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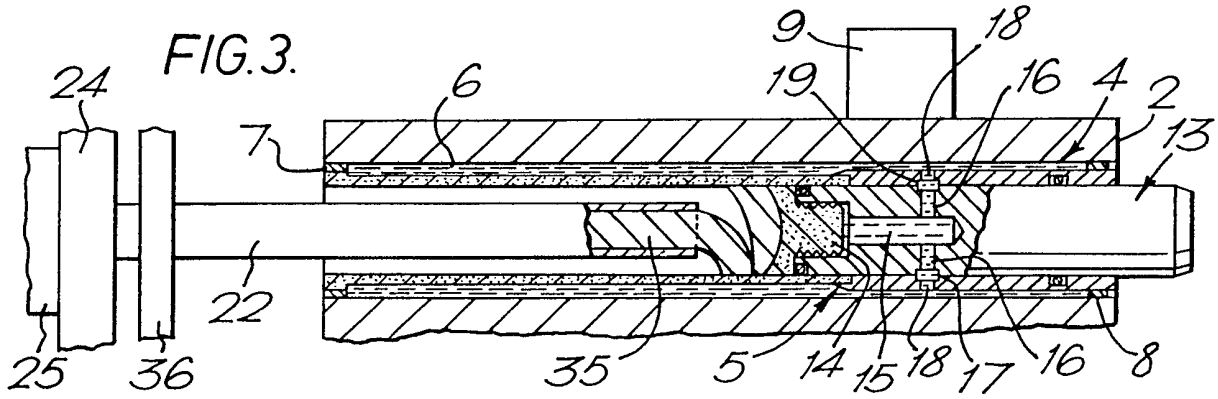
(56) Documents cited
GB A 2004454
GB 1274848
GB 1169500
GB 1076117
GB 0909905
GB 0845059
GB 0519453
WO 0000241

(58) Field of search
B5A

(54) Method for the production of helical protein products

(57) The helical protein product comprises abutting or non-abutting coils, and is made by positioning an injector tube 22 within a substantially cylindrical mould 5, and withdrawing the nozzle from the mould 5 parallel to the cylindrical axis thereof, whilst extruding proteinaceous product forming material from the tube so that the material is deposited in a substantially helical form upon the inner surfaces of the walls of the mould, rendering cohesive (by heat or acid coagulation) at least those regions of the said form which are in contact with the inner surfaces of the walls of the mould, and thereafter removing the product from the mould. Further material may be extruded into a central cavity of the form. The nozzle outlet may be directed towads the mould walls and the nozzle and mould may relatively rotate during extrusion. The mould walls may be pretreated with coagulating acid, or the acid may be admitted from a mould reservoir 6 via porous walls 5, 14, and a porous wall 28 of an end cap 26 (Fig. 2).

FIG.3.



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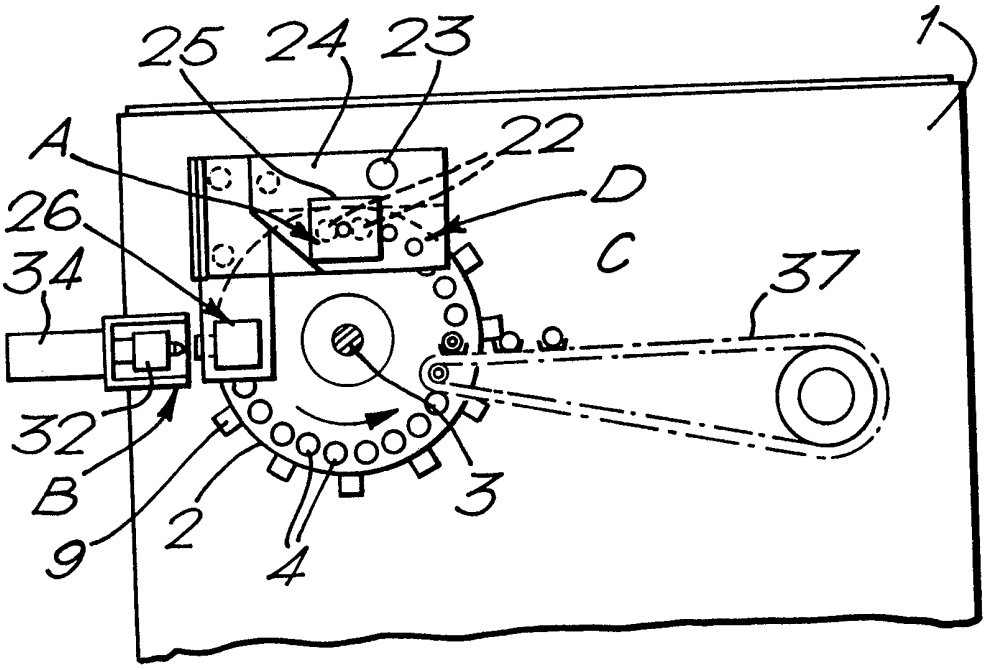
The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

FIG.1.



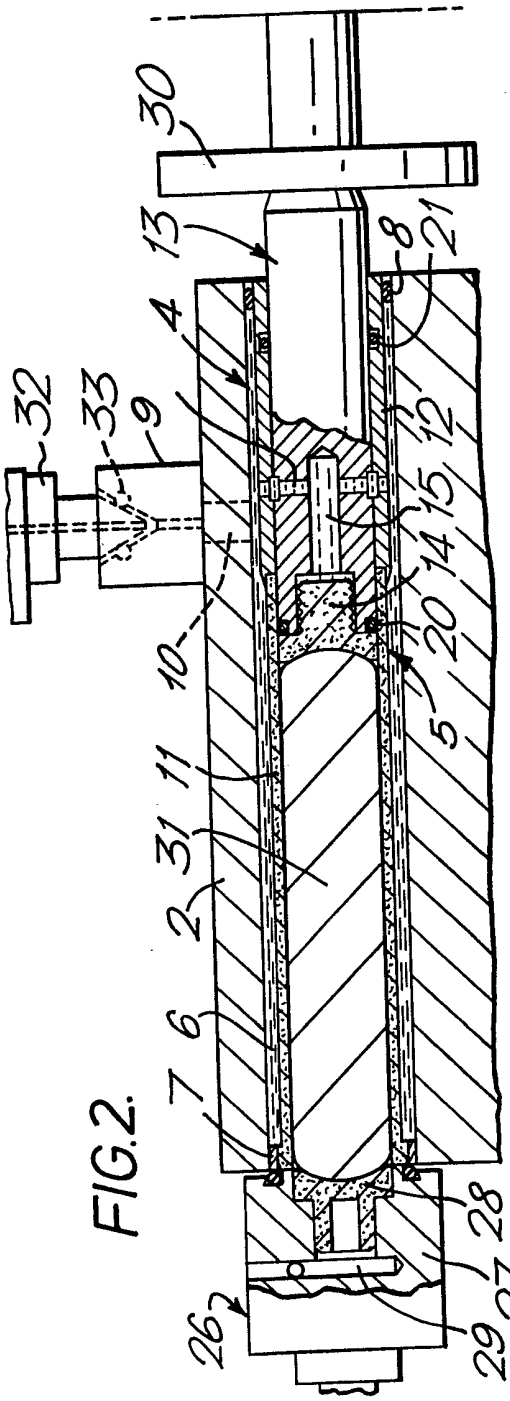

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FIG.2.

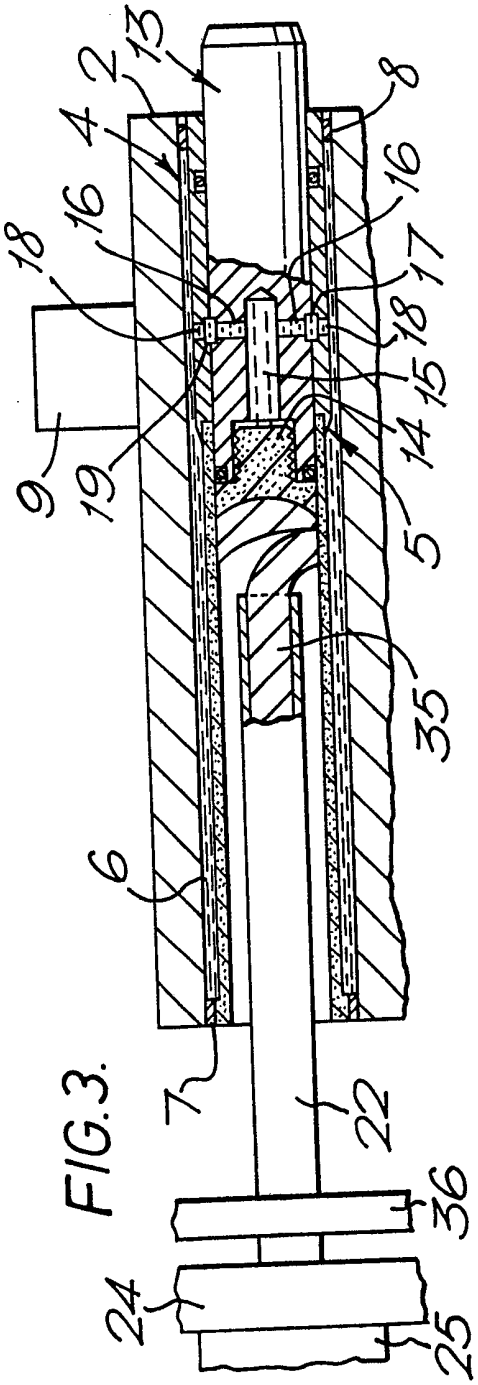
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FIG.3.

SPECIFICATION

Method for the production of protein products

This invention relates to a method for the production of protein products. Such protein products include meat products, fish products and meat-like products based on non-animal protein, e.g. comminted soya or wheat.

Many such products are prepared in a generally cylindrical form. Sausages for example are conventionally prepared by filling a tubular casing with meat emulsion. This casing may be edible e.g. being of natural gut or collagen, and can then remain on the product as the "skin". It is however desirable to keep costs to a minimum and it is for this reason that skinless products, such as sausages, may be preferred to products with skins, since the cost of enclosing the products within an edible skin can amount to a substantial proportion of the total manufacturing costs. In this specification "skinless" means free from a discrete external supporting membrane of e.g. collagen or natural gut.

A conventional method of producing skinless products involves the use of a permeable cellulose casing which may be inedible, or at least unacceptable for consumption. This is filled with e.g. meat paste, formed in links, heat processed to form a heat coagulated product and then cooled, after which the cellulose casing is removed. In United Kingdom Patent 1422344 there is described a process in which the filled casing is treated with an edible acid which reacts with protein at the surface of the meat paste to form a skin, prior to removal of the casing. This may avoid the necessity for heat processing to provide a coagulated skin, but the disposable casings are relatively expensive and their use is labour intensive.

It has been proposed to prepared a skinless product without the use of casings. One advantageous method of doing this is to treat the surface of e.g. a sausage, after it has been shaped, with a suitable fluid, for example an edible acid which reacts with uncooked protein and precipitates to form a cohesive surface for the sausage paste. In United States Patent 3503756 there is disclosed a process in which a meat emulsion is extruded, and then treated in an acid bath, either before or after cutting into suitable lengths for frankfurters or the like. The treating of the extruded meat does however present handling difficulties.

In United Kingdom Patent 1441494 there is disclosed a system in which an edible acid is introduced onto a meat emulsion before it is passed through an extrusion tube, so as to lubricate the emulsion as it passes through the tube, and also to form a cohesive skin for the product as it is extruded. The acid may be introduced through a sintered metal filter.

In United Kingdom Patent No. 2004454B, a method of producing a moulded meat or meat-like product of predetermined shape having a fluid treated surface is described wherein moulding is effected in a rigid mould cavity having a permeable wall through which is introduced the fluid for treating the product to produce a cohesive skin thereon. The treating fluid in the preparation of a skinless sausage for example may be edible acid at ambient or other temperature which, after being introduced through the permeable wall of the cavity, reacts with the protein of the meat to provide a cohesive surface.

The term "cohesive" used herein means treated, e.g. with heat or with edible acid, to coagulate available soluble protein at least in the surface layer of a product to render the product self supporting so that thereafter it can retain its shape.

Whilst by the above described method in U.K. Patent 2004454B it has proved to be possible to produce "skinless" protein products in an advantageous manner without the use of an external supporting membrane, the products are also generally in substantially cylindrical or cuboid form depending on the cross-section of the mould used.

There has developed a demand for protein products of novel constitution and appearance, as is well illustrated by the success met by the "fish finger", and an object of the present invention is to provide a method for the production of further such novel products.

According to one aspect of the invention there is provided a method for the preparation of a substantially helical protein product which method comprises positioning an extrusion nozzle within a substantially cylindrical mould, withdrawing the nozzle from the mould in a direction parallel to the cylindrical axis thereof, extruding proteinaceous product forming material from the nozzle during such withdrawal in such a manner as to deposit the material in a substantially helical form upon the inner surfaces of the walls of the mould, rendering cohesive at least those regions of the surface of the said form which are in contact with the inner surfaces of the walls of the mould, and thereafter removing the product from the mould.

While the extrusion nozzle preferably is directed substantially parallel to the cylindrical axis of the mould, alternatively the nozzle or at least the outlet thereof may be directed at least partially towards the mould walls and during extrusion the cylindrical mould and/or the nozzle may be rotated relative to one another, e.g. about the cylindrical axis of the mould. Such measures may assist in ensuring that a helical form is deposited. It has however been found that providing the rates of extrusion and withdrawal are correctly adjusted, a helical form can be obtained without

the aid of these measures.

Optionally in the process of the invention a further food material may be positioned within the central cavity of the helical protein product, e.g. by extrusion, conveniently during or shortly after the extrusion of the proteinaceous product forming material, to produce "filled" protein products.

Coagulation to render cohesive by heating may be effected e.g. by heating the walls of the mould to about 82°C thus rendering cohesive those surfaces of the product in contact with the walls. Coagulation by treating with edible acid is advantageously effected by the use of permeable moulds of e.g. sintered stainless steel and the introduction of edible acid or another suitable fluid through the walls of the mould onto the outwardly directed surfaces of the product within. Alternatively, the proteinaceous product forming material may be extruded onto mould surfaces which have been pretreated with edible acid whereby coagulation commences when the material contacts the mould surface. A porous mould wall has the ability to "hold" fluid in a surface region and this may be of use if pretreatment is desired.

In a particular embodiment, following acid treatment of protein product-forming material to develop the cohesive surface region, the pH balance of the product may be controlled by the application to the surface of an edible alkali (e.g. an aqueous alkaline solution of pH of about 9 to 14, food grade alkali such as a phosphate).

The invention is particularly applicable to the method and apparatus of U.K. Patent No. 2004454B where an accurately controlled predetermined quantity of edible acid is used.

The term "an edible acid" used herein is intended to cover an acid which is permitted for use in connection with foodstuffs and which does not result in the production of inedible products. Such acids include organic acids e.g. acetic acid, malic acid, ascorbic acid and citric acids, and inorganic acids, e.g. hydrochloric acid and phosphoric acid. The acid would generally be employed in the form of a simple aqueous solution with a pH of between 1.0 and 5.0, e.g. dependent on the availability of soluble protein content for precipitation; the higher that content, the higher the numerical value of the pH. The optimum pH can readily be determined by simple experimentation. In the case of the meat emulsion used for British-style sausages, a pH of about 1.5 to 2.5 may ordinarily be convenient but for fish meat such as is used in the preparation of fish fingers a pH of about 4 may be adequate. Other fluids may of course be employed prior to or together with acid fluid, depending on the operation intended to be carried out. Thus, for example, a liquid solution containing colouring matter, flavouring or smoke extracts to colour or flavour the surface of a product, may be employed.

In the method of the invention, the characteristics of the helical protein product may be varied by varying the rate of withdrawal of the extrusion nozzle, the rate of extrusion through the nozzle of the product forming material, the nozzle aperture size and the internal diameter of the mould. Other factors remaining the same, increased rate of nozzle withdrawal will result in the helix of the product being of lower frequency (ie the centres of neighbouring "coils" will be spaced further apart); increased extrusion rate will result in lower frequency; increased nozzle aperture size will result in the greater thickness of the coils (reducing the diameter of the central cavity); and increased mould internal diameter will result in increased central cavity diameter, increased frequency and reduced coil thickness. It is of course possible to select a coil thickness which is such that for practical purposes there is no central cavity in the product. By reducing coil thickness and by increasing frequency the extensibility of the final product (ie the % increase in length from the relaxed state to breakage as the product is extended along its axis) is increased; extensibilities of at least 500% are readily attainable.

To obtain helical products which maintain their helical shape well on handling, storage and cooking, it is advantageous to produce helical products the neighbouring coils of which abut.

Where further food material is to be extruded into the central cavity of the helical product during the extrusion of the proteinaceous product forming material, the further food material may be extruded from a second nozzle directed parallel to the axis of the mould.

To ensure that the further food material does not extrude in a helical form within or in admixture with the proteinaceous product forming material helix, it is advantageous either to extrude the further food material from the second nozzle at a higher extrusion velocity than that for the proteinaceous product forming material or to commence extrusion of the further food material after that of the proteinaceous product forming material (e.g. by using a second extrusion nozzle which projects further into the mould cavity than the extrusion nozzle for the proteinaceous product forming material). In either case, to prevent adhesion of proteinaceous material to the exterior of the second nozzle, this may be moistened or fabricated from a low friction material such as PTFE.

As the further food material, with which the helical protein products may be filled, the following deserve particular mention: potato, cheese, pastry and tubular egg; however other fillings may of course be used. The ends of the protein product may be so fashioned as to reduce the leakage of the filling upon the

cooking of the filled product, particularly where the further material is such that it melts upon heating.

As mentioned above, in the method of the present invention, the apparatus of UK Patent No. 2004454B may be used to advantage. As noted earlier, this apparatus comprises a rigid mould having a cavity, and means (the extrusion nozzle) for introducing proteinaceous product-forming material into the cavity, wherein the cavity has a permeable wall, and means are adapted and arranged to introduce an edible acid through the cavity wall for treating at least a major part of the surface of the product-forming material whilst in a helical shape.

The means for introducing product forming material into the cavity comprises a nozzle movable into the cavity. The mould may comprise a body of permeable material having a cavity extending therethrough, open at both ends, for example a hollow sintered stainless steel cylinder. A movable plunger may be provided for closing one end of the cavity and may also serve to compact the product forming material during moulding and/or to eject the formed product. The other end may be closed by a suitable end capping device or a further plunger. The mould may be disposed within non-permeable housing of stainless steel or plastics material, the space between the mould and housing being filled with edible acid. The permeability of the cavity wall may be chosen, e.g. being about 2×10^{-8} CM^2, such that no substantial acid passage through the wall will occur until excess acid is injected into the housing. The excess pressure created by such injection causes the acid to pass through the permeable wall and onto the surface of the product forming material in the cavity. The quantity of acid introduced through the permeable wall will be dependent upon the quantity injected into the housing and generally corresponds thereto.

In the production of helical protein products from British-style sausage meat, in mould cavities of about 37 cm^3, with mould internal diameters of 21 mm, an extrusion nozzle diameter of 10 mm an extrusion rate of about 60 $cm^3\ sec^{-1}$ and a withdrawal rate of the nozzle from the cavity of 18.4 cm sec^{-1} has been found suitable. In this way approximately 0.6 seconds is required to extrude the helix of product forming material into the mould. For helical protein products thus produced, about 2 cm^3 of acid of pH about 2.25 has been found appropriate per helical sausage to give a skin thickness of 0.3 mm; some, possibly about 70 to 80%, of the acid is used up in the acid-protein reaction to generate the cohesive surface on the product, the remaining acid serving as a lubricant for the ejection of the product from the mould.

The mould generally will be arranged for movement relative to a plurality of stations at which various operations are carried out, for example filling the cavity with product-forming material; shaping the end of the product with the plunger; injecting acid; ejecting the formed product for transferal, e.g. to an alkali treatment zone; and returning the plunger to its initial position prior to re-filling the cavity. These operations generally will be effected in continuous consecutive sequence.

Following ejection from the mould, the products, may be passed on, e.g. on a conveyor, for further operations such as drying, freezing, packing or, in the case of some, e.g. fish, products, breading.

Where a number of products are formed in a batch at the same time the end products may also be ejected onto a conveyor or the like as a unit ready for packaging with the minimum of further collating, handling etc.

It has been suggested that the mean product chirality will vary with the location of the manufacturing facility. This suggestion, based on analogy with vortex formation, is borne out to some extent by the products produced by the process of the invention in southern England which, for a sample of 16 products do not show equal distribution of right and left handed helices, instead having 11 left handed and 5 right handed.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which:—

Figure 1 is a front elevation of an embodiment of apparatus for use in a method in accordance with the invention;

Figure 2 is a partial longitudinal section of a mould unit, a component part of the apparatus shown in Fig. 1; and

Figure 3 is a partial longitudinal section of the mould unit of Fig. 2 showing the extrusion nozzle positioned therein.

Referring now to Figs. 1 to 3, the apparatus includes a frame 1 on which is mounted a rotatable cylindrical drum 2, on an axle 3 for driven rotation in a counter-clockwise direction about a horizontal axis as shown by the arrow on Fig. 1. The drum 2 is in the form of a block of high density polyethylene, althrough it could be of nylon or any other suitable material.

Around the perimeter of the drum 2 are provided a plurality of cylindrical, open-ended cavities I4 of circular cross-section, extending parallel to the axis of rotation. In each of these is mounted a cylindrical mould body 5 in the form of an open-ended tube of circular cross-section. The external diameter of the mould body 5 is less than the diameter of the cavity 4, for example by about $\frac{1}{4}$ to $\frac{1}{2}$ millimetre, so as to provide a reservoir 6 defined by the annular space between the two. The ends of the reservoir are sealed by a packing piece 7 and an O-ring 8 respectively.

The cavities 4 are grouped together in pairs

and with each pair is associated an acid injector port 9 provided with a ball-valve sealing system (not shown). The injector port communicates with its associated reservoirs 6 by means of a passage 10 (Fig. 2), communicating with a suitably disposed passage and thence via cross-bores suitably positioned along cavity 4, with the reservoirs 6. To reduce swelling of the high density polyethylene, and to minimize leakage of the acid, the cavities 4 may be provided with stainless steel liners.

Each mould body 5 is stainless steel, having a permeable, sintered portion 11 defining a mould cavity, and a solid portion 12. Within the mould body is sealably and slidably positioned a plunger generally indicated at 13, which may be of e.g. HDP. The end face of the plunger is formed by a sintered stainless steel insert 14 threaded into a cavity 15 in the plunger 13. The cavity 15 communicates by means of cross-bores 16 with a circumferential groove 17 in the outer surface of the plunger 13. Bores 18 extend through solid portion 12 of the mould body 5, and communicate with a circumferential groove 19 therein, arranged to co-operate with the groove 17 in the plunger 13. There is thus fluid communication between reservoir 6 and the cavity 15 in plunger 13. O-ring seals 20 and 21 in the plunger and mould body respectively, prevent leakage during fluid injection.

In operation, the drum 2 is rotated stepwise to selectively bring the pairs of associated mould bodies 5 with their associated plungers 13, to a number of operating stations. These are marked A, B, C and D on Figure 1.

At station A, the plunger 13 projects slightly from the mould cavity. Injector tubes 22 are inserted into the ends of the mould bodies 5 remote from the ends closed by plungers 13. One injector tube 22 is inserted into each of the pair of associated mould bodies 5, by means of suitable apparatus driving an arm 23 carrying a frame 24 on which the tubes are mounted. The tubes are guided through apertures in a stationary mounting plate 36.

An emulsion containing sausage meat of a plastic consistency is injected through the tubes by means of a suitable metering valve 25 feeding the tubes 22 simultaneously. The tubes 22 retract as injection takes place, frame 24 moving away from the drum 2. In a preferred embodiment injection of emulsion from tubes 22 is not commenced until after the tubes 22 have started to retract. Suitably, rates of emulsion extrusion into 37 cm^3 moulds having internal diameters of 21 mm are about 60 $cm^3\ sec^{-1}$ with a tube withdrawal speed of about 18.4 cm sec^{-1}: withdrawal is completed in about 0.6 secs. The injection of the emulsion 35, in which the salt and water soluble protein of the meat have been extracted during a blending or chopping operation at such a rate as to produce a helical protein smear on the inner surface of the mould bodies. When the mould cavities in the mould bodies 5 have helical forms of meat emulsion along the required lengths, the tubes 22 are fully retracted, and the drum indexed round to bring the pair of mould bodies to station B. Here the position is as shown in Fig. 2.

An end capping device 26 supported on the mounting plate is moved into position against both mould bodies by suitable means such as a pneumatic unit. This device includes a block 27 provided with a pair of sintered stainless steel inserts 28 mounted therein. The inserts communicate with a passageway 29 so that fluid can be passed through them. At the same time as the end capping device 26 is moved into position, a tamping plate 30 is moved forward by suitable means to contact the pair of associated plungers 13 to ensure that the second ends of the products, ie helical sausages 31 are formed correctly.

The reservoirs 6, and cavities in the plungers 13 and end capping device are already filled to capacity with a suitable edible acid, e.g. acetic acid of pH 2.25, and the sintered parts are saturated. As the products are formed, and acid injector nozzle 32, which has been moved into sealing engagement with the injector port 9, provided with a sealing ring 33 by suitable means such as a pneumatic device 34 mounted to frame 1, is used to inject additional acid into the reservoirs 6 and plunger cavities 15. The acid injector system communicates with passages 29 in end capping device 26 via an external line (not shown), and additional acid is therefore also passed into there. Thus acid passes through the permeable, sintered parts 11, 14 and 28 defining the mould cavities, and onto the surfaces of the products 31 to react with the protein and render cohesive the outwardly directed regions of the surface.

The acid injector nozzle 32, end capping device 26, and tamping plate 30 are then withdrawn, and the drum 2 indexed round until the pair of mould bodies with products 31 therein, reach station C. During this period which may be for example 6 or 7 seconds the acid penetrates the required depth of say 0.3 mm into the product surfaces to form an acceptable cohesive surface.

Adjacent the station C is a conveyor belt 37 onto which products 31 are ejected from the mould bodies 5 by means of push rods or plungers. The push rods or plungers are then withdrawn and further acid treated products 31 are indexed into position at station C for ejection. Following station C the mould bodies 5 are indexed to station D where a pair of return rods are inserted into the mould bodies urging plungers 13 back into the slightly retracted position adopted for the insertion of

product forming material at station A. The return rods are then retracted and the drum indexed round to bring the pairs or sets of mould bodies to station A, so that the moulding process can be repeated.

Although rotary apparatus has been described for the moulding process steps linear apparatus could be employed.

The invention extends also to the products and filled products made by a method in accordance with the invention. In one broad aspect it will be appreciated that the invention extends to substantially helical skinless protein products produced from proteinaceous product forming material containing soluble protein available for coagulation whereof at least the substantially outwardly directed regions of the product surface are cohesive.

CLAIMS

1. A method for the preparation of a substantially helical protein product which method comprises positioning an extrusion nozzle within a substantially cylindrical mould, withdrawing the nozzle from the mould in a direction parallel to the cylindrical axis thereof, extruding proteinaceous product forming material from the nozzle during such withdrawal in such a manner as to deposit the material in a substantially helical form upon the inner surfaces of the walls of the mould, rendering cohesive at least those regions of the surface of the said form which are in contact with the inner surfaces of the walls of the mould, and thereafter removing the product from the mould.

2. A method as claimed in claim 1, wherein the extrusion nozzle is directed substantially parallel to the cylindrical axis of the mould.

3. A method as claimed in claim 1, wherein at least the outlet of the nozzle is directed partially towards the mould walls and during extrusion relative rotational movement of the cylindrical mould and the nozzle is effected.

4. A method as claimed in claim 1, 2 or 3, wherein the walls of the mould are heated to coagulate and render cohesive those surfaces of the product in contact with the walls.

5. A method as claimed in claim 1, 2 or 3, wherein a permeable mould is used and an edible acid or other suitable fluid is introduced through the walls of the mould onto the outwardly directed surfaces of the product within to effect coagulation of said surfaces.

6. A method as claimed in any preceding claim wherein further food material is disposed within the central cavity of the helical protein product.

7. A method as claimed in claim 6, wherein said furtherm food material is extruded into the central cavity of the helical product during the extrusion of the proteinaceous product forming material, the further food material being extruded from a second nozzle directed parallel to the axis of the mould.

8. A substantially helical protein product produced by a method as claimed in any preceding claim.

9. A substantially helical skinless protein product produced from proteinaceous product forming material containing soluble protein available for coagulation whereof at least the substantially outwardly directed regions of the product surface are cohesive.

10. A method for the preparation of a substantially protein product substantially as hereinbefore described with reference to the accompanying drawings.

11. A substantially helical protein product substantially as hereinbefore described.

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