

PATENT SPECIFICATION

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(54) CHEMICAL PROCESS

(71) I, THAMBIAH KASIN-ATHAN a Singapore Citizen of 11 Dawn Estate, Off Templar Road, Seremban, West Malaysia, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the production of palm oil.

In the conventional process used in Malaysia for the production of palm oil, the palm fruit bunches are harvested and upon arrival at the processing mill are first heated to effect so-called sterilisation, that is deactivation of enzymes present in the palm fruit which would otherwise promote hydrolysis of fatty acid glycerides and consequently cause an undesired increase in the free fatty acid content of the palm oil product. It is generally thought desirable to sterilise within a relatively short period of time, that is in less than 24 hours, after harvesting and the sterilisation step is commonly carried out by subjecting the palm fruits whilst still on the palm fruit bunches to the action of superheated steam at a temperature of from 130 to 140°C.

The application of heat during the sterilisation step also serves to loosen the palm fruits and thereby to facilitate removal of the fruits from the bunches. The step of removing the fruits from the bunches is thus conveniently effected after sterilisation, for example using a thresher.

The next stage in the conventional process comprises digesting and pressing the palm fruit to extract the palm oil. During digestion, it is usual again to subject the fruit to the action of the superheated steam the introduction of which helps to loosen the pericarp (that is the outer, oil-bearing, fibrous portion of the fruit in which the fibres are bound together by cellular material) from the mesocarp (that is the shell which encloses the kernel of the fruit). Following digestion, the digested mash thus obtained can be pressed using for example a screw press which exerts pressure sufficient

to expel the liquid in the mash but insufficient pressure to crack the mesocarp enclosing the kernel. The mixture thus obtained contains palm oil, water naturally occurring in palm fruit and added as hot water during pressing to facilitate the operation of the presses and to aid the flow of the expressed material, and both relatively large and relatively small solid particles. The larger solid particles are conveniently separated by screening and recycled to the press. The water and small solid particles need to be separated by a step which in the industry is commonly referred to as "clarification"

The process which is at present conventionally used for clarification of the mixture obtained by digestion and pressing is both time consuming and expensive. Further water is added to the mixture in a clarification vessel and the temperature is maintained at above 100°C by introduction of water and superheated steam. Following this treatment the oil and water layers are allowed to separate and the clarified oil layer is drawn off from the aqueous sludge. The introduction of water and steam into the clarification vessel and the separation of the oil and aqueous sludge layers is repeated several times to ensure removal of the bulk of the oil. This treatment takes a prolonged period of time, usually 4 to 5 hours or longer. The final product remaining in the clarification vessel is an aqueous sludge having a relatively high water content.

Following clarification, the palm oil product can if desired be bleached. This step is conventionally carried out using Fuller's Earth.

The most troublesome step in the conventional process is that of clarification of the mixture obtained by digestion and pressing. As explained above, this step is both time consuming and expensive but there is the added difficulty that large quantities of aqueous sludge are obtained as by-product for which no useful purpose is known. This aqueous sludge has hitherto been discharged as waste effluent into rivers and streams but this means of disposal is

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undesirable and in some countries illegal on environmental grounds.

Another problem with the conventional process of producing palm oil is the difficulty of obtaining palm oil with a low free fatty acid content. Most desirably palm oil has a free fatty acid content of not more than 2% by weight whilst by the conventional process the palm oil produced frequently contains up to about 4% by weight of free fatty acid.

It is the object of the present invention to provide a new process for the production of palm oil.

According to the present invention, there is provided a process for the production of palm oil which comprises digesting palm fruit, pressing the digested mash thus obtained to provide a mixture of palm oil, water and particulate solids and subjecting the said mixture (if desired after partial removal of the said particulate solids) to a clarifying treatment which comprises the steps of agitating the said mixture at elevated temperature in the presence of an effective amount of a degumming agent, allowing the water and particulate solids in the said mixture to settle and separating the supernatant palm oil from the remainder of the said mixture.

The important feature of the process according to the present invention is the clarification treatment. It has thus been found that by introduction of an effective amount of a degumming agent into the mixture it is possible to effect an efficient and satisfactory recovery of palm oil without the addition of water and without the introduction of superheated steam into the extract. Preferred degumming agents for use in the process according to the invention include phosphoric acid and sodium hydroxide. The degumming agent is conveniently added to the mixture in a concentration of at least 0.3%, preferably at least 0.5% and advantageously in the range of from 0.5 to 1.5%, by weight of the mixture. An especially preferred amount of degumming agent has been found to be about 1.0% by weight of the mixture. Care should of course be taken in selecting the degumming agent to avoid the use of substances which at the concentrations used would have an undesired effect upon the palm oil in the mixture. Thus for example the use of phosphoric acid in high concentrations could result in acid hydrolysis of the fatty acid glycerides present in the palm oil. The optimum amount of any particular degumming agent to be used can readily be determined by simple experiment.

The treatment with degumming agent is carried out at elevated temperatures but can with advantage be effected at temperatures

somewhat lower than those used for the clarification treatment in the conventional process. Thus the mixture obtained by digestion and pressing is preferably maintained at an elevated temperature not exceeding 100°C, and advantageously from 90 to 100°C, whilst it is subjected to agitation. Heating can conveniently be effected using superheated steam circulating through coils in the clarification vessel or through a steam jacket for the clarification vessel. The period of time for which agitation must be continued using the process according to the invention is very much shorter than that found necessary with the conventional process. Thus agitation is preferably effected in the process according to the invention for period of at least 15 minutes, advantageously for a period of from 15 minutes to 30 minutes. During this period, particulate solids present in the mixture coagulate and settle out to the bottom of the containing vessel. The treatment may be effected at atmospheric pressure or *in vacuo* as desired.

Following agitation, the water and solids are allowed to settle and the supernatant palm oil can then be drawn off. This palm oil product is conveniently filtered (to remove minute traces of particulate matter e.g. of cellular dimensions) and cooled prior to storage. The settled solids include entrained liquids and are preferably drawn off from the bottom of the clarification vessel whereupon the entrained liquids can be mechanically separated from the solids. These entrained liquids contain a mixture of palm oil and water and upon standing separate into an upper oil phase and a lower aqueous phase. The lower aqueous phase can then be drained off and the upper palm oil phase can be filtered, dried, cooled and stored as further palm oil product.

Degumming agents have hitherto been commonly used in the refining of palm oil following on its separation from water and solid particles and phosphoric acid and sodium hydroxide have been utilised for this purpose. The combining of the degumming process and the process of separating the palm oil from water and solid particles in accordance with the present invention has the advantage of simplifying the clarification treatment as explained above. Without wishing to be limited by any theoretical explanation of the working of the invention, it is thought that gums present in the mixture obtained by digestion and pressing coalesce during the conventional clarification process and having the effect of inhibiting settling of solids from the mixture. The presence in the mixture of degumming agents in accordance

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with the process of the present invention has been found to result in coagulation of the solids and thus makes possible the simplified procedure used.

5 A further advantage of the process according to the present invention is that it has been found possible thereby to produce palm oil which consistently has a free fatty acid content of not more than 2% by weight. 10 Again without wishing to be limited by any theoretical explanation of the working of the invention, it is thought that the prolonged heating at elevated temperatures in the presence of large amounts of water 15 which is a feature of the conventional clarification process provides conditions favourable to the hydrolysis of fatty acid glycerides and that in consequence the free fatty acid content of the palm oil is 20 increased. The clarification treatment in accordance with the present invention can be carried out at lower temperatures for shorter periods of time in the presence of smaller quantities of water and 25 consequently the risk of undesired hydrolysis is substantially reduced.

A still further advantage of the process according to the invention is the avoidance of the above-mentioned waste disposal 30 problem with the conventional process. Water need not be added during the clarification treatment according to the present invention, and thus the discharged sludge from the clarification vessel is not 35 dispersed in large quantities of water (as is the case with the conventional process). Consequently this discharged sludge can be used for example as a nutritional additive for animal feedstuffs. If desired, the 40 nutritional value of the sludge can be improved by yeast fermentation. Thus the sludge, which after mechanical separation of entrained liquids is in the form of a semi-dry solid, can be allowed to cool to a 45 temperature of about 35°C and the pH of the sludge adjusted for the growth of commercial yeast. The sludge is then inoculated with commercial yeast and allowed to ferment for from 4 to 5 days. The 50 whole mass can then be dried, powdered and used as an animal feed additive.

The process according to the present invention is conveniently used in 55 conjunction with the conventional steps of sterilisation and threshing as described above. The palm oil product obtained can if desired be bleached for example with Fuller's Earth again as described above. Alternatively bleaching can if desired be 60 effected using activated carbon, conveniently powdered activated carbon. The bleaching step can be carried out *in vacuo* or under atmospheric conditions at elevated temperatures, preferably 130 to 140°C, for a 65 period of time of 30 to 40 minutes. The use

of a degumming agent at the clarification stage has an advantage in that the amount of bleaching agent such as Fuller's Earth or activated carbon needed for bleaching is less than would otherwise be the case. Thus for example it has been found possible to bleach the palm oil produced by the process according to the invention using as little as from 2 to 3% of Fuller's Earth or from 1 to 2% of activated carbon (by weight of oil).

The following Example illustrates the invention:—

Example

In this example:—

the raw material arriving at the mill is referred to as F.F.B. (i.e. fresh fruit bunches);

the process is described as carried out using a palm oil mill with a capacity of 30 tons F.F.B./hour operating for a period of 24 hours; and

the F.F.B. used have a fruit content of 80% by weight.

The F.F.B. arriving at the mill are loaded into dump-carts which move on tracks. The carts are then moved in batteries, each of which carry 30 tons of F.F.B., into a steel sterilising chamber capable of withstanding steam pressures up to 60 p.s.i. and lagged against loss of heat. After the carts have been moved into the sterilising chamber and the doors have been firmly secured, steam under a pressure of about 40 p.s.i. is introduced into the chamber and the steam pressure is maintained at this value for 1 hour. During this sterilisation treatment, free fatty acid producing enzymes present within the fruit are destroyed and the fruits are also loosened from the bunches.

At the end of one hour sterilisation treatment, the sterilisation chamber is relieved of the steam pressure and the doors are opened. The dump-carts are then moved out of the sterilisation chamber along tracks which extend beyond the far end of the chamber. The carts are then lifted by means of a mobile crane and dumped into a chute which leads to a thresher, i.e. a rotating cage which during its movement lifts and drops the bunches within itself so that the fruits are separated from the bunches. The thresher permits the loosened fruits to fall through openings in its periphery on to a conveyor which delivers the fruits to a digester. The denuded bunches pass through the thresher on to a conveyor which carries them to an incinerator.

The digester is a circular, steam-pocketed drum through the centre of which runs a rotor equipped with arms. The fruits passing through the digester are rubbed one against the other and also against the arms of the rotor. During this process steam is passed into the jacket of the digester and

maintained at a pressure of 40 p.s.i. During digestion the pericarp is loosened from the mesocarp which completely encloses the endocarp (i.e. kernel).

- 5 The digested mash is then passed to a screw press which exerts pressure sufficient to expel the liquid in the mash from the pericarp but insufficient to crack the mesocarp which encloses the kernel. The pressure exerted on the digested mash expels the bulk of the liquid in the pericarp. After expulsion of liquids, the solid material leaving the presses is then subjected to pneumatic treatment which separates the spent pericarp from the mesocarp and kernels enclosed therein. The spent pericarp separated by this pneumatic treatment is burnt in the boilers which produce the steam necessary for sterilisation and also for the generation of the power required for driving the motors of the mill and for provision of lighting.

- 20 The mesocarp enclosing the kernel, after separation from the spent fibres, is sent to the deshelling equipment which cracks the nuts open and separates the mesocarp from the kernel.

- 30 In the meanwhile the liquid coming off the screw presses amounting to 20% by weight of the fruits and containing the cellular matrix binding the fibrous component of the pericarp is passed through a vibrating screen which separates the coarse solid particles contained in the liquid. These coarse particles are recycled to the screw press whilst the liquid along with its cellular contents and gums is collected in a separate clarification tank equipped with an agitator and steam heating coils. The clarification tank which receives the oil from the screw press is lagged to prevent loss of heat. Phosphoric Acid (85%) amounting to 1% of the weight of oil is added to the contents of the clarification tank. The temperature of the liquid is maintained at 100°C and agitation of the oil is effected to ensure thorough distribution of the phosphoric acid. Agitation of the liquid is continued for a period of 30 minutes under atmospheric pressure. During agitation, the cellular matrix of the pericarp that is present in the oil coalesces and when agitation is stopped settles quickly to the bottom of the clarification tank.

- 55 Clear supernatant dark red oil having a free fatty acid content of below 2% by weight is drawn off the top of the clarification tank, filtered, dried, cooled and sent to storage.

- 60 The settled solids along with the entrained liquids are drawn off through the bottom of the clarification tank and the solids are separated from the liquids by mechanical means, i.e. either by the use of centrifugal filters or vacuum filters. The

liquids recovered which are a mixture of oil and water are collected in a separate vessel and allowed to stand for a period of one hour. During this period the recovered liquids separate into an upper oil phase and a lower aqueous phase. The lower aqueous phase is drained off and the upper oil phase is filtered, dried, cooled and sent to storage.

Products Obtained

The solids recovered per ton of F.F.B. amount to 20 Kgs. and, for a plant with a capacity of 30 tons of F.F.B./hour total solids produced per 24 hours amount to $20 \times 30 \times 24 \div 1000 = 14.4$ metric tons.

The quantity of dry fibres obtained by the pneumatic separation referred to above for a plant with a capacity of 30 tons of F.F.B./hour operating for 24 hours is 64.8 tons. The quantity of oil produced by a plant with a capacity as described above is 144 tons/24 hours or 20% of the total weight of F.F.B. processed.

The quantity of shells produced by a plant with a capacity as described above is 43.2 tons/24 hours.

The quantity of bunches produced by a plant with a capacity as described above is 144 tons/24 hours. The quantity of kernels produced by a plant with a capacity as described above is 32.4 tons/24 hours.

Bleaching of Crude Palm Oil

2% by weight powdered, activated carbon is added as a slurry in palm oil to crude palm oil produced as described above at a temperature of 130–140°C and at atmospheric pressure. The mixture is agitated for 30–40 minutes and the activated carbon is then separated off by means of a filter press.

The product obtained is pale yellow in colour and also has a free fatty acid content of below 2%.

Palm oil contains the following minor ingredients:

Amounts of Minor Components of Palm Oil

Carotenoids	500–700 P.P.M.	
Tocopherols	800–900 P.P.M.	
Sterols	300–300 P.P.M.	115
Phosphatides	500–500 P.P.M.	
Tri-Terpenic and Aliphatic Alcohols	800–800 P.P.M.	
	2900–3200 P.P.M.	

Carotenoids are the precursors of Vitamin A. Carotenoids in palm oil vary between 500–700 P.P.M. The major constituents are alpha-carotene and beta-carotene which together amount to about 450–630 P.P.M.

The other important constituents of the minor components are the tocopherols. The tocopherols are precursors of Vitamin E.

Thus the filter cake can be used as an animal feed additive. Alternatively the palm oil components adsorbed on the activated carbon can be extracted with ethyl alcohol and the ethyl alcohol extract after concentration by distillation can be used as an animal feed additive.

WHAT I CLAIM IS:—

1. A process for the production of palm oil which comprises digesting palm fruit, pressing the digested mash thus obtained to provide a mixture of palm oil, water and particulate solids and subjecting the said mixture (if desired after partial removal of the said particulate solids) to a clarifying treatment which comprises the steps of agitating the said mixture at elevated temperature in the presence of an effective amount of a degumming agent, allowing the water and particulate solids in the said mixture to settle and separating the supernatant palm oil from the remainder of the said mixture.

2. A process as claimed in claim 1 wherein the degumming agent comprises phosphoric acid.

3. A process as claimed in claim 1 wherein the degumming agent comprises sodium hydroxide.

4. A process as claimed in any of the preceding claims wherein the degumming agent is present in the said mixture in a concentration of at least 0.3% by weight of the mixture.

5. A process as claimed in claim 4 wherein the said concentration is at least 0.5% by weight of the mixture.

6. A process as claimed in claim 5 wherein the said concentration is from 0.5 to 1.5% by weight of the mixture.

7. A process as claimed in any of the preceding claims wherein the said mixture is agitated at a temperature not exceeding 100°C.

8. A process as claimed in claim 7 wherein the said temperature is from 90 to 100°C.

9. A process as claimed in any of the preceding claims wherein the said mixture is agitated for a period of at least 15 minutes.

10. A process as claimed in claim 9 wherein the said period is from 15 minutes to 1 hour.

11. A process as claimed in claim 10 wherein the said period is from 15 to 30 minutes.

12. A process as claimed in any of the preceding claims wherein the supernatant palm oil is drawn off from the settled water and solids.

13. A process as claimed in claim 12

wherein the mixture of palm oil and water entrained with the solids is subsequently separated therefrom.

14. A process as claimed in claim 13 wherein the palm oil is recovered from the said mixture.

15. A process as claimed in any of the preceding claims wherein the solids after separation from the palm oil are subjected to fermentation with yeast to provide an animal feed additive.

16. A process as claimed in any of the preceding claims wherein the palm fruit is heated to deactivate enzymes therein which are capable of promoting hydrolysis of fatty acid glycerides prior to digestion.

17. A process as claimed in claim 16 wherein the palm fruit is heated to a temperature of at least 130°C.

18. A process as claimed in claim 17 wherein the said temperature is from 130 to 140°C.

19. A process as claimed in any of claims 16 to 18 wherein the heating is effected before separation of the fruit from the fruit bunches.

20. A process as claimed in claim 19 wherein after heating the fruit is separated from the bunches in a thresher.

21. A process as claimed in any of the preceding claims wherein superheated steam is introduced during digestion of the palm fruit.

22. A process as claimed in claim 21 wherein the pressing of the digested palm fruit is effected using a screw press.

23. A process as claimed in any of the preceding claims wherein the mixture obtained by digesting and pressing is screened to remove coarse particles prior to the clarification treatment.

24. A process as claimed in any of the preceding claims wherein the palm oil is subsequently bleached.

25. A process as claimed in claim 24 wherein bleaching is effected using Fuller's Earth.

26. A process as claimed in claim 25 wherein from 2 to 3% of Fuller's Earth (by weight of oil) is used.

27. A process as claimed in claim 24 wherein bleaching is effected using activated carbon.

28. A process as claimed in claim 27 wherein from 1 to 2% of activated carbon (by weight of oil) are used.

29. A process as claimed in claim 1 substantially as herein described.

30. A process for the production of palm oil substantially as herein described in the Example.

31. Palm oil when produced by a process as claimed in any of the preceding claims.



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The other important constituents of the minor components are the tocopherols. The tocopherols are precursors of Vitamin E.

5 Thus the filter cake can be used as an animal feed additive. Alternatively the palm oil components adsorbed on the activated carbon can be extracted with ethyl alcohol and the ethyl alcohol extract after concentration by distillation can be used as
10 an animal feed additive.

WHAT I CLAIM IS:—

1. A process for the production of palm oil which comprises digesting palm fruit, pressing the digested mash thus obtained to
15 provide a mixture of palm oil, water and particulate solids and subjecting the said mixture (if desired after partial removal of the said particulate solids) to a clarifying treatment which comprises the steps of
20 agitating the said mixture at elevated temperature in the presence of an effective amount of a degumming agent, allowing the water and particulate solids in the said mixture to settle and separating the
25 supernatant palm oil from the remainder of the said mixture.

2. A process as claimed in claim 1 wherein the degumming agent comprises phosphoric acid.

30 3. A process as claimed in claim 1 wherein the degumming agent comprises sodium hydroxide.

35 4. A process as claimed in any of the preceding claims wherein the degumming agent is present in the said mixture in a concentration of at least 0.3% by weight of the mixture.

40 5. A process as claimed in claim 4 wherein the said concentration is at least 0.5% by weight of the mixture.

6. A process as claimed in claim 5 wherein the said concentration is from 0.5 to 1.5% by weight of the mixture.

45 7. A process as claimed in any of the preceding claims wherein the said mixture is agitated at a temperature not exceeding 100°C.

8. A process as claimed in claim 7 wherein the said temperature is from 90 to 100°C.

50 9. A process as claimed in any of the preceding claims wherein the said mixture is agitated for a period of at least 15 minutes.

55 10. A process as claimed in claim 9 wherein the said period is from 15 minutes to 1 hour.

11. A process as claimed in claim 10 wherein the said period is from 15 to 30 minutes.

60 12. A process as claimed in any of the preceding claims wherein the supernatant palm oil is drawn off from the settled water and solids.

13. A process as claimed in claim 12

wherein the mixture of palm oil and water entrained with the solids is subsequently separated therefrom.

14. A process as claimed in claim 13 wherein the palm oil is recovered from the said mixture.

15. A process as claimed in any of the preceding claims wherein the solids after separation from the palm oil are subjected to fermentation with yeast to provide an animal feed additive.

16. A process as claimed in any of the preceding claims wherein the palm fruit is heated to deactivate enzymes therein which are capable of promoting hydrolysis of fatty acid glycerides prior to digestion.

17. A process as claimed in claim 16 wherein the palm fruit is heated to a temperature of at least 130°C.

18. A process as claimed in claim 17 wherein the said temperature is from 130 to 140°C.

19. A process as claimed in any of claims 16 to 18 wherein the heating is effected before separation of the fruit from the fruit bunches.

20. A process as claimed in claim 19 wherein after heating the fruit is separated from the bunches in a thresher.

21. A process as claimed in any of the preceding claims wherein superheated steam is introduced during digestion of the palm fruit.

22. A process as claimed in claim 21 wherein the pressing of the digested palm fruit is effected using a screw press.

23. A process as claimed in any of the preceding claims wherein the mixture obtained by digesting and pressing is screened to remove coarse particles prior to the clarification treatment.

24. A process as claimed in any of the preceding claims wherein the palm oil is subsequently bleached.

25. A process as claimed in claim 24 wherein bleaching is effected using Fuller's Earth.

26. A process as claimed in claim 25 wherein from 2 to 3% of Fuller's Earth (by weight of oil) is used.

27. A process as claimed in claim 24 wherein bleaching is effected using activated carbon.

28. A process as claimed in claim 27 wherein from 1 to 2% of activated carbon (by weight of oil) are used.

29. A process as claimed in claim 1 substantially as herein described.

30. A process for the production of palm oil substantially as herein described in the Example.

31. Palm oil when produced by a process as claimed in any of the preceding claims.

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32. Palm oil as claimed in claim 31 having a free fatty acid content of not greater than 2% by weight.

5 33. Animal feed additives when produced by a process as claimed in claim 15.

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