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METHOD AND DEVICE FOR THE INDUSTRIAL PROCESSING OF RAPE SEED WITH RECOVERY OF COLD PRESSED RAPE SEED CORE OIL

TECHNICAL FIELD OF THE INVENTION

The invention relates to a method of processing grains of a rape seed comprising the steps of unshelling the grains and separating a low-shell grain fraction from a high-shell grain fraction, and pressing cold-pressed rape core oil out of the low-shell grain fraction at temperatures below 65 °C, wherein an oil cake is obtained. Further, the present invention relates to an apparatus for carrying out such a method comprising unshelling rolls forming a nip for unshelling the grains, a separation device arranged downstream of the nip and comprising at least one sieve or air separator for separating a low-shell grain fraction from a high-shell grain fraction, flaking rolls for rolling the low-shell grain fraction to flakes, and a screw press for pressing cold-pressed rape core oil from the flakes, wherein the screw press puts out an oil cake.

Rape seed (brassica napus), inclusive of so-called 0, 00 and 0+ rape seed cultivars and Canola, is the commercially most important oil seed after soy bean and provides a valuable resource for food industry, feeding stuff industry, biodiesel production and oleo chemistry. In contrast to soy bean which primary serves as a source of plant protein, rape seed is primarily cultivated for oil extraction. Mainly, rape seed oil is processed into biodiesel and edible oil. In the production of rape seed oil from rape seed, a residue remains which is designated as coarse colza meal if the rape seed oil is only pressed off or after additional solvent extraction. Even the coarse colza meal remaining after additional solvent extraction makes up about 60 % of the starting material. Thus, it accrues in large quantities. In contrast to coarse soy meal, no usage as an only feed is possible when using coarse colza meal as animal feeding stuff. Toxins, anti-nutritive ingredients and the high-shell portion conflict a use as the only feed and a use in food industry although the rape seed protein contained generally has an amino acid composition which is convenient for use in feeding both humans and animals. Correspondingly, the market price of coarse colza meal is significantly lower than that one of coarse soy meal. At the same time, there is a high demand for proteins suitable for feeding purposes, particularly of genetically unmodified sources. A great need of such proteins, for example, exists in fish farming in aqua cultures.

To make industrial use of the rape seed protein contained in the residues of oil extraction from rape seed at least as feeding stuff, it is necessary to reduce or remove the toxins and other objectionable associated materials. Further, the protein content shall preferably increase up to the level of coarse soy meal and soy protein concentrate produced therefrom.

PRIOR ART

The industrial production of oil from rape seed takes place mechanically and/or chemically. In the mechanical production, the oil is pressed out of the grains of the rape seed. If temperatures below 65 °C are kept in pressing, so-called cold-pressed rape core oil is obtained. At these temperatures, the residual oil content of the oil cake resulting from rape seed due to pressing may be reduced to about 20 percent per weight of the dry matter. By pressing at higher temperatures, the residual oil content can be reduced further, wherein, however, cold-pressed rape core oil no longer accrues. If the grains of the rape seed are unshelled prior to pressing to obtain a shell-free oil cake, the residual oil content of the oil cake is significantly above 20 % when cold-pressing only. By a successive extraction of the oil cake with hexane, which typically follows to disintegrating the oil cake, the residual oil content is reduced down to below 1 percent by weight.

After extraction, the already mentioned coarse colza meal remains which only has a limited value, even if the grains of the rape seed have been unshelled prior to pressing the rape core oil out of them.

A method and an arrangement for unshelling rape seed in which a combined pressure and impact treatment of the grains of the rape seed takes place to reduce the shell content to less than 5 % are known from **DE 40 41 994 A1**. In the know method, the following steps are executed after cleaning the grains: classifying the grains and separating minor sizes, reducing the moisture content of the grains by drying, pressure treatment by rolling with a nip which is 0.2 to 0.4 times an average grain diameter, impact loosening the broken up shells from the cores of the grains by pneumatic conveying, air-separating and electro-separating the shells from the cores. In the known arrangement, a seed bunker, a scale, an iron eliminator, a classification deck, unshelling rolls, a cyclone, an air-separator and an electro-separator are connected in series for this purpose. The production of rape seed core oil from the cores may follow to the unshelling of the rape seed.

A method and a device for producing edible oil from rape seed are known from **EP 1 074 605 A1**. By classification, the rape seed is separated into fractions of different particle sizes. The cleaned and classified rape seed is dried. The dried rape seed is broken up. The broken up rape seed is separated into fractions of different particle size, a fraction called usable fragments is divided into unshelled rape seed and shells. The unshelled rape seed is moistened and flaked afterwards. Then, the unshelled rape seed is cold-pressed in a press to obtain cold-pressed rape core oil. The accruing oil cake, like the other byproducts of the known method, may be used as animal feed. Alternatively, an energetic use of the separated byproducts, particularly of the shell fraction, is proposed.

WO 2011/029611 A2 describes a method of processing grains of rape seed, wherein the grains are unshelled, separated in core fractions, on the one hand, and shell fractions, on the other hand, and wherein the core fractions are subjected to one or more pressings. The method is carried out in such a way that a solid matter and oil containing oil cake remaining from the oil production is output as a basic material, filler or additive for food for humans, either directly or after a further grinding step. In case of outputting a basic material for food for humans, the shell-free oil cake may be ground, the ground material may be de-oiled by extraction and then serve as a basis for a protein concentration and/or protein isolation.

A method for producing soy protein concentrate from white soybean flakes is known from **WO 2011/161665 A1**. The soybean flakes are extracted for removing oil in a continuously operating hexane extractor. After partially stripping the hexane, the flakes are transferred into an aqueous alcohol extractor to extract the remaining hexane, sugar and other alcohol soluble material.

A method for producing a detoxified protein concentrate product from defatted oil seed, particularly rape seed, is known from **US 4,158,565 A**. Here, the unshelled and defatted cores of the rape seed are extracted with an aqueous alcohol solvent under non-oxidizing conditions, and the solid matter residue of the extraction is dried at temperatures below 60 °C.

A method for obtaining native organic materials, particularly oils, fats, waxes, dyes, vitamins and/or other lipophilic materials and their derivatives from native substances by means of centrifugal force is known from **EP 1 228 701 A1**. For this purpose, a starting material is comminuted, the lipophilic materials are extracted from the comminuted

starting material by means of an extracting agent, and, in a centrifugal field, the slurry is separated in an aqueous phase containing solid components and a liquid, organic phase which includes the hydrophobic materials.

A method of producing a protein preparation from rape seed, which includes unshelling the grains of the rape seed, mechanically de-oiling in which only a part of the oil is separated and which is executed at a temperature averaged over the period of the pressing step of less than 80 °C, and an extraction is known from **WO 2010/096943 A2**. In the mechanical de-oiling which is carried out at the temperature averaged over the period of the pressing step of less than 80 °C, only a part of the oil is separated. In the extraction, protein foreign substances are separated from the protein meal. Processing with regard to the grain size follows to the extraction to obtain a bulk material of a predetermined grain size distribution. Particularly, the known method starts with unshelling the grains of the rape seed by breaking-up in an impact mill and separating in a core-rich coarse fraction and a shell-rich fine fraction in an air stream in a zig-zag-separator. The core fraction is then pressed cold in a screw press at temperatures between 30 and 45 °C down to a residual oil content of about 23 percent per weight, wherein the oil cake is obtained in form of compressed strands called oil cake pellets. The oil cake pellets are de-oiled with hexane in a Soxhlet apparatus down to a residual oil content of below 3 %. Then, the solvent is removed in an air stream at room temperature. The extracted protein meal pellets obtained in this way are treated with an ethanol solution in a percolation process without further comminution. The accruing final protein concentrate is used with or without consecutive comminution.

A method and an arrangement of producing oil from legume seed, wherein grains of, for example, rape seed are processed by producing platelets followed by moistening these platelets with a successive expansion and drying, and pressing at temperatures < 100 °C down to a residual oil content of 15 to 25 %, are known from **DE 40 35 349 A1**. An oil cake produced in pressing is extracted at temperatures of about 65 °C.

A method and an apparatus for thermal conditioning of oil seeds and oil fruits, particularly legume seeds, for the production of oils and fats ,on the one hand, and an oil and fat free coarse meal suitable as concentrated feed, on the other hand, are known from **DE 35 29 229 C1**. Here, the cleaned, dried and comminuted oil seeds and oil fruits, after an upfront flat rolling, are heated up to above 100 °C for a short time at an over-atmospheric pressure in an air or oxygen free atmosphere, and afterwards expanded abruptly by

simultaneously cooling down to temperatures below 100 °C. In this way, it is achieved that the urease activity in the coarse meal is inhibited to a far extent and that both the entire proteins and, to a considerable extent, their water solubility survive. The known thermal conditioning may take place successive to a pressing and prior to an extraction in which an extraction temperature of 50 to 65 °C is adjusted. With regard to rape seed, it is particularly proposed to at first condition the flat rolled grains at comparatively mild conditions thermally, to then press the warm material for producing rape core oil, and to thermally condition the oil cake at enhanced conditions, to cool it down and to extract it in a known way afterwards. In this way, it shall be achieved to obtain the oil content of the shells optimally and to achieve a clear separation of pressed rape core oil from the cores and extracted oil from the shells.

OBJECT OF THE INVENTION

It is the object of the invention to provide a method and an apparatus by which, besides a high value cold-pressed rape core oil, a protein containing product is obtained which may be further processed to high value feed and food stuffs, wherein an industrial realization of the method and the apparatus are ensured.

SOLUTION

The object of the invention is achieved by a method comprising the features of independent claim 1 and by an apparatus comprising the features of claim 11. Preferred embodiments of the method according to the invention and the apparatus according to the invention are defined in the dependent claims.

DESCRIPTION OF THE INVENTION

In a method according to the invention of processing grains of a rape seed comprising the steps of unshelling the grains and separating a low-shell grain fraction from a high-shell grain fraction and pressing cold-pressed oil from the low-shell grain fraction at temperatures below 65 °C, wherein an oil cake is obtained, pressurized steam is supplied to the oil cake obtained by the pressing, and the oil cake is afterwards expanded into collets, wherein, under the influence of the steam, the oil cake is temporarily heated up to above 100 °C.

In the method according to the invention, the grains of the rape seed are unshelled prior to pressing-out the cold-pressed rape core oil. Correspondingly, the oil cake obtained by the pressing, and also the collets obtained by expanding the oil cake include no or only few shells. Besides a certain increase of quality of the cold-pressed rape core oil, this particularly results in a considerable increase of the value of the collets. Already as such, these collets are usable as animal feed. Due to the heating up of the oil cake, they are hygienically unobjectionable and nevertheless have an advantageous amino acid composition with at maximum little undesired denaturations due to the short term of this heating up. Particularly, the collets have a connected but open structure which is advantageous for their further processing as it will be explained in the following.

If necessary, the method according to the invention may start with cleaning the grains of the rape seed to remove contaminations like stones or chaff. The grains cleaned in this way may be subjected to a classification with regard to grain sizes to separate grains which are not well suited for a subsequent unshelling of the grains. Particularly, grains smaller than a minimum size between 1.4 mm and 1.8 mm, preferably of about 1.6 mm, and bigger than a maximum size between 2.6 and 3.0 mm, preferably of about 2.8 mm, may be separated. The grains exceeding the maximum size may be unshelled separately by means of a device adjusted to their grain size, and the grains having a grain size below the minimum size may be used in another way. Typically, the proportion of smaller grains is below 8 percent by weight, often below 4 percent by weight.

Already beforehand or afterwards, the grains are adjusted to a moisture content between 3 and 7 percent by weight, preferably of about 5 percent by weight, for unshelling, and they are dried for this purpose if needed. Where applicable, the drying temperature should be selected such that a grain temperature of 70 °C, preferably of 60 °C, is not exceeded. For unshelling, the grains are, for example, guided through to a nip between unshelling rolls, which is typically at least 20 % smaller than the minimum size of the grains. The grains may also pass through several nips with decreasing sizes one after the other.

Afterwards, the grains broken up between the unshelling rolls are separated by sieving and/or air separating including an aspiration of the shells into the low-shell grain fraction and the high-shell grain fraction. The shells remaining in the low shell-grain fraction do not make up more than 4 percent by weight. Preferably, they are not more than 3.5 percent by weight. On the other hand, cores are found in the high-shell grain fraction,

which may make up up to 40 percent by weight of the high-shell grain fraction. Thus, the high-shell fraction is suitably further processed for obtaining a further low-shell grain fraction. This preferably occurs by adding water of about 20 to 30 °C, i. e. about room temperature of 25 °C, to the high-shell grain fraction, which triggers a swelling of the fibers contained in the cores. Due to another morphology, this swelling does not or at least not to the same extent take place with the fibers contained in the shells. Further, the cores differ from the shells by a higher oil content. After swelling of the fibers in the cores, the cores have a lower density than water, whereas the shells still have a higher density than water. Thus, a floatation of the cores occurs, wherein the floatation and the associated separation of cores and shells may be supported by introducing fine gas bubbles and/or slightly low-shear stirring. The floating cores are removed as the further low-shell grain fraction. They may be de-watered via a belt press and added to the previously separated low-shell grain fraction. This addition may take place already prior to pressing the cold-pressed rape core oil but also later. However, the further low-shell grain fraction is introduced into the main stream of the material prior to supplying the pressurized steam and the following expansion into the collets. The separated shell fraction may be separated due to its higher density than water, be purified further and then, for example, used thermally or in a biogas plant.

After unshelling, the moisture content of the low-shell grain fraction may be increased to 5 to 9 percent by weight or preferably about 7 percent by weight of its dry matter. This slightly increased moisture content is advantageous in afterwards pressing the cold-pressed oil. It is also advantageous, when the low-shell grain fraction is rolled to flakes prior to pressing. The adjustment of the moisture content of the low-shell grain fraction may also be realized in that at least a part of the further low-shell grain fraction from the floatation and with correspondingly increased moisture content is added already prior to the pressing or the rolling of the low-shell grain fraction to flakes. The flakes preferably comprise a flake thickness of 0.1 to 0.5 mm. Correspondingly, the low-shell grain fraction is passed through at least one nip formed by flaking rolls.

During pressing, the cold-pressed rape core oil may be collected in a first oil fraction which is heated up during pressing to not more than a limit temperature, and in a second oil fraction which is heated up during pressing to more than the limit temperature. Then, the first oil fraction has the lowest thermal influence on its oil composition, and it is the most high-grade rape core oil produced by the method according to the invention. The second oil fraction is still high-grade cold-pressed rape core oil. Further, a third oil fraction

may be collected which is heated up during pressing to more than a further limit temperature. The limit temperature between the first and the second oil fraction may be between 40 and 50 °C or about 45 °C, the further limit temperature may be about 60 °C. During the pressing according to the invention at temperatures below 65 °C, the low-shell grain fraction may be pressed down to a first residual oil content of 18 to 28 percent by weight or 20 to 24 percent by weight, i. e. about 22 percent by weight of its dry matter. The cold-pressed rape core oil may in a usual way be processed by filtration and/or sedimentation and provides cold-pressed native rape core oils of food quality.

The oil cake obtained by the pressing is disintegrated, and the further low-shell grain fraction or what is left of it is added. This material is supplied to an expander for supplying the steam and the successive expansion. By adding the pressurized steam, the material is compressed and in doing so heated up for a short time to typically 130 to 140 °C, prior to being expanded and thus cooled down again by decompression of the steam. The expanded objects obtained are the collets produced according to the invention. In contrast to pellets, in which the oil cake may be obtained, these collets have an open core structure which eases their further processing. The short time temperature increase to over 100 °C and up to 140 °C caused by steam and pressure inhibits enzymes and salmonellae. Further, it results in a partial denaturation of the proteins contained in the collets. This partial denaturation does not essentially limit the feed and food value of the proteins. However, the partial denaturation of the proteins results in that the proteins remain in the collets and do not get lost during a successive extraction of the collets to extract further oil and undesired ingredients from them.

The collets are extracted with hexane to reduce the collets to a second residual oil content of less than 2 percent by weight or of 0.3 to 1.3 percent by weight of its dry matter. Generally, instead of hexane, another organic solvent may be used in which oil is soluble well, like for example isopropanol. As well as for all steps of the method according to the invention described up to here, industrial standard technology may be used for the extraction, particularly carousel extractors and belt extractors. The solvent used encloses the collets in a percolation, wherein a miscella is formed from the solvent in which the oil contained in the collets is solved. In a known way, this miscella is separated from the solvent by distillation so that the oil remains. This oil is rape core extraction oil. The extracted collets can be dried and disintegrated, wherein a high protein content rape core meal having a protein content of more than 40, preferably more than 42 percent by weight is obtained. This rape core meal may be processed further.

Alternatively, the collets extracted with hexane may be processed further directly, i. e. without drying and/or disintegrating.

Thus, the collets may be demoistured by simple drainage or dripping off the hexane prior to outputting them out of the hexane extractor to not destroy the structure of the hexane-wet collets and to not produce fines. In this way, typically more than 50 % of the hexane can be removed out of the collets. At the exit of the hexane extractor, the collets are taken up and transported by a conveying unit in a non-destructive way, like for example by a conveyer screw or a conveyer belt. The conveyer unit conveys the hexane-wet collets without shearing to a filter which is divided into separation areas. The material is transferred unto a filter in a non-destructive way. The filter may be a closed rotation filter or a belt filter, particularly a vacuum belt filter. A cellular wheel sluice may be installed between the conveying unit and the filter to provide for a separation of the solvent areas. After the hexane-wet collets have been arranged on the filter, the filter is brought in a first position, in which the hexane content of the hexane-wet collet is reduced further. This may be accelerated by applying a vacuum to a vacuum belt filter. Thus, a hexane content of less than 40 percent by weight can be realized. In doing so, the hexane has concentrated towards the filter due to the capillary effect so that a low-hexane layer has been formed above the hexane in the capillaries in the collets. Beginning at a second position of the filter, pure alcohol or a water-alcohol-azeotrope may be overlayered to replace the hexane. Due to the resulting layering of the solvents in the collets, there is a nearly plane alcohol/hexane boundary layer so that the hexane may essentially be collected separated from the alcohol.

With a belt filter, the solvent may also be replaced by small amounts of the alcohol. After two to three washing steps, the hexane in the structure of the collets is replaced by the alcohol without residue. In doing so, only small volumes of a mixed hexane-alcohol-fraction accrue which can be separately processed by distillation.

An extraction of the collets with an aqueous alcohol solution to obtain a purified rape protein concentrate may follow to the solvent replacement or to drying the collets extracted with hexane. Here, the aqueous alcohol solution may comprise 70 to 96 percent by volume alcohol. 80 to 90 percent by volume alcohol are preferred. This alcoholic extraction, particularly with ethanol, serves for removing toxins and other anti-nutritive ingredients. At the preferred alcohol concentration, the swelling of the fibers contained in the rape material and the associated increase in volume remain small. In

this way, it is also avoided that the percolation rates of the collets strongly drop due to the swelling. Preferably, the collets are extracted with a countercurrent of the aqueous alcohol solution. Here, a ratio of solid matter to solvent from 1 to 2 up to 1 to 4 is suitable. Preferably, at least 10 extraction stages are undergone in countercurrent. Towards the end of the extraction, a replacement washing with alcohol of at least 90, preferably 96 percent, may take place to ease the drying of the extracted material. The extracts from the extraction stages are collected. After distilling the alcohol off, a rape molasses remains.

The purified rape protein concentrate may, particularly after replacing the aqueous solution by the alcohol of at least 95 percent, be dried by , for example, toasting, flash-drying or vacuum-drying. The dried rape protein concentrate has a protein content of more than 60 percent by weight related to its dry matter.

In an apparatus for carrying out the method according to the invention for processing grains of a rape seed comprising unshelling rolls forming a nip for unshelling the grains, a separation device arranged downstream of the nip and comprising at least on sieve or air separator for separating a low-shell grain fraction from a high-shell grain fraction, flaking rolls for rolling the low-shell grain fraction to flakes, and a screw press for pressing cold-pressed rape core oil out of the flakes, wherein the screw press puts out an oil cake, an expander arranged downstream of the screw press is provided for expanding the oil cake into collets in that pressurized steam is supplied to the oil cake. Further, a floatation basin can be provided to separate the high-shell grain fraction by floatation in water into a further low-shell grain fraction and a shell fraction. This floatation basin may, optionally, comprise a pressurized air connector flowing-in at or close to the bottom and/or a stirrer.

An extractor arranged downstream of the expander is provided to extract the collets with hexane, to subject the still hexane-wet collets to a solvent replacement, and to extract the collets after the solvent replacement with an aqueous alcohol solution.

Advantageous developments of the invention result from the claims, the description and the drawings. The advantages of features and of combinations of a plurality of features mentioned at the beginning of the description only serve as examples and may be used alternatively or cumulatively without the necessity of embodiments according to the invention having to obtain these advantages. Without changing the scope of protection as defined by the enclosed claims, the following applies with respect to the disclosure of

the original application and the patent: further features may be taken from the drawings, in particular from the illustrated designs and the dimensions of a plurality of components with respect to one another as well as from their relative arrangement and their operative connection. The combination of features of different embodiments of the invention or of features of different claims independent of the chosen references of the claims is also possible, and it is motivated herewith. This also relates to features which are illustrated in separate drawings, or which are mentioned when describing them. These features may also be combined with features of different claims. Furthermore, it is possible that further embodiments of the invention do not have the features mentioned in the claims.

The number of the features mentioned in the claims and in the description is to be understood to cover this exact number and a greater number than the mentioned number without having to explicitly use the adverb "at least". For example, if a screw press is mentioned, this is to be understood such that there is exactly one screw press or there are two screw presses or more screw presses. Additional features may be added to these features, or these features may be the only features of the respective product.

The reference signs contained in the claims are not limiting the extent of the matter protected by the claims. Their sole function is to make the claims easier to understand.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention is further explained and described with reference to preferred embodiment examples depicted in the figures.

Fig. 1 is a block diagram of an apparatus according to the invention and of the process of the method according to the invention.

DESCRIPTION OF THE DRAWINGS

In a block diagram, **Fig. 1** shows an apparatus 1 according to the invention and at same time the process of a method according to the invention. Rape seed from a bunker 2 is subjected to a classification and cleaning in a sieving machine 3. Cleaned grains 4 within a predetermined grain size range are obtained from the sieving machine 3. After optional drying to adjust a moisture content of the grains 4 to about 5 percent by weight, the grains 4 are unshelled by means of unshelling rolls forming a nip and a downstream separation

device. The results are a low-shell grain fraction 6 and a high-shell grain fraction 31. The low-shell grain fraction 6 is rolled with flaking rolls 7 to flakes after moistening to adjust a moisture content of about 7 percent by weight of its dry matter. In a screw press 8, cold-pressed rape core oil 25 is pressed out of the flakes. A resulting oil cake 9 is forwarded to an expander 14.

On the other hand, water is added to the shell-rich grain fraction 31 to form a suspension 32 in which the fibers contained in the core part of the high-shell grain fraction 31 swell. Afterwards, a floatation 33 occurs in which a further low-shell grain fraction 10 floats and thus separates from the shell fraction 11. The shell fraction 11 can be dried and/or ground and used, for example, in a incineration or biogas plant. The further low-shell grain fraction 10 is pressed in a belt press 12. Its solid matter part is added to the oil cake 9 in front of the expander 14. Water pressed off by the belt press is processed in an oil clarifier 13 in which oil 26 is separated. The purified water is UV-treated and used again. The oil cake 9 and the further low-shell grain fraction 10 are disintegrated and supplied to an expander 14. In the expander 14, by supplying pressurized steam, the temperature of the oil cake 9 is increased for a short time to over 100 °C, typically 130 to 140 °C. When getting out of the expander, the steam decompresses and cools the material which gets out in form of collets 30. In an extractor 15, the collets 30 are at first subjected to a hexane extraction 16. An alcoholic extraction 18 follows to a solvent replacement 17. Instead of the solvent replacement, a drying 19 of the hexane extracted collets may take place. Hereto, a pelletisation 20 or a further expansion of the dried material may follow. The alcoholic extraction 18 may also be executed with a meal resulting from the drying 19. In a distillation 21, extraction oil 27 is produced from the miscella of the hexane extraction 16. In a distillation 22, solvent is recovered from the solvent replacement 17. From a distillation 23 of the alcoholic extract from the alcoholic extraction 18 a molasses 28 results. A drying 24 of the residue of the alcoholic extraction 18 provides a purified rape protein concentrate 29.

EXAMPLE

10 tons of rape seed, for example, 00 rape seed, are cleaned. Depending on the contamination level, 2 to 3 % of the starting material are removed. In a subsequent classification, up to 4 % grains of a grain size below 1.6 mm and above 2.8 mm are removed. 94 % of the original rape seed having a moisture content between 7 and 9 % are forwarded to the drying.

At 60 to 70 °C, the rape seed is dried to a moisture content of 5 percent by weight, and, after cooling down to 30 °C, it is supplied to the unshelling rolls 5. The separation into the high-shell grain fraction 31 and the low-shell grain fraction 6 results in about 75 to 80 percent by weight low-shell grain fraction and 20 to 25 percent by weight high-shell grain fraction 31. The high-shell grain fraction 31 comprises 30 to 40 percent by weight core material, whereas the low-shell grain fraction includes below 4 % shells. In total, the high-shell grain fraction 31 includes about 17 percent by weight oil and 14 percent by weight protein. Water of 20 to 30 °C is added to the high-shell grain fraction 31. With regard to mass parts, a ratio of 6 to 1 results, i. e. at least 6 kg water are allocated to 1 kg high-shell grain fraction 31. After addition of the water, the resulting suspension 32 is agitated and mixed by stirring slightly without shearing. The fibers of the cores in the high-shell grain fraction 31 swell for 15 minutes. In the following floatation 33 of the stirred high-shell grain fraction, a separation into the floating further low-shell grain fraction 10 and the shell fraction 11 takes place. For enhancing the floatation, finely distributed air may be blown in. The swollen cores of the further low-shell grain fraction 10 are collected with the belt press 12. The water is separated and, in a cycle, added to a new high-shell grain fraction 31. The further low-shell grain fraction 10 collected with the belt press 12 is de-watered and added to the oil cake 9 in front of the expander 14.

The low-shell grain fraction 10 is adjusted to a moisture content of 6 to 7 % and afterwards rolled to flakes of a thickness of 0.2 to 0.4 mm by means of the flaking rolls 7. By means of cooling, the flakes are kept at a temperature between 35 and 40 °C. The flakes are directly supplied to the screw press 8. In the screw press 8, the flakes are compressed by the screw of the screw press. The leaking out cold-pressed rape core oil 25 is collected separately for temperature ranges. The first oil of a temperature from 35 to 40 °C is native cold-pressed virgin rape core oil. The oil fraction between 45 and 60 °C is native cold-pressed rape core oil. Both oil fractions together result in about 2.8 tons cold-pressed rape core oil 25 of which 40 % are virgin rape core oil and 60 % are native cold-pressed rape core oil. The oil cake 9 leaving the screw press 8 has a residual oil content of 22 to 23 percent by weight.

The further low-shell grain fraction 10 from the belt press 12 is added to the oil cake 9, disintegrated and supplied to the expander 14. In the expander 14, under addition of pressurized steam 30, the oil cake is heated up such that a temperature between 130 und 140 °C is reached for 5 to 10 seconds when leaving the expander 14. The pressure at the exit of the expander 14 is between 30 and 40 bar. The resulting expanded material

are the collets 30. The collets 30 are cooled down and, in a carousel extractor of the extractor 15, extracted with hexane at 60 °C in multiple steps in countercurrent under percolation. The resulting miscella is distilled, and the hexane is supplied to the process again. The extraction time is between 0.5 and 2 hours, preferably about 1 hour. An extracted rape core extraction oil 27 having a mass of 1.1 tons results.

The hexane-wet oil-extracted collets 30 are dripped off and demoistured. The collets 30 may then be forwarded to a drying to a high protein content rape protein meal or to a belt filter. Particularly, the belt filter is a vacuum belt filter. After further transport, the contained hexane is overlayered with ethanol of 96 percent. In the further course, the ethanol is sucked through the collets, wherein the ethanol is supplied in countercurrent. After three steps, the hexane is replaced by ethanol, and the collets are now overlayered with ethanol of 80 percent and further processed in countercurrent, wherein a swelling time of 15 minutes is reached. Subsequently, the material is supplied to a further stage of the extractor 15 in which the collets are extracted with ethanol of 80 percent, wherein the extraction time is 1 to 3 hours. The last alcoholic step is a replacement of the alcohol-water-mixture by ethanol of 96 percent to reduce the energy cost of a subsequent drying 24. The alcohol is distilled off and used again. The molasses 28 remains. The dry matter of the molasses 28 corresponds to about 10 % of the rape seed processed. The rape protein concentrate 19 purified by the alcoholic extraction is dried and yields 3 tons.

The rape protein concentrate 29 has the following composition:

The rape protein concentrate has the following composition:

Protein content related to dry matter (N*6.25)	62,0% +/-2%,
Dry matter	90% +/-2%
Oil content	0,4% +/-0,2%
Glycosinolate content	less than 1 µg/g
Polyphenols	less than 0,1%
Sinapines	less than 0,1%

Phytic acid	3% +/- 1%
Pale color	
Neutral taste	
Yield of concentrate related to classified rape seed	30%

The exemplary amino acid composition shows a composition getting close to the rape seed:

TYPICAL AMINO ACIDS				
		on Sample g/100g DM	on Protein g/100g Protein	
Aspartic Acid	Asp	4,94	8,13	NE
Glutamic Acid	Glu	11,16	18,36	NE
Hydroxyprolin	Hyp	0,17	0,28	NE
Serine	Ser	2,79	4,59	NE
Glycine	Gly	3,55	5,84	NE
Histidine	His	1,86	3,06	E
Arginine	Arg	4,45	7,33	(NE)
Threonine	Thr	2,99	4,92	E
Alanine	Ala	2,80	4,60	NE
Proline	Pro	3,68	6,06	NE
Tyrosine	Tyr	1,60	2,63	(NE)
Valine	Val	3,58	5,89	E BCAA
Methionine	Met	1,18	1,94	E BCAA
Isoleucine	Ile	2,73	4,49	E
Leucine	Leu	4,73	7,78	E BCAA
Phenylalanine	Phe	2,72	4,47	E
Lysine	Lys	4,05	6,66	E
Cysteine/Cyst	Cys	1,68	2,76	(NE)
Tryptophan	Trp	1,03	1,69	E

NE= not essential *E= essential* *BCAA=branched-chain amino acids*

Essential AA			*on AA*
standard	*24,87*	*40,90*	*40%*
for Infants/children	*35,26*	*58,00*	*57%*
BCAA	*9,49*	*15,61*	*15,4%*

LIST OF REFERENCE NUMERALS

1	apparatus
2	bunker
3	sieving machine
4	grains
5	unshelling rolls
6	low-shell grain fraction
7	flaking rolls
8	screw press
9	oil cake
10	further low-shell grain fraction
11	shell fraction
12	belt press
13	oil separator
14	expander
15	extractor
16	hexane extraction
17	solvent replacement
18	alcoholic extraction
19	drying
20	pelletisation
21	distillation
22	distillation
23	distillation
24	drying
25	cold-pressed rape core oil
26	oil
27	extraction oil
28	molasses
29	purified rape protein concentrate
30	steam
31	high-shell grain fraction
32	suspension
33	floatation

Patentkrav

1. Fremgangsmåde til forarbejdning af korn (4) fra rapsfrø med de følgende trin:

- afskalning af kornene (4), til hvilket formål kornene (4) føres ind igennem en valsespalte mellem afskalningsvalser (5), og fraseparering af en kornfraktion med få skaller (6) fra en kornfraktion med mange skaller (31) ved hjælp af sigtning og/eller vindsigtning og
- presning af koldpresset rapskerneolie (25) fra kornfraktionen med få skaller (6) ved temperaturer på under 65 °C, hvor der tilvejebringes en pressekage (9);

kendetegnet ved,

- **at** de skaller, der bliver tilbage i kornfraktionen med få skaller, ikke udgør mere end 4 vægtprocent,
- **at** kornfraktionen (6) med få skaller presses til et første restolieindhold på 20 til 24 vægtprocent af deres tørmasse,
- **at** der tilføres spændt vanddamp (30) til pressekagen (9), og pressekagen (9) efterfølgende ekspanderes til collets, hvor pressekagen (9) opvarmes midlertidigt til over 100 °C under indvirkning fra vanddampen (30),
- **at** de nævnte collets ekstraheres med hexan eller et andet organisk opløsningsmiddel for at reducere de nævnte collets til et andet restolieindhold på mindre end 2 vægtprocent af deres tørmasse, og
- **at** de nævnte collets, der er ekstraheret med hexan eller det andet organiske opløsningsmiddel, ekstraheres med en vandig alkoholopløsning for at opnå et renset rapsproteinkoncentrat (29), hvor den vandige alkoholopløsning har 70 til 96 volumenprocent alkohol.

2. Fremgangsmåde ifølge krav 1, **kendetegnet ved, at** kornene (4) ved afskalningen har en fugtighed på 3 til 7 vægtprocent eller på 4 til 6 vægtprocent af deres tørmasse.

3. Fremgangsmåde ifølge krav 1 eller 2, **kendetegnet ved, at** kornfraktionen med få skaller (31) ved hjælp af flotation (33) i vand opdeles i en yderligere kornfraktion med få skaller (10) og en skalfraktion (11), hvor eventuelt den yderligere kornfraktion med få skaller (10) tilsættes til kornfraktionen med få

skaller (6) inden tilførslen af den spændte vanddamp (30).

4. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** kornfraktionen med få skaller (6) med en fugtighed på 5 til 9 vægtprocent eller på 6 til 8 vægtprocent af deres tørmasse valses til flager, som eventuelt har en flagetykkelse på 0,1 til 0,5 mm.

5. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** den koldpressede rapskerneolie (25) opfanges i en første oliefraktion, som under presningen opvarmes til ikke mere end en grænsetemperatur, og i en anden oliefraktion, som under presningen opvarmes til mere end grænsetemperaturen, hvor grænsetemperaturen ligger mellem 40 og 50 °C eller mellem 44 og 46 °C, at kornfraktionen med få skaller (6) presses til et første restolieindhold på 18 til 28 vægtprocent eller på 20 til 24 vægtprocent af sin tørmasse, og at pressekagen (9) findeles inden tilførslen af den spændte vanddamp (30).

6. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** de nævnte collets ekstraheres med hexan eller det andet organiske opløsningsmiddel for at reducere de nævnte collets til et andet restolieindhold på 0,3 til 1,3 vægtprocent af deres tørmasse.

7. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** den vandige alkoholopløsning har 80 til 90 volumenprocent alkohol.

8. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** de nævnte collets, som stadig er opløsningsmiddel-våde, underkastes en opløsningsmiddeludskiftning (17), hvor der anvendes mindst et opløsningsmiddel, der skal udskiftes, som er udvalgt blandt ren alkohol og en vand-alkohol-azeotrop.

9. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** den vandige alkoholopløsning fortrænges med mindst 95 %-ethanol.

10. Fremgangsmåde ifølge et af de foregående krav, **kendetegnet ved, at** det rensede rapsproteinkoncentrat (29) tørres ved hjælp af ristning, lyntørring eller

vakuumtørring.

11. Indretning til udførelse af fremgangsmåden til forarbejdning af korn (4) fra rapsfrø ifølge et af de foregående krav med
- afskalningsvalser (5), der danner en valsespalte, til afskalning af kornene (4);
- en separationsindretning, der er efterkoblet valsespalten, med mindst en sigte eller vindsigte til fraseparering af en kornfraktion med få skaller (6) fra en kornfraktion med mange skaller (31);
- flagevalser (7) til valsning af kornfraktionen med få skaller (6) til flager og
- en snekkepresse (8) til presning af koldpresset rapskerneolie (25) fra flagerne, hvor snekkepressen (8) udleder en pressekage (9);
kendetegnet ved
- en ekspanderingsindretning (14), der er efterkoblet snekkepressen (8), til tilførsel af spændt vanddamp (30) til pressekagen (9) og til efterfølgende ekspandering af pressekagen (9) til collets og
- en ekstraheringsindretning (15), som er udformet til at ekstrahere de nævnte collets med hexan eller et andet organisk opløsningsmiddel, at underkaste de nævnte collets, der stadig er opløsningsmiddel-våde, en opløsningsmiddeludskiftning (17) og at ekstrahere de nævnte collets efter opløsningsmiddeludskiftningen (17) med en vandig alkoholopløsning.

12. Indretning ifølge krav 11, **kendetegnet ved, at** et flotationsbassin er tilvejebragt og udformet til at opdele kornfraktionen med få skaller (31) ved hjælp af flotation (33) i vand i en yderligere kornfraktion med få skaller (10) og en skalfraktion (11), hvor flotationsbassinet eventuelt har en tryklufttilslutning, der udmunder ved eller i nærheden af dets bund, og/eller et røreværk.

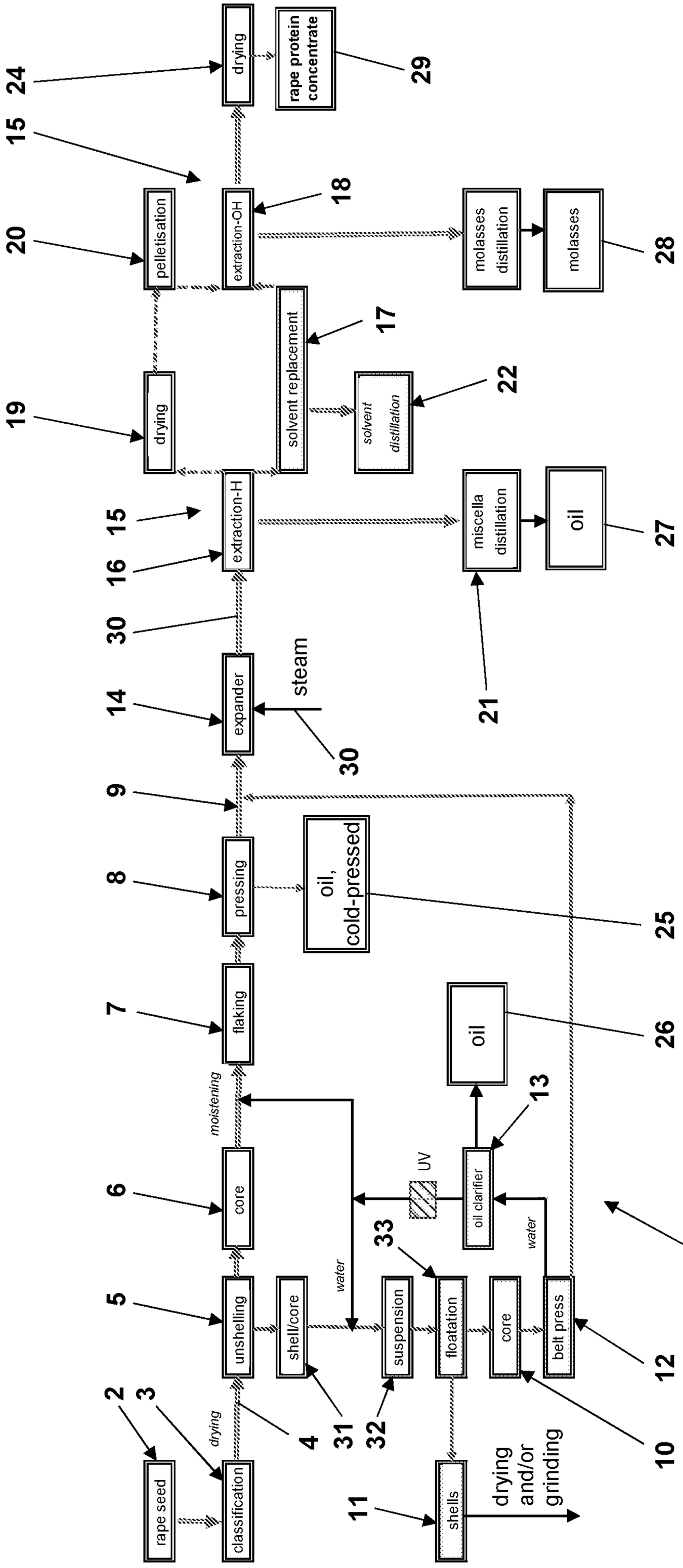
drying
rape protein concentrate
29
24
15
18
20
pelletisation
extraction-OH
molasses distillation
molasses
28
solvent replacement
17
19
drying
22
solvent distillation
extraction-H
miscella distillation
oil
27
16
30
21
14
expander
steam
30
9
8
pressing
oil, cold-pressed
25
7
flaking
moistening
oil
26
6
core
UV
oil clarifier
13
33
water
1
5
unshelling
shell/core
suspension
floatation
core
belt press
12
2
3
drying
4
31
32
10
rape seed
classification
11
shells
drying and/or grinding

Fig. 1