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Process for the manufacture of a composite consumable product by double extrusion.

5 A subject-matter of the present invention is a process for the manufacture of a composite consumable product by double extrusion and a plant for carrying out the process.

10 EP 0,626,138 (Quaker Oats) discloses a process for the manufacture of instant cereals, in which a mixture based on cereal flour and water is cooked-extruded, the cooked-extruded mixture, to which pieces of food substance have been added, is shaped into flakes, the flakes are toasted, they are coated with a sugar syrup, forming a film at the surface thereof, and
15 they are dried.

US 3,764,715 (Quaker Oats) discloses a process for the manufacture of a coated instant cereal, in which a mixture based on cereal flour and water is prepared, the mixture is cooked-extruded-expanded in
20 the form of a tubular strand using an extruder equipped with a coextrusion die comprising an annular outlet orifice surrounding a central outlet orifice, the syrup is injected inside the tubular strand via the central outlet orifice, the cereal strand comprising the sugar
25 syrup is cut into pieces at the die face, and the pieces are dried so that the syrup which is present in them diffuses from the inside towards the outside and forms a film of dry syrup around them.

EP 0,815,729 (Société des Produits Nestlé S.A.)
30 discloses a process for the manufacture of a foodstuff by extrusion, in which a first food substance to be processed is introduced into a first section of a twin-screw extruder, a second food substance to be processed is introduced into a second section of the twin-screw
35 extruder separated dynamically from the first, these substances are each processed independently in their section of the extruder, the two masses obtained are extruded by being passed through at least one die and the extruded or coextruded products are cut up.

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An aim of the present invention is to provide a process and a plant which make possible simplified and particularly well controlled manufacture of a composite consumable product.

5 To this end, in the process according to the present invention, a liquid or pasty consumable substance is prepared in a first section of a twin-screw extruder, a plasticizable consumable substance is cooked-extruded in a second section of the twin-screw
10 extruder separated dynamically from the first, at least one strand of a cooked-extruded mass is obtained, it is cut up into pieces, the liquid or pasty consumable substance is added to the cooked-extruded mass and pieces of a composite consumable product are obtained
15 therefrom.

Likewise, the plant according to the present invention comprises a twin-screw extruder separated into two distinct sections by a dynamic separation device, at least one die, cutting means and a device
20 for adding a liquid or pasty substance.

Such a process and such a device effectively enable simplified and particularly well-controlled manufacture of a composite consumable product.

The composite consumable product which can be
25 obtained by the present process and/or using the present plant, in particular a coated product, a coextruded product with a soft interior and crunchy exterior or a composite product impregnated throughout its body, also comes within the scope of the present
30 invention.

In the present account, the expression "consumable substance" must be understood as a substance which can be consumed by human beings and/or as a substance which can be consumed by pets, such as dogs
35 or cats, for example.

The expression "plasticizable consumable substance" covers all the components introduced together or separately, simultaneously or successively, into the second section of the extruder and cooked-

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extruded altogether at least over a portion of this section.

Any plasticizable consumable substance from which it is possible to produce, by cooking-extrusion, products more particularly intended for humans, such as breakfast cereals, cereals for infants, snacks, breadcrumbs or confectionery, or products more particularly intended for pets, such as dry pet food, for example, may be the starting substance in carrying out the present process.

The plasticizable consumable substance can thus be based on milled cereal and water and can comprise a major portion of cereal flour or semolina, in particular wheat, barley, oats, maize and/or rice flour or semolina, and water, for example.

The plasticizable consumable substance can additionally comprise starch, in particular wheat, barley, rice, tapioca, potato or maize starch, sugar, in particular sucrose, glucose or fructose, oil or fat, in particular butter oil or a palm kernel, ground nut or maize oil or fat, a source of plant fibre, such as bran, nonfatty solids from milk, in particular skimmed milk powder, and/or additives, such as vitamins, trace elements, antioxidants and/or dyes, for example.

The plasticizable consumable substance can also comprise, in particular in the case where it is more particularly intended for consumption by pets, leguminous flour or semolina, such as soya, meat or fish meal or hydrolysate, and/or tallow, for example.

The components of the plasticizable consumable substance and their respective proportions can be chosen and they can be introduced individually and/or as a premix into the second section of the extruder.

The plasticizable consumable substance can be cook-extruded in the second section of the extruder under pressure, shear and temperature conditions suited to the characteristics of the product which it is desired to obtain, in particular as a function of the

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water content and of the degree of expansion which it is desired to obtain after the extrusion.

It is possible to cook-extrude a plasticizable consumable substance exhibiting a water content of 14-23%, in order to obtain an expanded product, for example.

It is possible to cook-extrude a plasticizable consumable substance exhibiting a water content of 24-36%, in order to obtain a non-expanded or not very expanded product, for example.

The non-expanded or not very expanded product, which has been cut up, can be converted into flakes by rolling and toasting, for example.

Furthermore, the liquid or pasty consumable substance can be prepared in the first section of the extruder under stirring and temperature conditions suitable for obtaining good mixing of its components and good fluidity of the mixture (which ensures that it can be pumped), while avoiding or, on the contrary, while promoting, if appropriate, a reaction of some of its components, in particular an enzymatic or nonenzymatic reaction, for example.

The liquid or pasty consumable substance thus prepared can be added in various ways to the cooked-extruded plasticizable consumable substance, in particular by coating, coextrusion or impregnating throughout its body, for example.

A liquid consumable substance for coating can be prepared in the form of a syrup intended more particularly for humans which comprises in particular sugar or honey and water, as well as additional components, such as milk powder, fruit or vegetable pulp or concentrate, cocoa powder, dyes, vitamins, trace elements, flavourings, salt and/or spices, indeed even oils, for example.

Materials or microorganisms with probiotic or prebiotic properties or functional plant extracts, such as guarana, ginseng, acerola, rosehip, cola or garcinia extracts, indeed even procyanidol oligomers (P.C.O.)

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such as can be extracted from grape or strawberry seeds, for example, can advantageously be added to such a syrup.

In such a syrup, the sugar can be sucrose,
5 fructose, dextrose or raw cane sugar, for example.

A liquid consumable substance for coating intended more particularly for pets can be prepared which comprises in particular protein hydrolysate or vegetable extract and water, as well as additional
10 components, such as dyes, flavourings, vitamins and/or trace elements, for example.

A pasty consumable substance intended more particularly for humans can be prepared which comprises in particular minced meat, tomato sauce and/or cheese
15 for savoury products or almonds, hazelnuts, chocolate and/or jam for sweet products, as well as additional components, such as milk powder, fruit or vegetable pulp or concentrate, cocoa powder, dyes, vitamins, trace elements, flavourings, salt and/or spices, indeed
20 even oils, for example.

Materials or microorganisms with probiotic or prebiotic properties or functional plant extracts, such as guarana, ginseng, acerola, rosehip, cola or garcinia extracts, indeed even procyanidol oligomers (P.C.O.)
25 such as can be extracted from grape or strawberry seeds, for example, can advantageously be added to such a pasty consumable substance.

A pasty consumable substance intended more particularly for pets can be prepared which comprises
30 in particular protein hydrolysate, fat, in particular tallow, and/or molasses, as well as additional components, such as dyes, flavourings, vitamins and/or trace elements, for example.

The pieces of cooked-extruded plasticizable
35 consumable substance can be coated before or at the time when they are cut up at the outlet of the extruder and, for this, coextrusion of the cooked-extruded strand and of the liquid or pasty consumable substance through a die comprising an annular outlet orifice

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surrounding a central outlet orifice can be provided, the strand being extruded through the central orifice and the liquid or pasty consumable substance being distributed through the annular orifice around the
5 cooked-extruded strand, for example.

The pieces can also be coated after they have been cut up and, for this, provision may be made to spray a liquid consumable substance onto the cut-up pieces while stirring them, for example.

10 The liquid or pasty consumable substance can also be encapsulated by coextruding this substance and the cooked-extruded strand through a die comprising an annular outlet orifice surrounding a central outlet orifice, the strand being extruded through the annular
15 orifice and the liquid or pasty consumable substance being distributed through the central orifice inside the cooked-extruded strand, for example.

The cooked-extruded strand can also be impregnated with the liquid or pasty consumable
20 substance, this impregnation being carried out throughout the body by reinjection of the liquid or pasty consumable material in the second section of the extruder, close to its outlet but sufficiently upstream for it to be well mixed with the mass to be extruded
25 before it is extruded.

The cooked-extruded strand can advantageously be cut into pieces directly at the outlet of the second section of the extruder.

Finally, the composite product in pieces thus
30 obtained can be dehydrated to a residual water content of less than 5%, for example.

The plant for carrying out the process according to the present invention thus comprises a twin-screw extruder separated into two distinct
35 sections by a dynamic separation device, at least one die, cutting means and a device for adding a liquid or pasty substance.

The dynamic separation device can be produced in the form of a blocking region with reverse pitch of

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the twin-screw device and can also comprise cones positioned head-to-tail.

5 An outlet opening of the first section of the extruder can be provided which entirely covers an outlet region of the twin-screw device and which overlaps, on either side, onto a compression region and onto a dynamic separation region, for example.

10 The outlet region can comprise one or more bilobes on one screw and a collar on the other screw, the collar facing the outlet opening, for example.

An outlet opening of the second section can be provided in the axis or on the side of the downstream end of the extruder, for example.

15 The outlet opening of the first section can be connected via a pipe to at least one coextrusion die provided at the outlet of the extruder or to at least one spray nozzle provided in a device separate from the extruder or to at least one reinjection opening provided in the barrel of the extruder close to the outlet opening of the second section, for example.

20 The outlet opening of the second section can emerge directly onto the die, for example.

25 The die can be an extrusion or coextrusion die through which the substance processed in the second section can be extruded or pressed under the effect of a pressure exerted by the twin-screw device. It can comprise one or more extrusion pipes emerging onto one or more outlet orifices provided in a front wall of the die, for example.

30 The cutting means can be produced in the form of a multiblade rotary cutter, in particular comprising 2-16 blades, rotating against the outlet orifice or orifices of the die, in other words against the front wall of the die, for example.

35 The addition device can be provided at the actual outlet of the second section of the extruder in the form of at least one coextrusion die, or close to the outlet opening of the second section, upstream of the outlet opening, in the form of at least one

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reinjection opening provided in the barrel of the extruder, or at the outlet or after the outlet of the extruder in the form of at least one spray nozzle included in a device separate from the extruder, for
5 example.

A separate addition device can be provided in the form of a hollow cylindrical drum rotating about a generally horizontal axis which exhibits, in its upper part or in a side part, at least one spray nozzle
10 capable of spraying a liquid consumable substance over the product to be coated stirred in the cylinder, for example.

A preferred addition device of this type can be provided in the form of a rotary cylindrical drum, a
15 first open part of which surrounds the die of the extruder and the cutting means, and a second non-open part of which extends downstream of the cutting means, which exhibits, in its upper part or in a side part, at least one spray nozzle capable of spraying a liquid
20 consumable substance directly over the pieces of product ejected by the cutting means.

In the latter case, the cutting means can advantageously be driven by a hydraulic motor which is smaller in size than a conventional electric motor, for
25 example.

A drying device can be provided in the form of a hot-air drying tunnel, for example.

A feed device for each section can be provided in the form of one or more feed openings provided in
30 the barrel of the twin-screw device, starting from the upstream end of the extruder for the first section and from a transportation region following the blocking region of the twin-screw device for the second section, for example.

35 A geometry of the screws can be provided which is suited, for each section, to the plasticizable consumable substance or to the liquid or pasty consumable substance to be processed and to the product which it is desired to obtain.

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It is possible in particular to provide successive and/or alternating transporting, transporting-mixing-dissolving, compressing-dissolving or mixing-dissolving regions on the first section and
5 successive and/or alternating transporting, compacting, compressing, kneading or mixing regions on the second section, for example.

In order to define these various regions, it is possible to vary the pitch and the handedness of the
10 screws, the space left empty defined in particular by the respective diameters of the shafts and of the flights, or the insertion of bilobes of various shapes, for example. It is also possible to vary a subdivision of the barrel of the extruder into several independent
15 compartments, the temperature of which can be individually adjusted by circulating a cooling or heating fluid, for example.

Finally, the mechanical energy needed to prepare the liquid or pasty consumable substance, to
20 process the plasticizable consumable substance, to distribute or spray the liquid or pasty consumable substance and to extrude the processed substance can be supplied by a single means for driving the screws of the twin-screw device, such as an electric motor, for
25 example.

In order to ensure that the processed plasticizable consumable substance passes through the die, this motor can be assisted or the load on it can be lightened using a positive-displacement pump, such
30 as a gear pump, connected upstream of the die, for example.

More precise control of the spraying, the distribution and the injection of a liquid or pasty consumable substance can also be provided by connecting
35 a positive-displacement pump between the outlet of the first section of the extruder and the spray nozzle, the coextrusion die or the reinjection opening, for example.

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The plant according to the present invention is described below with reference to the appended drawing, in which:

- 5 - Figure 1 diagrammatically represents a first embodiment of the plant, in which an addition device is provided directly at the outlet of the second section of the extruder in the form of a coextrusion nozzle,
- 10 - Figure 2 diagrammatically represents a second embodiment of the plant, in which an addition device is provided after the outlet of the extruder in the form of at least one spray nozzle included in a device separate from the extruder,
- 15 - Figure 3 diagrammatically represents a third embodiment of the plant, in which an addition device is provided at the outlet of the extruder in the form of at least one spray nozzle included in a device separate from the extruder,
- 20 - Figure 4 diagrammatically represents a fourth embodiment of the plant, in which an addition device is provided close to the outlet opening of the second section, upstream of the outlet opening, in the form of at least one reinjection opening provided in the barrel of the extruder,
- 25 - Figure 5 is a diagrammatic view in vertical section of the extruder along the axis of the left-hand screw, illustrating an embodiment of the geometry of the screws of the plants represented in Figures 1, 2, 3 and 4,
- 30 - Figure 6 is a diagrammatic view in horizontal section of the extruder along the plane defined by the axes of the two screws, illustrating the same embodiment of the geometry of the screws as that represented in Figure 5, and
- 35 - Figure 7 represents in greater detail the embodiment of the outlet opening for the liquid or pasty consumable substance represented in Figure 5.

In the embodiment represented in Figure 1, the present plant comprises a twin-screw extruder separated into two distinct sections 1 and 2 by a dynamic

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separation device 3, at least one die 4, cutting means 5, 6, an addition device 7, 8, and a drying device (not represented).

5 The twin-screw device is driven by a motor 9 and it is enclosed in a jacketed barrel subdivided into seven compartments i-vii in each of which can be circulated a cooling or heating fluid.

10 In this first embodiment of the plant, the components of a liquid or pasty consumable substance A are introduced into the first section 1 through a feed device comprising at least one feed opening 10 provided in the first compartment i of the barrel. The liquid or pasty consumable substance prepared in the first section 1 exits from this section via an outlet opening 15 11 provided in the compartment iv of the barrel at the dynamic separation device 3. This opening 11 is connected to the die 4 via a pipe 12 which passes through a positive-displacement pump 13 which makes it possible to inject the liquid or pasty consumable substance into an extrusion pipe 16 emerging onto an annular or central outlet orifice 8.

20 A plasticizable consumable substance B is introduced into the second section 2 through a feed device comprising at least one feed opening 14 provided 25 in the fifth compartment v of the barrel, downstream of the dynamic separation device 3. The mass of substance B processed in the second section 2 is pressed through an extrusion pipe 15 emerging onto a central or annular outlet orifice 7.

30 In this first embodiment, the addition device is thus provided at the actual outlet of the second section of the extruder, where it is produced in the form of a coextrusion die comprising the two extrusion pipes 15 and 16 emerging respectively onto the central 35 or annular orifice 7 and onto the annular or central orifice 8, depending upon whether the strand is extruded through the central orifice and a liquid or pasty consumable substance is distributed through the annular orifice around the extruded strand or whether

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the strand is extruded through the annular orifice and a liquid or pasty consumable substance is distributed through the central orifice inside the extruded strand.

The strand of composite product thus obtained
5 is cut up into pieces using the cutting means comprising a rotary cutter 5 which rotates against the outlet orifices of the die 4 and is driven by an electric motor 6.

The pieces can subsequently be dried, if
10 appropriate, in a drying device (not represented).

In the embodiment represented in Figure 2, the present plant is analogous to that represented in Figure 1, except for the fact that it comprises an addition device 17 provided after the outlet of the
15 extruder in the form of at least one spray nozzle included in a device separate from the extruder and that it additionally comprises a drying device represented by 18.

The separate addition device 17 is provided in
20 the form of a hollow cylindrical drum (not represented) rotating about a generally horizontal axis and exhibiting, in its upper part or in a side part, at least one spray nozzle (not represented) capable of spraying a liquid consumable substance over the product
25 to be coated stirred in the cylinder.

In this second embodiment of the plant, a liquid consumable substance A is prepared in the first section and is injected into the spray nozzle via the pipe 12.

30 A plasticizable consumable substance B is processed in the second section 2 and is pressed through at least one extrusion pipe 15 of the die emerging onto at least one outlet orifice 7. The cooked-extruded strand thus obtained is cut up into
35 pieces by cutting means (not represented) and the pieces are introduced, indeed even transported, into the addition device 17 in order to be coated therein with the liquid consumable product sprayed over them by the spray nozzle.

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The coated pieces are subsequently dried in the drying device 18 which can be produced in the form of a hot air dryer, for example.

5 In the embodiment represented in Figure 3, the present plant is analogous to that represented in Figure 1, except for the fact that it comprises an addition device 30, 31 provided at the outlet of the extruder in the form of at least one spray nozzle included in a device separate from the extruder and
10 that it additionally comprises a drying device represented by 18.

In this third embodiment of the plant, a liquid consumable substance A is prepared in the first section 1 and is injected into at least one spray nozzle 31 via
15 the pipe 12.

A plasticizable consumable substance B is processed in the second section 2 and is pressed through at least one extrusion pipe 15 of the die emerging onto at least one outlet orifice 7. The
20 cooked-extruded strand thus obtained is cut up into pieces by cutting means attached to the die 4 comprising a rotary cutter 5 which rotates against the outlet orifices of the die and is driven by a hydraulic motor 6.

25 The addition device comprises at least one spray nozzle 31 provided in a rotary cylindrical drum 30, a first open part 32 of which surrounds the cutting means 5, 6 and the die 4 and a second non-open part of which extends downstream of the cutting means.

30 In the embodiment represented in Figure 4, the present plant is analogous to that represented in Figure 1, except for the fact that it comprises an addition device provided upstream of the outlet of the extruder, in the form of at least one reinjection
35 opening 33 provided in the barrel of the extruder in the middle of the final compartment vii of the second section 2.

In this fourth embodiment of the plant, a pasty consumable substance A is prepared in the first section

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1 and is reinjected into the section 2 close to its outlet but sufficiently upstream for it to be well mixed with a plasticizable consumable substance B processed in the section 2, before the latter is
5 pressed through at least one extrusion pipe 15 of the die emerging onto at least one outlet orifice 7.

The composite strand thus obtained is cut up into pieces by cutting means comprising a rotary cutter
5 which rotates against the outlet orifices of the die
10 and is driven by an electric motor 6.

The pieces can subsequently be dried, if appropriate, in a drying device (not represented).

Figures 5 and 6 diagrammatically represent an embodiment of the geometry of the screws which can be
15 used without distinction in each of the plants represented in Figures 1 to 4.

In the section 1, the screws successively exhibit a transporting region 19 (200/100), a transporting-mixing-dissolving region 20 (100/66), a
20 compressing-dissolving region 21 (200/33), a mixing-dissolving region 22 (140/various bilobes), a compressing-dissolving region 21 (100/33), a mixing-dissolving region 22 (150/various bilobes), a compressing-dissolving region 21 (100/33), a syrup
25 outlet region 23 (two 15 mm bilobes on one screw, one 30 mm collar on the other screw) and a dynamic separating region 3 (30 mm cones, 50/-25, 100/-50).

In the section 2, the screws successively exhibit a transporting region 19 (200/100), a
30 transporting region 20 (100/66), a compressing region 21 (100/33), a compressing region 24 (100/50), a compressing region 21 (200/33), a kneading region 25 (100/-33) and a compressing region 26 (100/35).

The figures in brackets give the length of the
35 region and the length of the pitch in mm for screws with a diameter of 88 mm and a distance between axes of 72 mm, the plant in this instance comprising a Clextral BC-72 twin-screw extruder.

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The geometry represented is not limited to these dimensions which are given by way of example. It can be transposed to other extruder models, in particular the BC-45 model (screw with a diameter of 55 mm and distance between axes of 45 mm) or the BC-92 model (screw with a diameter of 115 mm and a distance between axes of 92 mm) of the same series, for example.

The screw pitches are preferably double, except for the reverse pitch of the blocking region, which is preferably single.

In contrast to the reverse pitch of the kneading region 25, which exhibits on its perimeter notches for the passage of the processed mass, the reverse pitch of the blocking region 3 does not exhibit any of them, so as to be able to be as efficient as possible in its role as dynamic separation device.

As is seen in more detail in Figure 7, the outlet opening 11 of the first section 1 of the extruder exhibits an axial oblong shape, in this instance the shape of a figure eight, covering the entire length of the outlet region 23 (facing the collar) and overlapping onto the compression region 21 and the separation region 3 (facing the cones).

The examples below are presented by way of illustration of the process according to the present invention and of the products which it makes it possible to obtain. The percentages and parts are shown therein by weight, unless otherwise indicated.

30 **Example 1**

Use is made of a plant as represented in Figures 2 or 3 and 5-7, in which the extruder is a Clextral BC-72 type twin-screw device with a screw diameter of 88 mm and a screw length of 2100 mm.

35 The addition device is produced in the form of a hollow cylindrical drum provided after the outlet of the extruder, which drum rotates about a generally horizontal axis and exhibits, in its upper part, three twin-fluid nozzles exhibiting an internal diameter of

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2.5 mm, or in the form of a partially open rotary cylindrical drum, which drum surrounds the die of the extruder and the cutting means and exhibits, in a side part, a horizontal row of five spray nozzles, the
 5 furthest upstream of which is positioned at the cutting means.

The drying device is a hot air drying tunnel.

In order to prepare a syrup in the first section of the extruder, 60 kg/h of caster sugar are
 10 dissolved therein in 13 kg/h of water and the temperature of the syrup or sugar solution is brought therein to 76°C.

In order to prepare a cereal base in the second section of the extruder, the following components are
 15 mixed therein (kg/h):

	Maize semolina	84.0
	Wheat flour	11.4
	Sucrose	4.8
20	Sodium chloride	1.2
	Calcium carbonate	0.6
	Oatmeal	6.0
	Wheat starch	12.0
	Palm kernel fat	10.0
25	Water	13.0

To do this, the powders are first dry-mixed. The dry mixture, the fat and the water are subsequently mixed.

30 The mixture is processed, namely it is cooked-extruded at 150°C under 155 bar, the screws of the extruder rotating at 218 rpm.

The thermoplastic mass thus obtained is extruded through a die produced in the form of a front
 35 plate pierced with four cylindrical pipes each emerging onto a circular outlet orifice with a diameter of 5 mm.

The cylindrical strands thus extruded-expanded in the ambient space are immediately cut up using a four-blade cutter rotating at 6000 rpm against the

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front wall of the die, the cutter being driven by a conventional electric motor (option chosen in the case where the addition device is provided after the outlet of the extruder) or by a hydraulic motor integral with the die (option which makes possible the use of an addition device at the die).

Expanded cereal pellets are thus obtained with a diameter of approximately 10 mm.

The pellets are coated by spraying them with the above syrup while stirring them, the syrup being sprayed under the effect of a stream of entrainment air ejected out of the nozzle under a pressure of 1.8 bar.

The cereal pellets are dried with the air at 113°C up to a residual water content of less than 3%.

Light and crunchy sugar-coated breakfast cereal pellets are thus obtained.

Example 2

A composite pet food with a soft interior and a crunchy exterior is prepared using a plant as represented in Figure 1.

In order to prepare a pasty consumable substance for the soft interior in the first section of the twin-screw device (Clextral BC-72 type), the following components are introduced therein and are mixed therein continuously in the following proportions, given as % by weight:

Meat protein hydrolysate	40
Lecithin	0.5
Chicken fat	45
Molasses	10.5
Dye	3
Vitamins and trace elements	1

In the first section, the screws exhibit a length to diameter ratio of 9:1 (for a total length to diameter ratio of 20:1) and they are composed of transportation screw and mixing bilobe elements. The

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temperature of the barrel is maintained at approximately 49°C.

In order to prepare a plasticizable consumable substance, namely a cereal base for the crunchy exterior, in the second section of the twin-screw device, the following components are introduced therein, are mixed therein and are processed therein continuously in the following proportions, given as % by weight:

10

Milled wheat	45
Milled maize	24
Chicken meal	13
Soya flour	13
15 Vitamins	1
Trace elements	0.5
Tallow	3.5

In the second section, the screws exhibit a length to diameter ratio of 10:1 and they are composed of a double-pitch screw element for transportation, a reverse pitch element for compression and shearing and a trapezoidal single thread element for expulsion or pressing. The temperature of the barrel is maintained at approximately 120°C.

The consistency of the pasty substance for the soft interior is adjusted in the first section so that it is just capable of being pumped through the die but that it rapidly sets solid after exiting from the die.

The food substance, plasticized and heated under the effect of the pressure, shear and temperature in the second section, greatly expands on exiting from the die and forms a shell which becomes solid and crusty during cooling and drying.

The pasty substance and the cereal base are coextruded at respective throughputs such that the ratio by weight of the soft interior to the crunchy exterior of the composite product is 40%:60%.

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The activity of the water in the soft interior and that in the crunchy exterior are adjusted so that the interior remains soft and the exterior remains crunchy during a storage period of at least six months.

5

Example 3

A composite food which is impregnated throughout its body is prepared using a plant as represented in Figure 4.

10 In order to prepare an impregnating syrup in the first section of the twin-screw device (Clextral BC-72 type), mackerel flesh, an enzyme for its digestion, sucrose and molasses are introduced therein and are mixed therein continuously in the following
15 proportions, given in % by weight:

Mackerel flesh emulsion	80
Enzyme	0.5
Sucrose	10
20 Molasses	9.5

In the first section, the screws exhibit a length to diameter ratio of 9:1 (for a total length to diameter ratio of 20:1) and they are composed of
25 transportation screw and mixing bilobe elements. The rotational speed of the screws is chosen such that the mackerel flesh is minced. The temperature of the barrel is maintained at 120°C.

In order to prepare a plasticizable consumable
30 substance, namely a cereal base, the following components are introduced into the second section of the twin-screw device, are mixed therein and are processed therein continuously in the following proportions, given as % by weight:

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	Wheat	45
	Maize	15
	Chicken meal	17
	Soya	14.3
5	Vitamins	1
	Trace elements	0.5
	Dye	3
	Tallow	4.2

10 In the second section, the screws exhibit a
length to diameter ratio of 10:1 and they are composed
of a double-pitch screw element for transportation, a
reverse pitch element for compression and shearing and
a trapezoidal single thread element for expulsion or
15 pressing. The temperature of the barrel is maintained
at approximately 120°C.

 The impregnating syrup prepared in the first
section is thus reinjected into the second section
close to its outlet but sufficiently upstream for it to
20 be well mixed with the cereal base before it is
extruded.

 The ratio by weight of the syrup to the cereal
base in the composite product is 10%:90%.

 The composite product thus obtained has an
25 appetizing mackerel flavour and proves to be pleasant
to eat, both for humans and for pets.

Claims:-

1. The process for the manufacture of a composite consumable product by double extrusion, in which a liquid or pasty consumable substance is prepared in a first section of a twin-screw extruder, a plasticizable consumable substance is cooked-extruded in a second section of the twin-screw extruder separated dynamically from the first, at least one strand of a cooked-extruded mass is obtained, it is cut up into pieces, the liquid or pasty consumable substance is added to the cooked-extruded mass and pieces of a composite consumable product are obtained therefrom, in which the liquid or pasty consumable substance is added to the cooked-extruded mass by coating.

2. Process according to claim 1, in which the pieces are coated after they have been cut up by spraying a liquid consumable substance over the cut-up pieces while stirring them.

3. Process for the manufacture of a composite consumable product by double extrusion, in which a liquid or pasty consumable substance is prepared in a first section of a twin-screw extruder, a plasticizable consumable substance is cooked-extruded in a second section of the twin-screw extruder separated dynamically from the first, at least one strand of a cooked-extruded mass is obtained, it is cut up into pieces, the liquid or pasty consumable substance is added to the cooked-extruded mass and pieces of a composite consumable product are obtained therefrom, in which the cooked-extruded strand is impregnated with the liquid or pasty consumable substance by reinjecting this substance into the second section of the extruder close to its outlet.

4. Plant for the manufacture of a composite consumable product by double extrusion, comprising a twin-screw

extruder separated into two distinct sections by a dynamic separation device, at least one die, cutting means and a device for adding a liquid or pasty substance, in which the outlet opening of the first section is connected to at least one spray nozzle provided in an addition device separate from the extruder.

5. Plant according to claim 4, in which the separate addition device is produced in the form of a rotary cylindrical drum, a first open part of which surrounds the die of the extruder and the cutting means and a second non-open part of which extends downstream of the cutting means, the spray nozzle or nozzles being provided in its upper part or in a side part.

6. Plant for the manufacture of a composite consumable product by double extrusion, comprising a twin-screw extruder separated into two distinct sections by a dynamic separation device, at least one die, cutting means and a device for adding a liquid or pasty substance, in which the outlet opening of the first section is connected via a pipe to an addition device comprising at least one reinjection opening provided in the barrel of the extruder close to the outlet opening of the second section.

7. Coated composite consumable product obtained by the process according to claims 1 or 2.

8. Composite consumable product impregnated throughout its body which can be obtained by the process according to claim 3.