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(19)

(54) PROTEIN FOOD PRODUCTS

(71) We, F. B. MERCER LIMITED, a British Company, of Central Buildings, Richmond Terrace, Blackburn, Lancashire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described, in and by the following statement:—

Background of the Invention

This invention relates to the manufacture of food products from protein sources and more particularly to the production of a high protein content food product which can act as a meat substitute, or as a food which complements real meat or meat substitute.

Numerous efforts have been made in recent years to produce a satisfactory meat substitute possessing the required amount of protein and having acceptable properties as regards flavour, texture and appearance adequately to simulate real meat. It is known for example to produce meat substitutes by a fibre spinning process or by a cook-extrusion process. In the spinning process, a protein dope solution or slurry is extruded or spun into a coagulent bath in the form of a multifilament tow which is mixed with a suitable edible binder such as starch or egg albumen. The tow may be stretched to orientate the molecules and cut into lengths for use in food products. In the cook extrusion process, a protein dough is fed to a cook extruder where it is subjected to cooking heat and pressure prior to extrusion. The extrudate, when it encounters ambient conditions, expands to form a structure having meat-like qualities.

It has been proposed that the "toughness" or "tenderness" of products resulting from the above processes can be varied by varying the degree of orientation, or, in the case of the fibre spinning process, by varying the number of diameter of fibres in a tow, but it has been found that although the products can be made to taste like real meat, when chewed, the fibres tend to fall apart and the consistency is not like that of real meat.

British Patent Specification No. 1,499,802, published 1st February, 1978, describes and claims a food product having a fibrous structure comprising an integrally extruded net of an edible protein-containing material compressed and bonded to form a block, and also a method of making a food product having a fibrous texture comprising integrally extruding a net of an edible protein-containing material and compressing and bonding the net to form a block.

The Invention

The present invention provides a food product comprising a block which includes a compressed and bonded, integrally-extruded net of an edible protein-containing material and additional edible fibres, and a method of making a food product, comprising integrally extruding a net comprising an edible protein-containing material, and compressing and bonding the net to form a block, the block incorporating additional edible fibres. The additional fibres are additional in the sense that although they can reinforce the protein-containing material of the net, the fibres do not constitute the fundamental material of the net.

Using the invention, the consistency of manufactured protein food products can be made more closely to simulate that of real meat as the protein structure is in the form of a net of integrally interconnected strands or filaments rather than a tow of substantially unidirectionally extending adherent strands. The additional fibres act as reinforcement in the compressed block, and increase the tensile strength and enhance the chewing properties. The extruded protein-containing material forms continous fibres which extend generally longitudinally but are also interconnected laterally whilst the additional fibres are discontinuous and do not necessarily extend in any preferred direction.

Even if the food product of the invention cannot be used alone as a meat substitute, it can be a useful complement to real meat or meat substitute. In general, cook-extrusion without the addition of fibres does not give a product having the texture of meat, but the product is a protein-containing product which can be used with success as an adjunct to real meat or meat substitute. If fibres are added, there is a significant improvement in texture whilst the two or three dimensional net structure is maintained, and products can be produced which are marketable as meat substitutes. Fibre spinning or wet spinning without the addition of fibres can give a product which is marketable but which is greatly improved by addition of fibres, but wet spinning tends to be complex and relatively expensive.

The invention is applicable to the known type of cook extrusion process as well as fibre spinning processes and extrusion processes in which no cooking of the protein dough occurs in the extruder but post-extrusion cooking or "heat-coagulation" of the product is effected. In each case, an integral net extrusion head is substituted for the conventional extruder of spinning head so that the material leaves the extruder or spinning head in the form of an integrally extruded or spun net for subsequent stretch orientation, if required, and compression into block form. As spinning processes are in effect extrusion processes using liquid materials, the term "extruding" as used herein covers both normal extrusion and spinning, where the context admits.

In carrying the invention into effect, for additional product bulk, a plurality of integral net extrusion heads may be used, and the plurality of nets thereby produced may be stretch orientated and compressed together into block form.

Ingredients and other parameters for the production of protein-containing doughs and dopes or slurries useful in carrying out the invention can be generally as used in the known extrusion and spinning processes for producing edible protein products. The ingredients may for instance be soya bean, corn or peanut proteins or animal proteins such as casein. Examples of such ingredients and other ingredients as described in U.K. Patent Specifications Nos. 1,335,595, 1,335,596 and 1,335,597, the basis of the present invention being that to improve the chewing properties or texture of the known products, they are extruded in integral net form rather than monofilament form and additional fibres are incorporated.

After extrusion or spinning of the net product and before compression into block form, the net or nets may be coated with a bonding agent such as an edible binder like egg albumen if such is required to bond the net structure into a block. Some products may be capable of self-bonding however without the addition of a binder.

The additional fibres may be incorporated in the raw material prior to extrusion or may be included after extrusion, for example by adding fibres to the bonding agent if one is used; generally in processes involving cook-extrusion or extrusion followed by heat coagulation, the fibres will be included in the raw material whereas for web spinning processes, the fibres will be included after extrusion of the net such as by addition to a bonding agent.

Numerous types of reinforcing fibres can be used, and examples of these are as follows:—

(1) Fibres produced from raw material which was wet spun and contained a relatively high percentage of edible protein.

(2) A highly purified viscose rayon or methyl cellulose fibre which is edible but has substantially no nutritional value.

(3) A highly refined and purified wood pulp flock.

(4) Fibres shredded from protein materials manufactured by fungal growth.

(5) Fibres produced from ground nuts or lactic casein.

(6) Real meat or other animal or vegetable fibres.

The percentage of reinforcing fibres used either when included in the raw material before extrusion or when added to a bonding medium or both is determined by the required chewing properties, though in general up to 20% by weight can be included in the block (% of total weight of block). It is comtemplated that the fibres will be short, and the fibre length can be of the order of up to 1/8" for fibres included in the raw material prior to extrusion and up to 1/2" for fibres added to a bonding medium.

The integral extrusion or spinning of the or each net is preferably carried out using a process and apparatus of the type disclosed in the U.K. Patent Specification No. 836,555. This process utilizes relatively rotating, reciprocating or oscillating sets of die orifices which are continually brought into and out of register to produce integrally extruded or spun net intersections when the respective sets of orifices are in register, the intersections gradually dividing into separate net strands as the orifices move out of register and the strands gradually merging again into integral intersections as pairs of orifices again move into register. Other integral net extrusion processes can be used however to produce a protein-containing net in accordance with the invention.

Preferably when using apparatus as disclosed in U.K. Patent Specification No. 836,555, the net is extruded or spun in tubular form from relatively rotating or oscillating inner and outer circular dies. This produces a tubular net having a diamond-like mesh, e.g. a mesh structure in which at least one set of strands extends helically around the tube. The tubular net may be extruded into a coagulant bath and can be stretch orientated in the direction of extrusion, for example by differential speed draw rollers. Then if required, a bonding medium such as egg albumen or starch which may contain the additional fibres can be applied and the net compressed and bonded to form a block. The block can be cut into cake or slab form.

Brief Description of the Drawings

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figures 1, 2 and 3 are diagrammatic elevations of respective first, second and third plants producing an edible meat substitute; and

Figure 4 is a perspective view of part of the first plant.

Detailed Description of the Drawings

In each of Figures 1, 2 and 3, a pump or extruder 1 supplies an edible protein solution to a bank of like die heads 2, each die head being of the type disclosed in U.K. Patent Specification No. 836,555 and comprising inner and outer dies which for example can produce a tubular net product with longitudinal strands and further helical strands around the tube and having integral intersections. For wet spinning (Figure 3), it is envisaged each die head has a diameter in the range of from 6" to 16" with from 200 to 800 die orifices per die lip. The preferred range from the cross-sectional areas of die orifices is from 0.0001 to 0.000625 square inches, whether the die orifices are square or of another shape. For cook extrusion (Figures 1 and 2), the die orifices can be larger and fewer in number.

Figure 1 is a plant for cook extruding a net to which additional edible fibres have already been added. The multiple tubular nets 3 (see also Figure 4) coming from the die heads 2 pass into an applicator and condensing unit 4. The condensing unit 4 contains a condensing funnel 5 (see Figure 4), which funnel 5 has a ring-shaped downstream part 6, and compressing rolls 7 for compressing the already condensed tow issuing from the part 6 to form a coherent tow 8. The condensing funnel 5 is provided with rings of spray nozzles 9 (indicated schematically in Figure 4) connected by manifolds to a pump 10 (Figure 1) for pumping a mixture containing binder to the nozzles 9 and spraying the mixture onto the nets 3 before they are condensed. In operation, the rolls 7 can be driven at such a speed that they stretch and molecularly orientate the tow between the part 6 of the condensing funnel 5 and the rolls 7.

The tow 8 is finally cut off into blocks by means of cutter blades 11.

The plant of Figure 2 is for cook extrusion of a net and applying the additional fibres to the outside of the net. The same references as in Figure 1 are used for similar or identical parts. The nozzles 9 are not included in a compressing unit 12, but are included in a separate applicator 13, which sprays onto the nets a mixture containing binder and the additional fibres.

The plant of Figure 3 is for wet spinning a net and applying the additional fibres to the outside of the net. Once again, references of Figure 1 are used for similar or identical parts.

The tubular nets 3 are spun directly into a coagulant bath 14 in which the nets 3 are collapsed into a flat tow 15. The tow 15 is passed into a machine 16 for stretching and molecularly orientating the tow 15 (which machine may include a second coagulant bath if desired), and then into a washing bath 17, through a dryer 18 and through a binder and fibre bath 19. A mixture containing binder and the additional fibres is contained in the bath 19.

EXAMPLES

In the Examples, all percentages and ratios are by weight.

Example 1

A conventional soya protein mixture for cook extrusion was prepared, and about 10% (by weight of the total mixture) of short fibres having a length of up to 1/8 inch was added. The food product was made as described with reference to Figure 1 above, the binder being a conventional bonding medium.

Example 2

A conventional soya protein mixture was cook extruded using a plant described with reference to Figure 2, and a conventional bonding medium which contained sufficient fibres to provide a fibre weight of 10% of the total weight of the product was sprayed onto the extruded nets.

Example 3

Soya protein was obtained by extraction of 1 part of solvent-extracted soya-bean meal with 8 parts of 0.1 molar sodium hydroxide containing sodium sulphide (0.05%) (in order to prevent oxidation of protein thiol groups), for one hour at

ambient temperature. The insoluble residue was removed by centrifuging and the protein precipitated from the clear supernatant by acidification with sulphuric acid (3 molar) to a pH around 3.5. The protein was separated by centrifuging, washed three times with water, and finally collected as a moist protein paste having a solids content around 22%, by centrifuging at 15,000 r.p.m. for 10 minutes.

Sufficient 2 molar sodium hydroxide solution and distilled water were then added with careful mixing to bring the pH to 12.4, the protein content to 11.0% and the NaOH/protein ratio to 0.08. The solution was deaerated by centrifuging to produce a spinning dope with a viscosity of 19 poise when measured at 25°C on the Shirley-Ferranti (R.T.M.) cone and plate viscometer at a rate of shear of 150 sec^{-1}, and 3.3 poise at a rate of shear of 1200 sec^{-1}. The solution was transferred to the spinning apparatus of Figure 3 and after filtration was extruded. The coagulating bath contained 6% acetic acid and 12% sodium chloride, and the emerging extrudate formed a network structure which was allowed to collapse into a flat tow. The tow could be forwarded into a second coagulating bath (not shown in Figure 3) containing 30% sodium chloride, 3% sodium sulphate, and 0.3% sulphuric acid, thereby receiving a hardening treatment over a period of 10 minutes. After water rinsing in the washing bath, the product was dried, was dipped in the bath which contained a binder, flavour additive, colour additives and sulphur dioxide, as well as edible fibres, and compressed in the unit into a flexible flat tow, dried, and cut into chunks by the blades. The chunks contained edible protein fibres in a network structure with added edible fibres. The chunks simulated meat in handling, cutting and chewing texture.

Example 4

Sufficient sodium hydroxide solution and sodium sulphite were added with stirring to the soya protein paste (prepared as in Example 3) to bring the pH to 12.7, the protein concentration to 12.2g/100g and the sodium sulphite concentration to 1.0g/100g. After deaeration by centrifuging, the viscosity of the resultant spinning solution was found to be 17 poise when measured at a rate of shear of 150 sec^{-1} and 3.6 poise measured at 1200 sec^{-1}. The solution was processed as in Example 3 except the second coagulating bath contained a composition similar to that of the first bath, and the strands were allowed to harden in the second coagulating bath for a period of 1 hour. The end-product was similar to that of Example 3.

WHAT WE CLAIM IS:—

1. A food product comprising a block which includes a compressed and bonded, integrally-extruded net of an edible protein-containing material and additional edible fibres.

2. The product of claim 1, wherein the net is extruded in the form of a tube.

3. The product of claim 2, wherein strands of the net are extruded to extend helically along the tube.

4. The product of any one of the preceding claims, wherein the net comprises longitudinally molecularly orientated strands.

5. The product of any one of the preceding claims, and comprising a plurality of the integrally-extruded nets, compressed and bonded to form the block.

6. The product of any one of the preceding claims, wherein the additional edible fibres are within the edible protein-containing material of the net.

7. The product of claim 6, wherein the additional fibres have a length of up to about 1/8 inch.

8. The product of any one of the preceding claims, wherein the or some of the additional fibres are adhered to the outside of the net.

9. The product of claim 8, wherein the additional fibres have a length of up to about 1/2 inch.

10. A method of making a food product, comprising integrally extruding a net comprising an edible protein-containing material, and compressing and bonding the net to form a block, the block incorporating additional edible fibres.

11. The method of claim 10, wherein the net is bonded by the addition of an edible binder to the net.

12. The method of claim 10 or 11, wherein the net is extruded from relatively moving sets of extrusion die orifices which are continually brought into and out of register to produce integrally extruded net intersections when the respective sets of orifices are in register, the intersections gradually dividing into separate net strands as the orifices move out of register and the strands gradually merging again into integral intersections as pairs of orifices again move into register.

13. The method of any one of claims 10 to 12, wherein the net is extruded into a coagulant bath.

14. The method of any one of claims 10 to 12, wherein the net is extruded by wet spinning.

15. The method of any one of claims 10 to 14, wherein the net is stretched to molecularly orientate the strands thereof.

16. The method of any one of claims 10 to 15, wherein the net is coated with a bonding

agent containing the additional fibres, prior to compressing the net and fibres to form a block.

17. The method of claim 16, wherein the additional fibres have a length of up to 1/2 inch.

18. The method of any one of claims 10 to 17, wherein the net as extruded comprises the or some of the additional fibres.

19. The method of claim 18, wherein the additional fibres within the net have a length of up to 1/8 inch.

20. The method of any one of claims 10 to 19, comprising integrally extruding a plurality of said nets and compressing and bonding the nets to form a block.

21. The food product of claim 1 and substantially as herein described.

22. A food product, substantially as herein described in any one of the Examples.

23. A method of making a food product, substantially as herein described with reference to any one of Figures 1 and 4, Figure 2 and Figure 3 of the accompanying drawings.

24. A method of making a food product, substantially as herein described in any one of the Examples.

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1586564 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

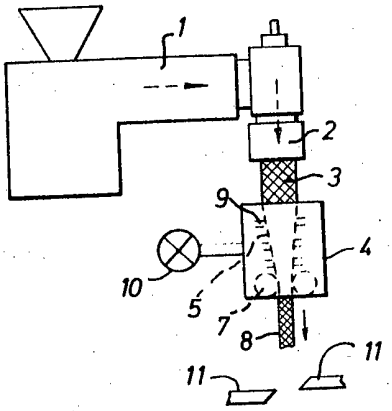

FIG. 1.

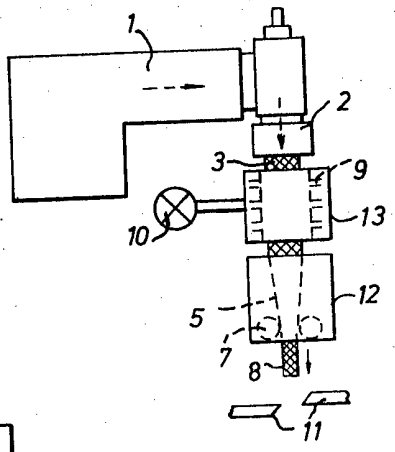

FIG. 2.

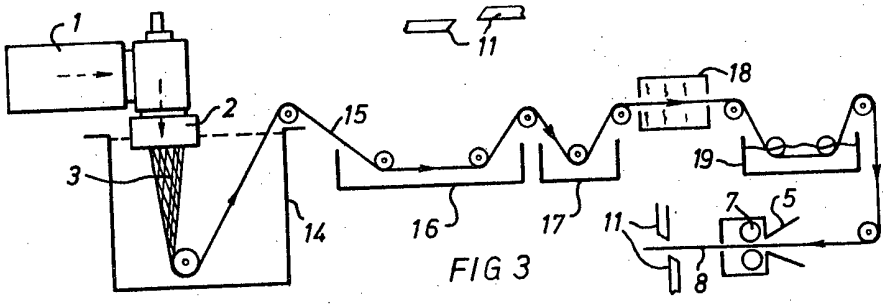

FIG 3

1586564 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

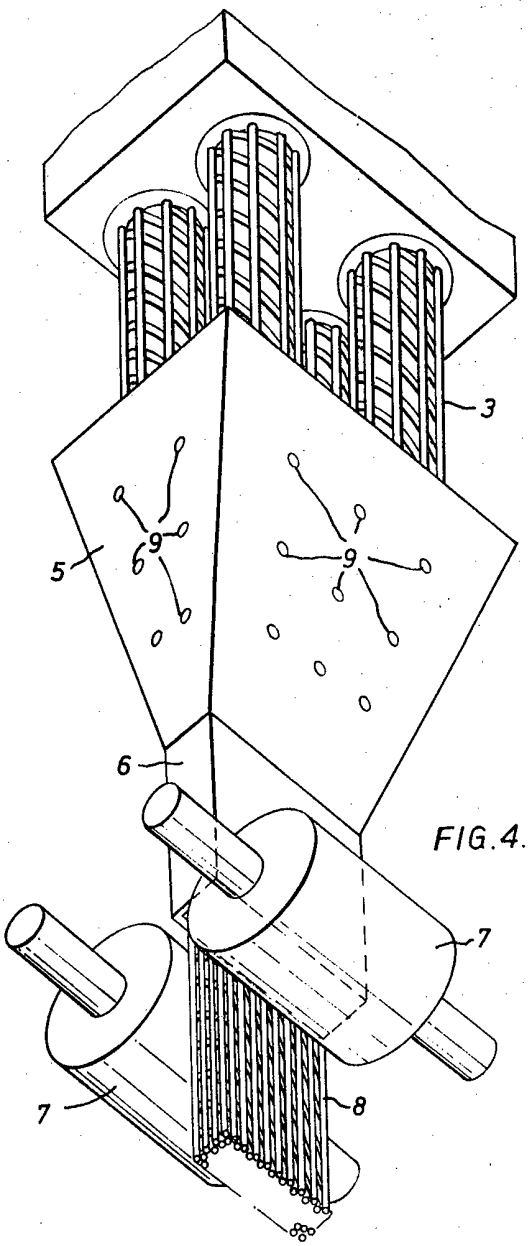

FIG.4.