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Process for the preparation of a ~~foodstuff by extrusion~~

The subject of the present invention is a process for preparing a foodstuff by extrusion and an installation for carrying out the process.

5 EP0169126 (CLEXTRAL) describes a process for preparing a composite foodstuff using an extruder having several successive zones, in which extruder a stream of food substance leaving a first zone comprising a twin-screw unit is split into several independent streams in
 10 a second zone comprising two single-screw units, the two independent streams undergoing distinct processing operations, especially distinct colorations, in this second zone and being recombined in a third zone comprising a die to form a single composite product, especially
 15 a product containing two differently coloured and/or flavoured co-extruded parts.

The object of the present invention is to propose a process and an installation envisaging a particularly effective and/or versatile use of a twin-screw extruder,
 20 allowing the preparation of one or more foodstuffs, especially of a composite foodstuff containing several parts with different compositions, textures and/or colours.

To achieve this, in the process according to the
 25 present invention, 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 extruder, this section being separated dynamically from
 30 the first, these substances are each processed independently in their own section of the extruder, the two masses obtained are extruded, passing them through at least one die, and the extruded product or products is or are cut.

Likewise, the installation according to the
 35 present invention comprises a twin-screw extruder split into two distinct sections by dynamic-separation device, at least one extrusion die and at least one cutting device.

Such a process and such a piece of equipment

effectively allow a particularly effective and/or versatile use of a twin-screw extruder, thanks to which use it is possible to prepare one or more foodstuffs, especially a composite foodstuff containing several parts with different compositions, textures and/or colours.

In this description, the expression "food substance" covers all the components introduced together or separately, at the same time or in succession, into one or other of the two sections of the extruder and processed altogether at least in part of this section.

In order to carry out the current process, it is possible to start with food substances from which it is possible to produce, by extrusion, the widest possible range of foodstuffs such as breakfast cereals, children's cereals, snacks, crumb coatings, confectionery, pasta or products for domestic animals, for example.

The components and their respective proportions can be chosen, and these substances can then be processed in the extruder under conditions of pressure, shear and temperature which are chosen to suit the characteristics of the product to be obtained, especially as a function of the water content and degree of expansion which is to be obtained after the die.

A first substance and/or a second substance having a water content of 14-22% may be processed in order to obtain an expanded product.

Such a cut expanded product may be dehydrated down to a water content of less than 5%, for example.

A first and/or a second substance having a water content of 24-36% may be processed to obtain a little- or non-expanded product.

The cut little- or non-expanded product may be converted into flakes by rolling and toasting, for example.

Provision may be made to pass at least one of the two substances through a die after it has been subjected to an intermediate processing operation, the latter taking place between an outlet from its section of the extruder and the die, such as prolonged cooking of a

substance intended for the production of breakfast cereals with a good cooked taste, for example.

It is possible to start from similar or different first and second food substances and to process each in its own section of the extruder in similar or different ways.

Thus similar first and second substances can be processed in similar ways when there is a desire to increase the productivity of an extruder, the length and power characteristics of which are too high for the type of product it is desired to prepare.

In this case, the two masses of processed substance can be passed through two similar dies or through similar orifices of a common die, for example.

Preferably, the starting point is different first and second substances, and these are processed in different ways in the extruder in order to make it possible, using a single extruder, to prepare novel composite products containing not only two differently coloured and/or flavoured parts, but also containing several parts with different compositions, textures and/or colours.

In particular, it is possible to co-extrude a mass of processed substance which expands and a mass of processed substance which does not expand on leaving the die, in order to prepare crunchy expanded snacks filled with a soft filling, or to co-extrude two masses of processed substance which expand on leaving the die, in order to prepare crunchy snacks with two components of different texture, taste and colour, for example.

The installation for carrying out the process according to the present invention therefore comprises a twin-screw extruder split into two distinct sections by a dynamic-separation device, at least one die and at least one cutting device.

The dynamic-separation device may be produced in the form of a blocking zone where the twin-screw unit is of opposite hand, for example.

In this embodiment of the dynamic-separation device, provision may be made for one outlet from the

first section of the extruder to straddle a compression zone and the blocking zone of the twin-screw unit, for example.

5 Provision may be made for an outlet from the second section to be along the axis of or to the side of the downstream end of the extruder, for example.

The outlet from each section may be connected by an appropriate duct to a distinct die, to a common die or to distinct elements of one and the same die, for
10 example.

Provision may be made for there to be a feed device for each section, in the form of one or more feed openings provided in a barrel of the twin-screw unit, starting from the upstream end of the extruder for the
15 first section, and starting from a transport zone following the blocking zone of the twin-screw unit for the second section, for example.

It is possible to envisage a screw geometry which, for each section, is adapted to suit the substance to be processed and to the product which is to be
20 obtained. In particular, successive and/or alternating zones for transporting, compacting, compressing, kneading or mixing, for example, may be envisaged. To define these various zones, the pitch of the screws, the space left
25 empty for the substance to be processed, defined especially by the respective diameters of the shafts and of the flights, may be altered, or bilobes of varying shapes may be inserted, for example. It is also possible to act on a subdivision of the barrel of the extruder into
30 several independent compartments, the temperature of which may be adjusted individually by circulating a cooling or heating fluid, for example.

Finally, the mechanical energy needed to process the first and second food substances in the two sections
35 of the extruder and pass them through the die or dies may be supplied by a single means of driving the screws of the twin-screw unit, such as an electric motor for example.

To pass a food substance through a die, this

motor may be assisted or the load on it may be lightened using a positive-displacement pump such as a gear pump connected upstream of the die, for example.

5 The installation according to the present invention is described hereinbelow with reference to the appended drawing in which:

- Figure 1 diagrammatically represents one embodiment of the installation intended to process in similar ways a first and a second food substance which are similar,
- 10 - Figure 2 diagrammatically represents one embodiment of the installation intended to process in different ways a first and a second food substance which are different in order to prepare two different products,
- Figure 3 diagrammatically represents one embodiment of the installation intended to process in different ways a first and a second food substance which are different in order to prepare a co-extruded composite product,
- 15 - Figure 4 diagrammatically represents one embodiment of the geometry of the screws of the installation represented in Figure 1,
- 20 - Figure 5 diagrammatically represents one embodiment of the geometry of the screws of the installations represented in Figures 2 and 3, and
- Figure 6 represents in greater detail the embodiment of the dynamic-separation device for the screws represented in Figures 4 and 5.
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 In the embodiment represented in Figure 1, the present installation comprises a twin-screw extruder split into two distinct sections 1 and 2 by a dynamic-separation device 3, at least one die 4 and 5 and at least one cutting device, not represented.

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 The twin-screw unit is driven by a motor 6 and is contained in a double-walled barrel subdivided into seven compartments i-vii, in each of which a cooling or heating fluid can be circulated.

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 In this installation, a first substance A is introduced into the first section 1 through a feed device comprising a feed opening 7 provided in the first compartment i of the barrel. The mass of substance A pro-

cessed in the first section 1 leaves the extruder through an outlet 8 provided in the compartment iv of the barrel at the location of the dynamic-separation device 3 and connected to the die 4.

5 A second substance A similar to the first one is introduced into the second section 2 through a feed device comprising a feed opening 9 provided in the fifth compartment v of the barrel, downstream of the dynamic-separation device 3. The mass of substance A processed in
10 the second section 2 leaves the extruder through an outlet 10 provided along the axis of its downstream end and connected to the die 5, which is similar to the die 4.

15 In the embodiment represented in Figure 2, the present installation has differences regarding the geometry of the screws as compared with the embodiment represented in Figure 1.

20 In this installation, a first substance A is processed in the first section 1 and a second substance B different from the first, is processed in a different way in the second section 2, the two processed masses being extruded by passing them through respective dies 4 and 5 in order to prepare different products.

25 In the embodiment represented in Figure 3, the present installation has differences as regards the dies 4 and 5 as compared with the embodiment represented in Figure 2, the dies this time forming distinct elements of a common co-extrusion die.

30 In this installation, a first substance A is processed in the first portion 1, a second substance B, which is different from the first, is processed in a different way in the second section 2, and the two processed masses are then co-extruded.

35 In the embodiment represented in Figure 4, the geometry of the screws is very similar on both sections 1 and 2 of the extruder.

 In section 1, the screws have, in succession, a transport zone 11 (200/100), a compacting zone 12 (100/50), a compression zone 13 (100/33), an intermediate

transport zone 14 (100/66), a compression zone 15 (100/35 + 200/28), a kneading zone 16 (100/-33), a compression zone 17 (100/35), an expulsion zone 18 (three-off 12.5 bilobes), and a blocking zone 3 (100/-25).

5 In section 2, the screws have, in succession, a compacting zone 12 (50/50), a transport zone 11 (200/100), a compression zone 13 (100/33), a transport zone 14 (100/66), a compression zone 15 (100/35 + 200/28), a kneading zone 16 (100/-33) and a compression
10 zone 17 (100/-35).

 The figures given in brackets give the length of the zone and the pitch in mm, for screws 88 mm in diameter and a distance of 72 mm between axes, the installation in this case comprising a CLEXTRAL BC-72
15 twin-screw extruder.

 The geometry represented is not limited to these dimensions which are given by way of example. It may be transposed onto other models of extruder, especially the models BC-45 (screws 55 mm in diameter, with a distance
20 of 45 mm between axes) or BC-72 (screws 115 mm in diameter, with a distance of 92 mm between axes) in the same series, for example.

 The screw flights are preferably double, except for the reverse flight in the blocking zone which is
25 preferably single.

 In contrast to the opposite-handed flight in the kneading zone 16 which on its periphery has cutouts for the passage of the processed mass, the opposite-handed flight in the blocking zone 3 has none in order that it
30 can be as effective as possible in fulfilling its role as a dynamic-separation device.

 The outlet 8 from the first section 1 of the extruder has an axial oblong shape, in this case the shape of a figure eight, covering the entire length of
35 the expulsion zone 18, straddling the compression zone 17 and the blocking zone 3.

 In the embodiment represented in Figure 5, the geometry of the screws in the second section 2 of the extruder is similar to that represented in Figure 4. By

contrast, the geometry of the screws in the first section 1 differs from this as regards the compression zone 15 ($100/35 + 50/35 + 100/28$ instead of $100/35 + 200/28$). It also differs from the geometry of Figure 4 as regards the zone 16 which here is a mixing zone formed of 10 bilobes 15 mm thick, instead of a kneading zone.

Figure 6 shows in greater detail how the outlet 8 from the first section 1 of the extruder covers the entire length of the expulsion zone 18, straddling the compression zone 17 and the blocking zone 3. In particular it has been observed that it is essential for this opening to overlap the blocking zone 3, by a fraction of the length of the opening which corresponds approximately to 0.1 - 0.3 times the diameter of the screw, for example, so that the substance taken up by the first flight or flights of the opposite-handed screw can be discharged and expelled effectively.

It is also important, to ensure good dynamic separation, for the blocking zone to be long enough, namely for it to have a length at least equal to the diameter of the screws, for an opposite-handed screw flight of between approximately $1/5$ and $1/3$ of this diameter, for example.

The examples below are given by way of an illustration of the process according to the present invention and of the products which can be obtained thereby. The percentages and parts here are given by weight.

In these examples, the oil may be chosen, if need be, as a function of the physical purpose it has in the processed and extruded mass, and as a function of its taste, neutral or otherwise. It may be chosen from palm kernel oil, groundnut oil or corn oil, for example.

In these examples too, the mixture of flours, the oil and the water are introduced, as appropriate, individually into the feed opening of the extruder section in question.

Example 1

Use is made of an installation like the one

represented in Figures 1 and 4. The extrusion dies are made in the form of pierced plates each having 6 cylindrical extrusion ducts 3.5 mm in diameter.

5 This installation is used to prepare one single same breakfast cereal product with the ingredients and under the conditions given in Tables 1a) and 1b) below.

Table 1a) gives the ingredients of a mixture of flours, their proportions in a typical mixture and the possible range of their proportions.

10 Table 1b) gives the quantities of the ingredients introduced into each section of the installation per hour, the water content of the substance or of the processed mass and the operating conditions.

Table 1a): Mixture of flours

15	Ingredient	Typical mixture (%)	Possible range (%)
	Cornflour	20	0-80
	Wheat flour	64	0-80
	Oatmeal	10	0-80
	Sugar	4.9	2-12
20	Salt	1	0-3
	Vitamins and trace elements	0.1	0.1-0.2
	Total	100	100

Table 1b): Operating conditions

	Parameter	Units	Value	Possible range
	Mixture of flours	kg/h	300	200-350
	Palm kernel oil	kg/h	10	0-20
5	Water	kg/h	20	10-30
	Water content of the mass	%	16.1	14-22
	Rotational speed of the screws	rpm	350	250-450
10	Temperature of the mass in the extruder	°C	162	150-170
	Pressure of the product in the extruder	bar	132	80-150
	Current	A	294	200-400
15	Residence time in each section	s	30	20-45
	Density of the extruded product	g/l	115	50-160

Breakfast cereals in the shape of small balls 8 to 12 mm in diameter are thus obtained.

20 Example 2

Use is made of an installation like the one represented in Figures 2 and 5. The extrusion dies are produced in the form of plates each pierced with 6 cylindrical extrusion ducts 3.5 mm in diameter.

25 This installation is used to prepare two different breakfast cereal products with the ingredients and under the conditions given in Tables 2a and 2b below.

30 Table 2a) gives the ingredients of mixtures of flours, their proportions in two typical mixtures, A and B, and the possible range of their proportions.

Table 2b) gives the quantities of ingredients introduced into each section of the installation per hour, the water content of the substances or of the processed masses and the operating conditions.

35 To process the mass A, the injection of steam into the first section in the region of the intermediate transport zone 14 is provided.

Table 2a): Mixtures of flours

	Ingredient	Mixture A (%)	Mixture B (%)	Range mix. A (%)	Range mix. B (%)
	Cornflour	91	20	85-98	0-80
	Wheat flour	-	64	-	0-80
5	Oatmeal	-	10	-	0-80
	Sugar	6.9	4.9	0-12	0-12
	Salt	2	1	0-3	0-3
	Vitamins and trace elements	0.1	0.1	0.1-0.2	0.1-0.2
10	Total	100	100	100	100

Table 2b): Operating conditions

	Parameter	Units	Value	Possible range
	Mixture of flours A	kg/h	200	150-300
	Steam	kg/h	15	0-25
15	Water	kg/h	35	0-60
	Water content A	%	28.8	24-36
	Mixture of flours B	kg/h	180	150-300
	Oil	kg/h	13	0-25
	Water	kg/h	14	0-25
20	Water content B	%	16.3	14-23
	Rotational speed of screws	rpm	250	200-450
	Temperature mass A	°C	125	100-140
	Pressure mass A	bar	26	20-100
	Temperature mass B	°C	170	140-180
25	Pressure mass B	bar	132	80-150
	Current	A	184	150-400
	Residence time	s	30	20-45
	Density (B)	g/l	103	60-160

Two different breakfast cereal products in the form of expanded small balls 8-12 mm in diameter are thus obtained.

Example 3

Use is made of an installation like the one represented in Figures 3 and 5. The co-extrusion die

includes two sets of a combination of an annular extrusion opening A with an inside diameter of 8 mm and an outside diameter of 12 mm surrounding a circular extrusion opening B 6 mm in diameter.

5 This installation is used to prepare a co-extruded composite cereal product with the ingredients and under the conditions given in Tables 3a) and 3b) below.

10 Table 3a) gives the ingredients of mixtures of flours, their proportions in two typical mixtures A and B, and the possible ranges of their proportions.

15 Table 3b) gives the quantities of ingredients introduced into each section of the installation per hour, the water content of the substances or of the processed masses and the operating conditions.

Table 3a): Mixture of flours

Ingredient	Mixture A (%)	Mixture B (%)	Range mix. A (%)	Range mix. B (%)
Cornflour	64	20	0-80	0-80
Wheat flour	20	64	0-80	0-80
20 Oatmeal	10	10	0-80	0-80
Sugar	4.9	4.9	0-12	0-12
Salt	1	1	0-3	0-3
Vitamins and trace elements	0.1	0.1	0.1-0.2	0.1-0.2
25 Total	100	100	100	100

Table 3b): Operating conditions

	Parameter	Units	Value	Possible range
	Mixture of flours A	kg/h	120	120-240
	Oil	kg/h	11	10-20
5	Water	kg/h	21	10-40
	Water content A	%	22.5	14-23
	Mixture of flours B	kg/h	230	200-300
	Oil	kg/h	8	8-16
	Water	kg/h	16	10-40
10	Water content B	%	16.3	14-23
	Rotational speed of screws	rpm	340	200-450
	Temperature mass	°C	154	140-180
	Pressure mass	bar	81	80-150
	Current	A	197	150-300
15	Residence time	s	30	25-45
	Density	g/l	104	60-160

Co-extruded breakfast cereals with a shape similar to the planet Saturn surrounded by its ring are thus obtained, the contrast between the sphere and the ring being enhanced by a difference in shade and texture, the diameter of the spherical centre being 12-16 mm, the inner edge of the ring being attached to an equator of the sphere, and the outside diameter of the ring being 18-24 mm.

Claims

1. Process for preparing a foodstuff by extrusion, in which a first food substance to be processed is introduced into a first section of a twin-screw extruder,
5 a second food substance to be processed is introduced into a second section of the twin-screw extruder, this section being separated dynamically from the first, these substances are each processed independently in their own section of the extruder, the two masses obtained are
10 extruded, passing them through at least one die, and the extruded product or products is or are cut.
2. Process according to Claim 1, in which a first substance and/or a second substance which has a water
15 content of 14 to 22% is processed to obtain an expanded product.
3. Process according to Claim 2, in which such a cut expanded product is dehydrated down to a water content of less than 5%.
4. Process according to Claim 1, in which a first
20 and/or a second substance having a water content of 24-36% is or are processed to obtain a little- or non-expanded product.
5. Process according to Claim 4, in which the cut little-or non-expanded product is converted into flakes
25 by rolling and toasting.
6. Process according to Claim 1, in which the first substance and the second substance are similar and are each processed in their own section in similar ways.
7. Process according to Claim 1, in which the first
30 substance and the second substance are different and are each processed in their own section in different ways.
8. Process according to Claim 3, in which the two masses of processed substance are passed through two similar dies or through similar orifices of a common die.
- 35 9. Process according to Claim 4, in which each of the two masses of processed substances is passed through different orifices of a common die.
10. Process according to Claim 4, in which the two masses of processed substances are co-extruded.



11. Installation for carrying out the process according to Claim 1, comprising a twin-screw extruder split into two distinct sections by dynamic-separation device, at least one extrusion die and at least one cutting device.
12. Installation according to Claim 8, in which the dynamic-separation device comprises a blocking zone where the twin-screw unit is of opposite hand.
13. Installation according to Claim 8, in which an outlet from the first section of the extruder straddles a compression zone and the blocking zone of the twin-screw unit.

