

increase the nutritional quality and palatability of these less expensive protein sources, many people add additional nutrients (amino acids, vitamins, and minerals) and sugars to these less expensive protein sources.

[0006] Even with the increased additional nutrients (amino acids, vitamins, and minerals) and sugars to these less expensive protein sources, these products can still cause health issues such as nausea, diarrhea, stomach cramps, irritability, fatigue, high blood pressure, acne, wrinkles, joint pain, and sleep issues. While animal-derived meats are often complex and variegated mixtures of tissues, cells, biomolecules and inorganic species, previous attempts to replicate meat-like qualities with similarly complex mixtures (for example with whole legumes or fungal thallic tissues) have typically proven ineffective, instead yielding products with qualities reflective of their ingredients, rather than of meat. Such endeavors are not only challenged by the proper selection of meat-mimetic ingredients, but also the omission of species which detract from meat profiles. For example, while certain mushrooms contain many categories of red meat-flavored molecules, trace quantities of lactones, aliphatic ketones, heavy alcohols, free amino acids, free sugars, and free vitamins in these mushrooms typically mask their otherwise robust meat flavors.

[0007] What is needed is a meat alternative formulation that utilizes sources of plant proteins, is sustainable, is flavorful, and does not cause additional health concerns to meet consumer satisfaction.

SUMMARY

[0008] In one aspect, the present disclosure provides a meat alternative formulation comprising: a heme protein and a plant-based protein, wherein the meat alternative formulation does not include free amino acids selected from the group consisting of cysteine, cystine, selenocysteine, and methionine. In another aspect, the present disclosure provides a meat alternative formulation comprising: (a) a heme protein; (b) a plant-based protein; (c) a plant-based fiber; (d) a fat; and (e) water; wherein the formulation does not include free amino acids selected from the group consisting of cysteine, cystine, selenocysteine, and methionine. In another aspect, the present disclosure provides a method of producing a meat alternative formulation, the

method comprising: (a) combining a plant-based connective tissue analog, a plant-based fiber, a plant-based protein, or any combination thereof, with water to form a hydrated composition; (b) combining a plant-based connective tissue analog, a plant-based protein, a plant-based fiber, a fat, a mineral, water, or any combination thereof, with a heme protein to form a heme protein composition, wherein the heme protein comprises a bovine myoglobin; and (c) combining the hydrated composition and the heme protein composition; wherein the method does not include adding free amino acids selected from the group consisting of cysteine, cystine, selenocysteine, and methionine. Provided herein is a meat alternative formulation comprising a bovine myoglobin and a plant-based protein comprising a bovine myoglobin and a plant-based protein. The meat alternative formulation may not include free amino acids containing sulfur, which may be selected from the group consisting of cysteine, cystine, selenocysteine, and methionine. The meat alternative formulation may also not include free added thiamin. The meat alternative formulation may also not include free sugars in an amount exceed 1.5 weight percent (wt%). At least 20% of heme moieties of the heme protein may be metmyoglobin or metheme. The heme protein may have a purity of at least 20%. At least 95% of the heme protein may be in a holo-form. The heme

CLAIMS

What is claimed is:

1. A meat alternative formulation comprising: a heme protein and a plant-based protein, wherein the meat alternative formulation does not include free amino acids selected from the group consisting of cysteine, cystine, selenocysteine, and methionine.
2. The meat alternative formulation of claim 1, wherein the meat alternative formulation further does not include free sugars in an amount exceeding 1.5 weight percent (wt%), optionally in an amount exceeding 0.2 wt%.
3. The meat alternative formulation of claim 1, wherein the heme protein is a bovine myoglobin and, wherein at least 20% of heme moieties of the heme protein are metmyoglobin or metheme.
4. The meat alternative formulation of any one of claims 1-3, wherein the heme protein has a purity of at least 20%.
5. The meat alternative formulation of any one of claims 1-4, wherein at least 95% of the heme protein is in a holo-form.
6. The meat alternative formulation of any one of claims 1-5, wherein the heme protein has a dissociation constant (K_d) of at least 500 μM for molecular oxygen.
7. The meat alternative formulation of any one of claims 1-6, wherein the heme protein is present at 0.2 wt% to 2 wt% of the meat alternative formulation.
8. The meat alternative formulation of any one of claims 1-7, wherein the plant-based protein is isolated or derived from wheat, pea, soy, canola, potato, chickpea, lentil, chickpea, fava bean, mung bean, rice, corn, sorghum, quinoa, vegetables, seaweed, bacteria, yeast, mushrooms, or any combination thereof.
9. The meat alternative formulation of claim 8, wherein the plant-based protein comprises a soy protein, a rice protein, a pea protein, a canola protein, or any combination thereof.

10. The meat alternative formulation of any one of claims 1-9, wherein the plant-based protein comprises less than 30% fats and carbohydrates by weight.
11. The meat alternative formulation of claim any one of claims 1-10, wherein the plant-based protein is present at 0.5 wt% to 40 wt%.
12. The meat alternative formulation of any one of claims 1-11, further comprising a hydrocolloid, optionally wherein the hydrocolloid is present at 1 wt% to 5 wt%.
13. The meat alternative formulation of claim 12, wherein the hydrocolloid is selected from the group consisting of konjac gum, gum Arabic, carrageenan, agar-agar, pectin, alginate, gellan, konjac glucomannan, xanthan, modified starch, methyl cellulose, hydroxypropyl methyl cellulose, carboxymethyl cellulose, guar gum, locust bean gum, tara gum, gum tragacanth, gum ghatt, their derivatives, and any combination thereof.
14. The meat alternative formulation of claim 13, wherein the hydrocolloid is selected from the group consisting of konjac flour, methyl cellulose, gum Arabic, carrageenan, and any combination thereof.
15. The meat alternative formulation of any one of claims 1-13, further comprising a plant-based fiber, optionally wherein the plant-based fiber is present at at least 5 wt%.
16. The meat alternative formulation of claim 15, wherein the plant-based fiber is selected from the group consisting of konjac flour, guar gum, xanthan gum, psyllium, chitin, inulin, pectin, dextrin, a starch, a cellulose, a hemicellulose, a starch, a lignin, a citrus fiber extract, and any combination thereof.
17. The meat alternative formulation of claim 16, wherein the plant-based fiber is selected from the group consisting of inulin, gum Arabic, citrus fiber, maltodextrin, and any combination thereof.
18. The meat alternative formulation of any one of claims 1-17, further comprising a fat.
19. The meat alternative formulation of claim 18, wherein the fat is selected from the group consisting of algal oil, fungal oil, corn oil, olive oil, soy oil, peanut oil,

walnut oil, almond oil, sesame oil, cottonseed oil, rapeseed oil, canola oil, safflower oil, sunflower oil, flax seed oil, palm oil, palm kernel oil, coconut oil, babassu oil, shea butter, mango butter, cocoa butter, wheat germ oil, borage oil, black currant oil, sea-buckhorn oil, macadamia oil, saw palmetto oil, conjugated linoleic oil, alpha linoleic acid, arachidonic acid enriched oil, docosahexaenoic acid (DHA) enriched oil, eicosapentaenoic acid (EPA) enriched oil, palm stearic acid, sea-buckhorn berry oil, macadamia oil, saw palmetto oil, rice bran oil; margarine, and other hydrogenated fats, and any combination thereof.

20. The meat alternative formulation of claim 19, wherein the fat is sunflower oil, coconut oil, and any combination thereof.
21. The meat alternative formulation of any one of claims 18-20, wherein the fat is present at 1 wt% to 30 wt%, optionally wherein the fat is 12 wt% to 17 wt% of the meat alternative formulation.
22. The meat alternative formulation of any one of claims 1-21, further comprising a binder, optionally wherein the binder is present at 0.25 wt% to 1.5 wt%.
23. The meat alternative formulation of claim 22, wherein the binder is selected from the group consisting of starch, gum, methyl cellulose, lecithin, and any combination thereof.
24. The meat alternative formulation of any one of claims 1-23, further comprising water at 30 wt% to 60 wt%.
25. The meat alternative formulation of any one of claims 1-24, further comprising a polyunsaturated fatty acid.
26. The meat alternative formulation of any one of claims 1-25, wherein the formulation does not comprise an ingredient isolated from an animal, an animal tissue, or an animal cell.
27. The meat alternative formulation of any one of claims 1-26, wherein the formulation has: (a) a viscosity of at least about 1000 cP prior to cooking; (b) a hardness of at least about 8000 g subsequent to cooking, as determined by

texture profile analysis; (c) an elasticity of at least about 0.8 cm subsequent to cooking; and/or (d) a cohesion of at least about 0.7% subsequent to cooking.

28. The meat alternative formulation of any one of claims 1-27, wherein the formulation is homogenous.

29. The meat alternative formulation of any one of claims 1-28, wherein the formulation is a gel, a paste, or an emulsion.

30. A meat alternative formulation comprising:

- (a) a heme protein;
- (b) a plant-based protein;
- (c) a plant-based fiber;
- (d) a fat; and
- (e) water;

wherein the formulation does not include free amino acids selected from the group consisting of cysteine, cystine, selenocysteine, and methionine.

31. The meat alternative formulation of claim 30, further comprising: a plant-based connective tissue (PBCT) analog.

32. The meat alternative formulation of claim 30, wherein the plant-based protein comprises a first plant-based protein and a second plant-based protein, wherein the first plant-based protein and second plant-based protein are from different plants.

33. The meat alternative formulation of any one of claims 31-32, wherein (a) the first plant-based protein is present at 0.5 wt% to 25 wt% (b) the second plant-based protein is present at 0.5 wt% to 1.5 wt%, and/or (c) the PBCT analog is present at about 1 wt%.

34. The meat alternative formulation of claim 33, wherein the PBCT analog comprises a cartilage analog, a perimysium analog, a tendon analog, or any combination thereof.
35. The meat alternative formulation of any one of claims 30-34, wherein the water is present at 40 wt% to 60 wt%.
36. The meat alternative formulation of any one of claims 30-35, further comprising a binder, a fat, a mineral, a polyunsaturated fatty acid (PUFA), or a combination thereof.
37. The meat alternative formulation of any one of claims 30-36, wherein the formulation is a meat alternative nugget formulation, a meat alternative sausage formulation, or a meat alternative burger formulation.
38. The meat alternative nugget formulation of claim 37 comprising: (a) about 0.38 wt% PBCT, wherein the PBCT comprises about 0.08 wt% of a perimysium analog and about 0.3 wt% of a tendon analog; or (b) about 1.5 wt% PBCT, wherein the PBCT comprises about 0.3 wt% of a cartilage analog, about 0.6 wt% of a perimysium analog, and about 0.6 wt% of a tendon analog.
39. The meat alternative nugget formulation of any one of claims 37-38, wherein: (a) the plant-based fiber is present between 20 wt% and 60 wt%; (b) the plant-based protein present is between 3 wt% and 12 wt%; and (c) the fat is present between 0.5 wt% and 4.5 wt%.
40. The meat alternative nugget formulation of any one of claims 37-39, wherein at least a portion of the PBCT is desiccated and optionally rehydrated prior to addition to the meat alternative nugget formulation.
41. The meat alternative sausage formulation of claim 37, wherein: (a) the plant-based protein is present at 12 wt% to 30 wt%; (b) the fat is present at 7 wt% to 22 wt%; and/or (c) water is present at 35 wt% to 60 wt% water.

42. The meat alternative sausage formulation of claim 41, wherein the fat has a melting point above about 20°C.
43. The meat alternative sausage formulation of any one of claims 41-42, comprising at least two different fats.
44. The meat alternative sausage formulation of any one of claims 37, or 41-42, wherein the formulation does not comprise a plant-based fiber.
45. The meat alternative sausage formulation of claim 37, or 41-42, comprising about 1.5 wt% PBCT, wherein the PBCT comprises about 0.25 wt% of a cartilage analog, about 0.25 wt% of a perimysium analog, and about 1 wt% of a tendon analog.
46. A method of producing a meat alternative formulation, the method comprising:
- (a) combining a plant-based connective tissue analog, a plant-based fiber, a plant-based protein, or any combination thereof, with water to form a hydrated composition;
 - (b) combining a plant-based connective tissue analog, a plant-based protein, a plant-based fiber, a fat, a mineral, water, or any combination thereof, with a heme protein to form a heme protein composition, wherein the heme protein comprises a bovine myoglobin; and
 - (c) combining the hydrated composition and the heme protein composition;
- wherein the method does not include adding free amino acids selected from the group consisting of cysteine, cystine, selenocysteine, and methionine.
47. The method of claim 46, wherein the method further does not include adding free sugars.
48. The method of claim 46 or 47, wherein 25% to 75% of the mass the hydrated composition comprises water.
49. The method of any one of claims 46-48, wherein (b) comprises solubilizing the heme protein.

50. The method of any one of claims 46-49, wherein (b) comprises forming a gel from the fat and the plant-based connective tissue analog prior to the combining with the heme protein.
51. The method of any one of claims 46-50, wherein (c) further comprises adding a second fat.
52. The meat alternative burger formulation of claim 37, comprising:
- (a) 0.5 wt%-2 wt% bovine myoglobin;
 - (b) 0.5 wt%-40 wt% plant-based protein;
 - (c) 10 wt%-20 wt% plant-based fat; and
 - (d) 1 wt%-3 wt% plant-based connective tissue analog (PBCT);
- wherein the formulation does not include free amino acids selected from the group consisting of cysteine, cystine, selenocysteine, and methionine.
53. The meat alternative burger formulation of claim 52, wherein the plant-based protein is textured soy protein, optionally wherein the textured soy protein is minced.
54. The meat alternative burger formulation of any one of claims 37, or 52-53, comprising:
- (a) 1 wt% bovine myoglobin;
 - (b) 19.5 wt% textured soy protein;
 - (c) 8 wt% high oleic sunflower oil;
 - (d) 7 wt% coconut oil;
 - (e) 0.5 wt% cartilage analog;
 - (f) 0.3 wt% perimysium analog; and
 - (g) 0.2 wt% tendon analog.