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A Process for Structuring a Food
Product and the Product Obtained

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This invention relates to the structuring of food products.

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There are already various known techniques for structuring pasty products which are applied above all to the treatment of proteins and which lead to structured products having varied physical and organoleptic characteristics.

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One known technique involves extrusion. In this technique, a moistened paste of fat-free vegetable flour is rendered plastic by heat and pressure in an extrusion chamber. The paste issues through the extrusion nozzles into an expansion chamber at atmospheric pressure or in vacuo. Under the effect of the sudden decompression by which some of the water is expelled from the hot material, the hot material is expanded and rigidified.

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In another known technique known as explosion structuring, steam is injected under pressure and at elevated temperature into an aqueous suspension of protein material in the amorphous or non-organised state and optionally containing a glucidic filler and fats. The protein is structured and rendered porous by instantaneous evaporation of the water through sudden expansion of the steam.

The techniques mentioned above have their disadvantages. Thus, they may be accompanied by a reduction in the nutritive value of the food arising out of the heat treatment. Extrusion does not enable fats or sugar to be incorporated and only leads to articles of small dimensions. In addition, these techniques can only be carried out under strict control and are complex and expensive.

On the other hand, ultra-high-frequency energy is normally used in food technology for pasteurising or sterilising products in their packs, for coagulating a binder or even for the post-drying of cooked products.

It has been found that the disadvantages of known structuring techniques can be obviated by applying a simple and inexpensive method.

Accordingly, the present invention relates to a process for structuring a food, which comprises preparing a paste having a dry matter content of from 10 to 50% by weight and containing a protein material which is non-denatured oleaginous vegetable protein, such as soya proteins, or non-denatured fish protein, such as fish scraps, and/or a pre-gelatinised puree of vegetables rich in starch, such as potato puree, and a chemical leavening agent and subjecting the paste to microwave radiation. The process according to the present invention may be carried out as follows: the paste containing the chemical leavening agent is pumped through a nozzle and delivered in the form of a band onto a conveyor belt passing through a tunnel and receiving ultra-high frequency energy through a radiating-slot applicator. Under the effect of the heat generated in the mass and the evolution of carbon dioxide,

the band of paste expands with the formation of a cellular structure. This structure is set by continuation of the drying process.

5 The constituent material of the paste may be selected from non-denatured oleaginous vegetable proteins, non-denatured fish protein, and purees of vegetables.

10 The oleaginous vegetable proteins may be whole or fat-free, for example soya in the form of milk or flour. Examples include fat-free soya flour obtained by grinding cakes; fat-containing soya flour or cakes containing an added vegetable or animal fat; soya milk containing proteins, lipids and soluble sugars after separation of the insoluble polysaccharides and
15 concentration; soya milk containing insoluble polysaccharides after concentration; the complex formed from a whole soya milk by co-precipitation of the proteins, lipids and insoluble polysaccharides at the isoelectric pH, separation of the soluble sugars,
20 followed by neutralisation. One advantageous starting product is formed by a soya curd obtained by coagulation of the soya milks and soya complex mentioned above and, more particularly, by the coagulation of a soya milk from which the insoluble polysaccharides have been
25 separated. This soya milk is obtained by the addition of a coagulating agent such as, for example, a calcium salt such as CaCl_2 or $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ or glucono- δ -lactone or even a mixture of this calcium salt or salts with glucono- δ -lactone, in a quantity of from 1 to 4% by
30 weight, based on the dry matter of the milk, followed by separation to the required dry matter content.

Alternatively, coagulation may be obtained by adding one of the coagulating agents, for example glucono- δ -lactone, and then another coagulating agent, for example, the calcium salt, to the curd before structuring.

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Another starting material is formed by fish proteins, particularly the fish scraps obtained after separation of the bones from the waste during filleting. The untreated scraps are advantageously mixed with scraps which have undergone a "smoothing" treatment or

10 disintegration by fine-grinding.

A further starting material is formed by a puree of vegetables rich in starch, particularly potatoes, prepared from freshly cooked potatoes or from

15 potatoes reconstituted from the potato flakes by the addition of water or milk. It is important that the protein materials used should be in a native state, i.e. non-denatured by chemical or heat treatment capable of altering their gelling properties. Thus, the commercial isolates and concentrates

20 of soya proteins which have generally undergone a heat shock are not suitable for the process according to the invention. The puree of vegetables rich in starch should be pregelatinised before the structuring phase.

The paste contains the various materials mentioned

25 above either individually or in admixture. It is obtained either directly or by reconstitution from a powder and water, optionally with the addition of fats or sugar. A chemical leavening agent is added thereto. It produces the cellular

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expansion by the evolution of carbon dioxide in the mass of the product under the effect of heat. It also has the effect of increasing the pH value. Adjustment of the pH value of the mass to between 6.0 and 7.5 is beneficial to the cohesion of the product. The leavening agent used may be selected from commercial leavening powders and conventional chemical leavening agents. Examples include a commercial leavening powder containing a substance giving off carbon dioxide, a stabiliser and a neutralising acid substance, such as a mixture of equal parts by weight of sodium bicarbonate, acid disodium pyrophosphate and starch; sodium bicarbonate optionally containing an added edible acid, such as citric or tartaric acid; ammonium bicarbonate; glucono- δ -lactone, etc. The quantity of leavening agent added to the paste depends on the type of starting material and on its dry matter content. Satisfactory results are obtained with a quantity of commercial leavening powder of from 1 to 20% and preferably 5% by weight, based on the dry matter content of the paste, and with a quantity of chemical leavening agent, such as sodium bicarbonate, of from 0.5 to 15% and preferably 2% by weight, based on the dry matter content of the paste, and with a quantity of ammonium bicarbonate of from 0.5 to 5% by weight, based on the dry matter content of the paste.

It is also possible to incorporate in the mass of the paste flavourings which produce either a savoury taste, such as for example cheese flavourings, pizza sauce, tomato or vegetable concentrate, meat flavouring based on protein

hydrolysates, aromatic fats, smoked meat flavouring, spices, etc., or a sweet taste: flavourings, extracts or pastes of fruits such as lemon, pineapple, orange, vanilla, cocoa powder, caramel flavouring, sweetened products, etc.

5 The dry matter content of the paste to be structured should lead to an adequate viscosity:

- If the paste is too viscous, the mass is heterogeneous, granular, disperses poorly with the leavening agent
- 10 or the flavouring additives and is difficult to pump,
- too liquid, the paste spreads out over the belt of the microwave oven and the throughput has to be reduced.

 The paste advantageously has a dry matter content of from 10 to 30% by weight. Where a soya curd, a fish paste

15 or a potato puree is used as starting material, the paste preferably has a dry matter content of from 15 to 22% by weight. In some cases, where the paste is reconstituted from powder-form starting materials, such as soya cakes, a powder-form soya milk or curd, the dry matter content in the premix

20 before structuring may be of the order of 30 to 50% by weight, depending on the water absorption level and the composition of the powders, to give the required viscosity of the paste.

 The structuring tunnel comprises one or more

25 compartments. It may vary in length depending on the degree of drying required in the end product.

 In one embodiment, the band of paste undergoes expansion in a compartment comprising an ultra-high-frequency applicator. The dry matter content of the product after this

operation is of the order of 88 to 90% by weight. The drying process carried out in vacuo or in air may be continued to a dry matter content of the order of 90 to 97% by weight. In that case, the tunnel may comprise a single, longer compartment equipped with an antenna.

In a modification, the tunnel may comprise several antennae with different power outputs.

The tunnel may even comprise an applicator in a first sequence and a conventional infrared radiation heating system in a second sequence. The conveyor belt may have different characteristics, the form given to the product depending on the configuration of the belt. For example, it may be in the form of a gutter capable of receiving the liquid product or in the form of a flexible belt forming a mould for the product. The ultra-high-frequency energy to be delivered depends on the nature of the product and on the quantity of water which it is desired to evaporate and hence on the initial water content of the paste, its throughput and the water content required in the end product.

A throughput of 1 to 8 kg per hour for a useful powder of 5 kW at a frequency of 2450 MHz corresponds to a residence time in the tunnel of from 1 to 8 minutes.

The process according to the invention enables a whole range of products varying in their moisture content to be obtained :

- Products of the snack type, of which the dry matter content is from 90 to 97% by weight, which requires intensive drying as indicated above.

- Products intended to be worked in the fresh or frozen state, in which case their dry matter content is from 15 to 70% by weight and the powder applied and/or the residence time are respectively lower and shorter.

5. Products of the snack type may be homogenous or composite with several layers made of different starting materials obtained for example by co-extrusion using a multiple-bore nozzle. They may be flavoured in the mass as indicated above or surface-flavoured at the entrance to the conveyor belt, for example with cheese, a pizza flavouring, an aromatic paste based on protein hydrolysates, pieces of bacon, spices, etc. An aromatic paste, for example of cheese, a paste of nuts, etc. may then be introduced into the mass in a large quantity without any adverse effect upon structuring. The products may also be flavoured by coating after passage through the structuring tunnel, for example with a layer of chocolate or with a savoury or fatty covering.

20 The process according to the invention enables various products to be utilised by making them suitable for all kinds of culinary application.

- It enables waste, such as fish scraps, to be utilised without altering their taste and nutritional value by virtue of the mildness of the structing treatment.

25 - It enables a paste of high moisture content to be directly and continuously structured in dimensions which cannot be obtained with conventional structuring processes and is distinguished by its operational simplicity.

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- The structuring of a soya curd gives an organoleptically neutral product which no longer has a soya taste, which is rich in proteins and lipids and which has a high nutritional value : the antitrypsic factor is reduced, approximately 70% of the flatulent sugars contained in the beans are eliminated.

- Products of the snack type based ^{on}soya rehydrate very easily in water at 20 to 70°C without losing their cohesion and their cellular structure.

The process according to the invention is illustrated by the following Examples in which the percentages and parts quoted are by weight, unless otherwise indicated.

EXAMPLE 1

Soya semolina is ground and the flakes obtained are converted into milk by the addition of water in a ratio of 1:7. The milk is then pasteurised at 110°C and the insoluble fractions are eliminated therefrom by centrifuging. The milk which contains 81% of dry matter and 93% of the proteins from the starting semolina is then coagulated by the addition of calcium chloride in a quantity of 3%, based on dry matter. The curd obtained is then separated. It has a dry matter content of 18%, corresponding to 64% of the dry matter and 85% of the protein used, and contains from 58 to 62% of proteins and from 26 to 29% of lipids, based on dry matter.

The paste is then mixed with 3% of commercial leavening powder containing 1/3 of sodium bicarbonate, 1/3 of acid disodium pyrophosphate and 1/3 of starch. The paste

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then has a dry matter content of 20.4% and a pH of 6.5.

The paste is then pumped through a flat nozzle measuring 6 mm to 55 mm at a rate of 7 kg/hour onto a conveyor

belt passing through the structuring tunnel 1.80 m long

5 and equipped with a radiating-slot applicator connected by a waveguide to a generator delivering a power of 5kW at a frequency of 2450 MHz. The paste passes through the tunnel in 260 seconds. The product expands and assumes a cellular structure whilst the core temperature reaches approximately
10 90°C. The product of the snack type has a dry matter content of 97%, is light yellow in colour and has a cellular crispy structure without any taste of soya.

The same procedure carried out without the addition of leavening agent gives a greyish, fissured product with a
15 hard dry texture.

EXAMPLES 2-3

Similar results are obtained by proceeding in the same way as in Example 1, but by preparing the soya curd as indicated in Table 1 below:

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TABLE 1

Example	Coagulating agent	% of coagulating agent used, based on dry matter	% dry matter before structuring
2	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	3.8	21.9
3	glucono- δ -lactone	4	22

EXAMPLES 4-9

The procedure is as in Examples 1 to 3 using the starting materials and method indicated in Table 2 below for preparing the soya curd:

TABLE 2

Example	Soya-based starting material	Coagulating agent	% of coagulating agent used based on dry matter	% dry matter before structuring
4	Milk+insoluble fractions (proteins +lipids+soluble sugars+insoluble polysaccharides)	CaCl_2	3	23.5
5	"	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	3.8	22
6	"	glucono- δ -lactone	4	23
7	Complex obtained by isoelectric co-precipitation of the proteins+lipids+insoluble polysaccharides and neutralisation to pH 7	CaCl_2	3	18.3
8	"	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	3.8	17.6

/continued.....				
9	"	glucono- δ-lactone	4	17.1

The products obtained after passage through the structuring tunnel as in Example 1 are light yellow in colour with good expansion, but have a drier texture than the products of Examples 1 to 3.

EXAMPLES 10 to 16

5 The procedure is as in Example 1, except that the starting material subjected to structuring is based on soya products other than soya curd, i.e. either soya milk or soya complex dried by spray-drying or soya milk reconstituted by the addition of fats to the fat-free soya cakes. The
10 composition of the paste subjected to structuring is shown in Table 3 below :

TABLE 3

Example	Starting material	% dry matter before structuring	pH-value of the paste
10	Milk containing:lipids+ proteins+soluble sugars, spray-dried	40.1	-
11	Milk containing:lipids+ proteins+soluble sugars+ insoluble polysaccharides, spray-dried	33.1	-
12	Complex obtained by iso-electric co-precipitation of the proteins+lipids+ insoluble polysaccharides and neutralisation to pH 7, spray dried	35	-
13	Fat-free soya cakes or flour SOJA FLUFF W 200 (CENTRAL SOJA U.S.A.) containing Nx 6,25 based on dry matter : 52% fats : 1-3%	34.4	6.8
14	Flour of Example 13+ 11% of soya oil	39.4	6.7
15	Flour of Example 13+ 22% of soya oil	45.3	6.8
16	Flour of Example 13+ 11% of bacon fat	39.2	6.8

Although the starting materials can be conveniently structured, the products obtained are less expanded and have a drier texture than the products based on soya curd of Examples 1 to 9.

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EXAMPLES 17-22

The procedure is as in Example 1, the soya curd subjected to structuring varying in its dry matter content.

Table 4 below shows the influence of the initial dry matter content of the soya curd on the structuring conditions.

TABLE 4

Example	% of leavening agent, based on dry matter of the curd *	% dry matter of the curd	% dry matter of the paste	pH
17	4.85	16.50	17.20	6.2
18	6.84	19.00	20.00	6.3
19	14.94	20.08	22.41	6.5
20	17.30	17.34	19.75	6.5
21	22.99	13.05	15.58	6.4
22	29.53	10.16	12.78	6.5

Example	Viscosity ** mPaS (cps)	Microwave treatment time (seconds)	Throughput of curd (kg/h)
17	-	240	7.00
18	-	240	7.00
19	870,000	182	7.88
20	124,000	155	7.88
21	30,800	125	6.31
22	1,060	139	3.07

* commercial leavening powder, 3% or sodium bicarbonate, 1% based on the mass as such

** before viscosity measurement, the mass is smoothed (finely ground) for 10 minutes

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EXAMPLE 23

5g of product have been rehydrated for 10 minutes in an excess of water at 60°C. It is found that the structure of the products of Examples 1 to 12 is highly resistant whilst the structure of the products of Examples 14 and 16 remains just intact.

EXAMPLES 24 to 27

Fish scraps coming from bone separators during filleting and containing 17.9% of dry matter are defrosted and 1.4% of commercial leavening agent added thereto. After mixing and, optionally, smoothing of the mass for 5 minutes, the paste is distributed by means of a 5 cm wide and 0.6 cm thick nozzle onto the belt of the radiating-slot microwave applicator. The power applied is 3 kW and the treatment time 85 seconds at a frequency of 2450 MHz.

On issuing from the applicator, the band of fish has a dry matter content of 18 to 22%. The results of evaluation of the texture and taste are set out in Table 5 below.

TABLE 5

Example	Starting material	Structuring cohesion	Evaluation of taste
24	fish scraps	pumping difficulties	good taste, texture moisture
25	smoothed fish scraps	good cohesion	less clean fish taste, compact texture
26	50% fish scraps 50% smoothed fish scraps	good cohesion	acceptable fish taste, compact texture

27	75% fish scraps 25% smoothed fish scraps	good cohesion	good fish taste and texture
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The band of fish has good cohesion and a clean fish taste. When cooked in a frying pan, it has the appearance, texture and taste of a fillet.

Similar results are obtained using 1% of sodium bicarbonate or ammonium bicarbonate as leavening agent. In the absence of leavening agent, the product obtained has poor cohesion and a brittle texture.

EXAMPLE 28

Potato puree which has been obtained by the addition of 10 of water to potato flakes, which has a dry matter content of from 16.5 to 18.2% and to which 1% of commercial leavening agent is added, is structured under the same conditions as in Example 1. The product obtained has a good snack texture and a clean taste of potato.

15 EXAMPLE 29

Potato puree which has been obtained by steam cooking and then grinding whole peeled potatoes, which has a dry matter content of 15.3% and to which 0.5% of sodium bicarbonate is added, is structured under the same conditions as in Example 1.

20 The product obtained is comparable with that of Example 28.

EXAMPLES 30-31

Sucrose is added to the curd prepared in the same way as in Example 1 and the mixture is structured in the same way as in that Example. The treatment parameters are set out

25 in Table 6 below :

TABLE 6

Examples	% dry matter of starting curd	% sucrose added based on total dry matter	% leavening agent* based on dry matter
30	17.9	30.9	5.0
31	17.8	62.9	3.3

Examples	% dry matter of mixture	Viscosity in mPaS (cps)	Microwave treatment time (seconds)	Throughput of curd kg/h
30	23.7	64,000	270	7.3
31	37.7	17,200	270	8.0

* commercial leavening powder

The products obtained are well structured.

EXAMPLES 32-37

Following the procedure of Example 1, the soya curd is coagulated with different coagulating agents and the leavening agent and, optionally, the calcium salt are added to the curd before structuring under the conditions shown in Tables 7 and 8 below :

TABLE 7

Examples	Soya milk coagulated with....% of CaCl_2 based on dry matter	Leavening agent* based on dry matter %
32	1.5	4.3
33	2.0	4.3
34	2.5	4.4

Examples	Dry matter content before structuring %	Structure of end product
32	18.6	irregular, highly aerated, large cells
33	18.7	fairly regular, few large cells, less expanded than 32
34	18.2	less expanded than 32 and 33

* commercial leavening powder.

TABLE 8

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Examples	Soya milk coagulated with....% of glucono- δ -lactone based on dry matter	pH of curd	pH of curd before structuring (add NaHCO_3 , 1% based on the mass as such)
35	4	5.4	7.0
36	4	5.4	7.0
37	+ 1.5 1.5 CaCl_2	5.5	7.0

Examples	Addition of CaCl_2 (%) based on dry matter in the mass before structuring	Structure of end product
35	-	irregular, highly aerated, large cells.
36	1	less expansion and more compact than 35
37	-	expansion equal to 35, regular



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CLAIMS

1. A process for structuring a food, which comprises preparing a paste having a dry matter content of from 10 to 50% by weight and containing a protein material which is non-denatured oleaginous vegetable protein or non-denatured fish protein and/or a pregelatinised puree of vegetables rich in starch and a chemical leavening agent and subjecting the paste to microwave radiation.
2. A process as claimed in Claim 1 in which the non-denatured protein material is soya proteins or fish scraps.
3. A process as claimed in Claim 1 in which the pregelatinised puree of vegetables is a potato puree.
4. A process as claimed in any of Claims 1 to 3 in which the paste contains a soya curd obtained by coagulating an optionally fat-free, fresh or reconstituted soya milk or a soya complex obtained from a whole soya milk by isoelectric co-precipitation of the proteins, lipids and polysaccharides, followed by neutralisation.
5. A process as claimed in Claim 4, in which the soya curd is obtained by coagulating a soya milk or a soya complex with a calcium salt and/or glucono- δ -lactone.
6. A process as claimed in any of Claims 1 to 5 wherein the chemical leavening agent is a commercial leavening powder containing a substance producing carbon dioxide, a stabiliser and an acid neutralising substance.
7. A process as claimed in any of Claims 1 to 5 wherein the chemical leavening agent is sodium or ammonium bicarbonate.



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8. A process as claimed in any of Claims 1 to 7, in which the paste is formed into a band which is delivered onto a conveyor belt having the required configuration which passes through a structuring tunnel equipped with a radiating-slot microwave energy applicator which causes the band to swell and dry, leaving it with a cellular structure.

9. A process as claimed in Claim 8, wherein the paste passes through a structuring tunnel over a period of 1 to 8 minutes.

10. A process as claimed in any of Claims 1 to 9 wherein the structured product is dried in vacuo or in air to a dry matter content of from 90 to 97% by weight.

11. A process as claimed in any of Claims 1 to 9 wherein the paste is treated in the structuring tunnel until it has a dry matter content of from 15 to 70% by weight either for direct use or for freezing of the structured product.

12. A process as claimed in Claim 10, in which the product is flavoured after structuring by coating to transform it into an article of the snack type.

13. A process for structuring a food, substantially as described with particular reference to any of the Examples.

14. A structured food obtained by a process as claimed in any of Claims 1 to 13.

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