

AGGLOMERATION

1 This invention relates to a process for agglomerating
at least two particulate food products, in which the
particles of at least one secondary product are made to
adhere to the particles of a main product by means of a
5 liquid agglomerating agent.

 The invention also relates to an apparatus for
continuously carrying out this process, comprising an
inclined rotary drum, a frame supporting the drum, drive
means for rotating the drum about its axis, means for introducing the
10 main product at the upper end of the drum and means for removing
the agglomerated product at the lower end of the drum.

 The problem of incorporating heat-sensitive components,
such as certain proteins or certain amino acids,
flavourings or vitamins, in cereal flakes obtained, for
15 example, by roller drying or by extrusion of a
cereal-based paste has been solved in various ways,
including dry-mixing or agglomeration of the particles of
the heat-sensitive components with the cereal flakes after
drying of the flakes.

20 Now, the dry mixing of particulate products which
often differ considerably in their granulometry and
apparent density is difficult and involves the danger of
overrapid separation. This risk is particularly
serious when a product of relatively low bulk
25 density is dry-mixed with a product of relatively high
bulk density.

 However, the known agglomeration processes intended
to overcome this drawback of dry-mixing can also have
certain disadvantages, particularly when the particulate
30 products differ in their hygroscopicity.

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1 Thus, one known process comprises moistening an
intimate mixture of flakes based on starch issuing from
a roller dryer and powder-form food or aromatic products
with water in a fluidized bed or an agglomeration channel
5 to make the powder adhere to the flakes. This process
involves the risk of agglomerating the powder particles
with one another when they are more hygroscopic than the
flakes.

10 Similarly, another known process comprises introducing
cereal flakes and a sugar syrup into a rotary drum,
allowing the flakes and the syrup to mix along the
first two thirds of their path in the drum and then
introducing an aromatic powder of the freeze-dried ice
cream type into the last third of the drum so that it
15 adheres to the still tacky flakes. This process
involves the risk of agglomerating the flakes with one
another and of obtaining an irregular distribution of the
powder around the flakes.

20 The object of the present invention is to provide a
process and an apparatus which enable particulate food
products differing from one another in their granulometry,
bulk density and hygroscopicity to be agglomerated and
which, in particular, enable the particles of a powder of
comparatively high bulk density and hygroscopicity
25 to be made to adhere uniformly to flakes of comparatively
low bulk density and hygroscopicity while, at the
same time, providing for very high homogeneity of the
mixture of said particulate products.

30 To this end, the present invention provides a process
for the agglomeration of at least two particulate food
products, in which the particles of at least one secondary
product are made to adhere to the particles of a main
product by means of a liquid agglomerating agent, wherein a
vortex of the particles of said main product is formed
35 about a horizontal or inclined axis, said agglomerating
agent is sprayed onto the vortex from outside and the
particles of said secondary product are distributed in the
vortex from inside.

5 The present invention also provides an apparatus
 for continuously carrying out the process claimed in Claim
 1, comprising a rotary drum inclined with respect to the
 horizontal, a frame supporting the drum, drive means for
 rotating the drum about its axis, means for introducing
 the main product at the upper end of the drum and means for
 removing the agglomerated product at the lower end of the
 drum, and further comprising means for producing a vortex
 of the particles of main product about an inclined axis in
 10 a first part of the drum, at least one means for
 distributing secondary product in an ascending half in a
 second part of the drum and means for spraying the
 agglomerating agent into said descending half in said
 second part of the drum.

It has been found that this process and, in
 particular, this apparatus lend themselves better than
 known processes and apparatus to the agglomeration of
 particulate food products having different physical
 characteristics in regard to their granulometry
 their hygroscopicity and their bulk density. In
 particular, it has surprisingly been found that the
 particles of a comparatively more hygroscopic secondary
 product, such as a skimmed milk powder for example,
 may be made to adhere very uniformly to particles of a
 comparatively less hygroscopic main product, such as
 cereal flakes for example, using a relatively small
 quantity of agglomerating agent while, at the same time,
 guaranteeing very high homogeneity of the mixture of the
 various particles. It is assumed that this surprising
 result is attributable to the fact that the coating of
 the particles of main product with the droplets of
 agglomerating agent and the contacting of the particles
 of secondary product with the particles of the coated main
 product thus take place separately in space, but quasi-
 simultaneously in time. It is thus possible in particular
 to spray very fine droplets of agglomerating agent
 which coat or cover the particles of main product very
 uniformly, but only come into contact with them a

fraction of a second before the particles of secondary product. Thus, if a sugar syrup for example is sprayed
5 in the form of very fine droplets, the quantity of water which they contain does not have time either to evaporate

- 1 or to penetrate sufficiently into the particles of main product for the agglomerating or adhesive effect to be lost.

*In the context of the invention, the expressions
5 "a first part and a second part or even a third part of the drum" designate slices of cylindrical space cut by planes perpendicular to the axis of the drum in the cylindrical space delimited by the wall of the drum. The parts follow one another from the upper end to the lower
10 end of the drum.

Similarly, the expressions "ascending half and descending half of the drum" designate the semicylindrical spaces cut by the vertical plane passing through the axis of the drum in the cylindrical space delimited by the
15 wall of the drum. The terms "ascending" or "descending" used in these expressions locate the two "halves" in relation to the axis of the drum by designating the side where the wall of the drum makes an ascending or descending movement at axis level.

20 To carry out the process according to the invention, the vortex of particles is preferably formed in a rotary drum, the rotation of the vortex being maintained by gravitation and by friction against the wall of the drum.

This is because it is possible to form a vortex of
25 particles which rotate about an axis in a rotary drum, the friction against the wall of the drum imparting an upward impulse to the ascending side of the vortex and gravitation ensuring the downward falling movement of the descending side of the vortex. A vortex such as
30 this is adjacent the wall of the drum in the ascending half of the drum and leaves an empty space in the descending half of the drum. The agglomerating agent may thus be sprayed onto the descending side of the vortex from the space left free between the vortex and
35 the wall of the drum in the descending half of the drum.

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1 The axis of rotation of a vortex such as this is
substantially parallel to the axis of the drum and is
situated at substantially the same level in the
ascending half of the drum. The particles of said
5 secondary product may be distributed in the vortex from
an inner zone of the vortex coinciding with or close
to its axis of rotation. For example, the particles of
secondary product may be distributed in the form of a
curtain falling from the distribution zone into the
10 lower part of the vortex.

Although the process may be carried out in batches,
in some cases with certain advantages, it is generally
preferred to carry out the process continuously. Thus,
said vortex of particles may be formed in an inclined
15 drum, the main product may be continuously introduced into
the vortex at the upper end of the drum and the agglomer-
ated product may be continuously removed from the vortex,
i.e. collected, at the lower end of the drum.

✓The nature of the particles of the main food product
20 which lends itself to the process according to the
invention may vary. The particles may be granules of
a freeze-dried product or flakes obtained by roller
drying of a cereal paste for example. The particles in
question may also be expanded cereals obtained by
25 extrusion cooking of a moistened cereal flour and having
various shapes, such as for example stars, rings or
flakes of relatively large size.

The secondary particulate food products which lend
themselves to the process according to the invention
30 are preferably in the form of a relatively fine powder,
although other forms of granulometry similar to those
of the main product are also possible. For example,
the process according to the invention may be used to
agglomerate at least two different secondary products
35 in the form of flakes or granules with a main product

1 itself in the form of flakes or granules. However, the
process according to the invention is particularly suitable
for making a powder containing heat-sensitive components,
such as for example certain proteins or certain amino
5 acids, vitamins, flavourings or pigments, adhere to the
particles of said main product.

The edible liquid agglomerating agents suitable for
carrying out the process according to the invention may
also be of various types. It is sufficient that they
10 be, on the one hand, finely sprayable and, on the other
hand, capable of exerting an agglomerating or adhesive
effect between the particles of the main product and the
particles of the second product. It is even possible
to use a non-aqueous liquid, such as for example a molten
15 fat. However, the process according to the invention is
particularly suitable for agglomeration by means of a
syrup of sugar and/or starch, particularly a syrup of
high dry matter content.

Thus, in one particular embodiment of the process
20 according to the invention, the particles of the main pro-
duct are flakes of cereals obtained by roller drying
of a paste based on cereals, the secondary product is a
skimmed milk powder and the agglomerating agent is a
syrup of sugar and/or starch.

25 In another particular embodiment of the process
according to the invention, the particles of the main
product are expanded cereals obtained by extrusion cooking
of a moistened cereal flour, the secondary product is a
powder of fruit, cocoa or sugar and the agglomerating
30 agent is a syrup of sugar and/or starch.

Preferably and in general, where the process
according to the invention is carried out continuously,
65-85 parts by weight of particulate main product
having a bulk density of 90-200 g/l and a water
35 content of 0.5-12% by weight are introduced hourly into

1 the vortex, 15-30 parts by weight of syrup of sugar and/or
starch having a water content of 15-60% by weight are
sprayed hourly onto the vortex, 3-30 parts by weight of
secondary particulate product having a water content of
5 0-12% by weight are distributed hourly in the vortex and
102-118 parts by weight of agglomerated particulate
product having a bulk density of 120-250 g/l and a
water content of 2.0-15% by weight are removed hourly
from the vortex.

10 The process according to the invention is particularly
appropriate for making a minor quantity of secondary
particulate product adhere to a major quantity of a
particulate main product of relatively low apparent
density so as to retain the shape and individual
15 character of the particles of main product and to obtain
an agglomerated particulate product also having a re-
latively low bulk density.

In the particular embodiment relating to the expanded
cereals intended in particular for consumption as break-
20 fast cereals, the quantities of secondary particulate
product used are generally relatively modest, the
objective generally being to improve the appearance and
organoleptic qualities of the main product. It is
thus precisely possible by the process according to the
25 invention to cover the surface of relatively large part-
icles of main product particularly uniformly with relat-
ively small particles of secondary product.

With regard to the particular embodiment relating
to the cereal flakes intended in particular for reconsti-
30 tution in the form of an instant pap, it should be
noted that it is possible to obtain by roller drying
flakes of cereals having a very low bulk density,
which provides the reconstituted product with an unctuous
texture, and a very low water content which provides
35 the flakes with good keeping qualities.

1 The process according to the invention enables most
of these qualities to be retained in the agglomerated end
product which generally has a water content of 2.0-6.5%
by weight. Where the agglomerated end product has a
5 water content of 4.0-6.5% by weight, it may in any case be
of advantage to carry out post-drying after agglomeration.
However, it has been found that it is possible, particu-
larly where a syrup of very high dry matter content is
used, to obtain a water content of 2.0-4.0% by weight
10 which enables the post-drying step to be omitted if
required.

 In this embodiment, the process enables a skimmed
milk powder, of which the particles generally have a
mean diameter of the order of 0.1-0.2 mm, to be made to
15 adhere to cereal flakes generally having a thickness of
0.5-1.0 mm and a mean diameter of 2-5 mm in such a regular
and uniform manner that the dimensions and shape of the
flakes are remarkably preserved while the bulk
density of the flakes remains low enough for the unctuous
20 qualities of the reconstituted product to be preserved.

 The process according to the invention thus enables
the syrup to be sprayed in the form of very fine droplets.
Thus, the syrup may be sprayed under pressure in the
form of a mist. So as not to risk blocking the spray
25 nozzle(s) or losing any of the agglomerating or adhesive
effect, it is preferable where necessary to spray the
syrup at a temperature above the crystallization
temperature of the sugar. With a sucrose solution having
a dry matter content of 58-85% by weight for example,
30 the appropriate temperature is at least 70-120°C and the
pressure in the spray nozzle may be of the order of
12-25 bar for example. Where the spray nozzle used is
one in which the dispersion of a jet of solution is
ensured by a concentric jet of air, it has been found
35 that it is of advantage to use an air temperature much

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1 higher than the temperature of the solution, for example
150-250°C, and that lower pressures may be applied.

2 In cases where it is desired to obtain an end
product containing little or no sugar, a starch syrup
5 may advantageously be used. Starch syrups may be
obtained by hydrolysis of cereals for example. Syrups
such as these pose problems of adhesion and viscosity
from much lower dry matter contents. It is possible
with advantage to use syrups containing 35-45% by weight,
10 based on dry matter, of hydrolyzed starch having a DE
(dextrose equivalent) of 30-60 for example.

In addition, in one particular embodiment of the
process according to the invention, the vortex is heated
or cooled. In this way, it is possible in particular
15 to influence certain properties of the end product,
particularly its water content or the possibly overly
tacky nature of its surface. Heating may be carried
out, for example, by convection, radiation or contact.
Similarly, cooling may be carried out, for example, by
20 convection or contact.

Finally, so far as the total residence time of the
particles in the vortex is concerned, it may advantageously
be from a few tens of seconds to a few minutes, for example
of the order of 1-3 minutes. However, it is important
25 to note that it is not the residence time of the
particles in the vortex which determines the success of
the process according to the invention, but rather the
fact that the coating of the particles of main product
with the droplets of agglomerating agent and the con-
30 tacting of the particles of secondary product with
the particles of the coated main product take place
separately in space, but quasi-simultaneously in time.

The apparatus for continuously carrying out the
process according to the invention is thus distinguished
35 in particular by the fact that it comprises means for

1 rotating the particles of main product to form said
vortex in the first part of the inclined drum, this
vortex then moving on as it were towards the lower end
of the drum by virtue of the general spiral movement
5 of the particles in the vortex. The means for rotating
the particles advantageously consist of projecting elements
disposed against the wall of the drum in its first part.
They are preferably in the form of radial fins fixed to
the wall of the drum.

10 The apparatus is further characterized in that it
contains at least one means for distributing secondary
product in the ascending half in the second part of the
drum, these means thus being located inside the space
intended to be occupied by the vortex. These means
15 advantageously have a linear configuration so as to
distribute the product in particular along a line parallel
to or even coincident with the axis of the vortex. This
distribution means preferably comprises a tube which is
connected at one end to a metering unit, is open at its
20 other end, is drilled with holes underneath and is
arranged parallel to the axis of the drum.

So far as the means for spraying the agglomerating
agent is concerned, it may also advantageously have a
linear configuration or may at least ensure spraying of
25 the agglomerating agent over a fraction of the length of
the vortex corresponding approximately to the fraction
of the length of the vortex in which said particulate
secondary product is distributed. This spray means
preferably comprises several high-pressure spray nozzles
30 arranged along an axis parallel to the axis of the drum.
The preferred means for distributing the secondary product
and spraying the agglomerating agent are thus parallel to
one another in said second part of the drum. In view
of the spread of the beam of droplets projected by each
35 nozzle, the spray means is advantageously located at mid-

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1 height in the drum.

In order to ensure constant friction conditions between the vortex and the wall of the drum, the apparatus may additionally comprise at least one scraper blade
5 disposed against the wall of the drum parallel to its axis in said second part at the top of said ~~ascending~~ ^{descending} half. It is advantageously positioned in such a way that the scraped particles drop back near the spray means, for example in such a way that they drop back into a space
10 left free between the spray means and the wall of the drum.

In one particular embodiment, the apparatus according to the invention additionally comprises means for cooling or heating the vortex in a third part of the drum. This means may be in the form of openings for the distribution
15 of hot or cold air or in the form of elements for heating or cooling the wall of the drum for example. An infrared or microwave heating system for example may also be provided.

In addition, each end of the drum may advantageously
20 be provided with an annular retaining diaphragm having an external diameter equal to and an internal diameter smaller than that of the drum while a fixed retaining plate may be provided against the lower end of the drum in the extension of its ascending half. The retaining
25 diaphragm provided at the upper end of the drum is intended to prevent particles of main product from leaving the drum at the moment when they are rotated by the rotation means. The retaining diaphragm arranged at the lower end of the drum is intended to retain the
30 particles of agglomerated product ready for removal so as to facilitate adjustment of the residence time of the product in the drum. Similarly, the closure plate is intended to apply a slight pressure to the lower end of the vortex which assists in ensuring its cohesion or spatial
35 definition.

1 Finally, the frame supporting the drum may
advantageously be provided with a mechanism to enable
the inclination of the drum to be regulated. This is
because, for a drum of given dimensions, the residence
5 time of the product in the drum depends directly on that
inclination. If it is desired to modify the output of
the production line, it is of advantage also to be able
to adapt the residence time of the product in the drum.
For a drum 1 meter in length and 0.7 m in diameter and
10 for outputs of approximately 400-1200 kg of agglomerated
product per hour, it is possible to use an inclination of
10-15° for example. Under these conditions and with a
rotational speed of the drum of approximately 16-22 r.p.m.
sufficient to form the vortex, the residence time of the
15 particles of main product in the drum may be approximately
1-3 minutes while the instantaneous charge of the drum,
i.e. the weight of the vortex, may be of the order of
50 kg.

 The apparatus for continuously carrying out the pro-
20 cess according to the invention is described hereinafter
with reference to the accompanying drawings, wherein:

 Figure 1 is a diagrammatic side elevation of one
embodiment of the apparatus.

 Figure 2 is a diagrammatic front view of the appar-
25 atus shown in Figure 1.

 The apparatus shown in Figures 1 and 2 comprises an
inclined drum 1, a frame 2 supporting the drum, drive
means 3,4 for rotating the drum about its axis, means 6
for introducing the main product at the upper end of
30 the drum and means 7 for removing the agglomerated product
at the lower end of the drum.

 The introduction means 6 and removal means 7 are
fixed funnels or channels which are not integral with the
drum.

35 The drive means consist of a variable-speed motor 3

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1 which transmits the rotational movement to the drum by friction on a drive ring 4 fixed to the drum.

The apparatus additionally comprises means 8 for rotating the particles 9 of main product about an inclined axis in the first part of the drum extending axially from its upper end, means 10 for distributing secondary product 11 in the ascending half of the second part of the drum which follows the first part and extends axially to the lower end of the drum and means 12 for spraying the agglomerating agent 13 into the descending half of the second part of the drum.

The means 8 for rotating the particles 9 is formed by radial fins 8 fixed to the wall of the drum.

The means 10 for distributing secondary product 11 is fixed, but not integral with the drum and comprises a tube which is connected at its upstream end 14 to a metering unit (not shown), is open at its downstream end 15, is drilled with holes 16 underneath and is arranged parallel to the axis 5 of the drum. the distribution means 10 is disposed in the space intended to be occupied by the vortex. The vortex is shown in section in Figure 2 and rotates about an axis substantially parallel to the axis 5 of the cylinder. The distribution means 10 is thus intended to distribute the particles 11 of secondary product along a line parallel to and situated slightly above the axis of the vortex.

The means 12 for spraying the agglomerating agent 13 is fixed, but not integral with the drum and comprises three high-pressure spray nozzles 28 disposed substantially at mid-height in the drum along an axis parallel to the axis of the drum. The spray means 12 is disposed outside the space intended to be occupied by the vortex and is parallel to the distribution means 10 itself disposed in the space intended to be occupied by the vortex.

35 The apparatus shown also comprises a scraper blade 17

- 1 which is fixed, but not integral with the drum and which
is disposed against the wall of the drum parallel to
the spray means 12, but above and at a greater distance
from the vertical plane passing through the axis 5 of
5 the cylinder so that the scraped particles do not drop
onto the spray means.

The apparatus additionally comprises an annular
retaining diaphragm 18 at the upper end of the drum, an
annular retaining diaphragm 19 at the lower end of the
10 drum and a closure plate 20 disposed against the lower
end of the drum. The two annular retaining diaphragms
18 and 19 are fixed to the wall of the drum and each
define an opening smaller in diameter than the drum.
The closure plate 20 is fixed, but not integral with
15 the drum, is formed with an opening 21 through which the
distribution means 10 passes and is semicircular in shape.
It is disposed against the lower end of the drum in the
extension of its ascending half, i.e. in the extension of
the space intended to be occupied by the vortex.

- 20 Finally, the frame 2 supporting the drum is provided
with a mechanism 22, 23, 24 for regulating the inclination
25 of the drum relative to the horizontal plane 26. The
inclination adjusting mechanism comprises a crank
actuating a lever 23 which causes a table 27 supporting
25 the drum to pivot about an axis passing through bearings
24 formed in the frame 2.

The process according to the invention is illustrated
by the following Examples in which the percentages and
parts are by weight.

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EXAMPLE 1

- To prepare an instant dehydrated pap in the form
of flakes, cereal flakes prepared by roller drying of
a cereal paste are used as the main product. These
35 flakes have a thickness of approximately 0.6-0.7 mm, a

1 mean diameter of approximately 2-3 mm, a bulk density
of 90 g/l and a water content of 2.5%. Their composition
is that of a wheat flour to which 6.25% skimmed milk
powder, based on dry matter, has been added.

5 The secondary product used is skimmed milk powder
to which a premix of skimmed milk powder, vitamins and
iron pyrophosphate is added so that the respective
concentrations of these two additives in the end product
are 0.15% and 0.036%, based on dry matter. This skimmed
10 milk powder has a bulk density of approximately
600 g/l and a water content of 4%. It consists of
particles having a mean diameter of approximately 0.1-0.2 mm.

The agglomerating agent used is a sucrose syrup
having a dry matter content of 70% heated to 75°C.

15 The secondary product and the main product are
agglomerated with the agglomerating agent, in other words
the skimmed milk powder is made to adhere to the cereal
flakes with the hot sugar syrup in an apparatus similar to
that described above with reference to the drawing, of
20 which the drum has a length of 1 meter, a diameter of
0.7 meter and an inclination of 15°.

The cereal flakes are introduced into the drum at
its upper end at a rate of 850 kg/h. The drum is
rotated at 16-20 r.p.m. so that the cereal flakes are
25 rotated about an axis substantially parallel to that
of the drum in its ascending half. Once they have
been set rotating in the first part of the drum by the
radial fins fixed to its wall, the particles continue
their rotational movement while descending slowly along
30 the drum in a spiral movement, all the moving particles
constituting a well-defined integral vortex.

252 kg/h of skimmed milk powder containing 25 kg
of the premix of skimmed milk powder, vitamins and iron
pyrophosphate are distributed in the vortex by a
35 distribution means consisting of a tube 7 cm in diameter

1 which is drilled underneath with a plurality of holes
4 mm in diameter over a width of 2.5 cm and a length of
20 cm and which is disposed in the vortex parallel to
and slightly above its axis at a distance of 50 cm from
5 the lower end of the drum. The milk powder thus
distributed descends in the form of a curtain of powder
and immediately mixes intimately with the vortex.

171 kg/h of sucrose syrup are sprayed at 75°C onto
the descending side of the vortex at a distance of 20-30 cm
10 from the vortex by a spray means consisting of three nozzles
arranged along an axis parallel to the axis of the
drum at intervals of 15 cm from its lower end. Spraying
is carried out under a pressure of 15 bar with the
aid of 3 concentric air jets at 150°C or under a pressure
15 of 25 bar without the assistance of concentric air jets
so that the three beams of microscopic droplets projected
against the vortex form a genuine mist which envelops
and immediately coats the particles of the vortex.
1298 kg/h of agglomerated product having a water content
20 of 6.44%, a bulk density of 180 g/l and a granulo-
metry comparable with that of the cereal flakes of said
main product are removed or collected at the lower end
of the drum.

It was found that this agglomeration process did not
25 cause any loss of lysine.

It was also found that the mixing index, defined as
the quotient of the mean deviation from the means concen-
tration of a given component in the end product, is
3.7% for proteins, 8% for iron and 12.5% for vitamin C.
30 This proves that this agglomeration process also guarantees
very high homogeneity of the mixture, in other words
high homogeneity of the composition of separate samples
of the agglomerated product.

The agglomerated product is then subjected to
35 post-drying for 3 minutes at 80°C, during which its

1 water content is reduced to 2.5%, again without any loss
of lysine.

EXAMPLE 2

5 The procedure is as described in Example 1, except
that half the hourly quantities indicated are used. To
this end, the inclination of the drum is adjusted to
10° instead of 15° in relation to the horizontal plane.
An agglomerated product comparable with that of Example 1
10 is obtained.

EXAMPLE 3

The procedure is as described in Example 1, except
that a sucrose syrup having a dry matter content of
15 75% heated to 80°C is used as the agglomerating agent.
1287 kg/h of agglomerated product having a water content
of 5.6% and qualities comparable with those of the
agglomerated product of Example 1 are obtained.

20 EXAMPLE 4

To prepare an instant dehydrated pap in the form
of flakes, cereal flakes prepared by roller drying of
a cereal paste are used as the main product. These
flakes have a thickness of 0.6-0.7 mm, a mean diameter of
25 2-3 mm, a bulk density of 90 g/l and a water content
of 2.5%. Their composition is as follows (in % based on
dry matter):

	hydrolyzed wheat flour	31.4
30	non-hydrolyzed wheat flour	50.0
	butter oil	3.0
	vegetable oil	8.9
	skimmed milk	6.7

35 The secondary product used is skimmed milk powder

1 enriched in iron and vitamins having a bulk density
of approximately 600 g/l and a water content of 4% and
consisting of particles having a mean diameter of
approximately 0.1-0.2 mm.

3/ 5 — The agglomerating agent used is a sucrose syrup
having a dry matter content of 75% heated to 80°C.

With the same apparatus and in the same way as in
Example 1, a vortex of the cereal flakes is formed,
800 kg/h of these flakes are introduced into the vortex,
10 159 kg/h of the sucrose syrup is sprayed onto the
descending side of the vortex at 80°C, 275 kg/h of
skimmed milk powder are distributed in the vortex and
1244 kg/h of agglomerated product are collected or removed
from the vortex.

15 The agglomerated product obtained has a water content
of 5.7%, a bulk density of 175 g/l and a granulo-
metry comparable with that of the flakes of said main
product. It has the following composition (in %, based
on dry matter):

20	hydrolyzed wheat flour	21.0
	non-hydrolyzed wheat flour	33.6
	skimmed milk	27.2
	sucrose	10.2
25	vegetable oil	6.0
	butter oil	2.0

It was found that the agglomeration process did not
cause any loss of lysine in relation to the respective
30 lysine contents of the main and secondary products. It
was also found that the mixing index was very good,
namely approximately 3-4% for proteins, approximately 8%
for iron and approximately 12% for vitamin C.

The agglomerated product is then subjected to post-
35 drying for approximately 3 minutes at 80°C, during which

1 its water content is reduced to 2.5%, again without any
loss of lysine.

EXAMPLE 5

5 To prepare an instant dehydrated pap in the form
of flakes without gluten or sucrose, cereal flakes pre-
pared by roller drying of a cereal paste are used as
the main product. These flakes have a thickness of
approximately 0.6-0.7 mm, a mean diameter of approximately
10 2-3 mm, a bulk density of approximately 90 g/l and
a water content of 1.7%. Their composition is as follows
(in %, based on dry matter):

	hydrolyzed corn flour	40
15	non-hydrolyzed corn flour	48
	butter oil	3
	vegetable oil	9

The secondary product used is skimmed milk powder
20 enriched with iron and vitamins having a bulk density
of approximately 600 g/l and a water content of 3.3% and
consisting of particles having a mean diameter of approx-
imately 0.1-0.2 mm.

A syrup of hydrolyzed corn flour having a dry matter
25 content of 41% and a DE of 55 and heated to 85°C is
used as the agglomerating agent.

With the same apparatus and in the same way as in
Example 1, a vortex of the cereal flakes is formed,
800 kg/h of these flakes is introduced into the vortex,
30 83 kg/h of the hydrolyzed corn flour syrup heated to
85°C are sprayed onto the descending side of the vortex,
359 kg/h of skimmed milk powder are distributed in the
vortex and 1242 kg/h of agglomerated product are collected
or removed from the vortex.

35 This agglomerated product has a water content of

1 5.9%, a bulk density of approximately 200 g/l and a
granulometry comparable with that of the flakes of said
main product. This product, free from gluten and
sucrose, has the following composition (in %, based on
5 dry matter):

	hydrolyzed corn flour	29.8
	non-hydrolyzed corn flour	32.4
	skimmed milk	29.8
10	vegetable oil	6.1
	butter oil	1.9

The agglomerated product is then subjected to post-
drying for a few minutes at 80°C, during which its water
15 content is reduced to 2.5%.

EXAMPLE 6

To prepare breakfast cereals, expanded cereals in
the form of stars, rings or almonds having dimensions
20 of the order of 1 cm and obtained by extrusion cooking
of a flour of moistened cereals containing sugar, salt,
malt and fats are used as the main product. These expanded
cereals have been predried. They have a bulk density
of 110 g/l and a water content of 1%. Their composition
25 is as follows (in %, based on dry matter):

	corn flour	70
	wheat flour	17
	sucrose	7
30	sodium chloride	1
	malt	3
	fats	2

The secondary product used is a vitamin-enriched
35 apricot powder having a bulk density of 737 g/l and

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1 a water content of virtually 0% and consisting of particles having a mean diameter below 0.3 mm.

A sucrose syrup having a dry matter content of 78% heated to 80°C is used as the agglomerating agent.

5 The secondary product and main product are agglomerated with the agglomerating agent, in other words the apricot powder is made to adhere to the expanded cereals with the aid of the hot sugar using the same apparatus and the same procedure as in Example 1.

10 To this end, the inclination and rotational speed of the drum are adjusted to adequate values of 10-15° and 16-22 r.p.m., respectively, and a vortex of the expanded cereals is formed, 500 kg/h of these cereals are introduced into the vortex, 180 kg/h of the sucrose syrup are sprayed
15 onto the descending side of the vortex, 20 kg/h of apricot powder are distributed in the vortex and 700 kg/h of agglomerated product having a bulk density of 150 g/l and a water content of 5.6% are collected or removed from the vortex.

20 The breakfast cereals thus obtained have all the qualities of the starting expanded cereals together with all the flavour of the apricot powder. These cereals may even be subjected to post-drying for a few minutes at 80°C to reduce their moisture content to 2.5% without
25 affecting their flavour.

EXAMPLE 7

To prepare breakfast cereals, expanded cereals in the form of flakes having a mean diameter of 1-2 cm for a
30 thickness of 1-2 mm and the same composition as the expanded cereals of Example 6, a bulk density of 100 g/l and a water content of 8% are used as the main product.

The secondary product used is a cocoa powder having
35 a bulk density of 440 g/l, a water content of 4.4%

- 1 and consisting of particles having a mean diameter below 0.3 mm.

A sucrose syrup having a dry matter content of 70% heated to 70°C is used as the agglomerating agent.

- 5 With the same apparatus and in the same way as in Example 6, 35 kg/h of this cocoa powder are made to adhere to 700 kg/h of these expanded cereals using 210 kg/h of the sucrose syrup. An agglomerated product having a water content of 14% is obtained. After post-drying
10 for several minutes at 80°C, breakfast cereals having a water content of 2.5% and a bulk density of 150 g/l are obtained.

These cereals have a strong chocolate flavour and colour.

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EXAMPLE 8

- To prepare breakfast cereals, cornflakes having a mean diameter of 1-2 cm and obtained by steeping, crushing and drying of grains of corn are used as the main product.
20 These flakes have a bulk density of 100 g/l and a water content of 9%.

- The secondary product used is sucrose in the form of icing sugar having a mean particle diameter below 0.1 mm. This icing sugar has a water content of 0% and a bulk
25 density of 675 g/l.

A sucrose syrup having a dry matter content of 75% heated to 80°C is used as the agglomerating agent.

- With the same apparatus and in the same way as described in Example 6, 25 kg/h of the icing sugar are
30 made to adhere to 500 kg/h of the cornflakes using 200 kg/h of the sucrose syrup. 725 kg/h of agglomerated product having a water content of 7% are obtained. After post-drying for a few minutes at 80°C, breakfast cereals having a water content of 2.5% and a bulk density of
35 140 g/l are obtained.

1 These sugared flakes have a surface of surprising
snowy appearance due to a particular crystallization of
the sugar applied with such little water.

5 EXAMPLE 9

To prepare breakfast cereals, expanded cereals in
the form of flakes similar in their dimensions to the
flakes used in Example 7 are used as the main product.
These flakes have a bulk density of 100 g/l and a
10 water content reduced to 1% by predrying.

Expanded cereals in the form of needles approximately
5 mm long and 1-1.2 mm wide also having a water content
of 1%, but a bulk density of 150 g/l are used as
the secondary product.

15 A sucrose syrup having a dry matter content of 80%
heated to 90°C is used as the agglomerating agent.

With the same apparatus and in the same way as
described in Example 6, 50 kg/h of the cereal needles are
made to adhere to 500 kg/h of the cornflakes using 175 kg/h
20 of the sucrose syrup. 725 kg/h of agglomerated product
having a bulk density of 150 g/l and a water content
of 2.8% are obtained.

These breakfast cereals have a very natural fibrous
appearance.

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CLAIMS

1. A process for the agglomeration of at least two particulate food products, in which the particles of at least one secondary product are made to adhere to the particles of a main product by means of a liquid agglomerating agent, wherein a vortex of the particles of said main product is formed about a horizontal or inclined axis, said agglomerating agent is sprayed onto the vortex from outside and the particles of said secondary product are distributed in the vortex from inside.
2. A process as claimed in Claim 1, wherein the said vortex of particles is formed in a rotary drum, the rotation of the vortex being maintained by gravitation and by friction against the wall of the drum.
3. A process as claimed in Claim 2, wherein said agglomerating agent is sprayed onto the descending side of the vortex from a space left free between the vortex and the wall of the drum in a descending half of the drum.
4. A process as claimed in Claim 1 wherein said vortex of particles is formed in an inclined drum, said particulate main product is continuously introduced into the vortex at the upper end of the drum and the agglomerated product is continuously removed from the vortex at the lower end of the drum.
5. A process as claimed in Claim 1, wherein the particles of said main product are cereal flakes obtained by roller drying of a paste based on cereals, the secondary product is a skimmed milk powder and the agglomerating agent is a syrup of sugar and/or starch.
6. A process as claimed in Claim 1, wherein the particles of the main product are expanded cereals obtained by extrusion cooking of a moistened cereal flour, the secondary product is a powder of fruit, cocoa or sugar and the agglomerating agent is a syrup of



sugar and/or starch.

7. A process as claimed in Claim 1, wherein 65-85 parts by weight of particulate main product having a bulk density of 90-200 g/l and a water content of 0.5-12% by weight are introduced hourly into the vortex, 15-30 parts by weight of sugar syrup and/or starch syrup having a water content of 15-60% by weight are sprayed hourly onto the vortex, 3-30 parts by weight of particulate secondary product having a water content of 0-12% by weight are distributed hourly in the vortex and 102-118 parts by weight of particulate agglomerated product having a bulk density of 120-250 g/l and a water content of 2.0-15% by weight are removed hourly from the vortex.
8. A process as claimed in any of Claims 5 to 7, wherein the syrup is sprayed under pressure in the form of a mist at a temperature above the crystallization temperature of said sugar.
9. A process as claimed in Claim 1, wherein the vortex is heated or cooled.
10. An apparatus for continuously carrying out the process claimed in Claim 1, comprising a rotary drum inclined with respect to the horizontal, a frame supporting the drum, drive means for rotating the drum about its axis, means for introducing the main product at the upper end of the drum and means for removing the agglomerated product at the lower end of the drum, and further comprising means for producing a vortex of the particles of main product about an inclined axis in a first part of the drum, at least one means for distributing secondary product in an ascending half in a second part of the drum and means for spraying the agglomerating agent into said descending half in said second part of the drum.
11. An apparatus as claimed in Claim 10, wherein the means for rotating the particles consists of radial fins fixed to the wall of the drum.
12. An apparatus as claimed in Claim 10 or 11,



wherein the means for distributing the secondary product comprises a tube which is connected at one end to a metering unit, is open at its other end, is drilled with holes underneath and arranged parallel to the axis of the drum.

13. An apparatus as claimed in any of Claims 10 to 12, wherein said means for spraying the agglomerating agent comprises several high-pressure spray nozzles arranged along an axis parallel to the axis of the drum.

14. An apparatus as claimed in any of Claims 10 to 13, further comprising at least one scraper blade against the wall of the drum parallel to its axis in said second part at the top of said ~~ascending~~ ^{descending} half.

15. An apparatus as claimed in any of Claims 10 to 14, further comprising means for cooling or heating the vortex in a third part of the drum.

16. An apparatus as claimed in any of Claims 10 to 15, wherein each end of the drum is provided with an annular retaining diaphragm which is equal in its external diameter to the drum but smaller in its internal diameter and a fixed semi circular closure plate is disposed parallel against the lower end of the drum in its ascending half.

17. An apparatus as claimed in any of Claims 10 to 16, wherein said frame is provided with a mechanism for adjusting the inclination of the drum.