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(54) Titre : PRODUIT ALIMENTAIRE ET PROCEDE DE RETENTION DE L'HUMIDITE DANS DES ALIMENTS CUITS
(54) Title: FOOD PRODUCT AND PROCESS FOR RETAINING MOISTURE IN COOKED FOOD

(57) Abrégé/Abstract:
A meat or fish composition which retains moisture during cooking is provided. A dry protein mixture or an aqueous acidic protein solution derived from animal muscle tissue is added to the meat or fish prior to cooking. The dry protein mixture and aqueous acidic protein solution comprise myofibrillar proteins and sarcoplasmic proteins substantially free and sarcomeres.

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FOOD PRODUCT AND PROCESS FOR RETAINING MOISTURE IN COOKED FOOD

BACKGROUND OF THE INVENTION

This invention relates to a process for retaining liquid in cooked food. More particularly, this invention relates to such a process which utilizes animal muscle protein to retain moisture in food and to the food product utilized in the process.

Prior to the present invention, meat or fish cooked at an elevated temperature loses its moisture to the surrounding atmosphere. In so doing, the cooked meat or fish undesirably loses its natural or added flavors so that it becomes less tasteful. Fluid loss during cooking of meat or fish can range up to 30% to 40% by weight based upon the weight of the meat or fish prior to cooking. A prior solution for retaining moisture in the meat or fish without additives took the form of wrapping the meat or fish in a solid moisture barrier such as aluminum foil. This solution is undesirable since the surface of the meat or fish remains soft rather than having a desirable crust.

Prior attempts to retain moisture in cooked meat or fish with additives have included the use of sodium tripolyphosphate, a coating of fat free flour, based, batter containing an egg white substitute (U.K. Patent Application 2,097,646), water-in-oil emulsion (U.S. Patent 3,406,081), protein or protein isolate and a fat (U.S. Patents 4,031,261 and 4,935,251), milk solids (U.S. Patent 2,282,801) and lecithin (U.S. Patents 2,470,281 and 3,451,826).

Accordingly, it would be desirable to provide a form of fish or meat which can be cooked while retaining its moisture and natural or added flavors without the use of a solid moisture barrier so that the surface of the cooked meat or fish could become crusty during cooking. In addition, it would be desirable to provide such a form of fish or meat which is not less nutritional than the original fish or meat or which is even more nutritional than the original fish or meat to be cooked. In addition, it would be desirable to provide such a form of fish or meat wherein the majority of

moisture or added flavors or spices in the uncooked fish or meat is retained during cooking.

SUMMARY OF THE INVENTION

According to the invention, there is provided a process for retaining moisture in uncooked animal muscle tissue during cooking of the animal muscle tissue which comprises: (a) adding to said uncooked animal muscle tissue a protein mixture selected from the group consisting of an aqueous acidic protein solution, having a pH of about 3.5 or less, of myofibrillar proteins and sarcoplasmic proteins derived from animal muscle tissue, a dry protein mixture of myofibrillar proteins and sarcoplasmic proteins derived from animal muscle tissue obtained by drying said aqueous acidic protein solution and mixtures thereof by an adding method selected from the group consisting of applying said protein mixture to at least one surface of said uncooked animal muscle tissue, mixing said protein mixture with said uncooked animal muscle tissue, injecting said protein mixture into said uncooked animal muscle tissue and a combination of at least two of said adding methods and (b) cooking said uncooked animal muscle tissue and protein mixture from step (a).

In accordance with this invention, animal muscle tissue to be cooked is coated or admixed or injected with a dry protein mixture or an aqueous acidic solution of protein mixture derived from animal muscle tissue comprising a mixture of myofibrillar proteins and sarcoplasmic proteins obtained by one of the processes disclosed in U.S. Patents 6,005,073; 6,288,216; 6,136,959 and/or 6,451,975. By the phrase, "dry protein mixture" as used herein is meant a dehydrated, protein mixture of

myofibrillar proteins and sarcoplasmic proteins derived from animal muscle tissue and which is obtained from an aqueous acid solution (less than or equal to pH 3.5) or an aqueous alkaline solution (greater than or equal to pH 10.5) and having a final pH of about 4.5 or less or between pH 6.5 and 8.5. The dry protein mixture also contains less than about 15 weight percent water, preferably between about 3 and 10 weight percent water and most preferably between about 3 and 7 weight percent water based on the total weight of the protein mixture and water. While a dry protein mixture containing 0% water is useful in the present invention, dry powders, in general, containing 0 to 3 weight percent water can be dangerous to process on a commercial scale since they have an explosive nature. Solid mixtures of myofibrillar proteins and sarcoplasmic proteins containing greater than about 15 weight percent water based on total weight of the protein mixture and water are undesirable in this invention since they are microbially unsound. In addition, it has been found that a mixture of myofibrillar proteins and sarcoplasmic proteins derived from animal muscle tissues having a pH grater than 4.5 to about 6.5 are not useful in the present invention since they do not retain significant moisture in cooked meat or fish. Furthermore, such proteins derived from solutions having a pH of 8.5 or above are not useful since they can be physiologically harmful.

By the phrase "aqueous acidic protein solution" as used herein is meant an aqueous solution of myofibrillar proteins and sarcoplasmic proteins derived from animal muscle tissue and having a pH of 3.5 or less and preferably between about 2.5 and about 3.5 but not so low as to adversely affect the protein functionality. The aqueous acidic protein solution can be obtained directly from animal muscle tissue

acidic by the processes described below or by dissolving the dry protein mixture in water or in a pharmaceutically or food grade acceptable aqueous acidic solution.

In accordance with this invention the dry protein mixture of myofibrillar proteins and sarcoplasmic protein, in powder form, dehydratred form or small particulate form is applied to the surface of animal muscle tissue to be cooked or is mixed with the animal muscle tissue (ground, minced as thinly sliced) to be cooked such as hamburger or sausage. Alternatively, the aqueous acidic protein solution can be injected into the muscle tissue of fish or meat or it can be applied to the surface of the fish or meat or it can be mixed with the fish or meat. The fish or meat containing the dry protein mixture then can be cooked at elevated temperature in the absence of a solid moisture barrier while retaining a substantial majority of its original moisture. The difference in weight between meat or fish treated in accordance with this invention compared with fish or meat not injected, mixed or coated with the dry protein mixture or aqueous acidic protein solution is between about 4 and about 21 %, more usually, between about 4 and about 10 %.

DESCRIPTION OF SPECIFIC EMBODIMENTS

In accordance with this invention, animal muscle to be cooked is coated, admixed and/or injected with a dry protein mixture or an aqueous acidic protein solution of myofibrillar proteins and sarcoplasmic proteins derived from animal muscle tissue and obtained by the processes disclosed in U.S. Patents 6,005,073, 6,288,216, 6,136,959 and 6,451,975. This dry protein mixture is obtained by one of four processes. In two processes, (acid processes) animal muscle tissue is formed into small tissue particles which are then mixed with sufficient acid to form a solution of the tissue having a pH of 3.5 or less, but not such a low pH as to adversely modify the animal tissue protein. In one of these two processes, the solution is centrifuged to form a lowest membrane lipid layer, an intermediate layer of aqueous acidic protein solution and a top layer of neutral lipids (fats and oils). The intermediate layer of aqueous acidic protein solution then is separated from the membrane lipid layer or from both the membrane lipid layer and the neutral lipid layer. In a second of these two processes, no centrifugation step is effected since the starting animal muscle tissue contains low concentrations of undesired membrane lipids, oils and/or fats. In both processes, the protein mixture is free of myofibrils and sarcomeres. In both processes, the protein in the aqueous acidic protein solution is recovered after

centrifugation (when used) by drying the aqueous acidic solution, such as by evaporation, spray drying or lyophilization to form the dry protein mixture having the low pH it had when it was dissolved in the aqueous acidic protein solution. Alternatively, the aqueous acidic protein solution can be utilized with the uncooked meat or fish without drying. It is preferred to utilize one of these two acid processes to obtain the dry protein mixture or the aqueous acidic protein solution. In another alternative process, the protein in the aqueous acidic protein solution can be precipitated and recovered and mixed with a pharmaceutically acceptable or food grade acid to form an aqueous acidic protein solution of a desired viscosity. This latter alternative process is particularly suitable for forming an aqueous acidic protein solution that can be injected into meat or fish.

In two other processes, (alkaline processes) animal muscle tissue is formed into small tissue particles which are then mixed with sufficient aqueous base solution to form a solution of the tissue wherein at least 75% of the animal muscle protein is solubilized, but not such a high pH as to adversely modify the animal tissue protein. In one process, the solution is centrifuged to form a lowest membrane lipid layer, an intermediate aqueous protein rich layer and a top layer of neutral lipids (fats and oils). The intermediate aqueous protein-rich layer then is separated from the membrane lipid layer or from both the membrane lipid layer and the neutral lipid layer. In a second process, no centrifugation step is effected since the starting animal muscle proteins contain low concentrations of undesired membrane lipids, oils and/or fats. In both processes, the protein mixture is free of myofibrils and sarcomeres. In both processes, the pH of the protein-rich aqueous phase can be lowered to a pH below about 3.5, preferably between about 2.0 and 3.5. In both processes, the protein in the aqueous acidic solution is recovered after centrifugation (when used) by drying the aqueous acidic protein solution, such as by evaporation, spray drying or lyophilization to form a powder product having the low pH it had when it was dissolved in the aqueous acidic solution. Alternatively, the aqueous acidic protein solution can be applied directly to the meat or fish without drying. The protein in aqueous basic solution having a pH above 8.5 and recovered after centrifugation (when used) is not dried, such as by spray drying or lyophilization to form a powder product since these powders can be a source of health problems to a consumer in contrast to the dry composition recovered from the aqueous acidic solution discussed above. In addition, the aqueous basic protein solution is not

useful in the present invention for the same health problem reason. In one aspect of these two other processes, the pH of the basic solution can be lowered to about 5.5 to precipitate the protein. The pH of the precipitated protein then is raised to between 6.5 and 8.5 and a solid product is recovered such as by drying including spray drying, lyophilization or evaporation or which can be comminuted and applied to the fish or meat. In another aspect of this process, the precipitated protein can be mixed with a pharmaceutically acceptable or food grade acid to form an aqueous acidic protein solution of a desired viscosity. The latter process is particularly suitable for forming an aqueous acidic protein solution that can be injected into meat or fish.

The dry protein mixture or the aqueous acidic protein solution then is applied to, admixed with and/or injected into the meat or fish. The dry acidic protein mixture or aqueous acidic protein solution can be applied alone or in admixture with conventional food or nutritive additives such as breading or batter coatings, spice dry rubs, cracker meal, corn meal or the like. It is preferred to utilize the aqueous acidic protein solution, with or without food or nutritional additives, for injection. The dry protein mixture and /or aqueous acidic protein solution can be coated on the surface of the meat or fish with an applicator or can be coated by tumbling the meat or fish in the solution or in a marinade containing the acidic aqueous protein solution or dry acidic protein mixture in a tumbling or vacuum tumbling apparatus.

In summary, the dry protein mixture or the aqueous acidic protein solution utilized in the present invention can be obtained by the following methods:

1. Reduce the pH of comminuted animal muscle tissue to a pH less than about 3.5 to form an acidic protein solution, centrifuge the solution to form a lipid–rich phase and an aqueous phase and recover an aqueous acidic protein solution substantially free of membrane lipids that can be used in this invention.

2. Spray dry the aqueous acidic protein solution obtained by method 1 to form a dry protein mixture substantially free of membrane lipids that can be used in the present invention.

3. Lyophilize the aqueous acidic protein solution obtained by method 1 to form the dry protein mixture substantially free of membrane lipids that can be used in the present invention.

4. Increase the pH of the aqueous acidic protein solution from method 1 to about pH 5.0-5.5 to effect precipitation of the proteins and then readjust the protein

back to a pH of about 4.5 or less using acid in a minimum volume to concentrate the aqueous acidic protein solution to between 1.6-15% protein.

5. Reduce the pH of comminuted animal muscle tissue to form an aqueous acidic protein solution that can be used in the present invention.

6. Spray dry the aqueous acidic protein solution obtained by method 5 to form the dry protein mixture that can be used in the present invention.

7. Lyophilize the aqueous acidic protein solution obtained by method 5 to form the dry protein mixture that can be used in the present invention.

8. Increase the pH of the aqueous acidic protein solution from method 5 to about pH 5.0-5.5 to effect precipitation of the proteins and then readjust the protein back to a pH of about 4.5 or less using acid in a minimum volume to concentrate the aqueous acidic protein solution to between about 1.6-15% protein.

9. Increase the pH of comminuted animal muscle tissue to a pH above about 10.5, centrifuge the solution to form a lipid–rich phase and an aqueous phase and recover an aqueous basic protein solution. In one embodiment, reduce the pH of the aqueous basic solution to a pH of less than about 3.5 to obtain an aqueous acidic protein solution substantially free of membrane lipids that can be used in this invention. In a second embodiment, reduce the pH of the aqueous basic solution to about 5.0 – 5.5 to precipitate the protein, raise the pH of the precipitated protein to 6.5 – 8.5, dry and comminute the protein. In a third embodiment, reduce the pH of the aqueous basic solution to about 5.0-5.5 to precipitate the protein, lower the pH of the precipitated protein to a pH of 4.5 or less to form a concentrated aqueous acidic solution and use the concentrated aqueous acidic solution or dry the solution and use the recovered dry protein.

10. Spray dry the aqueous acidic protein solution obtained by method 9 to form a dry acidic protein mixture substantially free of membrane lipids that can be used in the present invention.

11. Lyophilize the aqueous acidic protein solution obtained by method 9 to form the dry acidic protein mixture substantially free of membrane lipids that can be used in the present invention.

12. Increase the pH of the aqueous, acidic protein solution from method 9 to about pH 5.0-5.5 to effect precipitation of the proteins and then readjust the protein

back to a pH of about 4.5 or less using acid in a minimum volume to concentrate the aqueous acidic solution to between 1.6-15% protein.

13. Increase the pH of comminuted animal muscle tissue to a pH above about 10.5 to form an aqueous basic protein solution. In one embodiment, reduce the pH of the basic solution to below about 3.5 to form an aqueous acidic protein solution that can be used in the present invention. In a second embodiment, reduce the pH of the aqueous basic solution to about 5.0 – 5.5 to precipitate the protein, raise the pH of the precipitated protein to 6.5 – 8.5, dry and comminute the protein. In a third embodiment, reduce the pH of the aqueous basic solution to about 5.0 – 5.5 to precipitate the protein, raise the pH of the precipitated protein to 6.5 – 8.5, dry and comminute the protein. In a third embodiment, reduce the pH of the aqueous basic solution to about 5.0-5.5 to precipitate the protein, lower the pH of the precipitated protein to a pH of 4.5 or less to form a concentrated aqueous acidic solution and use the concentrated aqueous acidic solution or dry the solution and use the recovered dry protein.

14. Spray dry the aqueous acidic solution obtained by method 13 to form a dry acidic protein mixture that can be used in the present invention.

15. Lyophilize the aqueous acidic solution obtained by method 13 to form the dry acidic protein mixture that can be used in the present invention.

The protein products utilized in the present invention comprise primarily myofibrillar proteins that also contains significant amounts of sarcoplasmic proteins. The sarcoplasmic proteins in the protein product admixed with, injected into or coated on the animal muscle tissue comprises above about 8%, preferably above about 10%, more preferably above about 15 % and most preferably above about 18%, up to about 30% by weight sarcoplasmic proteins, based on the total weight of protein in the dry acidic protein mixture or aqueous acidic protein solution.

In accordance with this invention the dry protein mixture of myofibrillar proteins and sarcoplasmic proteins, in powder form, small coarse particle or dehydrated form is applied to the surface of animal muscle to be cooked, or is mixed with the animal muscle tissue to be cooked such as hamburger, sliced reformulated beef or sausage. The term "a surface" as used herein is a surface of the fish or meat which is positioned 90 degrees from an adjacent surface or surfaces of the meat or fish. In addition, the term "a surface" can comprise the connecting surface connecting two adjacent surfaces positioned 90 degrees from each other. Preferably,

the entire surface of the meat or fish is coated with the dry acidic protein mixture or aqueous acidic protein solution. The coated fish or meat then can be cooked at elevated temperature while retaining a substantial majority of its original moisture.

In one aspect of this invention, particulate meat or fish such as ground meat or fish, e.g. hamburger, is mixed with the dry protein mixture comprising myofibrillar proteins and sarcoplasmic proteins at a weight ratio usually comprising about 0.03 to about 18% weight of the protein mixture based on the weight of the uncooked meat or fish, preferably between about 0.5 and 10% weight based on the weight of uncooked meat or fish and most preferably comprising between about 0.5 to about 5% weight based on the weight of the uncooked meat or fish. In addition, the aqueous acidic protein solution can be added to the meat or fish in the same ratios based on the weight of protein in the solution. When the dry protein mixture and/or aqueous acidic protein solution is applied to at least one surface of the meat or fish or it is applied by injection, the amount of the protein mixture added is the same weight ratio as set forth above when mixed with ground meat or fish. When utilizing less than about 0.03% weight dry protein mixture or aqueous acidic protein solution, effective moisture retention is not observed. When utilizing greater than about 15 % weight dry protein mixture or aqueous acidic protein solution, the cooked meat or fish can become undesirably hard.

The animal muscle tissue which is modified in accordance with this invention comprises meat and fish, including shell fish. Representative suitable fish include deboned flounder, sole, haddock, cod, sea bass, salmon, tuna, trout or the like. Representative suitable shell fish include shelled shrimp, crabmeat, crayfish, lobster, scallops, oysters, or shrimp in the shell or the like. Representative suitable meats include ham, beef, lamb, pork, venison, veal, buffalo or the like; poultry such as chicken, mechanically deboned poultry meat, turkey, duck, a game bird or goose or the like either in fillet form or in ground form such as hamburg. The meats can include the bone of the animal when the bone does not adversely affect the edibility of the meat such as spare ribs, lamb chops or pork chops. In addition, processed meat products which include animal muscle tissue such as a sausage composition, a hot dog composition, emulsified product or the like can be coated, injected or mixed with the dry acidic protein mixture and/or the aqueous acidic protein solution, or a combination of these protein addition methods. Sausage and hot dog compositions

include ground meat or fish, herbs such as sage, spices, sugar, pepper, salt and fillers such as dairy products as is well known in the art.

The fish or meat containing the dry protein mixture or aqueous acidic protein solution then can be cooked in a conventional manner such as by baking, broiling, deep fat frying, pan frying, in a microwave oven or the like. It has been found that the cooked meat or fish provided in accordance with this invention weighs between about 4% and about 21%, more usually between about 4% and about 9% by weight greater than cooked untreated meat or fish starting from the same uncooked weight.

The following examples illustrate the present invention and are not intended to limit the same. Percent (%) in Tables 1 -8 reflects the comparative loss of moisture in the controls verses the moisture loss in the compositions of this invention (moisture content of a composition of this invention/moisture content of control X 100).

Example 1: Incorporation (chicken protein isolate-acid)

Chicken protein isolate from myofibrillar and sarcoplasmic proteins was produced according to US Patent 6,005,073 (low pH) from chicken breast muscle; and freeze-dried until it contained approximately 5% moisture. The aqueous acidic protein solution from which the dry protein mixture was obtained had a pH of 2.68. The dry protein mixture (protein isolate) was incorporated into fresh, ground beef (75% lean) by hand kneading for 1 min and shaped into hamburgers of uniform size. To approximately one-quarter lb. of beef (exactly weighed) was added 0-1.5 grams of the dried protein isolate. The hamburgers were pan-fried on an Iwatani* (Tokyo, Japan) portable butane grill on high temperature for a total of 15 min (10 min then flipped and additional 5 min). The internal centers of the hamburgers reached 150° F ± 2 ° F after cooking. The cooked hamburgers were drained on paper towels for twenty seconds prior to weighing (two decimal places).

Table 1

Muscle (g) Tissue (Hamburger)	Protein isolate (g)	Start wgt (g)	End wgt. (g)	Cooking loss (%)	Favorable difference in hamburger gain* Pct. Pts./ %
113.17	0.00	113.17	70.93	37.32	control
113.13	1.00	114.13	82.26	27.92	9.40 / 134

*Trade-mark

113.02	1.50	114.52	84.11	26.55	10.77 / 141

* versus control, not including the weight of the protein isolate

The hamburgers containing from 1-1.5 g protein isolate had improved color, were shiny in appearance on the hamburger's interior, and had much greater juiciness and better mouth-feel than the control. No discernable differences were found between the exterior surfaces of the control (0.00g. Protein isolate) or the samples with added protein isolate.

Example 2: Incorporation (Cod protein isolate-acid)

Cod protein isolate from myofibrillar and sarcoplasmic proteins was produced according to US Patent 6,005,073 (low pH) from fresh Atlantic cod muscle. The aqueous acidic protein solution recovered was adjusted to pH 5.5 to enact protein precipitation. The pH of the precipitate was then raised to pH 7.04 and freeze-dried until it contained approximately 7% moisture. The dry protein mixture (protein isolate) was incorporated into fresh, ground beef (75% lean) by hand kneading for 1 min and shaped into hamburgers of uniform size. To approximately one-quarter lb. of beef (exactly weighed) was added 0-1.5 grams of dried protein isolate. The hamburgers were pan-fried on an Iwatani (Tokyo, Japan) portable butane grill on high temperature for a total of 15 min (10 min then flipped and additional 5 min). The internal centers of the hamburgers reached 155° F ± 2 ° F after cooking. The cooked hamburgers were drained on paper towels for twenty seconds prior to weighing (two decimal places).

Table 2

Muscle (g)	Protein isolate (g)	Start wgt (g)	End wgt. (g)	Cooking loss (%)	Favorable difference in hamburger gain* Pct. Pts./ %
113.05	0.00	113.05	81.40	28.00	control
113.01	0.50	113.51	89.64	21.03	6.97 / 133
112.92	1.00	113.92	88.49	22.32	5.68 / 125

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113.08	1.50	114.58	89.68	21.73	6.27 / 129

*Versus control, not including the weight of the protein isolate

The hamburgers containing from 0.5-1.5 g protein isolate had improved color, were shiny in appearance on the hamburger's interior, and had much greater juiciness and better mouth-feel than the control. No discernable differences were found between the exterior surfaces of the control (0.00 g. Protein isolate) or the samples with added protein isolate.

Example 3: Incorporation (chicken protein isolate-alkaline)

Chicken protein isolate from myofibrillar and sarcoplasmic proteins was produced according to US Patent 6,136,959 (high pH) from chicken breast muscle. A dry protein isolate was obtained by precipitation at a pH of 5.5 followed by a readjustment of the precipitate pH to pH 7.12 and subsequently freeze dried. The dry protein mixture (protein isolate) was incorporated into fresh, ground beef (80 % lean) by hand kneading for 1 min and shaped into hamburgers of uniform size. To beef (exactly weighed) was added 0 and 4.0 grams of dried protein isolate. The hamburgers were cooked on high in a Sharp* Carousel (1000 watt) microwave oven for a total of 110 seconds (no flipping). The internal centers of the hamburgers reached 183° F ± 4 ° F after cooking. The cooked hamburgers were drained on paper towels for twenty seconds prior to weighing (two decimal places).

Table 3

Muscle (g)	Protein isolate (g)	Start wgt (g)	End wgt. (g)	Cooking loss (%)	Favorable difference in hamburger gain* Pct. Pts./ %
98.64	0.00	98.64	59.60	39.58	control
98.59	4.00	102.59	70.86	30.93	7.26 / 128

*Versus control, not including the weight of the protein isolate

The hamburger containing 4 g protein isolate had improved color, was shiny in appearance on the hamburger's interior, and had much greater juiciness and better mouth-feel than the control (0.00 g. Protein isolate). No discernable

*Trade-mark

differences were found between the exterior surfaces of the control or the samples with added protein isolate.

Example 4: Incorporation (Chicken protein isolate-acid- adjusted to pH 5.5)

Chicken protein isolate from myofibrillar and sarcoplasmic proteins was produced according to US Patent 6,005,073 (low pH) from fresh chicken muscle and readjusted to pH 5.5. Moisture content of the precipitate was 74%. The protein isolate was chopped in a Waring* food processor for 20 seconds to reduce size and was incorporated into fresh, ground chicken breast by hand kneading for 1 min prior to being shaped into patties of uniform size. The chicken pieces were cooked on high in ZipLock® disposable containers in a Sharp* Carousel (1000 watt) microwave oven for 20 seconds, flipped and microwaved an additional 20 seconds. The internal centers of the chicken pieces reached 190° F ± 0 °F after cooking. The cooked chicken pieces were drained on paper plates prior to weighing (two decimal places).

Table 4

Muscle (g)	Protein isolate (g)	Start wgt (g)	End wgt. (g)	Cooking loss (%)	Difference in hamburger gain* Pct. Pts./ %
53.93	0.00	53.93	46.63	13.54	control
55.18	1.04	56.22	47.59	15.35	-1.81 / 85
54.09	2.68	56.77	47.69	15.99	-2.45 / 85
53.45	4.09	57.54	49.89	13.30	0.24 / 102

*Versus control, not including the weight of the protein isolate

Both the coated sample and the control had visible pooled water around them after cooking and were very similar in appearance. This example illustrates that a substantially neutral pH form of the protein isolate produced by the process of U.S. Patent 6,005,073 is not useful in the present invention.

Example 5: Coating (chicken protein isolate-acid)

Chicken protein isolate from myofibrillar and sarcoplasmic proteins was produced according to US Patent 6,005,073 (low pH) from chicken breast muscle. A

*Trade-mark

dry protein isolate was obtained by precipitation at a pH of 5.5 followed by a readjustment of the precipitates to pH 6.73 and subsequently was freeze-dried until it contained approximately 5% moisture. Fresh chicken breasts were cut into uniform portions, weighed and pressed into a dish containing the dry protein mixture (protein isolate) until coated (with varying amounts of coating). The coated chicken pieces were cooked on high in ZipLock® disposable containers in a Sharp Carousel (1000 watt) microwave oven for 20 seconds, flipped and microwaved an additional 20 seconds. The internal centers of the chicken pieces reached 179° F ± 0 °, except for the control, which reached 172° F after cooking. The cooked chicken pieces were drained on paper plates prior to weighing (two decimal places).

Table 5

Muscle (g)	Protein isolate (g)	Start wgt (g)	End wgt. (g)	Cooking loss (%)	Favorable difference in chicken gain* Pct. Pts./ %
53.05	0.00	53.05	45.56	14.12	control
49.65	0.97	50.62	47.62	5.93	8.19 / 238
53.23	1.27	54.50	52.34	3.96	10.16 / 357
49.37	1.75	51.12	48.86	4.42	9.70 / 319
51.98**	0.77	52.75	49.92	5.36	8.76 / 263

*Versus control, not including the weight of the protein isolate

** Coated only on the top surface

The chicken pieces containing between 0.97-1.75 g protein isolate had improved color, were shiny in appearance on the chicken's interior, and had much greater juiciness and better mouth-feel than the control. (0.00 g. Protein isolate). The coated pieces retained their original size and shape, whereas the control was very shape distorted. A large pool of moisture was found in the control container and very little to none in the coated pieces containers. The chicken piece coated on one-side only had slight distortion in size and a small amount of pooled moisture was found in the container after cooking.

Example 6: Coating (chicken, cod, & pork protein isolate-acid)

Dry acidic protein mixtures (protein isolate) from chicken breast, Atlantic cod fillet, and pork loin containing myofibrillar and sarcoplasmic proteins were produced

according to US Patent 6,005,073 (low pH). Dry protein isolates were obtained by precipitation at pH's about 5.5 followed by readjustment of the precipitate's pH to about neutrality. The precipitates subsequently were freeze-dried. Atlantic cod isolate was manufactured using 0.1 % (of the total water weight) sodium tripolyphosphate prior to homogenization as a metal chelating antioxidant. Pieces to be coated were cut into uniform portions, weighed and pressed into a dish containing the dried protein isolates until coated (with varying amounts of coating). The coated chicken pieces were cooked on high in ZipLock® disposable containers in a Sharp Carousel (1000 watt) microwave oven at 20 second intervals until an internal temperature in the centers of the muscle pieces reached 172° F. The cooked pieces were drained on paper plates prior to weighing (two decimal places).

Table 6

Material coated	Type of protein isolate	Start wgt (g)	End wgt. (g)	Cooking loss (%)	Favorable difference in material gain* Pct. Pts./ %
Haddock Haddock control	Cod ----	63.73 49.69	63.01 47.65	1.13 5.11	3.98 / 452
Chicken Chicken control	Chicken ----	44.22 42.34	43.73 32.82	1.11 22.48	21.37 / 2025
Chicken Chicken control	Pork ----	38.20 36.69	36.62 31.59	4.14 13.90	9.76 / 336
Cod Cod control	Cod ----	158.21 122.93	153.22 114.93	2.15 6.51	4.35 / 303
Chicken ** Chicken control	Chicken	81.04 80.22	71.64 65.89	11.60 17.86	6.26 / 154

*Versus control, not including the weight of the protein isolate

** Baked at 350° F for 15 min.

The pieces containing protein isolate were shiny in appearance on the interior and had much greater juiciness and better mouth-feel than the controls (0.00 g. Protein isolate). The coated pieces retained their original size and shape, whereas the controls were very shape distorted. Large pools of moisture were found in the controls containers and very little to none in the coated pieces containers.

Example 7: Coating (chicken protein isolate-acid- adjusted to pH 5.5)

Protein isolate from chicken breast myofibrillar and sarcoplasmic proteins was produced according to US Patent 6,005,073 (low pH) and readjusted to pH 5.5. Moisture content of the precipitate was 74%. One sample was freeze-dried at pH 5.5 until a moisture content of approximately 6%. Pieces to be coated were cut into uniform portions, weighed and pressed into a dish containing the pH 5.5 protein isolates until coated (with varying amounts of coating). The coated chicken pieces were cooked on high in ZipLock® disposable containers in a Sharp Carousel (1000 watt) microwave oven at 20 second intervals until an internal temperature in the centers of the chicken pieces reached 192° F ± 3° F. The sample coated with protein powder was cooked to an internal temperature of 181° F. The cooked chicken pieces were drained on paper plates prior to weighing (two decimal places).

Table 7

Muscle (g)	Protein isolate (g)	Start wgt(g)	End wgt. (g)	Cooking loss (%)	Difference in chicken wgt.* Pct. Pts./ %
32.74	0.00	32.74	25.08	23.40	control
31.63	4.41	36.04	26.58	26.25	-2.85 / 89
42.00	0.00	42.00	37.53	10.64	control
40.60	5.42	46.02	37.53	12.58	-1.94 / 85
55.59	0.00	55.59	50.69	8.81	control
53.13**	0.87	54.00	49.22	8.85	-0.04 / 99

*Versus control, not including the weight of the protein isolate

** coated using freeze-dried protein at pH 5.5.

The pieces containing protein isolate at pH 5.5 appeared in much worse condition than the controls. The coating formed a coarse surface with a curdled milk appearance. Both the coated sample and the control had visible pooled water around them after cooking. The sample coated with dehydrated protein (pH 5.5) had an acceptable appearance comparable to other dehydrated proteins tested. As in Example 4, this example illustrates that a substantially neutral pH form of the protein composition is not useful in the present invention.

Example 8: Inject into chicken (chicken protein isolate pH 2.8 acid)

Protein isolate from chicken breast myofibrillar and sarcoplasmic proteins was produced according to US Patent 6,005,073 (low pH). The protein precipitate

obtained at pH 5.5 was readjusted back to pH 2.8 using 2 M HCl. The thick consistency solution thus produced contained 3.7 % protein. Chicken breast pieces to be coated were cut into uniform portions, weighed and injected using a BD 5 ml syringe (25 gauge needle) with different amounts of weighed protein (pH 2.8) solution. The injected chicken pieces were cooked on high in ZipLock® disposable containers in a Sharp Carousel (1000 watt) microwave oven at 20 second intervals until an internal temperature in the centers of the chicken pieces reached 170° F ± 7° F. The cooked chicken pieces were drained on paper plates prior to weighing (two decimal places).

Table 8

Muscle (g)	Protein isolate (g)	Start wgt (g)	End wgt. (g)	Cooking loss (%)	Favorable difference in chicken gain* Pct. Pts./ %
107.22	0.00	107.22	100.79	6.00	control
107.19	1.36	108.55	104.38	3.84	2.16 / 156
120.36	13.85	134.21	128.76	4.06	12.98 / 148

*Versus control, not including the weight of the protein isolate

The pieces containing the protein isolate in aqueous acidic solution were shiny in appearance and had much greater juiciness and better mouth-feel than the control. The injected pieces retained their original size and shape, whereas the control was very shape distorted. Two of the samples had higher end weights than their original muscle weights after cooking. Large pools of moisture were found in the control containers and very little to none in the injected pieces containers.

Example 9: Inject into chicken (pork protein isolate pH 2.8 acid)

Protein isolate from pork loin myofibrillar and sarcoplasmic proteins was produced according to US Patent 6,005,073 (low pH). The precipitate at pH 5.5 was readjusted back to pH 2.8 using 2 M HCl and 0.5% NaCl (w/w). The solution was found to be 2.25 % protein. Chicken breast pieces to be coated were cut into uniform portions, weighed and injected using a BD 5 ml syringe (18 gauge needle) with protein (pH 2.8) solution. The injected chicken pieces were cooked on high in ZipLock® disposable containers in a Sharp Carousel (1000 watt) microwave oven at

20 second intervals for a total of 80 seconds. The internal temperature in the centers of the chicken pieces reached 176° F for the control and 198 ° F for the treated sample. The cooked chicken pieces were drained on paper plates prior to weighing (two decimal places).

Table 9

Muscle (g)	Protein isolate (g)	Start wgt (g)	End wgt. (g)	Cooking loss (%)	Favorable difference in chicken gain* Pct. Pts./ %
61.99	0.00	61.99	50.79	18.07	Control
56.71	0.79	57.50	54.66	4.94	13.13 / 366

*Versus control, not including the weight of the protein isolate

The piece containing protein isolate was shiny in appearance and had much greater juiciness and better mouth-feel than the control. The injected piece retained its original size and shape. A large pool of moisture was found in the control container and very little to none in the injected piece container.

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CLAIMS:

1. A process for retaining moisture in uncooked animal muscle tissue during cooking of the animal muscle tissue which comprises:

(a) adding to said uncooked animal muscle tissue a protein mixture selected from the group consisting of an aqueous acidic protein solution, having a pH of about 3.5 or less, of myofibrillar proteins and sarcoplasmic proteins derived from animal muscle tissue, a dry protein mixture of myofibrillar proteins and sarcoplasmic proteins derived from animal muscle tissue obtained by drying said aqueous acidic protein solution and mixtures thereof by an adding method selected from the group consisting of applying said protein mixture to at least one surface of said uncooked animal muscle tissue, mixing said protein mixture with said uncooked animal muscle tissue, injecting said protein mixture into said uncooked animal muscle tissue and a combination of at least two of said adding methods

and (b) cooking said uncooked animal muscle tissue and protein mixture from step (a).

2. The process of claim 1 wherein the protein mixture is applied to all surfaces of said uncooked animal muscle tissue.

3. The process of claim 1 wherein the protein mixture is mixed with said uncooked animal muscle tissue.

4. The process of claim 1 wherein the protein mixture is injected into said uncooked animal muscle tissue.

5. The process of any one of claims 1 to 4 wherein said protein mixture is an aqueous acidic protein solution

of myofibrillar proteins and sarcoplasmic proteins derived from animal muscle tissue.

6. The process of any one of claims 1 to 5 wherein said uncooked animal muscle tissue is fish.

7. The process of any one of claims 1 to 5 wherein said uncooked animal muscle tissue is shellfish.

8. The process of claim 7 wherein said shellfish is shrimp.

9. The process of any one of claims 1 to 5 wherein said uncooked animal muscle tissue is poultry.

10. The process of any one of claims 1 to 5 wherein said uncooked animal muscle tissue is meat.

11. The process of any one of claims 1 to 5 wherein said protein mixture is derived from fish muscle tissue.

12. The process of any one of claims 1 to 5 wherein said protein mixture is derived from poultry muscle tissue.

13. The process of any one of claims 1 to 5 wherein said protein mixture is derived from meat muscle tissue.

14. The process of any one of claims 1 to 13 wherein said protein mixture is substantially free of animal membrane lipids.

15. The process of any one of claims 1 to 14 wherein said animal muscle tissue is included in a sausage composition.

16. The process of any one of claims 1 to 15 wherein said protein mixture is mixed with a food additive selected

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from the group consisting of a breading, a batter, a spice dry rub, cracker meal and mixtures thereof.

17. The process of any one of claims 1 to 16 wherein said pH is between about 2.5 and about 3.5.

18. The process of any one of claims 1 to 14 wherein said animal muscle tissue is included in a hot dog composition.

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