(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 December 2014 (31.12.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/207625 A2

(51) International Patent Classification:
A23C 11/10 (2006.01)

(21) International Application Number:
PCT/IB2014/062414

(22) International Filing Date:
19 June 2014 (19.06.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PCT/CN2013/000787 28 June 2013 (28.06.2013) CN

(71) Applicant: **KONINKLIJKE PHILIPS N.V.** [NL/NL]; High Tech Campus 5, NL-5656 AE Eindhoven (NL).

(72) Inventors: **SUIJVER, Jan Frederik**; c/o High Tech Campus, Building 5, NL-5656 AE Eindhoven (NL). **HUANG, Zhuangxiong**; c/o High Tech Campus, Building 5, NL-5656 AE Eindhoven (NL). **TE VELDE, Mart Kornelis-Jan**; c/o High Tech Campus, Building 5, NL-5656 AE Eindhoven (NL). **HUI, Tat Chi Enoch**; c/o High Tech Campus, Building 5, NL-5656 AE Eindhoven (NL). **VAN DEN AKER, Karel Johannes Adrianus**; c/o High Tech Campus, Building 5, NL-5656 AE Eindhoven (NL).

(74) Agents: **COOPS, Peter** et al.; High Tech Campus, Building 5, NL-5656 AE Eindhoven (NL).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

[Continued on next page]

(54) Title: METHOD AND DEVICE FOR MAKING SOY MILK AND SOY MILK DERIVATIVE

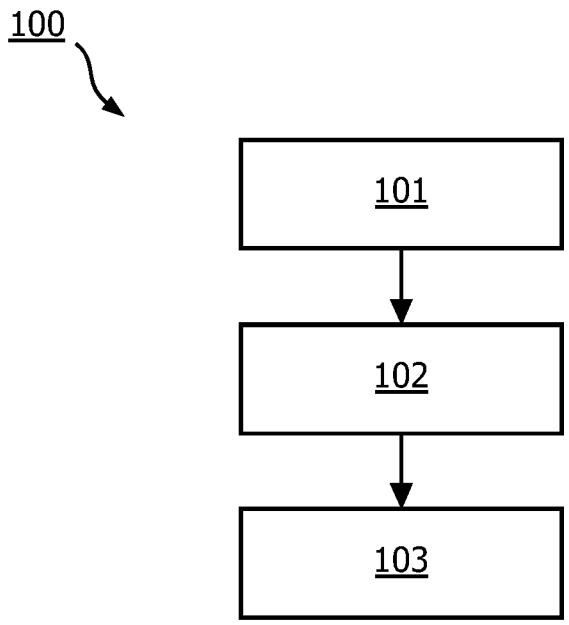

FIG. 1

(57) Abstract: The present invention relates to a method of making soy milk, the method (100) comprising the steps of: grinding (101) soybeans into powder; mixing (102) the powder with solvent to form a mixture; and heating (103) the mixture with a steam jet, wherein the steam jet is injected into the mixture. The present invention also relates to a device for making soy milk, and to a method and device for making tofu. By grinding (dry) soybeans into powder directly and cooking them using a steam jet, instant soy milk/tofu can be produced in adjustable quantities.

WO 2014/207625 A2

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

METHOD AND DEVICE FOR MAKING SOY MILK AND SOY MILK DERIVATIVE

FIELD OF THE INVENTION

The invention relates to a method and a device for making a cereal beverage and a derivative thereof, in particular a method and a device for making soy milk and tofu.

BACKGROUND OF THE INVENTION

Soy milk is a well-known health food, which contains different kinds of nutrients, like high-quality proteins, vitamins, amino acids and trace elements. People in Asia always like to make soy milk at home, thus, home soy milk makers are becoming more and more popular. The market for home soy milk makers has grown rapidly in recent years.

Soy milk derivatives (such as tofu and tofu nao) are popular in China. This kind of food has a high nutritive value and can be cooked in various ways. Nowadays, consumers buy tofu, which is made in large quantities, from food chain stores or supermarkets. With increasing concern about hygiene and safety issues of food production, more and more consumers prefer to make food themselves at home. Soy milk is a good example thereof, and consumers believe that soy milk makers satisfy their needs in this regard.

Conventionally, the soy milk-making process using a soy milk maker basically includes three phases. The first phase is a soaking phase. In said first phase, dry beans are usually put into water and kept at room temperature for some time. The second phase is a blending/cooking phase, which can be automatically controlled by a controller. In said second phase, the soaked beans and water are introduced into a main body of the soy milk maker, and are heated for about 1 to 10 minutes at a predetermined temperature. A blender is arranged to blend the soybeans into small particles. The third phase is a filtering phase. A filter (commonly a 50-mesh filter) is used to filter the mixture made in the second phase. The relatively bigger particles (also referred to as residue hereinafter)

cannot pass the filter and will be removed. The final soy milk obtained after filtering is a mixture of water and small particles of hulls and cotyledons. Consequently, the traditional procedure for making a single block of tofu is a time-consuming process which requires more than 10 hours of preparation time due to soaking of dry soybeans overnight, and a complicated preparation and laboring method.

SUMMARY OF THE INVENTION

Soaked beans are used as input for conventional soy milk makers, because dry beans are too hard to blend for low-cost blenders. Furthermore, it is a must to blend soybeans in a fluidic environment by means of a conventional soy milk maker, since the soybeans move with the water flow in the container, which ensures that all soybeans go through the area near the blender and are crushed by the blender eventually. Without the movement of the water flow, the soybeans would stay at the bottom of the soy milk maker and could not be divided into particles.

The disadvantages of the conventional soy milk-making process comprise:

1) The whole process costs too much time. For example, only the first phase of soaking will take at least several hours.

2) A lot of residues are generated and finally rejected by consumers. To remove residues, an additional filtering step is required, which is time consuming. Furthermore, the nutrition in residues is wasted. One reason for a long boiling time is to extract nutrition from residues;

3) Conventional soy milk makers can only make a large quantity of soy milk (typically at least 1 liter) due to their bulky architecture.

It is thus desired to provide a method and a device for making soy milk and tofu, which can instantly (about one minute or less) make soy milk/tofu directly from dry soybeans and which allows the soy milk/tofu quantity to be adjustable according to consumer needs.

The basic idea of the present invention is to use a device for grinding soybeans (or a mixture of soybeans and other dry beans/cereals) into very fine particles, and use a steam jet for fast cooking the fine particles.

In order to address one or more of the abovementioned concerns, an embodiment of the invention provides a method of making soy milk, the method comprising the steps of: grinding soybeans into powder; mixing the powder with a solvent to form a mixture; and heating the mixture with a steam jet, wherein the steam jet is injected into the mixture.

In principle, this can overcome one or more of the disadvantages of conventional soy milk makers as described above: a very short bean-to-cup time and thus instant fresh soy milk is available, since grinding 10g of beans typically takes about 10 seconds or less; and cooking soy powder into soy milk using a steam jet typically takes one minute or less per cup (about 200 ml) due to the absence of large particles. The high temperature (e.g. above 97°C) produced with the steam jet can eliminate
anti-nutritional factors (such as enzymes in soybeans).

Preferably, the soybeans are dry and/or the average diameter of the powder is less than 160 microns. Grinding dry soybeans directly enables preprocessing such as overnight soaking to be dispensed with. At an average diameter of the powder of less than 160 microns, there is no (or very little) residue, and no filtering step is required. Full extraction of nutrition can be achieved due to the absence of large particles.

In a preferred embodiment of the invention, the grinding step is performed by a grinding device in the form of a flow-through device. “Flow-through” means that grinding is a flow-through process and it can be done in dry environment (in contrast to a wet batch process in conventional soy milk makers). This property, given a proper dosing system, makes it possible to grind any amount of soybeans. By nature the steam jet cooking technology is also a flow-through process, which is linearly adjustable according to the desired quantity. This could potentially enable consumers to enjoy a single cup of freshly-prepared soy milk within less than 1 minute. This might fundamentally change the soy milk-making culture and industry.

In a preferred embodiment of the invention, the grinding process is a single-step grinding process. Alternatively, the step of grinding comprises pre-grinding for dehulling the soybeans and fine-grinding.

In a preferred embodiment of the invention, the grinding device comprises: a

grinding tool having an abrasive surface; a bean delimiting tool for putting the soybeans and the grinding tool in a position for contacting each other, the bean delimiting tool having a surface for retaining the soybeans in such a position; and a rotatable means for realizing relative movement of the soybeans and the abrasive surface.

In an embodiment of the invention, a method of making tofu is proposed. The method of making tofu comprises the steps of: making soy milk according to any of the methods mentioned in the above embodiments; filtering the soy milk to eliminate bean dregs; adding coagulant to the filtered soy milk for coagulating the filtered soy milk; heating the soy milk to the boil with a steam jet; and keeping the soy milk within a preset temperature range for a predetermined period of time.

The production of a single block of silken tofu (250 - 500 g) can be simplified. This potentially enables the instant making of tofu directly from dry dehulled soybeans without any filtration steps. The steam jet technology could extract soy milk from dry soybean powder and is capable to inactivate enzymes during soy milk extraction. The pressure generated by the steam device itself is found to evenly distribute coagulants in soy milk and increase the speed of protein coagulation after chemical coagulant has been dispensed into the soy milk.

In order to address one or more of the abovementioned concerns, an embodiment of the invention provides a device for making soy milk, the device comprising: a grinding device for grinding soybeans into powder; a container for blending the powder with a solvent to form a mixture; a steam device for generating a steam jet to heat the mixture, wherein the steam jet is injected into the mixture.

With such a configuration, a very short bean-to-cup time and thus instant fresh soy milk is available, since grinding 10g of beans typically takes about 10 seconds or less; and cooking soy powder into soy milk using a steam jet typically takes one minute or less per cup (about 200 ml) due to the absence of large particles. The high temperature (e.g. above 97°C) produced with the steam jet can eliminate anti-nutritional factors (such as enzymes in soybeans).

Preferably, the soybeans are dry, and/or the average diameter of the powder is less than 160 microns.

In a preferred embodiment of the invention, the grinding device grinds the soybeans in a flow-through process.

In a preferred embodiment of the invention, the grinding device comprises: a grinding tool having an abrasive surface; a bean delimiting tool for putting the soybeans and the grinding tool in a position for contacting each other, the bean delimiting tool having a surface for retaining the soybeans in such a position; and a rotatable means for realizing a relative movement of the soybeans and the abrasive surface.

In a preferred embodiment of the invention, the steam jet is injected directly into the mixture.

Advantageously, the steam jet is injected into the mixture downwards or in a horizontal direction.

In a preferred embodiment of the invention, the device further comprises a temperature sensor for detecting the temperature of the mixture.

The invention also discloses a home tofu maker, the home tofu maker comprising: a device for making soy milk according to any embodiment of the invention; a filter for filtering the soy milk from the device; and a container for containing the filtered soy milk; wherein a steam jet is used for heating the filtered soy milk after coagulant has been added to the filtered soy milk.

This potentially enables instant tofu making directly from dry dehulled soybeans without any filtration steps. The steam jet technology could be used to extract soy milk from dry soybean powder and is capable to inactivate enzymes during soy milk extraction. The pressure generated by the steam device itself is found to evenly distribute coagulants in soy milk and increase the speed of protein coagulation after chemical coagulant has been dispensed into the soy milk.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter. However, the invention is not limited to these exemplary embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described based on various embodiments with

reference to the accompanying drawings, in which:

Fig. 1 shows a flowchart of a method of making soy milk according to an embodiment of the invention;

Fig. 2 shows a schematic diagram of a device for making soy milk according to an embodiment of the invention;

Figs. 3 and 4 show elements of a grinding device according to an embodiment of the invention;

Figs. 5 and 6 show elements of a grinding device according to another embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made to embodiments of the disclosure, one or more examples of which are illustrated in the figures. The embodiments are provided by way of explanation of the disclosure, and are not meant as a limitation of the disclosure. For example, features illustrated or described as part of one embodiment may be used with another embodiment to yield a still further embodiment. It is intended that the disclosure encompass these and other modifications and variations as come within the scope and spirit of the disclosure.

In the present invention, materials for producing soy milk may include, for example, soybeans, black beans, combinations of legumes and vegetables, combinations of legumes and fruits, combination of legumes and cereals, or any combination of these materials. The solvent may be, for example, water, mineral water, tap water, alkaline water, salt water, alcohol, or any combination of these solvents.

Fig. 1 shows a flowchart of a method 100 of making soy milk according to an embodiment of the invention, the method 100 comprising the steps of: grinding 101 soybeans into powder; mixing 102 the powder with solvent to form a mixture; and heating 103 the mixture with a steam jet, wherein the steam jet is injected into the mixture.

Fig. 2 shows a schematic diagram of a device 200 for making soy milk according to an embodiment of the invention, the device 200 comprising: a grinding device 201 for

grinding soybeans into powder; a container 202 for blending the powder with solvent to form a mixture; a steam device 203 for generating a steam jet to heat the mixture, wherein the steam jet is injected into the mixture.

These configurations can in principle overcome one or more of the disadvantages of conventional soy milk makers as described hereinabove: a very short bean-to-cup time and thus instant fresh soy milk is available, since grinding 10g of beans typically takes about 10 seconds or less; and cooking soy powder into soy milk using a steam jet typically takes one minute or less per cup (about 200 ml) due to the absence of large particles. The high temperature (e.g. above 97°C) produced with the steam jet can eliminate anti- nutrients (such as enzymes in soybeans).

The method and device for making soy milk according to the embodiment of the invention enable instant (about one minute or less) soy milk making directly from soybeans. It also allows the quanyity of soy milk to be adjusted according to consumer needs: single/half-cup serve is also possible.

The steam jet guarantees homogeneous heating of the fluid, while simultaneously mixing the required ingredients to realize a fast and reproducible end result.

The main requirements to be met by the steam jet are:

1) Exit orifice for steam, located in/near said container, such that the orifice is at least partially submerged below the surface of said fluid, and is able to deliver a highly turbulent flow in the fluid; Pressurized steam in combination with a sufficiently high steam flow is needed to ensure sufficient mechanical energy for the turbulent flow; For example, mechanical energy transferred from exit orifice to fluid in excess of 15 J/s, preferably above 35 J/s;

2) Pressurized steam to further enhance efficient mixing: in the steam generation unit the pressure should be at least 50,000 Pa above ambient pressure, preferably in excess of 100,000 Pa;

3) Large transfer of thermal energy into the fluid: more than 400 J/s, preferably above 750 J/s.

Moreover, fluid dilution due to steam condensation during heating can remain below 25%, preferably below 10%. That is, the concentration of the soy milk can be

controlled based on the original quantity of the mixture and the thermal energy contained in the steam jet per unit weight. The actual steam-jet cooking time can be adjusted according to the power, flow rate and other device parameters, and also depends on the quantity of soy milk to be cooked.

Preferably, the soybeans are dry, and/or the average diameter of the powder is less than 160 microns. Grinding dry soybeans directly allows preprocessing such as overnight soaking to be dispensed with. At an average diameter of the powder of less than 160 microns, there is no (or very little) residue, and no filtering step is required. Full extraction of nutrients can be achieved due to absence of large particles.

In a preferred embodiment of the invention, the step of grinding is performed by a grinding device as a flow-through process. "Flow-through" means that such a grinding process is a flow-through process, and it can be done in dry environment (in contrast to a wet batch process in conventional soy milk makers). Given a proper dosing system, this makes it possible to grind any amount of soybeans. The steam-jet cooking technology is also a flow-through process by nature, and it is linearly adjustable according to the desired quantity. This can potentially enable consumers to enjoy a single cup of freshly prepared soy milk within less than 1 minute. This might fundamentally change the soy milk-making culture and industry.

In a preferred embodiment of the invention, the grinding step is a single grinding step. Such a grinding mode enables soybeans to be ground in a relatively short time.

Alternatively, the step of grinding comprises pre-grinding for dehulling the soybeans and fine-grinding. The main purpose of pre-grinding is to dehull soybeans and to break the soybean coats into smaller pieces (otherwise big pieces of bean coats may cause problems in bean feeding at a fine setting). In the second step (i.e. fine-grinding), the pre-ground soy particles pass through the grinding device again at a fine setting.

Figs. 3-6 show elements of the grinding devices according to embodiments of the present invention. "Flow-through" grinding is also illustrated in Figs. 3-6.

In a preferred embodiment of the invention, the grinding device 1, 2 comprises: a grinding tool 20 having an abrasive surface 21; a bean delimiting tool 40, 42, 50 for putting the soybeans 5 and the grinding tool 20 in a position for contacting each other,

the bean delimiting tool 40, 42, 50 having a surface 44, 53 for retaining the soybeans 5 in such a position; and a rotatable means 30 for realizing relative movement of the soybeans 5 and the abrasive surface 21.

Fig. 3 shows elements of a first basic embodiment of a grinding device 1 according to the present invention. The grinding device 1 is a device which is adapted to perform a grinding process on soybeans 5, which are diagrammatically shown as circles in Fig. 3. The grinding device 1 can be an integral part of a soy milk maker, but it is also possible for the grinding device 1 to be a stand-alone device.

The grinding device 1 comprises a reservoir 10 for containing a plurality of soybeans 5. For the purpose of performing a grinding action on the soybeans 5, a grinding tool 20 having an abrasive surface 21 is provided. In the shown example, the grinding tool 20 comprises a disc-shaped portion 22 having a circular circumference, which is rotatable about a central axis 23. The abrasive surface 21 is present on a free side of the disc-shaped portion 22. On the other side of the disc-shaped portion 22, the grinding tool 20 is directly connected to a drive shaft 31 of a motor 30, which may be a simple electric motor.

Fig. 4 shows a side of the grinding tool 20 where the abrasive surface 21 is present. In this figure, it can be seen that, in the shown example, the abrasive surface 21 covers the entire free side of the disc-shaped portion 22. Furthermore, a direction of rotation of the grinding tool 20 about the central axis 23 of the disc-shaped portion 22, which is performed by the grinding tool 20 during a grinding process, is indicated by means of an arrow 24. The abrasive surface 21 may be a sandpaper surface, and may be arranged on the disc-shaped portion 22 such as to be replaceable.

In the grinding device 1, soybeans 5 are made to contact the abrasive surface 21 of the grinding tool 20 under pressure, one bean 5 after the other, so that the beans 5 are gradually ground away from one side, namely the side where the beans contact the abrasive surface 21.

Various ways of causing soybeans 5 and abrasive surface 21 to be pressed against each other are feasible within the framework of the present invention. For example, the grinding device 1 may comprise a kind of gripper (not shown) having two arms for

gripping a soy bean 5, such that the soy bean 5 is accommodated in a space between ends of the arms, wherein the gripper may be movable for putting the bean 5 in a position for contacting the abrasive surface 21 and maintaining the contact between the bean 5 and the abrasive surface 21 until the bean 5 is ground away. In the process, as the bean 5 gets smaller, the ends of the arms of the gripper are moved more and more towards the abrasive surface 21.

As shown in Figs. 3 and 4, the grinding device according to an embodiment of the present invention comprises a combination of a tube-shaped member 40 defining a space 41 for accommodating at least one soybean and a rod 42 which is slideably arranged inside the tube-shaped member 40. The tube-shaped member 40 may have a circular cross-section, wherein a diameter of the tube-shaped member 40 may be adapted to a diameter of the soybeans 5 in such a way that the cross-section of the tube-shaped member 40 covers only one soy bean 5. A free end 43 of the tube-shaped member 40 is arranged at a position close to the abrasive surface 21. In the shown example, the length of the tube-shaped member 40 is considerably larger than the diameter of the tube-shaped member 40, so that the tube-shaped member 40 can contain a string of beans 5 as shown in Fig. 3.

The rod 42 has a surface 44 for pressing against the beans 5 inside the tube-shaped member 40, so that it is possible to press the beans 5 against the abrasive surface 21 during a grinding process. Any suitable means may be applied for exerting the required pressure on the rod 42.

The tube-shaped member 40 is connected to the reservoir 10 by means of a conduit 11 which is suitable for transporting soybeans 5 from the reservoir 10 to the tube-shaped member 40. Fig. 3 illustrates how the conduit 11 can be filled with a string of soybeans 5. It is possible to have a suitable valve (not shown) or the like on a side of the conduit 11 which is connected to the reservoir 10 and/or on a side of the conduit 11 which is connected to the tube-shaped member 40 in order to control the supply of beans 5 from the reservoir 10 to the tube-shaped member 40. In view of the fact that the rod 42 may be used for blocking and unblocking a bean entrance opening 45 of the tube-shaped member 40, such a valve can also be omitted. In any case, the tube-shaped member 40 can be

filled with a number of soybeans 5 when the rod 42 is in a retracted position, i.e. in a position furthest away from the free end 43 of the tube-shaped member 40.

Fig. 4 illustrates the fact that the tube-shaped member 40 is arranged at a position which is off center with respect to the abrasive surface 21. On the basis of this arrangement of the tube-shaped member 40, it is achieved that when the grinding tool 20 is rotated about the central axis 23, the free end 43 of the tube-shaped member 40 is continually exposed to another area of the abrasive surface 21, inside a ring-shaped portion 25 of the abrasive surface 21 as indicated by a dashed line in Fig. 4. Advantageously, the mutual position of the abrasive surface 21 and the tube-shaped member 40 can be adjusted in such a way that the tube-shaped member 40 is made to cover another ring-shaped portion of the abrasive surface 21. In this way, it can be achieved that the entire abrasive surface 21 is used in the grinding process before it is worn-out and needs to be replaced by a new one. It is also possible that the tube-shaped member 40 is arranged such as to be movable in an axial direction, i.e. a direction in which a longitudinal axis 46 of the tube-shaped member extends, if so desired, or that the tube-shaped member 40 is arranged so as to be tiltable, for example, such that the free end 43 of the tube-shaped member 40 can be moved away from the abrasive surface 21, which may be handy for various purposes, including cleaning purposes.

In the following, the functioning of the grinding device 1 according to the present invention is further explained. A grinding process can take place when at least one soybean 5 is present inside the tube-shaped member 40. The soybean 5 can be put in the right position, i.e. a position at the free end 43 of the tube-shaped member 40, by means of the rod 42.

At the start of a grinding process, the motor 30 is activated so that the grinding tool 20 performs a rotation movement about the central axis 23. The speed of rotation is preferably in a range of 500 to 5,000 revolutions per minute, even more preferably in a range of 1,000 to 2,500 revolutions per minute, while the torque is preferably at most 2 Nm, more preferably 1 Nm, and even more preferably at most 0.2 Nm. Pressure is exerted on the rod 42, so that the soybean 5 is pressed against the abrasive surface 21. As a result of the contact between the soybean 5 and the moving abrasive surface 21, the soy

bean 5 is ground. The rod 42 is gradually pressed in a direction towards the abrasive surface 21, causing the soybean 5 to be abraded more and more, and the process is continued until the soybean 5 is so small that it can escape between the free end 43 of the tube-shaped member 40 and the abrasive surface 21. Hence, the mutual position of the abrasive surface 21 and the tube-shaped member 40 in the direction of the longitudinal axis 46 of the tube-shaped member 40 is a determining factor in respect of the size of the largest particles in the soy powder obtained as a result of the grinding process. Consequently, adjustment of the grinding size can be achieved through adjustment of the mutual position as mentioned.

Basically, the grinding process to be performed by means of the grinding device 1 involves a rotation movement of the grinding tool 20 and a gradual movement of the rod 42 in the direction of the abrasive surface 21, for pressing one soybean 5 after the other against the abrasive surface 21. When the last soybean 5 of a string of beans 5 has left the tube-shaped member 40, the rod 42 is retracted, so that the tube-shaped member 40 can be filled with a new string of beans 5 and the grinding process can be continued if so desired.

The soy powder which is obtained as a result of the grinding process is collected from the abrasive surface 21 in any suitable way. For example, a cup (not shown) or the like can be placed at a suitable position underneath the grinding tool 20 for receiving the soy powder falling into the cup under the influence of gravity.

In respect of the central axis 23 of the disc-shaped portion 22 of the grinding tool 20 and the longitudinal axis 46 of the tube-shaped member 40, it is noted that these axes 23, 46 can have the same orientation, but this is not necessary. In the shown example, both the central axis 23 of the disc-shaped portion of the grinding tool 20, which serves as a rotation axis 23 of the grinding tool 20, and the longitudinal axis 46 of the tube-shaped member 40 extend in a substantially horizontal direction. However, in a practical embodiment of the grinding device 1 according to the present invention, the tube-shaped member 40 may have a tilted arrangement with respect to the horizontal, with the free end 43 at a lowest level, so that it is achieved that soybeans 5 automatically move towards the free end 43 under the influence of gravity. This is most convenient

when it comes to filling the tube-shaped member 40 with a number of beans 5.

Fig. 5 shows elements of a second basic embodiment of a grinding device 2 according to the present invention, and Fig. 6 shows a sectional view taken along line A-A in Fig. 5. In the following, when terms such as top and bottom are used, these terms are to be understood to relate to the orientation of the grinding device 2 as shown in Fig. 5, which is a normal, operational orientation. Thus, it can be said that Fig. 6 provides a top view of the section as indicated.

The grinding device 2 is a device which is adapted to perform a grinding process on soybeans 5, which are diagrammatically shown as ellipses in Figs. 5 and 6. By grinding the soybeans 5, soy powder is formed, which is suitable to be used in a soy-making process by allowing a quantity of water to interact with the soy powder, so that the soy powder is extracted. The grinding device 2 can be an integral part of a soy milk maker, but it is also possible for the grinding device 2 to be a stand-alone device.

The grinding device 2 comprises a reservoir 10 for containing a plurality of soybeans 5. For the purpose of performing a grinding action on the soybeans 5, a grinding tool 20 having an abrasive surface 21 is provided. In the shown example, the grinding tool 20 comprises a cylinder-shaped portion 26 having a circular circumference, which is rotatable about a longitudinal axis 27, which axis 27 has a substantially vertical orientation in the shown example. A direction of a rotation movement of the grinding tool 20 about the longitudinal axis 27 of the cylinder-shaped portion 26, which is performed by the grinding tool 20 during a grinding process, is indicated by means of an arrow 28 in Fig. 6. The abrasive surface 21 is present at the curved cylinder wall of the cylinder-shaped portion 26. At one end of the cylinder-shaped portion 26, the grinding tool 20 is directly connected to a drive shaft 31 of a motor 30, which may be a simple electric motor.

In addition to the grinding tool 20, the grinding device 2 comprises a housing 50 for encompassing the cylinder-shaped portion 26 of the grinding tool 20. The housing 50 has a grinding chamber 51 for allowing the grinding tool 20 to extend inside the housing 50. In the shown example, the housing 50 is arranged right underneath the reservoir 10, so that the soybeans 5 can be transported directly from the reservoir 10 to the grinding

chamber 51.

The grinding chamber 51 is shaped like an asymmetric funnel, wherein an opening with the largest dimensions is present at the top, and an opening with the smallest dimensions is present at the bottom. As seen in a sectional view taken in a vertical direction, one area 52 of a surface 53 of the housing 50 delimiting the grinding chamber 51, which surface 53 will hereinafter be referred to as delimiting surface 53, extends in a substantially vertical direction, i.e. a direction parallel to the longitudinal axis 27 of the cylinder-shaped portion 26 of the grinding tool 20 in the shown example, and another area 54 of the delimiting surface 53 is inclined with respect to the vertical, thereby being non-parallel to the longitudinal axis 27 as mentioned, as illustrated in Fig. 5. For example, an angle α between the inclined area 54 and the vertical may be about 15°. The cylinder-shaped portion 26 of the grinding tool 20 is arranged such as to extend near the vertical area 52, so that a small gap 55 is present between the abrasive surface 21 and that area 52, and a larger gap 56 which gradually gets smaller in a downward direction is present around a major part of the cylinder-shaped portion 26 of the grinding tool 20. Unlike the surface 21 of the grinding tool 20, the delimiting surface 53 does not need to have abrasive properties, so that it can have a smooth appearance instead.

Fig. 6 illustrates the fact that an outlet 57 for discharging bean particles obtained as a result of the grinding process preferably has a tangential orientation with respect to the circumference of the cylinder-shaped portion 26 of the grinding tool 20. Advantageously, the height (that is the dimension parallel to the longitudinal axis 27) of the outlet 57 is more or less the same as the height of the cylinder-shaped portion 26 of the grinding tool 20, so that bean particles can be removed from the grinding chamber 51 at any level, whereby accumulation of soy powder in a bottom portion of the grinding chamber 51 is prevented. In order to prevent the soybeans 5 from reaching the outlet 57 without having contacted the grinding tool 20 as it rotates and hence without being ground at all, the delimiting surface 53 comprises another vertical area 58 facing the abrasive surface 21 at a close distance.

In the grinding device 2, soybeans 5 are made to contact the abrasive surface 21 of the grinding tool 20 by making them move downwards in a funnel-shaped grinding

chamber 51 in which the grinding tool 20 is arranged. At a certain point, a soy bean 5 is wedged between the abrasive surface 21 and the delimiting surface 53, as it were, whereby a bit of the bean 5 is ground off due to the fact that the abrasive surface 21 moves with respect to the bean 5. Every reduction in bean size caused in this way, results in the bean 5 moving further down. It is advantageous if the abrasive surface 21 has a spiraling texture 29 as shown in Fig. 5, as such a texture 29 can have a function in grabbing the beans 5 and facilitating the desired downward movement of the beans 5. Eventually, as a result of the grinding process, a bean 5 is divided into numerous fragments 6, which are diagrammatically shown as small triangles in Figs. 5 and 6. When the fragments 6 are small enough to pass between the abrasive surface 21 and the vertical area 52 of the delimiting surface 53, the fragments 6 exit the grinding chamber 51 and enter the outlet 57. For the sake of clarity, the direction in which the fragments 6 subsequently move through the outlet 57 is indicated by means of an arrow 59 in Fig. 6.

Such a "flow-through" grinding device potentially enables instant (about one minute or less) soy milk making directly from dry soybeans. It also allows the quantity of soy milk to be adjustable according to consumer needs: single/half-cup serve is also possible. Due to the intrinsic sieving capability of the architecture, no (or very few) soy residues (big particles) will be produced. This not only has the advantage that full use is made of soy materials, but more importantly, no extra filtering step is required.

In an embodiment of the invention, a method of making tofu is also proposed. The method of making tofu comprises the steps of: making soy milk according to any of the methods mentioned in the above embodiments; filtering the soy milk to eliminate bean dregs; adding coagulant to the filtered soy milk for coagulating the filtered soy milk; heating the soy milk to the boil by means of a steam jet; and keeping the soy milk within a preset temperature range for a predetermined period of time.

The production of a single block of silken tofu (250 - 500 g) can be simplified. This potentially enables instant tofu making directly from dry dehulled soybeans without any filtration steps. The steam-jet technology could be used to extract soy milk from dry soybean powder and to inactivate enzymes during soy milk extraction. The pressure generated by the steam device itself is found to evenly distribute coagulants in soy milk

and increase the speed of protein coagulation after chemical coagulant has been dispened into the soy milk.

According to a preferred embodiment of the invention, the steam jet is injected directly into the mixture. As stated above, by directly injecting the steam jet into the mixture, a sufficiently large steam flow can ensure sufficient mechanical energy for the turbulent flow. This enables fast heating and mixing. It should also be noted that the vehement and thorough mixing creates a uniform temperature in the fluid (i.e. the mixture), resulting in good controllability of the temperature during the cooking process.

Advantageously, the steam jet is injected into the mixture in a downward or a horizontal direction to achieve a violent vortex in the mixture.

In a preferred embodiment of the invention, the device further comprises a temperature sensor for detecting the temperature of the mixture. The cooking process can therefore be stopped as a function of the detected temperature in the mixture. With the temperature sensor, calculating the cooking time is not necessary, since the detected temperature can accurately indicate the cooking phase.

A home maker for making tofu is also disclosed, the home maker comprising: a device for making soy milk according to any of the embodiments of the invention; a filter for filtering the soy milk made by the device; and a containing device for containing the filtered soy milk; wherein a steam jet is used for heating the filtered soy milk after coagulant has been added to the filtered soy milk.

This potentially enables instant tofu making directly from dry dehulled soybeans without any filtration steps. Steam-jet technology could be used to extract soy milk from dry soybean powder and is capable to inactivate enzymes during soy milk extraction. The pressure generated by the steam device itself is found to evenly distribute coagulants in soy milk and increases the speed of protein coagulation after chemical coagulant has been dispensed into the soy milk.

Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a

plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

CLAIMS

1. A method (100) of making soy milk, the method (100) comprising the steps of:

- grinding (101) soybeans into powder;

- mixing (102) the powder with solvent to form a mixture; and

- heating (103) the mixture with a steam jet, wherein the steam jet is injected into the mixture.

2. The method (100) according to claim 1, wherein the soybeans are dry, and/or the average diameter of the powder is less than 160 microns.

3. The method (100) according to claim 1, wherein the step of grinding is performed by a grinding device (1, 2) in a flow-through process.

4. The method (100) according to any one of claims 1 to 3, wherein the step of grinding is a single-step grinding.

5. The method (100) according to any one of claims 1 to 3, wherein the step of grinding comprises:

pre-grinding for dehulling the soybeans; and

fine-grinding.

6. The method according to claim 3, wherein the grinding device (1, 2) comprises:

a grinding tool (20) having an abrasive surface (21);

a bean delimiting tool (40, 42; 50) for putting the soybeans (5) and the grinding tool (20) in a position for contacting each other, the bean delimiting tool (40, 42; 50) having a surface (44; 53) for retaining the soybeans (5) in such a position; and

a rotatable means (30) for realizing a relative movement of the soybeans (5) and the abrasive surface (21).

7. A method of making tofu, the method comprising the steps of:

- making soy milk according to the method of claims 1 to 6;

- filtering the soy milk to eliminate bean dregs;

- adding coagulant to the filtered soy milk for coagulating the filtered soy milk;

- heating the soy milk to the boil by means of a steam jet; and

- keeping the soy milk within a preset temperature range for a predetermined period of time.

8. A device (200) for making soy milk, the device (200) comprising:

a grinding device (201, 1, 2) for grinding soybeans into powder;

a container (202) for blending the powder with solvent to form a mixture;

a steam device (203) for generating a steam jet to heat the mixture, wherein the steam jet is injected into the mixture.

9. The device (200) according to claim 8, wherein the soybeans are dry, and/or the average diameter of the powder is less than 160 microns.

10. The device (200) according to claim 8, wherein the grinding device (201, 1, 2) grinds the soybeans in a flow-through process.

11. The device (200) according to claim 10, wherein the grinding device (1, 2) comprises:

a grinding tool (20) having an abrasive surface (21);

a bean delimiting tool (40, 42; 50) for putting the soybeans (5) and the grinding tool (20) in a position for contacting each other, the bean delimiting tool (40, 42; 50) having a surface (44; 53) for retaining the soybeans (5) in such a position; and

a rotatable means (30) for realizing a relative movement of the soybeans (5) and the abrasive surface (21).

12. The device (200) according to claim 8, wherein the steam jet is injected directly into the mixture.

13. The device (200) according to claim 12 , wherein the steam jet is injected into the mixture in a downward or horizontal direction.

14. The device (200) according to claim 8, wherein the device (200) further comprises a temperature sensor for detecting the temperature of the mixture.

15. A home maker for making tofu, the home maker comprising:

a device (200) for making soy milk according to claims 8 to 14;

a filter for filtering the soy milk made by the device (200); and

a containing device for containing the filtered soy milk;

wherein a steam jet is used for heating the filtered soy milk after coagulant has been added to the filtered soy milk.

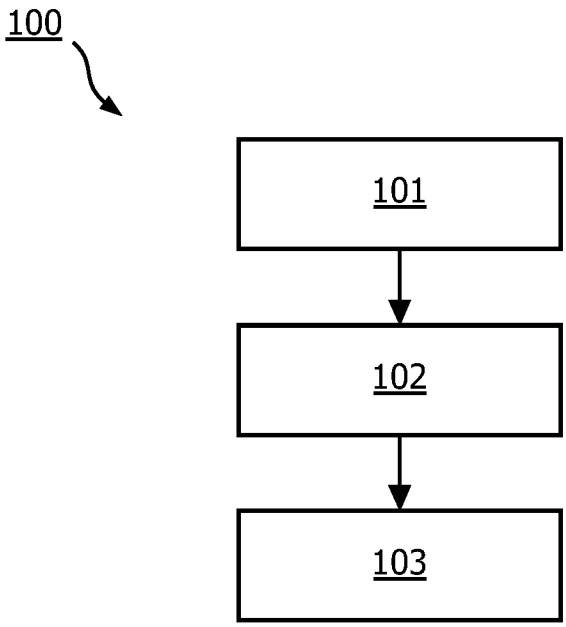

FIG. 1

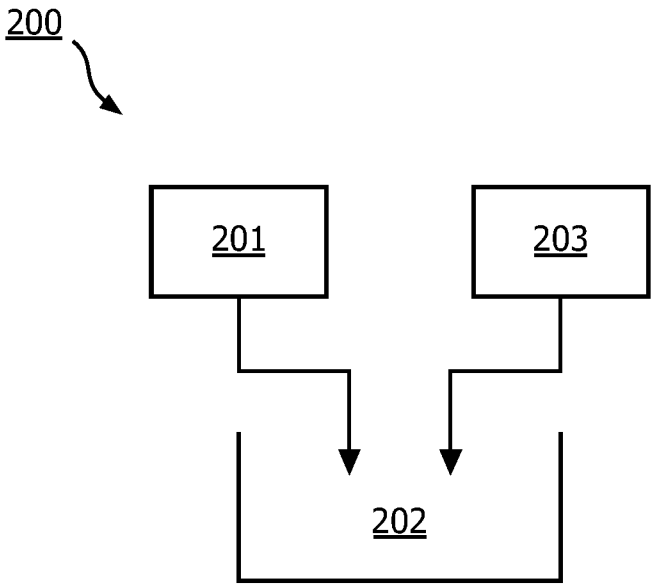

FIG. 2

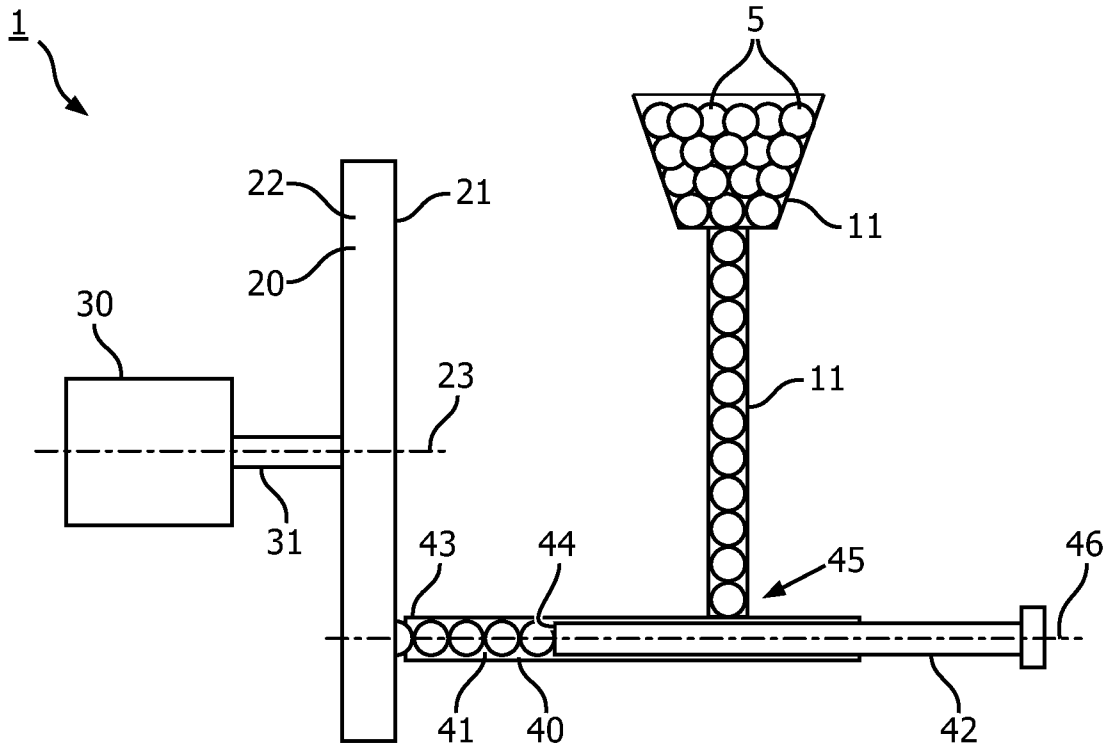

FIG. 3

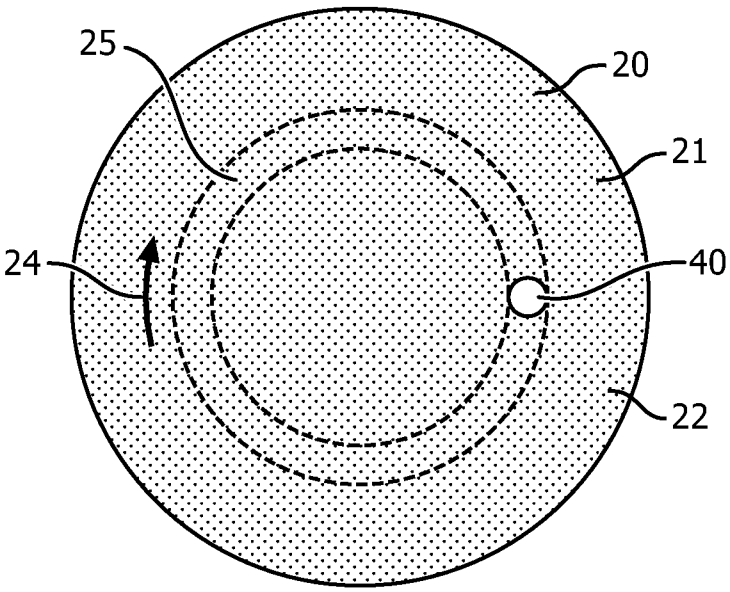

FIG. 4

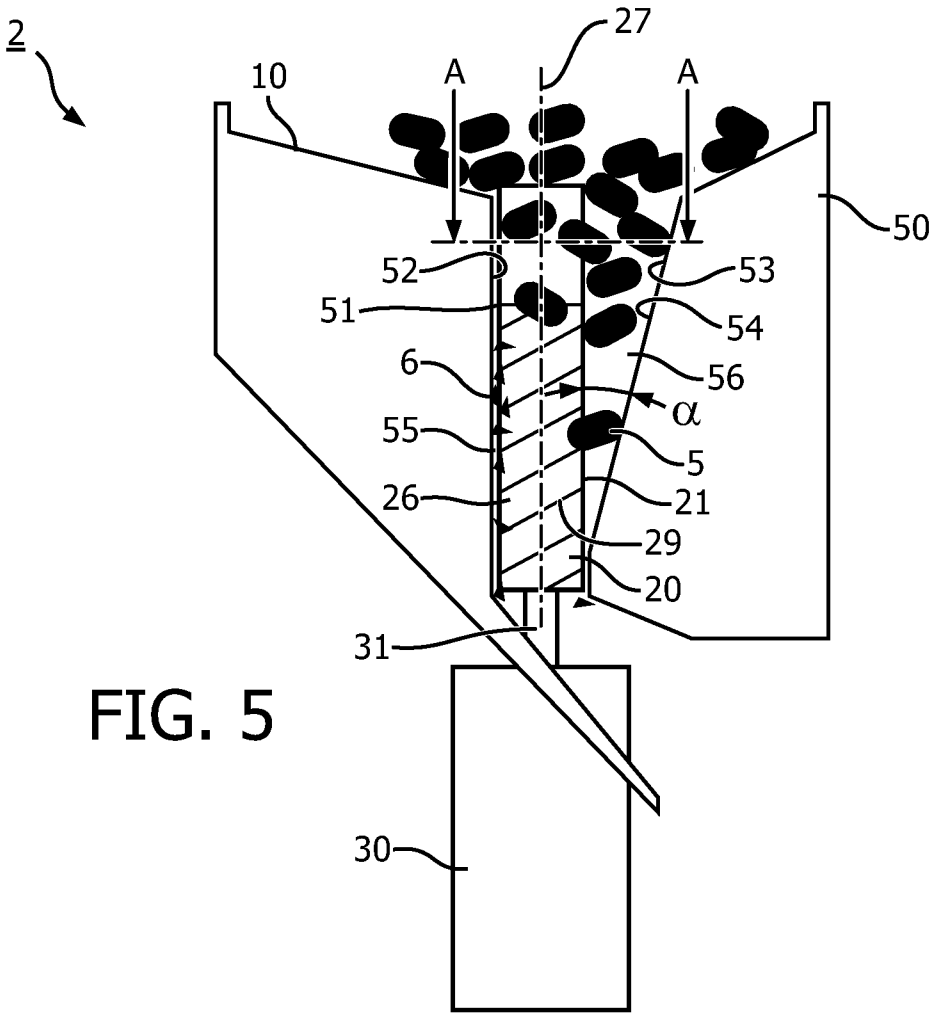
2
10
A
27
A
50
52
53
51
54
6
56
α
55
5
26
21
29
20
31
30

FIG. 5

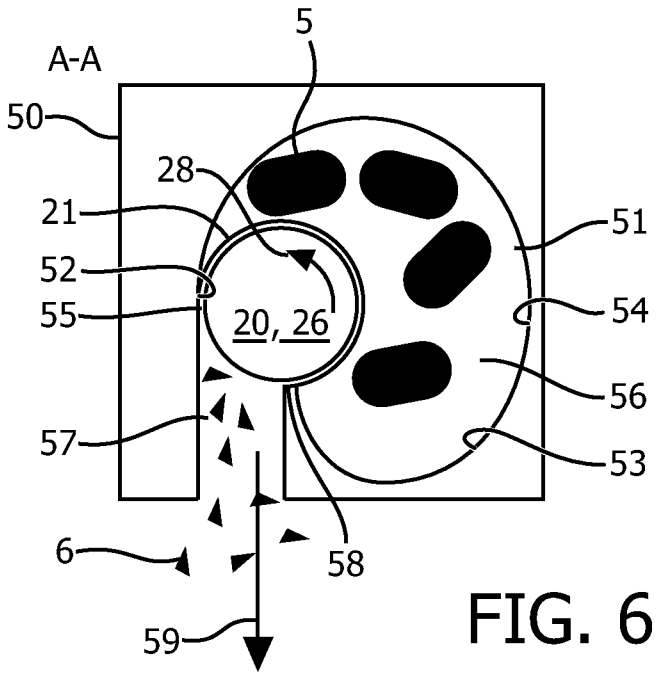
A-A
5
50
28
21
51
52
55
20, 26
54
56
57
53
6
58
59

FIG. 6