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54 Titre : Process for shelling fruits with shells.

57 Abrégé :

A method of treating nuts with shells containing a non-aqueous liquid comprising the steps of first removing at least 50% of the non-aqueous liquid from the shells of the nuts; and thereafter subjecting the nuts to cold treatment to embrittle the shells. This method relates especially to cashew nuts and to the shelling of such nuts.

PROCESS FOR SHELLING FRUITS WITH SHELLS

Technical Field

- 5 This invention relates to a method of shelling fruits with shells, particularly but not exclusively cashew nuts.

Background Art

- 10 The cashew nut tree (*Anacardium Occidentale*) produces a fruit, or cashew apple. This fruit is pear shaped and is similar in size to a large guava. At the bottom of the fruit, the seed (or nut) develops and hangs externally. The seed (or nut) is kidney shaped and is in reality the true fruit of the tree. When the fruit is ripe, it falls to the ground. The nut is then harvested and dried, in
15 preparation for shelling.

Raw cashew nuts consist of an outer skin, connected to a honey comb – like fibrous layer, which contains a highly corrosive and toxic resin known as cashew nut shell liquid (CNSL). This fibrous layer is in turn connected to an
20 inner shell which envelopes the kernel. The kernel is further protected by a

membrane, or seed coat.

The outer skin is extremely tough but pliable. The CNSL (90% anacardic acid and 10% cardol) offers great protection against attack by insects, rodents and
5 birds. The inner shell allows water absorption into the kernel, but prevents penetration of CNSL.

Due to the toughness of the outer skin and the presence of the CNSL, the shelling of cashew nuts is an expensive process. Not only is it difficult to break
10 the outer skin without damaging the kernel, but great care must be taken that the CNSL does not contaminate the kernel. Contamination leads to an inferior taste. Furthermore, the seed coat clings to the kernel and has to be manually scraped off once the shell has been removed.

15 Different processes have been suggested and are in use for shelling cashew nuts. Generally raw cashew nuts are bulk stored in a low humidity environment with a water content of 8-12% (by mass). This is in order to prevent stack burn and germination. Before shelling, the raw nuts are soaked in water in order to increase the water content. The absorption of water causes:

20 1) The shell of the nut to swell and pull away from the kernel;

- 2) The kernel to become flexible which reduces breakage during shelling;
- 3) Reduced burning of the kernel if CNSL removal is done by roasting of the raw nuts; and
- 4) Reduced viscosity of the CNSL.

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After soaking the nuts in water the CNSL is removed by different methods including :

- 1) Roasting the raw nuts in CNSL at about 250°C and then centrifugally removing the residue CNSL;
- 10 2) Super-heated steam application to the raw nuts and collection of condensate; and
- 3) Solvent extraction.

The shells may then be removed mechanically by centrifugally spinning the
15 nuts and releasing them at high speed against an object; or pressing the nuts through inward turning rollers; or dropping the nuts through rotating conical abrasive surfaces until the shell separates from the nut. These mechanical methods have the disadvantage that they have a poor to very poor whole kernel recovery which reduces the value drastically. Semi-mechanical process
20 are accordingly more popular since they result in higher yields of whole

kernels. Such semi-mechanical processes include:

- 1) Splitting the nut between two blades with a foot operated plunger;
- 2) Various hand operated cutting, sawing and squeezing devices; and
- 3) Hand shelling, by cracking the shell with a small wooden mallet.

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French Patent 2450 067 suggests a process of shelling nuts by plunging the nuts into liquid air or liquid nitrogen and then crushing the nuts by mechanical hammering to break the shells. The shelling is preceded by a double sizing process, humidification, steam drying and drying. This process has the
10 disadvantage that when the nuts are treated with the liquid air or nitrogen, the kernels easily become embrittled and break during the hammering process. The process does not disclose removal of CNSL prior to cryogenic treatment.

Disclosure of the Invention

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The inventors have now found that if the CNSL is removed prior to subjecting the nuts to liquid nitrogen treatment, the recovery of whole kernels is increased.

20 As indicated above CNSL removal is a known process but not in combination

with cryogenic treatment. In the prior art the CNSL is removed to prevent kernel contamination and easier handling of the nut. During cryogenic treatment the last mentioned advantages have no significance since the CNSL will be "frozen" during cryogenic treatment and difficulties relating to contamination or handling due to CNSL would not occur. Accordingly
5 CNSL removal would not be contemplated where cryogenic treatment is to be applied.

It is accordingly an object of the present invention to provide an alternative
10 method of shelling fruit with shells.

According to the present invention a method of treating nuts with shells containing a non-aqueous liquid comprises the steps of :

- first removing at least 50% (by mass) of the non-aqueous liquid from the
15 shells of the nuts; and
- thereafter subjecting the nuts to cold treatment to embrittle the shells.

In this specification "non-aqueous liquid" is a liquid other than water.

20 In a preferred embodiment of the invention the nuts may comprise cashew

nuts which include shells with CNSL therein as a non-aqueous liquid. Preferably at least 50% (by mass) of the CNSL is removed prior to subjecting the nuts to the cold treatment, preferably as much CNSL as is practically possible is removed.

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The invention also includes a method of treating cashew nuts with shells containing CNSL, the method comprising the steps of :

- first removing at least 50% (by mass) of the CNSL from the shells of the nuts; and
- 10 - thereafter subjecting the nuts to cold treatment to embrittle the shells.

The CNSL may be removed by subjecting the nuts to heat treatment, preferably subsequent to humidifying the nuts. The nuts may be subjected to heat treatment by roasting the nuts, preferably from 180 to 300°C, preferably
15 from 200 to 270°C, and preferably at about 220°C. The roasting may be carried out in a liquid, preferably in CNSL. The roasting may be for a period of 1 to 3 minutes, preferably 1,5 to 3 minutes, preferably about 2 minutes.

Additionally, but preferably alternatively, the nuts may be subjected to heat
20 treatment to remove CNSL and at least partially replace it with water.

Preferably the nuts are subjected to steam treatment to remove CNSL and to at least partially replace CNSL with water. More than 70% (by mass) of the CNSL may be removed. Preferably steam is applied at a temperature from 90 to 150°C; preferably from 100 to 140°C and most preferably at about 125°C.

- 5 The steam treatment may be for a period of 5 to 35 min, preferably 10 to 30 minutes, preferably about 15 minutes.

Steaming may take place at a pressure of above atmospheric pressure.

- 10 The heat treated nuts may be subjected to centrifugal treatment to further remove at least some of the remaining CNSL especially where the nuts have been roasted. In cases where the nuts are subjected to heat treatment to replace CNSL with water, the centrifugal treatment may be omitted.

- 15 Subsequent to the heat treatment the nuts may be cooled or allowed to cool to ambient temperature.

The method may also include the step of humidifying the nuts to increase the water content in the shells prior to removing the non-aqueous liquid.

- 20 Preferably the nuts have a water content of between 8 and 12% (by mass)

prior to humidification.

Preferably the nuts are humidified in order that the shells have a water content of between 15% and 50% (by mass), preferably between 20% and 40% (by
5 mass). Where the nuts are roasted to remove the CNSL, the water content is preferably about 30% (by mass). Where the nuts are subjected to heat treatment to remove CNSL and replace it with water, the water content is preferably about 25% (by mass). The nuts may be humidified through any known process such as soaking the nuts in water.

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Where the method includes the step of humidifying the nuts to increase the water content in the shells prior to removing the non-aqueous liquid, the humidification preferably takes place at a temperature below 20°C, preferably below 15°C, preferably from 3 to 15°C, preferably from 5 to 10°C, most
15 preferably at a temperature of about 7°C. Preferably the nuts are humidified by soaking them in water. Preferably the nuts are soaked in the water for a period of 12 to 96 hours. Where the nuts are subjected to roasting to remove CNSL, the nuts or preferably soaked in water for a period of about 72 hours at a temperature of about 7°C to obtain a water content of about 30% (by
20 mass). Where the nuts are subjected to heat treatment to replace CNSL with

water, the nuts are soaked in water for a period of about 24 hours at a temperature of about 7°C to obtain a water content of about 25% (by mass).

The humidification of the nuts is preferably carried out in such a manner to
5 control the amount of water reaching the kernels (especially in the case of
cashew nuts). If the water content of the kernels rises to above 14% by mass
it causes the kernels to split. It is believed that at the lower temperatures
indicated above, especially below 15°C, better control is obtained of the
movement of water to the kernels. Furthermore if the nuts are humidified
10 above 20°C, tannins contained in the seed coat are deposited onto the kernel
which leads to discoloration.

The cold treatment to embrittle the shells may comprise cryogenic treatment.

Preferably the nuts are brought into contact with a medium in liquid form,
15 which medium would be in the form of a gas at ambient temperature and at
atmospheric pressure. The medium may comprise liquid nitrogen or liquid air.

Preferably it comprises liquid nitrogen.

20 In cases where CNSL is removed without being replaced with water, the nuts

may be treated with liquid nitrogen for a period from 10 to 90 seconds, preferably from 20 to 60 seconds, preferably about 40 seconds. In cases where the CNSL is replaced with water, the nuts may be treated with liquid nitrogen for 10 to 60 seconds, preferably 15 to 40 seconds, preferably about 20 seconds.

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Care should be taken not to subject the nuts to too long cold treatment, to prevent the kernels from becoming embrittled. It is believed that when the CNSL is removed prior to cold treatment the kernel is better isolated and less prone to become embrittled. It is also believed that when the CNSL remains
10 in the shells, freezing of the CNSL results not in embrittlement of the shell, but rather hardening of the shell.

Sizing of the nuts may take place prior to subjecting them to cold treatment to embrittle the shells. This is especially the case where the nuts are roasted to
15 remove CNSL. It is believed that sizing is not necessary where CNSL is replaced with water.

Subsequent to the cold treatment the embrittled shells of the nuts may be cracked. The cracked shells may then be removed.

20

Known methods of cracking the shells may be employed.

In one embodiment of the invention the nuts may be centrifugally flung against an object, preferably the object is rotating in a direction opposite to the
5 movement of the nuts.

It is also foreseen that the cracking may occur through ultrasonic treatment of the nuts subsequent to embrittlement.

10 It also is foreseen that the cracking may occur through subjection of the nuts subsequent to embrittlement to high frequency mechanical vibration.

Preferably cracking should take place as soon as possible after the cold treatment. Preferably cracking should take place within seven seconds of the
15 cold treatment to embrittle the shells.

Once the shell has been removed the seed coat remains on the seed and has to be removed. The seed coat may be manually removed.

20 It is foreseen that the kernel with the seed coat may be treated by means of a

gas such as ozone to enhance removal of the seed coat.

It is foreseen that a bleaching agent, such as ozone can be used to bleach kernels which have become discoloured.

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According to another aspect of the present invention there is provided a method of treating cashew nuts which contain CNSL in their shells comprising the steps of :

- humidifying cashew nuts at a temperature below 20°C in order that the
10 shells contain more than 10% (by mass) water;
- thereafter removing CNSL from the shells; and
- thereafter subjecting the nuts to cold treatment to embrittle the shells.

Preferably CNSL is replaced with water.

15

The method may also include the step of removing the shells subsequent to the cold treatment.

According the another aspect of the present invention a method of shelling
20 nuts with shells containing a non-aqueous liquid comprises the steps of:

- first removing at least 50% of the non-aqueous liquid from the shells of the nuts;
- thereafter subjecting the nuts to cold treatment to embrittle the shells; and
- thereafter cracking the embrittled shells of the nuts to remove said shells.

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The invention also relates to products (especially shelled kernels of cashew nuts) produced by the above methods.

The invention will now be further described by means of the following non-limiting examples.

Example 1

15 An amount of 900kg dry raw cashew nuts, having a water content of about 8% by mass, was sized into four different categories according to known methods.

The sizes were as follows (size in mm width):

Group 1 : smaller than 15mm

Group 2 : from 15mm to 19mm

20 Group 3 : larger than 19mm to 23mm

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Group 4 : larger than 23mm

The nuts were then soaked in water at a temperature of 7°C for a period of 72 hours to allow the water content in the shells of the cashew nuts to raise above 10% (by mass). The water content of the nuts increased to 35% by mass.

The cashew nuts were then roasted in CNSL for a period of two minutes. The nuts of group 1 were roasted at a temperature of 210°C, the nuts of group 2 at a temperature of 220°C, the nuts of group 3 at a temperature of 230°C and the nuts of group 4 at a temperature of 240°C. The cashew nuts were then removed from the hot CNSL and remaining oil was removed by subjecting the nuts to centrifugal treatment for a period of 2 minutes.

Thereafter the cashew nuts were allowed to cool to ambient temperature. The cashew nuts were then submerged in liquid nitrogen for a period of 40 seconds.

After removal from the liquid nitrogen the nuts were mechanically hurled against a steel surface, where the shells shattered to separate them from the kernels.

A 97% whole kernel recovery rate was achieved, without any CNSL contamination to the kernels.

Example 2

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An amount of 900kg dry raw cashew nuts, having a water content of about 8% by mass, was soaked in water at a temperature of 7°C for a period of 24 hours to allow the water content in the shells of the cashew nuts to raise above 10% (by mass) to about 25% (by mass).

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The cashew nuts were then steamed in a closed container containing water at a pressure of about 288 kPa for a period of 15 minutes at 125°C, after which they were removed and allowed to cool to ambient temperature.

15 The nuts were then submerged in liquid nitrogen for a period of 20 seconds.

After removal from the liquid nitrogen, the nuts were mechanically hurled against a steel surface, where the shells shattered, to separate them from the kernels.

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A 94% whole kernel recovery was achieved, without any CNSL contamination to the kernels.

The method of example 1 used less liquid nitrogen compared to the method of
5 example 2. However, the method of example 2, where CNSL is removed and
replaced with water by means of steam treatment, was found to be a cleaner
and an easier method. In example 2 no sizing was required.

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CLAIMS

1. A method of treating nuts with shells containing a non-aqueous liquid comprising the steps of :
- 5
- first removing at least 50% of the non-aqueous liquid from the shells of the nuts; and
 - thereafter subjecting the nuts to cold treatment to embrittle the shells.
- 10
2. The method of claim 1 wherein the nuts are cashew nuts with shells containing CNSL, and wherein the method comprises the steps of :
- first removing at least 50% of the CNSL from the shells of the nuts; and
 - thereafter subjecting the nuts to cold treatment to embrittle the shells.
- 15
3. The method of claim 2 wherein as much CNSL as is practically possible is removed.
- 20
4. The method of claim 2 wherein the CNSL is removed by

subjecting the nuts to heat treatment.

5. The method of claim 4 wherein the nuts are subjected to heat treatment by roasting the nuts at a temperature from 180 to 300°C.

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6. The method of claim 4 wherein the nuts are subjected to heat treatment to remove CNSL and at least partially replace it with water.

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7. The method of claim 6 wherein the nuts are subjected to steam treatment to remove CNSL and at least partially replace CNSL with water.

15 8. The method of any one of the claims 2 to 7 wherein the nuts are humidified to increase the water content in the shells to between 15 and 50% (by mass) prior to removing the CNSL.

20 9. The method of claim 8 wherein the nuts are soaked in water in order that the shells have a water content from 25 to 30% (by

mass).

10. The method of either one of claims 8 or 9 wherein the humidification takes place at a temperature below 20°C.
- 5
11. The method of claim 10 wherein the humidification takes place at a temperature from 3 to 15°C.
12. The method of claim 10 wherein the humidification takes place at
- 10 a temperature from 5 to 10°C.
13. The method of any one of the preceding claims wherein the cold treatment to embrittle the shells comprises cryogenic treatment.
- 15 14. The method of claim 13 wherein the nuts are brought into contact with liquid nitrogen and/or liquid air.
15. The method of any one of the preceding claims wherein the embrittled shells of the nuts are cracked subsequent to the cold
- 20 treatment.

16. The method of claim 2 comprising the steps of :
- humidifying the cashew nuts at a temperature below 20°C in order that the shells contain more than 10% (by mass) water;
 - 5 - thereafter removing at least 50% of the CNSL from the shells;
 - and
 - thereafter subjecting the nuts to cold treatment to embrittle the shells.

- 10 17. The method of claim 16 wherein the removed CNSL is replaced with water.

18. A method of shelling nuts with shells containing a non-aqueous liquid comprising the steps of :

- 15 - first removing at least 50% of the non-aqueous liquid from the shells of the nuts;
- thereafter subjecting the nuts to cold treatment to embrittle the shells; and
 - thereafter cracking the embrittled shells of the nuts to remove
- 20 said shells.

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5 19. Shelled nuts prepared by the method of claim 18.