A method of preparing a pasteurized protein rich liquid extract from a protein source (preferably chosen from waste meat, fish or seafood) by forming an aqueous liquid mixture or an aqueous slurry containing the protein source and hydrolyzing the protein source with an enzyme complex extracted from kiwifruit or an enzyme complex including enzymes extracted from kiwifruit, at a temperature of between 30 - 35°C for at least six hours and then rapidly heating the resulting hydrolysate to a temperature of at least 60°C (and preferably 80°C) to deactivate the enzymes and pasteurize the hydrolysate.
ENZYMATIC RECOVERY OF PROTEIN

FIELD OF THE INVENTION

The present invention is directed to methods for the recovery of protein from a protein source.

BACKGROUND

Protein is an essential food group to animals. It is important for strength, immunity and general health.

If a person's diet is deficient in protein they will experience fatigue, irritability and lethargy. In more severe cases of protein deficiency symptoms such as growth failure, loss of muscle mass and edema is seen. The more serious symptoms are generally seen in impoverished countries but many elderly in first world countries can suffer from this also.

Protein can come from a number of different plant or animal sources. However, the most valuable source of protein for a significant portion of the world's human, and to a lesser extent animal population, is meat. It has been postulated that the reason for this is that the amino acid sequence replicates the structure of the non-skeletal portion of the body and therefore contributes less by way of non-congenial side effects than for example milk or soy proteins. However, meat has some disadvantages that limit its commercial suitability for use in human/animal nutrition.

The first of these is storage/wastage.

Fresh raw meat is probably the most nutritious protein source for human/animal uptake but fresh meat is an attractive host for a wide variety of disease organisms. Many of these organisms cause spoilage of the meat and can be fatal to humans if ingested, therefore fresh meat is not a practical or prudent option as a mainstream source of protein.
Many processing methods have been devised to prevent meat spoiling including the use of heat, moisture modification and the application of preserving agents. Each has severe limitations.

The vast majority of the harmful organisms that spoil meat are destroyed by temperatures in excess of 75°C even for relatively short periods of time (such as in the pasteurization of milk). However, the solid nature of meat makes it practically impossible to uniformly expose it to this temperature in a commercial process. To achieve the appropriate temperature at the core of the meat the extremities inevitably get exposed to higher temperatures. As temperatures rise in excess of 75°C there is a corresponding denaturing effect on the structure of the meat proteins. The higher the heat and the longer the period of exposure, the greater the extent of structural damage.

If meat is first made into a homogeneous liquid it can subsequently be uniformly heat treated in the same manner as milk or any other liquid that is subjected to flash-pasteurization, with minimal structural damage to the protein composition.

Mechanical liquefaction of meat is a possibility but practically presents problems associated with accelerated oxidation.

Enzyme hydrolysis of meat is another possibility. This is not in itself new technology, as it has been known for some time and is in use commercially for a number of processes such as removal of the lining of intestine material to make sausage casings, fletching hides and the like.

Notwithstanding, the use of meat hydrolysates as a component of edible products has to a large extent been unsuccessful due to an unacceptable flavour component imparted by the chemical hydrolysis process. This is caused by "bitter peptides" formed as a result of the hydrolyzing enzyme cleaving the bonds binding the chains of amino acids into the protein structure.

Several peptides, each with differing amino acid sequences, have been cited as contributors to the bitter taste of meat hydrolysate, making elimination of the offending peptides a complex process.
A second disadvantage of meat is its digestibility.

Many carnivores and omnivores, especially humans, experience some difficulty digesting meat. This is particularly so in the case of infants, invalids, and the aged. It is not uncommon for elderly people to experience such discomfort digesting meat that they find it expedient to eliminate it from the diet. In the absence of a suitable protein replacement this can lead to gradual protein malnutrition with a consequential deterioration in strength, immunity and general health.

Nutritional absorption from the gastro-intestinal tract relies on pre-enzymatic hydrolysis of the food source. It is well documented that meat takes considerably longer to pass through the gastro-intestinal tract than fruit or vegetables. Whether this reflects the time required for the gastro-intestinal tract to hydrolyze the material or the time required to absorb the nutritional components of the hydrolysate is not well understood.

In addition to the above it is beneficial if the method for recovering protein makes use of protein source which might otherwise be wasted. This ensures that increasingly scarce protein sources around are most efficiently utilized. For example, animal carcasses have traditionally had the meat removed from the bone by hand using a knife in a process termed 'de-boning'. This preparation technique is common for every major domesticated animal eaten by man, for example, beef, lamb, venison, pork, chicken, turkey, duck, rabbit, and fish. The process generally removes the vast majority of meat from the frame. However, there is inevitably some meat and/or proteinacious material still attached to or intracted in the frame. This is particularly true where the bone structure is more complex, for example, in smaller animals or around the appendages of the animal.

After the meat has been removed from the frame the remaining portion is usually processed by 'rendering' to achieve meat and bone meal. These products can be used for various purposes, including as stock feed and fertiliser. Often the rendering process would be carried out by a party other than the slaughter house. Said party has traditionally paid a small price to the slaughter house or meat processor for the meat free bones.

In an effort to obtain the most value from each animal carcass, meat processors later began using machines known as mechanical de-boning machines. These machines work by
breaking the bones into smaller pieces and feeding the material with force toward a heavy
duty fine mesh screen. A significant portion of the meat, fat, and cartilaginous material is
extruded through the screen. The mechanically de-boned meat can be used in products
such as sausages, reconstituted meat, and pet foods. The remaining material comprises of
virtually all of the bone and some remaining meat, fat, sinew, cartilage and marrow. This
waste or residue still goes to be rendered but now contains somewhat less meat than it did
in the days prior to mechanical de-boning and is of less value. The rendering plant
operator is less inclined to pay for this waste and in fact may charge the meat processor to
dispose of it.

Much prior art exists in the field of enzyme hydrolysis in relation to foodstuffs. In US
3,970,520 there is disclosed a process for preparing a proteinaceous material using a
proteolytic enzyme mixture of ficin, papain, and neutral protease from B. Subtilis. WO
05/079593A1 teaches the use of an extract of Zingiber comprising at least one cysteine
protease as a food improver for a protein containing food. US 5,709,901 teaches a meat
modifier based on the combination of an ester composition and protease. In particular it
mentions the disadvantages of using papain as a meat tenderizer, and the disadvantages of
using elastase, which has a high substrate specificity, to tenderize meat.

US 4,100,024 relates to the preparation of polypeptides from soy protein through
hydrolysis with a microbial, alkaline, proteinase. US 3,640,725 relates to a process of
separating nutritional components from soybeans or other oilseeds, employing enzymatic
hydrolysis of protein using a proteolytic enzyme, preferably derived from an Aspergillus
or Bacillus sp.

In US 4,176,199 there is disclosed a method of extraction of protein from edible beef
bones by crushing the bones to a predetermined size, then cooking the bones in
approximately equal parts of water by weight with a papain based proteolytic enzyme by
heating in water at stepped up temperatures for up to 6 hours.

US 6,319,527 relates to a method of preparing a uniformly tender meat product having an
extended shelf life comprising the steps of selecting one or more meat ingredients wherein
the muscle weight is comprised of whole protein tissue fibres, such as beef or pork, and
mixing an acidulent with the meat to form a pretenderized meat product. Subsequently,
the pre-tenderized meat product is mixed with an enzymatic tenderizer and cooked. The finished product is typically packaged in an oxygen-impermeable film, which also contains a microbe-inhibiting atmosphere and an oxygen-moisture scavenging agent.

US 4,302,473 relates to a process for manufacturing soybean proteins from soybean protein concentrates using a neutral protease. The neutral protease may be any protease capable of acting in a neutral to slightly alkaline pH range (pH 7 to pH 9) and may include, for example, papain, bromelain, ficin, trypsin, chymotrypsin, cathepsin, or the like; papain being preferable.

US 6,589,574 discloses a process for the preparation of protein hydrolysate from a milk protein by hydrolyzing an aqueous milk protein with a fungal protease obtained from Aspergillus sp. at a pH of 7.5-8.5, a temperature of 40±5°C for a time period of 30 minutes to 2 hours, followed by heating the resulting reaction mixture at 65-70°C for at least 3 minutes, and separating the clarified supernatant and drying the clarified liquor thus obtained to get the protein hydrolysate.

The disadvantages associated with the prior art processes are several. In particular, the end products tend to be bitter tasting unpalatable products which are unsuitable for use in most foodstuffs. In addition the methods are complicated and costly and thus unsuitable for large commercial application.

OBJECT

It is an object of the present invention to provide an improved method for recovering protein from a protein source or to at least to provide the public with a useful alternative.

STATEMENTS OF THE INVENTION

In one aspect the present invention provides a method of preparing a protein rich liquid extract from a protein source, said method comprising the following steps:

(a) processing the protein source into a liquid mixture or slurry with or without the addition of water;
(b) hydrolyzing the protein source using an enzyme complex extracted from kiwifruit or an enzyme complex including enzymes extracted from kiwifruit, at a temperature of up to 40°C for at least six hours, and then rapidly heating the resulting hydrolysate to a temperature of at least 60°C to deactivate the enzymes.

Preferably the protein source is hydrolyzed at a temperature of between 30-35°C for about eight hours.

Preferably the resulting hydrolysate is rapidly heated to a temperature of about 80°C to both deactivate the enzymes and pasteurize the hydrolysate. This heating step is preferably carried out after the separation of the liquid hydrolyzed protein from the residue of bones, fiber or other non-liquid or non-protein material.

In a further aspect the present invention provides a method of extracting protein from a proteinaceous waste material, said method comprising the following steps:

(a) processing the proteinaceous waste material in order to increase the surface area of the material;

(b) forming an aqueous liquid mixture or an aqueous slurry containing the processed proteinaceous waste material;

(c) hydrolyzing the proteinaceous waste material using an enzyme complex extracted from kiwifruit or an enzyme complex including enzymes extracted from kiwifruit, at a temperature of up to 40°C for at least six hours;

(d) rapidly heating the resulting hydrolysate to a temperature of at least 60°C to deactivate the enzymes;

(e) processing the resulting hydrolysate to separate a protein rich liquid broth from the residue.

Step (e) is preferably carried out before step (d) as the waste material (bones, fiber or other non-liquid or non-protein residue) is likely to be discarded and may not need to be pasteurized.
Preferably the proteinaceous waste material is hydrolyzed at a temperature between 30-35°C for about eight hours.

Preferably the hydrolysate is rapidly heated to a temperature of about 80°C to both deactivate the enzymes and pasteurize the hydrolysate.

In still a further aspect the present invention provides a palatable protein rich extract made in accordance with the method described herein.

In still a further aspect the present invention provides a palatable pasteurized hydrolysed protein extract comprising at least 16% by weight of protein and deactivated or substantially deactivated kiwifruit enzymes.

Preferably the protein extract is in liquid form and contains at least 25% of water soluble protein. Alternatively the protein extract may be in the form of a freeze dried powder.

DETAILED DESCRIPTION

The present invention provides a method of preparing a protein rich liquid extract from a protein source. The protein source useable in this invention may be any source of protein from any living organism. For example, the protein source may be selected from the group consisting of animals, birds, fish, fungi, insects, bacteria, molluscs including shellfish, or plants. Preferred protein sources for use in this invention are protein sources of low economic value such as waste products from the meat processing industry. An example of such a product is mechanically de-boned meat residue or waste (which can include, for example, bone, tendons, and fat). Other preferred protein sources include soy, soy meal, milk, whey, chicken skin, and shellfish, such as the green lipped mussel. Whilst the method of this invention can also be applied to high grade protein sources or protein sources of high economic value, in practice the method is particularly suited to dealing with protein sources from waste materials such as mechanically de-boned meat waste, from which it has not previously been practical or economically feasible to recover protein.
In accordance with the method of this invention, the protein source is processed into a liquid mixture or slurry before it is subjected to enzyme hydrolysis. The liquid mixture or slurry may be prepared with or without the addition of water. The amount of water required as an ingredient will vary depending on the protein source used. The water requirement relates to the amount of inter-cellular and interstitial moisture contained in the protein source and the relative ease with which the enzyme achieves the progressive hydrolysis reaction releasing additional moisture to the soup to carry the enzyme to the next reaction site. For example, some fish can be treated with the enzyme in dry powder form and without the addition of water. On the other hand, meat such as beef and venison requires the addition of water to achieve an effective hydrolysis reaction. The amount of water used will be determined to some extent by the processor depending on the speed of the reaction required and the specific end use of the product.

The protein source may be processed prior to the hydrolysis process in order to increase the surface area of the material to be exposed to the enzyme which will have a significant influence on the rate of the hydrolysis reaction. For example, given that all other conditions remain the same, a 5 kg solid piece of beef treated with 150 g of enzyme will take much longer to hydrolyze than a similar weight of chopped, flaked, shredded or minced beef treated with the same amount of enzyme. This is largely due to the increased surface area of the chopped material providing better access for the enzyme to react with the material.

The protein source is hydrolyzed using enzymes of a proteolytic nature, and preferably selected from the group consisting of cysteine proteases. More preferably the enzymes are selected from the group consisting of fruit-derived cysteine proteases or fruit-derived enzyme complexes, such as papain, actinidin, bromelain, ficin, or cyphomandrase.

Most preferably, the protein source is hydrolyzed using an enzyme complex extracted from kiwifruit or an enzyme complex including enzymes extracted from kiwifruit. Kiwifruit enzymes include actinidin which is a thiol cysteine protease obtained from the fruit of Actinidia species such as Actinidia chinensis, or Actinidia deliciosa (common name, kiwifruit). A particularly suitable enzyme complex for use in this invention is that manufactured by Vital Food Processors Limited of Auckland, New Zealand, under the
brand name PROACTINASE, which is comprised predominantly of actinidin, although the enzyme complex is thought to comprise possibly four other protease enzymes in minor quantities and a lipase enzyme also in a minor quantity. Vital Food Processors Limited currently manufactures various grades of this enzyme complex which have differing levels of protease activity, all of which are suitable for use in the methods of the present invention.

The process of hydrolysis is preferably carried out at a temperature of up to 60°C for a period of at least six hours. Preferably the protein source is hydrolyzed at a temperature of between 30-35°C for about eight hours. The activity or rate of reaction of the kiwifruit enzyme complex PROACTINASE increases uniformly as the temperature of the substrate increases, reaching optimum commercial activity when operating in the temperature range of 27-33°C. Temperatures above 33°C and below 45°C in fact achieve faster reaction times but in a large commercial operation it is impractical to achieve these temperatures without risking hotspots that will deactivate any enzyme coming in contact with these spots and risking overall diminished reaction time. It has been found that if a meat protein source is hydrolyzed for a period of about six to ten hours at these temperatures, the meat faction will progressively soften and start to fall away from the bones and other material without causing excessive degradation of the protein. Mechanical agitation of the mixture prior to or during this hydrolysis stage may or may not be utilised. Such agitation is advantageous as the protein source is given maximum exposure to the enzymes and it can result in easy separation of proteinaceous material from bones and the like and facilitate the liquefaction of the proteins.

The amount of enzymes or enzyme complex required to achieve complete hydrolysis varies depending on the composition of the protein source being treated. Typically the enzyme complex is used in an amount of about 1-3% by weight. The enzyme complex may be used in dry powder form or may be mixed with water and used in liquid form.

At the completion of the time period for enzyme hydrolysis, the resultant hydrolysate is then rapidly heated to a temperature of at least 60°C to deactivate the enzymes. Actinidin is reported to be largely deactivated at a temperature of about 60°C. However the enzyme complex PROACTINASE demonstrates some minor residual activity even after treatment
at 80°C for sixty seconds albeit that the activity is severely curtailed. This residual activity helps to confirm the presence of protease enzymes other than actinidin in this particular enzyme complex. Preferably the resulting hydrolysate is rapidly heated to a temperature of about 80°C to both deactivate the enzymes and pasteurize the hydrolysate. Preferably the hydrolysate is subjected to the increased temperature for about three to five minutes, or longer if necessary.

As well as providing for the deactivation of the enzymes used in the method according to the present invention the rapid heating step facilitates the separation of the components of the hydrolysate. For example, a fat or oil rich layer may be separated from the proteinaceous aqueous layer provided there are enough fats in the protein source. When the protein source used is mechanically de-boned meat waste, the rapid heating step facilitates the separation of the bone, meat, cartilage and sinew. Mechanical agitation of the mixture during the rapid heating stage may or may not be utilized, but is advantageous as it results in an almost immediate conversion of the protein hydrolysate into liquid, and when using a waste meat protein source, the meat comes cleanly away from the bones. The bones can then be removed from the hydrolysate, leaving a liquid paste which can be further filtered to remove any fine bone chips, then allowed to stand until the fat rises to the surface and can be removed if desired by siphoning or centrifugation or other means. The remaining liquid paste can then be re-heated to about 80°C if desired before being packaged and/or processed for the desired use. The viscosity of the liquid paste can be altered by the addition of water if desired. The liquid paste has a high protein content, and preferably the protein content is at least 16%. More preferably the protein extract contains at least 25% of water soluble protein. The liquid paste can be stored for several weeks under normal refrigeration while maintaining its liquid state. Alternatively the product can be frozen and will return to a liquid state on thawing at ambient temperature. The product may also be dried into powder form by freeze drying or spray drying or the like.

The liquid paste may be further processed by subjecting it to high speed centrifugation which will cause it to separate into three distinct fractions, being the fats, a clear liquid containing over 99% of the protein content, and the meat fibre. Accordingly, several different products can be recovered. The clean fats have a ready market. The fibre can be...
used to blend back into a range of products. The clear liquid protein could be used as an ingredient in new food concepts or as a food supplement.

The protein rich extract provided by the method according to the present invention may be used in any number of products, including, but not limited to, reconstituted protein foods for humans or animals, protein rich sources for micro-organism growth, or for protein fortification or as additional functional ingredients in other foods. Examples of some of the foods it may be used in are gravy, sauces, marmite, Bovril, soups and so on. Where the protein rich extract is obtained from a meat waste protein source, the extract may be used to make a range of products including meat jerky, salami type products or sausage type products.

It is considered that the methodology discussed herein produces a palatable pasteurized protein rich extract with reduced bitterness. The isolated hydrolysed protein may be more desirable for applications where taste is a factor due to the reduced bitterness over products obtained by other methods of hydrolysis.

The product from the present invention if made with a meat waste protein source is, in effect, hydrolyzed meat. It is considered that digestibility of the protein contained therein would be enhanced, nutrient uptake would be accelerated and digestive discomfort would be minimized if not eliminated.

Further aspects and advantages of the present invention will become apparent from the ensuing examples which are given by way of example only. It is to be appreciated that improvements and/or modifications may be made without departing from the scope or spirit of the invention. Even though the following examples relate to ovine waste, chicken waste, chicken skin and green lipped mussel, it must be appreciated that the methods are applicable to any other protein source.

The mechanically de-boned meat residue or waste used in the following examples was processed in a machine made by an American company called "Beehive". There are however other similar machines known in the art and suitable for carrying out such a process.
EXAMPLE 1

Several experiments were conducted using ovine mechanically de-boned waste as the protein source in the method of the present invention. A typical result was the recovery of 50% of an aseptically packaged, low fat liquid meat free of bone, a 10% recovery of isolated animal fat and a 40% recovery of clean bone suitable as a source of calcium or bone powder. The liquid meat was found to have a typical protein content of about 16% depending on the specific source of the input material.

Method

Ovine mechanically de-boned waste material (14.5kg) and PROACTINASE (0.35kg) were mixed with water (10.50kg). The mixture is held between 32°C and 35°C for eight hours. The mash was then heated to 80°C to effect pasteurisation and to deactivate the proteolytic enzymes. As the temperature is increased agitation is intensified and the bone came cleanly away from the attached meat, cartilage, and sinew which formed a smooth paste.

Results

Although the relative portions of each fraction varied between experiments depending on the source and content of the raw material, a typical analysis was as follows:

<table>
<thead>
<tr>
<th>1. OVINE WASTE</th>
<th>Weight In</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inputs:</strong></td>
<td></td>
</tr>
<tr>
<td>Waste Material</td>
<td>14.50kg</td>
</tr>
<tr>
<td>Proactinase</td>
<td>0.35kg</td>
</tr>
<tr>
<td>Added Water</td>
<td>10.50kg</td>
</tr>
<tr>
<td><strong>Total inputs</strong></td>
<td><strong>25.35kg</strong></td>
</tr>
<tr>
<td><strong>Outputs:</strong></td>
<td></td>
</tr>
<tr>
<td>Liquid</td>
<td>14.10kg</td>
</tr>
<tr>
<td>Bones</td>
<td>3.90kg</td>
</tr>
<tr>
<td><strong>Total outputs</strong></td>
<td><strong>18.00kg</strong></td>
</tr>
</tbody>
</table>
In summary, the 14.5kg of proteinaceous waste material that entered the hydrolysis process yielded 3.9kg of bone (26.3%) and 10.6kg of non-bone liquid (73.1%). The 10.6kg of non-bone liquid contained 1.2kg of fat (8.3% of the total input). After removal of the fat the resultant liquid was found to have a protein content of 16%.

5 **EXAMPLE 2**

Mechanically de-boned chicken meat waste (100lb) was treated with 2.5% w/w dry powdered PROACTINASE (2.5lb). The mixture was held between 30°C and 35°C for eight hours. At completion of the exposure period 51bs of boiling water is added and the temperature raised quickly to 80°C. The bones are collected and the fat layer is then siphoned off from the remaining water.

<table>
<thead>
<tr>
<th>Minus Total solid input</th>
<th>14.85kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>= Residual Water (17.5%)</td>
<td>3.15kg</td>
</tr>
<tr>
<td>Added Water lost</td>
<td>7.35kg</td>
</tr>
<tr>
<td>Bone as % of waste in</td>
<td>26.3%</td>
</tr>
<tr>
<td>Waste in less bone</td>
<td>10.6kg</td>
</tr>
<tr>
<td>% of waste material in</td>
<td>73.1%</td>
</tr>
</tbody>
</table>

2. **CHICKEN WASTE**

<table>
<thead>
<tr>
<th>Inputs:</th>
<th>Weight In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanically de-boned chicken meat</td>
<td>100lb</td>
</tr>
<tr>
<td>Proactinase</td>
<td>2.5lb</td>
</tr>
<tr>
<td><strong>Total inputs</strong></td>
<td><strong>102.5lb</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outputs:</th>
<th>Weight In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid</td>
<td>42lb</td>
</tr>
<tr>
<td>Ash (bone)</td>
<td>1.2lb</td>
</tr>
</tbody>
</table>
In summary, from 100lb of proteinaceous waste material, the above process yielded 16% protein, 12% fat, 1-2% ash, and 70% water.

**EXAMPLE 3**

Processing chicken skin to turn it into a liquid is a more direct process. The skin should be kept as clean as possible during the preparation and recovery and coarsely ground or chopped to increase the surface area exposure to the enzymes.

Chopped chicken skin (50kg) was added to the PROACTINASE (1kg). The mixture, which does not require any additional water, was held between 30°C and 35°C for eight hours. Slow stirring was maintained during this period. At the completion of enzyme exposure period the temperature was brought quickly to 80°C without stirring. The temperature is held for three to five minutes. This ensures that the fat will come to the surface. The fat layer can then be siphoned off if desired or left in situ.

### 3. CHICKEN SKIN

<table>
<thead>
<tr>
<th>Inputs:</th>
<th>Weight In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste material</td>
<td>50kg</td>
</tr>
<tr>
<td>Proactinase</td>
<td>1kg</td>
</tr>
<tr>
<td><strong>Total inputs</strong></td>
<td><strong>51kg</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outputs:</th>
<th>Weight In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid</td>
<td>45kg</td>
</tr>
<tr>
<td>Bones</td>
<td>0kg</td>
</tr>
<tr>
<td><strong>Total outputs</strong></td>
<td><strong>45kg</strong></td>
</tr>
</tbody>
</table>
EXAMPLE 4

50 kg of whole New Zealand green lipped mussels in their shells were hammer milled to a course slurry and then added to 1kg of PROACTINASE. The mixture was held between 30°C and 35°C for eight hours. At the completion of enzyme exposure the temperature was brought quickly to 80°C. The shell cleanly separated from the hydrolysate.

<table>
<thead>
<tr>
<th>Inputs:</th>
<th>Weight In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mussel slurry</td>
<td>50kg</td>
</tr>
<tr>
<td>Proactinase</td>
<td>1kg</td>
</tr>
<tr>
<td>Total inputs</td>
<td>51kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outputs:</th>
<th>Weight In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shell</td>
<td>15kg</td>
</tr>
<tr>
<td>Hydrolysate</td>
<td>24.5kg</td>
</tr>
<tr>
<td>Total outputs</td>
<td>39.5kg</td>
</tr>
</tbody>
</table>

It is envisioned that omega 3 lipids could then be extracted from the hydrolysed mussel meat.

It is envisaged that protein extracts made from plant derived protein sources such as soy, and also other animal derived protein sources such as milk and whey could be produced by the methods described herein.

Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof.
ADVANTAGES

The resultant hydrolysate of the method of the above examples of the present invention provides a pasteurized liquid meat having reduced pathogen loading due to destruction of pathogens by both heat and hydrolysis of the pathogens constituent protein.

The hydrolysate has the advantage of having an apparent absence of bitter peptides (not detected by taste panels). This is because if the enzyme complex is used in accordance with the appropriate methodology, when it is applied to the protein source it results in a hydrolysate devoid of the peptides that impart the classic bitter aftertaste associated with most commercial protease reacted hydrolysates.

The hydrolysate also has a high degree of digestibility (30% water soluble protein in the hydrolysate as opposed to 14% from mechanically liquefied meat from the same source).

In addition to the above, the method of the present invention provides an effective way to separate components from the protein source. It provides for the separation of fat, peptides and amino acids as well as the extraction of meat fiber/solids with significantly reduced water soluble proteins and fats.

The hydrolysate is also suitable for moisture adaptation by spray drying, freeze-drying or other technology.

The method of the present invention also utilizes the nutrients available from hydrolysis of not only the flesh/meat component but also the bone marrow, connective tissue and cartilaginous material, thus having an improved nutritional composition than standard meat hydrolysates.

The method of the present invention enables the recovery of high value components from a low value meat /protein source which might otherwise be discarded.

The product of the present invention provides a protein source which, in effect is hydrolyzed prior to ingestion (as opposed to being hydrolyzed post ingestion). This should result in a product in which digestibility is enhanced, nutrient uptake is accelerated and digestive discomfort would be minimized if not eliminated.
VARIATIONS

It is to be understood that the scope of the invention is not limited to the described embodiments and therefore that numerous variations and modifications may be made to these embodiments without departing from the scope of the invention as set out in the specification. Where in the foregoing description reference has been made to integers or components having no equivalents then such equivalents are herein incorporated as if individually set forth.

It is acknowledged that the term 'comprise' may, under varying jurisdictions, be attributed with either an exclusive or an inclusive meaning. For the purpose of this specification, and unless otherwise noted, the term 'comprise' shall have an inclusive meaning, that is, it will be taken to mean an inclusion of not only the listed components it directly references, but also other non-specified components or elements. This rationale will also be used when the term 'comprised' or 'comprising' is used in relation to one or more steps in a method or process.
CLAIMS

1. A method of preparing a protein rich liquid extract from a protein source, said method comprising the following steps:

   (a) processing the protein source into an aqueous liquid mixture or slurry with or without the addition of water;

   (b) hydrolyzing the protein source using an enzyme complex extracted from kiwifruit or an enzyme complex including enzymes extracted from kiwifruit, at a temperature of up to 40°C for at least six hours, and then rapidly heating the resulting hydrolysate to a temperature of at least 60°C to deactivate the enzymes.

2. The method as claimed in claim 1, wherein the protein source is hydrolyzed at a temperature of between 30-35°C for about eight hours.

3. The method as claimed in claim 1 or 2, wherein the resulting hydrolysate is rapidly heated to a temperature of about 80°C to both deactivate the enzymes and pasteurize the hydrolysate.

4. A method of extracting protein from a proteinaceous waste material, said method comprising the following steps:

   (a) processing the proteinaceous waste material in order to increase the surface area of the material;

   (b) forming an aqueous liquid mixture or an aqueous slurry containing the processed proteinaceous waste material;

   (c) hydrolyzing the proteinaceous waste material using an enzyme complex extracted from kiwifruit or an enzyme complex including enzymes extracted from kiwifruit, at a temperature of up to 40°C for at least six hours;

   (d) processing the resulting hydrolysate to separate a protein rich liquid broth from the residue;
(e) rapidly heating the resulting hydrolysate to a temperature of at least 60°C to deactivate the enzymes.

5. The method as claimed in claim 4, wherein the proteinaceous waste material is hydrolyzed at a temperature between 30-35°C for about eight hours.

6. The method as claimed in claim 4 or 5, wherein the hydrolysate is rapidly heated to a temperature of about 80°C to both deactivate the enzymes and pasteurize the hydrolysate.

7. A palatable protein rich extract made in accordance with the method of any one of claims 1-6.

8. A palatable pasteurized hydrolyzed protein extract comprising at least 16% by weight of protein and deactivated or substantially deactivated kiwifruit enzymes.

9. The protein extract as claimed in claim 8, wherein the extract is in liquid form and contains at least 25% of water-soluble protein.

10. The protein extract as claimed in claim 8, wherein the extract is a freeze dried powder.
INTERNATIONAL SEARCH REPORT

International application No. PCT/7NZ2007/000015

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.
A23J 3/34 (2006.01)

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)

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

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

WPIDS, MEDLINE, FSTA, HCA, BIOSIS: & keywords: kiwifruit, protein, meat, enzyme, actinidin, hydrolys, and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>X</td>
<td>US 2005/0220938 A1 (ABE et al) 6 October 2005 See paragraphs [0015]-[0020], [0042], claims</td>
<td>1-3, 7-10 4-6</td>
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<td>Y</td>
<td>US 6479083 B1 (HAN et al) 12 November 2002 See column 3 lines 46-55, column 5 line 38, claims</td>
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Date of actual completion of the international search 13 April 2007

Date of mailing of the international search report 17 APR2007

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