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(54) **PROCESS FOR MAKING DRIED POWDERY AND GRANULAR KRILL**

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(57) **ABSTRACT**

A dried powdery and granular krill product containing all components of krill. The proteolytic enzymes originally contained in krill materials are perfectly disabled. The product is produced by a process including only heating as means for denaturing protein and disabling the proteolytic enzymes originally contained in krill materials. The product is produced by a process including no chemicals treatment to remove water and disable or inactivate the proteolytic enzymes in any production steps, and generating no waste-water. The production process comprises the steps of lightly dehydrating krill, coarsely crushing the krill, and drying the coarsely crushed krill under heating. Thus, water is removed from the krill by only heating, and degradation of the lipid in the krill product is prevented without using an anti-oxidant. Application fields are enlarged and the preservation characteristic is improved. The so-called zero-emission method and product, generating no wastes, are realized.

FIG.1

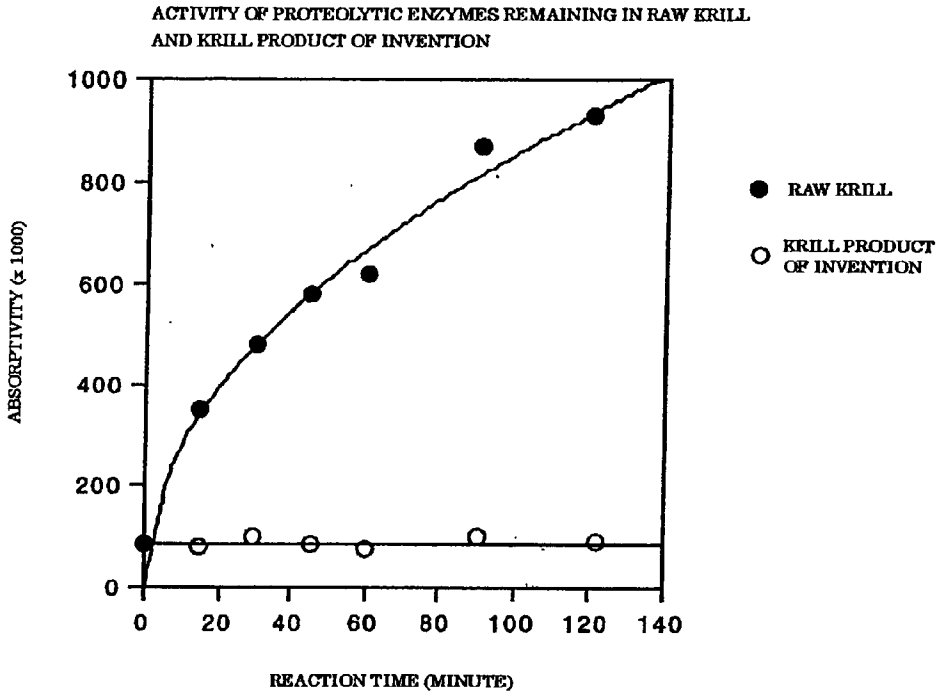
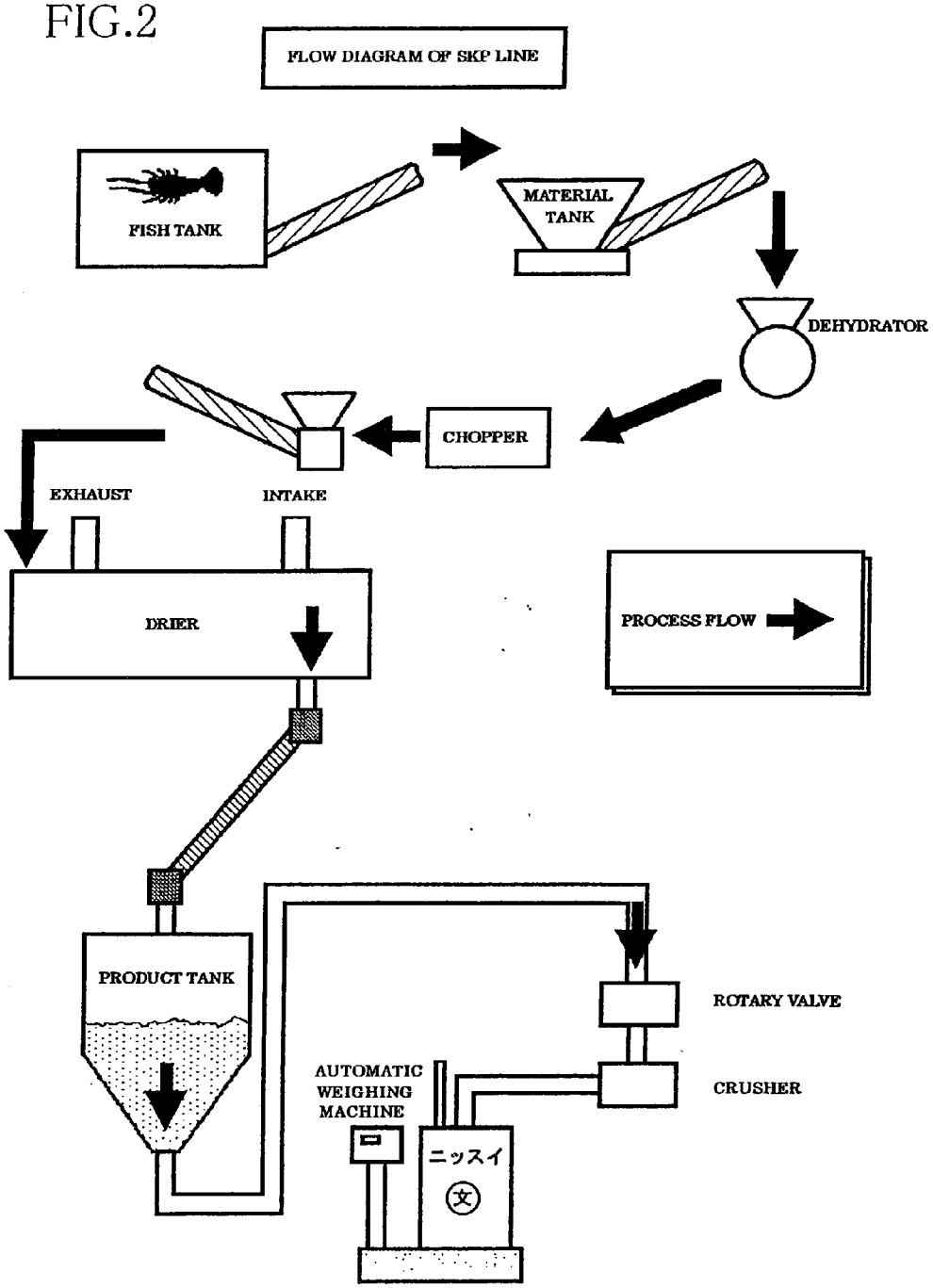


FIG.2



PROCESS FOR MAKING DRIED POWDERY AND GRANULAR KRILL

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a dried powdery and granular krill product which contains all components of krill and in which lipid degradation is sufficiently prevented with no need of an anti-oxidant.

[0003] 2. Description of the Prior Art

[0004] Krill are animal plankton living primarily in the Arctic and Antarctic Oceans, and about 80 kinds of krill have been known up to date. Of those many kinds of krill, Antarctic Krill (*Euphasia superba*) living in the Antarctic Ocean are found in abundance as one of natural resources. Therefore, survey of the resource and development of the method of catching the krill have been extensively conducted in the period of 1970 to 1985, including studies for developing methods of processing the krill to be useful in practical applications.

[0005] Krill are comparable to fish, flesh and fowl in point of nutritive value, but there are several problems in processing the krill for practical applications. One of the problems is that krill lose freshness in short time. If krill are left to stand after being caught, the heads and chests of the krill start changing into black color in 1-2 hours even at a low atmospheric temperature of about 0° C. Further, shells of the heads and chests of krill are so vulnerable to external pressure that the krill are easily broken down upon impacts applied at the time of catching, whereupon the enzymes present in the internal organs flow out and decompose muscles. Those phenomena occur under actions of the enzymes present in krill. It is thought that tyrosinase is responsible for the former color-changing phenomenon, and protease is responsible for the latter muscle-decomposing phenomenon.

[0006] Accordingly, those enzymes require to be disabled or inactivated when processing krill. In other words, it has been required immediately after catching krill to quickly freeze the krill down to below −40° C., thereby inactivating the enzymes, or to heat the krill up to above 80° C., thereby disabling the enzymes, followed by preserving the krill.

[0007] Known krill products include raw frozen and peeled krill products which are subjected to quick freezing and then preserved in a frozen condition, boiled krill products which are heated and then preserved in a frozen condition, and krill meal which is heated and dried and then preserrved at the normal temperature. The following Tables 1 and 2 list classifications of those products depending on how krill are processed, and features and points to be improved of the products.

[0008] The known products are used in various applications. However, because the products are transported from the Antarctic Ocean to Japan, the product price greatly depends on the transportation cost. There is hence a desire for extracting excellent characteristics of krill more efficiently and realizing krill products having a higher value added.

TABLE 1

Processing	Processing Object	Product Examples
Quick freezing, Preserve in frozen condition	Inactivate enzymes	Raw frozen and stripped krill
Heating, Preserve in frozen condition	Disable enzymes	Boiled krill
Heating & drying, Preserve at normal temperature	Disable enzymes	Krill meal

[0009]

TABLE 2

Product Examples	Features	Points to be improved
Raw frozen and stripped krill	Products have flavor, taste and feeling of raw krill.	Remaining high water content and activity of enzymes necessitate storage and distribution in frozen state. Enzymes are activated upon thawing and product quality degrades. Drips flow out.
Boiled krill	Heating disables enzymes and makes protein stable to give meat-like feeling.	Flavor and taste components flow out during boiling. Cold chain is required because of high water content.
Krill meal	Heating disables enzymes and makes protein stable. Meal can be stored at normal temp. because of low water content.	Digestibility lowers due to protein denaturation during heating. Water-soluble components flow out into stickwater.

[0010] Japanese Unexamined Patent Publication No. 57-11876 discloses a method of impeding activity of the proteolytic enzymes in krill and utilizing the krill as protein materials. With the disclosed method, a krill paste is degenerated with alcohol to effect fixation (denaturation) of protein and degeneration of the enzymes at the same time. The processed krill paste is then washed with water to remove alcohol. The disclosed method however has the following problems.

[0011] 1. Water-soluble protein and low-molecular protein, which are not yet denatured, are removed together with alcohol during washing with water.

[0012] 2. Free amino acids and extract components, which are taking in part of providing good taste, are also removed together with alcohol during washing with water.

[0013] 3. Polar lipid is removed together with alcohol during washing with water. Most of the lipid in krill is phospholipid and is rich in polyunsaturated fatty acids (PUFAs). Thus these PUFAs are removed.

[0014] 4. Alcohol can be recovered and reused, but an alcohol recovery system pushes up the cost.

[0015] For the above reasons, the above-disclosed method has difficulties in realizing practical use.

[0016] Further, Japanese Unexamined Patent Publication No. 8-298967 discloses a method of producing dried shrimp granules. With this disclosed method, raw shrimps are

crushed by a mincing apparatus (meat grinder) into the form of ground meat. The ground meat is then heated under agitation, followed by drying.

[0017] More specifically, according to the embodiment disclosed in the above Publication, shrimp materials are first crushed into the form of ground meat. The ground meat described in the embodiment includes not only the meat in the completely ground form, but also fragments of shrimps in the finely chopped form. Concretely, the above process is performed by a meat grinder which is used for producing mince or the like. Also according to the description in the embodiment, a maximum grain size representing the coarsely ground state is about 2 mm square. The shrimp materials thus processed are dried under heating to thereby provide dried shrimp granules. Considering specific properties of krill, however, it is inferred that even if krill are dried under heating after being processed in a similar manner as in the prior art, ground krill are very difficult to dry into a satisfactory condition.

[0018] From intensive studies, the inventors found that when krill are processed in a similar manner as in the prior art, lipid, protein and water contained in the krill are brought into an emulsified state, and the processed krill are very difficult to dry even with a heating and drying machine. Such a difficulty is related to the fact that most of the lipid in krill is phospholipid, as described above, and therefore emulsification is further increased. In other words, water in the krill is stabilized in structure with emulsification and becomes still harder to evaporate under heating.

[0019] In addition, when krill are crushed into the form of ground meat, the proteolytic enzymes present in the internal organs of the krill develop activity, and a temperature rise during the grinding process increases the activity of those enzymes. As a consequence, proteolysis in the krill is promoted and specific taste is deteriorated.

[0020] Moreover, when ground materials are dried by a heating and drying machine, the materials come into contact with a heating surface of the machine, and a coating(a layer) grows gradually. Then, there occurs finally such a phenomenon that the materials adhering to the heating surface are scorched. To prevent the occurrence of such a phenomenon, the heating surface of the machine must be scraped by a stirring vane or the like. Taking into account the structure and accuracy of the machine and an influence of thermal expansion of the machine under heating, however, it is very difficult to always keep constant a gap between the heating surface and the tip of the stirring vane. As a result, the materials cannot be avoided from being scorched, thus leading to a deterioration of flavor and taste and a lowering of digestibility.

SUMMARY OF THE INVENTION

[0021] An object of the present invention is therefore to effectively utilize krill as one of valuable aquatic resources, and to provide a dried powdery and granular krill product and a method of producing the dried powdery and granular krill product, which contains all components of krill and has a good preservation ability while activity of the enzymes in the krill is totally disabled.

[0022] The present invention resides in a dried powdery and granular krill product that contains all components of krill. Because of containing all components of krill, the present product has a function capable of sufficiently preventing degradation of the lipid in the krill product without using an anti-oxidant. In the dried powdery and granular krill product, the proteolytic enzymes originally contained in krill materials are perfectly disabled. Accordingly, the present invention also resides in a dried powdery and granular krill product which contains all components of krill and in which the proteolytic enzymes originally contained in krill materials are perfectly disabled. The present product is produced by a process including only heating as means for denaturing protein and disabling the proteolytic enzymes originally contained in krill materials. Accordingly, the present invention further resides in a dried powdery and granular krill product which contains all components of krill, in which the proteolytic enzymes originally contained in krill materials are perfectly disabled, and which is produced by a process including only heating as means for denaturing protein and disabling the proteolytic enzymes originally contained in krill materials.

[0023] The dried powdery and granular krill product of the present invention is produced by a process including no chemicals treatment to remove water and disable or inactivate the proteolytic enzymes in any production steps, and generating no wastewater. The production process comprises the steps of lightly dehydrating krill, coarsely crushing the krill, and drying the coarsely crushed krill under heating.

[0024] The dried powdery and granular krill product of the present invention is subjected to no chemical treatment using chemicals, etc. in any production steps, and is processed by only heating. Also, there is no step in the production process in which wastewater is generated. Thus, water is removed from the krill by only heating. Moreover, application fields are enlarged and the preservation characteristic is improved. The so-called zero-emission method and product, generating no wastes, are realized.

[0025] The production method of the present invention comprises steps of removing seawater from krill, coarsely crushing the krill, and drying the coarsely crushed krill under heating. In the conventional process of producing krill meal, krill are first boiled in water in the same amount as the krill, and are then subjected to separation into solid and liquid components. The solid component is heated and dried using a drier. The liquid component obtained from the solid/liquid separation is called stickwater and preserved separately. For this reason, the conventional krill meal contains less water-soluble components than the krill product of the present invention, and therefore has disadvantages in not providing satisfactory flavor and taste in the extracted form, etc. and attractiveness of feed to fish under cultivation, etc. Further, the conventional production process is disadvantageous in that protein is excessively denatured by heating applied in both the boiling and heating/drying steps, and digestibility of the product is reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] **FIG. 1** is a graph showing activity of the proteolytic enzymes remaining in raw krill and the product of the present invention; and

[0027] **FIG. 2** is a schematic view of a production line for the product of the present invention.

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