NON-ANIMAL BASED PROTEIN SOURCES WITH FUNCTIONAL PROPERTIES

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 62/888,674, filed August 19, 2019, the contents of which are incorporated by reference in its entirety.

SEQUENCE LISTING

[0002] The instant application contains a Sequence Listing which has been submitted in ASCII format via EFS-Web and is hereby incorporated by reference in its entirety. Said ASCII copy, created on August 18, 2020, is named 49160-717.601_ST25.txt and is 287,890 bytes in size.

BACKGROUND OF THE INVENTION

[0003] Proteins are important dietary nutrients and food ingredients. They can serve as a fuel source or as sources of amino acids, including the essential amino acids that cannot be synthesized by the body. The daily recommended intake of protein for healthy adults is 10% to 35% of a person's total calorie needs, and currently the majority of protein intake for most humans is from animal-based sources. In addition, proteins are used in a wide variety of foods and food ingredients. In many cases, these proteins are sourced from animals. With the world population growth and the coinciding growth in global food demand, there is a need to provide alternative sustainable, non-animal-based sources of proteins as useful source of protein for daily diet, food ingredients and food products.

SUMMARY OF THE ~~INVENTION~~DISCLOSURE

[0004] Additional aspects and advantages of the present disclosure will become readily apparent to those skilled in this art from the following detailed description, wherein only illustrative ~~embodiment~~examples of the present disclosure are shown and described. As will be realized, the present disclosure is capable of other and different ~~embodiment~~examples, and its several details are capable of modifications in various obvious respects, all without departing from the disclosure. Accordingly, the drawings and description are to be regarded as illustrative in nature, and not as restrictive.

[0004a] In one aspect, provided herein is an ingredient composition for producing an egg-less food item, the ingredient composition comprising a recombinant ovalbumin (rOVA) and ash, wherein the egg-less food item does not comprise any egg-white proteins except the rOVA; wherein the pH of the rOVA when solubilized in an aqueous solution is above 3.5; wherein the ingredient composition comprises from about 1% to about 98% rOVA and at least 0.5% ash w/w or w/v; wherein when the ingredient composition is present in the egg-less food item in an amount

comprising between about 2% and about 15% (w/w) rOVA in the egg-less food item; and wherein the rOVA provides an equivalent or an improvement in a characteristic compared to an otherwise similar egg-less food item comprising native egg white, wherein the characteristic is selected from the group consisting of: gelling, foam capacity, foam stability, whipping, fluffing, binding, springiness, aeration, coating, film forming, emulsification, browning, thickening, texturizing, humectant, clarification, and cohesiveness.

[0005] In some ~~embodiment~~examples, provided herein are ingredients for producing egg-less food items. The ingredient composition for producing an egg-less food item may comprise a recombinant ovalbumin (rOVA), wherein the pH of the rOVA may be between about 3.5 and about 7.0; wherein the rOVA when present in the egg-less food item in an amount between about 2% and about 15% (w/w); and wherein the rOVA provides to the egg-less food item at least one egg white characteristic selected from gelling, foaming, whipping, fluffing, binding, springiness, aeration,

solubilized. In some cases, the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of an ostrich OVA and the pH is less than about 6.0 and above about 3.7 when solubilized.

[0011] In some cases, the pH when solubilized may be between about 6 and about 6.8. In some cases, the pH of the rOVA when solubilized may be less than about 6.1. In some cases, the rOVA may be present in the egg-less food item in an amount of less than about 8%. In some cases, the rOVA may be present in the egg-less food item in an amount of about 7% or less than 7%.

[0012] In some ~~embodiment~~examples, provided herein are baked goods. A baked food product, may comprise: (i) a recombinant ovalbumin (rOVA), wherein the pH of the rOVA when solubilized may be between about 3.5 and about 7.0; (ii) at least one fat or oil; (iii) at least one grain starch; and (iv) at least one sweetener; wherein the rOVA provides the baked food product at least one egg white characteristic selected from binding, springiness, aeration, browning, texturizing, humectant, and cohesiveness, and the baked food product does not comprise any natural egg white proteins or a natural egg white.

[0013] In some cases, the rOVA may be present at about 2% to 15% in the product (w/w of total protein or w/w of total food product prior to baking). In some cases, the rOVA is present at about 2% to about 5% in the product (w/w). In some cases, the baked good may comprise a dairy component or a leavening agent, or a combination thereof. In some cases, the product may be a cake, a bread, a roll, a pastry, a cracker, a muffin, a scone, a biscuit, or a cookie. In some cases, the baked product may have a crumb structure equivalent to or better than a similar baked product made with a natural egg white or a natural whole egg. In some cases, the rOVA may comprise an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1. In some cases, the rOVA may comprise an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA. In some cases, the percentage weight loss is lower in a baked product made with rOVA when compared to an equivalent baked product made with whole egg.

[0014] In some ~~embodiment~~examples, provided herein are emulsified products. An emulsified product may comprise: (i) a recombinant ovalbumin (rOVA); (ii) at least one fat or oil; (iii) water; wherein the rOVA may be present in the product at about 2% to 15% (w/w). In some cases, the emulsified product may comprise an acidifying agent. In some cases, the product may be a salad dressing, a sauce, mayonnaise, sandwich spread or a gravy.

[0015] In some ~~embodiment~~examples, described herein are food products comprising (i) a recombinant ovalbumin (rOVA), wherein the pH of the rOVA when solubilized may be between about 3.5 and about 7.0; (ii) at least one sweetener; and (iii) optionally, a consumable liquid; wherein the rOVA

may be present in the food product at about 2% to about 15% (w/w) and wherein the rOVA provides foaming, whipping, fluffing or aeration to the food product.

[0016] In some cases, the rOVA may further provide gelation to the food product. In some cases, the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of a chicken OVA and the pH is between about 6.5 and 7.0 when solubilized. In some cases, the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of an ostrich OVA and the pH is less than about 6.0 and above about 3.7 when solubilized. In some cases, the food product may be a meringue, a whipped dessert, a whipped topping or a soufflé. In some cases, the rOVA may provide a foam capacity to the food product of at least 20%, 30%, 40%, or 50% greater than native egg white. In some cases, the rOVA may provide a time to foaming to the food product that may be at least 20%, 30%, 40%, or 50% faster than native egg white. In some cases, the pH of the rOVA when solubilized is between about 3.5 and about 4.5.

[0017] In some cases, the rOVA is present in the food product at about 5% to about 10% (w/w). In some cases, the rOVA is present in the food product at about 7% to about 8% (w/w). In some cases, the rOVA is present in the food product at about 4%, about 7%, or about 12% (w/w). In some cases, the pH of the rOVA when solubilized is about 6. In some cases, the rOVA is present in the food product at between about 9% and about 10% (w/w). In some cases, the pH of the rOVA when solubilized is about 7. In some cases, the product may be a beverage. In some cases, the beverage may be a consumable alcohol. In some cases, the rOVA provides foaming, whipping, fluffing or aeration to the consumable alcohol beverage. In some cases, the beverage is a coffee drink. In some cases, the rOVA provides foaming, whipping, fluffing or aeration to the coffee drink. In some cases, the coffee drink lacks a dairy component.

[0018] In some cases, the rOVA may comprise an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1. In some cases, the rOVA may comprise an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA. In some cases, the rOVA does not contaminate the food product with Salmonella. In some cases, the food product is a protein bar, an energy bar, a nutrition bar or a granola bar. In some cases, the food product comprises between about 4% and about 8% (w/w) rOVA. In some cases, the bar is baked or is unbaked.

[0019] In some ~~embodiment~~examples, described herein is a meat-analog food product. A meat-analog food product may comprise: (i) a recombinant ovalbumin (rOVA); (ii) at least one fat or oil; and (iii) a plant-derived protein; wherein the rOVA may be present in the food product between about 2% and about 15% (w/w); and wherein the rOVA acts as a binding agent or a gelling agent, or a combination thereof.

[0020] In some cases, the plant protein may be an extruded plant protein. In some cases, the plant protein may be a non-extruded plant protein. In some cases, the meat analog food product may be selected from a burger, patty, sausage, hot dog, sliced deli meat, jerky, bacon, nugget, a ground meat-like composition, and a formed meat-like composition. In some cases, the rOVA may provide a hardness to the food product that may be greater than native egg white. In some cases, the rOVA may provide a chewiness to the food product that may be greater than native egg white. In some cases, the rOVA may provide a springiness comparable to native egg white.

[0021] In some cases, the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of a chicken OVA and the pH is between about 6.5 and 7.0 when solubilized. In some cases, the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of an ostrich OVA and the pH is less than about 6.0 and above about 3.7 when solubilized. In some cases, the rOVA is present in the food product at about 4%, at about 5%, or at about 6% (w/w). In some cases, the rOVA may comprise an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1. In some cases, the rOVA may comprise an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.

[0022] In some ~~embodiment~~examples, provided herein are egg-white substitutes. An egg-white substitute may comprise: (i) a recombinant ovalbumin (rOVA); (ii) at least one fat or oil; and (iii) a polysaccharide or polysaccharide-containing ingredient; wherein the rOVA may be present in the composition at about 2% to 15% (ww); and wherein the composition may have one or more characteristics selected from hardness, adhesiveness, fracturability, cohesiveness, gumminess, and chewiness, and the one or more characteristics are equivalent to or improved as compared to natural egg white when the egg-white substitute may be cooked.

[0023] In some cases, the egg-white substitute may further comprise a flavoring agent or a coloring agent, or a combination thereof. In some cases, the polysaccharide or polysaccharide-containing ingredient may be a starch. In some cases, the polysaccharide or polysaccharide-containing ingredient may be selected from gellan gum, sodium alginate, and psyllium or any combination thereof. In some cases, the rOVA may provide a hardness to the food product that may be greater than native egg white.

[0024] In some cases, the rOVA may provide a chewiness to the food product that may be greater than native egg white. In some cases, the rOVA may provide a gumminess and/or springiness comparable to native egg white. In some cases, the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of a chicken OVA and the pH is between about 6.5 and 7.0 when solubilized. In some cases, the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of an ostrich OVA and the pH is less than about 6.0 and above

about 3.7 when solubilized. In some cases, the rOVA is present in the food product between about 10% and about 12% (w/w).

[0025] In some cases, the rOVA may comprise an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1. In some cases, the rOVA may comprise an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.

[0026] In some ~~embodiment~~examples, described herein are powdered ingredient compositions. A powdered ingredient composition may comprise a recombinant ovalbumin (rOVA), wherein the pH of the rOVA when solubilized may be between about 3.5 and about 7.0, wherein the rOVA may be at least 75% w/w of the composition, and wherein the rOVA may comprise one or more N-linked glycosylation sites having mannose linked to an N-acetyl glucosamine, and wherein the N-linked glycosylation sites lack galactose. In some cases, the rOVA may comprise an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1. In some cases, the rOVA may comprise an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA. In some cases, the amino acid sequence of the rOVA lacks an N-terminal methionine. In some cases, the rOVA further includes an EAEA amino acid sequence (SEQ ID NO: 75) at its N-terminus. In some cases, the composition comprises at least at least about 80%, at least about 85%, or at least about 90% rOVA (w/w).

[0027] In some ~~embodiment~~examples, a liquid composition may comprise a recombinant ovalbumin (rOVA) and the composition may comprise at least 50% rOVA (w/w of total protein or w/w of total composition). In some cases, the composition may comprise at least about 60%, at least about 65%, at least about 75%, at least about 80%, at least about 85%, or at least about 90% rOVA (w/w).

[0028] In some cases, the rOVA may comprise an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1. In some cases, the rOVA may comprise an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.

[0029] In some cases, the amino acid sequence of the rOVA lacks an N-terminal methionine. In some cases, the rOVA further includes an EAEA amino acid sequence (SEQ ID NO: 75) at its N-terminus. In some cases, the pH of the solubilized rOVA may be between about 3.5 and about 7.0. In some cases, the pH of the solubilized rOVA may be between about 6 and about 6.8. In some cases, the pH of the solubilized rOVA may be less than about 6.1.

[0030] In some cases, the rOVA may provide to an egg-less food item at least one egg white characteristic selected from gelling, foaming, whipping, fluffing, binding, springiness, aeration, coating, film forming, emulsification, browning, thickening, texturizing, humectant, clarification, and cohesiveness. In some cases, the rOVA may provide an equivalent or an improvement in the

characteristic compared to native egg white in a similar egg-less food item. In some cases, the rOVA may provide to the egg-less food item a foam capacity of at least 20%, 30%, 40%, or 50% greater than native egg white.

[0031] In some cases, the rOVA may provide to the egg-less food item a time to foaming that may be at least 20%, 30%, 40%, or 50% faster than native egg white. In some cases, the rOVA may provide to the egg-less food item a hardness that may be greater than native egg white. In some cases, the pH of the rOVA when solubilized is between about 3.5 and about 4.5. In some cases, the rOVA is present in the egg-less food item at about 5% to about 10% (w/w). In some cases, the rOVA is present in the egg-less food item at about 7% to about 8% (w/w). In some cases, the rOVA is present the egg-less food item at about 4%, about 7%, or about 12% (w/w). In some cases, the pH of the rOVA when solubilized is about 6. In some cases, the rOVA may provide to the egg-less food item a chewiness that may be greater than native egg white. In some cases, the rOVA may provide to the egg-less food item a springiness comparable to native egg white.

[0032] In some cases, the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of a chicken OVA and the pH is between about 6.5 and 7.0 when solubilized. In some cases, the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of an ostrich OVA and the pH is less than about 6.0 and above about 3.7 when solubilized. In some cases, the rOVA does not contaminate the egg-less food item with Salmonella.

[0033] In some ~~embodiment~~examples, described herein are dry or powdered compositions comprising a recombinant ovalbumin (rOVA), wherein the composition may comprise at least 50% rOVA (w/w of total protein or w/w of total composition). In some cases, the composition may comprise at least about 60%, at least about 65%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, or at least about 95% rOVA (w/w). In some cases, the rOVA may comprise an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1.

[0034] In some cases, the rOVA may comprise an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA. In some cases, the amino acid sequence of the rOVA lacks an N-terminal methionine. In some cases, the rOVA further includes an EAEA amino acid sequence (SEQ ID NO: 75) at its N-terminus. In some cases, the rOVA may provide to an egg-less food item at least one egg white characteristic selected from gelling, foaming, whipping, fluffing, binding, springiness, aeration, coating, film forming, emulsification, browning, thickening, texturizing, humectant, clarification, and cohesiveness. In some cases, the rOVA may provide an equivalent or an improvement in the characteristic compared to native egg white in a similar egg-less food item.

[0035] In some cases, the rOVA may provide to the egg-less food item a foam capacity of at least 20%, 30%, 40%, or 50% greater than native egg white. In some cases, the rOVA may provide to the egg-less food item a time to foaming that may be at least 20%, 30%, 40%, or 50% faster than native egg white. In some cases, the pH of the rOVA when solubilized is between about 3.5 and about 4.5. In some cases, the rOVA is present in the egg-less food at about 4%, about 7%, or about 12% (w/w). In some cases, the pH of the rOVA when solubilized is about 6.

[0036] In some cases, the rOVA may provide to the egg-less food item a hardness that may be greater than native egg white. In some cases, the rOVA may provide to the egg-less food item a chewiness that may be greater than native egg white. In some cases, the rOVA may provide to the egg-less food item a springiness comparable to native egg white. In some cases, the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of a chicken OVA and the pH is between about 6.5 and 7.0 when solubilized. In some cases, the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of an ostrich OVA and the pH is less than about 6.0 and above about 3.7 when solubilized.

[0037] In some ~~embodiment~~examples, provided herein are methods of making a food product. A method of making a food product may comprise: (i) providing a recombinant ovalbumin (rOVA) at a pH when solubilized of between about 3.5 and about 7.0; (ii) combining the rOVA in an amount between 2% and 15% (w/w) with one or more consumable ingredients to form a food product, wherein the rOVA may provide at least one egg white characteristic to the food product selected from gelling, foaming, whipping, fluffing, binding, springiness, aeration, coating, film forming, emulsification, browning, thickening, texturizing, humectant, clarification and cohesiveness.

[0038] In some ~~embodiment~~examples, provided herein are methods of making an ingredient. A method of producing an ingredient composition may comprise: (i) expressing a recombinant ovalbumin (rOVA) in a microbial cell, wherein the rOVA may be secreted by the microbial cell into a liquid media; (ii) harvesting the liquid media containing secreted rOVA; (iii) performing a separation step at a pH of about 3.5; (iv) solubilizing the rOVA at a pH of about 12; (v) adjusting the final pH of the rOVA to between about 3.5 and about 7.0 to generate the ingredient composition.

[0039] In some cases, the separation step may comprise ion exchange chromatography or ammonium sulfate precipitation. In some cases, the ion exchange chromatography may be cation exchange chromatography or anion exchange chromatography, or a combination thereof. In some cases, the method further may comprise a filtration step following the solubilizing step. In some cases, the microbial cell may be a fungal cell. In some cases, the fungal cell may be a Pichia sp. In some cases, the microbial cell expresses a recombinant helper factor; wherein the helper factor enhances the level of expression or accumulation of rOVA.

[0040] In some cases, the rOVA may comprise an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1. In some cases, the rOVA may comprise an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA. In some cases, the amino acid sequence of the secreted rOVA lacks an N-terminal methionine. In some cases, the secreted rOVA further includes an EAEA amino acid sequence (SEQ ID NO: 75) at its N-terminus.

[0041] In some ~~embodiment~~examples, an egg-less food product may comprise a recombinant ovalbumin (rOVA) in an amount of between about 15% and about 25% (w/w of total protein or w/w of food product). In some cases, the egg-less food product may comprise the rOVA) in an amount of up to about 23% (w/w).

[0042] In some ~~embodiment~~examples, provided herein are uses of recombinant ovalbumin (rOVA). The recombinant ovalbumin (rOVA) may be used as an ingredient in making a baked good. rOVA may be used as an ingredient in making an egg-less food product. rOVA may be used as an ingredient in making a meat-analog food product. rOVA may be used as an ingredient in making an egg-white substitute. rOVA may be used as a substitute egg-wash for a baked product; wherein the substitute egg-wash may provide film formation equivalent to or better than an egg-wash may comprise a natural egg white or a natural whole egg.

[0043] rOVA may comprise an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1. rOVA may comprise an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA. In some cases, the rOVA is present in the egg-wash in an amount between 8% and 9% (w/w).

[0044] In some ~~embodiment~~examples, described herein are large-scale production of recombinant ovalbumin (rOVA). A large-scale production of rOVA, may comprise an at least 1-liter liquid culture of microbial cells expressing the rOVA. In some cases, the large-scale production may comprise an at least 10-liter liquid culture of microbial cells expressing the rOVA. In some cases, the large-scale production may comprise an at least 100-liter liquid culture of microbial cells expressing the rOVA. In some cases, the large-scale production may comprise an at least 1000-liter liquid culture of microbial cells expressing the rOVA. In some cases, the large-scale production comprises an at least 10,000-liter liquid culture of microbial cells expressing the rOVA. In some cases, the large-scale production comprises an at least 100,000-liter liquid culture of microbial cells expressing the rOVA. In some cases, the large-scale production comprises about a 200,000-liter liquid culture of microbial cells expressing the rOVA.

[0045] In some ~~embodiment~~examples, provided herein may be an ingredient composition for producing an egg-less food item comprising a recombinant ovalbumin. The recombinant ovalbumin may provide at least one egg white characteristic selected from the group consisting of gelling, foaming,

whipping, fluffing, binding, springiness, aeration, coating, film forming, emulsification, browning, thickening, texturizing, humectant, clarification and cohesiveness.

[0046] The egg white characteristic provided by the recombinant ovalbumin may be substantially the same or better than the same characteristic provided by a native egg white. The composition may not contain any native egg white protein. The composition may not contain any animal products.

[0047] The composition may not contain any protein extracted from an egg. The color of the composition may be improved in whiteness or colorlessness as compared to a native egg white. The recombinant ovalbumin may comprise a polypeptide sequence derived from the group consisting of chicken, goose, quail, ostrich, and duck.

[0048] The recombinant ovalbumin may be sensory neutral with regard to taste, smell, mouthfeel or any combination thereof. The recombinant ovalbumin may provide the features of foaming and coagulation to the composition.

[0049] In some ~~embodiment~~examples, provided herein are baked products comprising the ingredient composition provided herein. The recombinant ovalbumin may provide structure, texture or both structure and texture to the baked product. The recombinant ovalbumin may provide a protein fortification to the baked product. The recombinant ovalbumin may be at a concentration of between about 1% and about 20% (weight ovalbumin/weight product) in a baked product. The recombinant ovalbumin may be at a concentration of between about 0.1% and about 5% (weight ovalbumin/weight product) in a baked product.

[0050] The recombinant ovalbumin may be compatible with gluten formation. The baked product may be selected from the group consisting of cake, cookie, bagel, biscuit, bread, muffin, cupcake, scone, pancake, macaroon, meringue, choux pastry and soufflé. The cake made using such an ingredient may be pound cake, sponge cake, yellow cake, or angel food cake. The composition may further comprise one or more components selected from the group consisting of a sweetening agent, a gum, a hydrocolloid, a starch, a fiber, a plant protein, algal protein, a coloring agent and a flavoring extract.

[0051] The composition may provide one or more characteristics suitable for an egg-like dish, and wherein the characteristic may be selected from the group consisting of foaming, coagulation, binding, structure, texture, film-formation, nutritional profile, cholesterol free and protein fortification. In some ~~embodiment~~examples, provided herein are egg-like dishes comprising the ingredient composition described herein. The egg-like dish may be selected from the group consisting of scramble, omelet, patty, soufflé, quiche and frittata. The egg-like dish may be vegan, vegetarian, halal or kosher.

[0052] The composition may provide one or more characteristics suitable for a processed meat product or meat-like product, and wherein the characteristic may be selected from the group consisting of high protein content, binding, and sensory neutrality. In some ~~embodiment~~examples, provided herein are meat-like products, comprising the ingredient compositions provided herein.

[0053] The meat-like product may be selected from the group consisting of a burger, patty, sausage, hot dog, sliced deli meat, jerky, bacon, nugget and ground meat-like mixture or formed meat or meat-like composition. Ovalbumin may be present in an amount between about 0.1% and 30% in the meat-like product (weight ovalbumin/weight product).

[0054] The recombinant ovalbumin may provide the characteristic of binding suitable for adhesion of a food coating. A food coating may comprise the ingredients described herein. The food coating may be a batter or a breading. The recombinant ovalbumin may further provide the characteristic of crunchy texture to the food coating when cooked, baked or fried.

[0055] The recombinant ovalbumin may provide the characteristic suitable for a confectionary selected from the group consisting of odor neutrality, flavor, mouthfeel, texture, nutritional value and protein fortification. A confectionary product may comprise the ingredient compositions described herein. The confectionary may not contain egg or egg white. The confectionary may not contain any proteins extracted from egg or egg white. The recombinant ovalbumin may provide a firm or chewy texture to the confectionary. The recombinant ovalbumin may be present in an amount between about 0.1% and 15% (weight ovalbumin/weight confectionary). The confectionary may be a gummy, a taffy or a nougat.

[0056] The recombinant ovalbumin may provide a characteristic suitable for a dairy-like beverage selected from the group consisting of odor neutrality, flavor, mouthfeel, foaming, frothiness, texture, and nutritional value. A dairy-like beverage may comprise the ingredient compositions described herein. The dairy-like beverage may not contain egg or egg white. The beverage may be selected from the group consisting of smoothie, milkshake, “egg-nog”, and coffee beverage. The recombinant ovalbumin may be present in an amount between about 0.1% and 20% (weight ovalbumin/volume beverage).

[0057] Recombinant ovalbumin may provide a characteristic suitable for a dessert product selected from the group consisting of creamy texture, low fat content, odor neutrality, flavor, mouthfeel, texture, binding, and nutritional value. A dessert product may comprise the ingredient compositions described herein. The dessert product may be selected from the group consisting of a mousse, a cheesecake, a custard, a pudding, a popsicle, a frozen dessert, and an ice cream. The dessert product may be vegan, vegetarian or dairy-free. The recombinant ovalbumin may be present in an amount between about 0.1% and 10% (weight ovalbumin/weight dessert product).

[0058] The recombinant ovalbumin may provide a characteristic suitable for a sauce or dressing selected from the group consisting of binding, emulsifying, odor neutrality, and mouthfeel. A sauce or dressing may comprise the ingredient compositions described herein. The sauce or dressing may be selected from the group consisting of salad dressing, mayonnaise, commercial mayonnaise substitutes, alfredo sauce, and hollandaise sauce. The sauce or dressing may not contain egg, egg white, or any protein extracted from egg.

[0059] The recombinant ovalbumin may provide a characteristic suitable for a snack food selected from the group consisting of binding, protein supplementation, flavor neutrality, odor neutrality, and mouth feel. A snack food may comprise the ingredient compositions described herein. The snack food may be a protein bar, a nutrition bar or a granola bar. The ingredient composition may further comprise one or more additional components selected from the group consisting of a sweetener, a gum, a plant protein, algal protein, a flavoring, a colorant, a thickener, an acidulant and an emulsifier.

[0060] In some ~~embodiment~~examples, provided herein are methods of producing an egg white replacer. The egg-white replacer may comprise providing a recombinant ovalbumin; mixing the recombinant ovalbumin with at least one additional component to form the egg white replacer. The recombinant ovalbumin may provide at least one egg white characteristic selected from the group consisting of gelling, foaming, whipping, fluffing, binding, springiness, aeration, creaminess and cohesiveness to the egg white replacer. The egg white replacer may not contain any egg, egg white, protein extracted or isolated from egg. The at least one egg white characteristic may be the same or better than a native egg provided in the same amount or concentration (weight/volume).

[0061] The method may further comprise producing the recombinant ovalbumin in a heterologous host cell, wherein the host cell may be E.coli, yeast, filamentous fungus, or Trichoderma. The yeast or filamentous fungus may be selected from the group consisting of a Saccharomyces species and a Pichia species. The recombinant ovalbumin may be secreted from the host cell. The recombinant ovalbumin may be glycosylated by the host cell and wherein the glycosylation of the ovalbumin may be not identical to ovalbumin isolated from chicken egg.

[0062] The method may further comprise treating the secreted ovalbumin with a deglycosylation enzyme. The deglycosylation enzyme may be expressed by the host cell.

[0063] The host may comprise a nucleic acid sequence encoding the recombinant ovalbumin, and the recombinant ovalbumin has an amino acid sequence of an ovalbumin from an avian species. The host may comprise a nucleic acid sequence encoding the recombinant ovalbumin, and the recombinant ovalbumin has an amino acid sequence of an ovalbumin that has at least 95% sequence identity with an ovalbumin from an avian species. The avian species may be chicken, duck, goose, ostrich, or quail.

[0064] The ovalbumin from the avian species may be selected from the group consisting of SEQ ID NO. 1-74.

[0065] In some ~~embodiment~~examples, provided herein is a recombinant protein composition for use as an egg-white replacer. The composition can comprise a recombinant ovalbumin and at least one additional component. The recombinant ovalbumin may provide at least one egg white characteristic selected from the group consisting of gelling, foaming, whipping, fluffing, binding, springiness, aeration, creaminess and cohesiveness to the composition. The composition may not contain any egg, egg white, protein extracted or isolated from egg. The at least one egg white characteristic may be the same or better than a native egg compared at the same amount or concentration (weight/volume).

[0066] The recombinant ovalbumin may have an amino acid sequence of an ovalbumin from an avian species. The recombinant ovalbumin may have an amino acid sequence of an ovalbumin that has at least 95% sequence identity with an ovalbumin from an avian species.

[0067] The avian species may be chicken, duck, goose, ostrich, or quail. The ovalbumin from the avian species may be selected from the group consisting of SEQ ID NO. 1-74.

[0068] An animal nutrition composition may comprise a recombinant ovalbumin (rOVA). The rOVA may be in a form selected from whole cell extract, fractionated cell extract and isolated protein. The composition may be comprised within a pet food, an animal feed, a chewy treat, bone broth, smoothie or other liquid for animal nutrition and a solid nutritional supplement suitable for animal consumption.

[0069] Additionally, any composition, food product, ingredient, use, or method disclosed herein is applicable to any herein-disclosed composition, food product, ingredient, use, or method. In other words, any aspect or ~~embodiment~~example described herein can be combined with any other aspect or ~~embodiment~~example as disclosed herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0070] The novel features of the invention are set forth with particularity in the appended claims. A better understanding of the features and advantages of the present invention will be obtained by reference to the following detailed description that sets forth illustrative embodiments, in which the principles of the invention are utilized, and the accompanying drawings of which:

[0071] FIGs. 1A-B illustrate glycosylation patterns of native OVA and rOVA produced in P. pastoris respectively.

[0072] FIG. 2 illustrates pound cakes and their cross-sections made using rOVA compared to cakes made using eggs.

[0073] FIG. 3 illustrates meringues made using rOVA compared to meringues made using eggs.

CLAIMS

WHAT IS CLAIMED IS:

1. An ingredient composition for producing an egg-less food item, the ingredient composition comprising a recombinant ovalbumin (rOVA) and ash,~~),~~

wherein the egg-less food item does not comprise any egg-white proteins except the rOVA;

wherein the pH of the rOVA when solubilized in an aqueous solution is above ~~between about~~ 3.5;

wherein the ingredient composition comprises from about 1% to ~~and~~ about 98% rOVA and at least ~~7.~~0.5% ash w/w or w/v;

wherein ~~the rOVA~~ when the ingredient composition is present in the egg-less food item in an amount comprising between about 2% and about 15% (w/w) rOVA in the egg-less food item;~~),~~ and

wherein the rOVA provides an equivalent or an improvement in a characteristic compared to an otherwise similar ~~the~~ egg-less food item comprising native~~at least one~~ egg white, wherein the characteristic is selected from the group consisting of: gelling, foam capacity, foam stability~~foaming~~, whipping, fluffing, binding, springiness, aeration, coating, film forming, emulsification, browning, thickening, texturizing, humectant, clarification, and cohesiveness.

~~2.~~ 2. The ingredient composition of claim 1, wherein the rOVA ~~composition is dried or is a powder.~~

~~3. The ingredient composition of claim 1 or claim 2, wherein the composition~~ comprises a polypeptide represented by~~at least 75% rOVA (w/w of total protein or w/w of total composition).~~

~~4. The ingredient composition of claim 3, wherein the powder composition is at least about 80%, at least about 85%, or at least about 90% rOVA (w/w).~~

~~5. The ingredient composition of claim 3 or claim 4, wherein the powder is a concentrate.~~

~~6. The ingredient composition of any one of claims 2 to 5, wherein the powder composition is an isolate.~~

~~7. The ingredient composition of claim 1, wherein the composition is a liquid.~~

~~8. The ingredient composition of claim 7, wherein the liquid composition is a concentrate.~~

~~9. The ingredient composition of claim 7 or claim 8, wherein the liquid composition comprises at least 50% rOVA (w/w of total protein or w/w of composition).~~

~~10. The ingredient composition of claim 7, wherein the liquid the composition comprises at least about 60%, at least about 65%, at least about 75%, at least about 80%, at least about 85%, or at least about 90% rOVA (w/w).~~

~~11. The ingredient composition of any one of claims 1 to 3, wherein the rOVA provides an equivalent or an improvement in the characteristic compared to native egg white in a similar food item.~~

~~12. The ingredient composition of any one of claims 1 to 11, wherein the rOVA provides a foam capacity of at least 20%, 30%, 40%, or 50% greater than native egg white.~~

~~13. The ingredient composition of any one of claims 1 to 12, wherein the rOVA provides a time to foaming that is at least 20%, 30%, 40%, or 50% faster than native egg white.~~

~~14. The ingredient composition of claim 12 or claim 13, wherein the pH of the rOVA when solubilized is between about 3.5 and about 4.5.~~

~~15. The ingredient composition of any one of claims 1 to 14, wherein the rOVA provides a hardness to the egg-less food composition that is comparable to or greater than native egg white in baked embodiments.~~

~~16. The ingredient composition of any one of claims 1 to 15, wherein the rOVA provides a chewiness to the egg-less food composition that is greater than native egg white.~~

~~17. The ingredient composition of claim 15 or claim 16, wherein the rOVA provides a springiness comparable to native egg white.~~

~~18.~~ ~~The ingredient composition of any one of claims 1 to 17, wherein the rOVA comprises~~ an amino acid sequence selected from the group consisting of SEQ ID NO: 1-74~~2 or SEQ ID NO: 1~~ or an amino acid sequence with at least 97~~70~~% identity with one of~~to SEQ ID NO: 2 or~~ SEQ ID NO: 1-74.

~~19.~~ 3. The ingredient composition of claim~~any one of claims~~ 1 or 2~~to 18~~, wherein the rOVA comprises an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.

~~20.~~ 4. The ingredient composition of claim 2~~18~~ or claim 3~~19~~, wherein the amino acid sequence of the rOVA lacks an N-terminal methionine.

~~21.~~ 5. ~~The ingredient composition of claim 20, wherein the rOVA further includes an EAEA amino acid sequence (SEQ ID NO: 75) at its N-terminus.~~

~~22.~~ The ingredient composition of any one of claims 1 to 4, wherein the ingredient composition is a powder~~21, wherein the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of a chicken OVA and the pH is between about 6.5 and 7.0 when solubilized~~.

6. The ingredient composition of claim 5, wherein the powder comprises at least 50% rOVA w/w or w/v or at least 75% rOVA w/w or w/v.

7. The ingredient composition of any one of claims 1 to 6, wherein the rOVA provides to the egg-less food item a foam capacity higher than a foam capacity provided by native egg white in a similar egg-less food item.

~~23.~~ 8. The ingredient composition of any one of claims 1 to 7~~21~~, wherein the rOVA provides to~~improved gelation when~~ the egg-less food item a hardness higher than a hardness provided by native egg white in a similar egg-less food item~~rOVA comprises an amino acid sequence of an ostrich OVA and the pH is less than about 6.0 and above about 3.7 when solubilized~~.

~~24.~~ 9. The ingredient composition of any one of claims 1 to 8~~21, wherein the pH when solubilized is between about 6 and about 6.8.~~

~~25. The ingredient composition of any one of claims 1 to 21, wherein the pH of the rOVA when solubilized is less than about 6.1.~~

~~26.~~ ~~The ingredient composition of any one of claims 1 to 25~~, wherein rOVA is present in the egg-less food item in an amount of less than about 8%.

~~27.~~ 10. ~~The ingredient composition of any one of claims 1 to 25, wherein rOVA is present in the egg-less food item in an amount of about 7% or less than 7%.~~

~~28.~~ The ingredient composition of any one of claims 1 to 9~~27~~, wherein the rOVA is expressed by a yeast or fungal host cell. ~~does not contaminate the composition with Salmonella.~~

11. The ingredient composition of claim 10, wherein the host cell is selected from a Pichia species, a Saccharomyces species, a Trichoderma species, a Pseudomonas species and an Aspergillus species.

12. The ingredient composition of any one of claims 1 to 11, wherein a glycosylation pattern of the rOVA is devoid of N-linked galactose units.

13. The ingredient composition of any one of claims 1 to 12,

~~29. A baked food product, comprising:~~

~~a recombinant ovalbumin (rOVA),~~ wherein the pH of the rOVA when solubilized is between about 3.5 and about 4.5.~~7.0;~~

14. The ingredient composition of any one of claims 1 to 13, wherein the ingredient composition further comprises one or more consumable additives.

15. The ingredient composition of claim 14, wherein the ~~at least one fat or oil;~~

~~at least one grain starch; and~~

~~at least~~ one or more consumable additives~~sweetener;~~

~~wherein the rOVA provides the baked food product at least one egg white characteristic selected from binding, springiness, aeration, browning, texturizing, humectant, and cohesiveness,~~

~~and the baked food product does not~~ comprise ~~any natural egg white proteins or~~ a flavoring~~natural egg white.~~

~~30. The baked food product of claim 29, wherein the rOVA is present at about 2% to 15% in the product (w/w of total protein or w/w of total food product prior to baking).~~

~~31. The baked food product of claim 30, wherein the rOVA is present at about 2% to about 5% in the product (w/w).~~

~~32. The baked food product of claim 29 or claim 30, further comprises a dairy component or a leavening~~ agent, a coloring agent, an oil, a polysaccharide or a combination thereof.

~~33.~~ 16. The ingredient composition~~baked food product~~ of any one of claims 1~~29~~ to 15~~32~~, wherein the egg-less food item~~product~~ is a baked product. ~~cake, a bread, a roll, a pastry, a cracker, a muffin, a scone, a bagel, a biscuit, or a cookie.~~

~~34.~~ 17. The ingredient composition~~baked product~~ of claim 16~~33~~, wherein the baked product has a crumb structure equivalent to or better than a similar baked product made with a natural egg white ~~or a natural whole egg~~.

18. The ingredient composition of claim 16 or claim 17, wherein the baked product is selected from the group consisting of cake, cookie, bagel, biscuit, bread, cracker, muffin, cupcake, scone, roll, pastry, pancake, macaroon, meringue, choux pastry, and soufflé

~~35.~~ 19. ~~The baked product of one of claims 29 to 34, wherein the rOVA comprises an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1.~~

~~36.~~ The ingredient composition~~baked product~~ of any one of claims 16 to 18~~29 to 35, wherein the rOVA comprises an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.~~

37. The baked product of any one of claims 29 to 36, wherein the baked product has a crumb structure equivalent to or better than a similar percentage weight loss is lower in a baked product made with a natural egg white.rOVA when compared to an equivalent baked product made with whole egg.

38. 20. The ingredient composition anyAn emulsified product comprising:

a recombinant ovalbumin (rOVA);

at least one of claims 1 to 15, fat or oil;

water;

wherein the egg-lessrOVA is present in the product at about 2% to 15% (w/w).

39. The emulsified product of claim 38 further comprising an acidifying agent.

40. The emulsified product of claim 38 or claim 39, wherein the product is a salad dressing, a sauce, mayonnaise, a commercial mayonnaise substitute, sandwich spread or a gravy.

41. A food item is a product comprising:

a recombinant ovalbumin (rOVA), wherein the pH of the rOVA when solubilized is between about 3.5 and about 7.0;

at least one sweetener; and

optionally, a consumable liquid or semi-solid;

wherein the rOVA is present in the food product. at about 2% to about 15% (w/w) and wherein the rOVA provides foaming, whipping, fluffing or aeration to the food product.

42. 21. The ingredient compositionfood product of claim 2041, wherein the liquid compositionrOVA further comprises one or more solvents. provides gelation to the food product.

43. 22. The ingredient compositionfood product of any one of claims 1 to 15claim 42, wherein the egg-less food itemrOVA provides improved gelation when the rOVA comprises an amino acid sequence of a chicken OVA and the pH is an emulsified between about 6.5 and 7.0 when solubilized.

44. The food product of claim 42, wherein the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of an ostrich OVA and the pH is less than about 6.0 and above about 3.7 when solubilized.

45. 23. The ingredient composition any onefood product of claims 1 to 1541-44, wherein the egg-less food itemproduct is a meringue, a whipped dessert, a whipped topping or a soufflé.

~~46. The food product of any one of claims 41 to 45, wherein the rOVA provides a foam capacity to the food product of at least 20%, 30%, 40%, or 50% greater than native egg white.~~

~~47. The food product of any one of claims 41 to 46, wherein the rOVA provides a time to foaming to the food product that is at least 20%, 30%, 40%, or 50% faster than native egg white.~~

~~48. The food product of claim 46 or claim 47, wherein the pH of the rOVA when solubilized is between about 3.5 and about 4.5.~~

~~49. The food product of any one of claims 41 to 48, wherein the rOVA is present in the food product at about 5% to about 10% (w/w).~~

~~50. The food product of claim 49, wherein the rOVA is present in the food product at about 7% to about 8% (w/w).~~

~~51. The food product of claim 46 or claim 47, wherein the rOVA is present in the food product at about 4%, about 7%, or about 12% (w/w).~~

~~52. The food product of claim 51, wherein the pH of the rOVA when solubilized is about 6.~~

~~53. The food product of claim 46 or claim 47, wherein the rOVA is present in the food product at between about 9% and about 10% (w/w).~~

~~54. The food product of claim 53, wherein the pH of the rOVA when solubilized is about 7.~~

~~55. The food product of claim 41, wherein the product is a beverage.~~

~~56. The food product of claim 55, wherein the beverage is a consumable alcohol.~~

~~57. The food product of claim 56, wherein the rOVA provides foaming, whipping, fluffing or aeration to the consumable alcohol beverage.~~

~~58. The food product of claim 55, wherein the beverage is a coffee drink.~~

~~59. The food product of claim 58, wherein the rOVA provides foaming, whipping, fluffing or aeration to the coffee drink.~~

~~60. The food product of claim 58 or claim 59, wherein coffee drink lacks a dairy component or comprises a dairy component.~~

~~61. The food product of any one of claims 41 to 60, wherein the rOVA comprises an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1.~~

62. The food product of any one of claims 41 to 61, wherein the rOVA comprises an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.

63. The food product of any one of claims 41 to 62, wherein the rOVA does not contaminate the food product with Salmonella.

64. The food product of any one of claims 41 to 63, wherein the food product is a protein bar, an energy bar, a nutrition bar or a granola bar.

65. The food product of claim 64, wherein the food product comprises between about 4% and about 8% (w/w) rOVA.

66. The food product of claim 64 or claim 65, wherein the bar is baked or is unbaked.

67. A meat-analog food product comprising:

a recombinant ovalbumin (rOVA);

at least one fat or oil; and

a plant-derived protein;

wherein the rOVA is present in the food product between about 2% and about 15% (w/w); and

wherein the rOVA acts as a binding agent or a gelling agent, or a combination thereof.

68. The meat-analog food product of claim 67, wherein the plant protein is an extruded plant protein.

69. The meat-analog food product of claim 67, wherein the plant protein is a non-extruded plant protein.

70. The meat-analog food product of any one of claims 67 to 69, wherein the meat analog food product is selected from a burger, patty, sausage, hot dog, sliced deli meat, jerky, bacon, nugget, a ground meat-like composition, and a formed meat-like composition.

71. The meat-analog food product of any one of claims 67 to 70, wherein the rOVA provides a hardness to the food product that is greater than native egg white.

72. The meat-analog food product of any one of claims 67 to 71, wherein the rOVA provides a chewiness to the food product that is greater than native egg white.

73. The meat-analog food product of claim 71 or claim 72, wherein the rOVA provides a springiness comparable to native egg white.

74. The meat-analog food product of any one of claims 67 to 73, wherein the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of a chicken OVA and the pH is between about 6.5 and 7.0 when solubilized.

75. The meat-analog food product of any one of claims 67 to 73, wherein the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of an ostrich OVA and the pH is less than about 6.0 and above about 3.7 when solubilized.

76. The meat-analog food product of any one of claims 67 to 73, wherein the rOVA is present in the food product at about 4%, at about 5%, or at about 6% (w/w).

77. The meat-analog food product of any one of claims 67 to 73, wherein the rOVA comprises an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1.

78. The meat-analog food product of any one of claims 67 to 76, wherein the rOVA comprises an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.

79. An egg-white substitute comprising:

a recombinant ovalbumin (rOVA);

at least one fat or oil; and

a polysaccharide or polysaccharide-containing ingredient;

wherein the rOVA is present in the composition at about 2% to 15% (w/w); and

wherein the composition has one or more characteristics selected from hardness, adhesiveness, fracturability, cohesiveness, gumminess, and chewiness, and the one or more characteristics are equivalent to or improved as compared to natural egg white when the egg white substitute is cooked.

80. The egg-white substitute of claim 79, further comprising a flavoring agent or a coloring agent, or a combination thereof.

81. The egg white substitute of claim 79 or claim 80, wherein the polysaccharide or polysaccharide-containing ingredient is a starch.

82. The egg-white substitute of any one of claims 79 to 81, wherein the polysaccharide or polysaccharide-containing ingredient is selected from gellan gum, sodium alginate, and psyllium or any combination thereof.

83. The egg white substitute of any one of claims 79 to 82, wherein the rOVA provides a hardness to the food product that is greater than native egg white.

84. The egg-white substitute of any one of claims 79 to 83, wherein the rOVA provides a chewiness to the food product that is greater than native egg white.

85. The egg-white substitute of claim 83 or claim 84, wherein the rOVA provides a gumminess and/or springiness comparable to native egg white.

~~86. The egg-white substitute of any one of claims 79 to 85, wherein the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of a chicken OVA and the pH is between about 6.5 and 7.0 when solubilized.~~

~~87. The egg-white substitute of any one of claims 79 to 85, wherein the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of an ostrich OVA and the pH is less than about 6.0 and above about 3.7 when solubilized.~~

~~88. The egg-white substitute of any one of claims 79 to 85, wherein the rOVA is present in the food product between about 10% and about 12% (w/w).~~

~~89. The egg-white substitute of any one of claims 79 to 88, wherein the rOVA comprises an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1.~~

~~90. The egg-white substitute of any one of claims 79 to 88, wherein the rOVA comprises an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.~~

~~91. A powdered ingredient composition comprising a recombinant ovalbumin (rOVA),~~

~~wherein the pH of the rOVA when solubilized is between about 3.5 and about 7.0,~~

~~wherein the rOVA is at least 75% w/w of the composition, and~~

~~wherein the rOVA comprises one or more N-linked glycosylation sites having mannose linked to an N-acetyl glucosamine, and wherein the N-linked glycosylation sites lack galactose.~~

~~92. The powdered ingredient composition of claim 91, wherein the rOVA comprises an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1.~~

~~93. The powdered ingredient composition of claim 91 or claim 92, wherein the rOVA comprises an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.~~

~~94. The powdered ingredient composition of claim any claim 92 or 93, wherein the amino acid sequence of the rOVA lacks an N-terminal methionine.~~

~~95. The powdered ingredient composition of any one of claims 91 to 94, wherein the rOVA further includes an EAEA amino acid sequence (SEQ ID NO: 75) at its N-terminus.~~

~~96. The powdered composition of any one of claims 91 to 95, wherein the composition comprises at least at least about 80%, at least about 85%, or at least about 90% rOVA (w/w).~~

~~97. A liquid composition comprising a recombinant ovalbumin (rOVA), the composition comprising at least 50% rOVA (w/w of total protein or w/w of total composition).~~

~~98. The liquid composition of claim 97, wherein the composition comprises at least about 60%, at least about 65%, at least about 75%, at least about 80%, at least about 85%, or at least about 90% rOVA (w/w).~~

99. The liquid composition of claim 97 or claim 98, wherein the rOVA comprises an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1.

100. The liquid composition of any one of claims 97 to 99, wherein the rOVA comprises an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.

101. The liquid composition of claim 99 or claim 100, wherein the amino acid sequence of the rOVA lacks an N-terminal methionine.

102. The liquid composition of claim 101, wherein the rOVA further includes an EAEA amino acid sequence (SEQ ID NO: 75) at its N-terminus.

103. The liquid composition of any one of claims 97 to 102, wherein the pH of the solubilized rOVA is between about 3.5 and about 7.0;

104. The liquid composition of any one of claims 97 to 103, wherein the pH of the solubilized rOVA is between about 6 and about 6.8.

105. The liquid composition of any one of claims 97 to 104, wherein the pH of the rOVA when solubilized is less than about 6.1.

106. The liquid composition of any one of claims 97 to 105, wherein the rOVA provides to an egg-less food item at least one egg white characteristic selected from gelling, foaming, whipping, fluffing, binding, springiness, aeration, coating, film forming, emulsification, browning, thickening, texturizing, humectant, clarification, and cohesiveness.

107. The liquid composition of claim 106, wherein the rOVA provides an equivalent or an improvement in the characteristic compared to native egg white in a similar egg-less food item.

108. The liquid composition of any one of claims 97 to 107, wherein the rOVA provides to the egg-less food item a foam capacity of at least 20%, 30%, 40%, or 50% greater than native egg white.

109. The liquid composition of any one of claims 97 to 108, wherein the rOVA provides to the egg-less food item a time to foaming that is at least 20%, 30%, 40%, or 50% faster than native egg white.

110. The liquid composition of any one of claims 106 to 109, wherein the pH of the rOVA when solubilized is between about 3.5 and about 4.5.

111. The liquid composition of any one of claims 106 to 110, wherein the rOVA is present in the egg-less food item at about 5% to about 10% (w/w).

112. The liquid composition of claim 111, wherein the rOVA is present in the egg-less food item at about 7% to about 8% (w/w).

113. The liquid composition of any one of claims 106 to 109, wherein the rOVA is present the egg-less food item at about 4%, about 7%, or about 12% (w/w).

114. The liquid composition of claim 113, wherein the pH of the rOVA when solubilized is about 6.

115. The liquid composition of any one of claims 97 to 114, wherein the rOVA provides to the egg-less food item a hardness that is greater than native egg white.

116. The liquid composition of any one of claims 97 to 115, wherein the rOVA provides to the egg-less food item a chewiness that is greater than native egg white.

117. The liquid composition of claim 115 or claim 116, wherein the rOVA provides to the egg-less food item a springiness comparable to native egg white.

118. The liquid composition of any one of claims 97 to 117, wherein the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of a chicken OVA and the pH is between about 6.5 and 7.0 when solubilized.

119. The liquid composition of any one of claims 97 to 117, wherein the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of an ostrich OVA and the pH is less than about 6.0 and above about 3.7 when solubilized.

120. The liquid composition of any one of claims 97 to 119, wherein the rOVA does not contaminate the egg-less food item with Salmonella.

121. A dry or powdered composition comprising a recombinant ovalbumin (rOVA), the composition comprising at least 50% rOVA (w/w of total protein or w/w of total composition).

122. The dry or powdered composition of claim 121, the composition comprising at least about 60%, at least about 65%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, or at least about 95% rOVA (w/w).

123. The dry or powdered composition of claim 121 or claim 122, wherein the rOVA comprises an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1.

124. The dry or powdered composition of any one of claims 121 to 123, wherein the rOVA comprises an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.

125. The dry or powdered composition of claim 123 or claim 124, wherein the amino acid sequence of the rOVA lacks an N-terminal methionine.

126. The dry or powdered composition of claim 125, wherein the rOVA further includes an EAEA amino acid sequence (SEQ ID NO: 75) at its N-terminus.

127. The dry or powdered composition of any one of claims 121 to 126, wherein the rOVA provides to an egg-less food item at least one egg white characteristic selected from gelling, foaming, whipping, fluffing, binding, springiness, aeration, coating, film forming, emulsification, browning, thickening, texturizing, humectant, clarification, and cohesiveness.

128. The dry or powdered composition of claim 127, wherein the rOVA provides an equivalent or an improvement in the characteristic compared to native egg white in a similar egg-less food item.

129. The dry or powdered composition of any one of claims 121 to 128, wherein the rOVA provides to the egg-less food item a foam capacity of at least 20%, 30%, 40%, or 50% greater than native egg white.

130. The dry or powdered composition of any one of claims 121 to 129, wherein the rOVA provides to the egg-less food item a time to foaming that is at least 20%, 30%, 40%, or 50% faster than native egg white.

131. The dry or powdered composition of any one of claims 121 to 129, wherein the pH of the rOVA when solubilized is between about 3.5 and about 4.5.

132. The dry or powdered composition of any one of claims 121 to 129, wherein the rOVA is present in the egg-less food at about 4%, about 7%, or about 12% (w/w).

133. The food product of claim 132, wherein the pH of the rOVA when solubilized is about 6

134. The dry or powdered composition of any one of claims 121 to 133, wherein the rOVA provides to the egg-less food item a hardness that is greater than native egg white.

135. The dry or powdered composition of any one of claims 121 to 134, wherein the rOVA provides to the egg-less food item a chewiness that is greater than native egg white.

136. The dry or powdered composition of claim 134 or claim 135, wherein the rOVA provides to the egg-less food item a springiness comparable to native egg white.

137. The dry or powdered composition of any one of claims 121 to 136, wherein the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of a chicken OVA and the pH is between about 6.5 and 7.0 when solubilized.

138. The dry or powdered composition of any one of claims 121 to 136, wherein the rOVA provides improved gelation when the rOVA comprises an amino acid sequence of an ostrich OVA and the pH is less than about 6.0 and above about 3.7 when solubilized.

139. A method of making a food product comprising:

providing a recombinant ovalbumin (rOVA) at a pH when solubilized of between about 3.5 and about 7.0;

combining the rOVA in an amount between 2% and 15% (w/w) with one or more consumable ingredients to form a food product,

wherein the rOVA provides at least one egg white characteristic to the food product selected from gelling, foaming, whipping, fluffing, binding, springiness, aeration, coating, film forming, emulsification, browning, thickening, texturizing, humectant, clarification and cohesiveness.

140. A method of producing an ingredient composition, the method comprising:

expressing a recombinant ovalbumin (rOVA) in a microbial cell, wherein the rOVA is secreted by the microbial cell into a liquid media;

harvesting the liquid media containing secreted rOVA;

performing a separation step at a pH of about 3.5;

solubilizing the rOVA at a pH of about 12;

adjusting the final pH of the rOVA to between about 3.5 and about 7.0 to generate the ingredient composition.

141. The method of claim 140, wherein the separation step comprises ion exchange chromatography or ammonium sulfate precipitation.

142. The method of claim 141, wherein the ion exchange chromatography is cation exchange chromatography or anion exchange chromatography, or a combination thereof.

143. The method of any one of claims 140 to 142, wherein the method further comprises a filtration step following the solubilizing step.

144. The method of any one of claims 140 to 143, wherein the microbial cell is a fungal cell.

145. The method of claim 144, wherein the fungal cell is a Pichia sp.

146. The method of claim 144 or claim 145, wherein the microbial cell expresses a recombinant helper factor; wherein the helper factor enhances the level of expression or accumulation of rOVA.

147. The method of any one of claims 140 to 146, wherein the rOVA comprises an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1.

148. The method of any one of claims 140 to 147, wherein the rOVA comprises an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.

149. The method of claim 147 or claim 148, wherein the amino acid sequence of the secreted rOVA lacks an N-terminal methionine.

150. The method of any one of claims 140 to 149, wherein the secreted rOVA further includes an EAEA amino acid sequence (SEQ ID NO: 75) at its N-terminus.

151. An egg-less food product comprising a recombinant ovalbumin (rOVA) in an amount of between about 15% and about 25% (w/w of total protein or w/w of food product).

152. The egg-less food product of claim 151, comprising the rOVA in an amount of up to about 23% (w/w).

153. Use of a recombinant ovalbumin (rOVA) as an ingredient in making a baked product.

154. Use of a recombinant ovalbumin (rOVA) as an ingredient in making an egg-less food product.

~~155. Use of a recombinant ovalbumin (rOVA) as an ingredient in making a meat-analog food product.~~

~~156. Use of a recombinant ovalbumin (rOVA) as an ingredient in making an egg-white substitute.~~

~~157. Use of a recombinant ovalbumin (rOVA) as a substitute egg-wash for a baked product; wherein the substitute egg-wash provides film formation equivalent to or better than an egg-wash comprising a natural egg white or a natural whole egg.~~

~~158. The use of any one of claims 153 to 157, wherein the rOVA comprises an amino acid sequence of SEQ ID NO: 2 or SEQ ID NO: 1 or an amino acid sequence with at least 70% identity to SEQ ID NO: 2 or SEQ ID NO: 1.~~

~~159. The use of any one of claims 153 to 157, wherein the rOVA comprises an amino acid sequence of a duck OVA, an ostrich OVA, or a chicken OVA.~~

~~160. The use of any one of claims 153 to 158, wherein the rOVA is present in the egg-wash in an amount between 8% and 9% (w/w).~~

~~161. A large-scale production of a recombinant ovalbumin (rOVA), wherein the large-scale production comprises an at least 1-liter liquid culture of microbial cells expressing the rOVA.~~

~~162. The large-scale production of the rOVA of claim 161, wherein the large-scale production comprises an at least 10-liter liquid culture of microbial cells expressing the rOVA.~~

~~163. The large-scale production of the rOVA of claim 162, wherein the large-scale production comprises an at least 100-liter liquid culture of microbial cells expressing the rOVA.~~

~~164. The large-scale production of the rOVA of claim 162, wherein the large-scale production comprises an at least 1,000-liter liquid culture of microbial cells expressing the rOVA.~~

~~165. The large-scale production of the rOVA of claim 162, wherein the large-scale production comprises an at least 10,000-liter liquid culture of microbial cells expressing the rOVA.~~

~~166. The large-scale production of the rOVA of claim 162, wherein the large-scale production comprises an at least 100,000-liter liquid culture of microbial cells expressing the rOVA.~~

~~167. The large-scale production of the rOVA of claim 162, wherein the large-scale production comprises about a 200,000-liter liquid culture of microbial cells expressing the rOVA.~~