

**METHOD FOR THE PREPARATION OF A MEAT SUBSTITUTE PRODUCT,
MEAT SUBSTITUTE PRODUCT OBTAINED WITH THE METHOD AND
READY TO CONSUME MEAT SUBSTITUTE PRODUCT**

The invention relates to a method for the preparation of a meat substitute product which comprises protein, wherein:

- 1) a protein material, a hydrocolloid which precipitates with metal cations and water are added to one another,
- 2) the composition from step 1) is formed into a homogenous mixture,
- 3) the mixture from 2) is mixed with a solution of a metal cation with a valency of at least 2, in order to form a fibrous product,
- 4) the fibrous product is isolated.

The fibrous product, possibly after further processing, forms a meat substitute product. A method of this type is known from NL-C-1008364, in the name of A. C.Kweldam.

The said patent describes a method of the type described in the introduction for processing non-animal proteins, such as proteins derived from soya, rice, maize and the like, to form meat substitutes. It is assumed that the homogenous mixture as described above contains complexes of protein and hydrocolloid which precipitates with metal cations, which are precipitated in the form of fibres on account of the addition of a solution of a metal cation with a valency of at least 2.

The applicant has attempted to use the method described to convert milk protein or materials derived from milk protein into a fibrous meat substitute product. In the method described, a homogenous mixture of protein, hydrocolloid which precipitates with metal cations and water is generally made by stirring at a temperature in the range from 20 to 90°C, more particularly from 30 to 90°C, and generally at a temperature of approximately 50°C. At a slightly elevated temperature, the protein will melt and form a homogenous mixture with the hydrocolloid which precipitates with metal cations and water.

It should be noted that the term homogenous mixture in the present application is used to cover both emulsions, dispersions and solutions.

With some proteins, for example cheese milk protein, the use of an elevated temperature will lead to melting, with the result that the homogenous mixture is a distribution of two liquid materials which are not soluble in one another, i. e. an emulsion. With other milk proteins, there will be no melting, but rather dispersion or dissolution will take place.

In addition to the presence of organoleptic benefits, milk protein material is distinguished from vegetable protein through the absence of trypsin inhibitors (which are present in vegetable protein material, such as soya and maize) and a superior amino acid pattern. The PDCAAS (protein digestability corrected amino acid score) of protein from cow's milk is 1.21, while that of soya is 0.91 and that of wheat is 0.42. Normal beef has a score of 0.92 ; therefore, the milk protein material actually scores better than meat.

When the method described in the preamble is applied to milk protein or a material derived therefrom, the desired homogenous mixtures is not obtained or is difficult to obtain.

It is an object of the present invention to provide a solution to this drawback. One solution to this drawback is to provide a method in which the protein material comprises a milk protein material, and the mixture of protein material, hydrocolloid which precipitates with metal cations and water is formed in the presence of an amount of a phosphate material. This is because one problem is that the free calcium ions which are naturally present in milk protein or materials derived therefrom or are added during processing may form a precipitate with the added hydrocolloid, which precipitates with metal cations, prematurely, which has a highly adverse effect on the further sequence of the method and may lead to a serious lack of uniformity in the finished product, if a usable end product can be obtained at all. In the method according to the invention described above, the presence of a suitable amount of phosphate material means that a complex is formed with the free Ca^{2+} ion content, with the result that there is no premature precipitation of the hydrocolloid used. A homogenous mixture is then obtained without problems.

When the present method is carried out with a view to converting a milk protein material into a fibrous meat substitute product, without the presence of phosphate material, the homogenous mixture which is to be formed will not be formed or will only be formed with difficulty, since the calcium ions which are naturally present or are added during processing lead to premature precipitation of the hydrocolloid or polysaccharide used, resulting in a product with less cohesion which is more difficult to cut.

Surprisingly, it has now been found that the present method, for certain milk protein materials, can even be carried out without the presence of phosphate material, and a homogenous mixture can be formed and a good fibrous product obtained without problems.

In a particular embodiment, therefore, in the method described above the protein material comprises a milk protein-material selected from powdered milk, whey protein and caseinate (in particular food-grade alkali metal or ammonium caseinate), and the method is preferably carried out in the absence of a phosphate material.

Accordingly, the present invention relates to a method for the preparation of a meat substitute product which comprises protein, wherein:

- 1) a protein material, a hydrocolloid which precipitates with metal cations and water are added to one another,
- 2) the composition from step 1) is formed into a homogenous mixture,
- 3) the mixture from 2) is mixed under stirring with a solution of a metal cation with a valency of at least 2, in order to form a fibrous product,
- 4) fibrous product is isolated,
characterized in that
- 5) the protein material comprises a milk protein material selected from the group consisting of powdered milk, whey protein and caseinate.

The latter-mentioned caseinate is expediently alkali metal or ammonium caseinate of food-grade quality. Obviously, it is also possible to use mixtures of two or more protein materials to prepare a meat substitute product.

The hydrocolloid which precipitates with metal cations, and is a polysaccharide, may be selected from pectin with a low methoxyl group content, Gellan gum and alginate; sodium alginate is preferred. There are numerous commercially available alginates; in the context of the invention, use is made of, for example, Ca-reactive alginates such as of the type obtained from "Brown algae".

If a solution of a metal cation with a valency of at least 2 is added to the homogenous mixture in which there are substantially no longer any free calcium ions and which contains complexes of milk protein material and a hydrocolloid which precipitates with metal cations of this type, a fibrous product will be obtained in a controlled way and, optionally after washing and removal of excess moisture, has a meat substitute structure.

In connection with the invention, reference is also made to US-A 4,559, 233. The said patent describes the formation of a meat substitute starting from whey protein. Whey protein/xanthan gum complexes, which are precipitated isoelectrically, are formed. This publication does not describe the use of hydrocolloid which precipitates with metal cations, the formation of a complex between free calcium ions which are present and the precipitation step using a solution of metal cations with a valency of at least 2.

In the present method, a solution of a metal cation with a valency ≥ 2 is added to the homogenous mixture, after it has been formed, in order to form milkprotein/hydrocolloid fibres, such as milk protein/alginate fibres.

The metal cation solution generally contains soluble calcium or magnesium salts or mixtures thereof. Suitable calcium salts are calcium chloride, calcium acetate and calcium gluconate.

The hydrocolloid which is sensitive to metal cations may be selected from the group described above; however, it is expedient for the hydrocolloid to be sodium alginate.

Examples of suitable alginates are DMB sodium alginate (Manugel) from Kelco and FD125 from Danisco Cultor. It is also possible to use other alginates which form a precipitate with metal cations.

During the formation of the meat substitute products according to the present invention, the pH of the homogenous mixture of protein, hydrocolloid which precipitates with metal cations and water is advantageously set to a value in the range from 4 to 7.

Where the pH lies within this range will be selected according to the structure type of the meat substitute material which it is desired to prepare.

For example, to prepare a meat-type structure starting from a milk protein material, the pH will be set to a value between 5.0 and 7.0.

In the context of the present invention, the term meat-type structure is understood as meaning a structure which corresponds to the structure of beef, pork or chicken.

If a fish-type structure is desired, starting from milk protein material, the pH is set to a value between 4.5 and 6.0.

Specific details of the meat-or fish-type structure can be produced by varying the quantity of hydrocolloid, such as sodium alginate, used and also the type of alginate and the amount of calcium chloride.

In general, it is also possible to add finishing materials; they are preferably added to the homogenous mixture of protein, hydrocolloid which precipitates with metal cations and water, which is formed at elevated temperature. The finishing material may be selected from a flavouring, a colouring, vegetable or animal fat, vegetable or animal proteins and/or mixtures of two or more of these materials. Obviously, it is also possible for finishing materials to be added and mixed in after the fibrous product has been formed.

In a number of specific embodiments in which different starting materials are used, the method as described takes the following form.

The formation of a fibrous product starting from sodium caseinate is characterized in that

- a 10-15% strength by weight solution of sodium caseinate in water is made (total weight C) in the presence of 0.2-0.4% by weight of sodium polyphosphate, based on C

- butter is added in an amount of 15-20% by weight, based on C,
- 3-5% by weight, based on C, of sodium alginate, as well as water at approximately 50°C in an amount by weight of 80-95% by weight, based on C are added with stirring,
- the homogenous mixture formed is mixed with stirring with 3-5% strength by weight calcium chloride solution in an amount of 80-95% by weight, based on C, to form a fibrous product, and
- the fibrous product formed is isolated and finished.

In yet another embodiment, the method according to the invention is characterized in that, to form a fibrous product starting from whey protein

- a 15-20% strength by weight solution of whey protein in water is made (total weight D) in the presence of 0.2-0.4% by weight of sodium polyphosphate, based on D,
- butter is added in an amount of 12-18% by weight, based on D,
- 3-7% by weight, based on D, of sodium alginate, as well as water at approximately 50°C in an amount of 80-85% by weight, based on D, are added with stirring, and
- the homogenous mixture formed is mixed with stirring with 3-5% strength by weight calcium chloride solution in an amount of 80-85% by weight, based on D to form a fibrous product,
- the fibrous product formed is isolated and finished.

According to the invention, to form a fibrous product starting from skimmed milk powder,

- a 25-35% strength by weight solution of skimmed milk powder in water (total weight E) is made in the presence of 0.5-1.0% by weight, based on E, of sodium polyphosphate,
- butter is added in an amount of 11-15% by weight, based on E
- 4-6% by weight, based on E, of sodium alginate, as well as water at approximately 50°C in an amount by weight of 65-75%, based on E, are added with stirring,
- the homogenous mixture formed is mixed with stirring with a 3-5% strength by weight CaCl_2 solution in an amount by weight of 65-75%, based on E, to form a fibrous product,

- after which the fibrous product formed is isolated and finished.

In the specific embodiments given above, the quantities by weight and percentages are given as accurate numbers; however, it should be understood that deviations from these accurate values are permitted and that the values are intended to give an indication of the order of magnitude (by weight) of the materials with respect to one another.

The fibrous product which is obtained with the aid of the method according to the invention is expediently packaged after it has been shaped, isolated and finished as appropriate. A suitable packaging method is a vacuum-packaging method in which the product is placed into plastic packaging, for example made from polyethylene, under a vacuum and the packaging is sealed. Other packaging methods which can be used in this field may also be employed.

Before or after it has been packaged, the fibrous product may be subjected to a preserving treatment, such as pasteurization or sterilization. Pasteurization will in many cases be sufficient (for example at 62.8-65.5°C for 30 min). In addition to pasteurization, it is also possible to use other preservation techniques, such as the addition of preservatives or stabilizers (Na ascorbate, benzoic acid), pH adjustment, etc.

The invention also relates to a meat substitute product which is obtained with the aid of the method described above.

Finally, the invention relates to a ready to consume meat substitute product which is obtained by culinary processing of the meat substitute product obtained according to the invention.

The product which is obtained with the aid of the method can be cooked in the oven, grilled, poached, smoked and the like without problems; it can also be converted into snacks, sausages or the like. With regard to snacks, it should be noted that they may be savoury, for which purpose the flavourings required can be used. However, in view of the dairy nature of the starting materials, the fibrous product which is obtained using the method according to the invention is also eminently suitable for forming a sweet dessert-type product.

The fibrous product is a meat or fish substitute product or a savoury or sweet dessert-like snack, in which the fibres formed adhere to one another naturally. The appearance of the products obtained is of a culinary nature, the colour is white and the fibres have an appearance similar to that of meat fibres. After processing by baking, braising, smoking, microwave heating or other treatment, it has a true meat or fish appearance and sensation in the mouth or a fibrous dessert sensation if a material which has been/can be made sweet is used.

The homogenous mixture which is formed in the method generally contains 0.1 to 50% by weight of protein material, such as milk protein or products derived therefrom, preferably 1 to 40% by weight, based on dry matter.

The hydrocolloid which precipitates with metal cations, such as for example sodium alginate, is present in an amount of from 0.1 to 10% by weight, in particular 1 to 5% by weight; all percentages relating to the total weight of the homogenous mixture which is prepared in order to form the fibrous meat substitute product.

The solution used to form fibres, which is a solution of a metal cation with a valency of at least 2 as described above, generally has a concentration of from 0.01 to 15% by weight, preferably 0.05 to 10% by weight.

The strength of the fibre, which is related to the sensation in the mouth when a bite is taken, is affected by the salt concentration. For example, a higher salt concentration results in a stronger fibre.

After the formation of the homogenous mixture, which takes place at a temperature of 20 to 90°C, in particular 30 to 90°C and more particularly 50°C, the homogenous mixture is held at this temperature and the solution of a metal cation with a valency of at least 2, for example a calcium chloride solution, is added at approximately the same temperature.

The salt solution is added with stirring, generally gradually.

The salt solution for the precipitation of the fibres will generally contain 0.01 to 15% by weight of salt, for example CaCl_2 or Ca acetate. The CaCl_2 concentration is advantageously selected to lie in the range between 0.5 and 8% by weight; it is preferable for the concentration to be no higher than 4% by weight.

The total amount of salt solution will typically be added over the course of 0.5 to 5 minutes, in particular 1 minute for a batch size of 1 kg.

The addition is expediently effected by spraying a salt solution onto the homogenous mixture which is at a relatively high temperature; the salt solution will preferably be at a temperature which corresponds to the temperature of the homogenous mixture.

The homogenous mixture may contain fat, such as milk fat originating from the milk from which the protein was separated.

In this case, the fat content may be between 1 and 6% by weight, more particularly between 2.5 and 5% by weight, based on the total weight of the homogenous mixture.

Obviously, if a protein product in which there is no fat (anymore) is used, fat can be added to the homogenous mixture.

In this case, it is possible to choose from vegetable and animal fats; it will be expedient to use a saturated or unsaturated vegetable fat. Mixtures of fats can also be used.

Furthermore, colourings and flavourings can be added to the homogenous mixture.

After the fibrous product has been formed, it is thoroughly washed in order to remove residues of metal cations, and the excess moisture is also removed, for example by pressing. The finished product may, for example, be vacuum-packed, after which pasteurization takes place in order to further consolidate the product and also to obtain a good shelf life. Vacuum-packing has the further advantage that the structure of the product is improved further through compression of the fibres.

After washing and pressing, the fibrous product obtained has a residual moisture content of from 1 to 80% by weight, in particular 40 to 60% by weight. However, levels which are higher and lower than these particular levels are possible, depending on what is desired.

The invention will now be explained with reference to a number of non-limiting examples.

In the experiments, sodium alginate (Kelco DMB) was used as hydrocolloid which precipitates with metal cations; the precipitation solution used contained 4% by weight of CaCl_2 in water.

The phosphate material used was sodium polyphosphate $(\text{NaPO}_3)_n$ where $n=25$. All the percentages are based on weight, unless otherwise indicated.

Example I: Sodium caseinate as starting material

The method started from 85 grams of sodium caseinate (DMV International, sodium caseinate) with a calcium content of 76 mg/100 grams, a protein content of 90% and moisture content of 5%. The sodium caseinate was dissolved in 600 ml of water at 45°C. 2 grams of sodium polyphosphate were added, followed by 110 grams of butter. After mixing to form a homogenous mixture, 30 grams of sodium alginate and 600 ml of warm water were added with intensive mixing. The mixture obtained was treated with 600 ml of a 4% strength by weight calcium chloride solution until a long, strong fibre is obtained. After washing, pressing, flavouring and pasteurizing, this meat substitute product with a chicken structure and chicken flavour had a water content of 68-78%.

The advantage of using sodium caseinate is that there is no need for there to be whey-processing facilities onsite.

Example II: Whey-protein concentrate as starting material

125 grams of whey-protein concentrate (Arla, Lacprodan 80, calcium content: 374 mg/100 grams, moisture content 5.5%) with a protein content of 82% is dissolved in 600 grams of water at 45°C and mixed with 2 grams of sodium polyphosphate and 110 grams

of butter. After pressing/mixing, 40 grams of sodium alginate and 600 ml of water at 45°C are added to the mixture with intensive stirring. The mixture obtained is combined with 600 ml of a 4% strength by weight calcium chloride solution.

After washing and pressing, the meat product obtained is flavoured. After the product has been vacuum-packed and pasteurized, the result is a meat substitute with good cooking properties and a chicken-meat structure. The end product has a moisture content of 70-75%.

In a separate test, the abovementioned whey-protein concentrate was dissolved in water and then subjected to a denaturation treatment by heating for 10 minutes at 95°C. This was followed by cooling to 45°C and then the test was continued as described above. The result of the test was similar to the result of the original test described above; in this way, it was possible to limit the protein losses via the washing water.

Example III: Powdered milk as starting material

The milk protein used is skimmed milk powder (calcium content: 1160 mg/100 grams, moisture content: 4%, protein content: 30%).

An amount of 250 grams was dissolved in 600 ml of water to which 4 grams of sodium polyphosphate and 110 grams of butter were added. Then, 40 grams of sodium alginate and 600 ml of water were added to this mass. After treatment of the emulsion obtained with 600 ml of a 4% calcium chloride solution, a pleasant white fibre is obtained. Washing, pressing, flavouring, packaging and pasteurization results in a pleasant product with properties similar to those of meat. Without flavouring, the product has a neutral flavour similar to that of milk.

The above formulation which is based on powdered milk uses 4 grams of sodium polyphosphate. However, if the amount of calcium which is present is taken into consideration, it has been found that this amount can be increased to 8 grams, since, as with the other raw materials, there is an excess of phosphate material in the mixture.

Table 1 shows an overview of the tests carried out as well as the most important parameters.

Table 1: Summary of tests carried out

Raw material	Algi- nate (g)	Phos- phate (g)	Phos- phate (mmol)	Calcium in the raw material (mmol)	Net weight (g)	Weight of end pro- duct (g)	Product Composition								Cal- cium IN (g)	Cal- cium OUT (g)	Cal- cium Δ (g)
							pH	Cal- cium (mg/ 100g)	Cl ⁻ (%)	Fat (%)	Fat dm (%)	Mois- ture (%)	Ash (%)	Ash on dry			
Maasdam curd (45+)	40	12	117.6	79.8	1103	679	5.45	1010	0.2	11.2	38.6	71.0	3.2	11.0	3.2	7.0	3.8
50+ cheese, Maasdam type	40	12	117.6	117.2	1274	751	5.52	1020	0.3	22.0	50.8	56.7	3.5	8.1	4.7	7.7	3.0
Sodium casei- nate	30	2	19.6	1.50	997	613	6.13	634	0.2	13.1	44.6	70.6	2.0	6.8	0.06	3.9	3.8
WPC	40	2	19.6	11.7	1027	645	5.83	568	0.2	13.2	52.2	74.7	1.9	7.5	0.47	3.7	3.2
Powdered milk	40	4	39.2	72.3	983	561	5.58	1060	0.2	13.5	38.4	64.8	3.3	9.4	2.9	5.9	3.1

Calcium In and Out is understood as meaning the quantity of calcium in the raw material (In) and in the end product (Out).

The 600 ml of CaCl_2 added contained approximately 8.7 grams of Ca^{2+} . The final column of the table shows how many grams of calcium of these were taken up by the fibre (out - in),

In the examples discussed above, in the case of powdered milk, whey protein and sodium caseinate, it is possible to dispense with the use of a phosphate material yet still obtain an acceptable product, although the products which are prepared with phosphate material achieve slightly better scores in quality assessments.

In the case of powdered milk, it is generally also possible, by high pasteurization of the powdered milk solution, to obtain a good product with the advantage of lower protein losses in the washing water.

CLAIMS

1. Method for the preparation of a meat substitute product which comprises protein, wherein:
 - 1) a protein material, a hydrocolloid which precipitates with metal cations and water are added to one another,
 - 2) the composition from step 1) is formed into a homogenous mixture,
 - 3) the mixture from 2) is mixed under stirring with a solution of a metal cation with a valency of at least 2, in order to form a fibrous product,
 - 4) fibrous product is isolated,characterized in that
 - 5) the protein material comprises a milk protein material selected from the group consisting of powdered milk, whey protein, alkali metal caseinate and ammonium caseinate,
 - 6) the method is carried out in the absence of a phosphate material, and
 - 7) the solution of a metal cation with a valency of at least 2 is gradually added to the homogeneous mixture under stirring.
2. Method according to claim 1, characterized in that the milk protein material is powdered milk.
3. Method according to claim 1, characterized in that the milk protein material is whey protein.
4. Method according to claim 1, characterized in that the milk protein material is caseinate.
5. Method according to one or more of the preceding claims, characterized in that the hydrocolloid which precipitates with metal cations is present in an amount of 0.1-10% by weight, based on the total of all the constituents of the homogeneous mixture.

6. Method according to one or more of the preceding claims, characterized in that the homogeneous mixture contains 1 to 40% by weight of protein material.
7. Method according to one or more of the preceding claims, characterized in that the solution of a metal cation contains 0.05 to 10% by weight of a metal cation with a valency of at least 2.
8. Method according to claim 7, characterized in that the solution of a metal cation contains CaCl_2 in a concentration in the range between 0.5 and 8% by weight.
9. Method according to any one of the preceding claims, characterized in that the solution of a metal cation is sprayed onto the homogeneous mixture.
10. Method according to one or more of the preceding claims, wherein the homogeneous mixture has a fat content between 1 and 6% by weight.
11. Method according to one or more of the preceding claims, characterized in that the hydrocolloid which precipitates with metal cations is a polysaccharide selected from pectin with a low methoxyl group content, gellan gum and alginate.
12. Method according to one or more of the preceding claims, characterized in that the hydrocolloid which precipitates with metal cations is sodium alginate.
13. Method according to one or more of the preceding claims, characterized in that the pH of the homogeneous mixture of protein, hydrocolloid which precipitates with metal cations and water is set to a value in the range from 4-7.

14. Method according to one or more of the preceding claims, characterized in that the formation of the homogeneous mixture takes place at a temperature of 30 to 90°C.
15. Method according to one or more of the preceding claims, characterized in that the fibrous product obtained has a residual moisture content of from 40 to 80% by weight.
16. Method according to any one of the preceding claims, wherein the fibrous product is thoroughly washed in order to remove residues of metal cations, and the excess moisture is removed by pressing.
17. Method according to one or more of the preceding claims, characterized in that the fibrous product, after it has been formed and isolated, is pasteurised in order to be finished.
18. Method according to one or more of the preceding claims, characterized in that the fibrous product is packaged.