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(54) Title: VEGAN GELLED BEADS

(57) Abstract: The invention relates to a gelled bead having a weight of 7-1000 mg comprising by weight of the gelled bead: • 0.5-4 wt.% of kappa-carrageenan; • 0.2-2.5 wt.% of konjac mannan; and • 0-50 wt.% of fat; • 45-98 wt.% of water; wherein the combination of fat and water constitutes at least 75 wt.% of the gelled bead; and wherein the gelled bead optionally contains one or more ingredients selected from starch, cellulosic fiber, methylcellulose, protein isolate in a concentration of 0-5 wt.%, preferably of 0-5 wt.% and more preferably of 0-3 wt.%. The invention also relates to meat analogues comprising the gelled beads of the present invention and to processes of preparing such meat analogues.



VEGAN GELLED BEADS

FIELD OF THE INVENTION

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The present invention relates to vegan gelled beads that contain a combination of kappa-carrageenan and konjac mannan. The gelled beads of the present invention may be applied in, for instance, meat analogues to provide improved moisture release and less dryness in the ready-to-eat cooked product while at the same time maintaining acceptable product firmness at elevated temperature.

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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 meat protein contains all essential amino acids for humans. In addition, meat comprises essential vitamins, such as vitamin B12, and is rich in minerals. Meat also contains fat tissue, which greatly contributes to food acceptability by imparting specific characteristics such as appearance, texture, and mouthfeel. The fat tissue also contributes to the properties of the meat as it is prepared and cooked.

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However, from a health point of view, an excessive intake of meat products cannot be recommended, especially because the fat tissue in meat contains cholesterol and a higher proportion of saturated fats.

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Further, due to animal diseases such as mad cow disease, a global shortage of animal protein, growing consumer demand for religious (halal or kosher) food, and for economic reasons, there is an increased interest in the consumption of non-meat proteins by consuming meat analogues instead of actual meat products.

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Meat analogues are prepared such that they resemble meat as much as possible in appearance, taste and texture. Meat analogues are typically prepared from proteinaceous fibres of non-animal origin. Proteinaceous fibres, such as texturized vegetable protein, are characterised by having an identifiable structure and a structural integrity, such that each unit will withstand hydration, cooking and other procedures used in preparing the fibres for consumption.

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One of the main challenges faced in the development of meat analogues is to provide a product that is firm but not too 'dry', i.e. lacking juiciness or succulence. Generally speaking, there is an inverse relationship between the firmness of meat analogies and juiciness: the firmer they get the dryer they become, and *vice versa*. It is very hard to find a good balance between these two product attributes. Products tend to be either soft & juicy or dry & firm. The ideal solution should deliver juiciness in combination with sufficient firmness.

High melting fats such as coconut oil or shea butter have been used in meat analogues to provide sufficient product firmness at lower temperatures (refrigeration and ambient temperatures) and to achieve juiciness in the ready-to-eat cooked product. These high melting fats melt during cooking and create pools of molten fat in the product that are released upon cutting or chewing. Unfavourable aspects of the use of high melting fats are the relatively high amount of fat that is needed to achieve sufficient juiciness, and the high level of saturated fatty acids (SAFA) in these fats.

ADDITIONAL INFORMATION

US 4,427,704 describes a food product having a pH not higher than 8 comprising a gelled aqueous phase and at least one other food material, said gelled phase comprising 0.01 to 5 percent by weight of a mixture or reaction product of at least one glucomannan and at least one carrageenan in a ratio of glucomannan to carrageenan from 20:1 to 1:20.

CN 112655896 describes a binding composition for meat products comprising κ -carrageenan, konjac gum, and tetrasodium pyrophosphate.

CN 101558890 describes a simulated fat comprising konjac flour and carrageenan in a weight ratio of 1: 0.3 to 0.45, ovalbumin, an antifoaming agent, an alkaline gelling agent and water.

SUMMARY OF THE INVENTION

The inventors have developed a special vegan food ingredient, in the form of gelled beads, that can suitably be applied in, for instance, vegan meat analogues to provide improved moisture release and less dryness in the ready-to-eat cooked product and – surprisingly - at the same time providing a desirable product firmness at elevated temperature, e.g. 65°C when removed from the pan before consumption. The vegan gelled bead according to the present invention has a weight of 7-1000 mg and comprises by weight of the gel bead:

- 0.5-4 wt.% of kappa-carrageenan;

- 0.2-2.5 wt.% of konjac mannan; and
- 0-50 wt.% of fat;
- 45-98 wt.% of water;

wherein the combination of fat and water constitutes at least 75 wt.% of the gelled bead; and

- 5 wherein the gelled bead optionally contains one or more ingredients selected from starch, cellulosic fiber, methylcellulose, protein isolate in a concentration of 0-5 wt.%.

In a preferred embodiment, the gelled bead of the present invention, the gelled bead has a weight of 20-800 mg and comprises by weight of the gel bead:

- 10
- 0.8-3.5 wt.% of kappa-carrageenan;
 - 0.4-2.0 wt.% of konjac mannan; and
 - 10-45 wt.% of fat;
 - 50-90 wt.% of water;

wherein the combination of fat and water constitutes at least 80 wt.% of the gelled bead; and

- 15 wherein the gelled bead optionally contains one or more ingredients selected from starch, cellulosic fiber, methylcellulose, protein isolate in a concentration of 0-3 wt.%.

In a preferred embodiment, the gelled bead of the present invention, the gelled bead has a weight of 50-600 mg and comprises by weight of the gel bead:

- 20
- 1.5-3.0 wt.% of kappa-carrageenan;
 - 0.6-1.5 wt.% of konjac mannan; and
 - 20-40 wt.% of fat;
 - 55-80 wt.% of water;

wherein the combination of fat and water constitutes at least 90 wt.% of the gelled bead; and

- 25 wherein the gelled bead optionally contains one or more ingredients selected from starch, cellulosic fiber, methylcellulose, protein isolate in a concentration of 0-1 wt.%.

A second aspect of the invention relates to a particulate composition comprising at least 50 wt.% of the vegan gelled beads of the present invention.

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

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

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

A fourth aspect of the invention relates to a process of preparing a meat analogue, said process comprising:

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

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

- 0.5-4 wt.% of kappa-carrageenan;
- 0.2-2.5 wt.% of konjac mannan; and
- 0-50 wt.% of fat;
- 45-98 wt.% of water;

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

wherein the combination of fat and water constitutes at least 75 wt.% of the lump of vegan gel.

A fifth aspect of the invention relates to a meat analogue comprising 5-50 wt.% of the vegan gelled beads of the present invention.

In a preferred embodiment, the meat analogue comprises by weight of the meat analogue 5-40 wt.% of the vegan gelled beads of the present invention and 30-65 wt.%, calculated by weight of the dry matter that is contained in the meat analogue, of hydrated pieces of texturized vegan protein, said hydrated 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 hydrated pieces, 65-88 wt.% of plant protein.

DETAILED DESCRIPTION OF THE INVENTION

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

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.

5 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 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.

10 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 B in wt.% equals x:y.

15 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.

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

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

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

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.
30 Examples include burgers, sausages, nuggets, schnitzels etc. If the meat analogue is coated such as a nugget or schnitzel, the term "meat analogue" is understood to refer to the composition without the coating.

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

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.

5 The term “texturised vegan protein” or “TVP” as used herein refers to proteinaceous fibrous material which are 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
10 may also be cut in chunks and dried. Typical examples of dried TVP include Response™ TVP’s from 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 ground or cut for use in a meat analogue in e.g., meat grinder with a plate having 5 mm apertures. For the avoidance of doubt the term “pieces” in this context
15 encompasses both the TVP before and after comminution.

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
20 temperature. The melting point of a fat can be determined according to ISO 6321 (2021).

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

25 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 “melting point” as used herein refers the temperature at which the gelled bead starts to melt. It can be determined as follows. A cylinder of the gelled bead composition having a
30 diameter of 2.8 cm and a length of 4,5 cm is placed horizontally on a metal wire grid with parallel wires (2 mm wire diameter) distance between the parallel wires 2.5 cm and whereby the cylinder was placed perpendicular to the length of the wires. The grid with cylinder is placed in a steam oven, 100% steam. The temperature is increased with 1 °C per minute. The melting point is defined as the temperature at which cylinder has completely dropped through the wire
35 grid.

The gelled bead

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

The gelled bead of the present invention is particularly suitable for use in meat analogues. Accordingly, in a particularly preferred embodiment, the gelled bead does not contain any meat derived ingredients. Even more preferably, the gelled bead is a vegan gelled bead, does not contain animal-derived ingredients (e.g. milk, egg or ingredient derived therefrom). The gelled bead according to the invention comprises kappa-carrageenan, konjac mannan, optionally fat and water.

The gelled bead of the present invention offers the advantage that when incorporated in for example a meat analogue like a burger, upon heating the burger to 65 - 75°C the gel beads appear to be hardly visible anymore. Without wishing to be bound by theory it is hypothesised that the gel beads at least partly melt and spread in the meat analogue. Surprisingly, even with gel beads that may have partly melted the firmness just after cooking before serving e.g. 65°C is quite high. Preferably the gelled bead of the present invention has a melting point between 60 and 80 °C, preferably 65 to 75 °C. This advantageous behaviour can be further improved by limiting the amount of starch, cellulosic fibre, methylcellulose and/or protein isolate. Preferably, if starch, cellulosic fibre, methylcellulose and/or protein isolate are used the gelled bead contains no more than small quantities of starch, cellulosic fibre, methylcellulose and/or protein isolate. Preferably, the combination of starch, cellulosic fibre, methylcellulose and protein isolate is present in a concentration of 0-3 wt.% and more preferably of 0-1 wt.%.

According to a particularly preferred embodiment, the gelled bead does not contain methylcellulose. More preferably, the gelled bead does not contain cellulose ether.

According to another preferred embodiment, the gelled bead does not contain tetrasodium pyrophosphate.

Kappa-carrageenan and konjac mannan

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.

The combination of kappa-carrageenan and konjac mannan preferably constitutes at most 6.0 wt.%, more preferably at most 5.6 wt.%, even more preferably at most 5.2 wt.%, most preferably at most 5.0 wt.% of the gelled bead.

- 5 The combination of kappa-carrageenan and konjac mannan is preferably contained in the gelled bead in a concentration of 1.0-6.0 wt.%, more preferably of 1.4-5.6 wt.%, even more preferably of 1.7-5.2 wt.%, most preferably of 2.0-5.0 wt.% of the gelled bead.

- 10 The weight ratio of kappa-carrageenan and konjac mannan in the gelled bead is preferably from 1:4 to 12:1, more preferably from 1:3 to 9:1, even more preferably from 1:2 to 6:1, most preferably from 1:1 to 3:1.

- 15 Preferably, the combination of fat and water constitutes at least 80 wt.%, more preferably at least 85 wt.%, even more preferably at least 88 wt.%, most preferably at least 90 wt.% of the gelled bead.

Preferably, the gelled bead comprises by weight of the gelled bead at least 0.8 wt.%, more preferably at least 1.2 wt.%, most preferably, at least 1.5 wt.% kappa-carrageenan.

- 20 The gelled bead comprises by weight of the gelled bead preferably at most 3.5 wt.%, more preferably at most 3.2 wt.%, most preferably at most 3.0 wt.% kappa-carrageenan.

- 25 Kappa-carrageenan is preferably contained in the gelled bead in a concentration of 0.8-3.5 wt.%, more preferably of 1.2-3.2 wt.% and most preferably of 1.5-3.0 wt.%.

Preferably, the gelled bead comprises by weight of the gelled bead at least 0.4 wt.%, more preferably at least 0.5 wt.%, most preferably at least 0.6 wt.% konjac mannan.

- 30 The gelled bead comprises by weight of the gelled bead preferably at most 2.0 wt.%, more preferably at most 1.8 wt.%, most preferably at most 1.5 wt.% konjac mannan.

Konjac mannan is preferably contained in the gelled bead in a concentration of 0.4-2.0 wt.%, more preferably of 0.5-1.8 wt.% and most preferably of 0.6-1.5 wt.%.

- 35 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.

- 5 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.

10 **Fat and water**

If very low fat products are desired, preferably the gelled bead according to the invention contains 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 succulent meat analogue of very low fat content. The gelled bead according to the invention preferably comprises by weight of the
15 gelled bead 0-10 wt.%, more preferably 0-6 wt.% of fat, more preferably 0-4 wt.% of fat.

If reduced fat products are desired, preferably the gelled bead according to the invention contains a substantial amount of fat. This embodiment offers the advantage that the gelled bead can be used to prepare, for instance, a highly succulent meat analogue with a reduced
20 fat content. The gelled bead in accordance with this embodiment preferably comprises by weight of the gelled bead 10-45 wt.%, more preferably 20-40 wt.% of fat, more preferably 25-35 wt.% of fat.

The fat component of the gelled bead preferably has a low content of saturated fatty acids.
25 Preferably the fat contains by weight of fat less than 50 wt.%, more preferably less than 40 wt.% and most preferably less than 35 wt.% saturated fatty acids, calculated by weight of the total amount of fatty acids contained in the fat. Preferably the gel bead contains 0 to 20 wt.%, more preferably 0 to 15 wt.% and most preferably 0 to 8 wt.% saturated fatty acids, calculated by weight of the gel bead.

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The fat that is present in the gelled bead preferably has an N-value at 20°C of at least 5%, preferably of at least 10%, more preferably of 15-30 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*. The inventors have
35 found that in comparison of gelled beads containing fat having an N-value at 20°C of 0%, gelled beads containing fat that contains a significant amount of solid fat at 20°C are less prone to oil exudation at ambient temperature.

The fat preferably contains by weight of fat at least 50 wt.%, more preferably at least 60 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.

The fat component of the present invention preferably comprises one or more liquid oils in combination with one or more high melting fats. The one or more high melting fats are preferably selected from coconut fat or fraction thereof, palm kernel fat or a fraction thereof, palm stearin, palm mid fraction, shea butter or a fraction thereof and combinations thereof. More preferably the one or more high melting fats are selected from coconut fat or fraction thereof, palm kernel fat or a fraction thereof and combinations thereof.

The gelled bead of the present invention preferably does not contain hydrogenated fat.

The water content of the gelled bead is preferably in the range of 50-90 wt.%, more preferably of 55-80 wt.% and most preferably of 60-75 wt.% calculated by weight of the gel bead.

Protein

The gelled bead of the present invention preferably contains 0-4 wt.% protein, preferably 0-2 wt.% protein, most preferably 0-1 wt.% protein calculated by weight of the gel bead.

According to a preferred embodiment, any protein contained in the gelled bead is non-animal protein.

Example of non-animal protein 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.

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 vegan 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.

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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 a weight outside the specified range. The composition may also contain other particulate ingredients such as herbs and spices and combinations thereof.

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Method of preparing the vegan gelled bead

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

- combining 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 water content of the aqueous mixture is preferably in the range of 50-92 wt. %.

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Preferably, the gel mixture is heated to a temperature of at least 65 °C, more preferably to a temperature of 70 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.

25

Preferably, the method comprises the addition of fat. Preferably, in this embodiment, the fat is added when the gel mixture has a temperature of at least 10 °C, more preferably a temperature of 15 to 50°C, most preferably a temperature of 25 to 45°C.

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The gel mixture is preferably prepared by combining kappa-carrageenan, konjac mannan, liquid oil having a melting point of less than 15°C, high melting fat having a melting point of at least 30°C and water to produce a gel mixture. The liquid oil and the high melting fat may be pre-blended before they are combined with the kappa-carrageenan, konjac mannan and water.

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The liquid oil is preferably selected from 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.

The high melting fat is preferably selected from coconut fat or fraction thereof, palm kernel fat or a fraction thereof, palm stearin, palm mid fraction, shea butter or a fraction thereof and combinations thereof, more preferably from coconut fat or fraction thereof, palm kernel fat or a fraction thereof and combinations thereof. To improve admixing high melting fat with the gel mixture, the fat may be cut in small pieces or melted before admixing with the gel mixture. The step of admixing fat may be before or after the step of combining kappa-carrageenan, konjac mannan and water to produce a gel mixture.

The liquid oil and the high melting fat are preferably applied in a weight ratio of 1:1 to 9:1, preferably in a weight ratio of 6:4 to 5:1.

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

In an alternative embodiment the gel beads may be prepared *in situ*, for example, prepared after combination with other ingredients of the meat analogue. The gel mixture is injected into a dough comprising a blend of one or more other ingredients of the meat analogue. The gel mixture is allowed to form a gel within the matrix structure of the blend of the one or more other ingredients of the meat analogue dough. Exemplary apparatus and process conditions are described in WO 2023/275304 A1; WO 2022/112384 A1 and WO 2022/112382 A1.

A process of preparing a meat analogue

The present invention further provides a process of preparing a meat analogue, said process comprising:

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

(ii) providing a lump of gel comprising:

- 0.5-4 wt.% of kappa-carrageenan;
- 0.2-2.5 wt.% of konjac mannan; and
- 0-50 wt.% of fat;
- 45-98 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 the one or more ingredients; wherein the combination of fat and water constitutes at least 75 wt.% of the lump of gel.

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 and .

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

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 texturized vegan protein (TVP).

The hydrated pieces of TVP that are employed in the present process preferably contain, 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, 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 contained in the hydrated 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 hydrated pieces of TVP is soy protein.

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

The fat content of the hydrated pieces of TVP preferably is in the range of 0-10 wt.%, more preferably in the range of 0-6 wt.% and most preferably in the range of 0-4 wt.%.

The hydrated pieces of TVP preferably contain, calculated by weight of the dry matter that is contained in the hydrated pieces of TVP, 0-15 wt.%, more preferably 1-12 wt.% and most preferably 3-10 wt.% of dietary fiber.

5 The process of the present invention preferably comprises mixing 100 parts by weight of the hydrated pieces of TVP with 10-120 parts by weight of the gelled beads or of the lump of gel. More preferably, the process comprises mixing 100 parts by weight of the hydrated pieces of TVP with 20-90 parts by weight of the gelled beads or of the lump of gel.

10 The processes according to the present invention preferably yield meat analogues as described below.

Meat analogue

Finally, the invention further provides a meat analogue comprising by weight of the meat
15 analogue 5-50 wt.%, preferably 10-40 wt.% and most preferably 15-25 wt.% of the vegan gelled beads of the present invention.

The meat analogue preferably further comprises by weight of the meat analogue at least 8.5 wt.% of non-animal protein, preferably at least 8.8 wt.% of non-animal protein, most preferably,
20 the meat analogue comprises by weight of the meat analogue at least 9.0 wt.% of non-animal protein.

Preferably, the meat analogue comprises by weight of the meat analogue at most 22 wt.% of non-animal protein, preferably at most 20 wt.% of non-animal protein, most preferably the
25 meat analogue comprises by weight of the meat analogue at most 18 wt.% of animal protein.

Non-animal protein is preferably contained in the meat analogue in a concentration by weight of the meat analogue of 8.5-22 wt.%, more preferably of 8.8-20 wt.% and most preferably of 9.0-18 wt.%.

30

According to a preferred embodiment, at least 80 wt.%, more preferably at least 90 wt.% of the non-animal protein that is contained in the meat analogue is provided by pieces of texturized vegan protein (TVP). Said pieces of TVP may also be ground or cut before use. For the avoidance of doubt the term "pieces" in this context encompasses both the TVP before
35 and after comminution.

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 to wt.% of pieces of texturized vegan protein (TVP).

- 5 The meat analogue of the present invention preferably comprises hydrated TVP said hydrated TVP having a water content of 40-90 wt.%, more preferably 50-85 wt.% and most preferably 55-75 wt.%.

- 10 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 0-6 wt.% and most preferably in the range of 0-4 wt.%.

- 15 The pieces of TVP present in the meat analogue, calculated by weight of the dry matter that is contained in the pieces of TVP, preferably contain 0-15 wt.%, more preferably 0.5-12 wt.% and most preferably 1-10 wt.% of dietary fibre.

- 20 The pieces of TVP in the meat analogue of the present invention typically contain, calculated by weight of dry matter, 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, 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 contained in the pieces of TVP.

- 25 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.

- 30 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
35 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 per kg of kappa carrageenan and most preferably in a concentration of 200-10,000 mmol per kg of kappa carrageenan.

5

The meat analogue preferably has a pH of 5 to 6.5, more preferably a pH 5.2 to 5.8.

Preferably, the meat analogue of the present invention is a meat analogue comprising a crispy coating like a nugget or schnitzel. Any suitable coating known to the person skilled in the art may be used.

10

The meat analogue of the present invention may comprise additional ingredients besides the ones discussed above. Such additional ingredients may include gelling agents, thickeners, emulsifiers, acidulants, preservatives, colouring, meat flavouring, dietary fibres, vitamins and minerals.

15

The present invention further provides a vegan meat analogue preferably comprising by weight of the meat analogue:

- 10-40 wt.% and most preferably 15-25 wt.% of the vegan gelled beads of the present invention
- non-animal protein
- water
- meat flavouring
- acidulants

20

whereby the meat analogue preferably has a pH of 5 to 6.5, more preferably a pH 5.2 to 5.8.

25

The present invention further provides a vegan meat analogue preferably comprising by weight of the meat analogue:

- 10-40 wt.% and most preferably 15-25 wt.% of the vegan gelled beads of the present invention
- non-animal protein
- water
- meat flavouring
- acidulants

30

whereby the meat analogue provides more moisture release than compared with a meat analogue with the same composition but without said vegan gelled beads

35

The present invention further provides a vegan meat analogue preferably comprising by weight of the meat analogue

- 10-40 wt.% and most preferably 15-25 wt.% of the vegan gelled beads of the present invention
- non-animal protein
- water
- meat flavouring
- acidulants

whereby the meat analogue has a higher firmness at 65°C, preferably as measured herein, than compared with a meat analogue with the same composition but without said vegan gelled beads

The meat analogue of the present invention preferably is a burger, a meat ball, a nugget, a schnitzel, a steak or a sausage.

The invention is further illustrated by the following non-limiting examples.

EXAMPLES

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

Example 1

Gelled beads according to the invention were prepared on the basis of the recipe that is shown in Table 1.

Table 1

	Wt. %
Kappa-carrageenan ¹	2.00
Konjac gum ²	1.00
Sodium chloride	1.80
Coconut fat	8.50
Rapeseed oil	21.50
Lactic acid	0.55
Water	64.65

¹ WELCO Gelform 1263, Welding GmbH & Co. KG, Germany, (kappa carrageenan preparation made from natural strains of Eucheuma seaweed containing 3% KCl)

² Contains 88 wt.% konjac mannan

Kappa-carrageenan, konjac gum, salt and water were combined at 20 °C while shearing at speed 3 in a Thermomix® blender (Vorwerk, Germany). Next, the mixture was heated to 40 °C under continued shearing, following which the fat, oil and lactic acid were added. Finally, the whole mixture was heated under continued shearing at speed 5 to 75°C.

The hot emulsion so obtained was gradually cooled to 5°C and formed a firm gel. The gel was ground into gelled beads of about 5 mm in a meat grinder mounted on a Kenwood Chef mixer, using a grinding plate with 5 mm holes.

These gelled beads were used to prepare a sausage dough (Dough 1). A comparative sausage dough A was prepared without gelled beads. Instead comparative sausage A had an identical composition but was prepared by adding the ingredients of the gelled beads directly into the dough (Dough A). The recipes of the sausage doughs are shown in Table 2.

Table 2

	Wt. %	
	1	A
TVP ¹	7.92	7.92
Water	18.27	18.27
Cold water	15.00	27.93
Crushed ice	8.00	8.00
Spirit vinegar	0.57	0.57
Lactic acid	0.26	0.37
Binder mix ²	4.8	4.8
Soy lecithin	0.50	0.50
Herbs and spices	5.18	5.18
Flavouring	1.70	1.70
Kappa-carrageenan ³ (in dough)	0.80	1.20
Konjac gum ⁴ (in dough)	0.70	0.90
Sodium chloride	1.30	1.66
Coconut fat	0.00	1.70
Rapeseed oil	15.00	19.30
Gelled beads (Table 1)	20.00	0.00
TOTAL	100.00	100.00

¹ Soy based, protein content ≥ 68 wt.%, moisture content ≤ 12 wt.% Other 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, vital wheat gluten, citrus fibre

³ WELCO Gelform 1263, Welding GmbH & Co. KG, Germany, (kappa carrageenan preparation made from natural strains of Eucheuma seaweed containing 3% KCl)

⁴ Contains at least 88 wt.% konjac mannan

The sausages were prepared as follows:

- The TVP was combined with water, vinegar and lactic acid and sealed in a 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 and vital wheat gluten 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.
- Fats were added and mixed for a further 3 minutes at speed 1.
- Herbs, spices, and flavourings were mixed into the dough for 1 minute at speed 1.
- Finally, in the preparation of Dough 1, the gelled beads were added followed by 30 seconds of mixing at speed 1.

The sausages were prepared for consumption as follows:

- The aforementioned doughs were extruded into a vegan casing (28 mm diameter) and sausages were made by creating 10 cm sections using a thin rope.
- The sausage string so obtained was then pre-cooked in a steam oven set at a 100% steam atmosphere and cooked for 10 minutes at 60°C and followed by another 35 minutes at 95°C.
- The cooked sausages were cooled in ice water for 1 hour and then removed from their casing, sealed in plastic bags and frozen in a blast freezer to minus 20°C in 1 hour time and then placed in a minus 20°C freezer until use.
- On the day of consumption, the bags were placed in luke warm water for an hour to thaw.
- The thawed sausages were baked in a non-stick pan until a core temperature of 70°C was reached.

Results

The sausages were evaluated by a panel of 8 persons. The samples were coded and offered in randomised order to the panellists. Sausage 1 according to the invention was found to have improved firmness, moisture release, oiliness, mouthcoating while showing less dryness when compared to Sausage A.

The firmness of the sausages was determined after baking in a non-stick pan by Texture Profile Analysis (TPA), using a texture analyser (Stable Micro Systems, United Kingdom, Godalming) equipped with a thermal cabinet to keep samples at 65°C. A load cell of 50 kg was used, which was calibrated with a 5 kg weight. A 28 mm casing resulted in a 24 mm diameter sausage (surface area 452.3893 mm²) after steam oven precooking and pan frying, and was cut in 20 mm long sections to be compressed as an upright standing cylinder using a square probe of 4900 mm². The TPA sequence consisted of a double compression at 5 mm/s up to 50% strain. The measurements were performed at 65 °C with three replicates per sample.

The firmness of sausage 1 according to the invention was substantially higher than the firmness of sausage A.

Example 2

Sausages containing gelled beads were prepared as in Example 1, except that this time two other fat components were applied in the gelled beads compared to Example 1. The recipes of the gelled beads according to the invention for sausages 2 and 3 respectively are shown in Table 3. The gelled bead 3 had a melting point of 70°C.

Table 3

	Wt.%	
	2	3
Kappa-carrageenan ¹	2.00	2.00
Konjac gum ²	1.00	1.00
Sodium chloride	1.80	1.80
Coconut fat	30.00	0.00
Rapeseed oil	0.00	30.00
Lactic acid	0.55	0.55
Water	64.65	64.65

¹ WELCO Gelform 1263, Welding GmbH & Co. KG, Germany, (kappa carrageenan preparation made from natural strains of Eucheuma seaweed containing 3% KCl E508 and maltodextrin for standardisation)

² Contains at least 88 wt.% konjac mannan

The gel beads 2 and 3 of Table 3 were used to prepare sausages 2 and 3 respectively, in the same manner as in Example 1. These sausages were prepared for consumption and evaluated in the same way as described in Example 1. Both sausages 2 and 3 showed the same surprising advantages as Sausage 1 in Example 1 compared to sausage A.

Example 3

Sausages 4 and 5 containing gelled beads were prepared as in Example 1, except that this time the size of the gelled beads was varied. Gelled beads were prepared using a grinder provided with a plate having apertures with sizes of 3 and 10 mm, respectively.

- 5 Sausages 4 and 5 were prepared for consumption and evaluated in the same way as described in Example 1. Both sausages 4 and 5 showed the same surprising advantages as Sausage 1 in Example 1 compared to sausage A.

Example 4

- 10 Gel formulation #3 in Example 2 was processed into beads of 3 mm and 5 mm using a meat grinder provided with a grinding plate having apertures of 3 mm and 5 mm, respectively and in 3 mm gelled beads in the form of cubes using a vegetable cutter (Brunner-Anliker, type GSM 4-PA, Switzerland) with a 3 mm cutting plate. One kilogram of each batch was then transferred into a sieve and the liquid leaking out of the three batches of gelled beads was
15 collected over a period of 2 hours and w/w% calculated. The juice leakage was minor and could be further improved by cutting compared to grinding the gel as shown in Table.

Table 4

Juice leakage after 2h	3 mm ground beads	5 mm ground beads	3 mm cut beads
	+	+	++

20 **Comparative Example Xanthan and LBG**

Gelled beads based on the combination xanthan and locust bean gum were prepared on the basis of the recipe that is shown in Table 5.

Table 5

	Wt. %
Xanthan gum	0.80
Locust Bean gum	0.45
Sodium chloride	0.50
Coconut fat	8.50
Rapeseed oil	21.50
Spirit vinegar (20%)	1.00
Water	67.25

25

Water was heated to 100 °C in a Thermomix® blender at speed 3. Next, the temperature was lowered to 90 °C and a blend of xanthan gum, locust bean gum, and salt were added and mixed for 5 minutes at speed 5. Then rapeseed oil and coconut fat were added under continued shearing for 3 minutes.

The hot emulsion so obtained was gradually cooled to 5°C and formed a firm gel. The gel was ground into gelled beads of 5 mm in a meat grinder mounted on a Kenwood Chef mixer, using a meat grinder provided with a plate having apertures with a size of 5 mm.

5

These gelled beads were used to prepare sausages in the same way as described in Example 1. The sausages so obtained were found to be too soft at 65°C and to develop burns during pan frying.

CLAIMS

1. A vegan gelled bead for a meat analogue having a weight of 7-800 mg and comprising by weight of the gel bead:
 - 0.5-4 wt.% of kappa-carrageenan;
 - 0.2-2.5 wt.% of konjac mannan; and
 - 0-50 wt.% of fat;
 - 45-98 wt.% of water;wherein the combination of fat and water constitutes at least 75 wt.% of the gelled bead; and wherein the gelled bead optionally contains one or more ingredients selected from starch, cellulosic fiber, methylcellulose, protein isolate in a concentration of 0-5 wt.%, preferably of 0-3 wt.% and more preferably of 0-1 wt.%.
2. Gelled bead according to claim 1, wherein the combination of kappa-carrageenan and konjac mannan constitutes 1.0-6.0 wt.% of the meat analogue.
3. Gelled bead according to any one of the preceding claims, wherein kappa-carrageenan and konjac mannan are present in a weight ratio of 1:4 to 12:1.
4. Gelled bead according to any one of the preceding claims, wherein the combination of fat and water constitutes at least 80 wt.%, preferably at least 90 wt.% of the gelled bead.
5. Gelled bead according to any one of the preceding claims, wherein the meat analogue comprises by weight of the meat analogue at least 10 wt.% fat.
6. Gelled bead according to any one of the preceding claims, wherein the fat has an N-value at 20°C of at least 5%, preferably of at least 10%.
7. Gelled bead according to any one of the preceding claims, wherein the gelled bead contains 0-4 wt.% protein, preferably 0-2 wt.% protein, most preferably 0-1 wt.% protein.
8. Gelled bead according to any one of the preceding claims, wherein the gelled bead does not contain methylcellulose, preferably does not contain cellulose ether.
9. Gelled bead according to any one of the preceding claims, wherein the gelled bead has a weight of 50-600 mg and comprises by weight of the gelled bead:
 - 1.5-3.0 wt.% of kappa-carrageenan;

- 0.6-1.5 wt.% of konjac mannan; and
- 20-40 wt.% of fat;
- 55-80 wt.% of water;

wherein the combination of fat and water constitutes at least 90 wt.% of the gelled bead; and wherein the gelled bead optionally contains one or more ingredients selected from starch, cellulosic fiber, methylcellulose, protein isolate in a concentration of 0-3 wt.%.

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

11. A method of preparing a vegan gelled bead according to any one of the preceding claims, wherein the method comprises:

- combining 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:

- (i) combining a plurality of the vegan gelled beads according to claims 1-11 with other ingredients of the meat analogue; or
- (ii) providing a lump of gel comprising by weight of the gel:
 - 0.5-4 wt.% of kappa-carrageenan;
 - 0.2-2.5 wt.% of konjac mannan; and
 - 0-50 wt.% of fat;
 - 45-98 wt.% of water;

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

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

wherein the combination of fat and water constitutes at least 75 wt.% of the lump of vegan gel.

13. Meat analogue comprising 5-50 wt.% of the vegan gelled beads according to any one of claims 1-11.

14. Meat analogue according to claim 13, wherein the meat analogue is a vegan meat analogue, said meat analogue comprising by weight of the meat analogue.

- 10-40 wt.% and most preferably 15-25 wt.% of the vegan gelled beads of the present invention
- non-animal protein
- water
- meat flavouring
- acidulants

whereby the meat analogue preferably has a pH of 5 to 6.5, more preferably a pH 5.2 to 5.8, preferably whereby the meat analogue is a burger, a meat ball, a nugget, a schnitzel, a steak or a sausage.

15. Meat analogue according to claim 13 or 14 having a crispy coating.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/058519

A. CLASSIFICATION OF SUBJECT MATTER INV. A23D7/005 A23J3/22 A23D7/02 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	US 4 427 704 A (CHENEY PETER A [GB] ET AL) 24 January 1984 (1984-01-24) cited in the application examples 6,11,12 -----	1-4,7,8, 13
X	WO 2022/147357 A1 (MOTIF FOODWORKS INC [US]) 7 July 2022 (2022-07-07) paragraphs [0018], [0106], [0115], [0118], [0119], [140.175]; claims 2,5; examples 5,7 -----	1-15
X	GB 2 606 409 A (PLANT MEAT LTD [GB]) 9 November 2022 (2022-11-09) page 7; example 3 page 8, line 7/8 page 3, lines 26-29 ----- -/-	1,10-12
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
<p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"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</p> <p>"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</p> <p>"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</p> <p>"&" document member of the same patent family</p>		
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/EP2024/058519

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	CN 113 080 433 A (UNIV HUAZHONG AGRICULTURAL) 9 July 2021 (2021-07-09) claim 1; examples 1,3-5 -----	1 - 15
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Information on patent family members

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