



(51) International Patent Classification:

A23D 7/005 (2006.01) *A23J 3/22* (2006.01)
A23D 7/01 (2006.01) *A23J 3/26* (2006.01)
A23D 7/02 (2006.01)

(21) International Application Number:

PCT/EP2024/058610

(22) International Filing Date:

28 March 2024 (28.03.2024)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

23165269.4 29 March 2023 (29.03.2023) EP
23165270.2 29 March 2023 (29.03.2023) EP

(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).

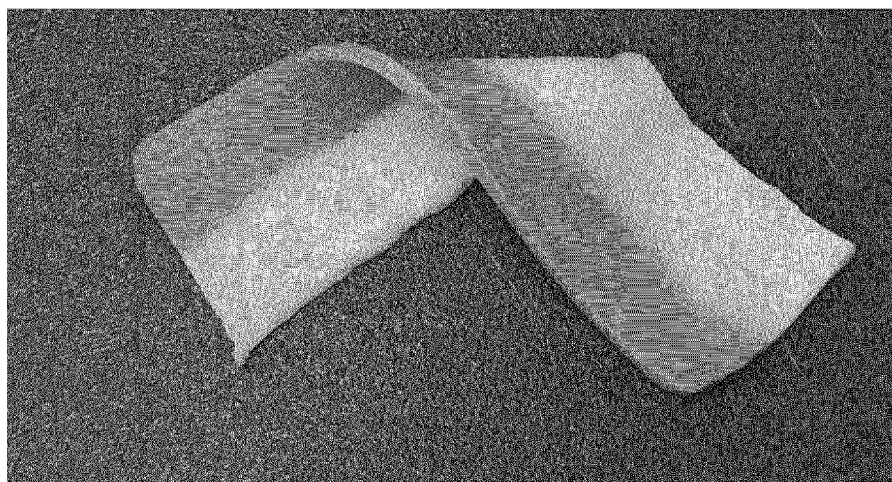
(74) Agent: **TURNER, Felicity, Margaret, Mary**; Unilever
Patent Group Bronland 14, 6708 WH Wageningen (NL).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG,
KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY,
MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA,
NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO,
RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS,
ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, CV,
GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST,
SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ,

(54) Title: MEAT ANALOGUE COMPRISING LAYERS OF FAT TISSUE MIMETIC

FIGURE 1



(57) Abstract: A invention relates to a meat analogue comprising layers of fat tissue mimetic, said fat tissue mimetic comprising: • 2 – 20 wt.% starch; • 0.5 – 5 wt.% of kappa-carrageenan; • 0.5 – 4 wt.% of konjac mannan; • 0 – 70 wt.% of fat; and • 60 – 84 wt.% of water. The meat analogues of the present invention exhibit a chewiness and appearance, closely resembling that of bacon, ham, pork belly and mortadella. The invention relates to a process of preparing the meat analogue by means of co-extrusion.



RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *of inventorship (Rule 4.17(iv))*

Published:

- *with international search report (Art. 21(3))*
- *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

MEAT ANALOGUE COMPRISING LAYERS OF FAT TISSUE MIMETIC

FIELD OF THE INVENTION

5 The present invention relates to a meat analogue comprising layers of fat tissue mimetic, said fat tissue mimetic comprising a combination of kappa-carrageenan and a source of konjac mannan (e.g., konjac gum) and a starch.

10 The invention also relates to a process of preparing the aforementioned meat analogue by means of co-extrusion.

BACKGROUND OF THE INVENTION

15 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, 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.

20 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.

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.

30 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.

35 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 a substantially lower caloric content than fat and that can easily be processed, e.g. in a meat grinder.

5 ADDITIONAL INFORMATION

WO 2020/208104 describes a method of extruding a meat analogue comprising an ingredient comprising a vegetable protein, the method comprising: applying a pressure to the meat analogue with an extruder; and passing the meat analogue through a short die in a direction of flow, wherein the short die is part of and/or is connected to the extruder, and creating sheared fibers in the meat analogue substantially perpendicular to the direction of flow of the meat analogue as the meat analogue is passed through the short die.

WO 2021/110760 describes a composition suitable for use in a plant-based food product comprising:

- a) Carrageenan;
- b) Cellulose ether;
- c) Glucomannan;
- d) Plant-based protein(s);
- e) Starch;
- f) Potassium chloride;

SUMMARY OF THE INVENTION

The inventors have developed a fat tissue mimetic that is particularly suited for application in meat analogues that resemble meat products that contain visible fat layers, such as bacon and ham.

A first aspect of the invention relates to a meat analogue comprising layers of fat tissue mimetic, said fat tissue mimetic comprising, by weight of said fat tissue mimetic:

- 2 – 20 wt.% starch;
- 0.5 – 5 wt.% of kappa-carrageenan;
- 0.5 – 4 wt.% of konjac mannan;
- 0 – 70 wt.% of fat; and
- 60 – 84 wt.% of water.

The meat analogues of the present invention exhibit a chewiness and appearance, closely resembling that of bacon, ham, pork belly and mortadella. The fat tissue mimetic that is employed in the meat analogue resembles animal fat and is ideally suited for use in the industrial production of the aforementioned types of meat analogues.

5

In a preferred embodiment, the invention relates to a meat analogue comprising 45-97 wt.% of a meat tissue mimetic and 3-55 wt.% of layers of fat tissue mimetic, said fat tissue mimetic comprising, by weight of said fat tissue mimetic:

- 8 – 45 wt.% of fat;
- 10 • 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.

15 In a preferred embodiment, the invention relates to a meat analogue comprising 60-90 wt.% of a meat tissue mimetic and 10-40 wt.% of layers of fat tissue mimetic, said meat tissue mimetic comprising by weight of the meat tissue mimetic 2 to 20 wt.% of non-animal protein, and said fat tissue mimetic comprising, by weight of said fat tissue mimetic:

- 12 – 30 wt.% of fat;
- 20 • 8 – 15 wt.% of starch;
- 1.0 – 3.0 wt.% of kappa-carrageena
- 1.2 – 2.8 wt.% of konjac mannan; and
- 60 – 72 wt.% of water.

25 A second aspect of the invention relates to a process of preparing the meat analogue of the present invention, wherein the process comprises the steps of:

- combining starch, kappa-carrageenan, konjac mannan, water and optionally further ingredients to produce a gel mixture;
- combining non-animal protein, preferably shredded or ground TVP, water, binder and optionally further ingredients to produce a proteinaceous dough;
- 30 • co-extruding the gel mixture and the proteinaceous dough;
- heating the co-extrudate to a temperature of at least 60 °C;
- cooling the heated co-extrudate to a temperature of less than 30 °C.

35 The gel mixture that is employed in the present process is quite viscous, allowing it to be co-extruded with the equally viscous proteinaceous dough. The heating of the co-extrudate

causes the gel mixture to form a firm gel and to develop a strong adherence to the heated treated proteinaceous dough.

In a preferred embodiment, the invention relates to a process of preparing the meat analogue of the present invention, the process comprising the steps of:

- combining starch, kappa-carrageenan, konjac mannan, water and optionally further ingredients to produce a gel mixture;
- combining texturised vegan protein, water, binder and optionally further ingredients to produce a proteinaceous dough;
- co-extruding the gel mixture and the proteinaceous dough;
- heating the co-extrudate to a temperature of 65-85 °C;
- cooling the heated co-extrudate to a temperature of less than 30 °C;

wherein the gel mixture and the proteinaceous dough are co-extruded to form a ribbon.

In another preferred embodiment, the invention relates to a process of preparing the meat analogue of the present invention, the process comprising the steps of:

- combining starch, kappa-carrageenan, konjac mannan, water and optionally further ingredients to produce a gel mixture;
- combining texturised vegan protein, water, binder and optionally further ingredients to produce a proteinaceous dough;
- co-extruding the gel mixture and the proteinaceous dough;
- heating the co-extrudate to a temperature of 65-85 °C;
- cooling the heated co-extrudate to a temperature of less than 30 °C;

wherein the gel mixture and the proteinaceous dough are co-extruded as a cylinder having a diameter of 4 to 30 cm.

In another preferred embodiment, the invention relates to a process of preparing the meat analogue of the present invention, the process comprising the steps of:

- combining starch, kappa-carrageenan, konjac mannan, water and optionally further ingredients to produce a gel mixture;
- combining texturised vegan protein, water, binder and optionally further ingredients to produce a proteinaceous dough;
- co-extruding the gel mixture and the proteinaceous dough;
- heating the co-extrudate to a temperature of 65-85 °C;
- cooling the heated co-extrudate to a temperature of less than 30 °C;

wherein the gel mixture and the proteinaceous dough are co-extruded as a rectangular slab having cross-section with a width of at least 12-40 cm and a height of 2-30 cm, following which the slab is sliced before or after heating in a direction that is perpendicular to the extrusion path to produce slices having a thickness of 0.5 to 10 mm.

5

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.

10

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.

15

The amount of ingredients of the fat tissue mimetic are expressed as wt% by weight of the fat tissue mimetic, unless indicated otherwise or clear from the context. This applies mutatis mutandis for the ingredients of the meat analogue.

20

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 B in wt.% equals x:y.

25

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, it should be understood that all ranges combining the different endpoints are also contemplated.

35

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. 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 "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 pregelatinised starch.

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 "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 20 °C and fats that are solid or semi-solid at 20 °C. The melting point of a fat can be determined according to ISO 6321 (2021).

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.

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 mammals, fish, crustacean, birds.

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 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 cut, shredded or ground for use in a meat analogue in e.g., meat grinder with a plate having 5 mm apertures. The term pieces in this context encompasses both chunks before and the TVP after comminution.

- 5 The term "co-extrusion", as used herein, refers to a process in which two or more materials are extruded simultaneously to produce a single product.

Meat analogue

10 The meat analogue of the present invention preferably is selected from bacon, ham, pork belly, mortadella, "Funny faces" cold cuts' and Dutch "Leverkaas".

The layers of fat tissue mimetic preferably constitute 3 - 55 wt.%, more preferably 5 - 45 wt.% and most preferably 10 - 40 wt.% of the meat analogue.

- 15 According to a preferred embodiment, the meat analogue does not contain any meat-derived ingredients. Even more preferably, the meat analogue does not contain animal-derived ingredients (e.g. milk, egg or ingredient derived therefrom).

Fat tissue mimetic

20 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 fat tissue mimetic.

25 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 fat tissue mimetic.

30 The combination of kappa-carrageenan and konjac mannan is preferably contained in the fat tissue mimetic 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 fat tissue mimetic.

The weight ratio of kappa-carrageenan and konjac mannan in the fat tissue mimetic 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.

Preferably, the fat tissue mimetic comprises by weight of the fat tissue mimetic 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.

- 5 The fat tissue mimetic comprises by weight of the fat tissue mimetic 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.

- 10 Kappa-carrageenan is preferably contained in the fat tissue mimetic 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. %.

- 15 Preferably, the fat tissue mimetic 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 fat tissue mimetic. More preferably the fat tissue mimetic 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 fat tissue mimetic. Most preferably the fat tissue mimetic comprises potassium cations in a concentration of 1.0-500 mmol per kg of the total amount of water that is contained in the fat tissue mimetic.

- 20 Potassium cations are preferably contained in fat tissue mimetic 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.

- 25 Preferably, the fat tissue mimetic comprises by weight of the fat tissue mimetic 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.

- 30 The fat tissue mimetic comprises by weight of the fat tissue mimetic 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.

- 35 Konjac mannan is preferably contained in the fat tissue mimetic 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. %.

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 a chemically modified starch. Even more preferably, the starch is a cross-linked starch. Yet more preferably, the starch is a cross-linked starch selected from hydroxypropyl distarch phosphate, distarch phosphate and combinations thereof. Most preferably, the starch is hydroxypropyl distarch phosphate.

Preferably, the fat tissue mimetic comprises by weight of the fat tissue mimetic at least 2 wt.%, more preferably at least 4 wt.%, even more preferably at least 6 wt.%, yet more preferably 7 wt.%, most preferably at least 8 wt.% of starch.

The starch preferably constitutes at most 20 wt.%, more preferably at most 17 wt.%, most preferably at most 15 wt.% of the fat tissue mimetic.

Starch is preferably contained in the fat tissue mimetic in a concentration by weight of the fat tissue mimetic of 4-18 wt.%, more preferably of 6-17 wt.% and most preferably of 8-15 wt.%.

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 fat tissue mimetic.

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 fat tissue mimetic.

The combination of starch, kappa-carrageenan and konjac mannan constitutes 5-21 wt.%, more preferably 7-18 wt.%, even more preferably 9-17 wt.%, most preferably 10-16 wt.% of the fat tissue mimetic

Water preferably constitutes 40-80 wt.%, more preferably 60-72 wt.% of the fat tissue mimetic.

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

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

The fat component of the fat tissue mimetic preferably has a low content of saturated fatty acids. Preferably the fat comprises 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.

The fat that is present in the fat tissue mimetic 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*.

The fat preferably comprises by weight of 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.

The fat tissue mimetic 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 fat tissue mimetic.

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

According to a preferred embodiment, any protein comprised in the fat tissue mimetic is non-animal protein, more preferably vegan protein.

Examples of non-animal protein sources that may be employed in the fat tissue mimetic 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.

According to the present invention, the fat tissue mimetic 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 fat tissue mimetic of the present invention does 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 fat tissue mimetic does not contain methylcellulose. More preferably, the fat tissue mimetic does not contain cellulose ether.

In addition to the fat tissue mimetic, the meat analogue of the present invention preferably comprises a meat tissue mimetic. Said meat tissue mimetic preferably has a reddish to brown colour. The meat tissue mimetic preferably constitutes 45 - 97 wt.%, more preferably 55 - 95 wt.% and most preferably 60 - 90 wt.% of the meat analogue.

The meat tissue mimetic preferably contains 2 to 20 wt.% non-animal protein by weight of the meat tissue mimetic.

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

The pieces of TVP in the meat tissue mimetic 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 in the meat tissue mimetic, 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.%.

The pieces of TVP in the meat tissue mimetic 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 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 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.

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 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.

The meat tissue mimetic

The meat tissue mimetic 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, flavouring, dietary fibres, vitamins and minerals.

According to a particularly preferred embodiment, besides pieces of TVP, the meat tissue mimetic 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 fat tissue mimetic.

According to a particularly preferred embodiment, the aqueous binder system contains 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.

As will be explained below, the meat analogue according to the present invention can suitably be produced by co-extrusion. Accordingly, in a preferred embodiment, the meat analogue is a co-extrudate.

The meat analogue of the present invention may suitably be provided in slices, preferably in the form of slices or slabs having a thickness of 0.03 to 2.0 cm, preferably of 0.07 to 0.5 cm.

The width and length of the slices and slabs are preferably in the range of 1 to 40 cm, preferably of 2 to 25 cm.

The diameter of sausage slices and slabs is preferably in the range of 0.5 to 30 cm, preferably of 2.0 to 15cm.

Process of preparing a meat analogue

A further aspect of the invention relates to a process of preparing the meat analogue comprising layers of fat tissue mimetic, said process comprising the steps of:

- combining starch, kappa-carrageenan, konjac mannan, water and optionally further ingredients to produce a gel mixture;
- combining non-animal protein, preferably shredded or ground TVP, water, binder and optionally further ingredients to produce a proteinaceous dough;
- co-extruding the gel mixture and the proteinaceous dough;
- heating the co-extrudate to a temperature of at least 60 °C;
- cooling the heated co-extrudate to a temperature of less than 30 °C.

The water content of the gel mixture is preferably in the range of 50-90 wt.%, more preferably in the range of 60-80 wt.%.

In accordance with one embodiment of the present process, the gel mixture and the proteinaceous dough are co-extruded as a ribbon. Preferably, the ribbon-shaped co-extrudate is cut during extrusion perpendicular to the extrusion path to provide slices having has a length

of at least 50 mm, more preferably of 100 to 400 mm. The cutting is preferably performed after the heating step.

5 The ribbon-shaped co-extrudate preferably has a width of 0.5 to 20 cm, preferably 1 to 10 cm, more preferably of 2 to 6 cm.

The ribbon-shaped co-extrudate preferably has a thickness of 0.1 to 4 cm, preferably 0.5 to 1 cm, more preferably of 0.7 to 0.5 cm.

10 In accordance with another embodiment of the present process, the gel mixture and the proteinaceous dough are co-extruded as a cylinder (to produce a sausage). Preferably, the circular shaped co-extrudate so obtained has a diameter of at least 1 cm, more preferably of 4 to 30 cm. The cylinder-shaped co-extrudate may be cut perpendicular to the extrusion path to produce slices or sausages. The cutting is preferably performed after the heating step.

15

In accordance with yet another embodiment of the present process, the gel mixture and the proteinaceous dough are co-extruded as a rectangular slab having cross-section with a width of at least 10 cm and a height of least 2 cm, following which prior to or after heating the slab is sliced in a direction that is perpendicular to the extrusion path to produce slices having a thickness of 0.5 to 10 mm, preferably of 1.0 to 4.0 mm. This embodiment allows the creation of intricate layers of fat tissue mimetic by using a specially designed mould. Preferably in this embodiment of the present process the gel mixture and the proteinaceous dough are co-extruded as a slab having a cross-section with a width of 12 to 40 cm and a height of 2 to 30 cm. The rectangular slab is preferably cut after the heating step.

25

The co-extrudate comprising the gel mixture and proteinaceous dough is heated to prepare the meat analogue. Preferably, the co-extrudate is heated to a temperature of 60 to 95 °C, more preferably to a temperature of 65 to 85 °C.

30

The pieces of TVP that are employed in the present process preferably 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 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

35

and combinations thereof. Gluten is an example of cereal protein that may be comprised in the hydrated pieces of TVP.

The following non-limiting examples further illustrate the invention.

5

EXAMPLES

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

10

Example 1

A gel mixture for the preparation of fat tissue mimetic was prepared on the basis of the recipe shown in Table 1.

15 **Table 1 Fat tissue mimetic**

	Wt.%	
	1	2
Kappa-carrageenan	2.50	2.00
Konjac gum ¹	2.50	2.00
Modified tapioca starch ²	10.00	8.00
Sunflower oil	17.00	17.00
Pea protein isolate	1.00	1.00
Sodium chloride	1.00	1.00
Lactic acid	0.55	0.55
Water	balance	balance

¹ Contains 88 wt.% glucomannan

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

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 gel mixture was 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 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 gel mixture was transferred into a piping bag.

5 A red proteinaceous dough was prepared based on the recipe shown in Table 2.

Table 2

	Wt. %
Crushed ice	29.75
Water	40.16
TVP ¹	5.36
Red colouring	0.85
Flavouring	3.53
Binders ²	8.84
Konjac gum ³	1.40
Kappa-carrageenan	1.40
Sodium chloride	1.02
Rapeseed oil	6.97
Lactic acid	0.43
Spirit vinegar	0.30
TOTAL	100.00

¹ 55-65% wheat gluten and 30-40% soy protein isolate (ex Foodflow)

² Methylcellulose, oat fibre and soy protein isolate

10 ³ Contains at least 88 wt. % glucomannan

The proteinaceous dough was prepared as follows:

- The TVP was combined with water and sealed in a plastic bag (Select PolyAmide vacuum bag, Hanos, Netherlands) under vacuum and left to hydrate for 2 hours.
- 15 • The hydrated TVP was transferred to a bowl chopper type mixer (Stephan UMC5 electronic, A. Stephan & Sohne, Hameln, Germany).
- The binders, konjac gum, kappa-carrageenan were well mixed and together with crushed ice added to the Stephan mixer and sheared at 1500 rpm for 3 minutes at a reduced pressure of 0.2 bar.
- 20 • Oil was added and sheared at 1500 rpm for 1 minute at a reduced pressure of 0.2 bar.
- Flavours, salt and acids were added and sheared at 1500 rpm for 1 minute at a reduced pressure of 0.2 bar.
- Fats were added and mixed for a further 3 minutes at speed 1.
- The red dough so obtained was transferred into a piping bag.

The gel mixture was extruded in a plastic container of 15 x 10 x 4 cm using a piping bag to obtain a layer of 2 cm thickness. On top of this, the red meat analogue dough was extruded until the container was full. The container was covered with a plastic lid and cooked in an oven at 100% steam for 55 minutes at 95°C. Next, the extruded composite was cooled to 5 °C and removed from the container.

The product was cut in 2 mm slices using a cold cut slicer (Deka, Netherlands). Figure 1 shows slices that were produced in this manner.

- 10 Assessment of the slices showed that the interface between the red meat-like phase and white fat tissue mimetic phase was without flaws, such as loss of cohesion between the two parts and/or air inclusions. In addition, the two phases remained attached during heating and transporting of the meat analogue when still hot, and during slicing of the cold meat analogue.
- 15 The fat tissue mimetic did not melt during heating. The fat tissue mimetic phase had a fatty gloss and chewy texture like real meat fat.

The two phases of the meat analogue can also be (co-)extruded to create a mortadella-like sausage, or a layered meat analogue that, for instance, resembles bacon rasher or pork belly.

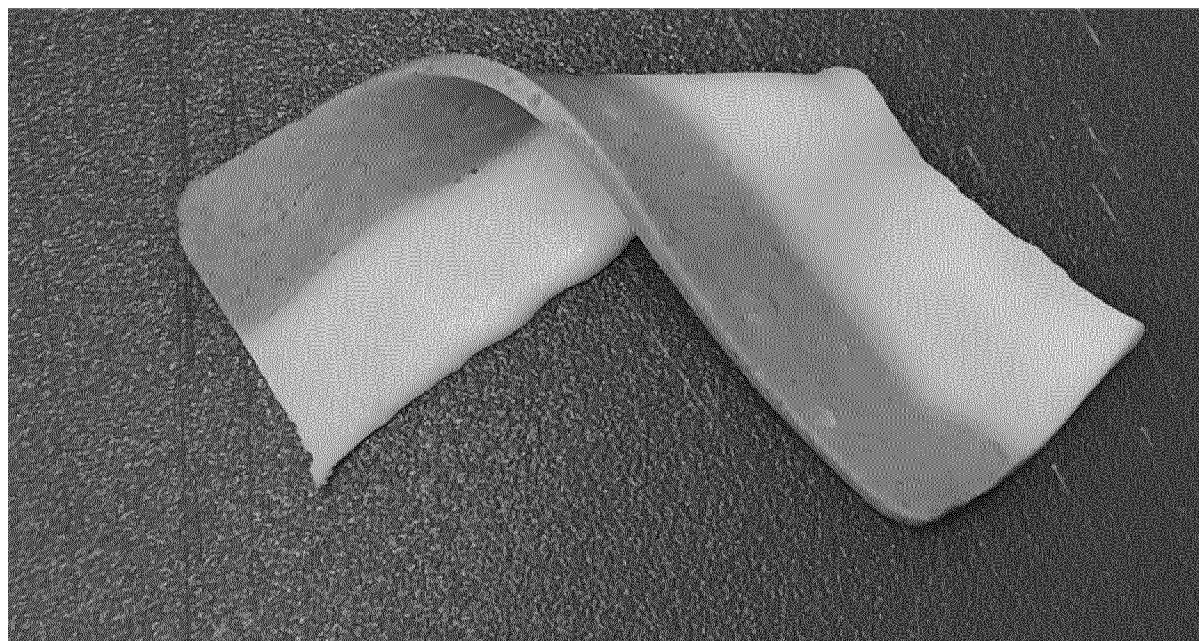
CLAIMS

1. A meat analogue comprising layers of fat tissue mimetic, said fat tissue mimetic comprising, by weight of said fat tissue mimetic:
 - 2 – 20 wt.% of starch;
 - 0.5 – 5 wt.% of kappa-carrageenan;
 - 0.5 – 4 wt.% of konjac mannan;
 - 0 – 70 wt.% of fat; and
 - 27 – 84 wt.% of water.
2. Meat analogue according to claim 1, wherein the fat-like layers constitute 3 to 55 wt.% of the meat analogue.
3. Meat analogue according to claim 1 or 2, wherein the fat tissue mimetic comprises 4 – 17 wt.%, preferably 6 – 15 wt.% of starch by weight of said fat tissue mimetic.
4. Meat analogue according to any of the preceding claims, wherein the combination of kappa-carrageenan, starch and konjac mannan constitutes 5 – 21 wt.% of the fat tissue mimetic.
5. Meat analogue according to any one of the preceding claims, wherein kappa-carrageenan and konjac mannan are present in a weight ratio of 1:7 to 7:1.
6. Meat analogue 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 fat tissue mimetic.
7. Meat analogue according to any one of the preceding claims, wherein the fat tissue mimetic does not contain methylcellulose.
8. Meat analogue according to any one of the preceding claims, wherein the meat analogue is selected from bacon, ham, pork belly, mortadella, Dutch Leverkaas and "Funny faces" cold cuts.

9. Meat analogue according to any one of the preceding claims, wherein the meat analogue comprises meat tissue mimetic, and wherein the meat tissue mimetic has a reddish to brown colour.
10. Meat analogue according to claim 9, wherein the meat analogue comprises 60-90 wt.% of the meat tissue mimetic and 10-40 wt.% of layers of fat tissue mimetic
11. Meat analogue according to any one of the preceding claims, wherein the meat analogue comprises 60-90 wt.% of a meat tissue mimetic and 10-40 wt.% of layers of fat tissue mimetic, said meat tissue mimetic comprising, 2 to 20 wt.% of non-animal protein, and said fat tissue mimetic comprising by weight of said fat tissue mimetic:
 - 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
12. A process of preparing the meat analogue according to any one of the preceding claims, wherein the process comprises:
 - combining starch, kappa-carrageenan, konjac mannan, water and optionally further ingredients to produce a gel mixture;
 - combining non-animal protein, preferably shredded or ground TVP, water, binder and optionally further ingredients to produce a proteinaceous dough;
 - co-extruding the gel mixture and the proteinaceous dough;
 - heating the co-extrudate to a temperature of at least 60 °C;
 - cooling the heated co-extrudate to a temperature of less than 30 °C.
13. Process according to claim 12, wherein the gel mixture and the proteinaceous dough are co-extruded as a ribbon having a width of 10 to 100 mm and a thickness of 0.5 to 10 mm and wherein the ribbon-shaped co-extrudate is cut during extrusion to provide slices having a length of at least 50 mm.
14. Process according to claim 12, wherein the gel mixture and the proteinaceous dough are co-extruded as a cylinder having a diameter of 4 to 30 cm.

15. Process according to claim 12, wherein the gel mixture and the proteinaceous dough are co-extruded as a rectangular slab having cross-section with a width of at least 12-40 cm and a height of least 4-30 cm, following which the slab is sliced in a direction that is perpendicular to the extrusion path to produce slices having a thickness of 0.5 to 10 mm.

FIGURE 1



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/058610

A. CLASSIFICATION OF SUBJECT MATTER					
INV.	A23D7/005	A23D7/01	A23D7/02	A23J3/22	A23J3/26
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.
Y	WO 2022/147357 A1 (MOTIF FOODWORKS INC [US]) 7 July 2022 (2022-07-07) paragraphs [0017], [0094], [0114], [0137], [0142]				1 - 15
Y	DATABASE GNPD [Online] MINTEL; 1 April 2021 (2021-04-01), anonymous: "Meat-Free Bacon Style Rashers", XP055945748, Database accession no. 8602257 abstract				1 - 15
Y	WO 2022/157584 A2 (BEVO BIOTEHNOLOSKE RESITVE D O O [SI]) 28 July 2022 (2022-07-28) paragraphs [0127] - [0130]				1 - 15
- / - -					
☒ 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/EP2024/058610

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2023/000109 A1 (NETTESHEIM FLORIAN [DK] ET AL) 5 January 2023 (2023-01-05) claims 1,2,4,5,10 -----	1 - 15
A	GB 2 606 409 A (PLANT MEAT LTD [GB]) 9 November 2022 (2022-11-09) page 3, lines 26-29 page 6, paragraph 25-28 claims 1,11 -----	1 - 15
A	WO 2023/275304 A1 (NESTLE SA [CH]) 5 January 2023 (2023-01-05) page 27 - page 28; example 5 -----	1 - 15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2024/058610

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2022147357 A1	07-07-2022	AU 2021413255 A1 CA 3203660 A1 CN 116847737 A EP 4271202 A1 US 2024049749 A1 WO 2022147357 A1	20-07-2023 07-07-2022 03-10-2023 08-11-2023 15-02-2024 07-07-2022
WO 2022157584 A2	28-07-2022	EP 4280890 A2 US 2024074454 A1 WO 2022157584 A2	29-11-2023 07-03-2024 28-07-2022
US 2023000109 A1	05-01-2023	BR 112022010760 A2 CN 115209742 A EP 4068982 A1 US 2023000109 A1 WO 2021110760 A1	23-08-2022 18-10-2022 12-10-2022 05-01-2023 10-06-2021
GB 2606409 A	09-11-2022	EP 4333629 A1 GB 2606409 A WO 2022234047 A1	13-03-2024 09-11-2022 10-11-2022
WO 2023275304 A1	05-01-2023	EP 4362690 A1 WO 2023275304 A1	08-05-2024 05-01-2023