

TITLE

An edible product comprising a solid center and a coating of fatty material

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Technical Field

The present disclosure relates to an edible product comprising a solid center and a coating of fatty material, and a method for the production thereof. In particular, the disclosure relates to confectionary products comprising a fruit center with a yoghurt or chocolate coating.

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Technical background

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Coating fruit jellies with fatty coating material containing probiotic bacteria is technically challenging due to the heat involved in the process for making the fruit jellies and melting the yoghurt wafers to provide liquid yoghurt, and the risk of water in the jelly center passing into the coating during storage where it accelerates probiotic cell death. Previous attempts to address this problem involve a process in which the jelly centre is initially coated with a barrier layer of fatty material prior to coating with a probiotic-containing outer coat, whereby the inner barrier coating prevents movement of moisture from the jelly center into the probiotic containing outer coating. A problem with this process is that the probiotics are not stabilised and external air and moisture that will kill the cells within a matter of hours post-production. In addition, colour changes to the coating are inevitable because free cells will utilise the sugar of the barrier layer as a sugar source, resulting in a drop in pH and consequent colour change to the coating. In addition, the presence of vitamins such as vitamin C, iron or zinc will react adversely in such a system and promote both colour change and cell death. These negatively impact the sensory and microbiological attributes of the product, more predominantly the taste (due to lower pH, oxidised vitamins presence in the fatty layer of the product. The impact of these physical changes also results in decay and shredding of the coating outer

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layer due to cell degradation and oxidation activity; hence. the jelly centre eventually becomes separated from the barrier layers since there is not compatible reaction or crosslinking in such a system. If the probiotic is outside the barrier layer, there is no option for slow release of taste and or probiotics for stabilisation.

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It is an objective of the invention to overcome at least one of the above-referenced problems.

Summary

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The objective is achieved by preparing a centre having an amphipathic surface comprising hydrophilic regions and hydrophobic regions. This may be achieved by applying a discontinuous thin coating of a hydrophobic fatty material such as yoghurt or chocolate to the center such that the surface after coating comprises hydrophilic carbohydrate regions and hydrophobic fatty material regions.

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Alternatively, when the center is a nut or fruit piece or cluster, the surface may be dusted with soluble plant-based fibre before application of a thin discontinuous coating of fatty material. The amphipathic surface is then dried and coated with fatty material comprising probiotic. The generation of a surface with discontinuous amphipathic character creates an electrostatic differential across the surface of the center to promote immobilisation and stabilisation of encapsulated probiotics, promotes cross-linking reaction generated between the fatty coating and the fruit center, immobilises encapsulated probiotics onto the amphipathic surface to create a "sandwich of stabilised encapsulated probiotics between the fruit piece and the fatty coating.

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In a first aspect, there is provided a process for producing an edible product comprising a center coated with a fatty material. The method comprises the steps of:

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applying an inner coat of fatty material to a surface of the centre, to provide an at least partially coated center having an amphiphilic surface;

drying the at least partially coated center;

5 applying an intermediatecoat of fatty material and encapsulated probiotic
bacteria to the coated centre;

drying the second coat; and

10 applying an outercoat of fatty material on the intermediate coat of fatty
material.

In any embodiment, the inner coat of fatty material is discontinuous.

15 In any embodiment, the center comprises a gel.

In any embodiment the gel is a fruit gel.

In any embodiment, the center comprises a nut or fruit piece, preferably dusted with
a soluble carbohydrate such as a soluble plant-based fibre.

20 In any embodiment, the center comprises a fruit or nut cluster bound with a binder
comprising carbohydrate.

In any embodiment, the center has a cuboid shape.

25 In any embodiment, the fatty material is selected from chocolate, yoghurt, caramel,
or a sugar- or starch-based coating.

In any embodiment, the process comprises an initial step of dusting the surface of
30 the center with a soluble plant-based fibre prior to the application of the
discontinuous coat of fatty material.

In any embodiment, the soluble plant-based fibre comprises a prebiotic plant-based fibre. An example is inulin.

5 In any embodiment, each step of applying a coat of fatty material comprises the steps of panning and spraying of the coating material. Thus, the coating steps are generally performed in a drum that is rotated (panning) and the fatty material is sprayed into the drum to apply the coating.

10 In any embodiment, one or more of the spraying steps comprise intermittently spraying the fatty material.

In any embodiment, each spraying step lasts about 3-10 seconds and each non-spraying step last for 1 to 3 seconds.

15 In any embodiment, one or more of the spraying steps comprise electrospraying of coating (e.g. fatty) material.

20 In any embodiment, the step of applying the inner coat of fatty material comprises spraying the fatty material at a first spraying rate and the step of applying the outer coat of fatty material comprises spraying the fatty material at a second spraying rate that is greater than the first spraying.

25 In any embodiment, the step of applying the inner coat of fatty material comprises intermittently spraying the fatty material for a first spraying time and the step of applying the outer coat of fatty material comprises intermittently spraying the fatty material for a second spraying time that is greater than the first spraying time.

30 In any embodiment, the second spraying time is at least 2, 3, 4, 5 or 6 time greater than the second spraying time.

In any embodiment, the first spraying time is 2-10 mins.

In any embodiment, the second spraying time is 15-120 mins.

In any embodiment, the first spraying rate is 2-10 mins.

- 5 In any embodiment, the second spraying time is 15-120 mins.

In any embodiment, the step of applying the outer coat of fatty material comprises circulating air around the product during the coating step.

- 10 In any embodiment, the step of applying the outer coat of fatty material comprises a first coating phase, a second coating phase, and a third coating phase.

In any embodiment, the first coating phase lasts for 3-7 minutes.

- 15 In any embodiment, the second coating phase lasts for 10-15 minutes.

In any embodiment, the third coating phase lasts for 30 to 90 minutes.

- 20 In any embodiment, the first coating phase is carried out without air circulation and the second and third coating phases are carried out with air circulation.

In any embodiment, the second and third coating phases are separated by a drying phase.

- 25 In any embodiment, the drying phase last for 30 second to 3 minutes.

In any embodiment, the step of drying the at least partially coated center comprises panning the coated center without spraying of the fatty material.

- 30 In any embodiment, the (optionally discontinuous) inner coat of fatty material comprises encapsulated probiotic bacteria.

In any embodiment, the probiotic bacteria are encapsulated in a food-grade matrix or shell.

5 In any embodiment, the step of applying the intermediate second coat of fatty material and encapsulated probiotic bacteria to the coated centre comprises spraying fatty material comprising probiotic bacteria on to the coated centre.

10 In any embodiment, the step of applying the intermediate second coat of fatty material and encapsulated probiotic bacteria to the coated centre comprises topically applying the encapsulated probiotic bacteria to the coated centre while spraying fatty material.

In another aspect, there is provided an edible product comprising:

15 a solid center;

an inner coating of fatty material applied to a surface of the solid centre;

20 an intermediate coating of fatty material comprising encapsulated probiotic bacteria; and

an outer coat of fatty material applied on the intermediate coating of fatty material;

25 wherein the inner coating of fatty material provides a solid center with a surface comprising hydrophilic regions and hydrophobic regions.

In any embodiment, the inner coating of fatty material is a discontinuous coating.

30 In any embodiment, the solid centre comprises a gel, ideally a fruit gel.

In any embodiment, the solid centre comprises a fruit and/or nut cluster comprising a carbohydrate binder.

5 In any embodiment, the solid centre comprises a nut or fruit piece, wherein a surface of the nut or fruit piece comprises a dusting of soluble plant-based fibre.

In any embodiment, the fatty material comprises calcium ions, in which the calcium ions crosslink the probiotic bacteria in the intermediate coat of fatty material.

10 In any embodiment, the fatty material comprises yoghurt, chocolate, caramel, starch- or sugar-based coating.

In any embodiment, a dusting of soluble plant fibre is disposed between the surface of the carbohydrate center and the inner (optionally discontinuous) coating of fatty material.
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In any embodiment, the (optionally discontinuous) inner coating of fatty material comprises encapsulated probiotic bacteria.

20 In any embodiment, the encapsulated probiotic bacteria are provided as microparticles comprising probiotic bacteria encapsulated in a food-grade matrix or shell.

In any embodiment, the solid center has a cuboid or irregular shape.
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In any embodiment, the edible product comprises an additional outer coat of fatty material disposed on the outer coat of fatty material.

In another aspect, the invention provides a method of producing an edible product comprising a solid center and a plurality of coats of a coating material, the method
30 comprising the steps of:

providing a solid centre of the edible product;

5 coating the center with an inner coat of coating material comprising simultaneously panning the center and spraying the coating material on to the center;

panning the coated center without spraying the coating material to dry the coated center;

10 applying a first outer coat of coating material to the coated centre comprising simultaneously panning the coated center and spraying the coating material on to the coated center; and

15 optionally, applying a second outer coat of coating material to the coated centre comprising simultaneously panning the coated center and spraying the coating material on to the coated center.

In any embodiment, the centre has a cuboid shape.

20 In any embodiment, the centre has a cuboid shape and the edible product is spherical.

In any embodiment, the centre is cuboid and has a first colour and the coating has a second colour that contrasts with the first colour. The first colour may be dark
25 colour (e.g. red or purple). The second colour may be white, cream or pink.

In any embodiment, a surface of the edible product comprises a pattern comprising edges and/or corners of the centre visible through the coating of coating material.

30 In any embodiment, the pattern comprises a plurality of lines corresponding to edges of the cuboid centre.

In any embodiment, the pattern comprises a plurality of triangular markings corresponding to corners of the cuboid centre.

5 In any embodiment, the step of coating the center with the inner coat comprises a first coating step comprising simultaneously spraying the coating material and panning to form a first inner coat and a second coating step comprising simultaneously spraying the coating material on the first coat and panning to provide a second inner coat.

10 In any embodiment, the or each coating step comprises intermittently spraying the coating material.

In any embodiment, the step of intermittent spraying of the coating material comprises spraying steps separated by non-spraying steps, in which each non-spraying step last for 1 to 10 seconds.

15 In any embodiment, the outer coat comprises a heat sensitive active agent.

In any embodiment, the process comprises a step of drying the first outer coat by panning the coated center without spraying prior to application of the second outer coat.

20 In any embodiment, the heat sensitive active agent comprises an encapsulated probiotic bacteria.

25 In any embodiment, the process comprises applying a final outer coat of a coating material to the coated center.

In any embodiment, the yoghurt comprises one or more acacia extract, Carnuba wax, Cocoa butter, typically in any amount of 0.001-0.0005% (w/w) of final product.

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In another aspect, there is provided an edible product made by a process of the invention.

Other aspects and preferred embodiments of the invention are defined and described in the other claims set out below.

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Brief Description of the Figures

FIG. 1 is a schematic illustration of a process according to one embodiment of disclosure in which (A) illustrates a solid center (B) a discontinuous coating of fatty material disposed on the surface providing a center with an amphiphilic surface comprising hydrophilic regions (corners) and hydrophobic regions (faces) (C) illustrates an intermediate coat of fatty material containing encapsulated probiotic bacteria and (D) illustrates the continuous outer coat of fatty material.

15 **FIG. 2** is a detailed view of the edible product of FIG. 1D.

FIG. 3 is a sectional view of an edible product according to another aspect of the disclosure in which the discontinuous coating of fatty material and the intermediate coating of fatty material both contains encapsulated probiotic.

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FIG. 4 is a schematic illustration of a process according to another embodiment of disclosure in which (A) illustrates a solid center which in this embodiment has an irregular bumpy surface having peaks and troughs (B) a discontinuous coating of fatty material disposed on the surface providing a center with an amphiphilic surface comprising hydrophilic regions (peaks) and hydrophobic regions (troughs) (C) illustrates an intermediate coat of fatty material containing encapsulated probiotic bacteria and (D) illustrates the continuous outer coat of fatty material.

25 **FIG. 5** is two views of an edible food product according to the disclosure illustrating a surface pattern comprising star shapes corresponding to corners of the center and lines corresponding to edges of the center.

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FIG. 6A shows a pectin cube (fruit gel) center having a discontinuous coating of yoghurt.

FIG.6B shows the partially coated pectin cube with an intermediate coating of
5 yoghurt containing encapsulated probiotic bacteria.

FIG.6C shows a finished edible product of the disclosure having a continuous outer coating of yoghurt.

10 **FIG.7** Product homogeneity testing for probiotic quantification in large production yoghurt bites Yogurt bites demonstrate highly reproducible and homogenous probiotic populations from gram to gram / serve to serve.

FIG.8 Probiotic recovery in finished product yogurt bites expressed as percent of
15 input. Values verify a high probiotic recovery which indicates minimal probiotic loss in the production and storage process.

FIG.9 Probiotic recovery after *in vitro* human digestion, (oral, gastric and intestinal phases) as function of time and gastro-intestinal section, relative to the dose in the
20 original yogurt bite (included in the graph for comparative purposes).

FIG.10 Detection of intact protein microparticles in probiotic yoghurt bite after production and accelerated storage testing. FTIR (Fourier – transform Infrared analysis endorses the presence of intact protein microparticles after the stress of
25 production processing and storage challenge tests.

FIG.11 Probiotic metabolic verification in Yoghurt bites post-production 3 month accelerated storage using flow cytometry (as per ISO 19344 analytical methods

30 **FIG.12** Probiotic functionality and membrane integrity verification is demonstrated in Yoghurt bites post-production and 3 month accelerated storage using flow cytometry analytical methods (as per ISO 19344 method)

FIG.13 Probiotic functionality and membrane integrity verification in Yoghurt bites post-production, 3 month accelerated storage and full in vitro human digestion, using flow cytometry analytical methods (as per ISO 19344 method)

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FIG. 14 Yoghurt bites with initial layer (no outer coating layer) after 15 min incubation in water (Room Temp). Moisture migration and fruit centre dissolution of fruit piece due to absence of the outer coating layer, as indicated by the brown solution, (dissolution of fruit centre).

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FIG.15 Yoghurt bites (with coating layer) after 15 min incubation in water. No leakage or dissolution of fruit piece due to the presence of the outer coating layer, as indicated by the clear solution. Hence, the coating layer prevents moisture migration to dissolve the fruit centre

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FIG. 16 Microscope image (x10) of yoghurt bite after initial layer is applied to fruit centre.

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Detailed Description of the Invention

All publications, patents, patent applications and other references mentioned herein are hereby incorporated by reference in their entireties for all purposes as if each individual publication, patent or patent application were specifically and individually indicated to be incorporated by reference and the content thereof recited in full.

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Where used herein and unless specifically indicated otherwise, the following terms are intended to have the following meanings in addition to any broader (or narrower) meanings the terms might enjoy in the art:

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Unless otherwise required by context, the use herein of the singular is to be read to include the plural and *vice versa*. The term "a" or "an" used in relation to an entity

is to be read to refer to one or more of that entity. As such, the terms "a" (or "an"), "one or more," and "at least one" are used interchangeably herein.

As used herein, the term "comprise," or variations thereof such as "comprises" or
5 "comprising," are to be read to indicate the inclusion of any recited integer (e.g. a feature, element, characteristic, property, method/process step or limitation) or group of integers (e.g. features, element, characteristics, properties, method/process steps or limitations) but not the exclusion of any other integer or group of integers. Thus, as used herein the term "comprising" is inclusive or open-
10 ended and does not exclude additional, unrecited integers or method/process steps.

As used herein, the term "edible product" refers to a product suitable for oral administration to human and animals, for example a food product, a confectionary
15 product, a nutritional supplement or a pharmaceutical product. Examples include coated nut, fruit pieces, fruit and/or nut clusters, coated caramels, fruit gels, coated gummies, lozanges.

As used herein, the term "center" refers to the center of the food product that is
20 coated in a fatty material. The centre is usually solid, e.g. a solid fruit piece or a gelled edible material such as a fruit gel. Examples of centers include fruit gels, nuts, fruit pieces, and nut clusters, for example dried fruits pieces, peanut brittle pieces, roasted nuts, pretzel balls / plant protein balls / malted milk balls, raisins, macadamia, hazelnuts, gelatin gum pieces, fruit loops, caramels, pectin, cashews,
25 pistachios, corn flakes. fruit clusters and fruit & nut clusters. The center may be freeze-dried, e.g. a freeze-dried fruit piece.

As used herein, the term "fruit gel" typically refers to a product made from fruit pulp or containing fruit or fruit extracts that is heated and then allowed to cool and gel in
30 a shaped mold to form a shaped fruit gel. The fruit gel may be any shape, such as cuboid, round, oval, pyramidal. The fruit gel may comprise pectin or a different gelling agent. The fruit gel generally comprises added sugar (e.g. sucrose). In one

embodiment, the fruit gel is free of added sugar, and includes an added sweetener, such as a low-calorie sweetener like a polyol, allulose or sucralose, and optionally includes a fibre.

- 5 As used herein the term “fatty material” refers to a food material that is solid at room temperature and configured for phase transition to a liquid upon heating. Examples include yoghurt, peanut butter and chocolate. The fatty material may contain added sugar or sweeteners, preservatives, colouring agents and the like. Generally, the fatty material comprises at least 20%, 25% or 30% fat (w/w). The
- 10 edible product may have two or more coats of the same fatty material, or a coat of one fatty material and a second coat of a different fatty material, for example an outer coat of yoghurt and an inner coat of peanut butter, or *vica-versa*. In any embodiment, the fatty material comprises added sugar. In any embodiment, the fatty material contains no added sugar but comprises a low calorie sweetener.

- 15 As used herein, the term “amphipathic” as applied to the surface of the centre means that it has regions that are hydrophilic and regions that are hydrophobic. The hydrophilic regions are comprised of carbohydrate forming part of the centre (or a coating on the centre, such as a dusting of soluble plant-based fibre) and the
- 20 hydrophobic regions are comprised of regions of fatty material coated on the centre as part of the inner coat. The fatty material contains relatively high amounts of fat which makes the material hydrophobic in nature. When the center comprises a carbohydrate such as pectin, the positive charge of the carbohydrate provides hydrophilic (charged) regions on the surface of the center. The generation of a
- 25 surface with discontinuous amphipathic character creates an electrostatic differential across the surface of the center to promote immobilisation and stabilisation of encapsulated probiotics, promotes cross-linking reactions generated between the fatty coating and the fruit center, immobilises encapsulated probiotics onto the amphipathic surface to create a “sandwich” of stabilised encapsulated
- 30 probiotics between the fruit piece and the fatty coating. The amphipathic inner coating also creates a dual release system that enhances the slow release kinetics of the product due to the position of the probiotics below the fatty coating layer i.e.

the fatty layer will melt in the mouth due low melting point and the encapsulated probiotic will release in the intestine of the consumer, and promotes the coalescence of hydrophobic fatty surface components (fatty components attracted to each other and concentrate on flat surfaces) to enhance the polar and non polar surface areas; Thi also helps generate of a spherical topography (build up of hydrophobic layers on fruit piece flat surfaces) to accelerate crosslinking reaction via calcium bridging with the fatty layer.

As used herein, the term “panning” refers to a well known process in which a material is coated onto a solid center by moving the center while simultaneously applying a coating material to the center. The process is usually performed in a rotating drum, with or without the circulation of air or other atmosphere modification. the frequency of rotation may be modified to compensate for the weight of the product increasing the process as coating is added to the material. Panning a product results in the application of a coating to the product, and the process parameters can be modified to achieve a partial or complete coating and various levels of moisture in the applied coat.

As used herein, the term “probiotic” refers to live beneficial bacteria and/or yeasts that naturally live in your body. Probiotics help keep your body healthy and working well, including fighting off bad bacteria when you have too much of it, helping you feel better. The probiotics employed in the invention may comprise a combination of different probiotics. Though there are many types of bacteria that can be considered probiotics, there are two specific types of bacteria that are common probiotics found in stores. These include *Lactobacillus* and *Bifidobacterium*. The term includes spore-forming and non-spore forming bacteria.

As used herein, the term “encapsulated probiotic” refers to a live probiotic encapsulated within a food grade plant protein. As used herein, the term “plant protein” refers to a protein preparation obtained from a plant source. Examples include plant protein powders, plant protein concentrates and plant protein isolates. Plant protein preparations can be obtained from pea, zein, barley, spelt, soya,

seaweed, hemp, seitan (wheat gluten), chickpea, tofu, lentil, mung bean, quinoa and other plant sources. Plant proteins having an isoelectric point above pH 5, 5.5 or 6 are preferred. Typically the encapsulated probiotic is made in a process characterised by at least 60%, 65%, 70%, 75%, 80%, 85% or 90%. Typically, the encapsulated probiotic are gastric resistant and ileal sensitive. This means that the microparticles can pass through a human stomach intact and break up in the ileum releasing the probiotic payload. Methods of making encapsulated probiotics are described in Examples 1 to 22 of WO 2023/144354.

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Exemplification

The invention will now be described with reference to specific Examples. These are merely exemplary and for illustrative purposes only: they are not intended to be limiting in any way to the scope of the monopoly claimed or to the invention described. These examples constitute the best mode currently contemplated for practicing the invention.

FIG. 1 is a schematic illustration of a process according to one embodiment of disclosure. (A) illustrates a solid center which in this case is a pectin cube – the pectin cube provides the surface of the cube with an overall positive charge due to the charge on the pectin. (B) illustrates a coating of fatty material, in this case yoghurt having a fat content of approximately 31% (w/w), discontinuously disposed on the surface of the cube. Due to the level of fat in the yoghurt, this provides the surface of the cube with hydrophobic regions where the cube is coated. As the center is a cube with faces, the yoghurt tends to coalesce on the faces providing hydrophobic regions of the faces of the cube, and at least partially exposed regions of pectin at the corners and along the edges, thus providing a center with an amphiphilic surface comprising hydrophilic regions (corners and edges) and hydrophobic regions (faces). The coalescing of the yoghurt on the faces is assisted by a drying step prior to the application of the intermediate coat. (C) illustrates an intermediate coat of fatty material containing encapsulated probiotic bacteria disposed on the inner discontinuous coat. (D) illustrates the continuous outer coat

of fatty material applied to the intermediate coat providing the finished edible product.

FIG. 2 is a detailed view of the edible product of FIG. 1D illustrating how the encapsulated probiotic bacteria (which carry a net negative charge) are concentrated at the exposed corners of the pectin cube where they are stabilised by the exposed positively charged pectin.

FIG. 3 is a sectional view of an edible product according to another aspect of the disclosure in which the discontinuous coating of fatty material and the intermediate coating of fatty material both contains encapsulated probiotic.

FIG. 4 is a schematic illustration of a process according to another embodiment of disclosure in which (A) illustrates a solid center which in this embodiment has an irregular bumpy surface having peaks and troughs (B) a discontinuous coating of fatty material disposed on the surface providing a center with an amphiphilic surface comprising hydrophilic regions (peaks) and hydrophobic regions (troughs) (C) illustrates an intermediate coat of fatty material containing encapsulated probiotic bacteria and (D) illustrates the continuous outer coat of fatty material.

FIG. 5 illustrates two views of an edible food product according to the disclosure illustrating a surface pattern comprising star shapes corresponding to corners of the center and lines corresponding to edges of the center.

EXAMPLES

- Examples 1-4 describe a process for producing fruit jelly cubes coated with yoghurt
- Example 5 describes a process for producing (whole) nuts coated with yoghurt
- Example 6 describes a process for producing (whole) fruit pieces coated with yoghurt

- Example 7 describes a process for producing fruit jelly cubes coated with yoghurt
- Example 8 describes a process for producing fruit jelly cubes coated with chocolate

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EXAMPLE 1 – Fruit cubes coated with yoghurt

1.1: Preparation of coating:

Flavour and yogurt flakes are melted at 55- 60 DegC

Melting temp relies on the size of the batch

10 If milk chocolate is used, the temperature is between 55- 65DegC

Batch of coating is not held any longer than 2-3 hours

Option to add soluble corn fibre or prebiotic into yoghurt coating to 1) increase fibre content of the product and 2) function as a plasticizer for the coating layer

15 **1.2: Loading of coating chamber**

Pectin fruit pieces (or other fruit pieces or charged fruit / nut particles are loaded into machine at 20DegC

Tumbling is started immediately without spray to avoid the material sticking

Air humidity is controlled to ensure that humidity doesn't contribute to cubes

20 sticking

Drum speed is at the max (80Hz) since the product is light - to promote even movement of fruit cubes inside the machine and no sticking

Pump Speed	7Hz
Drum Forward Speed	80Hz
Fan (Air)	Off
Time Length	7min

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1.3: Preparation of center with amphipathic surface

Yogurt (hydrophobic) coating is initially sprayed onto the piece to create a thin (inner) hydrophobic layer on the fruit piece and to initiate the re-shaping of the fruit piece. The kinetic heat of the drum helps to melt and reshape the yoghurt on the

30 surface of the fruit piece. The primary purpose of this step is to reduce the

stickiness of the fruit piece and specific spray conditions used promote the movement of the yoghurt to the centre of each cube surfaces, which keeps the edges exposed; hence it is a re-shaping step and not a layering step since a layer / membrane is not made. The coalescence of the yoghurt creates hydrophobic vs hydrophilic surfaces. This creates the ideal fruit base for coating: An amphipathic scaffold with both hydrophilic and hydrophobic surfaces. Temp is maintained at 20DegC and no air is needed because this initial re-shaping process does not apply a coating layer – the volume of spray is minimal hence the moisture evaporates fast

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Pump Speed	7Hz
Spray Time	5s
Stop Time	2s
Drum Forward Speed	55Hz
Fan (Air)	Off
Time Length	7min
Temp	20DegC

1.4 Priming and cooling steps

15 This cooling step is critical to ensure that the material / fruit pieces are free flowing and that the fruit based has the ideal morphology prior to coating. Lower drum speed is needed to ensure that no peeling of yoghurt occurs at the edges. The side surface of the cubes need to be visibly “weighted” with yoghurt. The fruit piece remains positively charged but the addition of the yogurt material to the surface of the cube reduces the surface to surface interaction to prevent aggregation of cube surfaces.

Novelty - This cooling step primes the fruit piece for the addition of the probiotic. Removal of water creates an highly amphipathic surface for the immobilisation of (negative) probiotics using yoghurt as a carrier. Two cooling steps are performed in order to gradually reduce moisture without damaging the surface of the piece or create peeling flaky product.

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Cooling Step 1

Spray Time	0s
Stop Time	0s
Drum Forward Speed	55Hz
Fan (Air)	Off
Time Length	5min
Temp	23-24 DegC

5 Cooling Step 2

Spray Time	0s
Stop Time	0s
Drum Forward Speed	20Hz
Fan (Air)	On
Fan Frequency	100Hz
Time Length	5min

1.5 Immobilisation of encapsulated probiotic

- 10 Probiotic is added during this immobilisation phase in the yoghurt coating (intermediate coating) where the yogurt acts as a delivery vehicle for the probiotic. The calcium present in the yoghurt material will creates an instantaneous immobilisation for the probiotic and generates a crosslinked immobilisation matrix on the surface of the pectin cube. The temp is 45 – 55DegC for the yogurt material

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Pump Speed	7Hz
Spray Time	5s
Stop Time	2s
Drum Forward Speed	40Hz
Fan (Air)	Off
Time Length	5min

1.6: Application of outer hydrophobic yoghurt coat

- Creation of the hydrophobic yogurt layer occurs in three phases. The air is
- 20 maintained at half capacity so that yogurt won't dry out quickly and can partially melt to form the ball shape.

Coating Phase 1

Pump Speed	7Hz
Spray Time	5s
Stop Time	2s
Drum Forward Speed	40Hz
Fan (Air)	Off
Time Length	5min
Temp	23 DegC

Coating Phase 2

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Spray Time	5s
Stop Time	2s
Drum Forward Speed	40Hz
Fan (Air)	On
Fan Frequency	50Hz
Time Length	15min

Stop spraying at 10th minute for gap drying 1 minute and then continue spraying.

Coating Phase 3

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Spray Time	5s
Stop Time	2s
Drum Forward Speed	30Hz
Fan (Air)	On
Fan Frequency	100Hz
Time Length	65min (more or less depending on the weight)

Stop spraying when the individual weight reaches the desired amount 1.2g 0 3g.

This step is to continue building up the yogurt layer until the desired weight is reached. The drum speed should be adjusted since the load weight increases

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significantly.

EXAMPLE 2 – Fruit cubes coated with yoghurt

The process described in Example 1 is performed with the exception that the pectin cubes when added to the drum are pre- treated with inulin to 1) apply enhance the electrostatic positive charge on the surface of the fruit piece surface 2) to further prevent sticking of the pectin pieces during the early stages of the process and 3)

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provide prebiotic material for the probiotic bacteria. Doublet formation / aggregates represent big losses and the application of soluble corn fibre will 1) prevent this doublet formation; 2) increase yield and 3) generate a highly positive charge to the surface to support the immobilisation of the encapsulated probiotic powder.

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Spray Time	5s
Stop Time	2s
Drum Forward Speed	80Hz
Fan (Air)	Off
Time Length	7min

High rotation speed of the drum is maintained to promote even movement of fruit cubes inside the machine while the corn fibre is added / sprayed
Air remains off to promote the electrostatic deposition of the (hydrophilic) fibre material onto the fruit cube surface.

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EXAMPLE 3 – Fruit cubes coated with yoghurt

The process described in Example 1 is performed with the exception that 50% of the encapsulated probiotic is added at Step 1.3 and the remaining probiotic is added at Step 1.5. In this embodiment, the probiotic is added topically as a powder immobilised onto the surface of the fruit base at Step 1.3 with the final 50% added at Step 1.5. The encapsulated probiotic has a negative charge and is electrostatically immobilised to the positively charged pectin on the surface of the partially coated fruit center. Yoghurt is sprayed while the encapsulated probiotics are added topically since the Ca present in the yoghurt (approx. 0.15% Ca content), provide a crosslinking to further immobilise the negatively charged encapsulated probiotics onto the surface of the positively charge pectin piece. The temp is 23-25DegC for the yogurt material and the drum operational parameters during Step 1.5 are as follows:

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Spray Time	3s
Stop Time	5s
Drum Forward Speed	20Hz
Fan (Air)	On
Fan Frequency	100Hz

Time Length	5min
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EXAMPLE 4 – Fruit cubes coated with yoghurt

- 5 The process described in Example 1 is performed with the exception that Step 1.5 comprises topical application of probiotic (in powder) while the yoghurt spray is applied. The temp is 23-25DegC for the yogurt material and the drum operational parameters during spraying the yoghurt are as per Example 4 above.

10 **EXAMPLE 5 – Nut centre coated with yoghurt**

- In this embodiment, the center is a nut.
- Arabic gum (prebiotic-) based sugar solution is used to coat the nuts (alternative to corn fibre).
- Semi dry the nut with air to make the surface become tacky with reduced moisture
- 15 Add maltodextrin, sugar powder, corn syrup solids or soluble corn fibre powder to coat the nuts to make the surface unsmooth.
- Dry the powder layer completely with air.
- The above steps can be repeated maximum three times until desired thickness is reached
- 20 Steps 1.1 to 1.6 of Example 1 are then carried out to coat the nuts.

EXAMPLE 6 – Fruit piece coated with yoghurt

- In this embodiment, the center is a fruit piece (specifically an apricot).
- Add maltodextrin, sugar powder, corn syrup solids or prebiotic or corn fibre powder
- 25 to coat the fruit to make the surface less tacky and more smooth
- Use Arabic gum / prebiotic -based sugar solution to coat around the fruits
- Completely dry out the solution layer
- Repeat above steps at least three times until the fruit surface is smooth and not tacky
- 30 Steps 1.1 to 1.6 of Example 1 are then carried out to coat the fruit pieces.

EXAMPLE 7 – Fruit cubes coated with chocolate

Melt the chocolate temperature between 45-55C; probiotics can be also added during the melting step (milk chocolate 45-50, dark chocolate 50-55C)

Adjust the flow rate/pump speed of the chocolate depending on the different

5 viscosity of the chocolate itself

Charge interaction is optimal due to positive sugar and negative probiotics - chocolate remains to be hydrophobic due to high fat content (hence compatible reactions remain the same)

Steps 1.1 to 1.6 of Example 1 are then carried out to coat the fruit cubes with
10 chocolate.

EXAMPLE 8 – Nut cluster center coated with yoghurt

In this embodiment, the center is a nut cluster prepared as follows:

Prepare sugar solution (and/or with any sweetener or processing aid)

15 Ensure all solids are dissolved and hydrated

Add probiotics powder into the solution under the temperature at 60C

Spray the sugar solution as a binder to the cluster nut blend and add additional sweetener or binder as needed.

Additional probiotics powder can be added in this step to tumble together with
20 sugar solution with cluster nut blend (charge interaction is optimal due to positive sugar and negative probiotics; hence compatible reactions remain the same)

Roast the cluster; cool down & break cluster into desired shape & size

Steps 1.1 to 1.6 of Example 1 are then carried out to coat the nut clusters with
yoghurt.

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Equivalents

The foregoing description details presently preferred embodiments of the present invention. Numerous modifications and variations in practice thereof are expected
30 to occur to those skilled in the art upon consideration of these descriptions. Those modifications and variations are intended to be encompassed within the claims appended hereto.

CLAIMS:

1. A process for producing an edible product comprising a center coated with a fatty material, the method comprising the steps of:

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applying a discontinuous coat of fatty material to a surface of the carbohydrate centre, to provide a partially coated center having an amphiphilic surface;

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drying the partially coated center;

applying an intermediate coat of fatty material and probiotic bacteria to the partially coated centre;

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drying the intermediate coat; and

applying a continuous third coat of fatty material on the intermediate coat of fatty material.

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2. A process according to Claim 1, in which the solid center comprises a fruit gel.

3. A process according to Claim 1 or 2, in which the solid center comprises a fruit and / or nut cluster bound with a carbohydrate.

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4. A process according to any preceding Claim, in which the solid center has a cuboid or irregular shape.

5. A process according to any preceding Claim, in which the fatty material is selected from chocolate, peanut butter and yoghurt.

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6. A process according to any preceding Claim, comprising an initial step of dusting the surface of the center with a soluble plant-based fibre prior to the application of the discontinuous coat of fatty material.
- 5 7. A process according to Claim 6, in which the soluble plant-based fibre comprises a prebiotic plant-based fibre.
8. A process according to any preceding Claim, in which each step of applying a coat of fatty material comprises the steps of panning and spraying of the coating
10 material.
9. A process according to Claim 8, in which the spraying steps comprise intermittently spraying the fatty material.
- 15 10. A process according to Claim 9, in which each spraying step a plurality of spraying intervals of 3-7 seconds separated by non-spraying intervals of 1 to 3 seconds.
11. A process according to any preceding Claim, in which the step of drying the
20 partially coated center comprises panning the coated center without spraying of the fatty material.
12. A process according to any preceding Claim, in which the discontinuous coat of fatty material comprises encapsulated probiotic bacteria.
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13. A process according to any preceding Claim, comprising applying a second outer coat of fatty material on the outer coat of fatty material.
14. A process according to any preceding Claim, in which the step of applying the
30 intermediate coat of fatty material and probiotic bacteria to the discontinuous coat of fatty material comprises spraying fatty material comprising encapsulated bacteria on to the discontinuous coat of fatty material.

15. A process according to any of Claims 1 to 13, in which the step of applying the intermediate coat of fatty material and probiotic bacteria to the discontinuous coat of fatty material comprise applying the encapsulated probiotic bacteria to the discontinuous coat of fatty material topically during or prior to spraying the intermediate coat of fatty material.
16. A process according to any preceding Claim, in which the discontinuous coat of fatty material comprises encapsulated probiotic bacteria.
17. An edible product comprising:
- a solid center having a surface comprising carbohydrate;
 - an inner discontinuous coating of fatty material applied to the surface of the solid centre;
 - an intermediate coat of fatty material applied on the inner discontinuous coating of fatty material, in which the intermediate coat of fatty material comprises probiotic bacteria; and
 - an outer continuous coating of fatty material applied to the intermediate coating of fatty material;
- wherein the inner discontinuous coating of fatty material provides a center with a surface comprising hydrophilic regions and hydrophobic regions.
18. An edible product according to Claim 17, in which the solid centre comprises a fruit gel.
19. An edible product according to Claim 17, in which the solid centre comprises a fruit or nut cluster comprising a carbohydrate binder.

20. A food product according to any of Claims 17 to 19, wherein a surface of the solid center comprises a dusting of soluble plant-based fibre.

- 5 21. A food product according to any of Claim 17 to 20, in which the fatty material comprises calcium ions, in which the calcium ions crosslink the encapsulated probiotic bacteria in the outer coat of fatty material.

- 10 22. A food product according to any of Claims 17 to 21, in which the fatty material comprises yoghurt, chocolate, peanut butter, caramel or a starch or sugar-based coating.

- 15 23. A food product according to any of Claims 17 to 22, in which the discontinuous inner coating of fatty material comprises encapsulated probiotic bacteria.

24. A food product according to any of Claims 17 to 23, in which the encapsulated probiotic bacteria are provided as microparticles comprising probiotic bacteria encapsulated in a food-grade matrix or shell.

- 20 25. A food product according to Claim 17, in which the solid center comprises a nut cluster coated with a carbohydrate.