressure elements such as balls, pebbles, rods, discs, cubes, rolls, or plates and the like, which are loosely confined in a treating chamber and subjected to agitation or vibration so as to repeatedly contact each other. This type of action is provided, for example, by the cascading and sliding action of the pressure elements such as found in a ball mill of conventional design. For certain applications, other equipment for producing individual pressure treatment of the cells, such as a hammer mill or a colloid mill may be employed.

In performing the extraction step with a ball mill, the oil carrying and displacing medium such as slightly acidic water is preferably added first in order to minimize oxidation, and the water may be pre-treated if desired to liberate dissolved air. Subsequently, the oil-bearing material is introduced into the ball mill which is then placed in operation for the requisite period of time which varies with different materials in accordance with the natural characteristics thereof.

The ball mill treatment may be carried at any selected one of a range of temperatures depending upon the effect heating has on the quality of the oil and the efficiency of the ball mill operation. Usually heat is desirable where it can be employed to aid maceration of the cell wall.

After the required ball mill treatment, the mixture of solid material, water, water solubles, and oil is flushed from the ball mill and subjected to subsequent treatment to recover the oil or any other desired constituents. Various known methods of treatment may be used to recover desired constituents from the slurry.

One form of treatment which may be employed is that of centrifugal separation which is preferably effected in two stages. The first stage may be effected with a common type of basket centrifuge to separate oil and water from the remaining materials in the slurry. The second stage may employ a liquid separator centrifuge for separating the oil and the water to recover cloudy wet oil. The recovered oil may be dried as, for example, in a continuous vacuum dryer and then filtered and placed in storage.

The above description is typical of extraction methods applicable to substantially all types of vegetable and animal materials which contain oil in cellular form. The application of the process to certain of the specific materials will now be described in detail.

Referring to Figure 1, a typical flow diagram is illustrated for use in the recovery of olive or avocado oils.

Olives, for example, may be fed as indicated by the line 10 to a cleaner where all stems, leaves, and material of similar character are removed and where the olives may be washed if desired. The clean olives are carried from the cleaner as indicated by the line 11 to a pitter of any desired construction where the olive pits are removed. It is preferred, however, to employ a ball mill pitter wherein the shell of the mill is perforated or formed by a screen and where the pressure elements are of a character such as "Danish pebbles," the ball load and the speed of rotation being controlled so that the pulp or oil containing material is separated from both the pits and the skins which are retained in the ball mill while the oil containing pulp is discharged through the

perforations. From the pitter, the pitted olives may be fed as indicated by the solid line 12 to a conventional form of peeler where the skins are removed. From the peeler, the peeled olives are discharged as indicated by the line 13 to the ball mill. As indicated by the dotted line 14, both the pitter and the peeler may be by-passed and the cleaned olives discharged directly into the ball mill or, as indicated by the dotted line 15, the pitted olives may be by-passed around the peeler and fed directly to the ball mill. Where the whole olives are fed directly to the ball mill, the ball load may be controlled so that the skins and the pits are not ground up during the delamination of the oil cells. In this way, the pits and skins will not interfere with the oil extraction from the oil bearing cells.

Ordinary olives contain a sufficient water content to serve as the non-oil-soluble oil-carrying medium. Where olives have become partially dehydrated, additional water may be required. In this event, a suitable amount of a non-oil-soluble oil-carrying medium, such as water, has been placed in the mill. The ball mill treatment may be continued for a period of, say, about fifteen to thirty minutes or for a sufficient period to delaminate the olives and form a heavy slurry in which the olive is present in substantially cellular form in the non-oil-soluble oil-carrying medium. At the same time, the point pressure effect carries out an individual treatment of each oil cell to liberate the oil. The water in the ball mill, where required, is of an amount to provide complete dispersion and wetting of the individual oil cells without obtaining so great a dispersion as to interfere with the efficiency of the ball mill operation. Where required, an amount of water will be added to the olives to provide a consistency of the slurry similar to that of cream. Microscopic examination of the slurry after the ball mill treatment has disclosed that substantially all of the oil cells have been separated and that there are few, if any, multicellular groups of oil cells.

After the ball mill treatment, the entire constituents of the slurry including solids, water, water-solubles and oil, are discharged as indicated by the line 16 into a basket centrifuge which serves to separate the solids from the water and oil. The solids from the basket centrifuge may be fed as indicated by the line 17 to the solids dryer, while the mixture of oil and water, as indicated by the line 18, is carried to a liquid separator centrifuge where the oil is separated from the water. The water containing the water solubles may be fed from the centrifuge, as indicated by the line 19, back to the liquid concentrator where it may be concentrated sufficiently for drying, and fed, as indicated by the line 20, to the solids dryer. The dried solids may be carried away as indicated by the line 21 to any suitable point of disposal.

The oil from the liquid separator centrifuge is still wet and may be conveyed as indicated by the solid line 23 to a vacuum dryer. The dry cloudy oil from the vacuum dryer is fed as indicated by the line 25 to a filter press if suitable construction from which the dry brilliant oil is conveyed as indicated by the line 26 to a suitable place of oil storage.

The press cake from the filter press may be carried as indicated by the line 27 to a press cake washer to liberate additional wet oil contained in the press cake, which may be carried from the press cake washer as indicated by the line 28

back to the vacuum dryer for further treatment. The oil-free cake from the press cake washer may be carried to a suitable point of disposal as indicated by the line 29.

In a typical run carried out at room temperature in accordance with the procedure outlined above, a 97% extraction by weight of oil has been obtained from olives. After the extraction process as described, the olive oil is ready for use.

The recovery of avocado oil is substantially similar to that described above for olives except that it is desirable, although not necessary, to have the material heated during the ball mill treatment. With avocado this heating serves to materially hasten and facilitate the oil recovery by softening the walls of the oil cells and by decreasing the viscosity of the oil. Usually the efficiency of the ball mill operation increases with a rise in temperature. However, the temperature employed for the treatment should not be high enough to have a deleterious effect upon the oil. If desired, the avocados can be controlled to remove the skin as a preliminary treatment in a ball mill operation as explained in connection with olives to thereby obtain a higher quality oil.

Figure 2 illustrates a typical flow diagram for a corn germ oil extraction plant through the ball mill treatment. Whole corn germ may be fed as indicated by the line 31 to the cleaner which serves to remove the husky material such as the corn germ caps and other undesirable solid material. The cleaned whole corn germ may be fed as indicated by line 32 to an imbiber, which may comprise a tank having suitable means for the introduction of water, steam, or both, so that the whole corn germ can be treated for the requisite time to effect imbibition of moisture.

As pointed out, the imbibition of moisture conditions the oil plasma of the corn germ for the extraction operation. The imbibed moisture is believed to activate the oil plasma because of its hydrophobic character and is believed to reduce the viscosity of the oil plasma and overcome the forces in the oil plasma which oppose coalescence of the oil. Thus the oil tends to collect in minute droplets during the imbibition step so as to be more readily available for further coalescence during the ball mill treatment.

From the imbiber, the corn germs are fed as indicated by the line 33 to a digester wherein the corn germs are subjected to the action of heat and a suitable starch reducing agent, such as weak sulphuric or hydrochloric acid, or starch reducing enzymes. As indicated by the dotted line 34, the imbiber may be by-passed and the imbibition step performed at the same time as the starch reduction step in the digester.

During the starch reduction step, the acid reduces the starch to sugars which may be conveyed for disposal as indicated by the line 35 to a sugar house for example. During the reduction step, all or substantially all of the water solubles will also be removed from around the corn germ. The reduction step therefore serves to expose the corn germ for direct pressure treatment. During the digesting step, heat is also preferably applied, for example by boiling, to speed up the reactions and also to aid in macerating the cell walls of the corn germ.

From the digester the starch-free corn germs may be carried as indicated by the line 36 to the ball mill where they are subjected to the multitudinous point pressure effect in the presence of water. Usually the water employed will be warmed and will have been deaerated. The

amount of water present is sufficient to produce the desired wetting and dispersion of the oil cells in the slurry, and the consistency of the mixture at the end of the treatment will be similar to that of heavy cream.

After the ball mill treatment, any suitable method may be employed for recovering the oil, as for example, the steps indicated in Figure 1 with respect to olives or avocados.

In a typical extraction run with the imbibing and digesting steps performed simultaneously, the cleaned whole corn germs were boiled for about 20 minutes in a .3% solution of sulphuric acid, and then treated in the ball mill with the addition of 300 to 400% water on a dry basis for one and one-half hours. Subsequently the oil was recovered as described in connection with Figure 1. A microscopic examination of the solids residue showed that substantially all of the cells had given up their oil.

Figure 3 illustrates a process which may be employed for oil-bearing animal materials, such as sardines, for example. The sardines may be fed as indicated by the line 41 to a cleaner where they may be washed thoroughly. Either whole sardines or the conventional form of sardines for canning may be employed. From the cleaner, the cleaned sardines are fed as indicated by the line 42 to a digester where heat is applied, for example in the form of steam, for softening and macerating the oil cells and conditioning the fish for a ball mill operation.

From the digester the softened fish may be carried as indicated by the line 43 to the ball mill where they are subjected to the multitudinous point pressure effect in the presence of natural or added water as described in connection with the preceding flow diagrams. The ball mill operation may be suitably controlled to delaminate and disintegrate all material except the bones, eyes and scales of the fish. The fish slurry from the ball mill may be treated to recover the oil as indicated in Figure 1. The oil recovered from sardines, for example, is of a yellow color and is considerably lighter in color, even where whole sardines are used as the source, than the oil produced by conventional methods. In a typical run, whole sardines were boiled in water for about five minutes, and then treated in the ball mill for about one and one-half hours.

Figure 4 shows a fragmentary flow diagram for use in recovery of oil from castor beans wherein the castor beans are first cleaned and then either passed directly, as indicated by the dotted line 46, to a grinder, or alternatively passed as indicated by the solid line 47 to a peeler to have the skins removed. The line 48 indicates feeding of the beans to the grinder where the beans are ground to facilitate the ball mill operation. If desired, the grinder may be by-passed as indicated by the line 48a and fed directly from the cleaner to the ball mill.

From the grinder the ground beans are fed through the line 49 to the ball mill where they are subjected to the multitudinous point pressure effect in the presence of water to break up the oil cells and liberate the oil as described in connection with other materials. If desired, heat may be applied during the ball mill treatment to accelerate the operation by macerating the walls of the oil cells. In a typical ball mill treatment, about 100% of water by weight was used, and the treatment continued for about one hour at a temperature of about 180° F.

After the ball mill treatment the oil may be

recovered from the resulting slurry in any convenient manner.

For the recovery of coconut oil, coconut meats may be fed as indicated by the line 51 to a digester where they are subjected to heat, as for example, by the use of steam or hot water, after which they are fed as indicated by the line 52 to a peeler where the skins are removed. If desired, either or both of the digester and peeler may be by-passed and the coconut meats fed directly to the grinder as indicated by the lines 56 and 57.

From the peeler, the coconut meat is fed as indicated by the line 53 to a coarse grinder to effect a coarse comminuting operation, from which the coarse ground meats are fed as indicated by the line 54 to a comminuter which effects a fine comminution of the material. From the comminuter the comminuted meats are fed through the line 55 to a ball mill where they are subjected in the presence of say 200% water by weight to the point pressure effect for a sufficient time, say one hour, to reduce the meat to cellular form in the oil-carrying medium and to break the oil cells and displace or express the oil therefrom. If desired, the fine comminuter may be by-passed as indicated by the line 58.

The slurry from the ball mill is then subjected to any suitable further treatment for recovery of the oil.

Figure 6 illustrates a modified process for recovering oil from the slurry resulting from the ball mill treatment. As shown, the slurry may be conveyed from the ball mill by line 16a to a filter press from which the oil, water, and water solubles are carried by line 18a to the liquid separator centrifuge. The press cake is then treated to remove any remaining oil by blowing with steam, water, or air, before being discharged through line 20a to the solids dryer.

I claim:

1. An oil extraction process for cellular oil-bearing materials which includes the step of reducing the material to substantially cellular form in an aqueous medium and liberating the oil from the individual oil cells by subjecting the material to the action of cascading pressure elements in the presence of the medium.

2. An oil extraction process for cellular oil-bearing material which includes subjecting the material while in an added aqueous medium to a ball mill effect for a period of time to reduce the material to cellular form for wetting by the medium and to apply pressure individually to the wetted oil cells to effect liberation of oil therefrom.

3. An oil extraction process for cellular oil-bearing material comprising olives which includes the step of reducing the material to substantially cellular form in an aqueous medium and liberating the oil from the individual oil cells by subjecting the material to the action of cascading pressure elements in the presence of the medium.

4. An oil extraction process for cellular oil-bearing material comprising sardines which includes the step of reducing the material to substantially cellular form in an aqueous medium and liberating the oil from the individual oil cells by subjecting the material to the action of cascading pressure elements in the presence of the medium.

5. An oil extraction process for cellular oil-bearing material comprising castor beans which includes the step of reducing the material to substantially cellular form in an aqueous medium and liberating the oil from the individual oil cells by subjecting the material to the action of cascading pressure elements in the presence of the medium.

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