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(71) Applicant (for all designated States except US):
UNILEVER IP HOLDINGS B.V. [NL/NL]; Weena 455,
3013 AL Rotterdam (NL).

(71) Applicant (for US only): **CONOPCO, INC., D/B/A
UNILEVER** [US/US]; 700 Sylvan Avenue, Englewood
Cliffs, New Jersey 07632 (US).

(72) Inventors: **BLIJDENSTEIN, Theodorus, Berend, Jan**;
Unilever Innovation Centre Wageningen B.V. Bronland
14, 6708 WH Wageningen (NL). **FLENDRIG, Leonar-
dus, Marcus**; Unilever Innovation Centre Wageningen B.V.
Bronland 14, 6708 WH Wageningen (NL). **PEDRINI,
Maria, Elena**; Unilever Innovation Centre Wageningen
B.V. Bronland 14, 6708 WH Wageningen (NL). **SAN-
TAGIULIANA, Marco**; Unilever Innovation Centre Wa-
geningen B.V. Bronland 14, 6708 WH Wageningen (NL).

(74) Agent: **TURNER, Felicity, Margaret, Mary**; Unilever
Patent Group Bronland 14, 6708 WH Wageningen (NL).

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(54) Title: GELLED BEADS

(57) Abstract: The invention relates to a fat tissue mimetic that can suitably be applied in, for instance, meat analogues. The fat tissue mimetic according to the present invention can be provided in the form of gelled beads comprising by weight of the gelled bead: 0 – 70 wt.% of fat; 2 – 20 wt.% of starch; 0.5 – 5 wt.% of kappa-carrageenan; 0.5 – 4 wt.% of konjac mannan; and 27 – 84 wt.% of water The invention also relates to a meat analogue comprising by weight of the meat analogue 5 – 55 wt.% of the aforementioned gelled beads.



GELLED BEADS

FIELD OF THE INVENTION

- 5 The present invention relates to gelled beads comprising a combination of kappa-carrageenan, a source of konjac mannan and a starch. The gelled beads of the present invention may be applied as a fat tissue mimetic in, for instance, meat analogues.

BACKGROUND OF THE INVENTION

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Meat is considered the highest quality protein source, not only due to its nutritional characteristics, but also for its appreciated taste. Meat is nutritious because of its excellent amino acid profile, as well as the fact that it comprises many essential vitamins such as vitamin B12, as well as minerals like iron, zinc and selenium. Additionally, meat contains fat tissue,
15 which contributes to food acceptability due to its effect on appearance, texture, mouthfeel and overall taste. Said fat tissue also affects the properties of the meat as it is prepared and cooked.

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Nevertheless, despite the excellent nutritional value of meat, excessive consumption of meat and meat products is often associated with an excessive caloric intake, resulting in excess weight and obesity. Furthermore, due to the high cholesterol levels and saturated fats in the fat tissue, excessive meat consumption is often associated with various chronic diseases such as cardiovascular disease and type 2 diabetes.

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Additionally, an increasing number of people are switching to a more plant-based diet due to the meat industry's negative impact on the environment and for ethical reasons.

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Whilst many consumers would be motivated to adopt a plant-based diet, many find it difficult to give up on animal-based foodstuffs. Thus, there is a growing demand for meat-free protein sources that emulate real meat's appearance, texture, mouthfeel and taste.

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Fat tissue is an important component of meat products and meat analogues alike, as it has a pronounced impact on the overall eating experience. One of the greatest challenges in the development of meat analogues is to provide fat tissue mimetic of non-animal origin that has the chewiness, appearance and glossiness, resembling that of animal fat tissue in real meat cold cuts such as salami and pepperoni and that can easily be processed, e.g. in a meat

grinder. In addition, such fat mimetic tissue should be compatible with a cooking step in the preparation of e.g. a cold cut meat analogue.

SUMMARY OF THE INVENTION

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The inventors have developed a fat tissue mimetic that can suitably be applied in, for instance, meat analogues, in particular, in cold cut analogues. The fat tissue mimetic according to the present invention can be provided in the form of gelled beads. Accordingly, the present invention provides a gelled bead comprising, by weight of the gelled bead:

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- 0 – 70 wt.% of fat;
- 2 – 20 wt.% of starch;
- 0.5 – 5.0 wt.% of kappa-carrageenan;
- 0.5 – 4.0 wt.% of konjac mannan; and
- 27 – 84 wt.% of water

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The gelled beads of the present invention can suitably be applied in meat analogues to provide a chewiness, appearance and glossiness, resembling that of animal fat tissue in cold cuts analogues such as salami and pepperoni. The gelled beads of the present invention may be applied as such into a meat analogue or they may be produced *in situ* during the production of the meat analogue, e.g. by combining a lump of gel with one or more other ingredients of the meat analogue before grinding the resulting combination.

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The gelled beads of the present invention retain firmness and show little or no leakage when heated to high temperatures. Thus, the gelled beads of the present can suitably be applied in products that are produced by a process that involves a heat treatment (e.g., pasteurisation).

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The present invention further provides a gelled bead comprising, by weight of the gelled bead:

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- 8 – 45 wt.% of fat;
- 4 – 18 wt.% of starch;
- 0.8 – 4.0 wt.% of kappa-carrageenan;
- 0.7 – 3.4 wt.% of konjac mannan; and
- 40 – 80 wt.% of water

The present invention also provides a gelled bead comprising by weight of the gelled bead:

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- 12 – 30 wt.% of fat;
- 8 – 15 wt.% of starch;

- 1.0 – 3.0 wt.% of kappa-carrageenan;
- 1.2 – 2.8 wt.% of konjac mannan; and
- 60 – 72 wt.% of water

5 The present invention further provides a particulate composition comprising at least 50 wt.% of the gelled beads of the present invention.

The present invention also provides a method of preparing the gelled bead of the present invention, wherein the method comprises:

- 10
- combining starch, kappa-carrageenan, konjac mannan and water to produce a gel mixture;
 - allowing the gel mixture to form a gel; and
 - comminuting the gel to produce gelled beads.

15 The present process offers the advantage that the comminution of the gel is accompanied with minimal leakage, even if the gel is comminuted in a grinder.

The present invention further provides a process of preparing a meat analogue with the aforementioned vegan gelled beads, wherein the process comprises:

- 20 a) preparing a dough by:
- (i) combining a plurality of the gelled beads with other ingredients of the meat analogue; or
 - (ii) providing a lump of gel comprising, by weight of the gel composition:
 - 0 – 70 wt.% of fat;
 - 25 • 2 – 20 wt.% of starch;
 - 0.5 – 5 wt.% of kappa-carrageenan;
 - 0.5 – 4 wt.% of konjac mannan; and
 - 27 – 84 wt.% of water,
- 30 combining the lump of gel with one or more other ingredients of the meat analogue; and comminuting the combination of the lump of gel and one or more ingredients;
- b) shaping the dough; and
- c) heating the shaped dough to a temperature of at least 65 °C.

35 The present invention further provides a meat analogue comprising by weight of the meat analogue 5-55 wt.% of the gelled bead.

The present invention further provides meat analogue comprising by weight of the meat analogue 10-40 wt.% of the gelled bead and 35-50 wt.%, calculated by weight of the dry matter that is contained in the meat analogue, of hydrated pieces of texturized vegan protein, said
5 pieces of texturised vegan protein having a water content of 50-85 wt.% and comprising, calculated by weight of the dry matter that is contained in the meat analogue, 65-88 wt.% of plant protein.

DETAILED DESCRIPTION OF THE INVENTION

10 The terms "a" and "an" and "the" and similar referents as used herein refer to both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise" and variations such as "comprises" or "comprising" will be
15 understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The amount of ingredients of the gel bead are expressed as wt% by weight of the gel bead, unless indicated otherwise or clear from the context. This applies mutatis mutandis for the
20 ingredients of the meat analogue and particulate composition, respectively.

Numerical ranges expressed in the format "from x to y" are understood to include x and y. Whenever components A and B are said to be present in a weight ratio of x:y, what is meant is that the concentration of component A in wt.% divided by the concentration of component
25 B in wt.% equals x:y.

Concentrations expressed by weight of dry matter, as mentioned herein, refer to the amount of dry ingredient present in a composition as a percentage of the total amount of dry matter contained in the same composition.

30 Ratios mentioned herein are based on weight/weight, unless indicated otherwise. Similarly, all percentages are percentages by weight (w/w) unless otherwise indicated.

When multiple preferred ranges are described in the format "from x to y" for a specific feature,
35 it should be understood that all ranges combining the different endpoints are also contemplated.

If, for a particular component, a range of 0% to y% or less than y% is recited, said ingredient may be absent.

5 The term "fat", as used herein, refers to glycerides selected from triglycerides, diglycerides, monoglycerides, phosphoglycerides and combinations thereof. The term "fat" encompasses fats that are liquid at ambient temperature and fats that are solid or semi-solid at ambient temperature. The melting point of a fat can be determined according to ISO 6321 (2021).

10 The term "modified starch" as used herein refers to starch derivatives that are prepared by physically, enzymatically, or chemically treating native starch to change its properties. The term "modified starch" encompasses pregelatinized starch.

15 The term "konjac mannan", as used herein, refers to the glucomannan that is present in konjac gum. Konjac mannan is a heteropolysaccharide comprising β -D-glucose and β -D-mannose

The term "vegan", as used herein, in relation to a product or an ingredient, refers to a product or an ingredient that has not been derived from animals. Meat, eggs and dairy products are examples of products that are not vegan.

20 The term non-animal protein as used herein refers to protein from a non-animal source like a plant protein, a fungal protein, a microbial protein, algae protein. It excludes protein from e.g. mammals, birds, fish, shell fish and crustacean.

25 The term "texturised vegan protein" or "TVP" as used herein refers to proteinaceous fibrous material that is produced by cooking an aqueous mixture of water, vegan protein concentrate (optionally vegan protein isolates) and optionally other ingredients in an extruder cooker and extruding the mixture. The extruded material is hydrated and can be used without further hydration as hydrated non-animal protein or hydrated TVP. After extrusion the TVP may also be cut in chunks and dried. Typical examples of dried TVP include Response™ TVP's from
30 Solae (US), and Arcon™ TVP's from ADM (US). Such dry irregular chunks are generally hydrated in the process of preparing a meat analogue. Some or all of the hydrated TVP may also be comminuted for use in a meat analogue in e.g., meat grinder with a plate having 5 mm apertures.

35 The term "comminuting", as used herein, refers to the reduction of the size of a material, e.g. by grinding, cutting and/or vibrating.

The term “meat analogue”, as used herein, refers to an edible product that does not contain animal meat but is designed to have the flavour, appearance, mouthfeel of animal meat. In particular the meat analogue is a cold cut analogue.

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The gelled bead, according to the present invention, preferably has a weight of 5 – 1000 mg, more preferably of 20 – 800 mg, most preferably of 50 – 600 mg.

The gelled bead of the present invention is particularly suitable for use in meat analogues.

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Accordingly, in a particularly preferred embodiment, the gelled bead does not contain any meat-derived ingredients. Even more preferably, the gelled bead does not contain animal-derived ingredients (e.g. milk, egg or ingredient derived therefrom).

Preferably, the combination of kappa-carrageenan and konjac mannan constitutes at least 1.0 wt.%, more preferably at least 1.4 wt.%, even more preferably at least 1.7 wt.%, most preferably at least 2.0 wt.% of the gelled bead.

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The combination of kappa-carrageenan and konjac mannan preferably constitutes at most 9.0 wt.%, more preferably at most 6.5 wt.%, even more preferably at most 5.7 wt.%, most preferably at most 5.0 wt.% of the gelled bead.

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The combination of kappa-carrageenan and konjac mannan is preferably contained in the gelled bead in a concentration of 1.0-9.0 wt.%, more preferably of 1.4-6.5 wt.%, even more preferably of 1.7-5.7 wt.%, most preferably of 2.0-5.0 wt.% of the gelled bead.

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The weight ratio of kappa-carrageenan and konjac mannan in the gelled bead is preferably from 1:7 to 7:1, more preferably from 1:5 to 5:1, even more preferably from 1:3 to 3:1, most preferably from 1:2 to 2:1.

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The starch that is employed in accordance with the present invention is preferably obtained from a source selected from tapioca, potato and corn.

Examples of starches that can be employed in accordance with the present invention include native starches and modified starches. According to a preferred embodiment, the starch is selected from native starch, pregelatinized starch and chemically modified starch. Even more preferably, the starch employed is a cross-linked starch. Yet more preferably, the starch is a

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cross-linked starch selected from hydroxypropyl distarch phosphate, distarch phosphate and combinations thereof. Most preferably, the starch is hydroxypropyl distarch phosphate.

5 Preferably, the gelled bead comprises by weight of the gelled bead at least 4 wt.%, more preferably at least 6 wt.%, even more preferably 7 wt.%, most preferably at least 8 wt.% of starch.

10 The starch preferably constitutes at most 18 wt.%, more preferably at most 17 wt.%, most preferably at most 15 wt.% of the gelled bead.

Starch is preferably contained in the gelled bead in a concentration of 4-18 wt.%, more preferably of 6-17 wt.% and most preferably of 8-15 wt.%.

15 Preferably, the gelled bead comprises by weight of the gelled bead at least 0.5 wt.%, more preferably at least 0.8 wt.%, even more preferably at least 1.0 wt.%, most preferably at least 1.4 wt.% of kappa-carrageenan.

20 The gelled bead comprises by weight of the gelled bead preferably at most 5.0 wt.%, more preferably at most 4.0 wt.%, even more preferably at most 3.0 wt.%, most preferably at most 2.8 wt.% of kappa-carrageenan.

25 Kappa-carrageenan is preferably contained in the gelled bead in a concentration of 0.5-5.0 wt.%, more preferably of 0.8-4.0 wt.%, even more preferably of 1.0-3.0 wt.% and most preferably of 1.4-2.8 wt.%.

30 Preferably, the gelled bead according to the invention comprises potassium cations in a concentration of at least 0.1 mmol per kg of the total amount of water that is contained in the gelled bead. More preferably the gelled bead comprises potassium cations in a concentration of 0.5-1,200 mmol per kg of the total amount of water that is contained in the gelled bead. Most preferably the gelled bead comprises potassium cations in a concentration of 1.0-500 mmol per kg of the total amount of water that is contained in the gelled bead.

35 Potassium cations are preferably contained in gelled bead in a concentration of at least 25 mmol per kg of kappa carrageenan, more preferably in a concentration of 50-25,000 mmol per kg of kappa carrageenan and most preferably in a concentration of 200-10,000 mmol per kg of kappa carrageenan.

The konjac mannan employed per the present invention is preferably sourced from the konjac plant (konjac konjac mannan).

5 Preferably, the gelled bead comprises by weight of the gelled bead at least 0.5 wt.%, more preferably at least 0.7 wt.%, more preferably at least 0.9 wt.%, most preferably at least 1.2 wt.% of konjac mannan.

10 The gelled bead comprises by weight of the gelled bead preferably at most 4.0 wt.%, more preferably at most 3.4 wt.%, even more preferably at most 3.0 wt.%, most preferably at most 2.8 wt.% of konjac mannan.

15 Preferably, the combination of starch, kappa-carrageenan and konjac mannan constitutes at least 5 wt.%, more preferably at least 7 wt.%, even more preferably at least 9 wt.%, most preferably at least 10 wt.% of the gelled bead.

Konjac mannan is preferably contained in the gelled bead in a concentration of 0.5-4.0 wt.%, more preferably of 0.7-3.4 wt.%, even more preferably of 0.9-3.0 wt.% and most preferably of 1.2-2.8 wt.%.

20 The combination of starch, kappa-carrageenan and konjac mannan preferably constitutes at most 21 wt.%, more preferably at most 18 wt.%, even more preferably at most 17 wt.%, most preferably at most 16 wt.% of the gelled bead.

Water preferably constitutes 40-80 wt.%, more preferably 60-72 wt.% of the gelled bead.

25 In one embodiment of the present invention, the gelled bead comprises not more than a minor amount of fat. This embodiment offers the advantage that the gelled bead can be used to prepare, for instance, a meat analogue of very low fat content. The gelled bead in accordance with this embodiment preferably comprises by weight of the gelled bead 0 – 10 wt.%, more
30 preferably 0 – 6 wt.% of fat, most preferably 0 – 4 wt.% of fat.

In another embodiment of the invention, the gelled bead comprises a substantial amount of fat. This embodiment offers the advantage that the gelled bead can be used to prepare a meat analogue having an oily mouthfeel. The gelled bead, in accordance with this embodiment,
35 preferably comprises by weight of the gelled bead 8 – 45 wt.%, more preferably 10 – 40 wt.% of fat, most preferably 12 – 30 wt.% of fat.

The fat component of the gelled bead preferably has a low content of saturated fatty acids. Preferably the fat comprises by weight of the fat less than 50 wt.%, more preferably less than 30 wt.% and most preferably less than 30 wt.% saturated fatty acids, calculated by the weight of the total amount of fatty acids contained in the fat.

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The fat that is present in the gelled bead preferably has an N-value at 20°C of 0-20%, preferably of 0-10%, most preferably of 0 wt.%. The N-value of the fat can suitably be determined by ISO method 8292-2:2008: *Animal and vegetable fats and oils – Determination of solid fat content by pulsed NMR – Part 2: Indirect method*.

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The fat preferably comprises by weight of the fat at least 60 wt.%, more preferably at least 80 wt.%, most preferably at least 95 wt.% of an oil that is liquid at 20 °C. Examples of such liquid oils include linseed oil, castor oil, sunflower oil, soybean oil, rapeseed oil, cottonseed oil, safflower oil, flaxseed oil, rice bran oil, olive oil, tung oil, cotton seed oil, peanut oil, algal oil and mixtures thereof.

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The gelled bead preferably does not contain hydrogenated fat.

Preferably, the combination of fat and water constitutes at least 60 wt.%, more preferably at least 70 wt.%, even more preferably at least 77.5 wt.%, most preferably at least 90 wt.% of the gelled bead.

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Non-animal protein

In a preferred embodiment, the gelled bead comprises by weight of the gelled bead 0.2 – 10 wt.%, preferably 0.4 – 5 wt.%, most preferably 0.5 – 3 wt.% of protein.

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According to a preferred embodiment, any protein comprised in the gelled bead is non-animal protein such as protein from plant, algae, fungus, or microbe.

Examples of non-animal protein sources that may be employed in the gelled bead include legume protein, cereal protein, oilseed protein, sesame protein, potato protein, algae protein, fungal protein and combinations thereof. More preferably, the non-animal protein is selected from legume protein, cereal protein, oilseed protein and combinations thereof. Even more preferably, the non-animal protein is selected from legume protein, cereal protein and combinations thereof. Examples of legume proteins that may be used include soy protein, pea protein, lupin protein, mung bean protein, faba bean protein, lentil protein, chickpea protein and combinations thereof.

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According to the present invention, the gelled bead is preferably a vegetarian product, i.e. it does not contain meat or by-products of animal slaughter. Even more preferably, the meat analogue is a vegan product, i.e., it does not contain any animal products (e.g. meat, eggs, dairy products).

The gelled beads of the present invention do not require the use of methylcellulose. Methylcellulose has exceptional binder capabilities as it forms a gel upon heating. However, since methylcellulose is obtained by chemical modification of cellulose, it does not fit with the clean label expectation of consumers. According to a particularly preferred embodiment, the gelled bead does not contain methylcellulose. More preferably, the gelled bead does not contain cellulose ether.

A particulate composition

Another aspect of the invention relates to a particulate composition comprising at least 50 wt.%, preferably at least 80 wt.% and most preferably at least 90 wt.% of the gelled beads of the present invention. This composition may suitably be used in the preparation of e.g. meat analogues. The particulate composition of the present invention may be free flowing, or alternatively, it may require some stirring or shaking to render the composition free flowing.

Besides the gelled beads, the particulate composition may contain gelled beads that are identical to the gelled bead as specified herein before, except that they have weight outside the specified range. The composition may also contain other particulate ingredients such as herbs, spices, flavourings and combinations thereof.

A method of preparing a gelled bead

A further aspect of the invention relates to a method of preparing the gelled bead of the present invention, wherein the method comprises:

- combining starch, kappa-carrageenan, konjac mannan and water to produce a gel mixture;
- allowing the gel mixture to form a gel; and
- comminuting the gel to produce gelled beads.

The water content of the gel mixture is preferably in the range of 50-90 wt.%.

Preferably, the gel mixture is heated to a temperature of at least 60 °C, more preferably to a temperature of 65 to 85 °C, following which the temperature of the gel mixture is reduced to below 30 °C, thereby allowing the gel mixture to form a gel.

- 5 In one embodiment, the method comprises the addition of fat. Preferably, in this embodiment, the fat is added before the gel mixture has been formed. The fat is preferable added in the form of an emulsion, especially an oil-in-water emulsion.

Comminuting of the gel may be achieved by, for instance, grinding or cutting.

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A method of preparing a meat analogue

A further aspect of the invention relates to a method of preparing a meat analogue which comprises the gelled bead as defined within the scope of this application, wherein said method comprises:

- 15 a) preparing a dough by:

(i) combining a plurality of the gelled beads with other ingredients of the meat analogue; or

(ii) providing a lump of gel comprising by weight of the gel composition:

- 0 – 70 wt.% of fat;
- 20 • 2 – 20 wt.% of starch;
- 0.5 – 5 wt.% of kappa-carrageenan;
- 0.5 – 4 wt.% of konjac mannan; and
- 27 – 84 wt.% of water,

combining the lump of gel with one or more other ingredients of the meat analogue;

25 and comminuting the combination of the lump of gel and one or more ingredients;

b) shaping the dough; and

c) heating the shaped dough to a temperature of at least 65 °C.

Comminuting the gel may be achieved by, for instance, grinding or cutting.

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The embodiment of the present process in which a plurality of gelled beads is combined with other ingredients of the meat analogue offers the advantage that the size of the gelled beads in the final product can easily be controlled. The embodiment in which gelled beads are formed *in situ* by employing a lump of gel that is comminuted together with other ingredients of the meat analogue offers the advantage that a separate comminution step is avoided and that less space is needed for transportation and storage of the gelled material.

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The plurality of gelled beads is preferably added in the form of a particulate composition comprising gelled beads as described herein before.

5 The lump of gel that is employed in the present process preferably has the same composition as the gelled beads of the present invention.

Preferably, the other ingredients of the meat analogue include hydrated pieces of texturised vegan protein (TVP).

10 The hydrated pieces of TVP that are employed in the present process preferably comprise, calculated by weight of the dry matter that is contained in the hydrated pieces of TVP, 50-90 wt.%, more preferably 65-88 wt.% and most preferably 70-86 wt.% of plant protein. The plant protein preferably is selected from legume protein, cereal protein, oilseed protein and combinations thereof. More preferably, the plant protein is selected from legume protein,
15 cereal protein and combinations thereof. Examples of legume protein that may suitably be employed are soy protein, pea protein, lupin protein, mung bean protein, faba bean protein, lentil protein, chickpea protein and combinations thereof. Gluten is an example of cereal protein that may be comprised in the hydrated pieces of TVP.

20 In the present process the dough can be shaped in many different forms, e.g. using moulds, extrusion or stamping.

The shaped dough is preferably heated to a temperature of 70-105 °C, more preferably to a temperature of 75-95 °C.

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Meat analogue

Yet another aspect of the invention relates to a meat analogue comprising by weight of the meat analogue 5-55 wt.%, preferably 10-40 wt.% of the gelled beads of the present invention. According to a particularly preferred embodiment, the meat analogue of the present invention
30 is a cold cuts analogue. Cold cuts are precooked or cured meat products that are served cold and do not require heating before consumption. Examples of cold cuts analogues that can suitably be prepared in accordance with the present invention include salami, chorizo, salchichón, bierwurst, liverwurst, corned beef, mortadella and spam.

35 The present invention further provides a meat analogue comprising, by weight of the meat analogue,

- 2 – 20 wt.% of non-animal protein;
 - 0 – 20 wt.% of fat;
 - 5 – 55 wt.%, preferably 10-40 wt.% of the gelled beads of the present invention;
 - flavouring
- 5 • 0.15 – 4 wt% of food grade acid, preferably citric acid, lactic acid, malic acid and combinations thereof.
- binding agents, preferably in amount of 0.1 – 15 wt%, preferably comprising the combination of kappa-carrageenan and konjac mannan.

10 The meat analogue preferably comprises by weight of the meat analogue 2 – 20 wt% of non-animal protein. If a coarser structure is desired at least some of the non-animal protein may comprise hydrated TVP chunks. If a less coarse structure is desired hydrated TVP may be comminuted before use or protein concentrate, protein isolate, plant flour may be used as source of protein.

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The meat analogue of the present invention preferably comprises, calculated by weight of the dry matter that is contained in the meat analogue, 30-65 wt.%, more preferably 35-50 wt.% of pieces of texturised vegan protein (TVP).

20 The pieces of TVP preferably have a water content of 40 – 90 wt.%, more preferably 50 – 85 wt.% and most preferably 55 – 75 wt.%.

The fat content of the pieces of TVP, calculated by weight of the dry matter that is contained in the pieces of TVP, is preferably in the range of 0 – 10 wt.%, more preferably in the range of

25 0 – 6 wt.% and most preferably in the range of 0 – 4 wt.%.

The pieces of TVP in the meat analogue of the present invention typically comprise, calculated by weight of the dry matter that is contained in the pieces of TVP, 50 – 90 wt.%, more preferably 65 – 88 wt.% and most preferably 70 – 86 wt.% of plant protein. The plant protein

30 preferably is selected from legume protein, cereal protein, oilseed protein and combinations thereof. More preferably, the plant protein is selected from legume protein, cereal protein and combinations thereof. Examples of legume proteins that may be used include soy protein, pea protein, lupin protein, mung bean protein, faba bean protein, lentil protein, chickpea protein and combinations thereof. Gluten is an example of cereal protein that may be comprised in

35 the pieces of TVP.

According to a particularly preferred embodiment, at least 50 wt.%, more preferably at least 80 wt.% and most preferably at least 90 wt.% of the plant protein that is present in the pieces of TVP is soy protein.

- 5 Preferably, the meat analogue according to the invention comprises potassium cations in a concentration of at least 0.1 mmol per kg of the total amount of water that is contained in the meat analogue. More preferably the meat analogue comprises potassium cations in a concentration of 0.5-1,200 mmol per kg of the total amount of water that is contained in the meat analogue. Most preferably the meat analogue comprises potassium cations in a
10 concentration of 1.0-500 mmol per kg of the total amount of water that is contained in the meat analogue.

Potassium cations are preferably contained in meat analogue in a concentration of at least 25 mmol per kg of kappa carrageenan, more preferably in a concentration of 50-25,000 mmol
15 per kg of kappa carrageenan and most preferably in a concentration of 200-10,000 mmol per kg of kappa carrageenan.

The meat analogue of the present invention may comprise additional ingredients besides the ones discussed above. Such additional ingredients may include binding agents (e.g gelling
20 agents, thickeners), emulsifiers, food grade acid, preservatives, colouring, flavouring, dietary fibres, vitamins and minerals.

Food grade acids

The meat analogue according to the invention preferably comprises an amount of food grade
25 acid of from 0.15 to 4 wt.%, preferably from 0.20 to 2.5 wt.%, more preferably from 0.25 to 1 wt.% by weight of the meat analogue, preferably whereby the food grade acid is selected from acetic acid, citric acid, lactic acid, malic acid and combinations thereof such that the level of undissociated acid is from 0.015 to 0.5 wt.%, preferably from 0.05 to 0.2 wt.%, more preferably from 0.075 to 0.2wt.%, even more preferably from 0.080 to 0.15 wt.%, even more preferably
30 from 0.080 to 0.13 wt.% even more preferably from 0.083 to 0.13 wt.% by weight of the meat analogue.

The meat analogue according to the invention preferably comprises an amount of food grade acid of from 0.15 to 2 wt.%, preferably from 0.20 to 1.5 wt.%, more preferably from 0.25 to 1
35 wt.% by weight of the meat analogue, preferably whereby the food grade acid is selected from acetic acid, citric acid, lactic acid, malic acid and combinations thereof such that the level of undissociated acetic acid is from 0.015 to 0.5 wt.%, preferably from 0.05 to 0.2 wt.%, more

preferably from 0.075 to 0.2wt.%, even more preferably from 0.080 to 0.15 wt.%, even more preferably from 0.080 to 0.13 wt.% even more preferably from 0.083 to 0.13 wt.% by weight of the meat analogue.

- 5 The amount of food grade acid can be determined by any suitable method and is routinely carried out by commercial laboratories including Eurofins and Nutrilab using HPLC. One preferred protocol is NEN -ISO 17294 as carried out by Eurofins (NL), Merieux (NL) or Nutrilab (NL). The sample is generally ground, suspended and centrifuged. After filtration the sample may be analysed using HPLC with a UV-detector at 210 nm.

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According to a particularly preferred embodiment, besides pieces of TVP and gelled beads, the meat analogue of the present invention comprises an aqueous binder system. The binder system is preferably present in the meat analogue in the form of a continuous phase that holds together the pieces of TVP and gelled beads.

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Binding agents

The meat analogue according to the invention preferably comprises a binding agent to bind other ingredients of the meat analogue, e.g., to bind textured vegetable protein particles and the gelled beads of the present invention. A suitable binding agent can be identified by titrating different binding agents against the cohesiveness and fracturability of the meat analogue. The binding agent preferably includes a gel forming agent. Preferably, the binding agent comprises a combination of gel forming plant protein, a gel forming polysaccharide and combinations thereof. The meat analogue according to the invention preferably comprises 0.1 to 25 wt.% of binding agent, preferably 0.1 to 15 wt.%, more preferably 0.2 to 11 wt.%, even more preferably 0.3 to 7 wt.% by weight of the meat analogue. The binding agent preferably comprises, based on the weight of the meat analogue, a combination of 0.3 to 7 wt% of a gel forming plant protein like gluten and 0.1 to 5 wt% of a gel forming polysaccharide like methylcellulose, konjac mannan, kappa carrageenan.

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According to a particularly preferred embodiment, the binding agents used in the meat analogue comprise kappa-carrageenan and konjac mannan. The inventors have found that by using a binder system that contains a combination of kappa-carrageenan and konjac mannan, cohesiveness of the meat analogue is improved. Preferably, the binding agent that is employed in the meat analogue comprises 0.1 to 2.5 wt.% of kappa carrageenan, based on the weight of the meat analogue. Preferably, the binding agent that is employed in the meat analogue comprises 0.1 to 2.5 wt % of konjac mannan, based on the weight of the meat analogue. Preferably, the binding agent that is employed in the meat analogue comprises the

combination of kappa carrageenan and konjac mannan in an amount of 0.2 to 5 wt % by weight of the meat analogue.

The following non-limiting examples further illustrate the invention.

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EXAMPLES

All ingredients used in the experiments described below were sourced in Europe, US and China.

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Example 1

In accordance with the present invention, gelled beads A, 1, 2, were prepared based on the recipes shown in Table 1.

15 **Table 1**

	Wt. %		
	A	1	2
Kappa-carrageenan	2.50	2.50	2.50
Konjac gum ¹	2.50	2.50	2.50
Modified tapioca starch ²			10.00
Modified potato starch ³		10.00	
Sunflower oil	17.00	17.00	17.00
Pea protein isolate	1.00	1.00	1.00
Sodium chloride	1.00	1.00	1.00
Lactic acid	0.55	0.55	0.55
Water	75.45	65.45	65.45

¹ Contains 88 wt.% glucomannan

² National Frigex® (hydroxypropyl di-starch phosphate of tapioca), ex Ingredion

³ X-Amylo (di-starch phosphate of potato), ex KMC

20 Kappa carrageenan used in all examples was a kappa carrageenan preparation made from natural strains of Eucheuma seaweed containing 3% KCl (WELCO Gelform 1263), Welding GmbH & Co. KG, Germany.

The gelled beads were prepared as follows:

- 25
- Pea protein isolate was added to the water and hydrated for 5 minutes by shearing at 3000 rpm using a Silverson (type L4RT; fitted with 1 mm hole emulsion screen). Shear was then increased to 5000 rpm and sunflower oil was slowly added and subsequently emulsified at full speed for 4 minutes.

- The emulsion was transferred to a bowl chopper type mixer (Stephan UMC5 electronic, A. Stephan & Sohne, Hameln, Germany).
- Konjac gum, kappa-carrageenan, salt and, where applicable, starch were blended well and together with the lactic acid added to the Stephan mixer and sheared at 1500 rpm for 2 minutes at a reduced pressure of 0.2 bar.
- The viscous mass so obtained was transferred to a plastic foil cooking bag and sealed under vacuum. The bag was placed in a steam oven and cooked for 1hour at 95 °C in a 100% steam environment.
- The hot emulsions so obtained were gradually cooled to 5°C and formed a firm gel.
- The gel was ground into beads using a meat grinder mounted on a Kenwood Chef orbital mixer, using a Wolff plate (grinding plate) with 7.6mm holes. A portion of the gels were cut into blocks of 10*10*40 mm for sensory evaluation of the gel.

The gelled beads were used to prepare a sausage dough having the composition that is shown in Table 2.

Table 2 Pepperoni Sausage dough

	Wt. %
Water	31.03
Crushed ice	11.87
TVP ¹	8.12
Colouring	0.23
Flavouring	0.16
Binders ²	4.22
Konjac gum ³	0.36
Kappa Carrageenan	0.64
Sodium chloride	1.53
Rapeseed oil	1.24
Lactic acid	0.60
Gelled beads	40.00
TOTAL	100.00

¹ Suitable TVP's for this invention include those from Caldic Ingredients Benelux B.V, ADM Specialty Ingredients Europe B.V. (e.g. Arcon-T 158-125 IP), Solae Overseas B.V. NL (e.g. Response® 4380 US IP)

² Methylcellulose, oat fibre, soy protein isolate

³ Contains at least 88 wt. % glucomannan

Sausages A, 1 and 2 were prepared as follows:

- The TVP was combined with water, lactic acid and sealed in a PE plastic bag (Select PolyAmide vacuumbags, Hanos, Netherlands) under vacuum and left to hydrate for 2 hours.
 - The hydrated TVP was transferred to a stainless steel bowl of a Kenwood Chef orbital mixer with K-beater mixing utensil.
 - Methylcellulose, soy protein isolate and oat fibre were added, followed by mixing for 30 seconds at speed 1.
 - Crushed ice and cold water were added and mixed for 1.5 minutes at speed 1.
 - Rapeseed oil was added and mixed for a further 3 minutes at speed 1.
 - Flavouring was mixed into the dough for 1 minute at speed 1.
 - Finally, the ground gelled beads prepared in Example 1 were added followed by 30 seconds of mixing at speed 1 resulting in the dough for sausages A, 1 and 2, respectively.
 - The doughs were extruded into a vegan casing (40 mm diameter) and cooked in a steam oven set at 100% steam atmosphere for 1 hour at 95°C.
 - The cooked sausages were cooled in ice water for 1 hour and stored in a 5 °C fridge.
 - On the day of evaluation the sausages were cut into 2 mm thick slices with a cold-cut slicing machine at 20°C (Deko, The Netherlands)
- The gelled beads in sausage A started melting during said cooking step in the steam oven, resulting in gel leaking out of the sausage. On the day of the evaluation the sausages were taken out of the refrigerator and cut into slices. There were no fat mimetic gelled beads visible in slices of sausage A.
- Sausages 1 and 2 were coded and offered in randomised order to a panel of 8 experienced tasters who were asked to score the sausages on glossiness and visibility of fat-like globules at 20°C. Both sausages 1 and 2 received a high glossiness score. Furthermore, the panel members reported that fat-like globules were clearly visible in both products, just like in a real meat pepperoni. Similar compositions with other non-crosslinked starches also provided good results.

Example 2 Sensory evaluation of the gel beads material

- Chewiness of the cut gel blocks of Example 1 was determined by a sensory panel. The gel blocks of 10*10*40 mm were coded and offered in randomised order to a panel of 8 experienced tasters who were asked to score the samples on chewiness at 20°C.

Sample A (without starch) was found to be very elastic and not chewy. In contrast thereto, samples 1 and 2 were perceived as very chewy. Similar compositions with other non-crosslinked starches also provided good results.

CLAIMS

1. A gelled bead comprising by weight of the gelled bead:
 - 2 – 20 wt.% of starch;
 - 0.5 – 5.0 wt.% of kappa-carrageenan;
 - 0.5 – 4.0 wt.% of konjac mannan;
 - 0 – 70 wt.% of fat; and
 - 27 – 84 wt.% of water.
2. Gelled bead according to claim 1, wherein the gelled bead comprises by weight of the gelled bead 8-45 wt.% fat.
3. Gelled bead according to any of the preceding claims, wherein the gelled bead comprises 4 – 17 wt.%, preferably 6 – 15 wt.% of starch.
4. Gelled bead according to any of the preceding claims, wherein the starch is a modified starch, preferably a cross-linked starch.
5. Gelled bead according to any of the preceding claims, wherein the combination of kappa-carrageenan, starch and konjac mannan constitutes 5 – 21 wt.% of the gelled bead.
6. Gelled bead according to any of the preceding claims, wherein kappa-carrageenan and konjac mannan are present in a weight ratio of 1:7 to 7:1.
7. Gelled bead according to any one of the preceding claims, wherein the combination of fat and water constitutes at least 70 wt.%, preferably at least 75 wt.% of the gelled bead.
8. Gelled bead according to any one of the preceding claims, wherein the gelled bead does not contain methylcellulose.
9. Gelled bead according to any one of the preceding claims, wherein the gelled bead comprises by weight of the gelled bead:
 - 12 – 30 wt.% of fat;
 - 8 – 15 wt.% of starch;
 - 1.0 – 3.0 wt.% of kappa-carrageenan;

- 1.2 – 2.8 wt.% of konjac mannan; and
- 60 – 72 wt.% of water

10. A particulate composition comprising at least 50 wt.%, preferably at least 80 wt.% by weight of the particulate composition of gelled beads according to any one of the preceding claims.

11. A method of preparing the gelled bead according to any one of claims 1-9, wherein the method comprises:

- combining starch, kappa-carrageenan, konjac mannan and water to produce a gel mixture;
- allowing the gel mixture to form a gel; and
- comminuting the gel to produce gelled beads.

12. A process of preparing a meat analogue, said process comprising:

a) preparing a dough by:

- (i) combining a plurality of the gelled beads according to claims 1 – 9 with other ingredients of the meat analogue; or
- (ii) providing a lump of gel comprising, by weight of the gel composition:
 - 0 – 70 wt.% of fat;
 - 2 – 20 wt.% of starch;
 - 0.5 – 5 wt.% of kappa-carrageenan;
 - 0.5 – 4 wt.% of konjac mannan; and
 - 60 – 84 wt.% of water,

combining the lump of gel with one or more other ingredients of the meat analogue; and

comminuting the combination of the lump of gel and one or more ingredients; wherein the combination of fat and water constitutes at least 75 wt.% of the lump of gel;

b) shaping the dough; and

c) heating the shaped dough to a temperature of at least 65 °C.

13. A meat analogue comprising, by weight of the meat analogue 5 – 55 wt.% of the gelled beads according to any one of claims 1 – 10.

14. Meat analogue according to claim 13, wherein the meat analogue is a cold cuts analogue.

15. Meat analogue according to claim 13 or 14, comprising, by weight of the meat analogue:

- 2 – 20 wt.% of non-animal protein;
- 0 – 20 wt.% of fat;
- 5 – 55 wt.%, preferably 10-40 wt.% of the gelled beads according to any one claims 1-9;
- flavouring
- 0.15 – 4 wt.% of food grade acid, preferably citric acid, lactic acid, malic acid and combinations thereof.
- binding agents, preferably in amount of 0.1 – 15 wt.%, preferably comprising the combination of kappa-carrageenan and konjac mannan.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/058497

A. CLASSIFICATION OF SUBJECT MATTER				
INV.	A23D7/005	A23D7/01	A23D7/02	A23J3/22
ADD.				
According to International Patent Classification (IPC) or to both national classification and IPC				
B. FIELDS SEARCHED				
Minimum documentation searched (classification system followed by classification symbols) A23D A23J				
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched				
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal				
C. DOCUMENTS CONSIDERED TO BE RELEVANT				
Category*	Citation of document, with indication, where appropriate, of the relevant passages			Relevant to claim No.
X	CN 103 876 061 B (NINGBO SULIAN FOOD CO LTD) 27 April 2016 (2016-04-27) paragraph [0009]; claim 1 -----			1
X	WO 2022/147357 A1 (MOTIF FOODWORKS INC [US]) 7 July 2022 (2022-07-07) paragraphs [0017], [0094], [0115], [0118], [0137]; claims 2,3,4 -----			1 - 15
X	US 2023/000109 A1 (NETTESHEIM FLORIAN [DK] ET AL) 5 January 2023 (2023-01-05) paragraphs [0018] - [0025], [0027], [0034], [0071], [0088] ----- - / - -			1
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.				
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family				
Date of the actual completion of the international search 17 June 2024			Date of mailing of the international search report 01/07/2024	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016			Authorized officer Galleiske, Anke	

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2024/058497

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DATABASE GNPD [Online] MINTEL; 1 April 2021 (2021-04-01), anonymous: "Meat-Free Bacon Style Rashers", XP055945748, Database accession no. 8602257 abstract -----	1 - 15

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Information on patent family members

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