

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 OF THE INVENTION

[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~~bovine myoglobin~~ 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 ~~or claim 2~~, 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 about 0.5 wt% to about 40 wt% of the meat alternative formulation.
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 ~~comprises~~ 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/or any combination thereof.
14. The meat alternative formulation of claim 13, wherein the hydrocolloid is selected from the group consisting of ~~comprises~~ konjac flour, methyl cellulose, gum Arabic, carrageenan, and/or any combination thereof.
- ~~15. The alternative formulation of any one of claims 12-14, wherein the hydrocolloid is about 1 wt% to about 5 wt% of the meat alternative formulation.~~
- ~~16-15.~~ 15. The meat alternative formulation of any one of claims 1-1~~3~~5, further comprising a plant-based fiber, optionally wherein the plant-based fiber is present at at least 5 wt%.
- ~~17-16.~~ 16. The meat alternative formulation of claim 1~~5~~6, wherein the plant-based fiber is selected from the group consisting of ~~comprises~~ 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/or any combination thereof.
- ~~18-17.~~ 17. The meat alternative formulation of claim 1~~6~~7, wherein the plant-based fiber is selected from the group consisting of ~~comprises~~ inulin, gum Arabic, citrus fiber, maltodextrin, and/or any combination thereof.

~~19. The meat alternative formulation of any one of claims 16-18, wherein the plant-based fiber is at least 5 wt% of the meat alternative formulation.~~

~~20-18.~~ The meat alternative formulation of any one of claims 1-17~~9~~, further comprising a fat.

~~21. The meat alternative formulation of claim 20, wherein the fat is isolated from a plant.~~

~~22-19.~~ The meat alternative formulation of claim ~~18~~~~20~~ or ~~21~~, 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.

~~23-20.~~ The meat alternative formulation of claim ~~19~~~~22~~, wherein the fat ~~is~~ ~~comprises~~ sunflower oil, coconut oil, ~~and/or~~ ~~any~~ combination thereof.

~~24-21.~~ The meat alternative formulation of any one of claims ~~18-20-23~~, wherein the fat is ~~present at about~~ 1 wt% to ~~about~~ 30 wt%, ~~optionally wherein the fat is 12 wt% to 17 wt% of the meat alternative formulation.~~ ~~of the meat alternative formulation~~

~~25-22.~~ The meat alternative formulation of any one of claims 1-21~~4~~, further comprising a binder, ~~optionally wherein the binder is present at 0.25 wt% to 1.5 wt%.~~

~~26-23.~~ The meat alternative formulation of claim ~~22~~~~5~~, wherein the binder ~~is~~ ~~selected from the group consisting of~~ ~~comprises~~ starch, gum, methyl cellulose, lecithin, ~~and/or~~ any combination thereof.

- ~~27. The meat alternative formulation of claim 25 or claim 26, wherein the binder is about 0.25 wt% to about 1.5 wt% of the meat alternative formulation.~~
- ~~28-24. The meat alternative formulation of any one of claims 1-237, further wherein the meat alternative formulation comprises water at from about 30 wt% to ~~about 60 wt% water~~.~~
- ~~29-25. The meat alternative formulation of any one of claims 1-248, further comprising a polyunsaturated fatty acid.~~
- ~~30-26. The meat alternative formulation of any one of claims 1-259, wherein the ~~alternative meat~~ formulation does not comprise an ingredient isolated from an animal, an animal tissue, or an animal cell.~~
- ~~31-27. The meat alternative formulation of any one of claims 1-2630, wherein ~~prior to cooking~~ the meat alternative formulation has: (a) has 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.~~
- ~~32. The meat alternative formulation of any one of claims 1-31, wherein subsequent to cooking the meat alternative formulation has a hardness of at least 8000 g as determined by texture profile analysis.~~
- ~~33. The meat alternative formulation of any one of claims 1-32, wherein subsequent to cooking the meat alternative formulation has an elasticity of at least 0.8 cm.~~
- ~~34. The meat alternative formulation of any one of claims 1-33, wherein subsequent to cooking the meat alternative formulation has a cohesion of at least 0.7%.~~
- ~~35-28. The meat alternative formulation of any one of claims 1-2734, wherein the ~~meat alternative~~ formulation is homogenous.~~
- ~~36-29. The meat alternative formulation of any one of claims 1-2835, wherein the ~~meat alternative~~ formulation is comprises a gel, a paste, or an emulsion.~~
- ~~37-30. 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 ~~meat alternative~~ formulation does not include free amino acids selected from the group consisting of cysteine, cystine, selenocysteine, and methionine.

38.31. The meat alternative formulation of claim 30, further ~~A meat alternative formulation~~ comprising:

- ~~(a) a heme protein;~~
- ~~(b) a plant-based protein;~~
- ~~(c) a plant-based fiber;~~
- a plant-based connective tissue (PBCT) analog;
- ~~a fat; and~~
- ~~(d) water;~~

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

39.32. The A 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, comprising:

- ~~(a) a heme protein;~~
- ~~(b) a first plant-based protein;~~
- ~~a second plant-based protein, wherein the first plant-based protein and second plant-based proteins are from different plants;~~
- ~~(c) a plant-based connective tissue analog;~~
- ~~(d) a plant-based fiber;~~
- ~~(e) a fat;~~

~~(f) a binder; and~~

~~(g) water;~~

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

~~40. The meat alternative formulation of any one of claims 37-39, wherein the meat alternative formulation further does not include free sugars in an amount exceeding 1.5 wt%.~~

~~41. The meat alternative formulation of any one of claims 37-40, wherein the meat alternative formulation further does not include free sugars in an amount exceeding 0.2 wt%.~~

~~42. The meat alternative formulation of any one of claims 37-41, wherein the heme protein is a bovine myoglobin.~~

~~43. The meat alternative formulation of any one of claims 37-42, wherein the heme protein is about 0.2 wt% to about 2 wt% of the meat alternative formulation.~~

~~44.33. ____ The meat alternative formulation of any one of claims 317-3243, wherein (a) the first plant-based protein is present at about 0.5 wt% to about 25 wt% of the total weight of the meat alternative formulation (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%.~~

~~45. The meat alternative formulation of any one of claims 39-44, wherein the second plant-based protein is about 0.5 wt% to about 1.5 wt% of the meat alternative formulation.~~

~~46. The meat alternative formulation of any one of claims 38-45, wherein the plant-based connective tissue analog is about 1 wt% of the meat alternative formulation.~~

~~47.34.~~ The meat alternative formulation of claim 3346, wherein the PBCT analog comprises about 0.50 wt% of the formulation is a cartilage analog, about 0.3 wt% is a perimysium analog, and about 0.2 wt% is a tendon analog, or any combination thereof.

~~48. The meat alternative formulation of any one of claims 39-47, wherein the binder is about 0.3 wt% to about 0.7 wt% of the meat alternative formulation.~~

~~49. The meat alternative formulation of any one of claims 37-48, wherein the fat is about 12 wt% to about 17 wt% of the meat alternative formulation.~~

~~50.35.~~ The meat alternative formulation of any one of claims 307-3449, wherein the water is present at about 40 wt% to about 60 wt% of the meat alternative formulation.

~~51.36.~~ The meat alternative formulation of any one of claims 307-3550, further comprising a binder, a fat, a mineral, a polyunsaturated fatty acid (PUFA), or a combination thereof.

~~52.37.~~ The A 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, comprising:
a plant-based fiber;
 a plant-based protein;
 a fat; and
 a heme protein;
wherein the meat alternative nugget formulation does not include free amino acids selected from the group consisting of cysteine, cystine, selenocysteine, and methionine.

~~53. The meat alternative nugget formulation of claim 52, wherein the meat alternative nugget formulation further does not include free sugars in an amount exceeding 1.5 wt%.~~

~~54. The meat alternative nugget formulation of either claim 52 or 53, further comprising about 0.3 to about 1.5 wt% of a plant-based connective tissue analog (PBCT).~~

~~55.38.~~ The meat alternative nugget formulation of claim ~~37~~54 comprising: (a) about 0.38 wt% PBCT, wherein the PBCT comprises about 0.08 wt% of the formulation is a perimysium analog and about 0.3 wt% of is 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.

~~56. The meat alternative nugget formulation of claim 54, comprising 1.5 wt% PBCT, wherein about 0.3 wt% of the formulation is a cartilage analog, about 0.6 wt% is a perimysium analog, and about 0.6 wt% is a tendon analog.~~

~~57.39.~~ The meat alternative nugget formulation of any one of claims ~~37-38~~52-56, wherein: (a) the plant-based fiber is present between about 20 wt% and about 60 wt% of the meat alternative nugget formulation; (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%.

~~58. The meat alternative nugget formulation of any one of claims 52-57, wherein the plant-based protein is between about 3 wt% and 12 wt% of the meat alternative nugget formulation.~~

~~59. The meat alternative nugget formulation of any one of claims 52-58, wherein the fat is between about 0.5 wt% and 4.5 wt% of the meat alternative nugget formulation.~~

~~60.40.~~ The meat alternative nugget formulation of any one of claims ~~37-39~~54-59, wherein at least a portion of the PBCT is desiccated and optionally rehydrated prior to addition to the meat alternative nugget formulation.

~~61. A meat alternative sausage formulation comprising:~~

- ~~(a) a plant-based protein;~~
- ~~(b) a fat;~~
- ~~(c) a plant-based connective tissue analog; and~~
- ~~(d) a heme;~~

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

~~62. The meat alternative sausage formulation of claim 61, wherein the meat alternative formulation further does not include free sugars in an amount exceeding 1.5 wt%.~~

~~63.41. The meat alternative sausage formulation of either claim 37 or 62, wherein: (a) the plant-based protein is present at about 12 wt% to about 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 of the meat alternative sausage formulation.~~

~~64. The meat alternative sausage formulation of any one of claims 61-63, wherein the fat is about 7 wt% to about 22 wt% of the meat alternative sausage formulation.~~

~~65.42. The meat alternative sausage formulation of any one of claims 41-64, wherein the fat has a melting point above about 20°C.~~

~~66.43. The meat alternative sausage formulation of any one of claims 41-42 or 61-65, wherein the fat comprises at least two different fats.~~

~~67.44. The meat alternative sausage formulation of any one of claims 37, or 41-42 or 61-66, wherein the meat alternative sausage formulation does not comprise a plant-based fiber.~~

~~68. The meat alternative sausage formulation of any one of claims 61-67 further comprising from about 35 wt% to about 60 wt% water.~~

~~69-45.~~ 69-45. The meat alternative sausage formulation of ~~any one of claims 37, or 41-42~~~~61-68~~, comprising about 1.5 wt% PBCT, wherein the PBCT comprises about 0.25 wt% of ~~the formulation is~~ a cartilage analog, about 0.25 wt% ~~of~~ a perimysium analog, and about 1 wt% ~~of~~ a tendon analog.

~~70-46.~~ 70-46. 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.

~~71-47.~~ 71-47. The method of claim ~~46~~~~70~~, wherein the method further does not include adding free sugars.

~~72-48.~~ 72-48. The method of claim ~~46 or 47~~~~70 or 71~~, wherein 25% to 75% of the mass the hydrated composition comprises water ~~comprises between about 25% and about 75% of the mass of the hydrated composition.~~

~~73-49.~~ 73-49. The method of any one of claims ~~46-48~~~~70-72~~, wherein (b) comprises solubilizing the heme protein.

~~74-50.~~ 74-50. The method of any one of claims ~~46-49~~~~70-73~~, wherein (b) comprises forming a gel from the fat and the plant-based connective tissue analog prior to the combining with the heme protein.

~~75-51.~~ 75-51. The method of any one of claims ~~46-50~~~~70-74~~, wherein (c) further comprises adding a second fat.

~~76. A meat alternative formulation comprising a bovine myoglobin, at least one plant-based protein, a plant-based connective tissue analog, and at least one fat; wherein the meat alternative formulation does not include free amino acids selected from the group consisting of cysteine, cystine, selenocysteine, and methionine.~~

~~77. The meat alternative formulation of claim 76, wherein the meat alternative formulation further does not include free sugars in an amount exceeding 1.5 wt%.~~

~~78. The meat alternative formulation of either claim 76 or 77, wherein the meat alternative formulation further does not include free sugars in an amount exceeding 0.2 wt%.~~

~~79.52.~~ The A 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 meat alternative burger formulation does not include free amino acids selected from the group consisting of cysteine, cystine, selenocysteine, and methionine.

~~80.53.~~ The meat alternative burger formulation of claim ~~52~~79, wherein the plant-based protein is textured soy protein, optionally wherein the textured soy protein is minced.

~~81. The meat alternative burger formulation of claim 80, wherein the textured soy protein is minced.~~

~~82. The meat alternative burger formulation of any one of claims 79-81, wherein the plant-based protein is 19.5 wt% of the formulation.~~

~~83. The meat alternative burger formulation of any one of claims 79-82, wherein the plant-based fat comprises high oleic sunflower oil and coconut oil.~~

~~84. The meat alternative burger formulation of claim 83, wherein the high oleic sunflower oil is 8 wt% of the formulation and the coconut oil is 7 wt% of the formulation.~~

~~85. The meat alternative burger formulation of any one of claims 79-84, wherein the PBCT comprises one or more of a cartilage analog, a perimysium analog, and a tendon analog, and wherein the formulation comprises 0-1.5 wt% cartilage analog, 0-1 wt% perimysium analog, and 0-3 wt% tendon analog.~~

~~86. The meat alternative burger formulation of claim 85, comprising 0.5 wt% cartilage analog, 0.3 wt% perimysium analog, and 0.2 wt% tendon analog.~~

~~87. The meat alternative burger formulation of claim 85 or 86, wherein the PBCT is hydrated with twice as much water as PBCT, as measured by wt% of the formulation.~~

~~88. The meat alternative burger formulation of any one of claims 79-87, comprising ≤ 1.5 wt% free sugars.~~

~~89.~~54. The meat alternative burger formulation of any one of claims 37, or 52-53~~79-88~~, 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.