(54) Title: METHOD FOR PICKLING AND/OR MARINATING NON-VEGETABLE FOODSTUFF RAW MATERIAL

(57) Abstract

A method for brining and/or marinating non-vegetable food raw materials which entails the raw materials being exposed for suitable periods alternately to reduced pressure in a gas phase and a liquid phase, by being lifted mechanically between the two phases, and constituting one or more of the steps; washing in fresh water or sea water, light salting in unsaturated brine, full salting in saturated brine and/or marinating in spiced brine in addition to application of ultrasound in combination with the above treatment. A device for implementing the method is also described.
**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>Austria</td>
<td>GB</td>
<td>United Kingdom</td>
<td>MR</td>
<td>Mauritania</td>
</tr>
<tr>
<td>AU</td>
<td>Australia</td>
<td>GE</td>
<td>Georgia</td>
<td>MW</td>
<td>Malawi</td>
</tr>
<tr>
<td>BB</td>
<td>Barbados</td>
<td>GN</td>
<td>Guinea</td>
<td>NE</td>
<td>Niger</td>
</tr>
<tr>
<td>BE</td>
<td>Belgium</td>
<td>GR</td>
<td>Greece</td>
<td>NL</td>
<td>Netherlands</td>
</tr>
<tr>
<td>BF</td>
<td>Burkina Faso</td>
<td>HU</td>
<td>Hungary</td>
<td>NO</td>
<td>Norway</td>
</tr>
<tr>
<td>BG</td>
<td>Bulgaria</td>
<td>IE</td>
<td>Ireland</td>
<td>NZ</td>
<td>New Zealand</td>
</tr>
<tr>
<td>BJ</td>
<td>Benin</td>
<td>IT</td>
<td>Italy</td>
<td>PL</td>
<td>Poland</td>
</tr>
<tr>
<td>BR</td>
<td>Brazil</td>
<td>JP</td>
<td>Japan</td>
<td>PT</td>
<td>Portugal</td>
</tr>
<tr>
<td>BY</td>
<td>Belarus</td>
<td>KE</td>
<td>Kenya</td>
<td>RO</td>
<td>Romania</td>
</tr>
<tr>
<td>CA</td>
<td>Canada</td>
<td>KG</td>
<td>Kyrgyzstan</td>
<td>RU</td>
<td>Russian Federation</td>
</tr>
<tr>
<td>CF</td>
<td>Central African Republic</td>
<td>KP</td>
<td>Democratic People’s Republic of Korea</td>
<td>SD</td>
<td>Sudan</td>
</tr>
<tr>
<td>CG</td>
<td>Congo</td>
<td>KR</td>
<td>Republic of Korea</td>
<td>SE</td>
<td>Sweden</td>
</tr>
<tr>
<td>CH</td>
<td>Switzerland</td>
<td>KZ</td>
<td>Kazakhstan</td>
<td>SI</td>
<td>Slovenia</td>
</tr>
<tr>
<td>CI</td>
<td>Côte d’Ivoire</td>
<td>LI</td>
<td>Liechtenstein</td>
<td>SK</td>
<td>Slovakia</td>
</tr>
<tr>
<td>CM</td>
<td>Cameroon</td>
<td>LK</td>
<td>Sri Lanka</td>
<td>SN</td>
<td>Senegal</td>
</tr>
<tr>
<td>CN</td>
<td>China</td>
<td>LU</td>
<td>Luxembourg</td>
<td>TD</td>
<td>Chad</td>
</tr>
<tr>
<td>CS</td>
<td>Czechoslovakia</td>
<td>LV</td>
<td>Latvia</td>
<td>TG</td>
<td>Togo</td>
</tr>
<tr>
<td>CZ</td>
<td>Czech Republic</td>
<td>MC</td>
<td>Monaco</td>
<td>TJ</td>
<td>Tajikistan</td>
</tr>
<tr>
<td>DE</td>
<td>Germany</td>
<td>MD</td>
<td>Republic of Moldova</td>
<td>TT</td>
<td>Trinidad and Tobago</td>
</tr>
<tr>
<td>DK</td>
<td>Denmark</td>
<td>MG</td>
<td>Madagascar</td>
<td>UA</td>
<td>Ukraine</td>
</tr>
<tr>
<td>ES</td>
<td>Spain</td>
<td>ML</td>
<td>Mali</td>
<td>US</td>
<td>United States of America</td>
</tr>
<tr>
<td>FI</td>
<td>Finland</td>
<td>MN</td>
<td>Mongolia</td>
<td>UZ</td>
<td>Uzbekistan</td>
</tr>
<tr>
<td>FR</td>
<td>France</td>
<td>MR</td>
<td>Mauritania</td>
<td>VN</td>
<td>Viet Nam</td>
</tr>
<tr>
<td>GA</td>
<td>Gabon</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
METHOD FOR PICKLING AND/OR MARINATING NON-VEGETABLE FOODSTUFF RAW MATERIAL

The invention concerns a new method for brining and/or marinating non-vegetable food raw materials and a device for use in connection with the method.

The object of preserving raw materials in food production is to increase the storage time of the raw materials without substantially altering their quality. This kind of treatment prevents biological decomposition in the raw materials, such as the activity caused by microorganisms or autolytic activity in the raw material's own cells. Nowadays preservation of this kind not only requires that bacterial and autolytic activity should be prevented, but that the product should also maintain an appetizing appearance with regard to consistency, colour and odour. Traditionally, this kind of preservation may consist of heat treatment, ionizing radiation, the addition of acid in order to lower the material's pH value, the removal of air around the raw materials and drying, either directly or indirectly by means of freezing, smoking, salting and preserving in sugar. The preservation of raw materials by drying, smoking and salting are methods which have been known and used in Norway for a long time, for preserving both meat and fish.

The preservation of, e.g., fish raw materials is particularly important since the fish is caught at locations which are often far removed from the places of consumption and at concentrated times of the year. There are two known methods of salting fish raw materials; dry salting and brining. Before preserving the fish in this way it is usually gutted, weighed and washed for further processing, possibly by placing it in cold storage/freezer before further processing. The fish which is taken out of the cold storage/freezer for salt fish production is normally washed and de-iced and then split (i.e. the fish is cut along the belly in such a manner that it is connected along the back and the backbone is removed from the third joint behind the anus with one oblique cut forwards). After splitting the fish is again washed and cleaned before entering the salting process.

In the case of dry salting, the fish is salted in layers with sufficient sea salt between each layer of fish. The brine which is produced when water is extracted from the fish runs out of the stack and the fish remains dry all the time. In the case of brining, the fish can be salted in a brine which is prepared in advance (brining) or the fish can be salted in the same way as for dry salting, but the salting takes place in the brine tank (brining).
Traditionally, brining is performed by stacking the split and washed fish in layers in large containers and sprinkling sea salt between the layers of fish. The salt will extract water from the cells and together with the salt this water will form a brine in which the fish will be left to lie. This brine will normally be saturated, and thereby have a salt concentration of approximately 24 Baumé-degrees. However, it will not be possible to maintain this salt concentration at a constant level due to the extraction of water from the tissue of the fish and the possibility of evaporation from the brine tanks. The salt will diffuse into the flesh of the fish, gradually reducing the osmotic transport of water out of the cells. Moreover, the salt in the cells will denature the proteins, thereby stopping any autolysis and deactivating microorganisms. The brine tanks are located in production premises without heating, since the temperature should preferably be between 5 degrees C and 8 degrees C during the process for approximately 2 to 3 weeks.

After 2 to 3 weeks the brine is emptied out. If the fish is not fully salted it is placed in a new brine solution. If it is fully salted the fish is cleanly cut around the neck, the black membrane may be removed and the fish is relocated. This means that it is stacked on pallets with rock salt between the layers and placed for from 3 days to a week in cold storage (+5 degrees C) to drain. A relocation of this kind entails mechanical handling of the fish which increases the risk of damage to the product.

The yield for salted fish is approximately 60%, whereof dry salting of fresh raw material has a yield of 60.9%, iced raw material 60.7%, while for brining it is 66.1% and 69.8% respectively, according to figures from Statens Fagskole for Fiskeriindustri, Vardø (The State Technical College for the Fishing Industry). Dry salted fresh fish contains 52.5% water and 18.7% salt while dry salted iced fish contains 55% water and 19.5% salt. With brining of fresh fish a water content of 54.9% and a salt content of 20.1% are obtained in the product, while the product of iced fish contains 58% water and 19.1% salt. Thus, brining appears to be the most advantageous since the water content is slightly greater with a consequent increase in the weight.

The traditional method entails costly and significant disadvantages. The process takes from 4 to 6 weeks, temperature variations affect the process, saturated brine can cause incrustation and yellowing, and the salt can draw gluey material out of the fish skin causing the layers to stick together. Unheated production premises can result in substantial temperature variations in the brine tanks and affect the product depending on where it is located in the stack. If the process is delayed at low temperatures, there is an increase in the possibility of fat turning rancid and giving an unpleasant taste. A
good supply of oxygen and light will also increase the possibility of rancidity, and together with impurities in the salt could cause discoloration of the flesh of the fish. Too rapid production of strong brine can lead to denaturation of the surface of the fish with the formation of a crust which prevents water from being extracted. In such cases the flesh of the fish can rot under the crust. Moreover, in the traditional brine tanks there is no arrangement for stirring the brine in order to ensure homogeneous concentration conditions in the tank.

There are many known methods for salting meat and fish where the object has been to shorten the salting time. With regard to meat, methods are known for brining, mechanical processing, exposure to a vacuum, exposure to increased pressure and various combinations of these elements (US 4 498 378, GB 1 596 873, EP 0 172 497, DE 2 056 048, DK 0574/88A, US 4 836 099, EP 0 277 882, US 4 522 118, GB 2 181 334, NO 168683B).

Processes are known in which meat is made more tender by exposing it to ultrasonic energy. Likewise it is known to use ultrasonic energy in processing fish, such as conserving or seasoning/maturing of fish (GB 1 561 185, DE-A1-27 46 584) to facilitate the processes. However, it does not appear to be known to use ultrasonic energy in a closed, airtight system in combination with vacuum.

Meat normally has a dense consistency with membranes around the muscles which delay the penetration of salt. A known method, therefore, is to inject brine into the meat with injection devices, both directly intramuscularly and by employing the existing cardiovascular system to facilitate the transport of brine into the meat. In addition the meat is exposed to a vacuum and/or increased pressure, together with mechanical processing which exposes the meat to considerable mechanical influence.

This causes the salt to be diffused more rapidly into the muscle cells, probably by a mechanical influence on the cell membrane, and gives a shorter salting time. However, there are problems in connection with this method, such as the formation of air bubbles in the meat, causing a reduction in quality, and unhomogeneous salting of the pieces of meat. There are also some special products of meat from mammals, birds, reptiles and amphibians which cannot tolerate hard mechanical treatment.

Fish cannot be processed mechanically since this will destroy the tissue and substantially reduce the quality of the product. There is disclosed in DK 149161B a method for salt preservation of fish wherein the fish is stacked in closed containers,
dry salted and exposed to a pulsating vacuum of 0.9 to 0.95 bar for 1.5 min. According to the description the bottom valve of the container is closed during the process, which of necessity must cause the extracted liquid to fill the container and it is doubtful to what extent the fish will be exposed to reduced pressure as it will be covered with the brine.

Thus it is an object of the present invention to provide a brining preserving method which considerably shortens the salting time, reduces the possibility of the extraction of glue, the formation of a crust and yellowing of the fish raw materials, and shortens the salting time for raw materials from mammals, birds, reptiles and amphibians and provides a product which is homogeneously salted, with an appetizing appearance and good flavour.

These objects are fulfilled by means of the present invention which is characterized by the features which are presented by the claims.

The present invention provides a method wherein non-vegetable food raw materials from cold storage or thawed from the freezer or salted are washed in fresh water or sea water and pickled, first in unsaturated brine (at approximately 18 Baumé-degrees) and thereafter in saturated brine (at approximately 24 Baumé-degrees) in a sealed, light-proof and airtight container system which consists of a liquid phase and a gas phase, where the gas phase is kept under a vacuum (0.20 to 0.97 bar) and the raw materials are mechanically moved from the liquid phase to the gas phase, and back to the liquid phase after given time periods, where the used liquids are cleaned and possibly recycled. The raw materials may possibly be exposed to ultrasonic treatment in combination with vacuum and brining. A device is also provided for the implementation of the method according to the invention.

The method and device according to the invention will now be described in more detail with reference to the illustrations, in which:

Fig. 1 is a schematic process diagram according to the invention,

Figs. 2a - 2b illustrate a vacuum salting machine according to the invention.

The method according to the invention is performed in a closed system (figs. 1, 2) which contains a varying number of brine baths, pipe connections and pump devices for pumping in/out of water/brine, pipe connections with a compressor for reduction of
the air pressure in the system, and the system is sealed against the inflow of air and
is light-proof, in addition to which it comprises a mechanical lifting device and a
temperature-controlled heating element. During the implementation of the method the
system is constantly exposed to an underpressure from 0,20 to 0,97 bar in all gas
spaces above the surfaces of the liquid. The used liquids can be cleaned and possibly
recycled after each stage, or at the conclusion of the entire salting/marinating process,
and the solid matter is collected for the possible separation of proteins and fat.

By means of the mechanical lifting/lowering device the raw materials are lifted from a
completely submerged state in the liquid/brine bath to complete exposure to the
superjacent gas space, where there is an underpressure in relation to atmospheric
pressure. The raw materials are submerged in the liquid/brine bath for 15 sec to
6 min, preferably for 3 min, and exposed to reduced pressure in the gas space for
1 sec to 3 min, preferably for 5 sec to 90 sec, and most preferably for 30 sec to
80 sec.

In combination with brine/vacuum exposure of the raw materials can ultrasonic energy
be used. This combination does not appear to be known in prior art, and ultrasonic
energy will be used when the raw materials are submerged in the brine/marinade to
further quicken the salting process. The ultrasounds is created by a known device and
the enforced effect will depend upon the type of raw materials and which method step
according to the invention is selected, how long the underpressure lasts and level of
underpressure. Thus the enforced ultrasonic energy will range from 0,1 to 2,5 W/cm²,
preferably 0,1-1,5 W/cm², while the frequency will range from 30 to 50 kHz, preferably
40 kHz. The ultrasonic energy can be applied in one or several of the method steps
and in parts of or the whole time the raw materials are submerged in the brine/-
marinade. Maintenance of constant, selected temperature during the ultrasound
application is obtained by suitable heat exchanger.

The method will now be described with fish as the raw material.

The method for salting non-vegetable food raw material according to the invention
comprises one or more of the following steps:

1) The brine bath(s) is filled with fresh water or sea water (salt concentration
approximately 3%) and the raw material, which is stacked in the salt containers, is
cleaned for from 20 min - 120 min during transfer between liquid phase and gas
phase where the residence time in the vacuum and the brine respectively are as indicated above.

2) The brine bath(s) is filled with unsaturated brine at from 15 to 22 Baumé-degrees, preferably approximately 18 Baumé-degrees, and for 20 min to 6 hours, preferably 2 hours, the raw material is lifted from a submerged state in the liquid phase for the above-stated period, up into the gas phase with underpressure, where the raw material is kept for the above-stated period.

3) The brine bath(s) is emptied of unsaturated brine and filled with saturated brine at approximately 24 Baumé-degrees and the raw material is lifted between the gas space with underpressure and the liquid phase for approximately 15 min to 48 hours, preferably 24 hours.

4) The brine bath(s) is filled with spiced brine/marinade and the raw materials are lifted between the gas phase and the liquid phase for 15 min to 24 hours, as indicated in steps 1 to 3.

If the raw material is fish, the product in 3 will be called fully salted fish and this is possibly thereafter relocated by being stacked in layers on a pallet, rock salt is sprinkled between the layers, and it is left to stand for equalization of the salt concentration (the salt concentration in the flesh of the fish becomes homogeneous) and draining for 3 to 4 days. This relocation, where the fish normally is placed under pressure, is necessary in order to obtain the water content which characterizes salted fish.

After each step the liquid/brine can be cleaned by means of a centrifuge or by separating the solid matter from the liquid phase by some other means. The cleaned liquid may be recycled to the brine baths. The cleaning can take place after each step or after the conclusion of the salting process. The solid matter is separated and may be sorted into proteins, carbohydrates and fat and/or used in other products, or in the manufacture of special products.

The fish is now salted and ready to be dried to form split cod according to the prior art. If the raw materials are meat, the salted product will be packed according to the prior art.
The method involving lifting of the food raw materials between brine and vacuum can also be used for marinating. Marinating is a known process where foodstuffs lie in spiced brine for from 2 hours to a week. According to the present method, it will be possible to perform marinating in from 15 min to 24 hours in a suitable brine according to the present method, depending on the type of raw material.

In table 1 examples are shown of processing times in the application of the present device for implementing the method.

**TABLE 1**  Processing times for the vacuum machine without ultrasound

<table>
<thead>
<tr>
<th>Raw materials</th>
<th>Step</th>
<th>Process type</th>
<th>Process time</th>
<th>Running frequency: Vacuum</th>
<th>Running frequency: Preserving liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish/meat</td>
<td>1</td>
<td>Wash/clean</td>
<td>20-120 min</td>
<td>5, 30, 90 sec</td>
<td>15 sec, 0.5-1.0 min</td>
</tr>
<tr>
<td>Fish/meat</td>
<td>2</td>
<td>Light salting</td>
<td>20-360 min</td>
<td>5 sec, 1.15-1.5 min</td>
<td>1.0 min</td>
</tr>
<tr>
<td>Fish/meat</td>
<td>3</td>
<td>Full salting</td>
<td>15-2880 min</td>
<td>5 sec, 1.15-1.5 min</td>
<td>1.0 min</td>
</tr>
<tr>
<td>Fish/meat</td>
<td>4</td>
<td>Marinating</td>
<td>15-1440 min</td>
<td>5 sec, 1.0 min, 1.5 min, 3.0 min</td>
<td>1.0-1.15, 2.0-3.0-4.0-6.0 min</td>
</tr>
</tbody>
</table>

In step 1 washing in fresh water, or sea water, causes the flesh of fish raw material in particular to become whiter. This can be an advantage in the case of iced raw material which may be encumbered with an odour due to inadequate storage caused by varying temperatures. Especially in the case of deep water fish, which have a great deal of slime on their skin, slight decomposition of this slime, which occurs even with icing, will create an unpleasant odour. The used water may be cleaned with a separator/centrifuge for recycling in the same or a similar method.
In step 2 water and soluble materials are extracted from the raw materials, while at the same time salt diffuses into the cells. There is a high diffusion of salt early in the salting period, regardless of the strength of the brine. Nevertheless it has been shown that the use of an unsaturated brine at this stage surprisingly reduces the possibility of incrustation, e.g. in fish raw material where the surface tissue is denatured and the salt is prevented from penetrating deeper into the tissue.

In step 3 the strength of the brine is increased, thus denaturing cell proteins and organelles and preserving the tissue against enzyme activity/autolysis. Thus the combination of steps 2 and 3 in the present method provides fish, e.g. with approximately 8% higher salt fish weight and 2 to 10% higher yield than with conventional salting, more salt and solid matter being bound up in the cells which in turn leads to improved preserving. Shortened processing time gives in addition to economical profit a final product characterized by better quality.

Table 2 illustrates the saving in production time for the method according to the invention compared with conventional brining.

**Table 2**

Production time for the present method without the use of ultrasonic energy compared with conventional brining

<table>
<thead>
<tr>
<th>Production phases</th>
<th>Present invention (days)</th>
<th>Conventional brining (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brining</td>
<td>0.6 - 1</td>
<td>14</td>
</tr>
<tr>
<td>Relocation and maturing</td>
<td>1 - 3</td>
<td>7</td>
</tr>
<tr>
<td>Drying in hot air drier</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total production time</td>
<td>5.6 - 8</td>
<td>25</td>
</tr>
</tbody>
</table>
From table 2 it can be seen that the total time for production of, e.g., split cod, with the present method is reduced from 25 days to 8 days, whereof the greatest saving of approximately 13 days occurs during the salting stages, while a saving of three days takes place during the relocation and maturing stage.

With regard to the possibility of incrustation, this can easily occur when the brine solution is too strong to begin with, since the greatest salt diffusion always occurs during the first few hours. By using unsaturated brine for approximately 2 hours, according to the present invention, the chances of incrustation are substantially reduced. In addition the chances of unsaturated fatty acids in the raw materials turning rancid are substantially reduced, since the salting process (steps 2 and 3) takes place in a light-proof system and oxygenation of unsaturated bonds will not occur when the fish is submerged in the brine. In the gas phase the partial pressure of oxygen will be reduced because the air pressure is reduced.

In traditional brining it may be possible to dilute the brine with water which is drawn by osmosis from the cells in the tissue of the fish, while in the present method a considerable evaporation takes place, which can amount to 9 - 11% of the total water content, of pure water from the surface of the liquid since the pressure in the gas space above the brine surface is reduced. Evaporation and precipitation of salt result in the brine being maintained at all times at the saturation concentration, and this is demonstrated by the gradual formation of a belt of precipitated salt along the walls of the brine tanks. Measurements of the Baumé-strength show that no change takes place in the salt concentration.

A heating element with temperature set at from 5 to 15 degrees C, preferably from 6 to 7 degrees C, ensures that the salting is performed under a constant temperature as opposed to the situation in a conventional brining method where the temperature varies according to the outside temperature and airing of the production premises.

Stirring of the brine with the resultant homogeneous concentration conditions is performed by lifting the raw material from brine to vacuum and lowering it back again. The vacuum effect modifies the cell membrane in the tissue of the fish, thus speeding up the diffusion of salt into the cell. It is a known fact that, e.g., fish flesh does not tolerate mechanical processing (see above). In the present invention it has been shown that lifting/lowering of the fish between brine and underpressure surprisingly represented a mechanical processing of the flesh which can encourage the diffusion of salt into the flesh. In addition the buoyancy of the fish material causes the layers of
fish to open up and the brine to circulate freely between the layers of fish. This results in optimum contact between fish and salt solution during the entire period. The mechanical exchange of the fish raw material between dry vacuuming in air and brining submerged in a brine bath affects the membrane structures and together with the exchange between vacuum and brine has been shown to accelerate the absorption of salt compared with conventional salting.

The advantages of the present method can therefore be summed up in the following points:

1. Full control of the production process.
2. Substantially shorter production time.
3. Reproducible process, meaning that fish caught at different times of the year and of different weight, gives a final product with similar salt content and quality.
4. Lower production costs, due to reduced storage and tied capital.
5. Better working environment.
6. Better hygiene since production takes place in a closed system, and the brine bath can be separated and sterilized for possible reuse by means of separating/centrifuging and ultraviolet radiation. In addition all waste products from the brining process can be collected for future controlled destruction, and subsequent utilization of the proteins obtained.
7. Improved and more uniform quality, since the method provides reduced loss of tissue fluids, and increases the carbohydrate and solid material content of the salt fish. The production process gives a low oxygen supply and the absence of the effect of light in the brining phase prevents catalysis which can cause the flesh of the fish, e.g., to turn rancid and become yellow, as well as hindering the growth conditions for halophilic, aerobic and psychrophilic bacteria. The method provides full control of the brining production and thereby the consumption of salt, the temperature of the brine in the process can be controlled and adjusted to a desired value between 5 and 15 degrees C by means of a thermostatically controlled heating element. This reduces the risk of burning due to the brine and incrustation due to good process control. The product is also free of unmelted salt crystals, which are pressed into, e.g., the flesh of the fish and which in particular can represent a quality-reducing disadvantage when using the dry salting method according to the state of the art.

Fig. 1 illustrates a device for implementing the method according to the invention. The device consists primarily of a salt depot 1, a brine tank 4, a vacuum salting machine 9
and a centrifuge/separation machine 19. From the salt depot 1, the salt is transferred by means of transport devices 2 and 3, e.g. PLS-controlled screw conveyors, to the brine tank 4, where water is supplied through a valve 6. The actual mixing of the salt and the water is performed by means of an agitator 5 according to a predetermined recipe, in Baumé-degrees. The brine is then pumped to the vacuum machine 9 via valves 7, whereof the valve on the bottom of the machine 9 isolates it when several vacuum machines 9 are run in series (indicated by broken lines in figure 1).

Fig. 2a illustrates the vacuum machine 9 during loading/unloading, where the loading hatches 8 are in an open position, and where the loading of the salt containers 21, e.g., is performed by means of a fork-lift truck 22. In order to prevent the medium from flowing out into the brine bath 24 and to prevent the salt containers 21 from shifting during the implementation of the process, there is provided above the containers 21 a cover 23, which is operated, e.g. by compressed air. The salt containers 21 can be stacked and provided with perforations for circulation of the brine.

Fig. 2b illustrates the machine 9 during the production process, where the salt containers 21 are lowered by means of the hoists 10 into the brine bath 24, and where the pump 11 has established the desired vacuum.

For loading/unloading of the machine 9 there are provided hydraulically operated loading hatches 8, which are sealed with rubber packings around the hatch openings. A hydraulic PC/PLS-operated process hoist 10 provides for the exchange between vacuum and the brine bath 24 in the bottom of the vacuum machine 9, while a vacuum pump 11 provides a vacuum. After the vacuum treatment a valve 13 provides pressure equalization with the environment. For cleaning, there is further provided a hatch 12 on the bottom of the machine 9, and a valve 14 for draining spoiled brine.

Recycling of brine is performed by means of a pump 15, which circulates the brine from the vacuum machine 9 through a heat exchanger 16 for heating or cooling. The latter optimizes and controls the temperature of the brine, preferably between 5 - 8 degrees C. The brine is then pumped back into the brine bath in the vacuum machine 9 on the opposite side of the machine (below the level of the liquid), a process which gives extremely good temperature distribution. For internal circulation of the brine there is further provided a valve 17, which is also closed in connection with cleaning the brine.
In order to separate solid matter and clean the brine before it is pumped back to the vacuum machine 9, there are provided valves 18 for connecting the brine cleaning equipment. The actual brine cleaning equipment consists of a centrifuge/separation machine 19, which separates solid matter from the brine, whereupon cleaned brine is pumped back to the machine 9. Before being cleaned, uncleaned brine will also be preheated in the heat exchanger 16. The machine 19 may, e.g., comprise a 2-stage machine which cleans the brine and separates the solid matter or a 3-stage machine which cleans the brine and separates solid matter and fat separately. Separated solid matter is collected in a depot 20. During operation, the production process from position 7 to 20 constitutes a closed circuit. This provides significant advantages, since the process is hermetically sealed. As mentioned earlier, cleaning and possibly recycling of liquid/brine can be performed after each stage or after the conclusion of the salting process, thus permitting the liquid/brine to be used several times.

The method will be further illustrated by means of embodiments on a laboratory scale, carried out with fish as raw materials.

Example 1

Brining of torsk (Brosme brosme)

The example shows weight loss and salt content in torsk after brining according to the present method.

The method was followed from step 1 to step 3 by means of the device according to the invention. The time for submersion in brine was 1 min, the time for exposure to reduced air pressure was 1.5 min and the total time taken was 24.3 hours. In addition the fish remained in the brine for a further 7 hours after the machine was switched off.

14.1 kg of torsk were treated from step 1, and after step 3 the weight had dropped to 13.2 kg, which gave a yield of 93.7% before relocating. Analysis of a random sample from this fish showed that the salt content was 17% and the water content was 56%.

It is a known fact that after brining fish has a salt saturation of 80 to 85% and has released 60 to 75% of the amount of liquid which is released in total when relocation and draining are included. An estimate on the basis of the above figures for salt saturation and water content in salted torsk will give a salt content of approximately 20% in salted fish, while at the same time the estimated release of water will give a yield of 89 to 91% for salted fish. The salt content is fully consistent with the values
which are obtained by conventional brining, while at the same time the yield is considerably higher.

Example 2

Brining of saithe (Pollachius virens) according to the present method.

The example shows weight loss after brining according to the present method.

Fresh saithe (4.2 kg) was supplied for salting and underwent a similar process to that described in example 1. After step 3 the basic material weighed 3.0 kg and the yield for salted fish was 85.7%. By applying the same estimate as in example 1 this will correspond to a yield of 72 to 78% for salted saithe.

Example 3

Brining of fresh cod (Gadus morhua) according to present methods.

The example shows that, after relocation, cod which was brined according to the present invention gave a better yield than the conventional method, despite the fact that the fish had spent a longer time than necessary in the brine.

The basic material was fresh hand-split cod, weight 18.9 kg without back. The brine was made of fresh water and 32 kg of sea salt. With a brine volume of 92.4 litres the brine strength amounts to 24.6 Baumé-degrees.

The salting was performed with the device according to the invention (the machine 9) and the running programme comprised 12.5 hours running with alternating vacuum and brine exposure (step 3), 10 hours rest in the brine, 3.5 hours running at step 3, 0.5 hours stop for control of temperature and evaluation of the salting process, and 18 hours running at step 3. This gives a total of 34 hours at step 3 and 10 hours rest in the brine.

The control stop after 16 hours running and 10 hours rest showed that the brine temperature was maintained (7.2 degrees C) and the salting process was judged to be 3/4 complete.

The weight after the salting process was 16.5 kg. This gives a yield of 87.3%, fully consistent with the yield for torsk and saithe which were processed for 24.5 hours with approximately 7 hours rest in the brine.
The cod was then removed from the brine and relocated, salt was sprinkled on, and it was left to drain for four days, whereof two days with a pressure of 21 kg.

The weight after relocation was 15,5 kg.

This gives a total yield of 82% for salted cod. According to experiments conducted by the Statens Fagskole for Fiskeriindustri, Vardo, (The State Technical College for the Fishing Industry), on 40 different batches of salted fish, which showed a yield of 66,1% with conventional brining, the present method gives a significantly better yield according to the examples presented. In all the examples the raw material spent a longer time in the brine than that indicated by the method, the fish in examples 1 and 2 remaining there for seven hours, while the fish in example 3 remained for 10 hours in the brine after the machine was switched off, and the raw material was processed for 10 hours longer than indicated by the method at step 3 in example 3. Longer residence in brine will normally indicate water loss from the fish raw material, with a resulting lower weight and lower yield. Nevertheless in all three examples the yield was higher than the yield obtained with conventional brining.

Example 4
Brining of frozen cod from Alaska according to the present method

The example demonstrates an embodiment of the present method wherein the pressure is 0,75 bar in the gas room above the liquid surface when the fish material is lifted up in the gas phase and 0,20 bar when the fish is submerged in the brine.

The raw materials were frozen cod from Alaska. The quality was good. The weight of the thawed raw materials, split, cleanly cut around the neck and washed, was 68,8 kg. The brine was produced of 200 litres of clean water and 67 kg of sea salt, giving a salt content of 22,5 Baumé-degrees in the brine at the start of the process. The temperature of the brine was approximately 15 degrees C.

The exposure time in vacuum was 1,5 min, the pressure was 0,75 bar. The submerging time in the brine was 3,0 min and the pressure above the brine surface was 0,20 bar. The process time was 15 hours, i.e. totally 5 hours in vacuum and 10 hours in brine.
After brining according to the present method the fish was drained in a vessel, with sea salt between the layers, and the vessel was filled up with saturated brine. This step lasted 22 hours.

A sample weighing 25 kg of this fully salted fish was delivered to Fiskeridirektorates Kontrollverk, of Møre og Romsdal (Government Control Laboratory for Fisheries) to analyze the content of salt and water. The results are exhibited in Appendix 1.

The fully salted fish was dried for 4 days to clipfish. A sensoric assessment of this fish gave the characterization of 7/8 dry.

Weight after salting: 56.93 kg
Weight after drying: 43.3 kg

Yield of the salting process: \[ \frac{56.93 \times 100}{68.8} = 82.7\% \]

This yield is considerably higher than in conventional brining (66-70%). The salt content and the water content of the product was 17-18% and 61.7-63.2%, respectively (Appendix 1), which is acceptable for brine salted fish. The production time for clipfish was 133 hours (approximately 5.5 days), which is considerably reduced compared to conventional salting and drying (approximately 25 days), while the temperature was maintained at 15 degrees C. The quality of the final product was excellent.
PATENT CLAIMS

1. A method for brining and/or marinating non-vegetable food raw materials under exposure to vacuum in a closed airtight system, characterized in that the raw materials in suitable periods of time are repeatedly exposed to reduced pressure (vacuum) in a gas phase by being mechanically lifted up into the gas phase from the liquid phase containing fresh water/sea water/brine/- marinade followed by submerging in the liquid phase in all method steps, possibly in combination with ultrasound exposure, where the method comprises one or more of the following steps:

1) washing of the raw materials in fresh water or sea water for 0.3 - 3 hours, and

2) lightly salting the raw materials in unsaturated brine at 15 - 22 Baumé-degrees for 20 min to 6 hours, and

3) fully salting the raw materials in saturated brine at approximately 24 Baumé-degrees for 15 min to 48 hours, and/or

4) marinating the raw materials in spiced brine for 15 min to 24 hours,

and the entire method is implemented in a sealed, light-proof and airtight system in which are performed the pumping out of air, the pumping out/in of fresh water/sea water/brine/marinade, and possibly the cleaning and recycling of used liquid in which the solid matter is taken care of, the lifting/lowering of the raw materials and the regulation of temperature with heating elements.

2. A method according to claim 1, characterized in that step 1 is preferably continued for 1 hour; step 2 is preferably continued for approximately 2 hours and step 3 is preferably continued for approximately 22 hours, and where the exposure to underpressure can be for 1 sec to 3 min, preferably from 5 sec to 90 sec, most preferably from 30 sec to 80 sec, and exposure to brine lasts from 15 sec to 6 min, preferably 2 min.

3. A method according to one of the preceding claims, characterized in that the ultrasound has a frequency of 30 to 50 kHz, preferably 40 kHz and an enforced effect of 0.1 to 2.5 watts/cm², preferably 0.1 to 1.5 watts/cm².
and the ultrasound is applied under one or several method steps, in a part of or the whole time the raw materials are submerged in the brine/marinade.

4. A method according to claim 1, characterized in that the underpressure in the gas space above the surface of the brine is set in the range from 0,20 to 0,97 bar.

5. A method according to claim 4, characterized in that the underpressure in the gas space is 0,75 bar when the raw materials are exposed to vacuum in the gas phase, and 0,20 bar when the raw materials are exposed to brining in the liquid phase.

6. A method according to claim 1, characterized in that fresh fish, frozen and thawed fish and previously salted fish are used as the basic material.

7. A method according to claim 1, characterized in that meat from mammals, birds, reptiles and amphibians is used as the basic material.

8. A method according to claim 1, characterized in that a temperature of 5 to 8 degrees C, preferably 7 degrees C is used in the brine bath.

9. A method according to claim 1, characterized in that when the raising/lowering mechanism between brine and gas space is moved, homogeneous concentration conditions and temperature conditions will be produced and the buoyancy of the raw materials encourages further optimum exposure to the salt solution during submersion in brine.

10. A method according to claim 1, characterized in that the cleaning of used water/sea water/brine/marinade is preferably performed after each individual step, and where the proteins are separated from the solid matter.

11. A device for use with the method according to claim 1, characterized in that it comprises a sealed, light-proof and airtight vessel or tank and where amongst other things there are provided lifting/lowering devices, temperature
control devices, valves for pumping in/out of air/liquid, and a device for application of ultrasound.

12. A device for use with the method according to claim 11, characterized in that it comprises a multi-stage machine which cleans and possibly recycles fresh water/sea water/brine/marinade and which separates and collects proteins and possibly fat from the solid matter.
# INTERNATIONAL SEARCH REPORT

**A. CLASSIFICATION OF SUBJECT MATTER**

**IPC6:** A23B 4/02

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

**IPC6:** A23B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic database consulted during the international search (name of database and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>WO, A1, 9218011 (TULIP INTERNATIONAL A/S), 29 October 1992 (29.10.92), claim 6</td>
<td>11-12</td>
</tr>
<tr>
<td>A</td>
<td>WO, A1, 8911224 (INJECT STAR PÖKELMASCHINEN GESELLSCHAFT M.B.H.), 30 November 1989 (30.11.89), page 3, line 8 - line 16, claim 8</td>
<td>1-12</td>
</tr>
<tr>
<td>A</td>
<td>US, A, 4229458 (C. DREANO ET AL), 21 October 1980 (21.10.80)</td>
<td>1-12</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

See patent family annex.

Date of the actual completion of the international search: 30 March 1995

Date of mailing of the international search report: 21-04-1995

Name and mailing address of the ISA/Swedish Patent Office:
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer:
Kerstin Boije Janson
Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US, A, 4836099 (P. THIODE), 6 June 1989 (06.06.89)</td>
<td>1-12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>US, A, 4498378 (L.W. NORRIE ET AL), 12 February 1985 (12.02.85)</td>
<td>1-12</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-----------------</td>
<td>------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO-A- 933657</td>
</tr>
<tr>
<td>WO-A1- 8911224</td>
<td>30/11/89</td>
<td>AT-B- 391056</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE-A- 5890257</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP-A,B- 0414734</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA-A- 1079569</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE-A- 2818862</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR-A,B- 2394250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GB-A- 1596873</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NL-A- 7804090</td>
</tr>
<tr>
<td>US-A- 4836099</td>
<td>06/06/89</td>
<td>AU-B- 605831</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AU-A- 1133088</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE-A- 3864529</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP-A,B- 0277882</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR-A,B- 2610479</td>
</tr>
<tr>
<td>US-A- 4498378</td>
<td>12/02/85</td>
<td>NONE</td>
</tr>
</tbody>
</table>