

CLAIMS:

1. An edible meat analogue comprising a plurality of protein strands and inter-strand sheaths material,

wherein in at least one sample of said edible meat analogue, the following conditions are fulfilled:

said plurality of protein strands are essentially aligned along a P axis of said at least one sample,

at least a portion of the protein strands are at least partially surrounded by the inter-strand sheaths material;

said inter-strand sheaths material comprises at least one component that has a melting point above 30°C;

said inter-strand sheaths material forms a network interconnecting between at least two neighboring, spaced apart, protein strands; and

wherein said inter-strand sheaths material is selected to provide at least one of the following physical properties:

an average hardness of at least 46N when measured from at least two directions perpendicular to the nominal direction of the protein strands in a specimen of said edible meat analogue; and

an average tensile strength of at least 0.012MPa when measured from at least two directions perpendicular to said nominal direction of the strands in a specimen of said edible meat analogue.

2. The meat analogue of claim 1, wherein said network interconnects between part of said plurality of strands.

3. The meat analogue of claim 1 or 2, wherein said protein strands comprise texturized protein.

4. The meat analogue of any one of claims 1 to 3, wherein said inter-strand sheaths occupy spaces between neighboring strands.

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5. The meat analogue of claim 4, wherein said spaces have a dimension of between 50 μ m and 5mm.
6. The meat analogue of any one of claims 1 to 5, wherein said inter-strand sheaths comprise a protein.
7. The meat analogue of any one of claims 1 to 6, wherein said inter-strand sheaths comprise a polysaccharide.
8. The meat analogue of any one of claims 1 to 7, wherein said inter-stand sheaths comprise a protein selected from plant protein, Texturized Vegetable Protein (TVP) and High Moisture Extruded (HME) proteins.
9. The meat analogue of any one of claims 1 to 8, wherein said inter-stand sheaths comprise a polysaccharide selected from pectin, alginate, carrageenan, chitosan, starch, cellulose derivatives, galactomannan and combination of same.
10. The meat analogue of any one of claims 1 to 9, wherein said inter-stand sheaths material comprises a combination of at least one protein and at least one polysaccharide.
11. The meat analogue of any one of claims 1 to 10, wherein said inter-strand sheaths comprise κ -carrageenan.
12. The meat analogue of any one of claims 1 to 11, wherein said inter-strand sheaths comprise gluten.
13. The meat analogue of any one of claims 1 to 12, wherein said inter-strand sheaths material comprises a combination of two or more components with different melting points, at least one being solid and at least one being liquid at a temperature between 30°C and 70°C.
14. The meat analogue of any one of claims 1 to 13, wherein said inter-strand sheaths material surrounds at least 50% of each protein strand.
15. The meat analogue of any one of claims 1 to 14, being characterized by at least one of the following,:
 - compression modulus of at least 0.5MPa when measured in a nominal direction of said protein strands in a specimen of the edible meat analogue;

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- average compression modulus of at least 0.4MPa when measured from at least two directions perpendicular to said nominal direction of the strands in a specimen of said meat analogue;
- hardness of at least 52N when measured in a nominal direction of the protein strands of a specimen of said meat analogue;
- tensile strength of at least 0.035MPa when measured in a nominal direction of said strands in a specimen of said meat analogue;

16. The meat analogue of claim 15, wherein said compression modulus is measured on a specimen having dimensions of 20mm*20mm*20mm.

17. The meat analogue of any one of claims 1 to 15, wherein hardness is measured on a specimen having dimensions of 20mm*20mm*20mm.

18. The meat analogue of any one of claims 1 to 15, wherein said tensile strength is measured on a specimen having dimensions of 50mm*20mm*10mm.

19. The meat analogue of any one of claims 1 to 18, being in a form of a steak with the protein strands being in direction perpendicular to the longitudinal axis of the meat analogue.

20. An additive manufacturing method for producing a meat analogue, the method comprising:

- (a) dispensing one or more strands of protein into at least one protein layer, each said protein layer comprising essentially aligned protein strands, at least a portion of said protein strands being spaced apart from its neighboring strand;
- (b) over one or more protein layers, dispensing an inter-strand sheaths material; and
- (c) repeating said steps (a) and (b) until reaching a desired dimension for said meat analogue;

wherein said inter-strand sheaths material occupies spaces between neighboring strands.

21. The method of claim 20, wherein protein strands are dispensed in a manner whereby at least a portion thereof fit into spaces between strands of a previously dispensed protein layer.

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22. The method of claim 20 or 21, wherein said inter-strand sheath forming material is dispensed in a manner interconnecting between at least two sequential protein layers.

23. The method of any one of claims 20 to 22, wherein at least a portion of the spaces between strands have dimensions that allow dispensed inter-strands forming material to inter-cross the protein layer onto which it is overlaid and come into contact with a previously dispensed inter-strand sheath forming material.

24. The method of any one of claims 20 to 23, wherein said inter-strand sheath is applied onto a protein layer in a form of a sheet.

25. The method of claim 24, wherein said sheet has a cross-section dimension (thickness) of between 0.05mm and 1mm.

26. The method of any one of claims 20 to 25, wherein said inter strand sheaths material is in a form of a film or a non-woven mesh.

27. The method of any one of claims 20 to 26, wherein said inter-strand sheath forming material is applied onto said protein strand layer in a form of an undulated sheet having alternating elongated concave segments configured to fit over at least a portion of said protein strands.

28. The method of any one of claims 20 to 27, wherein said inter-strand sheath forming material is dispensed in a liquid form.

29. The method of claim 28, wherein the inter-strand sheath forming material in liquid form is applied onto a preceding layer by any one of extruding, spraying, brushing, dipping, dispensing, ink-jet printing, screen printing.

30. The method of any one of claims 20 to 23, wherein said inter-strand sheath forming material is dispensed in a powder form.

31. The method of any one of claims 20 to 30, wherein said applying of the inter-strand sheath forming material is at temperatures at which said inter-strand sheath forming material is liquid and said method comprises cooling the inter-strand sheath forming material once applied, to a temperature at which it solidifies.

32. The method of any one of claims 20 to 31, wherein protein strands of a protein layer are applied on top of a space between two neighboring protein strands of its preceding protein layer so as to form a honeycomb like arrangement of the protein strands,

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when said protein layers are viewed from a cross-sectional plan perpendicular to the plan of the protein layer.

33. The method of any one of claims 20 to 32, wherein a protein layer is applied such that the protein strands therein are essentially aligned with a previously applied protein layer.

34. The method of any one of claims 20 to 33, comprising applying pressure onto the layers.

35. The method of claim 34, wherein said pressure applied causes at least 5% volume reduction of said meat analogue or of a portion thereof.

36. The method of claim 34, wherein said pressure applied causes at least 5% increase in density of said meat analogue or of a portion thereof.

37. The method of any one of claims 32 to 36, wherein said pressure is being applied in a direction perpendicular to the surface of the layers.

38. The method of claim 34, wherein said pressure comprises vacuum pressure.

39. The method of any one of claims 34 to 38, wherein said pressure is applied once said meat analogue reaches its desired dimensions or after dispensing N numbers of protein layers, N being an integer equal or above 1.

40. The method of any one of claims 20 to 39, wherein said plurality of strands are formed by dispensing a single elongated strand while maintaining segments of said strands in an essentially aligned configuration.

41. The method of any one of claims 20 to 40, wherein said plurality of strands are formed by dispensing individual strands with each strand being essentially aligned with at least a neighboring strand.

42. The method of any one of claims 20 to 41, wherein each protein strand has a cross-sectional dimension within a range of 0.1mm to 10mm.

43. The method of any one of claims 20 to 42, wherein each sheath has a thickness within a range of 0.1mm and 5mm.

44. The method of any one of claims 20 to 43, comprising at least one thermal treatment.

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45. The method of claim 44, comprising thermal treatment after applying at least part of the inter-strand sheath forming material.

46. The method of claim 44, wherein said thermal treatment comprises controlled heating of the meat analogue or a portion thereof to a core temperature of at least 40°C.

47. The method of any one of claims 20 to 46, wherein said inter-strand sheaths material is selected to provide at least one of the following physical properties:

an average hardness of at least 46N when measured from at least two directions perpendicular to the nominal direction of the protein strands in a specimen of said edible meat analogue; and

an average tensile strength of at least 0.012MPa when measured from at least two directions perpendicular to said nominal direction of the strands in a specimen of said edible meat analogue.

48. The method of claim 47, wherein said hardness is measured on a specimen having dimensions of 20mm*20mm*20mm.

49. The method of claim 47, wherein said tensile strength is measured on a specimen having dimensions of 50mm*20mm*10mm.