In a **first aspect**, the present disclosure refers to a protein composition comprising: at least 50% by dry weight of a plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof, wherein the protein composition is a low color protein composition or wherein the protein composition comprises less than 1.0% by dry weight of lipids.

In a **second aspect**, the present disclosure refers to a protein composition produced by a method comprising:

(a) adding an aqueous solution to a source protein composition to form a solution of solubilized protein;

(b) optionally removing solids from the solution of solubilized protein;

(c) optionally heating the solution of solubilized protein;

(d) optionally adjusting the pH of the solution of solubilized protein to about 4.0 to about 9.0;

(e) optionally cooling the solution of solubilized protein to about 0 °C to about 10 °C;

(f) adding an organic solvent to the solution of solubilized protein to form a solid phase and a liquid phase;

(g) separating the solid phase from the liquid phase to form the protein composition;

(h) optionally washing the protein composition with a wash solvent; and

(i) optionally treating the protein composition,

wherein the protein composition comprises at least at least 50% by dry weight of a plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof.

In a **third aspect**, the present disclosure refers to a food product comprising the protein composition of the first or second aspect.

In a **fourth aspect**, the present disclosure refers to a method for producing a protein composition, the method comprising:

(a) adding an aqueous solution to a source protein composition to form a solution of solubilized protein;

(b) optionally removing solids from the solution of solubilized protein;

(c) optionally heating the solution of solubilized protein;

(d) optionally adjusting the pH of the solution of solubilized protein to about 4.0 to about 9.0;

(e) optionally cooling the solution of solubilized protein to about 0 °C to about 10 °C;

(f) adding an organic solvent to the solution of solubilized protein to form a solid phase and a liquid phase;

(g) separating the solid phase from the liquid phase to form the protein composition;

(h) optionally washing the protein composition with a wash solvent; and

(i) optionally resolubilizing the protein composition,

wherein the protein composition comprises at least at least 50% by dry weight of a plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins.

In a **fifth aspect**, the present disclosure refers to a food product comprising a protein composition produced by the method of the fourth aspect.

In a **sixth aspect**, the present disclosure refers to a method of extracting small molecules from a protein source composition, the method comprising:

(a) adding an aqueous solution to a source protein composition to form a solution of solubilized protein;

(b) optionally removing solids from the solution of solubilized protein;

(c) optionally heating the solution of solubilized protein;

(d) optionally adjusting the pH of the solution of solubilized protein to about 4.0 to about 9.0;

(e) optionally cooling the solution of solubilized protein to about 0 °C to about 10 °C;

(f) adding an organic solvent to the solution of solubilized protein to form a solid phase and a liquid phase;

(g) separating the solid phase from the liquid phase to form a solution enriched in small molecules.

In a **seventh aspect**, the present disclosure refers to a food product comprising:

a fat;

optionally one or more flavor precursor compounds; and

at least 10% by dry weight of a protein composition, wherein the protein composition is the protein composition of the first or second aspect.

In an **eighth aspect**, the present disclosure refers to a food product comprising:

a fat;

optionally one or more flavor precursor compounds; and

at least 10% by dry weight of a protein composition, wherein the protein composition is a protein composition produced by the method of the fourth aspect.

In a **ninth aspect**, the present disclosure refers to a method for preparing a food product, the method comprising:

combining a fat, one or more optional flavor precursor compounds, and a protein composition, wherein the protein composition is the protein composition of the first or second aspect.

In a **tenth aspect**, the present disclosure refers to a method for preparing a food product, the method comprising:

combining a fat, one or more optional flavor precursor compounds, and a protein composition, the protein composition produced by the method by the method of the fourth aspect.

In an **eleventh aspect**, the present disclosure refers to a method for reducing perceived protein source flavor in a food product, the method comprising:

combining a fat, one or more flavor precursor compounds and a protein composition, the protein composition produced by the method of the fourth aspect,

wherein at least 5% by weight of the protein content of the food product comprises the protein composition, thereby reducing perceived protein source flavor in a food product, as compared to a food product having a similar protein content but lacking the protein composition.

In a **twelfth aspect**, the present disclosure refers to a method of evaluating a protein composition for effect on flavor in a food product, the method comprising:

determining that a level of one or more volatile compounds in a set of volatile compounds of a first protein composition from a protein source is higher than the level of the one or more volatile compounds of a second protein composition from the protein source; and

determining that the second protein composition is superior to the first protein composition for use in a food product.

In a **thirteenth aspect**, the present disclosure refers to a method of evaluating a protein composition for effect on flavor in a food product, the method comprising:

determining that a level of one or more volatile compounds in a set of volatile compounds of a source protein composition from a protein source is higher than the level of the one or more volatile compounds of a protein composition from the protein source; and

determining that the protein composition is superior to the source protein composition for use in a food product.

In a **fourteenth aspect**, the present disclosure refers to a method of reducing flavor in a protein composition, the method comprising:

(a) determining a level of one or more volatile compounds in a set of volatile compounds of a first protein composition from a protein source;

(b) preparing a second protein composition from the protein source, wherein preparing the second protein composition comprises reducing the amount of one or more components of the protein source that are included in the second protein composition; and

(c) determining that a level of one or more volatile compounds in a set of volatile compounds from the second protein composition is lower than the level of the one or more volatile compounds in a set of volatile compounds in the first protein composition.

In a **fifteenth aspect**, the present disclosure refers to a method of determining a cause of flavor in a protein composition, the method comprising:

(a) determining a level of one or more volatile compounds in a set of volatile compounds of a first protein composition from a protein source;

(b) providing a second protein composition from the protein source, wherein the second protein composition comprises a decreased amount of one or more components of the protein source;

(c) determining that a level of one or more volatile compounds in a set of volatile compounds from the second protein composition is lower than the level the of one or more volatile compounds in a set of volatile compounds in the first protein composition; and

(d) identifying the one or more components of the protein course to be a cause of flavor in the protein composition.

In a **sixteenth aspect**, the present disclosure refers to a milk replica comprising:

an emulsion of a fat, water, and the protein composition of the first or second aspect.

In one ~~aspect~~example, low flavor protein compositions are provided. Such low flavor protein compositions generally include at least 50% by dry weight of a plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate

proteins, or a combination thereof; wherein the plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or combination thereof are substantially aggregated, denatured, or both.

In some ~~embodiment~~examples, the low flavor protein composition has a luminance of at least 86 on a scale from 0 (black control value) to 100 (white control value). In some ~~embodiment~~examples, the low flavor protein composition has a luminance of at least 88 on a scale from 0 (black control value) to 100 (white control value). In some ~~embodiment~~examples, the low flavor protein composition has a luminance of at least 90 on a scale from 0 (black control value) to 100 (white control value).

In some ~~embodiment~~examples, the low flavor protein composition has a chroma value of less than 14. In some ~~embodiment~~examples, the low flavor protein composition has a chroma value of less than 12. In some ~~embodiment~~examples, the low flavor protein composition has a chroma value of less than 10. In some ~~embodiment~~examples, the low flavor protein composition has a chroma value of less than 8. In some ~~embodiment~~examples, the low flavor protein composition has a chroma value of less than 6.

In some ~~embodiment~~examples, the low flavor protein composition comprises less than about 1.2% by dry weight lipids (e.g., less than about 1.0% or less than about 0.5% by dry weight lipids).

In some ~~embodiment~~examples, the lipids comprise one or more of a fatty acid, a wax, a sterol, a monoglyceride, a diglyceride, a triglyceride, a sphingolipid, or a phospholipid.

In some ~~embodiment~~examples, the plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof is at least 90% by dry weight soy proteins.

In some ~~embodiment~~examples, a low flavor protein composition further includes at least one of a preservative, an antioxidant, or a shelf life extender.

In some ~~embodiment~~examples, the preservative, antioxidant, or shelf life extender comprises at least one of 4-hexylresorcinol, acetic acid, ascorbic acid, ascorbyl palmitate, ascorbyl stearate, benzoic acid, butylated hydroxyanisole (a mixture of 2-tertiarybutyl-4-hydroxyanisole and 3-

tertiarybutyl-4-hydroxyanisole), butylated hydroxytoluene (3,5-ditertiarybutyl-4-hydroxytoluene), calcium ascorbate, calcium propionate, calcium sorbate, *Carnobacterium divergens* M35, *Carnobacterium maltaromaticum* cb1, *carnosum* 4010, citric acid, a citric acid ester of a monoglyceride or diglyceride, dimethyl dicarbonate, erythorbic acid, ethyl lauroyl arginate, gum guaiacum, iso-ascorbic acid, L-cysteine, L-cysteine hydrochloride, lecithin, lecithin citrate, *Leuconostoc*, methyl paraben, methyl-*p*-hydroxybenzoate, monoglyceride citrate, monoisopropyl citrate, natamycin, nisin, potassium acetate, potassium benzoate, potassium bisulfite, potassium diacetate, potassium lactate, potassium metabisulfite, potassium nitrate, potassium nitrite, potassium sorbate, propionic acid, propyl gallate, propyl paraben, propyl-*p*-hydroxy benzoate, sodium acetate, sodium ascorbate, sodium benzoate, sodium bisulfite, sodium diacetate, sodium dithionite, sodium erythorbate, sodium iso-ascorbate, sodium lactate, sodium metabisulfite, sodium nitrate, sodium nitrite, sodium propionate, sodium salt of methyl-*p*-hydroxy benzoic acid, sodium salt of propyl-*p*-hydroxy benzoic acid, sodium sorbate, sodium sulfite, sorbic acid, sulfurous acid, tartaric acid, tertiary butyl hydroquinone, or a tocopherol.

In some ~~embodiment~~examples, the low flavor protein composition is in the form of a solution, suspension, or emulsion. In some ~~embodiment~~examples, the low flavor protein composition is in the form of a solid or a powder.

In some ~~embodiment~~examples, the low flavor protein composition has an average particle size of about 5 µm to about 40 µm in the largest dimension. In some ~~embodiment~~examples, the low flavor protein composition has an average particle size of about 10 µm to about 40 µm in the largest dimension. In some ~~embodiment~~examples, the low flavor protein composition has an average particle size of about 10 µm to about 30 µm in the largest dimension. In some ~~embodiment~~examples, the low flavor protein composition has an average particle size of about 10 µm to about 20 µm in the largest dimension.

In some ~~embodiment~~examples, the low flavor protein composition is in the form of an extrudate. In some ~~embodiment~~examples, an extrudate is substantially in the form of granules.

In some ~~embodiment~~examples, the granules have an average largest dimension of about 3 mm to about 5 mm. In some ~~embodiment~~examples, less than about 20% (w/w) of the granules have a largest dimension less than 1 mm. In some ~~embodiment~~examples, less than about 5% (w/w) of the granules have a largest dimension over 1 cm.

In some ~~embodiment~~examples, the extrudate has a bulk density of about 0.25 to about 0.4 g/cm^3. In some ~~embodiment~~examples, the extrudate has a moisture content of about 5% to about 10%. In some ~~embodiment~~examples, the extrudate has a protein content of about 65% to about 100% by dry weight. In some ~~embodiment~~examples, the extrudate has a fat content of less than about 1.0%. In some ~~embodiment~~examples, the extrudate has a sugar content of less than about 1%.

In some ~~embodiment~~examples, the extrudate has a hydration ratio of about 2.5 to about 3 after about 60 minutes of hydration at room temperature. In some ~~embodiment~~examples, the extrudate has a hydration time of less than about 30 minutes. In some ~~embodiment~~examples, the extrudate has a pH of about 5.0 to about 7.5 when hydrated.

In some ~~embodiment~~examples, the extrudate has a bite strength of about 2000 g to about 4000 g at a hydration ratio of about 3.

In some ~~embodiment~~examples, the low flavor protein composition has a protein dispersibility index of at least about 5 (e.g., at least about 10 or at least about 15). In some ~~embodiment~~examples, the low flavor protein composition has a sodium level up to about 1 %w/w (e.g., up to about 0.5, up to about 0.1, up to about 0.05, up to about 0.01, or up to about 0.005 %w/w).

In some ~~embodiment~~examples, the low flavor protein composition has a solubility of at least 5% (e.g., at least 10%, at least 15%, at least 20%, at least 25%, or at least 30%) in an aqueous solution (e.g., water). In some ~~embodiment~~examples, the aqueous solution has a pH of about 6.0 to about 8.0, of about 6.5 to about 7.5, of about 7.0 to about 8.0, of about 7.0, or of about 8.0. In some ~~embodiment~~examples, the aqueous solution can include a buffer.

In some ~~embodiment~~examples, the low flavor protein composition exhibits a temperature-dependent change in one or more mechanical properties (e.g., storage modulus, loss modulus, and/or viscosity) over a temperature range (e.g., heating from 25 °C to 95 °C, heating from 40 °C to 95 °C, heating from 60 °C to 95 °C, or heating from 80 °C to 90 °C). In some ~~embodiment~~examples, the temperature-dependent change is at least 5-fold (e.g., at least 10-fold, at least 100-fold, at least 500-fold, or at least 1,000-fold) in magnitude. In some ~~embodiment~~examples, the temperature-dependent change is substantially irreversible (e.g., upon cooling over the same temperature range, the magnitude of the change is up to 25%, up to 20%, up to 15%, up to 10%, up to 5%, up to 1%, up to 0.5%, or up to 0.1% the magnitude of the change observed upon heating). In some ~~embodiment~~examples, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at

least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 90 °C. In some ~~embodiment~~examples, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 95 °C. In some ~~embodiment~~examples, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 90 °C. In some ~~embodiment~~examples, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 95 °C.

In some ~~embodiment~~examples, the low flavor protein composition is a protein concentrate. In some ~~embodiment~~examples, the low flavor protein composition is a protein isolate.

Also provided are a food product comprising any low flavor protein composition as described herein.

In another ~~aspect~~example, low color protein compositions are provided. Such low color protein compositions generally include at least 50% by dry weight of a plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof; wherein the plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or combination thereof are substantially aggregated, denatured, or both, and wherein the low color protein composition has a luminance of least 86 on a scale from 0 (black control value) to 100 (white control value), a chroma value of less than 14, or both.

In some ~~embodiment~~examples, the low color protein composition has a luminance of at least 88 on a scale from 0 (black control value) to 100 (white control value). In some ~~embodiment~~examples, the low color protein composition has a luminance of at least 90 on a scale from 0 (black control value) to 100 (white control value).

In some ~~embodiment~~examples, the low color protein composition has a chroma value of less than 14. In some ~~embodiment~~examples, the low color protein composition has a chroma value of less than 12.

In some ~~embodiment~~examples, the low color protein composition has a chroma value of less than 10. In some ~~embodiment~~examples, the low color protein composition has a chroma value of less than 8. In some ~~embodiment~~examples, the low color protein composition has a chroma value of less than 6.

In some ~~embodiment~~examples, the low color protein composition comprises less than about 1.2% by dry weight lipids (e.g., less than about 1.0% or less than about 0.5% by dry weight lipids).

In some ~~embodiment~~examples, the lipids comprise one or more of a fatty acid, a wax, a sterol, a monoglyceride, a diglyceride, a triglyceride, a sphingolipid or a phospholipid.

In some ~~embodiment~~examples, the plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof is at least 90% by dry weight soy proteins.

In some ~~embodiment~~examples, the low color protein composition further includes at least one of a preservative, an antioxidant, or a shelf life extender.

In some ~~embodiment~~examples, the preservative, antioxidant, or shelf life extender comprises at least one of 4-hexylresorcinol, acetic acid, ascorbic acid, ascorbyl palmitate, ascorbyl stearate, benzoic acid, butylated hydroxyanisole (a mixture of 2-tertiarybutyl-4-hydroxyanisole and 3-tertiarybutyl-4-hydroxyanisole), butylated hydroxytoluene (3,5-ditertiarybutyl-4-hydroxytoluene), calcium ascorbate, calcium propionate, calcium sorbate, *Carnobacterium divergens* M35, *Carnobacterium maltaromaticum* cb1, *carnosum* 4010, citric acid, a citric acid ester of a monoglyceride or diglyceride, dimethyl dicarbonate, erythorbic acid, ethyl lauroyl arginate, gum guaiacum, iso-ascorbic acid, L-cysteine, L-cysteine hydrochloride, lecithin, lecithin citrate, *Leuconostoc*, methyl paraben, methyl-*p*-hydroxybenzoate, monoglyceride citrate, monoisopropyl citrate, natamycin, nisin, potassium acetate, potassium benzoate, potassium bisulfite, potassium diacetate, potassium lactate, potassium metabisulfite, potassium nitrate, potassium nitrite, potassium sorbate, propionic acid, propyl gallate, propyl paraben, propyl-*p*-hydroxy benzoate, sodium acetate, sodium ascorbate, sodium benzoate, sodium bisulfite, sodium diacetate, sodium dithionite, sodium erythorbate, sodium iso-ascorbate, sodium lactate, sodium metabisulfite, sodium nitrate, sodium nitrite, sodium propionate, sodium salt of methyl-*p*-hydroxy benzoic acid, sodium salt of propyl-*p*-hydroxy benzoic acid, sodium sorbate, sodium sulfite, sorbic acid, sulfurous acid, tartaric acid, tertiary butyl hydroquinone, or a tocopherol.

In some ~~embodiment~~examples, the low color protein composition is in the form of a solution, suspension, or emulsion. In some ~~embodiment~~examples, the low color protein composition is in the form of a solid or a powder.

In some ~~embodiment~~examples, the low color protein composition has an average particle size of about 5 µm to about 40 µm in the largest dimension. In some ~~embodiment~~examples, the low color protein composition has an average particle size of about 10 µm to about 40 µm in the largest dimension. In some ~~embodiment~~examples, the low color protein composition has an average particle size of about 10 µm to about 30 µm in the largest dimension. In some ~~embodiment~~examples, the low color protein composition has an average particle size of about 10 µm to about 20 µm in the largest dimension.

In some ~~embodiment~~examples, the low color protein composition is in the form of an extrudate. In some ~~embodiment~~examples, an extrudate is substantially in the form of granules.

In some ~~embodiment~~examples, the granules have an average largest dimension of about 3 mm to about 5 mm. In some ~~embodiment~~examples, less than about 20% (w/w) of the granules have a largest dimension less than 1 mm. In some ~~embodiment~~examples, less than about 5% (w/w) of the granules have a largest dimension over 1 cm.

In some ~~embodiment~~examples, the extrudate has a bulk density of about 0.25 to about 0.4 g/cm^3. In some ~~embodiment~~examples, the extrudate has a moisture content of about 5% to about 10%. In some ~~embodiment~~examples, the extrudate has a protein content of about 65% to about 100% by dry weight. In some ~~embodiment~~examples, the extrudate has a fat content of less than about 1.0%. In some ~~embodiment~~examples, the extrudate has a sugar content of less than about 1%.

In some ~~embodiment~~examples, the extrudate has a hydration ratio of about 2.5 to about 3 after about 60 minutes of hydration at room temperature. In some ~~embodiment~~examples, the extrudate has a hydration time of less than about 30 minutes. In some ~~embodiment~~examples, the extrudate has a pH of about 5.0 to about 7.5 when hydrated.

In some ~~embodiment~~examples, the extrudate has a bite strength of about 2000 g to about 4000 g at a hydration ratio of about 3.

In some ~~embodiment~~examples, the low color protein composition has a protein dispersibility index of at least about 5 (e.g., at least about 10 or at least about 15). In some ~~embodiment~~examples, the

low color protein composition has a sodium level up to about 1 %w/w (e.g., up to about 0.5, up to about 0.1, up to about 0.05, up to about 0.01, or up to about 0.005 %w/w).

In some ~~embodiment~~examples, the low color protein composition has a solubility of at least 5% (e.g., at least 10%, at least 15%, at least 20%, at least 25%, or at least 30%) in an aqueous solution (e.g., water). In some ~~embodiment~~examples, the aqueous solution has a pH of about 6.0 to about 8.0, of about 6.5 to about 7.5, of about 7.0 to about 8.0, of about 7.0, or of about 8.0. In some ~~embodiment~~examples, the aqueous solution can include a buffer.

In some ~~embodiment~~examples, the low color protein composition exhibits a temperature-dependent change in one or more mechanical properties (e.g., storage modulus, loss modulus, and/or viscosity) over a temperature range (e.g., heating from 25 °C to 95 °C, heating from 40 °C to 95 °C, heating from 60 °C to 95 °C, or heating from 80 °C to 90 °C). In some ~~embodiment~~examples, the temperature-dependent change is at least 5-fold (e.g., at least 10-fold, at least 100-fold, at least 500-fold, or at least 1,000-fold) in magnitude. In some ~~embodiment~~examples, the temperature-dependent change is substantially irreversible (e.g., upon cooling over the same temperature range, the magnitude of the change is up to 25%, up to 20%, up to 15%, up to 10%, up to 5%, up to 1%, up to 0.5%, or up to 0.1% the magnitude of the change observed upon heating). In some ~~embodiment~~examples, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 90 °C. In some ~~embodiment~~examples, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 95 °C. In some ~~embodiment~~examples, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 90 °C. In some ~~embodiment~~examples, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 95 °C.

In some ~~embodiment~~examples, the low color protein composition is a protein concentrate. In some ~~embodiment~~examples, the low color protein composition is a protein isolate.

Also provided are a food product comprising any low color protein composition as described herein.

In still another ~~aspect~~example, protein concentrates are provided. Such protein concentrations generally include at least 50% by dry weight of a plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof; and at least 9% by dry weight of one or more insoluble carbohydrates, wherein the plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or combination thereof are substantially aggregated, denatured, or both.

In some ~~embodiment~~examples, the protein concentrate has a luminance of at least 88 on a scale from 0 (black control value) to 100 (white control value). In some ~~embodiment~~examples, the protein concentrate has a luminance of at least 90 on a scale from 0 (black control value) to 100 (white control value).

In some ~~embodiment~~examples, the protein concentrate has a chroma value of less than 14. In some ~~embodiment~~examples, the protein concentrate has a chroma value of less than 12. In some ~~embodiment~~examples, the protein concentrate has a chroma value of less than 10. In some ~~embodiment~~examples, the protein concentrate has a chroma value of less than 8. In some ~~embodiment~~examples, the protein concentrate has a chroma value of less than 6.

In some ~~embodiment~~examples, the protein concentrate comprises less than about 1.2% by dry weight lipids (e.g., less than about 1.0% or less than about 0.5% by dry weight lipids).

In some ~~embodiment~~examples, the lipids comprise one or more of a fatty acid, a wax, a sterol, a monoglyceride, a diglyceride, a triglyceride, a sphingolipid, or a phospholipid.

In some ~~embodiment~~examples, the plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof is at least 90% by dry weight soy proteins.

In some ~~embodiment~~examples, the protein concentrate further includes at least one of a preservative, an antioxidant, or a shelf life extender.

In some ~~embodiment~~examples, the preservative, antioxidant, or shelf life extender comprises at least one of 4-hexylresorcinol, acetic acid, ascorbic acid, ascorbyl palmitate, ascorbyl stearate,

benzoic acid, butylated hydroxyanisole (a mixture of 2-tertiarybutyl-4-hydroxyanisole and 3-tertiarybutyl-4-hydroxyanisole), butylated hydroxytoluene (3,5-ditertiarybutyl-4-hydroxytoluene), calcium ascorbate, calcium propionate, calcium sorbate, *Carnobacterium divergens* M35, *Carnobacterium maltaromaticum* cb1, *carnosum* 4010, citric acid, a citric acid ester of a monoglyceride or diglyceride, dimethyl dicarbonate, erythorbic acid, ethyl lauroyl arginate, gum guaiacum, iso-ascorbic acid, L-cysteine, L-cysteine hydrochloride, lecithin, lecithin citrate, *Leuconostoc*, methyl paraben, methyl-*p*-hydroxybenzoate, monoglyceride citrate, monoisopropyl citrate, natamycin, nisin, potassium acetate, potassium benzoate, potassium bisulfite, potassium diacetate, potassium lactate, potassium metabisulfite, potassium nitrate, potassium nitrite, potassium sorbate, propionic acid, propyl gallate, propyl paraben, propyl-*p*-hydroxy benzoate, sodium acetate, sodium ascorbate, sodium benzoate, sodium bisulfite, sodium diacetate, sodium dithionite, sodium erythorbate, sodium iso-ascorbate, sodium lactate, sodium metabisulfite, sodium nitrate, sodium nitrite, sodium propionate, sodium salt of methyl-*p*-hydroxy benzoic acid, sodium salt of propyl-*p*-hydroxy benzoic acid, sodium sorbate, sodium sulfite, sorbic acid, sulfurous acid, tartaric acid, tertiary butyl hydroquinone, or a tocopherol.

In some ~~embodiment~~examples, the protein concentrate is in the form of a solution, suspension, or emulsion. In some ~~embodiment~~examples, the protein concentrate is in the form of a solid or a powder.

In some ~~embodiment~~examples, the protein concentrate has an average particle size of about 5 µm to about 40 µm in the largest dimension. In some ~~embodiment~~examples, the protein concentrate has an average particle size of about 10 µm to about 40 µm in the largest dimension. In some ~~embodiment~~examples, the protein concentrate has an average particle size of about 10 µm to about 30 µm in the largest dimension. In some ~~embodiment~~examples, the protein concentrate has an average particle size of about 10 µm to about 20 µm in the largest dimension.

In some ~~embodiment~~examples, the protein concentrate is in the form of an extrudate. In some ~~embodiment~~examples, an extrudate is substantially in the form of granules.

In some ~~embodiment~~examples, the granules have an average largest dimension of about 3 mm to about 5 mm. In some ~~embodiment~~examples, less than about 20% (w/w) of the granules have a largest dimension less than 1 mm. In some ~~embodiment~~examples, less than about 5% (w/w) of the granules have a largest dimension over 1 cm.

In some ~~embodiment~~examples, the extrudate has a bulk density of about 0.25 to about 0.4 g/cm^3. In some ~~embodiment~~examples, the extrudate has a moisture content of about 5% to about 10%. In some ~~embodiment~~examples, the extrudate has a protein content of about 65% to about 100% by dry weight. In some ~~embodiment~~examples, the extrudate has a fat content of less than about 1.0%. In some ~~embodiment~~examples, the extrudate has a sugar content of less than about 1%.

In some ~~embodiment~~examples, the extrudate has a hydration ratio of about 2.5 to about 3 after about 60 minutes of hydration at room temperature. In some ~~embodiment~~examples, the extrudate has a hydration time of less than about 30 minutes. In some ~~embodiment~~examples, the extrudate has a pH of about 5.0 to about 7.5 when hydrated.

In some ~~embodiment~~examples, the extrudate has a bite strength of about 2000 g to about 4000 g at a hydration ratio of about 3.

In some ~~embodiment~~examples, the protein concentrate has a protein dispersibility index of at least about 5 (e.g., at least about 10 or at least about 15). In some ~~embodiment~~examples, the protein concentrate has a sodium level up to about 1 %w/w (e.g., up to about 0.5, up to about 0.1, up to about 0.05, up to about 0.01, or up to about 0.005 %w/w).

In some ~~embodiment~~examples, the protein concentrate has a solubility of at least 5% (e.g., at least 10%, at least 15%, at least 20%, at least 25%, or at least 30%) in an aqueous solution (e.g., water). In some ~~embodiment~~examples, the aqueous solution has a pH of about 6.0 to about 8.0, of about 6.5 to about 7.5, of about 7.0 to about 8.0, of about 7.0, or of about 8.0. In some ~~embodiment~~examples, the aqueous solution can include a buffer.

In some ~~embodiment~~examples, the protein concentrate exhibits a temperature-dependent change in one or more mechanical properties (e.g., storage modulus, loss modulus, and/or viscosity) over a temperature range (e.g., heating from 25 °C to 95 °C, heating from 40 °C to 95 °C, heating from 60 °C to 95 °C, or heating from 80 °C to 90 °C). In some ~~embodiment~~examples, the temperature-dependent change is at least 5-fold (e.g., at least 10-fold, at least 100-fold, at least 500-fold, or at least 1,000-fold) in magnitude. In some ~~embodiment~~examples, the temperature-dependent change is substantially irreversible (e.g., upon cooling over the same temperature range, the magnitude of the change is up to 25%, up to 20%, up to 15%, up to 10%, up to 5%, up to 1%, up to 0.5%, or up to 0.1% the magnitude of the change observed upon heating). In some ~~embodiment~~examples, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at least 2,000 Pa, at

least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 90 °C. In some ~~embodiment~~examples, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 95 °C. In some ~~embodiment~~examples, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 90 °C. In some ~~embodiment~~examples, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 95 °C.

Also provided are a food product comprising any protein concentrate as described herein.

In yet another ~~aspect~~example, protein isolates are provided. Such protein isolates generally include at least 50% by dry weight of a plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof; and less than 8% by dry weight of one or more insoluble carbohydrates, wherein the plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or combination thereof are substantially aggregated, denatured, or both.

In some ~~embodiment~~examples, the protein isolate has a luminance of at least 88 on a scale from 0 (black control value) to 100 (white control value). In some ~~embodiment~~examples, the protein isolate has a luminance of at least 90 on a scale from 0 (black control value) to 100 (white control value).

In some ~~embodiment~~examples, the protein isolate has a chroma value of less than 14. In some ~~embodiment~~examples, the protein isolate has a chroma value of less than 12. In some ~~embodiment~~examples, the protein isolate has a chroma value of less than 10. In some ~~embodiment~~examples, the protein isolate has a chroma value of less than 8. In some ~~embodiment~~examples, the protein isolate has a chroma value of less than 6.

In some ~~embodiment~~examples, the protein isolate comprises less than about 1.2% by dry weight lipids (e.g., less than about 1.0% or less than about 0.5% by dry weight lipids). In some

~~embodiment~~example s, the lipids comprise one or more of a fatty acid, a wax, a sterol, a monoglyceride, a diglyceride, a triglyceride, a sphingolipid, or a phospholipid.

In some ~~embodiment~~example s, the plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof is at least 90% by dry weight soy proteins.

In some ~~embodiment~~example s, the protein isolate further includes at least one of a preservative, an antioxidant, or a shelf life extender.

In some ~~embodiment~~example s, the preservative, antioxidant, or shelf life extender comprises at least one of 4-hexylresorcinol, acetic acid, ascorbic acid, ascorbyl palmitate, ascorbyl stearate, benzoic acid, butylated hydroxyanisole (a mixture of 2-tertiarybutyl-4-hydroxyanisole and 3-tertiarybutyl-4-hydroxyanisole), butylated hydroxytoluene (3,5-ditertiarybutyl-4-hydroxytoluene), calcium ascorbate, calcium propionate, calcium sorbate, *Carnobacterium divergens* M35, *Carnobacterium maltaromaticum* cb1, *carnosum* 4010, citric acid, a citric acid ester of a monoglyceride or diglyceride, dimethyl dicarbonate, erythorbic acid, ethyl lauroyl arginate, gum guaiacum, iso-ascorbic acid, L-cysteine, L-cysteine hydrochloride, lecithin, lecithin citrate, *Leuconostoc*, methyl paraben, methyl-*p*-hydroxybenzoate, monoglyceride citrate, monoisopropyl citrate, natamycin, nisin, potassium acetate, potassium benzoate, potassium bisulfite, potassium diacetate, potassium lactate, potassium metabisulfite, potassium nitrate, potassium nitrite, potassium sorbate, propionic acid, propyl gallate, propyl paraben, propyl-*p*-hydroxy benzoate, sodium acetate, sodium ascorbate, sodium benzoate, sodium bisulfite, sodium diacetate, sodium dithionite, sodium erythorbate, sodium iso-ascorbate, sodium lactate, sodium metabisulfite, sodium nitrate, sodium nitrite, sodium propionate, sodium salt of methyl-*p*-hydroxy benzoic acid, sodium salt of propyl-*p*-hydroxy benzoic acid, sodium sorbate, sodium sulfite, sorbic acid, sulfurous acid, tartaric acid, tertiary butyl hydroquinone, or a tocopherol.

In some ~~embodiment~~example s, the protein isolate is in the form of a solution, suspension, or emulsion. In some ~~embodiment~~example s, the protein isolate is in the form of a solid or a powder.

In some ~~embodiment~~example s, the protein isolate has an average particle size of about 5 µm to about 40 µm in the largest dimension. In some ~~embodiment~~example s, the protein isolate has an average particle size of about 10 µm to about 40 µm in the largest dimension.

In some ~~embodiment~~examples, the protein isolate has an average particle size of about 10 µm to about 30 µm in the largest dimension. In some ~~embodiment~~examples, the protein isolate has an average particle size of about 10 µm to about 20 µm in the largest dimension.

In some ~~embodiment~~examples, the protein isolate is in the form of an extrudate. In some ~~embodiment~~examples, an extrudate is substantially in the form of granules.

In some ~~embodiment~~examples, the granules have an average largest dimension of about 3 mm to about 5 mm. In some ~~embodiment~~examples, less than about 20% (w/w) of the granules have a largest dimension less than 1 mm. In some ~~embodiment~~examples, less than about 5% (w/w) of the granules have a largest dimension over 1 cm.

In some ~~embodiment~~examples, the extrudate has a bulk density of about 0.25 to about 0.4 g/cm^3. In some ~~embodiment~~examples, the extrudate has a moisture content of about 5% to about 10%. In some ~~embodiment~~examples, the extrudate has a protein content of about 65% to about 100% by dry weight. In some ~~embodiment~~examples, the extrudate has a fat content of less than about 1.0%. In some ~~embodiment~~examples, the extrudate has a sugar content of less than about 1%.

In some ~~embodiment~~examples, the extrudate has a hydration ratio of about 2.5 to about 3 after about 60 minutes of hydration at room temperature. In some ~~embodiment~~examples, the extrudate has a hydration time of less than about 30 minutes. In some ~~embodiment~~examples, the extrudate has a pH of about 5.0 to about 7.5 when hydrated.

In some ~~embodiment~~examples, the extrudate has a bite strength of about 2000 g to about 4000 g at a hydration ratio of about 3.

In some ~~embodiment~~examples, the protein isolate has a protein dispersibility index of at least about 5 (e.g., at least about 10 or at least about 15). In some ~~embodiment~~examples, the protein isolate has a sodium level up to about 1 %w/w (e.g., up to about 0.5, up to about 0.1, up to about 0.05, up to about 0.01, or up to about 0.005 %w/w).

In some ~~embodiment~~examples, the protein isolate has a solubility of at least 5% (e.g., at least 10%, at least 15%, at least 20%, at least 25%, or at least 30%) in an aqueous solution (e.g., water). In some ~~embodiment~~examples, the aqueous solution has a pH of about 6.0 to about 8.0, of about 6.5 to about 7.5, of about 7.0 to about 8.0, of about 7.0, or of about 8.0. In some ~~embodiment~~examples, the aqueous solution can include a buffer.

In some ~~embodiment~~examples, the protein isolate exhibits a temperature-dependent change in one or more mechanical properties (e.g., storage modulus, loss modulus, and/or viscosity) over a temperature range (e.g., heating from 25 °C to 95 °C, heating from 40 °C to 95 °C, heating from 60 °C to 95 °C, or heating from 80 °C to 90 °C). In some ~~embodiment~~examples, the temperature-dependent change is at least 5-fold (e.g., at least 10-fold, at least 100-fold, at least 500-fold, or at least 1,000-fold) in magnitude. In some ~~embodiment~~examples, the temperature-dependent change is substantially irreversible (e.g., upon cooling over the same temperature range, the magnitude of the change is up to 25%, up to 20%, up to 15%, up to 10%, up to 5%, up to 1%, up to 0.5%, or up to 0.1% the magnitude of the change observed upon heating). In some ~~embodiment~~examples, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 90 °C. In some ~~embodiment~~examples, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 95 °C. In some ~~embodiment~~examples, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 90 °C. In some ~~embodiment~~examples, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 95 °C.

Also provided are a food product comprising any protein isolate as described herein.

In one ~~aspect~~example, low flavor protein compositions produced by the following methods are provided. Such methods generally include (a) adding an aqueous solution to a source protein composition to form a solution of solubilized protein; (b) optionally removing solids from the solution of solubilized protein; (c) adding an organic solvent to the solution of solubilized protein to form a solid phase and a liquid phase, and (d) separating the solid phase from the liquid phase to form a low flavor protein composition, wherein the low flavor protein composition comprises a plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins,

invertebrate proteins, or a combination thereof, and wherein the plurality of plant, fungal, algal, bacterial, protozoan, invertebrate proteins, or combination thereof are substantially aggregated, denatured, or both.

In some ~~embodiment~~examples, step (a) is performed at a pH of about 6.0 to about 9.0. In some ~~embodiment~~examples, step (a) is performed at a pH of about 7.5 to about 8.5. In some ~~embodiment~~examples, step (a) is performed at a pH of about 7.0 to about 11.0 (e.g., about 7.0 to about 10.0, about 8.0 to about 10.0, about 8.0 to about 9.0, or about 8.0).

In some ~~embodiment~~examples, step (b) comprises centrifugation, filtration, or a combination thereof.

In some ~~embodiment~~examples, prior to step (c), the pH of the solution of solubilized protein is adjusted to about 4.0 to about 9.0. In some ~~embodiment~~examples, prior to step (c), the pH of the solution of solubilized protein is adjusted to about 5.5 to about 7.5. In some ~~embodiment~~examples, prior to step (c), the pH of the solution of solubilized protein is adjusted to about 6.0 to about 7.0. In some ~~embodiment~~examples, prior to step (c), the pH of the solution of solubilized protein is adjusted to about 4.0 to about 7.0 (e.g., to about 4.0 to about 6.0, to about 4.5 to about 6.0, to about 4.5, or to about 6.0). In some ~~embodiment~~examples, prior to step (c), the solution of solubilized protein is heated, for example, for about 10 seconds to about 30 minutes (e.g., about 10 seconds to about 20 minutes, about 10 seconds to about 30 seconds, about 10 seconds to about 1 minute, about 10 seconds to about 2 minutes, about 10 seconds to about 5 minutes, about 10 seconds to about 10 minutes, about 10 seconds to about 15 minutes, about 30 seconds to about 20 minutes, about 1 minute to about 30 minutes, about 1 minute to about 20 minutes, about 2 minutes to about 20 minutes, about 5 minutes to about 20 minutes, about 10 minutes to about 20 minutes, or about 15 minutes to about 20 minutes) at a temperature of about 70 °C to about 100 °C (e.g., about 80 °C to about 100 °C, about 85 °C to about 100 °C, about 85 °C to about 95 °C, about 90 °C to about 100 °C, about 85 °C to about 90 °C, about 90 °C to about 95 °C, or about 95 °C to about 100 °C). In some ~~embodiment~~examples, prior to step (c), the organic solvent and/or the solution of solubilized protein are chilled, for example, to a temperature of about -20 °C to about 10 °C (e.g., about -20 °C to about 4 °C). In some ~~embodiment~~examples, prior to step (c), the solution of solubilized protein is heated and then chilled.

In some ~~embodiment~~examples, step (c) comprises adding an organic solvent. In some ~~embodiment~~examples, step (c) comprises adding the organic solvent to a final concentration of about 5% to about 70% (v/v). In some ~~embodiment~~examples, step (c) comprises adding the organic solvent to a final concentration of about 10% to about 50% (v/v). In some ~~embodiment~~examples, step (c) comprises adding the organic solvent to a final concentration of about 20% to about 30% (v/v). In some ~~embodiment~~examples, step (c) comprises adding the organic solvent to a final concentration of about 40% to about 90% (v/v) (e.g., to a final concentration of about 40% to about 70% (v/v), to a final concentration of about 40% to about 60% (v/v), or to a final concentration of about 45% to about 55% (v/v)).

In some ~~embodiment~~examples, the pH is adjusted by adding an acid. In some ~~embodiment~~examples, the acid is selected from the group consisting of hydrochloric acid, acetic acid, citric acid, tartaric acid, malic acid, folic acid, fumaric acid, and lactic acid. In some ~~embodiment~~examples, the acid is hydrochloric acid.

In some ~~embodiment~~examples, step (d) comprises centrifugation, filtration, or a combination thereof.

In some ~~embodiment~~examples, the organic solvent is ethanol (e.g., at least 80%, at least 85%, at least 90%, at least 95%, at least 98%, at least 99%, at least 99.5%, or 100% ethanol). In some ~~embodiment~~examples, the organic solvent is selected from the group consisting of ethanol, propanol, isopropyl alcohol, methanol, and acetone.

In some ~~embodiment~~examples, the method further comprises (e) washing the low flavor protein composition with an organic wash solvent. In some ~~embodiment~~examples, the method further comprises (e) washing the low flavor protein composition with an aqueous wash solvent. In some ~~embodiment~~examples, the method further comprises (e) washing the low flavor protein composition with first an organic wash solvent and second an aqueous wash solvent, or vice versa.

In some ~~embodiment~~examples, the organic wash solvent is ethanol (e.g., at least 80%, at least 85%, at least 90%, at least 95%, at least 98%, at least 99%, at least 99.5%, or 100% ethanol, or up to 20%, up to 15%, up to 10%, or up to 5% ethanol). In some ~~embodiment~~examples, the organic wash solvent is selected from the group consisting of ethanol, propanol, isopropyl alcohol, methanol, and acetone.

In some ~~embodiment~~examples, the organic wash solvent in step (e) is the same as the organic solvent in step (c).

In some ~~embodiment~~examples, the aqueous wash solvent is water. In some ~~embodiment~~examples, the aqueous wash solvent has a pH of about 6.0 to about 8.0, of about 6.5 to about 7.5, or of about 7.0. In some ~~embodiment~~examples, the aqueous wash solvent can include a buffer.

In some ~~embodiment~~examples, the method further includes drying the low flavor protein composition. In some ~~embodiment~~examples, the drying includes spray drying, mat drying, freeze-drying, or oven drying.

In some ~~embodiment~~examples, the source protein composition is at least 90% plant, algae, fungi, bacteria, protozoans, invertebrates, a part or derivative of any thereof, or a combination thereof on a dry weight basis. In some ~~embodiment~~examples, source protein composition is at least 90% a defatted soy flour, a defatted pea flour, or a combination thereof on a dry weight basis. In some ~~embodiment~~examples, the source protein composition is a soy protein composition, and the low flavor protein composition has an isoflavone content less than 90% of the isoflavone content of the source protein composition, on a dry weight basis. In some ~~embodiment~~examples, the source protein composition is a soy protein composition, and the low flavor protein composition has an isoflavone content less than 70% of the isoflavone content of the source protein composition, on a dry weight basis. In some ~~embodiment~~examples, the source protein composition is a soy protein composition, and the low flavor protein composition has an isoflavone content less than 50% of the isoflavone content of the source protein composition, on a dry weight basis. In some ~~embodiment~~examples, the source protein composition is a soy protein composition, and the low flavor protein composition has an isoflavone content less than 30% of the isoflavone content of the source protein composition, on a dry weight basis. In some ~~embodiment~~examples, the source protein composition is a soy protein composition, and the low flavor protein composition has an isoflavone content less than 10% of the isoflavone content of the source protein composition, on a dry weight basis.

In some ~~embodiment~~examples, when cooked in water, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition produces no more than 90% of the amount of one or more soy flavor compounds produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition).

In some ~~embodiment~~examples, when cooked in water, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition produces no more than 70% of the amount of one or more soy flavor compounds produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition).

In some ~~embodiment~~examples, when cooked in water, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition produces no more than 50% of the amount of one or more soy flavor compounds produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition).

In some ~~embodiment~~examples, when cooked in water, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition produces no more than 30% of the amount of one or more soy flavor compounds produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition).

In some ~~embodiment~~examples, when cooked in water, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition produces no more than 10% of the amount of one or more soy flavor compounds produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition).

In some ~~embodiment~~examples, when cooked in a flavor broth, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition produces no more than 90% (e.g., no more than 80%, 70%, 60%, 50%, 40%, 30%, 20%, or 10%) of the amount of one or more soy flavor compounds produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition).

In some ~~embodiment~~examples, when cooked in a flavor broth, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition produces at least 5% (e.g., at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%, or more) more of the amount of one or more volatile compounds in the meat volatile set produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition).

In some ~~embodiment~~examples, when cooked in a flavor broth, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the protein composition produces at least 5% (e.g., at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%, or more) more of the amount

of one or more volatile compounds in the meat volatile set produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition).

In some ~~embodiment~~examples, the one or more soy flavor compounds comprise at least one compound selected from the group consisting of hexanal, pentanal, 2-pentylfuran, 1-octen-3-ol, 1-octen-3-one, 1-hexanol, (E)-2-nonenal, (E,Z)-2,6-nonadienal, and (E,E)-2,4-decadienal.

In some ~~embodiment~~examples, the low flavor protein composition has a luminance of at least 88 on a scale from 0 (black control value) to 100 (white control value). In some ~~embodiment~~examples, the low flavor protein composition has a luminance of at least 90 on a scale from 0 (black control value) to 100 (white control value).

In some ~~embodiment~~examples, the low flavor protein composition has a chroma value of less than 14. In some ~~embodiment~~examples, the low flavor protein composition has a chroma value of less than 12. In some ~~embodiment~~examples, the low flavor protein composition has a chroma value of less than 10. In some ~~embodiment~~examples, the low flavor protein composition has a chroma value of less than 8. In some ~~embodiment~~examples, the low flavor protein composition has a chroma value of less than 6.

In some ~~embodiment~~examples, the low flavor protein composition comprises less than about 1.2% by dry weight lipids (e.g., less than about 1.0% or less than about 0.5% by dry weight lipids). In some ~~embodiment~~examples, the lipids comprise one or more of a fatty acid, a wax, a sterol, a monoglyceride, a diglyceride, a triglyceride, a sphingolipid, or a phospholipid.

In some ~~embodiment~~examples, the plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof is at least 90% by dry weight soy proteins.

In some ~~embodiment~~examples, low flavor protein composition further includes at least one of a preservative, an antioxidant, or a shelf life extender.

In some ~~embodiment~~examples, the preservative, antioxidant, or shelf life extender comprises at least one of 4-hexylresorcinol, acetic acid, ascorbic acid, ascorbyl palmitate, ascorbyl stearate, benzoic acid, butylated hydroxyanisole (a mixture of 2-tertiarybutyl-4-hydroxyanisole and 3-tertiarybutyl-4-hydroxyanisole), butylated hydroxytoluene (3,5-ditertiarybutyl-4-hydroxytoluene), calcium ascorbate, calcium propionate, calcium sorbate, *Carnobacterium divergens* M35, *Carnobacterium maltaromaticum* cb1, *carnosum* 4010, citric acid, a citric acid ester of a monoglyceride or diglyceride, dimethyl dicarbonate, erythorbic acid, ethyl lauroyl

arginate, gum guaiacum, iso-ascorbic acid, L-cysteine, L-cysteine hydrochloride, lecithin, lecithin citrate, *Leuconostoc*, methyl paraben, methyl-*p*-hydroxybenzoate, monoglyceride citrate, monoisopropyl citrate, natamycin, nisin, potassium acetate, potassium benzoate, potassium bisulfite, potassium diacetate, potassium lactate, potassium metabisulfite, potassium nitrate, potassium nitrite, potassium sorbate, propionic acid, propyl gallate, propyl paraben, propyl-*p*-hydroxy benzoate, sodium acetate, sodium ascorbate, sodium benzoate, sodium bisulfite, sodium diacetate, sodium dithionite, sodium erythorbate, sodium iso-ascorbate, sodium lactate, sodium metabisulfite, sodium nitrate, sodium nitrite, sodium propionate, sodium salt of methyl-*p*-hydroxy benzoic acid, sodium salt of propyl-*p*-hydroxy benzoic acid, sodium sorbate, sodium sulfite, sorbic acid, sulfurous acid, tartaric acid, tertiary butyl hydroquinone, or a tocopherol.

In some ~~embodiment~~examples, the low flavor protein composition is in the form of a solution, suspension, or emulsion. In some ~~embodiment~~examples, the low flavor protein composition is in the form of a solid or a powder.

In some ~~embodiment~~examples, the low flavor protein composition has an average particle size of about 5 µm to about 40 µm in the largest dimension. In some ~~embodiment~~examples, the low flavor protein composition has an average particle size of about 10 µm to about 40 µm in the largest dimension. In some ~~embodiment~~examples, the low flavor protein composition has an average particle size of about 10 µm to about 30 µm in the largest dimension. In some ~~embodiment~~examples, the low flavor protein composition has an average particle size of about 10 µm to about 20 µm in the largest dimension.

In some ~~embodiment~~examples, the low flavor protein composition is in the form of an extrudate. In some ~~embodiment~~examples, extrudate is substantially in the form of granules.

In some ~~embodiment~~examples, the granules have an average largest dimension of about 3 mm to about 5 mm. In some ~~embodiment~~examples, less than about 20% (w/w) of the granules have a largest dimension less than 1 mm. In some ~~embodiment~~examples, less than about 5% (w/w) of the granules have a largest dimension over 1 cm.

In some ~~embodiment~~examples, the extrudate has a bulk density of about 0.25 to about 0.4 g/cm^3. In some ~~embodiment~~examples, the extrudate has a moisture content of about 5% to about 10%. In some ~~embodiment~~examples, the extrudate has a protein content of about 65% to about 100% by dry weight. In

some ~~embodiment~~examples, the extrudate has a fat content of less than about 1.0%. In some ~~embodiment~~examples, the extrudate has a sugar content of less than about 1%.

In some ~~embodiment~~examples, the extrudate has a hydration ratio of about 2.5 to about 3 after about 60 minutes of hydration at room temperature. In some ~~embodiment~~examples, the extrudate has a hydration time of less than about 30 minutes. In some ~~embodiment~~examples, the extrudate has a pH of about 5.0 to about 7.5 when hydrated.

In some ~~embodiment~~examples, the extrudate has a bite strength of about 2000 g to about 4000 g at a hydration ratio of about 3.

In some ~~embodiment~~examples, the low flavor protein composition has a protein dispersibility index of at least about 5 (e.g., at least about 10 or at least about 15). In some ~~embodiment~~examples, the low flavor protein composition has a sodium level up to about 1 %w/w (e.g., up to about 0.5, up to about 0.1, up to about 0.05, up to about 0.01, or up to about 0.005 %w/w).

In some ~~embodiment~~examples, the low flavor protein composition has a solubility of at least 5% (e.g., at least 10%, at least 15%, at least 20%, at least 25%, or at least 30%) in an aqueous solution (e.g., water). In some ~~embodiment~~examples, the aqueous solution has a pH of about 6.0 to about 8.0, of about 6.5 to about 7.5, of about 7.0 to about 8.0, of about 7.0, or of about 8.0. In some ~~embodiment~~examples, the aqueous solution can include a buffer.

In some ~~embodiment~~examples, the low flavor protein composition exhibits a temperature-dependent change in one or more mechanical properties (e.g., storage modulus, loss modulus, and/or viscosity) over a temperature range (e.g., heating from 25 °C to 95 °C, heating from 40 °C to 95 °C, heating from 60 °C to 95 °C, or heating from 80 °C to 90 °C). In some ~~embodiment~~examples, the temperature-dependent change is at least 5-fold (e.g., at least 10-fold, at least 100-fold, at least 500-fold, or at least 1,000-fold) in magnitude. In some ~~embodiment~~examples, the temperature-dependent change is substantially irreversible (e.g., upon cooling over the same temperature range, the magnitude of the change is up to 25%, up to 20%, up to 15%, up to 10%, up to 5%, up to 1%, up to 0.5%, or up to 0.1% the magnitude of the change observed upon heating). In some ~~embodiment~~examples, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 90 °C. In some ~~embodiment~~examples, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at

least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 95 °C. In some ~~embodiment~~examples, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 90 °C. In some ~~embodiment~~examples, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 95 °C.

In some ~~embodiment~~examples, the low flavor protein composition is a protein concentrate. In some ~~embodiment~~examples, the low flavor protein composition is a protein isolate.

A food product including the low flavor protein composition as described herein.

In another ~~aspect~~example, provided herein is a protein composition including at least 50% by dry weight of a plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof, and less than 1.2% by dry weight fat, and wherein the plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or combination thereof are substantially aggregated, denatured, or both.

Implementations can include one or more of the following features. The protein composition can have a luminance of at least 86 on a scale from 0 (black control value) to 100 (white control value). The protein composition can have a luminance of at least 90 on a scale from 0 (black control value) to 100 (white control value). The protein composition can have a chroma value of less than 14. The protein composition can have a chroma value of less than 12. The protein composition can have a chroma value of less than 10. The composition can have a chroma value of less than 8. The protein composition can have a chroma value of less than 6. The protein composition can include less than about 0.5% by dry weight lipids. The lipids can include one or more of a fatty acid, a wax, a sterol, a monoglyceride, a diglyceride, a triglyceride, a sphingolipid or a phospholipid. The plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof can be at least 90% by dry weight soy proteins. The composition can further include at least one of a preservative, an antioxidant, or a shelf life extender. The protein composition can

be in the form of a solution, suspension, or emulsion. The protein composition can be in the form of a solid or a powder. The protein composition can have an average particle size of about 5 µm to about 40 µm in the largest dimension. The protein composition can have an average particle size of about 10 µm to about 40 µm in the largest dimension. The protein composition can have an average particle size of about 10 µm to about 30 µm in the largest dimension. The protein composition can have an average particle size of about 10 µm to about 20 µm in the largest dimension. The protein composition is in the form of an extrudate. The extrudate can be substantially in the form of granules. The granules can have an average largest dimension of about 3 mm to about 5 mm. Less than about 20% (w/w) of the granules can have a largest dimension less than 1 mm. Less than about 5% (w/w) of the granules can have a largest dimension over 1 cm. The extrudate can have a bulk density of about 0.25 to about 0.4 g/cm^3. The extrudate can have a moisture content of about 5% to about 10%. The extrudate can have a protein content of about 65% to about 100% by dry weight. The extrudate can have a fat content of less than about 1.0%. The extrudate can have a sugar content of less than about 1%. The extrudate can have a hydration ratio of about 2.5 to about 3 after about 60 minutes of hydration at room temperature. The extrudate can have a hydration time of less than about 30 minutes. The extrudate can have a pH of about 5.0 to about 7.5 when hydrated. The extrudate can have a bite strength of about 2000 g to about 4000 g at a hydration ratio of about 3. The protein composition can be a protein concentrate. The protein composition can be a protein isolate. Also provided herein are food products comprising any of the protein compositions provided herein.

In another ~~aspect~~example, methods for producing a low flavor protein composition are provided. Such methods typically include (a) adding an aqueous solution to a source protein composition to form a solution of solubilized protein; (b) optionally removing solids from the solution of solubilized protein; (c) adding an organic solvent to the solution of solubilized protein to form a solid phase and a liquid phase, and (d) separating the solid phase from the liquid phase to form a low flavor protein composition, wherein the low flavor protein composition can include a plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof.

Implementations can include one or more of the following features. Step (a) can be performed at a pH of about 6.0 to about 9.0. Step (a) can be performed at a pH of about 7.5 to

about 8.5. Step (a) can be performed at a pH of about 7.0 to about 11.0 (e.g., about 7.0 to about 10.0, about 8.0 to about 10.0, about 8.0 to about 9.0, or about 8.0). Step (b) can include centrifugation, filtration, or a combination thereof. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 4.0 to about 9.0. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 5.5 to about 7.5. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 6.0 to about 7.0. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 4.0 to about 7.0 (e.g., to about 4.0 to about 6.0, to about 4.5 to about 6.0, to about 4.5, or to about 6.0). In some ~~embodiment~~examples, prior to step (c), the solution of solubilized protein is heated, for example, for about 10 seconds to about 30 minutes (e.g., about 10 seconds to about 20 minutes, about 10 seconds to about 30 seconds, about 10 seconds to about 1 minute, about 10 seconds to about 2 minutes, about 10 seconds to about 5 minutes, about 10 seconds to about 10 minutes, about 10 seconds to about 15 minutes, about 30 seconds to about 20 minutes, about 1 minute to about 30 minutes, about 1 minute to about 20 minutes, about 2 minutes to about 20 minutes, about 5 minutes to about 20 minutes, about 10 minutes to about 20 minutes, or about 15 minutes to about 20 minutes) at a temperature of about 70 °C to about 100 °C (e.g., about 80 °C to about 100 °C, about 85 °C to about 100 °C, about 85 °C to about 95 °C, about 90 °C to about 100 °C, about 85 °C to about 90 °C, about 90 °C to about 95 °C, or about 95 °C to about 100 °C). In some ~~embodiment~~examples, prior to step (c), the organic solvent and/or the solution of solubilized protein are chilled, for example, to a temperature of about -20 °C to about 10 °C (e.g., about -20 °C to about 4 °C). In some ~~embodiment~~examples, prior to step (c), the solution of solubilized protein is heated and then chilled. Step (c) can comprise adding an organic solvent. Step (c) can include adding the organic solvent to a final concentration of about 5% to about 70% (v/v). Step (c) can include adding the organic solvent to a final concentration of about 10% to about 50% (v/v). Step (c) can include adding the organic solvent to a final concentration of about 20% to about 30% (v/v). Step (c) can include adding the organic solvent to a final concentration of about 40% to about 90% (v/v) (e.g., to a final concentration of about 40% to about 70% (v/v), to a final concentration of about 40% to about 60% (v/v), or to a final concentration of about 45% to about 55% (v/v)). The pH can be adjusted by adding an acid. In some ~~embodiment~~examples, the acid is selected from the group consisting of hydrochloric acid, acetic acid, citric acid, tartaric acid, malic acid, folic

acid, fumaric acid, and lactic acid. In some ~~embodiment~~examples, the acid is hydrochloric acid. Step (d) can include centrifugation, filtration, or a combination thereof. The organic solvent can be ethanol (e.g., at least 80%, at least 85%, at least 90%, at least 95%, at least 98%, at least 99%, at least 99.5%, or 100% ethanol). In some ~~embodiment~~examples, the organic solvent is selected from the group consisting of ethanol, propanol, isopropyl alcohol, methanol, and acetone. The method further can further include (e) washing the low flavor protein composition with an organic wash solvent. The method further can include (e) washing the low flavor protein composition with an aqueous wash solvent. The method further can include (e) washing the low flavor protein composition with first an organic wash solvent and second an aqueous wash solvent, or vice versa. The organic wash solvent can be ethanol (e.g., at least 80%, at least 85%, at least 90%, at least 95%, at least 98%, at least 99%, at least 99.5%, or 100% ethanol, or up to 20%, up to 15%, up to 10%, or up to 5% ethanol). In some ~~embodiment~~examples, the organic wash solvent is selected from the group consisting of ethanol, propanol, isopropyl alcohol, methanol, and acetone. The organic wash solvent in step (e) can be the same as the organic solvent in step (c). The aqueous wash solvent can be water. In some ~~embodiment~~examples, the aqueous wash solvent has a pH of about 6.0 to about 8.0, of about 6.5 to about 7.5, or of about 7.0. In some ~~embodiment~~examples, the aqueous wash solvent can include a buffer. The method can further comprise drying the low flavor protein composition. Drying can include spray drying, mat drying, freeze-drying, or oven drying. The source protein composition can be at least 90% plant, algae, fungi, bacteria, protozoans, invertebrates, a part or derivative of any thereof, or a combination thereof on a dry weight basis. The source protein composition can be at least 90% a defatted soy flour, a defatted pea flour, or a combination thereof on a dry weight basis. The source protein composition can be a soy protein composition, and the low flavor protein composition can have an isoflavone content less than 90% of the isoflavone content of the source protein composition, on a dry weight basis. The source protein composition can be a soy protein composition, and the low flavor protein composition can have an isoflavone content less than 70% of the isoflavone content of the source protein composition, on a dry weight basis. The source protein composition can be a soy protein composition, and the low flavor protein composition can have an isoflavone content less than 50% of the isoflavone content of the source protein composition, on a dry weight basis. The source protein composition can be a soy protein composition, and the low flavor protein

composition can have an isoflavone content less than 30% of the isoflavone content of the source protein composition, on a dry weight basis. The source protein composition can be a soy protein composition, and the low flavor protein composition can have an isoflavone content less than 10% of the isoflavone content of the source protein composition, on a dry weight basis. When cooked in water, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition can produce no more than 90% of the amount of one or more soy flavor compounds produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition). When cooked in water, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition can produce no more than 70% of the amount of one or more soy flavor compounds produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition). When cooked in water, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition can produce no more than 50% of the amount of one or more soy flavor compounds produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition). When cooked in water, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition can produce no more than 30% of the amount of one or more soy flavor compounds produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition). When cooked in water, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition can produce no more than 10% of the amount of one or more soy flavor compounds produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition). When cooked in a flavor broth, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition can produce no more than 90% (e.g., no more than 80%, 70%, 60%, 50%, 40%, 30%, 20%, or 10%) of the amount of one or more soy flavor compounds produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition). In some ~~embodiment~~example, the protein composition produces no more than 90% (e.g., no more than 70%, 50%, 30%, or 10%) of the amount of one or more volatile compounds in a set of volatile compounds produced by the source protein composition by solvent-assisted flavor

extraction (SAFE). The one or more soy flavor compounds comprise at least one compound selected from the group consisting of hexanal, pentanal, 2-pentylfuran, 1-octen-3-ol, 1-octen-3-one, 1-hexanol, (E)-2-nonenal, (E,Z)-2,6-nonadienal, and (E,E)-2,4-decadienal. The low flavor protein composition can have a luminance of at least 88 on a scale from 0 (black control value) to 100 (white control value). When cooked in a flavor broth, a 1% (w/v) suspension of the low flavor protein composition by dry weight of the low flavor protein composition can produce at least 5% (e.g., at least 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%, or more) more of the amount of one or more volatile compounds in the meat volatile set produced by cooking a 1% (w/v) suspension of the source protein composition (by dry weight of the source protein composition). The low flavor protein composition can have a luminance of at least 90 on a scale from 0 (black control value) to 100 (white control value). The low flavor protein composition can have a chroma value of less than 14. The low flavor protein composition can have a chroma value of less than 12. The low flavor protein composition can have a chroma value of less than 10. The low flavor protein composition can have a chroma value of less than 8. The low flavor protein composition can have a chroma value of less than 6. The low flavor protein composition can include less than about 1.2% by dry weight lipids (e.g., less than about 1.0% or less than about 0.5% by dry weight lipids). The lipids can include one or more of a fatty acid, a wax, a sterol, a monoglyceride, a diglyceride, a triglyceride, a sphingolipid, or a phospholipid. The plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof can be at least 90% by dry weight soy proteins. The low flavor protein composition can include at least one of a preservative, an antioxidant, or a shelf life extender. The low flavor protein composition can be in the form of a solution, suspension, or emulsion. The low flavor protein composition can be in the form of a solid or a powder. The low flavor protein composition can have an average particle size of about 5 μm to about 40 μm in the largest dimension. The low flavor protein composition can have an average particle size of about 5 μm to about 40 μm in the largest dimension. The low flavor protein composition can have an average particle size of about 10 μm to about 30 μm in the largest dimension. The low flavor protein composition can have an average particle size of about 10 μm to about 20 μm in the largest dimension. The low flavor protein composition can be in the form of an extrudate. The extrudate can be substantially in the form of granules. The granules can

have an average largest dimension of about 3 mm to about 5 mm. Less than about 20% (w/w) of the granules can have a largest dimension less than 1 mm. Less than about 5% (w/w) of the granules can have a largest dimension over 1 cm. The extrudate can have a bulk density of about 0.25 to about 0.4 g/cm^3. The extrudate can have a moisture content of about 5% to about 10%. The extrudate can have a protein content of about 65% to about 100% by dry weight. The extrudate can have a fat content of less than about 1.0%. The extrudate can have a sugar content of less than about 1%. The extrudate can have a hydration ratio of about 2.5 to about 3 after about 60 minutes of hydration at room temperature. The extrudate can have a hydration time of less than about 30 minutes. The extrudate can have a pH of about 5.0 to about 7.5 when hydrated. The extrudate can have a bite strength of about 2000 g to about 4000 g at a hydration ratio of about 3. In some ~~embodiment~~examples, the low flavor protein composition has a protein dispersibility index of at least about 5 (e.g., at least about 10 or at least about 15). In some ~~embodiment~~examples, the low flavor protein composition has a sodium level up to about 1 %w/w (e.g., up to about 0.5, up to about 0.1, up to about 0.05, up to about 0.01, or up to about 0.005 %w/w). In some ~~embodiment~~examples, the low flavor protein composition has a solubility of at least 5% (e.g., at least 10%, at least 15%, at least 20%, at least 25%, or at least 30%) in an aqueous solution (e.g., water). In some ~~embodiment~~examples, the aqueous solution has a pH of about 6.0 to about 8.0, of about 6.5 to about 7.5, of about 7.0 to about 8.0, of about 7.0, or of about 8.0. In some ~~embodiment~~examples, the aqueous solution can include a buffer. In some ~~embodiment~~examples, the low flavor protein composition exhibits a temperature-dependent change in one or more mechanical properties (e.g., storage modulus, loss modulus, and/or viscosity) over a temperature range (e.g., heating from 25 °C to 95 °C, heating from 40 °C to 95 °C, heating from 60 °C to 95 °C, or heating from 80 °C to 90 °C). In some ~~embodiment~~examples, the temperature-dependent change is at least 5-fold (e.g., at least 10-fold, at least 100-fold, at least 500-fold, or at least 1,000-fold) in magnitude. In some ~~embodiment~~examples, the temperature-dependent change is substantially irreversible (e.g., upon cooling over the same temperature range, the magnitude of the change is up to 25%, up to 20%, up to 15%, up to 10%, up to 5%, up to 1%, up to 0.5%, or up to 0.1% the magnitude of the change observed upon heating). In some ~~embodiment~~examples, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least

10,000 Pa) at 90 °C. In some ~~embodiment~~examples, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 95 °C. In some ~~embodiment~~examples, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 90 °C. In some ~~embodiment~~examples, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 95 °C. The low flavor protein composition can be a protein concentrate. The low flavor protein composition can be a protein isolate.

Also provided herein is a food product comprising a low flavor protein composition produced by any of the methods described herein.

In still another ~~aspect~~example, methods for making a detoxified protein composition are provided. Such methods generally include (a) adding an aqueous solution to a source protein composition to form a solution of solubilized protein; (b) optionally removing solids from the solution of solubilized protein; (c) adding an organic solvent to the solution of solubilized protein to form a solid phase and a liquid phase, and (d) separating the solid phase from the liquid phase to form a detoxified protein composition, wherein the detoxified protein composition can include a plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, wherein the source protein composition can be not suitable for human consumption.

Implementations can include one or more of the following features. The source protein composition can include one or more toxins in an amount sufficient to harm a human being. The source protein composition can be a cottonwood source protein composition. The source protein composition can include gossypol in an amount of more than 450 ppm. The detoxified protein composition can include gossypol in an amount of less than 450 ppm. The detoxified protein composition can include gossypol in an amount of less than 300 ppm. The detoxified protein composition can include gossypol in an amount of less than 100 ppm. The detoxified protein

composition can include gossypol in an amount of less than 10 ppm. In some ~~embodiment~~examples, a detoxified protein composition as described herein can include one or more toxins in an amount smaller than the amount in the source protein composition. In some cases, a detoxified protein composition can have a toxin content of less than about 90% (e.g., less than about 70%, 50%, 30%, or 10%) of the toxin content of the source protein composition. Non-limiting examples of toxins include gossypol (for example, in cottonwood), vicine or convicine (for example, in faba beans), cyanogenic glycosides (for example, in cassava or bamboo), glucosinolates (for example, in cruciferous vegetables), and glycoalkaloids (for example, in potato and bittersweet nightshade). Step (a) can be performed at a pH of about 6.0 to about 9.0. Step (a) can be performed at a pH of about 7.5 to about 8.5. Step (a) can be performed at a pH of about 7.0 to about 11.0 (e.g., about 7.0 to about 10.0, about 8.0 to about 10.0, about 8.0 to about 9.0, or about 8.0). Step (b) can include centrifugation, filtration, or a combination thereof. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 4.0 to about 9.0. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 5.5 to about 7.5. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 6.0 to about 7.0. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 4.0 to about 7.0 (e.g., to about 4.0 to about 6.0, to about 4.5 to about 6.0, to about 4.5, or to about 6.0). In some ~~embodiment~~examples, prior to step (c), the solution of solubilized protein is heated, for example, for about 10 seconds to about 30 minutes (e.g., about 10 seconds to about 20 minutes, about 10 seconds to about 30 seconds, about 10 seconds to about 1 minute, about 10 seconds to about 2 minutes, about 10 seconds to about 5 minutes, about 10 seconds to about 10 minutes, about 10 seconds to about 15 minutes, about 30 seconds to about 20 minutes, about 1 minute to about 30 minutes, about 1 minute to about 20 minutes, about 2 minutes to about 20 minutes, about 5 minutes to about 20 minutes, about 10 minutes to about 20 minutes, or about 15 minutes to about 20 minutes) at a temperature of about 70 °C to about 100 °C (e.g., about 80 °C to about 100 °C, about 85 °C to about 100 °C, about 85 °C to about 95 °C, about 90 °C to about 100 °C, about 85 °C to about 90 °C, about 90 °C to about 95 °C, or about 95 °C to about 100 °C). In some ~~embodiment~~examples, prior to step (c), the organic solvent and/or the solution of solubilized protein are chilled, for example, to a temperature of about -20 °C to about 10 °C (e.g., about -20 °C to about 4 °C). In some ~~embodiment~~examples, prior to step (c), the solution of solubilized protein is heated and

then chilled. Step (c) can comprise adding an organic solvent. Step (c) can include adding the organic solvent to a final concentration of about 5% to about 70% (v/v). Step (c) can include adding the organic solvent to a final concentration of about 10% to about 50% (v/v). Step (c) can include adding the organic solvent to a final concentration of about 20% to about 30% (v/v). Step (c) can include adding the organic solvent to a final concentration of about 40% to about 90% (v/v) (e.g., to a final concentration of about 40% to about 70% (v/v), to a final concentration of about 40% to about 60% (v/v), or to a final concentration of about 45% to about 55% (v/v)). The pH can be adjusted by adding an acid. In some ~~embodiment~~examples, the acid is selected from the group consisting of hydrochloric acid, acetic acid, citric acid, tartaric acid, malic acid, folic acid, fumaric acid, and lactic acid. In some ~~embodiment~~examples, the acid is hydrochloric acid. Step (d) can include centrifugation, filtration, or a combination thereof. The organic solvent can be ethanol (e.g., at least 80%, at least 85%, at least 90%, at least 95%, at least 98%, at least 99%, at least 99.5%, or 100% ethanol). In some ~~embodiment~~examples, the organic solvent is selected from the group consisting of ethanol, propanol, isopropyl alcohol, methanol, and acetone. The method further can include (e) washing the low flavor protein composition with an organic wash solvent. The method further can include (e) washing the low flavor protein composition with an aqueous wash solvent. The method further can include (e) washing the low flavor protein composition with first an organic wash solvent and second an aqueous wash solvent, or vice versa. The organic wash solvent can be ethanol (e.g., at least 80%, at least 85%, at least 90%, at least 95%, at least 98%, at least 99%, at least 99.5%, or 100% ethanol, or up to 20%, up to 15%, up to 10%, or up to 5% ethanol). In some ~~embodiment~~examples, the organic wash solvent is selected from the group consisting of ethanol, propanol, isopropyl alcohol, methanol, and acetone. The organic wash solvent in step (e) can be the same as the organic solvent in step (c). The aqueous wash solvent can be water. In some ~~embodiment~~examples, the aqueous wash solvent has a pH of about 6.0 to about 8.0, of about 6.5 to about 7.5, or of about 7.0. In some ~~embodiment~~examples, the aqueous wash solvent can include a buffer. The method can further comprise drying the detoxified protein composition. Drying can include spray drying, mat drying, freeze-drying, or oven drying. The source protein composition can be at least 90% plant, algae, fungi, bacteria, protozoans, invertebrates, a part or derivative of any thereof, or a combination thereof on a dry weight basis.

In yet another ~~aspect~~example, methods of extracting small molecules from a protein source composition are provided. Such methods generally include (a) adding an aqueous solution to a source protein composition to form a solution of solubilized protein; (b) optionally removing solids from the solution of solubilized protein; (c) adding an organic solvent to the solution of solubilized protein to form a solid phase and a liquid phase, and (d) separating the solid phase from the liquid phase to form a solution enriched in small molecules.

Implementations can include one or more of the following features. The source protein composition can be a soy source protein composition. The solution enriched in small molecules can include isoflavones. The solution enriched in small molecules can include isoflavones, pigments (e.g., chlorophylls, anthocyanins, carotenoids, and betalains), flavor compounds (e.g., soy flavor compounds), saponin, toxins (e.g., gossypol), natural products (e.g., plant natural products, pharmacologically active natural products), metabolites (e.g., primary and/or secondary metabolites), and/or phospholipids (e.g., lecithin). The small molecules can have molecular weights up to 900 daltons (e.g., up to 800, up to 700, up to 600, or up to 500 daltons). Step (a) can be performed at a pH of about 6.0 to about 9.0. Step (a) can be performed at a pH of about 7.5 to about 8.5. Step (a) can be performed at a pH of about 7.0 to about 11.0 (e.g., about 7.0 to about 10.0, about 8.0 to about 10.0, about 8.0 to about 9.0, or about 8.0). Step (b) can include centrifugation, filtration, or a combination thereof. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 4.0 to about 9.0. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 5.5 to about 7.5. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 6.0 to about 7.0. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 4.0 to about 7.0 (e.g., to about 4.0 to about 6.0, to about 4.5 to about 6.0, to about 4.5, or to about 6.0). In some ~~embodiment~~examples, prior to step (c), the solution of solubilized protein is heated, for example, for about 10 seconds to about 30 minutes (e.g., about 10 seconds to about 20 minutes, about 10 seconds to about 30 seconds, about 10 seconds to about 1 minute, about 10 seconds to about 2 minutes, about 10 seconds to about 5 minutes, about 10 seconds to about 10 minutes, about 10 seconds to about 15 minutes, about 30 seconds to about 20 minutes, about 1 minute to about 30 minutes, about 1 minute to about 20 minutes, about 2 minutes to about 20 minutes, about 5 minutes to about 20 minutes, about 10 minutes to about 20 minutes, or about 15 minutes to about

20 minutes) at a temperature of about 70 °C to about 100 °C (e.g., about 80 °C to about 100 °C, about 85 °C to about 100 °C, about 85 °C to about 95 °C, about 90 °C to about 100 °C, about 85 °C to about 90 °C, about 90 °C to about 95 °C, or about 95 °C to about 100 °C). In some ~~embodiment~~examples, prior to step (c), the organic solvent and/or the solution of solubilized protein are chilled, for example, to a temperature of about -20 °C to about 10 °C (e.g., about -20 °C to about 4 °C). In some ~~embodiment~~examples, prior to step (c), the solution of solubilized protein is heated and then chilled. Step (c) can comprise adding an organic solvent. Step (c) can include adding the organic solvent to a final concentration of about 5% to about 70% (v/v). Step (c) can include adding the organic solvent to a final concentration of about 10% to about 50% (v/v). Step (c) can include adding the organic solvent to a final concentration of about 20% to about 30% (v/v). Step (c) can include adding the organic solvent to a final concentration of about 40% to about 90% (v/v) (e.g., to a final concentration of about 40% to about 70% (v/v), to a final concentration of about 40% to about 60% (v/v), or to a final concentration of about 45% to about 55% (v/v)). The pH can be adjusted by adding an acid. In some ~~embodiment~~examples, the acid is selected from the group consisting of hydrochloric acid, acetic acid, citric acid, tartaric acid, malic acid, folic acid, fumaric acid, and lactic acid. In some ~~embodiment~~examples, the acid is hydrochloric acid. Step (d) can include centrifugation, filtration, or a combination thereof. The organic solvent can be ethanol (e.g., at least 80%, at least 85%, at least 90%, at least 95%, at least 98%, at least 99%, at least 99.5%, or 100% ethanol). In some ~~embodiment~~examples, the organic solvent is selected from the group consisting of ethanol, propanol, isopropyl alcohol, methanol, and acetone. The method further can include (e) washing the low flavor protein composition with an organic wash solvent. The method further can include (e) washing the low flavor protein composition with an aqueous wash solvent. The method further can include (e) washing the low flavor protein composition with first an organic wash solvent and second an aqueous wash solvent, or vice versa. The organic wash solvent can be ethanol (e.g., at least 80%, at least 85%, at least 90%, at least 95%, at least 98%, at least 99%, at least 99.5%, or 100% ethanol, or up to 20%, up to 15%, up to 10%, or up to 5% ethanol). In some ~~embodiment~~examples, the organic wash solvent is selected from the group consisting of ethanol, propanol, isopropyl alcohol, methanol, and acetone. The organic wash solvent in step (e) can be the same as the organic solvent in step (c). The aqueous wash solvent can be water. In some ~~embodiment~~examples, the aqueous wash solvent has a pH of about 6.0 to about

8.0, of about 6.5 to about 7.5, or of about 7.0. In some ~~embodiment~~example~~s~~, the aqueous wash solvent can include a buffer. The method can further include drying the low flavor protein composition. Drying can include spray drying, mat drying, freeze-drying, or oven drying. The source protein composition can be at least 90% plant, algae, fungi, bacteria, protozoans, invertebrates, a part or derivative of any thereof, or a combination thereof on a dry weight basis.

In yet another ~~aspect~~example, food products are provided. Such food products optionally include a fat; optionally one or more flavor precursor compounds; and at least 10% by dry weight of a low flavor protein composition, the low flavor protein composition comprising at least 50% by dry weight of a plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof, and wherein the plurality of plant, fungal, algal, bacterial, protozoan, invertebrate proteins, or combination thereof are substantially aggregated, denatured, or both.

Implementations can include one or more of the following features. The food product can be a plant-based food product. The food product can be an algae-based food product. The food product can be a fungus-based food product. The food product can be an invertebrate-based food product. The fat can include at least one fat selected from the group consisting of 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, rice bran oil, and combinations thereof. The one or more flavor precursors can comprise at least one compound selected from the group consisting of glucose, ribose, cysteine, a cysteine derivative, thiamine, alanine, methionine, lysine, a lysine derivative, glutamic acid, a glutamic acid derivative, IMP, GMP, lactic acid, maltodextrin, creatine, alanine, arginine, asparagine, aspartate, glutamic acid, glutamine, glycine, histidine, isoleucine, leucine, methionine, phenylalanine, proline, threonine, tryptophan, tyrosine, valine, linoleic acid, and mixtures thereof. Suitable flavor precursors can include sugars, sugar alcohols, sugar derivatives, oils (e.g., vegetable oils), free fatty acids, alpha-hydroxy acids, dicarboxylic acids, amino acids and derivatives thereof, nucleosides, nucleotides, vitamins, peptides, protein hydrolysates, extracts, phospholipids, lecithin, and organic molecules. The food product can be a meat analog. The food product can be in the form of ground meat, a sausage, or a cut of meat. The food product can be a dairy analog (e.g., milk,

fermented milk, yogurt, cream, butter, cheese, custard, ice cream, gelato, or frozen yogurt). The food product can contain no animal products. The fat can be present in the food product in an amount of about 5% to about 80% by dry weight of the food product. The fat can be present in the food product in an amount of about 10% to about 30% by dry weight of the food product. The food product can contain no fat. The food product can further include about 0.01% to about 5% by dry weight of a heme-containing protein. The food product can be a beverage (e.g., sports drink, protein shake, protein shot, energy drink, caffeinated beverage, coffee drink (e.g., milk coffee), milk, fermented milk, smoothie, carbonated beverage, alcoholic beverage, infant formula, or meal replacement). The fat can be present in the food product in an amount of about 0.01% to about 5% by weight of the beverage. The beverage can contain no fat. The low flavor protein composition can have a luminance of at least 86 on a scale from 0 (black control value) to 100 (white control value). The low flavor protein composition can have a luminance of at least 88 on a scale from 0 (black control value) to 100 (white control value). The low flavor protein composition can have a chroma value of less than 14. The low flavor protein composition can have a chroma value of less than 12. The low flavor protein composition can have a chroma value of less than 10. The low flavor protein composition can have a chroma value of less than 8. The low flavor protein composition can have a chroma value of less than 6. The low flavor protein composition can include less than about 1.2% by dry weight lipids (e.g., less than about 1.0% or less than about 0.5% by dry weight lipids). The lipids can include one or more of a fatty acid, a wax, a sterol, a monoglyceride, a diglyceride, a triglyceride, a sphingolipid, or a phospholipid. The plurality of plant proteins, fungal proteins, algal proteins, bacterial proteins, protozoan proteins, invertebrate proteins, or a combination thereof can be at least 90% by dry weight soy proteins. The food product can further include at least one of a preservative, an antioxidant, or a shelf life extender. The low flavor protein composition can be in the form of a solution, suspension, or emulsion. The low flavor protein composition can be in the form of a solid or a powder. The low flavor protein composition can have an average particle size of about 5 μm to about 40 μm in the largest dimension. The low flavor protein composition can have an average particle size of about 5 μm to about 40 μm in the largest dimension. The low flavor protein composition can have an average particle size of about 10 μm to about 30 μm in the largest dimension. The low flavor protein composition can have an average particle size of about

10 µm to about 20 µm in the largest dimension. The low flavor protein composition can be in the form of an extrudate. The extrudate can be substantially in the form of granules. The granules can have an average largest dimension of about 3 mm to about 5 mm. Less than about 20% (w/w) of the granules can have a largest dimension less than 1 mm. Less than about 5% (w/w) of the granules can have a largest dimension over 1 cm. The extrudate can have a bulk density of about 0.25 to about 0.4 g/cm^3. The extrudate can have a moisture content of about 5% to about 10%. The extrudate can have a protein content of about 65% to about 100% by dry weight. The extrudate can have a fat content of less than about 1.0%. The extrudate can have a sugar content of less than about 1%. The extrudate can have a hydration ratio of about 2.5 to about 3 after about 60 minutes of hydration at room temperature. The extrudate can have a hydration time of less than about 30 minutes. The extrudate can have a pH of about 5.0 to about 7.5 when hydrated. The extrudate can have a bite strength of about 2000 g to about 4000 g at a hydration ratio of about 3. In some ~~embodiment~~example**s**, the low flavor protein composition has a protein dispersibility index of at least about 5 (e.g., at least about 10 or at least about 15). In some ~~embodiment~~example**s**, the low flavor protein composition has a sodium level up to about 1 %w/w (e.g., up to about 0.5, up to about 0.1, up to about 0.05, up to about 0.01, or up to about 0.005 %w/w). The low flavor protein composition can have a solubility of at least 5% (e.g., at least 10%, at least 15%, at least 20%, at least 25%, or at least 30%) in an aqueous solution (e.g., water) or in the beverage. The aqueous solution or the beverage can have a pH of about 4.5 to about 8.0, of about 4.5 to about 7.0, of about 6.0 to about 8.0, of about 6.5 to about 7.5, of about 7.0 to about 8.0, of about 7.0, or of about 8.0. In some ~~embodiment~~example**s**, the aqueous solution can include a buffer. In some ~~embodiment~~example**s**, the low flavor protein composition exhibits a temperature-dependent change in one or more mechanical properties (e.g., storage modulus, loss modulus, and/or viscosity) over a temperature range (e.g., heating from 25 °C to 95 °C, heating from 40 °C to 95 °C, heating from 60 °C to 95 °C, or heating from 80 °C to 90 °C). In some ~~embodiment~~example**s**, the temperature-dependent change is at least 5-fold (e.g., at least 10-fold, at least 100-fold, at least 500-fold, or at least 1,000-fold) in magnitude. In some ~~embodiment~~example**s**, the temperature-dependent change is substantially irreversible (e.g., upon cooling over the same temperature range, the magnitude of the change is up to 25%, up to 20%, up to 15%, up to 10%, up to 5%, up to 1%, up to 0.5%, or up to 0.1% the magnitude of the change observed upon heating). In some

~~embodiment~~example s, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 90 °C. In some ~~embodiment~~example s, the storage modulus and/or loss modulus reach a value of at least 1,000 Pa (e.g., at least 2,000 Pa, at least 3,000 Pa, at least 4,000 Pa, at least 5,000 Pa, at least 6,000 Pa, at least 7,000 Pa, at least 8,000 Pa, at least 9,000 Pa, or at least 10,000 Pa) at 95 °C. In some ~~embodiment~~example s, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 90 °C. In some ~~embodiment~~example s, the viscosity reaches a value of at least 1,000 Pa·s (e.g., at least 2,000 Pa·s, at least 3,000 Pa·s, at least 4,000 Pa·s, at least 5,000 Pa·s, at least 6,000 Pa·s, at least 7,000 Pa·s, at least 8,000 Pa·s, at least 9,000 Pa·s, or at least 10,000 Pa·s) at 95 °C. The low flavor protein composition can be a protein concentrate. The low flavor protein composition can be a protein isolate.

In yet another ~~aspect~~example, methods for preparing a food product are provided. Such methods generally include combining a fat, one or more optional flavor precursor compounds, and a low flavor protein composition, the low flavor protein composition produced by a method comprising: (a) adding an aqueous solution to a source protein composition to form a solution of solubilized protein; (b) optionally removing solids from the solution of solubilized protein; (c) adding an organic solvent to the solution of solubilized protein to form a solid phase and a liquid phase, and (d) separating the solid phase from the liquid phase to form a low flavor protein composition.

In still another ~~aspect~~example, methods for reducing perceived protein source flavor in a plant-based food product are provided. Such methods generally include combining a fat, one or more flavor precursor compounds and a low flavor protein composition, the low flavor protein composition produced by a method comprising: (a) adding an aqueous solution to a source protein composition to form a solution of solubilized protein; (b) optionally removing solids from the solution of solubilized protein; (c) adding an organic solvent to the solution of solubilized protein to form a solid phase and a liquid phase, and (d) separating the solid phase from the liquid phase to form a low flavor protein composition, wherein at least 5% by weight of

the protein content of the food product can include the low flavor protein composition, thereby reducing perceived protein source flavor in a food product, as compared to a food product having a similar protein content but lacking the low flavor protein composition.

Implementations can include one or more of the following features. Step (a) can be performed at a pH of about 6.0 to about 9.0. Step (a) can be performed at a pH of about 7.5 to about 8.5. Step (a) can be performed at a pH of about 7.0 to about 11.0 (e.g., about 7.0 to about 10.0, about 8.0 to about 10.0, about 8.0 to about 9.0, or about 8.0). Step (b) can include centrifugation, filtration, or a combination thereof. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 4.0 to about 9.0. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 5.5 to about 7.5. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 6.0 to about 7.0. Prior to step (c), the pH of the solution of solubilized protein can be adjusted to about 4.0 to about 7.0 (e.g., to about 4.0 to about 6.0, to about 4.5 to about 6.0, to about 4.5, or to about 6.0). In some ~~embodiment~~examples, prior to step (c), the solution of solubilized protein is heated, for example, for about 10 seconds to about 30 minutes (e.g., about 10 seconds to about 20 minutes, about 10 seconds to about 30 seconds, about 10 seconds to about 1 minute, about 10 seconds to about 2 minutes, about 10 seconds to about 5 minutes, about 10 seconds to about 10 minutes, about 10 seconds to about 15 minutes, about 30 seconds to about 20 minutes, about 1 minute to about 30 minutes, about 1 minute to about 20 minutes, about 2 minutes to about 20 minutes, about 5 minutes to about 20 minutes, about 10 minutes to about 20 minutes, or about 15 minutes to about 20 minutes) at a temperature of about 70 °C to about 100 °C (e.g., about 80 °C to about 100 °C, about 85 °C to about 100 °C, about 85 °C to about 95 °C, about 90 °C to about 100 °C, about 85 °C to about 90 °C, about 90 °C to about 95 °C, or about 95 °C to about 100 °C). In some ~~embodiment~~examples, prior to step (c), the organic solvent and/or the solution of solubilized protein are chilled, for example, to a temperature of about -20 °C to about 10 °C (e.g., about -20 °C to about 4 °C). In some ~~embodiment~~examples, prior to step (c), the solution of solubilized protein is heated and then chilled. Step (c) can comprise adding an organic solvent. Step (c) can include adding the organic solvent to a final concentration of about 5% to about 70% (v/v). Step (c) can include adding the organic solvent to a final concentration of about 10% to about 50% (v/v). Step (c) can include adding the organic solvent to a final concentration of about 20% to about 30% (v/v). Step

(c) can include adding the organic solvent to a final concentration of about 40% to about 90% (v/v) (e.g., to a final concentration of about 40% to about 70% (v/v), to a final concentration of about 40% to about 60% (v/v), or to a final concentration of about 45% to about 55% (v/v)). The pH can be adjusted by adding an acid. In some ~~embodiment~~examples, the acid is selected from the group consisting of hydrochloric acid, acetic acid, citric acid, tartaric acid, malic acid, folic acid, fumaric acid, and lactic acid. In some ~~embodiment~~examples, the acid is hydrochloric acid. Step (d) can include centrifugation, filtration, or a combination thereof. The organic solvent can be ethanol (e.g., at least 80%, at least 85%, at least 90%, at least 95%, at least 98%, at least 99%, at least 99.5%, or 100% ethanol). In some ~~embodiment~~examples, the organic solvent is selected from the group consisting of ethanol, propanol, isopropyl alcohol, methanol, and acetone. The method further can include (e) washing the low flavor protein composition with an organic wash solvent. The method further can include (e) washing the low flavor protein composition with an aqueous wash solvent. The method further can include (e) washing the low flavor protein composition with first an organic wash solvent and second an aqueous wash solvent, or vice versa. The organic wash solvent can be ethanol (e.g., at least 80%, at least 85%, at least 90%, at least 95%, at least 98%, at least 99%, at least 99.5%, or 100% ethanol, or up to 20%, up to 15%, up to 10%, or up to 5% ethanol). In some ~~embodiment~~examples, the organic wash solvent is selected from the group consisting of ethanol, propanol, isopropyl alcohol, methanol, and acetone. The organic wash solvent in step (e) can be the same as the organic solvent in step (c). The aqueous wash solvent can be water. In some ~~embodiment~~examples, the aqueous wash solvent has a pH of about 6.0 to about 8.0, of about 6.5 to about 7.5, or of about 7.0. In some ~~embodiment~~examples, the aqueous wash solvent can include a buffer. The method can further include drying the low flavor protein composition. Drying can include spray drying, mat drying, freeze-drying, or oven drying. The source protein composition can be at least 90% plant, algae, fungi, bacteria, protozoans, invertebrates, a part or derivative of any thereof, or a combination thereof on a dry weight basis. The food product can be a plant-based food product. The food product can be an algae-based food product. The food product can be a fungus-based food product. The food product can be an invertebrate-based food product. The fat can include at least one fat selected from the group consisting of 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, rice bran oil, and combinations thereof. The one or more flavor precursors comprise at least one compound selected from the group consisting of glucose, ribose, cysteine, a cysteine derivative, thiamine, alanine, methionine, lysine, a lysine derivative, glutamic acid, a glutamic acid derivative, IMP, GMP, lactic acid, maltodextrin, creatine, alanine, arginine, asparagine, aspartate, glutamic acid, glutamine, glycine, histidine, isoleucine, leucine, methionine, phenylalanine, proline, threonine, tryptophan, tyrosine, valine, linoleic acid, and mixtures thereof.

In any of the ~~embodiment~~examples herein, the preservative, antioxidant, or shelf life extender can include at least one of 4-hexylresorcinol, acetic acid, ascorbic acid, ascorbyl palmitate, ascorbyl stearate, benzoic acid, butylated hydroxyanisole (a mixture of 2-tertiarybutyl-4-hydroxyanisole and 3-tertiarybutyl-4-hydroxyanisole), butylated hydroxytoluene (3,5-ditertiarybutyl-4-hydroxytoluene), calcium ascorbate, calcium propionate, calcium sorbate, *Carnobacterium divergens* M35, *Carnobacterium maltaromaticum* cb1, *carnosum* 4010, citric acid, a citric acid ester of a monoglyceride or diglyceride, dimethyl dicarbonate, erythorbic acid, ethyl lauroyl arginate, gum guaiacum, iso-ascorbic acid, L-cysteine, L-cysteine hydrochloride, lecithin, lecithin citrate, Leuconostoc, methyl paraben, methyl-p-hydroxybenzoate, monoglyceride citrate, monoisopropyl citrate, natamycin, nisin, potassium acetate, potassium benzoate, potassium bisulfite, potassium diacetate, potassium lactate, potassium metabisulfite, potassium nitrate, potassium nitrite, potassium sorbate, propionic acid, propyl gallate, propyl paraben, propyl-p-hydroxy benzoate, sodium acetate, sodium ascorbate, sodium benzoate, sodium bisulfite, sodium diacetate, sodium dithionite, sodium erythorbate, sodium iso-ascorbate, sodium lactate, sodium metabisulfite, sodium nitrate, sodium nitrite, sodium propionate, sodium salt of methyl-p-hydroxy benzoic acid, sodium salt of propyl-p-hydroxy benzoic acid, sodium sorbate, sodium sulfite, sorbic acid, sulfurous acid, tartaric acid, tertiary butyl hydroquinone, or a tocopherol.

As used herein, “low flavor” with respect to a protein composition means that the protein composition has less flavor than the source of the protein composition (e.g., soy, if a soy protein composition is described). For example, less (e.g., no more than 90%, 80%, 70%, 60%, 50%, 40%, 30%, 20%, or 10%) of one or more compounds that give rise to a distinguishing flavor associated with the source of the protein. In some ~~embodiment~~examples, a low flavor protein composition can have little flavor of its own. In some instances, a low flavor protein composition

has less flavor than a known protein composition (e.g., a commercial soy protein isolate, such as those described herein). Having less flavor can be determined, for example, by a trained human panelist, or, for example, by measurement of one or more volatile compounds commonly understood to impart flavor and/or aroma. In some ~~embodiment~~examples, a low flavor protein composition can have a discriminability index of at least 1.0 (e.g., at least 1.5, 2.0, 2.5, or 3.0). In some ~~embodiment~~examples, when assessed by a trained descriptive panel using the Spectrum method, a low flavor protein composition is described as having low intensity of one or more of: oxidized/rancid flavor, cardboard flavor, astringent flavor, bitter flavor, vegetable complex flavor, and sweet fermented flavor. In some ~~embodiment~~examples, when assessed by a trained descriptive panel using the Spectrum method, a low flavor protein composition is described as having low intensity of one or more of: beany flavor, fatty flavor, green flavor, pea flavor, earthy flavor, hay-like flavor, grassy flavor, rancid flavor, leafy flavor, cardboard flavor, acrid flavor, pungent flavor, medicinal flavor, metallic flavor, and brothy flavor.

As used herein, "low color" with respect to a protein composition means that the protein composition has less color than the source of the protein composition (e.g., soy, if a soy protein composition is described). For example, less of one or more compounds that give rise to a color in the protein. In some ~~embodiment~~examples, a low color protein composition can have little color of its own. In some instances, a low color protein composition has less color than a known protein composition (e.g., a commercial soy protein isolate, such as those described herein). Having less color can be determined, for example, by measuring the luminance and/or chroma of a protein composition. In some ~~embodiment~~examples, a low color protein composition can have a luminance of at least about 86 (e.g., at least about 88, 90, 92, or 94). In some ~~embodiment~~examples, a low color protein composition can have a chroma value of less than about 12 (e.g., less than about 10, 8, or 6).

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this ~~invention~~disclosure pertains. Although methods and materials similar or equivalent to those described herein can be used to practice the ~~invention~~disclosure, suitable methods and materials are described below. All publications, patent applications, patents, and other references mentioned herein are incorporated by reference in their entirety. In case of conflict, the present specification, including definitions,

will control. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting.

The details of one or more ~~embodiment~~example[s] of the disclosure are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the disclosure will be apparent from the description and drawings, and from the claims. The word "comprising" in the claims may be replaced by "consisting essentially of" or with "consisting of," according to standard practice in patent law.

DESCRIPTION OF THE DRAWINGS

Figure 1A is an exemplary flow chart for the preparation of a protein composition, according to some embodiments.

Figure 1B is an exemplary flow chart for the preparation of a protein composition, according to some embodiments.

Figure 1C shows exemplary phospholipid content of a protein composition prepared according some embodiments.

Figure 1D shows exemplary protein content in supernatants according some embodiments.

Figure 1E is an exemplary flow chart for the preparation of protein, according to some embodiments.

Figure 2A shows exemplary data for the production of several soy flavor compounds, when an exemplary SPI produced as described herein is cooked in a flavor broth (referred to as FLB_EtOH), as compared to commercial products cSPC-1 and cSPI-1 and a control of the flavor broth alone (FLB).

Figure 2B shows exemplary data for the production of several meat flavor compounds, when an exemplary SPI produced as described herein is cooked in a flavor broth (FLB_EtOH), as compared to commercial products cSPC-1 F and cSPI-1 and a control of the flavor broth alone (FLB).

Figure 2C shows exemplary data for the production of several soy flavor compounds, when an exemplary SPI produced as described herein (pureSPI) and an exemplary SPC produced