PATENT SPECIFICATION

699,692

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COMPLETE SPECIFICATION

Improvements in and relating to Protein Food Products

I, ROBERT ~~ARNIN~~ ALLAN BOYER, a citizen of the United States of America, of 1596 Teakwood Avenue, Cincinnati, Ohio, United States of America, do hereby declare the invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the manufacture of protein food products. More particularly, the invention relates to the manufacture of products which will have the flavour, colouring, taste and "chewiness" of meat and which need not contain either actual meat or animal flesh.

It is well known that proteins are essential to the human diet and that proteins in the form of meat are the most attractive of all protein foods to the average human taste. It is unfortunate however that meat is one of the most expensive classes of food and it has therefore long been the goal of food scientists to develop an inexpensive but satisfactory substitute for meat. Some progress has been made in this direction. Various meat flavours have been produced synthetically and are available commercially. As an example there may be cited bouillon cubes having chicken, beef and other meat flavours. Furthermore, various food dyes have been perfected so that it is possible synthetically to reproduce the colouring of various kinds of meat. It has also been demonstrated that some vegetable proteins although much lower in cost, have nutritive values approximately equal to many meat proteins. The stumbling block up to this point has been in the reproduction of the texture and appearance of natural meat, the texture of course involving the factor of "chewiness." Vegetable chops using wheat gluten as a base have a certain amount of "chewiness" but they do not reproduce the fibrous character of meat; and they fail to give that satisfaction that comes from the breakdown in the mouth during the mastication of a piece of meat.

With the above considerations in mind, it is an object of my invention to manufacture from animal or vegetable proteins a food product which closely resembles natural meat as to its appearance, fibrous qualities, flavour, nutritive value and chewiness.

It is another object of my invention to manufacture a food product as above outlined which will closely simulate the white meat of chicken or turkey, which will simulate a filet mignon or a pork chop or other specific types and cuts of meat.

It is another object of my invention to provide a process for the manufacture of protein food products simulating meat which process is relatively simple, inexpensive and which can be carried out on a continuous basis.

It is a further object of my invention, in its broadest aspect, to provide a process for the manufacture of food products from animal or vegetable proteins.

According to my invention there is provided a process for the manufacture of a food product which includes the steps of preparing filaments of protein and applying to the filaments a binder.

Any protein capable of being made into filaments may be used in the process of the invention. Such proteins are, for example, oil seed proteins such as soya bean or ground-nut protein, casein and proteins obtained from gluten, fish, or maize.

Artificial textile filaments have been made from proteins. Generally speaking, they are made by preparing a quantity of filaments from such proteins coagulating them in a coagulating bath and then stretching by means of a series of rolls revolving at increasing speeds. Such filaments are then placed in a salt solution such as sodium chloride of sufficient concentration to prevent the filaments from re-dissolving. About one-half per cent. is sufficient although higher salt concentration can be

used). These filaments, for textile purposes are then insolubilised by treatment in a formaldehyde bath.

The filaments are generally prepared by dispersing the proteins which are the starting material in a suitable dispersing medium such as an alkaline solution. Actually, depending upon the material dispersed, and the dispersing agent used, the dispersion may amount to a colloidal solution. This dispersion is then forced through fine orifices, for instance through a rayon spinneret, into a coagulating bath which is generally an acid salt solution. The streamlets coming through the spinneret are thus precipitated into the form of filaments. Alternatively, coarser filaments can be produced by the extrusion through dies of a plasticised mass of protein obtained by the addition of water, usually about 25%, to a protein, e.g. casein, in the form of a powder, and heating. The filaments produced by this mechanical extrusion process will be of much greater thickness than those produced by a rayon spinneret. These coarser filaments will be of a thickness of the order of paint brush bristles and even though they are stretched afterwards the final filament will be relatively coarse. On the other hand the filaments issuing from a spinneret, which actually is a small die having from perhaps five thousand to fifteen thousand holes each of the order of 0.003 inches in diameter, will be of a diameter of about 0.003 inches. When these filaments are stretched they are elongated and reduced in diameter until the average thickness of such a filament is of the order of 20 microns.

Regardless of the initial procedure in producing the filaments, the filaments will normally be white and elastic and resemble muscle tissue, the only distinction being that those issuing from an extrusion dye will be coarser than those produced by a spinneret. If a colouring agent is added to the protein dispersion, the resulting filaments will retain the approximate colour of the dye. As will be pointed out hereinafter, the extrusion process is used where it is desired to simulate a coarse grained meat, whereas the spinneret procedure is used where it is desired to simulate a relatively fine textured meat.

Thus, the spinneret usually produces several thousand filaments which are very fine (about 20 microns in diameter). These several thousand filaments constitute a group of filaments or a bundle of filaments which group or bundle may have a diameter of perhaps one quarter inch. If a battery of spinnerets or dies as above outlined are provided, there will be a considerable number of bundles or groups of filaments which, when assembled together, constitute what I have hereinafter called a "tow" of filaments, which tow, depending upon the number of dies or spinnerets used, may be conveniently three to four inches in diameter.

The formation of filaments in groups and tows is well known and does not form a part of the present invention except insofar as it may constitute a series of preliminary steps which, together with the procedures to be disclosed hereinafter, complete the process according to the invention. In my procedure of preparing filaments I borrow the technique as it is known today in the textile field.

In order to convert the filaments which have been produced as above set forth into a food product they should preferably be freed from excess salt solution by squeezing or centrifuging to reduce the moisture content to below 75 per cent. The filaments or groups of filaments are then treated with a binder. I define the term binder in connection with the present invention, as an edible agent or medium for holding the filaments in place in relation to each other. The binder, according to my invention, may exercise its function by holding the filaments together adhesively or by retaining them as in a matrix. The binder may be a material such as one of the starches, flours like wheat flour, dextrins, proteins, gums, alginates, or carboxy methyl cellulose, which perform their binding function either adhesively or by serving as a matrix in which the filaments are embedded and which may be applied in the solid state by dusting or in the fluid state as a dispersion, solution, melt or paste, by any convenient method. It will be clear that the binder may consist of individual materials, as outlined above, or of a combination of such materials.

When manufacturing a food product simulating meat, the filaments or groups of filaments after treatment with the binder, are usually passed through a bath of melted fat or treated with fat in solid form as by extruding a core-like mass of fat into the tow, whereupon the groups of filaments are usually assembled by pressing together and are cut into suitable lengths convenient for handling and sale. The pressure in assembling can of light or heavy depending upon the density and texture desired in the final product. For example, a finished piece might be constituted by a length of tow of eight or ten inches length and having a diameter of three or four inches. This final piece can then be sliced longitudinally or at a slight angle to the direction of the filaments or across the grain, depending upon the kind of meat which is being simulated.

In order to simulate various kinds of meat, there are a number of variables which can be modified but the fundamental procedures remain the same. I have pointed out above how filaments are grouped in groups. Dif-

ferences in effect can be produced by the number of groups which are assembled together before passing through the fat bath. Individual groups may be individually passed through the fat bath or two or more groups may be assembled together and passed through the fat bath as a unit. Another variable is the type of fat through which the groups are passed, and yet another variable is the thickness of fat coating applied. Other variables are the flavouring material which may be added with the fat and the colouring material which may also be added with the fat. The flavouring material may be any of the commercially available materials and may include protein hydrolysates. The flavouring and colouring material could be added at other stages in the process. The texture of the meat can be varied by the procedure outlined above, where instead of passing a dispersion of protein through a spinneret, the protein after having been plasticised, is extruded through dies. The latter procedure produces coarser filaments and can be used in the simulation of coarse grained meat.

By way of example, in simulating a pork chop or the like, instead of assembling the groups of filaments as they come out of a battery of spinnerets, these groups are kept separate, the groups being normally about one-quarter inch in diameter. Each of these groups is then passed individually through lard, shortening such as a hydrogenated vegetable oil, or other melted fats and given about a one-sixteenth inch coating of fat. After the fat coating, the coated groups are assembled together to give the final tow having a diameter of three to four inches. Before the final assembly the groups are passed through a binder, and flavouring, colouring, vitamins or other desired ingredients may be added.

In simulating a filet mignon, the procedure is similar to that for a pork chop except that the groups of filaments coming from the spinneret are first assembled into approximately four groups and a binder is applied before the fat coating procedure. In other words, individual groups are not fat coated but plural groups containing three or four spinneret groups are treated simultaneously with the fat coating.

In simulating the white meat of chicken or turkey, all the filament groups are assembled together after being treated with a binder, the treatment with fat, if desired, being carried out thereafter.

The toughness or tenderness of the product of the invention can be controlled by the amount of stretch which may be imparted to the filaments in the initial forming procedure. If the filaments are not stretched at all, the product may lack chewiness. It takes a certain amount of stretch, usually about 50 per cent. or more depending upon the diameter of the filaments, to produce a filament having appreciable elasticity. As the amount of stretch is increased, the effect is to make the filaments tougher. The more they are stretched the tougher the filaments become, and I have found that a stretch of about 400 per cent. is the practical limit beyond which the filaments tend to break. It is thought that this stretching produces an orientation of the molecules in the sense of producing an alignment of the molecules in the direction of stretching, and that it is sufficient, as a minimum, to stretch the filaments until such orientation is achieved.

If desired, toughness may also be controlled by the use of hardening chemicals. For instance, soaking the filaments in a solution of sodium chloride of any concentration up to saturation will have a toughening effect. Brine has a similar effect on many kinds of meat. Other chemicals, such as aluminium sulphate, or formaldehyde, will toughen the filaments although care must be taken to guard against toxicity or other undesirable effects, such as too great a degree of toughness. It will be appreciated that the filaments must not be hardened beyond a point compatible with digestibility.

If it is desired to tenderize the filaments, proteolytic enzymes (e.g. papain, bromelin, pepsin, trypsin) may be used as in the known procedures for tenderizing meats. Partial hydrolysis for the same purpose may be effected by the use of such agents as hydrochloric acid, sodium sulphide, and alkali hydroxides.

I have outlined above by way of example how certain specific kinds of meat can be simulated. It will be clear that many kinds of meat can be simulated simply by varying one or more of the variables mentioned above. If additional nutritive value is desired, it can be imparted to the final product by the addition of e.g., vitamin concentrates, dried milk or amino acids. The flavour of a product can, of course, be enhanced if, for example, in simulating the white meat of chicken or turkey the fat bath be of chicken fat or turkey fat. For simulating pork it would be desirable to use pork fat and for beef, beef fat.

It has been mentioned that it has been usual to place the formed filaments in a salt solution to prevent them from redissolving. The pH of this salt solution can be adjusted to any desired level, and it will be obvious that the pH of the filaments upon immersion in it will be accordingly adjusted. The pH of natural meat is usually about 6, and it will be seen that even the pH of natural meat may easily be, and usually is, reproduced. The pH can easily be increased or decreased if it is desired to produce unusual

effects, such as pickling, in the simulation of sauerbraten.

It should be noted that the end product, provided the procedures have been carried out under sterile conditions, will be absolutely sterile and wholly free from enzymes and bacteria. It may be found desirable for some purpose to add certain enzymes, but it must be noted that these will have been added intentionally. If the product is canned or vacuum packed under sterile conditions, the product will of course be absolutely sterile. This is not true of untreated natural meat which at all times contains bacteria and enzymes which contribute to its spoilage and decay.

Food products according to the invention may be encased in sausage casings by conventional methods.

The following Examples are given further to illustrate the invention, the parts being by weight.

Example 1.

240 parts of a commercial casein were suspended in 750 parts of water at room temperature. The suspension was stirred to form a slurry. A solution of 2 parts of sodium hydroxide in 10 parts of water was then added to the slurry with gentle stirring, and the resultant mixture was heated to a temperature of 180° F. and held at that temperature for one hour. Gentle stirring was continued during that operation. A homogeneous solution of casein, having a pH of about 6, was so obtained, which was then filtered and subjected to reduced pressure to deaerate it. The resultant solution was then forced through three spinnerets into a coagulating bath by means of a metering pump. The coagulating bath consisted of an aqueous solution containing 3% by weight of glacial acetic acid, and 12% sodium chloride and was at room temperature. Three bundles of precipitated casein filaments were thus continuously formed in the bath and were led through the bath, away from the spinnerets, by means of a revolving reel mounted at the end of the bath. The rate of revolution of the reel was so adjusted as to prevent any kinking of the filaments in the bath.

On leaving the coagulating bath the three bundles of filaments were amalgamated into one and this was then passed through a bath similar to the coagulating bath, except that its temperature was kept at 140° F. The filaments were stretched in this bath by means of a series of reels having increasing peripheral speeds. A stretching of 150% was obtained in this operation.

The filaments were then passed into a room temperature bath of a 12% aqueous solution of sodium chloride and were there stored until required for further processing.

The wash filaments, still in the continuous form, after half an hour's immersion in the 12% sodium chloride solution which had a pH of 7 or just over, acquired a pH of approximately 5.5. A portion of the filaments was then passed through a pair of squeeze rollers in order to free the filaments from excess sodium chloride solution. After passing through the rollers the filaments contained about 55% moisture.

100 parts of the filaments were then immersed in a bath consisting of:

100 parts of water
20 parts of skimmed milk powder
15 parts powdered egg albumen
10 parts of sugar
6 parts of sodium chloride
1 part of mono-sodium-glutamate
2 parts of a commercial chicken flavour extract
0.1 parts of a yellow food dye.

The filaments were allowed to soak in the bath until thoroughly saturated and gentle agitation was provided in the bath so as to allow the filaments to become saturated more quickly without causing their entanglement. The filaments were then removed from the bath and allowed to drain until dripping stopped.

The filaments were then placed in a mould in such a manner that the filaments were substantially parallel, and were then pressed firmly together so as to form a compact mass. The contents of the mould were then heated to a temperature of 170° F. for one hour and were then put in a refrigerator until they were thoroughly chilled. The chilled contents were then removed from the mould en masse. By slicing the resultant piece at a slight angle to the direction of the filaments slices were obtained which simulated the white meat of chicken.

Example 2.

A commercial "oil-free" peanut meal which had not been denatured to any substantial extent in the solvent extraction of the oil was extracted by the well-known process of treating the meal with a slightly alkaline aqueous solvent, clarifying the resulting protein containing extract by centrifuging and precipitating the protein from the extract by acidifying with acetic acid. The protein precipitated in the form of a curd and was separated from the mother liquor by allowing it to settle, decanting the supernatant liquor and gently pressing the settled protein curd until most of the free moisture was eliminated. The curd was then granulated up, dried at 100° F. and ground to a powder.

18 parts of the powder were suspended in 82 parts of water at room temperature and the suspension was stirred until there were no lumps or undissolved particles of protein present. To this suspension there was gradually added, with constant stirring, a 30% solu-

tion of sodium hydroxide until the resultant mixture had a pH of 12. Stirring was continued for about an hour until all the protein appeared to have dissolved and the mixture had attained an amber colour and was transparent when viewed in thin films. The resulting solution was filtered, de-aerated by being subjected to reduced pressure and converted into filaments in the manner described in Example 1.

After stretching the filaments were passed into a bath of sea-water, which had previously been sterilised and filtered, and the filaments were stored in the bath until required for further processing. The filaments acquired a pH of about 6 whilst in this bath.

A bath was prepared consisting of:

100 parts of beef broth (a commercial soup product)
20 parts of dry skimmed milk powder
10 parts of dried egg albumen
5 parts of wheat flour
6 parts of sugar
6 parts of sodium chloride
1 part of beef dripping obtained in the roasting of beef
1 part of mono-sodium glutamate
0.75 parts of a commercial brown food dye

100 parts of peanut protein filaments, centrifuged free of excess water, were immersed in the bath until saturated. The filaments, still in the continuous form, were then air dried until their outer surface had become slightly glazed and sticky. The interior of the bundle, however, was still quite moist.

The filaments were then passed through a bath of fat which was just sufficiently warm to ensure that the fat was in liquid form. The bath consisted of:

100 parts of a commercial shortening (essentially a hydrogenated vegetable oil)
50 parts of beef fat which had been browned previously until the pleasant and familiar odour of cooking beef could be detected.

The fat bath was prepared by comminuting brown beef fat in a high speed mixer until it was sufficiently fluid to allow it to be poured and by adding this fluid to the molten shortening.

The fat coated group of filaments was cut into uniform lengths and these were laid, arranged substantially parallel, in a pan and were then pressed into a compact mass. The covered pan was placed in an oven and was heated until a temperature of 170° F. was obtained within the protein mass, after which the pan was placed in a refrigerator until the contents were thoroughly chilled. The contents were removed en masse from the pan and several small holes were made in the mass along the direction of the filaments with an ordinary meat skewer. The chilled mass was then immersed into the fat bath until fat had filled the holes and a coating of fat was obtained on the surface.

The resulting product was sliced across the grain or at a slight angle to the direction of the filaments and the slices so obtained had an appearance and flavour similar to cooked roast beef which had been chilled to a point at which the fat in the beef solidifies and turns white.

What I claim is:—

1. A process for the manufacture of a food product which includes the steps of preparing filaments of protein and applying to the filaments a binder.

2. A process according to claim 1 which includes the steps of applying fat to the filaments.

3. A process according to claim 2 in which the filaments are passed through a bath of molten fat.

4. A process according to any of the preceding claims which includes the additional step of imparting orientation to the molecules within the filaments.

5. A process according to claim 4 in which the filaments are stretched from 50% to 400%.

6. A process according to any of the preceding claims in which the preparation of the filaments includes the steps of dispersing the protein in a dispersing medium and forcing the suspension obtained through fine orifices into a coagulating bath to produce a quantity of fine filaments and thereafter reducing the moisture content of the filaments.

7. A process according to any of claims 1-5 in which the preparation of the filaments includes the steps of plasticizing protein in powder form with an aqueous plasticizing agent and extruding the plasticized material through dies to produce a quantity of filaments.

8. A process according to any of the preceding claims in which the filaments are assembled to form a tow.

9. A process according to any of claims 2-8 in which individual groups of filaments are treated with fat.

10. A process according to any of claims 2-8 in which two or more groups of filaments are assembled together and then treated with fat.

11. A process according to claim 9 or 10 in which the application of the binder takes place at the same stage as the fat treatment.

12. A process of manufacturing a food product simulating meat according to any of the preceding claims in which a meat flavour is incorporated.

13. A process according to claim 12 which includes the step of incorporating fat of the fowl or animal whose meat is being simulated.

tion of sodium hydroxide until the resultant mixture had a pH of 12. Stirring was continued for about an hour until all the protein appeared to have dissolved and the mixture had attained an amber colour and was transparent when viewed in thin films. The resulting solution was filtered, de-aerated by being subjected to reduced pressure and converted into filaments in the manner described in Example 1.

After stretching the filaments were passed into a bath of seawater, which had previously been sterilised and filtered, and the filaments were stored in the bath until required for further processing. The filaments acquired a pH of about 6 whilst in this bath.

A bath was prepared, consisting of:

100 parts of beef broth (a commercial soup product)
20 parts of dry skimmed milk powder
10 parts of dried egg albumen
5 parts of wheat flour
6 parts of sugar
6 parts of sodium chloride
1 part of beef dripping obtained in the roasting of beef
1 part of mono-sodium glutamate
0.75 parts of a commercial brown food dye

100 parts of peanut protein filaments, centrifuged free of excess water, were immersed in the bath until saturated. The filaments, still in the continuous form, were then air dried until their outer surface had become slightly glazed and sticky. The interior of the bundle, however, was still quite moist.

The filaments were then passed through a bath of fat which was just sufficiently warm to ensure that the fat was in liquid form. The bath consisted of:

100 parts of a commercial shortening (essentially a hydrogenated vegetable oil)
50 parts of beef fat which had been browned previously until the pleasant and familiar odour of cooking beef could be detected.

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The fat coated group of filaments was cut into uniform lengths and these were laid, arranged substantially parallel, in a pan and were then pressed into a compact mass. The covered pan was placed in an oven and was heated until a temperature of 170° F. was obtained within the protein mass, after which the pan was placed in a refrigerator until the contents were thoroughly chilled. The contents were removed en masse from the pan and several small holes were made in the mass along the direction of the filaments with an ordinary meat skewer. The chilled mass was then immersed into the fat bath until fat had filled the holes and a coating of fat was obtained on the surface.

The resulting product was sliced across the grain or at a slight angle to the direction of the filaments and the slices so obtained had an appearance and flavour similar to cooked roast beef which had been chilled to a point at which the fat on the beef solidified and turns white.

What I claim is:—

1. A process for the manufacture of a food product which includes the steps of preparing filaments of protein and applying to the filaments a binder.

2. A process according to claim 1 which includes the steps of applying fat to the filaments.

3. A process according to claim 2 in which the filaments are passed through a bath of molten fat.

4. A process according to any of the preceding claims which includes the additional step of imparting orientation to the molecules within the filaments.

5. A process according to claim 4 in which the filaments are stretched from 50% to 100%.

6. A process according to any of the preceding claims in which the preparation of the filaments includes the steps of dispersing the protein in a dispersing medium and forcing the suspension obtained through fine orifices into a coagulating bath to produce a quantity of fine filaments and thereafter reducing the moisture content of the filaments.

7. A process according to any of claims 1-5 in which the preparation of the filaments includes the steps of plasticizing protein in powder form with an aqueous plasticizing agent and extruding the plasticized material through dies to produce a quantity of filaments.

8. A process according to any of the preceding claims in which the filaments are assembled to form a tow.

9. A process according to any of claims 2-8 in which individual groups of filaments are treated with fat.

10. A process according to any of claims 2-8 in which two or more groups of filaments are assembled together and then treated with fat.

11. A process according to claim 9 or 10 in which the application of the binder takes place at the same stage as the fat treatment.

12. A process of manufacturing a food product simulating meat according to any of the preceding claims in which a meat flavour is incorporated.

13. A process according to claim 12 which includes the step of incorporating fat of the fowl or animal whose meat is being simulated.

* C L M S *

14. A process for the manufacture of a food product substantially as described.

15. A food product whenever produced [illegible] any of the preceding claims.

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ERRATA

SPECIFICATION NO: 699,692

Page 1, line 1, *for* "ROBERT ALLEN BOYER" *read* "ROBERT ALLAN BOYER".

Page 2, line 95, *for* "alignates" *read* "alginates".

Page 5, line 48, *for* "high speed mixed" *read* "high speed mixer".

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