

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

[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 embodiments of the present disclosure are shown and described. As will be realized, the present disclosure is capable of other and different embodiments, 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.

[0005] In some embodiments, 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,

coating, film forming, emulsification, browning, thickening, texturizing, humectant, clarification, and cohesiveness.

[0006] In some cases, the composition may be dried or may be a powder. In some cases, the composition may comprise at least 75% rOVA (w/w of total protein or w/w of total composition). In some cases, the powder composition may be a concentrate. In some cases, the powder composition may be an isolate. In some cases, the powder composition may be at least about 75%, at least about 80%, at least about 85%, or at least about 90% rOVA (w/w). In some cases, the powder composition is at least about 80%, at least about 85%, or at least about 90% rOVA (w/w). In some cases, the powder is a concentrate. In some cases, the powder composition is an isolate.

[0007] In some cases, the composition may be a liquid. In some cases, the liquid composition may comprise at least 50% rOVA (w/w of total protein or w/w of composition). In some cases, 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). The term w/w of total protein in the context of a % rOVA means that the rOVA comprises a defined percentage of the total protein in the composition. In one example, a composition comprising at least 50% rOVA w/w of total protein would have at least half of the total protein being rOVA and the other half or so being another protein. Thus, the total composition does not necessarily need to be at least 50% rOVA by weight, only the composition's protein content must be at least 50% rOVA.

[0008] In some cases, the rOVA provides an equivalent or an improvement in the characteristic compared to native egg white in a similar food item. In some cases, the rOVA provides a foam capacity of at least 20%, 30%, 40%, or 50% greater than native egg white. In some cases, the rOVA provides 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 provides a hardness to the egg-less food composition that may be greater than native egg white. In some cases, the rOVA provides a chewiness to the egg-less food composition that may be greater than native egg white. In some cases, the rOVA provides a springiness comparable to native egg white.

[0009] 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.

[0010] 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.

[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 embodiments, 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 embodiments, 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 embodiments, 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 embodiments, 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 embodiments, 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 embodiments, 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 about 80%, at least about 85%, or at least about 90% rOVA (w/w).

[0027] In some embodiments, 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 in 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 embodiments, 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 EAEE 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 embodiments, 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 embodiments, 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 embodiments, 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 embodiments, 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 embodiments, 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 embodiments, 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 embodiments, 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 embodiments, 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 embodiments, 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 embodiments, 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 embodiments, 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 described herein can be combined with any other aspect or embodiment 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.

[0074] **FIG. 4** illustrates heat coagulation and foaming properties of whole egg, egg white and native OVA solutions.

[0075] **FIG. 5** illustrates heat coagulation and foaming properties of egg white and native OVA compared to rOVA.

[0076] **FIG. 6A** illustrates gel electrophoresis migration of glycosylated native and recombinant OVA. Also shown are deglycosylated recombinant OVA treated with EndoH and PNGaseF enzymes.

[0077] **FIG. 6B** illustrates a chromatogram depicting glycosylation patterns of rOVA produced in *P. pastoris*.

[0078] **FIG. 7** illustrates gelation results before and after foaming of various OVA samples compared to egg white.

[0079] **FIG. 8** illustrates film formation using nOVA, rOVA, whole egg wash and a commercial egg-white substitute.

[0080] **FIGs. 9A-B** illustrates emulsification results of nOVA, rOVA and egg white protein at acidic and neutral pH.

[0081] **FIG. 10** illustrates foaming of rOVA and control samples in an alcohol-based drink.

[0082] **FIG. 11** illustrates egg patties made using nOVA, rOVA and egg white proteins.

[0083] **FIG. 12** illustrates meringues made using rOVA samples and egg white proteins.

[0084] **FIG. 13** illustrates protein bars made with egg white proteins (EWP), nOVA and rOVA at different protein inclusion levels.

DETAILED DESCRIPTION OF THE INVENTION

[0085] While various embodiments of the invention have been shown and described herein, it will be obvious to those skilled in the art that such embodiments are provided by way of example only. Numerous variations, changes, and substitutions may occur to those skilled in the art without departing from the invention. It should be understood that various alternatives to the embodiments of the invention described herein may be employed.

[0086] Provided herein are compositions and methods of making compositions for non-animal-based sources of proteins which provide nutritional as well as functional properties to food ingredients and consumable products for ingestion by an animal, including a human, such as for daily diet, ingredients for human food and treats and for human and animal nutrition.

[0087] The compositions and methods provided herein contain fermentation-derived ovalbumin, produced through recombinant technology, i.e., a recombinant ovalbumin (rOVA). The compositions and methods for making compositions comprising rOVA can increase the protein

content of a consumable or food ingredient, and also provide functional features for use in the preparation of food ingredients and consumable food products for animal and human ingestion.

[0088] In some embodiments, the rOVA provides one or more functional characteristics such as of gelling, foaming, whipping, fluffing, binding, springiness, aeration, coating, film forming, emulsification, browning, thickening, texturizing, humectant, clarification, and cohesiveness. The rOVA with such feature(s) can be a food ingredient that provides for production of an egg-less or animal-free food ingredient or food product.

[0089] As used herein “native” in the context of native egg white, native egg protein, native ovalbumin and native egg, refers to the egg white, egg protein, ovalbumin or whole egg, respectively, produced by an animal or collected from an animal, in particular an egg-laying animal such as a bird. The rOVA and compositions containing rOVA can be used in food ingredients and food products, such that the ingredient or product does not contain any native egg white, native egg protein, native ovalbumin or native egg. In some cases, the ingredients or food products made using rOVA do not include any egg-white proteins other than rOVA. The rOVA and compositions containing rOVA can be used in food ingredients and food products, such that the ingredient or product does not contain any animal products.

[0090] In some embodiments, the rOVA can (alone or with other ingredients) substitute for the use of whole egg or egg white in the production of a food product. In some embodiments, the feature(s) provided by the rOVA is substantially the same or better than the same characteristic provided by a native egg white or native egg. For example, the rOVA and compositions containing rOVA can have gelling, foaming, whipping, fluffing, binding, springiness, aeration, coating, film forming, emulsification, browning, thickening, texturizing, preserving moisture (humectant), clarification, and cohesiveness, improved color, such as a whiter color, as compared to native egg white or native whole egg and compositions made with native egg white.

Food ingredients and food products with rOVA

[0091] Food ingredients and food products disclosed herein include compositions that comprise, consists essentially of, or consist of rOVA, where rOVA provides at least one functional feature to the composition, food ingredient, or food product. In some cases, at least one functional feature provided by the rOVA is comparable or substantially similar to a native egg or egg white or native OVA (nOVA). For instance, it may provide any one of gelling, foaming, whipping, fluffing, binding, springiness, aeration, coating, film forming, emulsification, browning, thickening, texturizing, preserving moisture (humectant), clarification, and cohesiveness comparable to a whole egg, egg-white or nOVA composition. In some embodiments, the at least one functional

feature is provided by or provided substantially by the inclusion of rOVA in the food ingredient or food product, for example, in the absence of any other whole egg proteins or egg white proteins.

[0092] Such compositions can include rOVA in an amount between 0.1% and 25% on a weight/weight (w/w) or weight/volume (w/v) basis. rOVA may be present at or at least at 0.1%, 0.2%, 0.25%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, 16%, 17%, 18%, 19%, 20%, 21%, 22%, 23%, 24%, or 25% on a weight/weight (w/w) or weight/volume (w/v) basis. These concentrations can be based on the dry weight of the composition. Additionally, or alternatively, the concentration of rOVA in such compositions is at most 30%, 20%, 15%, 10%, 5%, 4%, 3%, 2% or 1% on a w/w or w/v basis. In some embodiments, the rOVA in the food ingredient or food product can be at a concentration range of 0.1%-20%, 1% - 20%, 0.1%-10%, 1% - 10%, 0.1% - 5%, 1% - 5%, 2-10%, 4-8%, 4-10%, 4-12%, 0.1% - 2%, 1% - 2% or 0.1-1%.

[0093] Provided herein are consumable food compositions and methods of making such compositions where rOVA provides at least one feature of whole egg or egg-whites to a consumable food composition. In some embodiments, rOVA is added to a consumable food composition to increase the protein content, such as for added nutrition. In some embodiments, rOVA is present in the consumable food composition between about 1% and about 40% on a weight per total weight (w/w) and/or weight per total volume (w/v) of composition basis. For example, in a composition of 100 ml, rOVA is present at 30g and the rOVA is thus at a 30% concentration (w/v) or for example, in a composition of 100 g, rOVA is present at 30g and the rOVA is thus at a 30% concentration (w/w). In some embodiments, the concentration of rOVA is or is about 0.5%, 1%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, 16%, 17%, 18%, 19%, 20%, 21%, 22%, 23%, 24%, 25%, 26%, 27%, 28%, 29%, 30%, 31%, 32%, 33%, 34%, 35%, 36%, 37%, 38%, 39% or 40% on a w/w and/or w/v of composition basis. In some embodiments, the rOVA is present at a concentration of or of about 0.5-1%, 1-5%, 2-8%, 4-8%, 2-12%, 4-12%, 5-10%, 10-15%, 15-20%, 20-25%, 25-30% or rOVA is present concentration greater than 1%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, 16%, 17%, 18%, 19%, 20%, 21%, 22%, 23%, 24%, 25%, 26%, 27%, 28%, 29%, 30%, 31%, 32%, 33%, 34%, 35%, 36%, 37%, 38%, 39% or 40% w/w and/or w/v.

[0094] A consumable product can include one or more other proteins, such as a non-OVA protein or a non-recombinant protein. The rOVA can increase amount of protein content in a consumable product, and/or provide one or more egg-white like features. For example, the consumable composition can include a whey protein, a pea protein, a soy protein, an almond protein, an oat protein, a flax seed protein, a vegetable protein, or an egg-white protein. The consumable protein may include an extruded plant protein or a non-extruded plant protein. In some cases, the one or

more other proteins can comprise OVA having an amino acid sequence naturally found in a bird or a reptile.

[0095] In some embodiments, the compositions and methods for making compositions have an egg-white like property and increase the protein content in the composition. In some embodiments, the compositions and methods for making compositions with an egg-white like property increase the protein content, while not adversely affecting the stability, or one or more sensory qualities of the composition.

[0096] In some embodiments, the consumable food compositions and methods for making consumable food compositions comprise rOVA and the addition of rOVA generates an egg-white like composition. The consumable food composition may be a finished product or an ingredient for making a finished product, e.g., a liquid or a powdered rOVA composition.

[0097] rOVA protein may be used on its own or in combination with other components to form a composition. In some embodiments, rOVA is used as an ingredient to form a composition and the rOVA ingredient (or rOVA starting composition to be added) may contain about or at least about 10%, 20%, 30%, 40%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% rOVA by weight per total weight (w/w) and/or weight per total volume (w/v). In some cases, a composition described herein may contain up to about 10%, 20%, 30%, 40%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% rOVA by w/w or w/v. In some embodiments, about or at least about 10%, 20%, 30%, 40%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% of the protein in a composition is rOVA by weight per total weight (w/w) and/or weight per total volume (w/v). In some cases, up to or about 10%, 20%, 30%, 40%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% of the protein in a composition is rOVA by w/w or w/v.

[0098] In some embodiments, a composition described herein contains total protein at a concentration of about or at least 5, 6, 7, 8, 9, 10, 11, 12, 13, 13.2, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, or 75 g total protein per 100 mL liquid (e.g., water). In some cases, a composition described herein contains total protein at a concentration of about or at least 5, 6, 7, 8, 9, 10, 11, 12, 13, 13.2, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, or 100 g total protein per 100 g composition (e.g., powder).

[0099] In some embodiments, a composition described herein contains rOVA at a concentration of about or at least 5, 6, 7, 8, 9, 10, 11, 12, 13, 13.2, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, or 75 g per 100 mL liquid (e.g., water). In some cases, a composition described herein contains rOVA at a concentration of about or at least 5, 6, 7, 8, 9,

10, 11, 12, 13, 13.2, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, or 100 g total protein per 100 g composition (e.g., powder)

[0100] In some embodiments, a composition described herein contains total protein at a concentration of about or at least 0.1, 0.2, 0.3, 0.5, 0.7, 1.0, 1.2, 1.5, 1.7, 2.0, 2.2, 2.5, 2.7, 3.0, 3.2, 3.5, 3.7, 4.0, 4.2, 4.5, 4.7 or 5g total protein per 100 mL liquid (e.g., water). In some cases, a composition described herein contains total protein at a concentration of about or at least 0.1, 0.2, 0.3, 0.5, 0.7, 1.0, 1.2, 1.5, 1.7, 2.0, 2.2, 2.5, 2.7, 3.0, 3.2, 3.5, 3.7, 4.0, 4.2, 4.5, 4.7 or 5g total protein per 100 g composition (e.g., powder).

[0101] In some embodiments, a composition described herein contains rOVA at a concentration of about or at least 0.1, 0.2, 0.3, 0.5, 0.7, 1.0, 1.2, 1.5, 1.7, 2.0, 2.2, 2.5, 2.7, 3.0, 3.2, 3.5, 3.7, 4.0, 4.2, 4.5, 4.7 or 5g per 100 mL liquid (e.g., water). In some cases, a composition described herein contains rOVA at a concentration of about or at least 0.1, 0.2, 0.3, 0.5, 0.7, 1.0, 1.2, 1.5, 1.7, 2.0, 2.2, 2.5, 2.7, 3.0, 3.2, 3.5, 3.7, 4.0, 4.2, 4.5, 4.7 or 5g per 100 g composition (e.g., powder).

[0102] In some embodiments, the rOVA consumable composition is a liquid composition. In such cases, the concentration of rOVA in the liquid composition may be between 0.1% to 90%. The concentration of rOVA in the liquid composition may be at least 0.1%. The concentration of rOVA in the liquid composition may be at most 90%. The concentration of rOVA in the liquid composition may be from 0.1% to 1%, 0.1% to 5%, 0.1% to 10%, 0.1% to 15%, 0.1% to 20%, 0.1% to 25%, 0.1% to 30%, 0.1% to 35%, 0.1% to 40%, 1% to 5%, 1% to 10%, 1% to 15%, 1% to 20%, 1% to 25%, 1% to 30%, 1% to 35%, 1% to 40%, 5% to 10%, 5% to 15%, 5% to 20%, 5% to 25%, 5% to 30%, 5% to 35%, 5% to 40%, 10% to 15%, 10% to 20%, 10% to 25%, 10% to 30%, 10% to 35%, 10% to 40%, 15% to 20%, 15% to 25%, 15% to 30%, 15% to 35%, 15% to 40%, 20% to 25%, 20% to 30%, 20% to 35%, 20% to 40%, 25% to 30%, 25% to 35%, 25% to 40%, 30% to 35%, 30% to 40%, 35% to 40%, 40% to 45%, 45% to 50%, 50% to 55%, 55% to 60%, 60% to 65%, 65% to 70%, 70% to 75%, 75% to 80%, 80% to 85%, 85% to 90%, or 90% to 95% in weight per total volume (w/v). The concentration of rOVA in the liquid composition may be about 0.1%, 1%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, or 95% w/v. The concentration of rOVA in the liquid composition may be at least 0.1%, 1%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, or 95% w/v. The concentration of rOVA in the liquid composition may be at most 1%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, or 95% w/v. In some embodiments, rOVA is the sole protein in the liquid composition. In other embodiments, a liquid composition comprises proteins other than rOVA.

[0103] In some embodiments, the rOVA consumable composition is a solid composition. In such cases, the concentration of rOVA in the solid composition may be between 0.1% to 70%. The

concentration of rOVA in the solid composition may be at least 0.1%. The concentration of rOVA in the solid composition may be at most 70%. The concentration of rOVA in the solid composition may be 0.1% to 1%, 0.1% to 10%, 0.1% to 20%, 0.1% to 30%, 0.1% to 40%, 0.1% to 50%, 0.1% to 60%, 0.1% to 70%, 1% to 10%, 1% to 20%, 1% to 30%, 1% to 40%, 1% to 50%, 1% to 60%, 1% to 70%, 10% to 20%, 10% to 30%, 10% to 40%, 10% to 50%, 10% to 60%, 10% to 70%, 20% to 30%, 20% to 40%, 20% to 50%, 20% to 60%, 20% to 70%, 30% to 40%, 30% to 50%, 30% to 60%, 30% to 70%, 40% to 50%, 40% to 60%, 40% to 70%, 50% to 60%, 50% to 70%, or 60% to 70% weight per total weight (w/w) and/or weight per total volume (w/v). The concentration of rOVA in the solid composition may be 0.1%, 1%, 10%, 20%, 30%, 40%, 50%, 60%, or 70% w/w or w/v. The concentration of rOVA in the solid composition may be at least 0.1%, 1%, 10%, 20%, 30%, 40%, 50% or 60% w/w or w/v. The concentration of rOVA in the solid composition may be at most 1%, 10%, 20%, 30%, 40%, 50%, 60%, or 70% w/w or w/v.

[0104] In some embodiments, the rOVA consumable composition is a powdered composition. In such cases, the concentration of rOVA in the powder composition may be between 15% to 99% weight per total weight (w/w) and/or weight per total volume (w/v). The concentration of rOVA in the powder composition may be at least 15% w/w or w/v. In embodiments, the concentration of rOVA in the powder composition may be at most 99% w/w or w/v. The concentration of rOVA in the powder composition may be 15% to 30%, 15% to 45%, 15% to 60%, 15% to 75%, 15% to 80%, 15% to 85%, 15% to 90%, 15% to 95%, 15% to 99%, 30% to 45%, 30% to 60%, 30% to 75%, 30% to 80%, 30% to 85%, 30% to 90%, 30% to 95%, 30% to 99%, 45% to 60%, 45% to 75%, 45% to 80%, 45% to 85%, 45% to 90%, 45% to 95%, 45% to 99%, 60% to 75%, 60% to 80%, 60% to 85%, 60% to 90%, 60% to 95%, 60% to 99%, 75% to 80%, 75% to 85%, 75% to 90%, 75% to 95%, 75% to 99%, 80% to 85%, 80% to 90%, 80% to 95%, 80% to 99%, 85% to 90%, 85% to 95%, 85% to 99%, 90% to 95%, 90% to 99%, or 95% to 99% w/w or w/v. The concentration of rOVA in the powder composition may be about 15%, 30%, 45%, 60%, 75%, 80%, 85%, 90%, 95%, or 99% w/w or w/v. The concentration of rOVA in the powder composition may be at least 15%, 30%, 45%, 60%, 75%, 80%, 85%, 90% or 95% w/w or w/v. The concentration of rOVA in the powder composition may be at most 30%, 45%, 60%, 75%, 80%, 85%, 90%, 95%, or 99% w/w or w/v. In some embodiments, rOVA is the sole protein in the powder composition. In other embodiments, a powder composition comprises proteins other than rOVA.

[0105] In some cases, a powder composition may be a concentrate which comprises at least 70% rOVA w/w. In some cases, a powder composition may be a concentrate which comprises at least 80% rOVA w/w. In some cases, a powder composition may be an isolate which comprises at least 90% rOVA w/w. In some cases, a powder composition may be an isolate which comprises at least 95% rOVA w/w.

[0106] In some embodiments, the rOVA consumable composition is a concentrated liquid composition. In such cases, the concentration of rOVA in the concentrated liquid composition may be between 10% to 60% weight per total weight (w/w) and/or weight per total volume (w/v). The concentration of rOVA in the concentrated liquid may be at least 10% w/w or w/v. The concentration of rOVA in the concentrated liquid may be at most 60% w/w or w/v. The concentration of rOVA in the concentrated liquid may be 10% to 20%, 10% to 30%, 10% to 40%, 10% to 50%, 10% to 60%, 20% to 30%, 20% to 40%, 20% to 50%, 20% to 60%, 30% to 40%, 30% to 50%, 30% to 60%, 40% to 50%, 40% to 60%, or 50% to 60% w/w or w/v. The concentration of rOVA in the concentrated liquid may be about 10%, 20%, 30%, 40%, 50%, or 60% w/w or w/v. The concentration of rOVA in the concentrated liquid may be at least 10%, 20%, 30%, 40% or 50% w/w or w/v. The concentration of rOVA in the concentrated liquid may be at most 20%, 30%, 40%, 50%, or 60% w/w or w/v. The liquid may include any consumable solvent, e.g., water, dairy, oil, or other cooking base.

[0107] In some embodiments, the rOVA consumable composition is a prepared food for example, as a baked good, a salad dressing, an egg-like dish (such as an egg-patty or scramble), a dessert or dairy-like product or a meat-analog (such as a vegan meat patty, sausage or hot dog). Such compositions can include rOVA in an amount between 0.1% and 20% on a weight/weight (w/w) or weight/volume (w/v) basis. rOVA may be present at or at least at 0.1%, 0.2%, 0.25%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, 16%, 17%, 18%, 19%, or 20% on a weight/weight (w/w) or weight/volume (w/v) basis. Additionally, or alternatively, the concentration of rOVA in such compositions is at most 30%, 20%, 15%, 10%, 5%, 4%, 3%, 2% or 1% on a w/w or w/v basis. In some embodiments, the rOVA in the food ingredient or food product can be at a concentration range of 0.1%-20%, 1% - 20%, 0.1%-10%, 1% - 10%, 0.1% - 5%, 1% - 5%, 0.1% - 2%, 1% - 2% or 0.1-1%.

Features and characteristics of rOVA compositions and food ingredients and food products containing rOVA

[0108] The rOVA containing compositions herein can provide one or more functional features to food ingredients and food products. In some embodiments, the rOVA provides a nutritional feature such as protein content, protein fortification and amino acid content to a food ingredient or food product. The nutritional feature provided by rOVA in the composition may be comparable or substantially similar to an egg, egg white or native OVA (nOVA). The nutritional feature provided by rOVA in the composition may be better than that provided by a native whole egg or native egg white. In some cases, rOVA provides the one or more functional features of egg-white in absence of any other egg-white proteins.

[0109] rOVA compositions disclosed herein can provide foaming and foam capacity to a composition. For example, rOVA can be used for forming a foam to use in baked products, such as cakes, for meringues and other foods where rOVA can replace egg white to provide foam capacity. In some cases, rOVA provides foaming and foam capacity of egg-white in absence of any other egg-white proteins.

[0110] A composition comprising rOVA may have a foam height greater than a foam height of an egg white or a composition comprising nOVA. In some cases, a composition comprising rOVA may have a foam height of about or at least 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, 105%, 110%, 115%, 120%, 125%, 130%, 135%, 140%, 145%, 150%, 160%, 170%, 180%, 190%, 200%, 210%, 220%, 230%, 240%, 250%, 260%, 270%, 280%, 290%, 300%, 350%, 400%, 450%, or 500% relative to an egg white, nOVA compositions or a substitute egg white. In some cases, a composition comprising rOVA may have a foam height of up to 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, 105%, 110%, 115%, 120%, 125%, 130%, 135%, 140%, 145%, 150%, 160%, 170%, 180%, 190%, 200%, 210%, 220%, 230%, 240%, 250%, 260%, 270%, 280%, 290%, 300%, 350%, 400%, 450%, or 500% relative to an egg white, nOVA compositions or a substitute egg white. Substitute egg whites may include products such as aquafaba, chia seeds, flax seeds, starches; apple sauce, banana puree; condensed milk, etc. which are commonly used as egg white substitutes.

[0111] A composition comprising rOVA may have a foam stability greater than a foam stability of an egg white, nOVA compositions or a substitute egg white. In some cases, a composition comprising rOVA may have a foam stability of about or at least 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, 105%, 110%, 115%, 120%, 125%, 130%, 135%, 140%, 145%, 150%, 160%, 170%, 180%, 190%, 200%, 210%, 220%, 230%, 240%, 250%, 260%, 270%, 280%, 290%, 300%, 350%, 400%, 450%, or 500% relative to an egg white or a substitute egg white. In some cases, a composition comprising rOVA may have a foam stability of up to 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, 105%, 110%, 115%, 120%, 125%, 130%, 135%, 140%, 145%, 150%, 160%, 170%, 180%, 190%, 200%, 210%, 220%, 230%, 240%, 250%, 260%, 270%, 280%, 290%, 300%, 350%, 400%, 450%, or 500% relative to an egg white. Foam stability may be calculated by measuring drainage of a foamed solution. The drainage may be measured in 10-minute increments for 30 minutes to gather data for foam stability. The drained volume after 30 minutes may be compared to the initial liquid volume (5mL) for instance, foam Stability (%): $(\text{Initial volume} - \text{drained volume}) / \text{initial volume} * 100$.

[0112] A composition comprising rOVA may have a foam capacity greater than a foam capacity of an egg white, nOVA compositions or a substitute egg white. In some cases, a composition comprising rOVA may have a foam capacity of about or at least 50%, 55%, 60%, 65%, 70%, 75%,

80%, 85%, 90%, 95%, 100%, 105%, 110%, 115%, 120%, 125%, 130%, 135%, 140%, 145%, 150%, 160%, 170%, 180%, 190%, 200%, 210%, 220%, 230%, 240%, 250%, 260%, 270%, 280%, 290%, 300%, 350%, 400%, 450%, or 500% relative to an egg white, nOVA or a substitute egg white. In some cases, a composition comprising rOVA may have a foam capacity of up to 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, 105%, 110%, 115%, 120%, 125%, 130%, 135%, 140%, 145%, 150%, 160%, 170%, 180%, 190%, 200%, 210%, 220%, 230%, 240%, 250%, 260%, 270%, 280%, 290%, 300%, 350%, 400%, 450%, or 500% relative to an egg white, nOVA compositions or a substitute egg white. Foam capacity may be determined by measuring the initial volume of foam following the whipping and compare against the initial volume of 5mL. Foam Capacity (%) = (volume of foam / initial volume)*100.

[0113] A liquid composition may foam faster than a composition comprising egg whites, nOVA or a substitute egg white. In some cases, an rOVA composition foams at least 1%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100%, faster than an egg white, nOVA or substitute egg-white composition. In some cases, an rOVA composition foams up to 1%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100% faster than an egg white, nOVA or substitute egg-white composition.

[0114] A composition comprising rOVA may have a gel strength greater than a gel strength of an egg white, nOVA composition or a egg white substitutes. In some cases, the rOVA composition may have a gel strength within the range from 100 g to 1500 g, from 500 g to 1500 g, or from 700 g to 1500 g. In some cases, an rOVA composition has a gel strength of about or at least 10, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000, 1050, 1100, 1150, 1200, 1250, 1300, 1350, 1400, 1450, or 1500 g. In some cases, an rOVA composition has a gel strength of up to 10, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000, 1050, 1100, 1150, 1200, 1250, 1300, 1350, 1400, 1450, or 1500 g. In some cases, an rOVA composition has a gel strength of about or at least 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100% relative to an egg white, nOVA or egg white substitutes. In some cases, an rOVA composition has a gel strength of up to 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, 100% relative to an egg white, nOVA or egg white substitutes.

[0115] rOVA compositions disclosed herein can provide structure, texture or a combination of structure and texture. In some embodiments, rOVA is added to a food ingredient or food product for baking and the rOVA provides structure, texture or a combination of structure and texture to the baked product. rOVA can be used in such baked products in place of native egg white, native egg or native egg protein. The addition of rOVA to baked products can also provide protein

fortification to improve the nutritional content. In some embodiments, rOVA is used in a baked product in an amount between 0.1% and 25% on a weight/weight or weight/volume basis. In some embodiments, rOVA is used in a baked product in an amount between 0.1% and 5%. In some cases, rOVA provides the structure and/or texture of egg-white in absence of any other egg-white proteins.

[0116] rOVA compositions disclosed herein can be compatible with gluten formation, such that the rOVA can be used where gluten formation provides structure, texture and/or form to a food ingredient or food product.

[0117] Exemplary baked products in which rOVA can be used as an ingredient include, but are not limited to cake, cookie, bread, bagel, biscuits, muffin, cupcake, scone, pancake, macaroon, choux pastry, meringue, and soufflé. For example, rOVA can be used as an ingredient to make cakes such as pound cake, sponge cake, yellow cake, or angel food cake, where such cakes do not contain any native egg white, native whole egg or native egg protein. Along with rOVA, baked products may contain additional ingredients such as flour, sweetening agents, gum, hydrocolloids, starches, fibers, flavorings (such as flavoring extracts) and other protein sources. In some embodiments, a baked product may include rOVA and at least one fat or oil, at least one grain starch, and optionally at least one sweetener. Grain starch for use in such compositions include flours such as wheat flour, rice flour, corn flour, millet flour, spelt flour, and oat flour, and starches such as from corn, potato, sorghum, and arrowroot. Oil and fat for use in such compositions include plant-derived oils and fats, such as olive oil, corn oil, avocado oil, nut oils (e.g., almond, walnut and peanut) and safflower oil. rOVA may provide such baked goods with at least one characteristic of an egg white such as binding, springiness, aeration, browning, texturizing, humectant, and cohesiveness of the baked product. In some cases, the baked product does not comprise any natural egg white or natural egg, and/or does not include any other egg white derived proteins except rOVA. In some cases, rOVA is provided to the baked composition as an ingredient, such as starting with a concentrate, isolate or powder form of rOVA. In some cases, the rOVA provided as an ingredient for baked products is at a pH range between about 3.5 and 7.0. In some cases, a sweetener is included in the baked product such as a sugar, syrup, honey or sugar-substitute.

[0118] rOVA compositions disclosed herein can also be used to prepare egg-less food products, such as food products made where native whole egg or native egg white is a primary or featured ingredient such as scramble, omelet, patty, soufflé, quiche and frittata. In some embodiments, rOVA provides one or more functional features to the preparation including foaming, coagulation, binding, structure, texture, film-formation, nutritional profile, absence of cholesterol (i.e., cholesterol free) and protein fortification. Such egg-less preparations can be vegan,

vegetarian, halal, or kosher, or a combination thereof. An egg-less preparation (also referred to as an egg-white substitute) may include rOVA and at least one fat or oil, a polysaccharide or polysaccharide-containing ingredient, and a starch. In some cases, the egg-less preparation may also include a flavoring agent (such as to provide a salty, sulfur-like or umami flavor), and/or a coloring agent (for example to provide yellow-like or off-white color to the baked product). In some cases, the inclusion of rOVA in the egg-less preparation provides a characteristic of natural (native) egg white such as hardness, adhesiveness, fracturability, cohesiveness, gumminess and chewiness when the composition is heated or cooked. Exemplary polysaccharide or polysaccharide-containing ingredients for such compositions include gellan gum, sodium alginate, and psyllium. Oil and fat for use in such compositions include plant-derived oils and fats, such as olive oil, corn oil, avocado oil, and safflower oil.

[0119] rOVA compositions disclosed herein can be used for a processed meat product or meat-like product, or for fish-like or shell-fish-like products. In such products, rOVA can provide one or more functional characteristics such as protein content and protein supplementations as well as binding, texturizing properties. Exemplary meat and meat-like products include burger, patty, sausage, hot dog, sliced deli meat, jerky, bacon, nugget and ground meat-like mixtures. Meat-like products can resemble beef, pork, chicken, lamb and other edible and consumed meats for humans and for other animals. Fish-like and shell-fish like products can resemble, for example, fish cakes, crab cakes, shrimp, shrimp balls, fish sticks, seafood meat, crab meat, fish fillets and clam strips. In some embodiments, rOVA is present in an amount between about 0.1% and 30% w/w/ or w/v in the meat or meat-like product. In some embodiments, rOVA is used for a meat-like product (also referred to as a meat-analog and includes at least one fat or oil; and a plant-derived protein. Oil and fat for use in such compositions include plant-derived oils and fats, such as olive oil, corn oil, avocado oil, and safflower oil. Plant-derived proteins for use in meat analogs include soy protein, nut proteins, pea protein, lentil and other pulse proteins and whey protein. In some cases, such plant protein is extruded, in other cases, such plant protein is non-extruded protein. In some cases, a meat analog include rOVA at about 2% to 15% (w/w). In some cases for meat analog compositions, rOVA acts as a binding agent, a gelling agent or a combination of a binding and gelling agent for such compositions.

[0120] rOVA compositions disclosed herein can be employed in coatings for food products. For example, rOVA can provide binding or adhesion characteristics to adhere batter or breading to another food ingredient. rOVA can be used as an “egg-less egg wash” where the rOVA protein provides appearance, color and texture when coated onto other food ingredients or food products, such as baked products. In one example, the “egg-less egg wash” may be used to coat a baked good such that the baked good adheres to a coating (e.g., seed, salt, spice, and herb). The addition of

rOVA as a coating to a food product can provide a crunchy texture or increase the hardness, for example, of the exterior of a food product such as when the product is cooked, baked or fried.

[0121] rOVA compositions disclosed herein include sauces and dressings, such as an eggless mayonnaise, commercial mayonnaise substitutes, gravy, sandwich spread, salad dressing or food sauce. Inclusion of rOVA in a sauce or dressing, and the like, can provide one or more characteristics such as binding, emulsifying, odor neutrality, and mouthfeel. In some embodiments rOVA is present in such sauces and dressing in an amount between 0.1% and 3% or between about 3% and about 5% w/w/ or w/v. In some cases, the amount of rOVA in a sauce or dressing may be substantially similar to the amount of whole egg, egg-white or nOVA used in a commercially available or commonly used recipe. Exemplary sauces and dressing include mayonnaise, commercial mayonnaise substitutes, alfredo sauce, and hollandaise sauce. In some embodiments, the rOVA-containing sauce or dressing does not contain whole egg, egg white, or any other protein extracted from egg. In some cases, the sauce, dressing or other emulsified product made with rOVA includes at least one fat or oil and water. Exemplary fats and oils for such compositions include corn oil, safflower oil, nut oils, and avocado oil.

[0122] rOVA compositions can be used to prepare confectionaries such as eggless, animal-free, vegetarian and vegan confectionaries. rOVA can provide one or more functional features to the confectionary including odor neutrality, flavor, mouthfeel, texture, gelling, cohesiveness, foaming, frothiness, nutritional value and protein fortification. In some embodiments, the prepared confectionary containing rOVA does not contain any native egg protein or native egg white. rOVA in such confectionaries can provide a firm or chewy texture. In some embodiments, rOVA is present between about 0.1% and 15% in a confectionary. Exemplary confectionaries include a gummy, a taffy, a divinity candy, meringue, marshmallow, and a nougat. In some embodiments, a confectionary includes rOVA, at least one sweetener and optionally a consumable liquid. Exemplary sweeteners include sugar, honey, sugar-substitutes and plant-derived syrups. In some cases, the rOVA is provided as an ingredient for making confectionaries at a pH between about 3.5 and about 7. In some cases, the rOVA is present in the confectionary composition at about 2% to about 15% (w/v). In some embodiments, the confectionary is a food product such as a meringue, a whipped dessert, or a whipped topping. In some embodiments, rOVA in the confectionary provides foaming, whipping, fluffing or aeration to the food product, and/or provides gelation. In some cases, the confectionary is a liquid, such as a foamed drink. In some cases, the liquid may include a consumable alcohol (such as in a sweetened cocktail or after-dinner drink).

[0123] rOVA compositions herein can be used in dairy products, dairy-like products or dairy containing products. For example, rOVA can be used in preparations of beverages such as a smoothie, milkshake, "egg-nog", and coffee beverage. In some embodiments, rOVA is added to

additional ingredients where at least one ingredient is a dairy ingredient or dairy-derived ingredient (such as milk, cream, whey, and butter). In some embodiments, rOVA is added to additional ingredients to create a beverage that does not contain any native egg protein, native egg white or native egg. In some embodiments, rOVA is an ingredient in a beverage that does not contain any animal-derived ingredients, such as one that does not contain any native egg-derived or any dairy-derived ingredients. Examples of such non-dairy derived drinks include nut milks, such as soy milk or almond milk. rOVA can also be used to create beverage additions, such as creamer or “milk” to provide protein, flavor, texture and mouthfeel to a beverage such as a coffee, tea, alcohol-based beverages or cocoa. In some embodiments, rOVA is present in a beverage ingredient or beverage addition in an amount between about 0.1% and 20% w/w or w/v.

[0124] In some embodiments herein, rOVA can be used to prepare a dairy-like product such as yogurt, cheese or butter. Dairy products with rOVA can include other animal-based dairy components or proteins. In some embodiments, dairy products prepared with rOVA do not include any animal-based ingredients.

[0125] Preparations of dessert products can be prepared using rOVA. In dessert products rOVA can provide one or more characteristics such as creamy texture, low fat content, odor neutrality, flavor, mouthfeel, texture, binding, and nutritional value. rOVA may be present in an ingredient or set of ingredients that is used to prepare a dessert product. Exemplary dessert products suitable for preparation with rOVA include a mousse, a cheesecake, a custard, a pudding, a popsicle and an ice cream. In some embodiments, dessert products prepared to include rOVA are vegan, vegetarian or dairy-free. Dessert products that include rOVA can have an amount of rOVA that is between about 0.1% and about 10% rOVA w/w or w/v.

[0126] rOVA can be used to prepare a snack food, such as a protein bar, an energy bar, a nutrition bar or a granola bar. The rOVA can provide characteristics to the snack food including one or more of binding, protein supplementation, flavor neutrality, odor neutrality, coating and mouth feel. In some embodiments, rOVA is added to a preparation of a snack food in an amount between about 0.1% and 30% w/w or w/v.

[0127] rOVA can be used for nutritional supplements such as in parenteral nutrition, protein drink supplements, protein shakes where rOVA provides a high protein supplement. In some embodiments, rOVA can be added to such compositions in an amount between about 10% and 30% w/w or w/v.

[0128] In some embodiments, rOVA compositions can be used as an egg-replacer and an egg white-replacer. rOVA can be mixed or combined with at least one additional component to form the egg white replacer. rOVA can provide one or more characteristics to the egg-replacer or egg white-replacer, such as gelling, foaming, whipping, fluffing, binding, springiness, aeration,

creaminess and cohesiveness. In some embodiments, characteristic is the same or better than a native egg or native egg white provided in the same amount or concentration (w/w or w/v). In some embodiments, the egg-replacer or egg white-replacer, does not contain any egg, egg white, protein extracted or isolated from egg.

[0129] The rOVA-containing food ingredient and food products, such as described herein, can contain additional ingredients or components. For example, rOVA compositions can be prepared with an additional component such as one or more of a sweetener, a gum, a flavoring, a thickener, an acidulant and an emulsifier. Other ingredients such as flour, grains, oils and fats, fiber, fruit and vegetables can be combined with rOVA. Such rOVA compositions can be vegan, vegetarian, halal, kosher and animal-free, or a combination thereof. In some embodiments, rOVA can be a food ingredient or prepared for a food product that is normally animal based or normally contains animal-derived components, such as meat, dairy or eggs.

[0130] Compositions including rOVA including food ingredients and food products can be compatible with one or more steps of consumables preparation such as heated, baked, grilled, roasted, braised, microwaved, broiled, boiled, steamed, extruded, deep fried, or pan-fried, or processed using ohmic heating, Sue Vide, freezing, chilling, blanching, packaging, canning, bleaching, enriching, drying, pressing, grinding, mixing, par cooking, cooking, proofing, marinating, cutting, slicing, dicing, crushing, shredding, chopping, shaking, coring, spiralizing, rolling, juicing, straining, filtering, kneading, whisking, beating, whipping, grating, stuffing, peeling, smoking, curing, salting, preserving, pickling, fermenting, homogenizing, pasteurizing, sterilizing, irradiating, cold plasma processing, high pressure processing, pulse electric field processing, microwave assisted thermal sterilization, stabilizing, blending, pureeing, fortifying, refining, hydrogenating, aging, extending shelf life, or adding enzymes.

[0131] Food ingredients and food products prepared with rOVA can be essentially free of any microbial cells or microbial cell debris. For instance, rOVA may be secreted from a microbial host cell and isolated from microbial cells, culture media and/or microbial cell debris.

[0132] In some embodiments, rOVA may be prepared as a whole cell extract or fractionated extract such that an rOVA composition contains microbial cells and/or microbial cell components.

[0133] In one embodiment, an rOVA composition is prepared for animal consumption where the rOVA is present in a whole cell extract or fractionated extract such that an rOVA composition contains microbial cells and/or microbial cell components. In some embodiments, an rOVA composition is prepared for animal consumption where rOVA is isolated from microbial cells, culture media and microbial cell debris. Exemplary compositions for animal consumption can include 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. In these cases, the microbial cell extract or microbial cell debris may provide additional nutritional value.

[0134] Animals which may consume rOVA compositions can include companion animals (e.g., dog, cat, horse), farm animals, exotic animals (lion, tiger, zebra) as well as livestock (such as cow, pig, sheep, goat). rOVA compositions as described herein can also be used for aquaculture (such as for fish and shell fish) and for avian nutrition (such as for bird pets, zoo birds, wild birds, fowl and birds raised for human and animal food).

[0135] In some embodiments of the consumable food compositions described herein, the composition is essentially free of animal-derived components, whey protein, caseinate, fat, lactose, hydrolyzed lactose, soy protein, collagen, hydrolyzed collagen, or gelatin, or any combination thereof. A composition described herein may be essentially free of cholesterol, glucose, fat, saturated fat, trans fat, or any combination thereof. In some cases, a composition described herein comprises less than 10%, 5%, 4%, 3%, 2%, 1%, or 0.5% fat by dry weight. In some embodiments, the composition may be fat-containing (e.g., such as a mayonnaise and commercial mayonnaise substitutes) and such composition may include up to about 60% fat or a reduced-fat composition (e.g., reduced fat mayonnaise and commercial mayonnaise substitutes) and such composition may include lesser percentages of fat. A composition that free of an animal-derived component can be considered vegetarian and/or vegan.

[0136] In some embodiments, an rOVA powder composition comprises less than 5% ash. The term “ash” is an art-known term and represents inorganics such as one or more ions, elements, minerals, and/or compounds. In some cases, the rOVA powder composition comprises less than 5%, 4.5%, 4%, 3.5%, 3%, 2.5%, 2%, 1.5%, 1%, 0.75%, 0.5%, 0.25% or 0.1% ash weight per total weight (w/w) and/or weight per total volume (w/v).

[0137] In some embodiments, the moisture content of an rOVA powder composition may be less than 15%. The rOVA powder composition may have less than 15%, 12%, 10%, 8%, 6%, 5%, 3%, 2% or 1% moisture weight per total weight (w/w) and/or weight per total volume (w/v). In some embodiments, the carbohydrate content of an rOVA powder composition may be less than 30%. The rOVA powder composition may have less than 30%, 27%, 25%, 22%, 20%, 17%, 15%, 12%, 10%, 8%, 5%, 3% or 1% carbohydrate content w/w or w/v.

Sensory Neutrality and Improved Sensory Appeal

[0138] In some embodiments, in addition to the egg-white like properties, the addition of rOVA to a consumable food composition provides increased protein nutritional content, sensory neutrality or an improved sensory appeal as compared to other proteins in such compositions. As used herein “sensory neutrality” refers to the absence of a strong or distinctive taste, odor (smell) or combination of taste and smell, as well as texture, mouth-feel, aftertaste and color. A sensory

panel such as one described in Kemp et al. 2009 may be used by a trained sensory analyst. Sensory neutrality may provide an improved sensory appeal to a taster, such as a tester of foods or a consumer, when a consumable food composition containing rOVA is compared with another like composition that has a different protein such as nOVA, whey protein, pea protein, soy protein, whole egg or egg white protein at the same concentration.

[0139] In some embodiments, rOVA when added to a consumable food composition is substantially odorless, such as measured by a trained sensory analyst, in comparison with different solutions/products with a different protein component present in an equal concentration to the rOVA containing solution/product, for example, in the comparison is whey, soy, collagen, pea, egg white solid isolates and/or nOVA. In some embodiments of the rOVA compositions described herein, such compositions are essentially odorless at a protein concentration between about 0.5-1%, 1%-5%, 5-10%, 10-15%, 15-20%, 20-25%, 25-30% rOVA weight per total weight (w/w) and/or weight per total volume (w/v) or at a protein concentration of about 0.1, 1, 5, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or 30 g of total rOVA protein per 100 mL solution (e.g., per 100 mL water).

[0140] In some embodiments, the addition of rOVA to a consumable food composition also provides a neutral taste in addition to the characteristics such as egg-white like properties and increased protein nutrition content. A neutral taste can be measured for example, by a trained sensory analyst in comparison with solutions containing a different protein present in an equal concentration to the rOVA, for example, whey, soy, collagen, pea, whole egg, and egg white solid isolates (including native OVA).

[0141] In some embodiments, the addition of rOVA provides a reduction in a certain odor and/or taste that is associated with other proteins or egg-whites. For example, addition of rOVA has less of an "egg-like" odor or taste as compared to the addition of whole egg, fractionated egg or egg-white to a consumable food composition. In some embodiments, addition of rOVA has less of a metallic odor or taste as compared to other protein sources.

[0142] In some embodiments, the addition of rOVA has an improved mouth-feel as compared to the addition of other protein sources used to produce egg-white like properties. For example, the addition of rOVA is less grainy or has less precipitates or solids as compared to other protein sources.

[0143] In some embodiments, the addition of rOVA has an improved texture, for example, as compared to other available supplemental protein sources.

[0144] A consumable composition with rOVA may also have an improved sensory appeal as compared to the composition without rOVA or with a different protein present in an equal concentration to the rOVA. Such improved sensory appeal may relate to taste and/or smell. Taste

and smell can be measured, for example, by a trained sensory analyst. In some instances, a sensory analyst compares a consumable composition with rOVA to one without it or with a different protein or protein source in an equivalent amount.

[0145] As described herein, a consumable composition herein can be in a liquid form. A liquid form can be an intermediate product such as soluble rOVA solution. In some cases, a liquid form can be a final product, such as a beverage comprising rOVA. Example of different types of beverages contemplated herein include: a juice, a soda, a soft drink, a flavored water, a protein water, a fortified water, a carbonated water, a nutritional drink, an energy drink, a sports drink, a recovery drink, an alcohol-based drink, a heated drink, a coffee-based drink, a tea-based drink, a plant-based milk, a nut milk, a milk based drink, a non-dairy, plant based mild drink, infant formula drink, and a meal replacement drink.

pH of Compositions

[0146] The pH of an rOVA composition may be 3.5 to 8. The pH of an rOVA composition may be at least 3.5. The pH of an rOVA composition may be at most 8. The pH of an rOVA composition may be 3.5 to 4, 3.5 to 4.5, 3.5 to 5, 3.5 to 5.5, 3.5 to 6, 3.5 to 6.5, 3.5 to 7, 3.5 to 7.5, 3.5 to 8, 4 to 4.5, 4 to 5, 4 to 5.5, 4 to 6, 4 to 6.5, 4 to 7, 4 to 7.5, 4 to 8, 4.5 to 5, 4.5 to 5.5, 4.5 to 6, 4.5 to 6.5, 4.5 to 7, 4.5 to 7.5, 4.5 to 8, 5 to 5.5, 5 to 6, 5 to 6.5, 5 to 7, 5 to 7.5, 5 to 8, 5.5 to 6, 5.5 to 6.5, 5.5 to 7, 5.5 to 7.5, 5.5 to 8, 6 to 6.5, 6 to 7, 6 to 7.5, 6 to 8, 6.5 to 7, 6.5 to 7.5, 6.5 to 8, 7 to 7.5, 7 to 8, or 7.5 to 8. The pH of an rOVA composition may be 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, or 8. An rOVA composition with a pH between 3.5 to 7 may have one or more improved functionalities as compared to nOVA, egg white or egg-white substitute compositions.

[0147] The pH of an rOVA composition may be 2 to 3.5. The pH of an rOVA composition may be at least 2. The pH of an rOVA composition may be at most 3.5. The pH of an rOVA composition may be 2 to 2.5, 2 to 3, 2 to 3.5, 2.5 to 3, 2.5 to 3.5, or 3 to 3.5. The pH of an rOVA composition may be 2, 2.5, 3, or 3.5.

[0148] The pH of an rOVA composition may be 7 to 12. The pH of an rOVA composition may be at least 7. The pH of an rOVA composition may be at most 12. The pH of an rOVA composition may be 7 to 7.5, 7 to 8, 7 to 8.5, 7 to 9, 7 to 9.5, 7 to 10, 7 to 10.5, 7 to 11, 7 to 11.5, 7 to 12, 7.5 to 8, 7.5 to 8.5, 7.5 to 9, 7.5 to 9.5, 7.5 to 10, 7.5 to 10.5, 7.5 to 11, 7.5 to 11.5, 7.5 to 12, 8 to 8.5, 8 to 9, 8 to 9.5, 8 to 10, 8 to 10.5, 8 to 11, 8 to 11.5, 8 to 12, 8.5 to 9, 8.5 to 9.5, 8.5 to 10, 8.5 to 10.5, 8.5 to 11, 8.5 to 11.5, 8.5 to 12, 9 to 9.5, 9 to 10, 9 to 10.5, 9 to 11, 9 to 11.5, 9 to 12, 9.5 to 10, 9.5 to 10.5, 9.5 to 11, 9.5 to 11.5, 9.5 to 12, 10 to 10.5, 10 to 11, 10 to 11.5, 10 to 12, 10.5 to 11, 10.5 to 11.5, 10.5 to 12, 11 to 11.5, 11 to 12, or 11.5 to 12. The pH of an rOVA composition may be 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, or 12.

[0149] In some embodiments, the pH of rOVA may be adjusted prior to its inclusion in a composition or its use as an ingredient. In some embodiments, the pH of rOVA is adjusted during the purification and/or isolation processes. In some embodiments, the pH of the rOVA for use in an ingredient or in production of a food product composition is adjusted to between about 3.5 to about 7.0. In some cases, the pH of rOVA may be adjusted to more than one pH during the production process. For example rOVA may be expressed in a host cell such as a microbial cell, and in some cases the rOVA is secreted by the host cell into the growth media (e.g., liquid media). rOVA is separated from the host cells and such separation step may be performed at a selected pH, for example at a pH of about 3.5. In some cases, the rOVA at such separation pH may not be soluble or may not be fully soluble and the pH is adjusted to a higher pH, such as about pH 12. The rOVA may then be adjusted to a final pH between about 3.5 and about 7.0. Separation of rOVA from other components of the host cells or other components of the liquid media can include one or more of ion exchange chromatography, such as cation exchange chromatography and/or anion exchange chromatography, filtration and ammonium sulfate precipitation.

Additional components of compositions

[0150] The consumable food compositions containing rOVA disclosed herein and the methods of making such compositions may including adding or mixing the rOVA with one or more ingredients. For example, food additives may be added in or mixed with the compositions. Food additives can add volume and/or mass to a composition. A food additive may improve functional performance and/or physical characteristics. For example, a food additive may prevent gelation or increased viscosity due to the lipid portion of the lipoproteins in the freeze-thaw cycle. An anticaking agent may be added to make a free-flowing composition. Carbohydrates can be added to increase resistance to heat damage, e.g., less protein denaturation during drying and improve stability and flowability of dried compositions. Food additives include, but are not limited to, food coloring, pH adjuster, natural flavoring, artificial flavoring, flavor enhancer, batch marker, food acid, filler, anticaking agent (e.g., sodium silico aluminate), antigreening agent (e.g., citric acid), food stabilizer, foam stabilizer or binding agent, antioxidant, acidity regulatory, bulking agent, color retention agent, whipping agent (e.g., ester-type whipping agent, triethyl citrate, sodium lauryl sulfate), emulsifier (e.g., lecithin), humectant, thickener, excipient, solid diluent, salts, nutrient, sweetener, glazing agent, preservative, vitamin, dietary elements, carbohydrates, polyol, gums, starches, flour, oil, or bran.

[0151] Food coloring includes, but is not limited to, FD&C Yellow #5, FD&C Yellow #6, FD&C Red #40, FD&C Red #3, FD&C Blue No. 1, FD&C Blue No. 2, FD&C Green No. 3, carotenoids (e.g., saffron, β -carotene), anthocyanins, annatto, betanin, butterfly pea, caramel coloring,

chlorophyllin, elderberry juice, lycopene, carmine, pandan, paprika, turmeric, curcuminoids, quinoline yellow, carmoisine, Ponceau 4R, Patent Blue V, and Green S.

[0152] Ingredients for pH adjustment include, but are not limited to, Tris buffer, potassium phosphate, sodium hydroxide, potassium hydroxide, citric acid, sodium citrate, sodium bicarbonate, and hydrochloric acid.

[0153] Salts include, but are not limited, to acid salts, alkali salts, organic salts, inorganic salts, phosphates, chloride salts, sodium salts, sodium chloride, potassium salts, potassium chloride, magnesium salts, magnesium chloride, magnesium perchlorate, calcium salts, calcium chloride, ammonium chloride, iron salts, iron chlorides, zinc salts, and zinc chloride.

[0154] Nutrient includes, but is not limited to, macronutrient, micronutrient, essential nutrient, non-essential nutrient, dietary fiber, amino acid, essential fatty acids, omega-3 fatty acids, and conjugated linoleic acid.

[0155] Sweeteners include, but are not limited to, sugar substitute, artificial sweetener, acesulfame potassium, advantame, alitame, aspartame, sodium cyclamate, dulcin, glucin, neohesperidin dihydrochalcone, neotame, P-4000, saccharin, aspartame-acesulfame salt, sucralose, brazzein, curculin, glycyrrhizin, glycerol, inulin, mogroside, mabinlin, malto-oligosaccharide, mannitol, miraculin, monatin, monellin, osladin, pentadin, stevia, trilobatin, and thaumatin.

[0156] Carbohydrates include, but are not limited to, sugar, sucrose, glucose, fructose, galactose, lactose, maltose, mannose, allulose, tagatose, xylose, arabinose, high fructose corn syrup, high maltose corn syrup, corn syrup (e.g., glucose-free corn syrup), sialic acid, monosaccharides, disaccharides, polysaccharides (e.g., polydextrose, maltodextrin), and starch.

[0157] Polyols include, but are not limited to, xylitol, maltitol, erythritol, sorbitol, threitol, arabitol, hydrogenated starch hydrolysates, isomalt, lactitol, mannitol, and galactitol (dulcitol).

[0158] Gums include, but are not limited to, gum arabic, gellan gum, guar gum, locust bean gum, acacia gum, cellulose gum, and xanthan gum.

[0159] Vitamins include, but are not limited to, niacin, riboflavin, pantothenic acid, thiamine, folic acid, vitamin A, vitamin B6, vitamin B12, vitamin D, vitamin E, lutein, zeaxanthin, choline, inositol, and biotin.

[0160] Dietary elements include, but are not limited to, calcium, iron, magnesium, phosphorus, potassium, sodium, zinc, copper, manganese, selenium, chlorine, iodine, sulfur, cobalt, molybdenum, nickel, and bromine.

rOVA protein and production of rOVA protein

[0161] rOVA can have an amino acid sequence from any species. For example, an rOVA can have an amino acid sequence of OVA from a bird or a reptile or other egg-laying species. An rOVA having an amino acid sequence from an avian can be selected from the group consisting of: poultry,

fowl, waterfowl, game bird, chicken, quail, turkey, duck, ostrich, goose, gull, guineafowl, pheasant, emu, and any combination thereof. An rOVA can have an amino acid sequence derived from a single species, such as *Gallus gallus domesticus*. Alternatively, an rOVA can have an amino acid sequence derived from two or more species, and as such be a hybrid.

[0162] Exemplary OVA amino acid sequences contemplated herein are provided in Table 1 below as SEQ ID NOs: 1-74.

Table 1. OVA Sequences

Name	SEQ ID	Sequence
Chicken Ovalbumin with bolded signal sequence	1	MRFPSIFTAVLFAASSALAAPVNTTTEDETAQIPAEAVIGYSDLEGDFDVAVL FSNSTNNGLLFINTTASIAAKEEGVSLDKREAE AGSIGAASMEFCFDVFKELKV HHANENIFYCPIAIMSALAMVYLGAkdSTRtQINKVVRFDKLPFGDSIEAQCGTS VNVHSSLRDILNQITKPNDVYSFSLASRLYAEERYPILPEYLQCVKELYRGGLEPIN FQTAADQARELINSWVESQTNGIIRNVLPSSVDSQTAMVLVNAIVFKGLWEKAF KDEDTQAMPFRVTEQESKPVQMMYQIGLFRVASMASEKMKILELPFASGTMSML VLLPDEVSGLEQLESIINFEKLTEWTSSNVMEERKIKVYLPRMKMEEKYNLTsvL MAMGITDVfSSSANLSGISSAESLKISQAVHAAHAEINEAGREVVGSAEAGVDAA SVSEEFRADHPFLFCIKHIATNAVLFFGRCVSP
Chicken OVA sequence as secreted from pichia	2	EAEAGSIGAASMEFCFDVFKELKVHHANENIFYCPIAIMSALAMVYLGAkdSTRt QINKVVRFDKLPFGDSIEAQCGTSVNVHSSLRDILNQITKPNDVYSFSLASRLYA EERYPILPEYLQCVKELYRGGLEPINFQTAADQARELINSWVESQTNGIIRNVLPSS SVDSQTAMVLVNAIVFKGLWEKAFKDEDTQAMPFRVTEQESKPVQMMYQIGLF RVASMASEKMKILELPFASGTMSMLVLLPDEVSGLEQLESIINFEKLTEWTSSNV MEERKIKVYLPRMKMEEKYNLTsvLMAMGITDVfSSSANLSGISSAESLKISQAV HAAHAEINEAGREVVGSAEAGVDAA SVSEEFRADHPFLFCIKHIATNAVLFFGRC VSP
Predicted Ovalbumin [<i>Achromobacter denitrificans</i>]	3	MRVPAQLLGLLLLWLPGARCGSIGAASMEFCFDVFKELKVHHANENIFYCPIAIM SALAMVYLGAkdSTRtQINKVVRFDKLPFGDSIEAQCGTSVNVHSSLRDILNQIT KPNDVYSFSLASRLYAEERYPILPEYLQCVKELYRGGLEPINFQTAADQARELINS WVESQTNGIIRNVLPSSVDSQTAMVLVNAIVFKGLWEKAFKDEDTQAMPFRVT EQESKPVQMMYQIGLFRVASMASEKMKILELPFASGTMSMLVLLPDEVSGLEQL ESIINFEKLTEWTSSNVMEERKIKVYLPRMKMEEKYNLTsvLMAMGITDVfSSSA NLSGISSAESLKISQAVHAAHAEINEAGREVVGSAEAGVDAA SVSEEFRADHPFLF CIKHIATNAVLFFGRCVSPLEIKRAAAHHHHHH
OLLAS epitope-tagged ovalbumin	4	MTSGFANELGPRLMGKLTMGSIGAASMEFCFDVFKELKVHHANENIFYCPIAIMS ALAMVYLGAkdSTRtQINKVVRFDKLPFGDSIEAQCGTSVNVHSSLRDILNQIT KPNDVYSFSLASRLYAEERYPILPEYLQCVKELYRGGLEPINFQTAADQARELINS WVESQTNGIIRNVLPSSVDSQTAMVLVNAIVFKGLWEKTFKDEDTQAMPFRVT EQESKPVQMMYQIGLFRVASMASEKMKILELPFASGTMSMLVLLPDEVSGLEQL ESIINFEKLTEWTSSNVMEERKIKVYLPRMKMEEKYNLTsvLMAMGITDVfSSSA

Name	SEQ ID	Sequence
		NLSGISSAESLKISQAVHAAHAEINEAGREVVGSAEAGVDAASVSEEFRAADHPFLFCIKHIATNAVLFFGRCVSPSR
Serpin family protein [<i>Achromobacter denitrificans</i>]	5	MGGRRVRWEVYISRAGYVNRQIAWRRHHRSLTMRVPAQLLGLLLLWLPGARCG SIGAASMEFCFDVFKELKVHHANENIFYCPIAIMSALAMVYLGAkdSTRtQINKV VRFDKLPFGGDSIEAQCGTSVNVHSSLRDILNQITKPNdVYSFSLASRLYAEERYPI LPEYLQCVKELyRGGLEPINFQTAADQARELINSWVESQTNGIIRNVLQPSSVDSQ TAMVLVNAIVFKGLWEKAFKDEDtQAMPFRVTEQESKPVQMMYQIGLFRVASM ASEKMKILELpFASGTMSMLVLLPDEVSGLEQLESiINFEKLTEWTSSNVMEERKI KVYLPRMKMEEKYNLTsvLMAMGITDVFSSsANLSGISSAESLKISQAVHAAHAE INEAGREVVGSAEAGVDAASVSEEFRAADHPFLFCIKHIATNAVLFFGRCVSPLEIK RAAAHHHHHH
PREDICTED: ovalbumin isoform X1 [<i>Meleagris gallopavo</i>]	6	MGSIGAVSMEFCFDVFKELKVHHANENIFYSPFTIISALAMVYLGAkdSTRtQINK VVRFDKLPFGGDSVEAQCGTSVNVHSSLRDILNQITKPNdVYSFSLASRLYAEETy PILPEYLQCVKELyRGGLESINFQTAADQARGLINSWVESQTNGMIKNVLQPSSV DSQTAMVLVNAIVFKGLWEKAFKDEDtQAIPFRVTEQESKPVQMMYQIGLFKVA SMASEKMKILELpFASGTMSMWVLLPDEVSGLEQLETTISFEKMTewISSNIMEER RIKVYLPRMKMEEKYNLTsvLMAMGITDLFSSsANLSGISSAGSLKISQAVHAAy AEIYEAGREVIGSAEAGADATSVSEEFrVDHPFLyCIKHNLtNSILFFGRCISp
Ovalbumin precursor [<i>Meleagris gallopavo</i>]	7	MGSIGAVSMEFCFDVFKELKVHHANENIFYSPFTIISALAMVYLGAkdSTRtQINK VVRFDKLPFGGDSVEAQCGTSVNVHSSLRDILNQITKPNdVYSFSLASRLYAEETy PILPEYLQCVKELyRGGLESINFQTAADQARGLINSWVESQTNGMIKNVLQPSSV DSQTAMVLVNAIVFKGLWEKAFKDEDtQAIPFRVTEQESKPVQMMYQIGLFKVA SMASEKMKILELpFASGTMSMWVLLPDEVSGLEQLETTISFEKMTewISSNIMEER RIKVYLPRMKMEEKYNLTsvLMAMGITDLFSSsANLSGISSAGSLKISQAHAAY AEIYEAGREVIGSAEAGADATSVSEEFrVDHPFLyCIKHNLtNSILFFGRCISp
Hypothetical protein [<i>Bambusicola thoracicus</i>]	8	YYRVPCMVLCtAFHPYIFiVLLfALDNSEFTMGsIGAVSMEFCFDVFKELRVHHPN ENIFFCPFAIMSAMAMVYLGAkdSTRtQINKVIRFDKLPFGGDStEAQCGKSANv HSSLDILNQITKPNdVYSFSLASRLYAdETYSIQSEYLQCVNELyRGGLESINFQTA AADQARELINSWVESQTNGIIRNVLQPSSVDSQTAMVLVNAIVFRGLWEKAFKDE DTQTMPFRVTEQESKPVQMMYQIGSFkVASMASEKMKILELpLAsGTMSMLVLL PDEVSGLEQLETTISFEKLTEWTSSNVMEERKIKVYLPRMKMEEKYNLTsvLMA MGITDLFRSSANLSGISLAGNLKISQAVHAAHAEINEAGrKAVSSAEAGVDATSV SEEFRAADRPFLFCIKHIATKVVFFFGRYTSP
Egg albumin	9	MGSIGAASMEFCFDVFKELKVHHANDNMLYSPFAILSTLAMVFLGAkdSTRtQIN KVVFHDKLPFGGDSIEAQCGTSVNVHSSLRDILNQITKQNDAYSFSLASRLYAQET YTVVPEYLQCVKELyRGGLESVNFQTAADQARGLINAWVESQTNGIIRNlQPSS VDSQTAMVLVNAIAFKGLWEKAFKAEDtQTIPFRVTEQESKPVQMMYQIGSFkV ASMASEKMKILELpFASGTMSMLVLLPDDVSGLEQLESiISFEKLTEWTSSSiMEER KVKVYLPRMKMEEKYNLTsLLMAMGITDLFSSsANLSGISSVgSLKISQAVHAAH AEINEAGRDVVGSAGVDATEEFRAADHPFLFCVKHIEtNAILLFGRCVSP

Name	SEQ ID	Sequence
Ovalbumin isoform X2 [<i>Numida meleagris</i>]	10	MASIGAVSTEFCDVYKELRVHHANENIFYSPFTIISTLAMVYLGAkdSTRtQINK VVRFDKLPgFGDSIEAQCGTSVNVHSSLRDILNQITKPNdVYSfSLASRLYAeETy PILPEYLQCVKELyRGGLESINFQTAADQARELINSWVESQTSgIIKNVLQPSSVNS QTAMVLVNAIYFKGLWERAFKDEDtQAIPFRVTEQESKPVQMMSQIGSFkVASV ASEKVKILELPFVSGTMSMLVLLPDEVSGLEQLESTISTEKLTewTSSSIMEERKIK VFLPRMRMEEKYNLTsvLMAMGMTDLfSSSANLSGISSAESLKISQAVHAAYAEI YEAGREVVSSAEAGVDATSVSEEFrVDHPFLlCIKHNPtNSILFFGRcISP
Ovalbumin isoform X1 [<i>Numida meleagris</i>]	11	MALCKAFHPYIFIVLLFDVDNSAFTMASIGAVSTEFCDVYKELRVHHANENIFYS PFTIISTLAMVYLGAkdSTRtQINKVVRFDKLPgFGDSIEAQCGTSVNVHSSLRDIL NQITKPNdVYSfSLASRLYAeETyPILPEYLQCVKELyRGGLESINFQTAADQARE LINSWVESQTSgIIKNVLQPSSVNSQTAMVLVNAIYFKGLWERAFKDEDtQAIPFR VTEQESKPVQMMSQIGSFkVASVASEKVKILELPFVSGTMSMLVLLPDEVSGLEQ LESTISTEKLTewTSSSIMEERKIKVFLPRMRMEEKYNLTsvLMAMGMTDLfSSSA NLSGISSAESLKISQAVHAAYAEIYEAGREVVSSAEAGVDATSVSEEFrVDHPFLl CIKHNPtNSILFFGRcISP
PREDICTED: Ovalbumin isoform X2 [<i>Coturnix japonica</i>]	12	MGSIGAASMEFCFDVfKELKVHHANDNMLYSPFAILSTLAMVFLGAkdSTRtQIN KVVFHDKLPgFGDSIEAQCGTSANVHSSLRDILNQITKQNDAYSfSLASRLYAqET YTVVPEYLQCVKELyRGGLESVNFQTAADQARGLINAWVESQTNGIIRNIlQPSS VDSQTAMVLVNAIAFKGLWEKAfKAEDtQTIPFRVTEQESKPVQMMHQIGSFkV ASMASEKMKILELPfASGTMSMLVLLPDDVSGLEQLESTISFEKLTEwTSSSIMEE RKVKVYLPRMKMEEKYNLTsLLMAMGITDLfSSSANLSGISSVgSLKISQAVHAA YAEINEAGRDVVGSAAEAGVDATEEFrADHPFLfCVKHIEtNAILLfGRcVSP
PREDICTED: ovalbumin isoform X1 [<i>Coturnix japonica</i>]	13	MGLCTAFHPYIFIVLLFALDNSEFTMGSIGAASMEFCFDVfKELKVHHANDNMLY SPFAILSTLAMVFLGAkdSTRtQINKVVFHDKLPgFGDSIEAQCGTSANVHSSLRD ILNQITKQNDAYSfSLASRLYAqETyYTVVPEYLQCVKELyRGGLESVNFQTAADQ ARGLINAWVESQTNGIIRNIlQPSSVDSQTAMVLVNAIAFKGLWEKAfKAEDtQTI PFRVTEQESKPVQMMHQIGSFkVASMASEKMKILELPfASGTMSMLVLLPDDVS GLEQLESTISFEKLTEwTSSSIMEERKVKVYLPRMKMEEKYNLTsLLMAMGITDL fSSSANLSGISSVgSLKISQAVHAAYAEINEAGRDVVGSAAEAGVDATEEFrADHPF LFCVKHIEtNAILLfGRcVSP
Egg albumin	14	MGSIGAASMEFCFDVfKELKVHHANDNMLYSPFAILSTLAMVFLGAkdSTRtQIN KVVFHDKLPgFGDSIEAQCGTSANVHSSLRDILNQITKQNDAYSfSLASRLYAqET YTVVPEYLQCVKELyRGGLESVNFQTAADQARGLINAWVESQTNGIIRNIlQPSS VDSQTAMVLVNAIAFKGLWEKAfKAEDtQTIPFRVTEQESKPVQMMHQIGSFkV ASMASEKMKILELPfASGTMSMLVLLPDDVSGLEQLESTISFEKLTEwTSSSIMEE RKVKVYLPRMKMEEKYNLTsLLMAMGITDLfSSSANLSGISSVgSLKIPQAVHAA YAEINEAGRDVVGSAAEAGVDATEEFrADHPFLfCVKHIEtNAILLfGRcVSP
ovalbumin [<i>Anas platyrhynchos</i>]	15	MGSIGAASTEFCFDVfRELrvQHVNENIFYSPFSIISALAMVYLGArdNTRtQIDK VVVFHDKLPgFGESMEAQCGTSVSVHSSLRDILTQITKPSDNfSLfSASRLYAeETy AILPEYLQCVKELyKGGLESISfQTAADQARELINSWVESQTNGIIRNIlQPSSVDS

Name	SEQ ID	Sequence
		QTTMVLVNAIYFKGMWEKAFKDEDQTAMPFRMTEQESKPVQMMYQVGSFKVA MVTSEKMKILELPFASGMMSMFVLLPDEVSGLEQLESTISFEKLTEWTSSTMMEE RRMKVYLPRMKMEEKYNLTSVFMALGMTDLFSSSANMSGISSTVSLKMSEAVH AACVEIFEAGRDVVGSAEAGMDVTSVSEEFRAADHPFLFFIKHNPTNSILFFGRWM SP
PREDICTED: ovalbumin-like [<i>Anser cygnoides domesticus</i>]	16	MGSIGAASTEFCFDVFRELKVQHVNNENIFYSPLSIISALAMVYLGARDNTRTQIDQ VVHFDKIPGFGESEMAQCCTSVSVHSSLRDILTEITKPSDNFSLSFASRLYAEETY ILPEYLQCVKELYKGGLESISFQTAADQARELINSWVESQTNGIKNILQPSSVDSQ TTMVLVNAIYFKGMWEKAFKDEDQTAMPFRMTEQESKPVQMMYQVGSFKLAT VTSEKVKILELPFASGMMSMCVLLPDEVSGLEQLETTISFEKLTEWTSSTMMEE RMKVYLPRMKMEEKYNLTSVFMALGMTDLFSSSANMSGISSTVSLKMSEAVHA ACVEIFEAGRDVVGSAEAGMDVTSVSEEFRAADHPFLFFIKHNPTNSILFFGRWISP
PREDICTED: Ovalbumin-like [<i>Aquila chrysaetos canadensis</i>]	17	MGSIGAASTEFCFDVFRELKVQHVNNENIFYSPLTIISALSMVYLGARENTRAQIDK VLHFDKMPGFGDTIESQCGTSVSIHTSLKDMFTQITKPSDNYSLSFASRLYAEETY PILPEYLQCVKELYKGGLETISFQTAAEQARELINSWVESQTNGMIKNILQPSSVDP QTKMVLVNAIYFKGVWEKAFKDEDQEVFPRVTEQESKPVQMMYQIGSFKVAV MASEKMKILELPYASGQLSMLVLLPDDVSGLEQLESAITFEKLMAWTSSTTMEER KMKVYLPRMKIEEKYNLTSVLMALGVTDLFSSSANLSGISSAESLKISKAVHEAF VEIYEAGSEVVGSTEAGMEVTSVSEEFRAADHPFLFLIKHNPTNSILFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Haliaeetus albicilla</i>]	18	MGSIGAASTEFCFDVFRELKVQHVNNENIFYSPLTIISALSMVYLGARENTRAQIDK VLHFDKMTGFGDTVESQCGTSVSIHTSLKDIFTQITKPSDNYSLSLASRLYAEETY ILPEYLQCVKELYKGGLETISFQTAAEQARELINSWVESQTNGMIKNILQPSSVDP QTKMVLVNAIYFKGVWEKAFKDEDQEVFPRVTEQESKPVQMMYQIGSFKVAV MASEKMKILELPYASGQLSMLVLLPDDVSGLEQLESAITSEKLEWTSSTTMEER KMKVYLPRMKIEEKYNLTSVLMALGVTDLFSSSADLSGISSAESLKISKAVHEAF VEIYEAGSEVVGSTEGGMEVTSVSEEFRAADHPFLFLIKHKPTNSILFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Haliaeetus leucocephalus</i>]	19	MGSIGAASTEFCFDVFRELKVQHVNNENIFYSPLTIISALSMVYLGARENTRAQIDK VLHFDKMTGFGDTVESQCGTSVSIHTSLKDIFTQITKPSDNYSLSLASRLYAEETY ILPEYLQCVKELYKGGLETISFQTAAEQARELINSWVESQTNGMIKNILQPSSVDP QTKMVLVNAIYFKGVWEKAFKDEDQEVFPRVTEQESKPVQMMYQIGSFKVAV MASEKMKILELPYASGQLSMLVLLPDDVSGLEQLESAITSEKLEWTSSTTMEER KMKVYLPRMKIEEKYNLTSVLMALGVTDLFSSSADLSGISSAESLKISKAVHEAF VEIYEAGSEVVGSTEGGMEVTSFSEEFRAADHPFLFLIKHKPTNSILFFGRCFSP
PREDICTED: Ovalbumin [<i>Fulmarus glacialis</i>]	20	MGSIGAASTEFCFDVFRELKVQHVNNENIFYSPLSIISALSMVYLGARENTRAQIDK VVHFDKITGFGETIESQCGTSVSVHTSLKDMFTQITKPSDNYSLSFASRLYAEETY ILPEYLQCVKELYKGGLETTSFQTAADQARELINSWVESQTNGMIKNILQPGSVDP QTEMVLVNAIYFKGMWEKAFKDEDQAVPFRMTEQESKTVQMMYQIGSFKVAV MASEKMKILELPYASGELSMLVMLPDDVSGLEQLETAITFEKLMEWTSSNMME RKMKVYLPRMKMEEKYNLTSVLMALGVTDLFSSSANLSGISSAESLKMKSEAVHE AFVEIYEAGSEVVGSTGAGMEVTSVSEEFRAADHPFLFLIKHNPTNSILFFGRCFSP

Name	SEQ ID	Sequence
PREDICTED: Ovalbumin-like [<i>Chlamydotis macqueenii</i>]	21	MGSIGAASTEFCDVFKELRVQHVNNVCYSPLIIISALSLVYLGAENTRAQIDK VVHFDKITGFGESIESQCGTSVSVHTSLKDMFNQITKPSDNYSLSVASRLYAEERY PILPEYLQCVKELYKGGLESISFQTAADQAREAINSWVESQTNGMIKNILQPSSVD PQTEMVLVNAIFYFKGMWQKAFKDEDTQAVPFRISEQESKPVQMMYQIGSFKVAV MAAEKMKILELPYASGELSMLVLLPDEVSGLEQLENAITVEKLMEWTS SSPMEER IMKVYLPRMKIEEKYNLTSVLMALGITDLFSSSANLSGISAEESLKMSEAVHQAF EISEAGSEVVGSEAGIDATSVSEEFRADHPFLFLIKHNATNSILFFGRFCFSP
PREDICTED: Ovalbumin like [<i>Nipponia nippon</i>]	22	MGSISAASTEFCDVFKELKVQHVNNIFYSPLSIISALSMVYLGAENTRAQIEKV VHFDKITGFGESIESQCSTSVSVHTSLKDMFTQITKPSDNYSLSFASRFYAEETYPI PEYLQCVKELYKGGLETINFRTAADQARELINSWVESQTNGMIKNILQPGSVDPQ TDMVLVNAIFYFKGMWEKAFKDEDTQALPFRVTEQESKPVQMMYQIGSFKVAVL ASEKVKILELPYASGQLSMLVLLPDDVSGLEQLETAITVEKLMEWTSNNMEERK IKVYLPRIKIEEKYNLTSVLMALGITDLFSSSANLSGISSAESLKVSEAIHEAFVEIYE AGSEVAGSTEAGIEVTSVSEEFRADHPFLFLIKHNATNSILFFGRFCFSP
PREDICTED: Ovalbumin-like isoform X2 [<i>Gavia stellata</i>]	23	MVSIGAASTEFCDVFKELKVQHVNNIFYSPLSIISALSMVYLGAENTRAQIDK VVHFDKITGFEETIESQCSTSVSVHTSLKDMFTQITKPSDNYSLSFASRLYAEETYPI LPEYLQCVKELYKGGLETISFQTAADQARELINSWVESQTDGMIKNILQPGSVDP QTEMVLVNAIFYFKGMWEKAFKDEDTQAVPFRMTEQESKPVQMMYQIGSFKVAV MASEKMKILELPYASGGMSMLVMLPDDVSGLEQLETAITFEKLMEWTSNNMME ERKMKVYLPRMKMEEKYNLTSVLMALGMTDLFSSSANLSGISSAESLKMSEAVH EAFVEIYEAGSEAVGSTGAGMEVTSVSEEFRADHPFLFLIKHNPTNSILFFGRFCFSP
PREDICTED: Ovalbumin [<i>Pelecanus crispus</i>]	24	MGSIGAASTEFCDVFKELKVQHVNNIFYSPLSIISALSMVYLGAENTRAQIDK VVHFDKITGFGEPESQCGISVSVHTSLKDMITQITKPSDNYSLSFASRLYAEETYPI LPEYLQCVKELYKGGLETISFQTAADQARELINSWVENQTNGMIKNILQPGSVDP QTEMVLVNAVYFKGMWEKAFKDEDTQAVPFRMTEQESKPVQMMYQIGSFKVA VMASEKIKILELPYASGELSMLVLLPDDVSGLEQLETAITLDKLTWTSNAMEER KMKVYLPRMKIEKKYNLTSVLIALGMTDLFSSSANLSGISSAESLKMSEAIHEAFL EIYEAGSEVVGSTEAGMEVTSVSEEFRADHPFLFLIKHNPTNSILFFGRCLSP
PREDICTED: Ovalbumin-like [<i>Charadrius vociferus</i>]	25	MGSIGAASTEFCDVFKELKVQHVNNIFYSPLTIISALSMVYLGAENTRAQIDK VVHFDKIPGFGDTTESQCGTSVSVHTSLKDMFTQITKPSDNYSVSFASRLYAEETY PILPEFLECVKELYKGGLESISFQTAADQARELINSWVESQTNGMIKNILQPGSVDS QTEMVLVNAIFYFKGMWEKAFKDEDTQTVPFRMTEQETKPVQMMYQIGTFKVA MPSEKMKILELPYASGELCMLVMLPDDVSGLEELESSITVEKLMEWTSNNMME RKMKVFLPRMKIEEKYNLTSVLMALGMTDLFSSSANLSGISSAEPLKMSEAVHEA FIEIYEAGSEVVGSTGAGMEITSVSEEFRADHPFLFLIKHNPTNSILFFGRCVSP
PREDICTED: Ovalbumin-like [<i>Eurypyga helias</i>]	26	MGSIGAVSTEFCDVFKELKVQHVNNIFYSPLSIISALSMVYLGAENTRAQIDK VVHFDKITGSGETIEAQCGTSVSVHTSLKDMFTQITKPSENYSGFASRLYADETY PIIPEYLQCVKELYKGGLEMISFQTAADQARELINSWVESQTNGMIKNILQPGSVDP PQTEMILVNAIFYKGVWEKAFKDEDTQAVPFRMTEQESKPVQMMYQFGSFKVA AMAAEKMKILELPYASGALSMLVLLPDDVSGLEQLESITFEKLMEWTSNNMME

Name	SEQ ID	Sequence
		EKKIKVYLPRMKMEEKYNFTSVLMALGMTDLFSSSANLSGISSADSLKMSEVVH EAFVEIYEAGSEVVGSTGSGMEAASVSEEFRADHPFLFLIKHNPTNSILFFGRCFSP
PREDICTED: Ovalbumin-like isoform X1 [<i>Gavia stellata</i>]	27	MVSIGAASTEFCDVFKELKVQHVNNENIFYSPLSIISALSMVYLGARENTRAQIDK VVHFDKITGFEETIESQVQKKQCSTSVSVHTSLKDMFTQITKPSDNYSLSFASRLY AEETYPILPEYLQCVKELYKGGLETISFQTAADQARELINSWVESQTDGMKINILQ PGSVDPPQTEMVLVNAIFYFKGMWEKAFKDEDTQAVPFRMTEQESKPVQMMYQIG SFKVAVMASEKMKILELPYASGGMSMLVMLPDDVSGLEQLETAITFEKLMEWTS SNMMEERKMKVYLPRMKMEEKYNLTSVLMALGMTDLFSSSANLSGISSAESLK MSEAVHEAFVEIYEAGSEAVGSTGAGMEVTSVSEEFRADHPFLFLIKHNPTNSILF FGRCFSP
PREDICTED: Ovalbumin-like [<i>Egretta garzetta</i>]	28	MGSIGAASTEFCDVFKELKVQHVNNENIFYSPLSIISALSMVYLGARENTRAQIDK VVHFDKIIGFGESIESQCGTSVSVHTSLKDMFAQITKPSDNYSLSFASRLYAEETFPI LPEYLQCVKELYKGGLETLSFQTAADQARELINSWVESQTNGMIKDILQPGSVDPP QTEMVLVNAIFYFKGVWEKAFKDEDTQTVPFRMTEQESKPVQMMYQIGSFKVAV VAAEKIKILELPYASGALSMLVLLPDDVSSLEQLETAITFEKLTWTSSNIMEERKI KVYLPRMKIEEKYNLTSVLMDLGITDLFSSSANLSGISSAESLKVSEAIHEAIVDIY EAGSEVVGSSGAGLEGTSVSEEFRADHPFLFLIKHNPTSSILFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Balearica regulorum gibbericeps</i>]	29	MGSIGAASTEFCDVFKELKVQHVNNENIFYSPLSIISALSMVYLGARENTRAQIDK VVHFDKITGSGEAIESQCGTSVSVHISLKDMFTQITKPSDNYSLSFASRLYAEETYP ILPEYLQCVKELYKEGLATISFQTAADQAREFINSWVESQTNGMIKINILQPGSVDPP QTQMVLVNAIFYFKGVWEKAFKDEDTQAVPFRMTKQESKPVQMMYQIGSFKVAV MASEKMKILELPYASGQLSMLVMLPDDVSGLEQIENAITFEKLMEWTPNPMMEE RKMKVYLPRMKMEEKYNLTSVLMALGMTDLFSSSANLSGISSAESLKMSAEVHE AFVEIYEAGSEVVGSTGAGIEVTSVSEEFRADHPFLFLIKHNPTNSILFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Nestor notabilis</i>]	30	MGSIGEAATFCDVRELKVQHVNNENIFYSPLSIISALSMVYLGARENTRAQIDQV VHFDKITGFGDTVESQCGSSLSVHSSSLKDIFAQITQPKDNYSLNFAASRLYAEETYP LPEYLQCVKELYKGGLETISFQTAADQARELINSWVESQTNGMIKINILQPSVDPQ TEMVLVNAIFYFKGVWEKAFKDEETQAVPFRITEQENRPVQIMYQFGSFKVAVVA SEKIKILELPYASGQLSMLVLLPDEVSGLEQLENAITFEKLTWTSSDIMEEKKIKV FLPRMKIEEKYNLTSVLVALGIADLFSSSANLSGISSAESLKMSAEVHEAFVEIYE AGSEVVGSSGAGIEAASDSEEFRADHPFLFLIKHKPTNSILFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Pygoscelis adeliae</i>]	31	MGSIGAASTEFCDIFNELKVQHVNNENIFYSPLSIISALSMVYLGARENTRKAQIDKV VHFDKITGFGESIESQCSSTASVHTSFKDMFTQITKPSDNYSLSFASRLYAEETYPIL PEYSQCCKELYKGGLESISFQTAADQARELINSWVESQTNGMIKINILQPGSVDPPQ ELVLVNAIFYFKGTWEKAFKDKDTQAVPFRVTEQESKPVQMMYQIGSYKVAIVAS EKMILELPYASGELSMLVLLPDDVSGLEQLETAITFEKLMEWTPSNMMEERKV KVYLPRMKIEEKYNLTSVLMALGMTDLFSPSANLSGISSAESLKMSAEIHEAFVEI YEAGSEVVGSTEAGMEVTSVSEEFRADHPFLFLIKCNLTNSILFFGRCFSP

Name	SEQ ID	Sequence
Ovalbumin-like [<i>Athene cunicularia</i>]	32	MGSISTASTEFCFDVFKELKVQHVNNENIFYSPLSIISALSMVYLGARENTRAQIEKV VHFDKITGFGESIESQCCTSVSVHTSLKDMLIQISKPSDNYSLSFASKLYAEETYPIL PEYLQCVKELYKGGLESINFQTAADQARQLINSWVESQTNGMIKDILQPSSVDPQ TEMVLVNAIYFKGIWEKAFKDEDTQEVPRITEQESKPVQMMYQIGSFKVAVIAS EKIKILELPYASGELSMLIVLPDDVSGLEQLETAITFEKLIIEWTSPSIMEERKTKVYL PRMKIEEKYNLTSVLMALGMTDLFSPSANLSGISSAESLKMSEAIHEAFVEIYEAG SEVVGSAEAGMEATSVSEFRVDHPFLFLIKHNPNANIILFFGRCVSP
PREDICTED: Ovalbumin-like [<i>Calidris pugnax</i>]	33	MGSIGAASTEFCFDVFKELKVQHVNNENIFYSPLTIISALSLVYLGARENTRAQIDKV FHFDKISGFGETTESQCCTSVSVHTSLKEMFTQITKPSDNYSVSFASRLYAEDTYPI LPEYLQCVKELYKGGLETISFQTAADQAREVINSWVESQTNGMIKNILQPGSVDS QTEMVLVNAIYFKGMWEKAFKDEDTQTMPFRITEQERKPVQMMYQAGSFKVAV MASEKMKILELPYASGEFCMLIMLPDDVSGLEQLENSFSFEKLMWTTSNMMEE RKMKVYIPRMKMEEKYNLTSVLMALGMTDLFSSSANLSGISSAETLKMSEAVHE AFMEIYEAGSEVVGSTGSGAEVTGVYEEFRADHPFLFLVKHKPTNSILFFGRCVSP
PREDICTED: Ovalbumin [<i>Aptenodytes forsteri</i>]	34	MGSIGAASTEFCFDIFNELKVQHVNNENIFYSPLSIISALSMVYLGARENTRKAQIDKV VHFDKITGFGETIESQCCTSVSVHTSLKDTFTQITKPSDNYSLSFASRLYAETYPIL PEYSQCCKELYKGGLETISFQTAADQARELINSWVESQTNGMIKNILQPGSVDPQT ELVLVNAIYFKGTWEKAFKDKDTQAVPFRVTEQESKPVQMMYQIGSYKVAIVAS EKMKILELPYASRELSMLVLLPDDVSGLEQLETAITFEKLMWTTSSNMMEERKVK VYLPRMKIEEKYNLTSVLMALGMTDLFSPSANLSGISSAESLKMSEAVHEAFVEIY EAGSEVVGSTGAGMEVTSVSEEFRAHPFLFLIKCNPTNSILFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Pterocles gutturalis</i>]	35	MGSISAASAEFCFDVFKELKVQHVNNENIFYSPLSIISALSMVYLGARENTRKAQIDK VVHFDKITGSGETIEFQCCTSANIHPSLKDMMFTQITRLSDNYSLSFASRLYAERYP ILPEYLQCVKELYKGGLETISFQTAADQARELINSWVESQTNGMIKNILQPGSVNP QTEMVLVNAIYFKGLWEKAFKDEDTQTVPFRMTEQESKPVQMMYQVGSFKVAV MASDKIKILELPYASGELSMLVLLPDDVTGLEQLETSITFEKLMWTTSSNVMEERT MKVYLPHMRMEEKYNLTSVLMALGVTDLFSSSANLSGISSAESLKMSEAVHEAF VEIYESGSQVVGSTGAGTEVTSVSEEFRAHPFLFLIKHNPTNSILFFGRCFSP
Ovalbumin-like [<i>Falco peregrinus</i>]	36	MGSIGAASVEFCFDVFKELKVQHVNNENIFYSPLSIISALSMVYLGARENTRKAQIDK VVHFDKIAGFGAIESQCVTSASIHSLKDMMFTQITKPSDNYSLSFASRLYAEAYSI LPEYLQCVKELYKGGLETISFQTAADQARDLINSWVESQTNGMIKNILQPGAVDL ETEMVLVNAIYFKGMWEKAFKDEDTQTVPFRMTEQESKPVQMMYQVGSFKVA VMASDKIKILELPYASGQLSMVVLPDDVSGLEQLEASITSEKLMWTTSSSIMEEK KIKVYFPHMKIEEKYNLTSVLMALGMTDLFSSSANLSGISSAEKLVSEAVHEAF VEISEAGSEVVGSTEAGTEVTSVSEEFKADHPFLFLIKHNPTNSILFFGRCFSP
PREDICTED: Ovalbumin-like isoform X2 [<i>Phalacrocorax carbo</i>]	37	MGSIGAASSEFCFDIFKELKVQHVNNENIFYSPLSIISALSMVYLGARENTRAQIDKV VPFDKITASGESIESQCCTSVSVHTSLKDIFTQITKSSDNHLSLFSASRLYAETYPILP EYLQCVKELYEGGLETISFQTAADQARELINSWIESQTNGRIKNILQPGSVDPQTE MVLVNAIYFKGMWEKAFKDEDTQAVPFRMTEQESKPVQVMHQIGSFKVAVLAS EKIKILELPYASGELSMLVLLPDDVSGLEQLETAITFEKLMWTTSPNIMEERKIKVF

Name	SEQ ID	Sequence
		LPRMKIEEKYNLTSVLMALGITDLFSPLANLSGISSAESLKMSEAIHEAFVEISEAG SEVIGSTEAEVEVTNDPEEFRADHPFLFLIKHNPTNSILFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Merops nubicus</i>]	38	MGSIGAASTEFCFDVFKELKAQYVNENIFYSPMTIITALSMVYLGSKENTRAQIAK VAHFDKITGFGESIESQCGASASIQFSLKDLFTQITKPSGNHLSVASRIYAEETYPI LPEYLECMKELYKGGLETINFQTAANQARELINSWVERQTSGMIKNILQPSSVDS QTEMVLVNAIYFRGLWEKAFKVEDTQATPFRITEQESKPVQMMHQIGSFKVAVV ASEKIKILELPYASGRLTMLVVLDDVSGLKQLETTITFEKLMEWTTSNIMEERKI KVYLPKMKIEEKYNLTSVLMALGLTDLFSSSANLSGISSAESLKMSEAVHEAFVEI YEAGSEVVASAEAGMDATSVSEEFRADHPFLFLIKDNTSNSILFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Tauraco erythrolophus</i>]	39	MGSIGAASTEFCFDVFKELKGQHVNNENIFFCPLSIVSALSMVYLGARENTRAQIVK VAHFDKIAGFAESIESQCGTSVSIHTSLKDMFTQITKPSDNYSLNFASRLYAEETYP IPEYLQCVKELYKGGLETISFQTAADQAREIINSWVESQTNGMIKNILRPSSVHPQ TELVLVNAVYFKGTWEKAFKDEDQAVPFRITEQESKPVQMMYQIGSFKVAAVT SEKMKILEVPYASGELSMLVLLPDDVSGLEQLETAITAEKLIWTSSTVMEERKLK VYLPKMKIEEKYNLTTLVLTALGVTDLFSSSANLSGISSAQGLKMSNAVHEAFVEIY EAGSEVVGSKGEGTEVSSVSDEFKADHPFLFLIKHNPTNSIVFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Cuculus canorus</i>]	40	MGSIGAASTEFCFDVFKELKVHHVNNENILYSPLAIISSALSMVYLGAKENTRDQIDK VVHFDKITGIGESIESQCSTAVSVHTSLKDVFDQITRPSDNYSLAFASRLYAEETYP ILPEYLQCVKELYKGGLETIDFQTAADQARQLINSWVEDETNGMIKNILRPSSVNP QTKIILVNAIYFKGMWEKAFKDEDQEVFPFRITEQETKSVQMMYQIGSFKVAEVS SDKMKILELPYASGKLSMLVLLPDDVYGLEQLETVITVEKLEWTSSIVMEERITK VYLPKMKIMEKYNLTSLVLTAFGITDLFSPSANLSGISSTESLKVSEAVHEAFVEIHE AGSEVVGSAAGAGIEATSVSEEFKADHPFLFLIKHNPTNSILFFGRCFSP
Ovalbumin [<i>Antrostomus carolinensis</i>]	41	MGSIGAASTEFCFDVFKELKVQHVNNENIFYSPLSIISALSMVYLGARENTRAQIDK VVHFDKITGFEDSIESQCGTSVSVHTSLKDMFTQITKPSDNYSVGFASRLYAAETY QILPEYSQCVELYKGGLETINFQKAADQATELINSWVESQTNGMIKNILQPSSVD PQTQIFLVNAIYFKGMWQRAFKEEDQAVPFRISEKESKPVQMMYQIGSFKVAVI PSEKIKILELPYASGLLSMLVLLPDDVSGLEQLENAITLEKLMQWTSNMMMEERKI KVYLPKMRMEEKYNLTSVFMALGITDLFSSSANLSGISSAESLKMSDAVHEASVEI HEAGSEVVGSTGSGTEASSVSEEFRADHPFLFLIKHNPTDSIVFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Opisthocomus hoazin</i>]	42	MGSIGAASTEFCFDVFKELKFQHVNNENIFYSPLTIISALSMVYLGARENTRAQIDK VVHFDKIAGFEETVESQCGTSVSVHTSLKDMFAQITKPSDNYSLSFASRLYAEETY PILPEYLQCVKELYKGGLETISFQTAADQARDLINSWVESQTNGMIKNILQPSSVG PQTELILVNAIYFKGMWQKAFKDEDQEVPPFRMTEQQSKPVQMMYQTGSFKVA VVASEKMKILALPYASGQLSLLVMLPDDVSGLKQLESAITSEKLIWTSPPSMMEE RKIKVYLPKMKIEEKYNLTSVLMALGITDLFSPSANLSGISSAESLKMMSQAVHEAF VEIYEAGSEVVGSTGAGMEDSSDSEEFVVDHPFLFFIKHNPTNSILFFGRCFSP
PREDICTED: Ovalbumin-like	43	MGSIGPLSVEFCDDVFKELRIQHPRENIFYSPVTIISALSMVYLGARDNTKAQIEKA VHFDKIPGFGESIESQCGTSLSIHTSLKDIFTQITKPSDNYTVGIASRLYAEKYPILP EYLQCIKELYKGGLEPINFQTAEEQARELINSWVESQTNGMIKNILQPSSVNPETD

Name	SEQ ID	Sequence
[<i>Lepidothrix coronata</i>]		MVLVNAIYFKGLWEKAFKDEDIQTVPFRITEQESKPVQMMFQIGSFRVAEITSEKI RILELPYASGQLSLWVLLPDDISGLEQLETAITFENLKEWTSSTKMEERKIKVYLPR MKIEEKYNLTSLVLTSLGITDLFSSSANLSGISSAESLKVSSAFHEASVEIYEAGSKV VGSTGAEVEDTSVSEEFRAHDHPFLFLIKHNPSNSIFFFGRCFSP
PREDICTED: Ovalbumin [<i>Struthio camelus australis</i>]	44	MGSIGTASAEFCFDVFKELKVHHVNENIFYSPLSIISALSMVYLGARENKTQMEK VIHFDKITGLGESMESQCGTGVSIHTALKDMLSEITKPSDNYSLSLASRLYAEQTY AILPEYLQCIKELYKESLETVSFQTAADQARELINSWIESQTNGVIKNFLQPGSVDS QTELVLVNAIYFKGMWEKAFKDEDTQEVPFRITEQESRPVQMMYQAGSFKVATV AAEKIKILELPYASGELSMLVLLPDDISGLEQLETTISFEKLTEWTSNNMEDRNM KVYLPRMKIEEKYNLTSLVIALGMTDLFSPAANLSGISAESLKMSEAIHAAYVEI YEADSEIVSSAGVQVEVTSVSEEFRAHDHPFLFLIKHNPTNSVLFFGRCISP
PREDICTED: Ovalbumin-like [<i>Acanthisitta chloris</i>]	45	MGSIGAVSTEFSCDVFKELRIHHVQENIFYSPVTIISALSMIYLGARDSTKAQIEKA VHFDKIPGFGESIESQCGTSLSIHTSIKDMFTKITKASDNYSIGIASRLYAEKYPILP EYLQCVKELYKGGLESISFQTAAEQAREIINSWVESQTNGMIKNILQPSSVDPQTDI VLVNAIYFKGLWEKAFRDEDTQTVPFKITEQESKPVQMMYQIGSFKVAEITSEKIK ILEVPYASGQLSLWVLLPDDISGLEKLETAITFENLKEWTSSTKMEERKIKVYLPR MKIEEKYNLTSLVLTALGITDLFSSSANLSGISSAESLKVSEAFHEAIVEISEAGSKVV GSVGAGVDDTSVSEEFRAHDHPFLFLIKHNPTNSIFFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Tyto alba</i>]	46	MGSIGAASTEFCFDVFKELKVQHVNNENIFYSPLSIISALSMVYLGARENTRAQIDK VVHFDKIAGFGESTESQCGTSVSAHTSLKDMSNQITKLSLDNYSLSFASRLYAEETY PILPEYSQCVKELYKGGLESISFQTAAYQARELINAWVESQTNGMIKDILQPGSVD SQTMMVLVNAIYFKGIWEKAFKDEDTQEVPMTEQETKPVQMMYQIGSFKVAV IAAEKIKILELPYASGQLSMLVILPDDVSGLEQLETAITFEKLTEWTSASVMEERKI KVYLPRMSIEEKYNLTSLVIALGVTDLFSSSANLSGISSAESLRMSEAIHEAFVETY EAGSTESGTEVTSASEEFRAHDHPFLFLIKHKPTNSILFFGRCFSP
PREDICTED: Ovalbumin-like isoform X1 [<i>Phalacrocorax carbo</i>]	47	MGSIGAASSEFCFDIFKELKVQHVNNENIFYSPLSIISALSMVYLGARENTRAQIDKV VPFDKITASGESIESQVQKIQCSTSVSVHTSLKDIFTQITKSSDNHSLSFASRLYAE TYPILPEYLQCVKELYEGGLETISFQTAADQARELINSWIESQTNGRIKNILQPGSV DPQTEMVLVNAIYFKGMWEKAFKDEDTQAVPMTEQESKPVQVMHQIGSFKV AVLASEKIKILELPYASGELSMLVLLPDDVSGLEQLETAITFEKLMEWTSNIMEE RKIKVFLPRMKIEEKYNLTSLVLMALGITDLFSPLANLSGISSAESLKMSEAIHEAFV EISEAGSEVIGSTEAEVEVTNDPEEFRAHDHPFLFLIKHNPTNSILFFGRCFSP

Name	SEQ ID	Sequence
Ovalbumin-like [<i>Pipra filicauda</i>]	48	MGSIGPLSVEFCCDVFKELRIQHARENIFYSPVTIISALSMVYLGARDNTKAQIEKA VHFDKIPGFGESESQCGTSLSIHTSLKDIFTQITKPSDNYTVGIASRLYAEKYPIPL EYLQCIKELYKGGLEPISFQTAAEQARELINSWVESQTNGIKNILQPSSVNPETDM VLVNAIFYKGLWEKAFKDEGTQTPFRITEQESKPVQMMFQIGSFRVAEIASEKIR ILELPYASGQLSLWVLLPDDISGLEQLETAITFENLKEWTSSTKMEERKIKVYLPR MKIEEKYNLTSVLTSLGITDLFSSSANLSGISSAERLKVSSAFHEASMEINEAGSKV VGAGVDDTSVSEEFVRDPRFLFLIKHNPSNSIFFFGRCFSP
Ovalbumin [<i>Dromaius novaehollandiae</i>]	49	MGSIGAASTEFCFDMFKELKVHHVNENIISPLSIISILSMVFLGARENTKTQMEKV IHFDKITGFGESESQCGTSSVSHASLKDILSEITKPSDNYSLSLASKLYAEETYPVL PEYLQCIKELYKGSLETVSFQTAADQARELINSWVETQQTNGVIKNFLQPGSVPDQT EMVLVD AIYFKGTWEKAFKDEDTQEVPRITEQESKPVQMMYQAGSFKVATVA AEKMKILELPYASGELSMFVLLPDDISGLEQLETTISIEKLEWTSSNMEDRKM VYLPHMKIEEKYNLT SVL VALGMTDLFSPSANLSGISTAQTLKMSEAIHGAYVEIY EAGSEMATSTGVLVEAASVSEEFVRDHPFLFLIKHNPSNSILFFGRCIFP
Chain A, Ovalbumin	50	MGSIGAASTEFCFDMFKELKVHHVNENIISPLSIISILSMVFLGARENTKTQMEKV IHFDKITGFGESESQCGTSSVSHASLKDILSEITKPSDNYSLSLASKLYAEETYPVL PEYLQCIKELYKGSLETVSFQTAADQARELINSWVETQQTNGVIKNFLQPGSVPDQT EMVLVD AIYFKGTWEKAFKDEDTQEVPRITEQESKPVQMMYQAGSFKVATVA AEKMKILELPYASGELSMFVLLPDDISGLEQLETTISIEKLEWTSSNMEDRKM VYLPHMKIEEKYNLT SVL VALGMTDLFSPSANLSGISTAQTLKMSEAIHGAYVEIY EAGSEMATSTGVLVEAASVSEEFVRDHPFLFLIKHNPSNSILFFGRCIFPHHHHHH
Ovalbumin-like [<i>Corapipo altera</i>]	51	MGSIGPLSVEFCCDVFKELRIQHARENIFYSPVTIISALSMVYLGARDNTKAQIEKA VHFDKIPGFGESESQCGTSLSIHTSLKDIFTQITKPSDNYTVGIASRLYAEKYPIPL EYLQCIKELYKGGLEPISFQTAAEQARELINSWVESQTNGMIKNILQPSAVNPETD MVLVNAIFYKGLWEKAFKDEGTQTPFRITEQESKPVQMMFQIGSFRVAEITSEKI RILELPYASGQLSLWVLLPDDISGLEQLETAITFENLKEWTSSTKMEERKIKVYLPR MKIEEKYNLT SVLTSLGITDLFSSSANLSGISSAERLKVSSAFHEASMEIYEAGSKV VGSTGAGVDDTSVSEEFVRDPRFLFLIKHNPSNSIFFFGRCFSP
Ovalbumin-like protein [<i>Amazona aestiva</i>]	52	MEDQRGNTGFTMGSIGAASTEFCIDVFREL RVQHV NENIFYSPLTIISALSMVYLG ARENTRAQIDQVVHFDKIAGFGDTVESQCGSSPSVHNSLKT VXAQITQPRDNYSL NLASRLYAEESYPILPEYLQCVKELYNGGLETVSFQTAADQARELINSWVESQTN GIIKNILQPSSVDPQTEMVLVNAIFYKGLWEKAFKDEETQAVPFRITEQENRPVQM MYQFGSFKVAXVASEKIKILELPYASGQLSMLVLLPDEVSGLEQNAITFEKLEW TSSDLMEERKIKVFFPRVKIEEKYNLTAVLVSLGITDLFSSSANLSGISSAENLKMS EAVHEAXVEIYEAGSEVAGSSGAGIEVASDSEEFVRDHPFLFLIXHNPTNSILFFGR CFSP
PREDICTED: Ovalbumin-like [<i>Melopsittacus undulatus</i>]	53	MGSIGAASTEFCIDVFREL RVQHV NENIFYSPLSIISALSMVYLGARENTRAQIDEV FHFDKIAGFGDTVDPQCGASLSVHKSLQN VFAQITQPKDNYSLNLASRLYAEESY PILPEYLQCVKELYNEGLETVSFQTGADQARELINSWVENQTNGVIKNILQPSSVD PQTEMVLVNAIFYKGLWQKAFKDEETQAVPFRITEQENRPVQMMYQFGSFKVAV

Name	SEQ ID	Sequence
		VASEKVKILELPYASGQLSMWVLLPDEVSGLEQLENAITFEKLTTEWTSDDLTEER KIKVFLPRVKIEEKYNLTAVLMALGVTDLFSSSANFSGISAAENLKMSEAVHEAF VEIYEAGSEVVGSSGAGIEAPSDSEEFRAHPFLFLIKHNPTNSILFFGRCFSP
Ovalbumin-like [<i>Neopelma chrysocephalum</i>]	54	MGSIGPLSVEFCCDVFKELRIQHARDNIFYSPVTIISALSMVYL GARDNTKAQIEKA VHFDKIPGFGEIESQCGTSLSVHTSLKDIFTQITKPRENYTVGIASRLY AEEKYPIL PEYLQCIKELYKGGLEPISFQTAAEQARELINSWVESQTNGMIKNILQPSSVNPETD MVLVNAIYFKGLWKKAFKDEGTQTPFRITEQESKPVQMMFQIGSFRVAEITSEKI RILELPYASGQLSLWVLLPDDISGLEQLES AITFENLKEWTSSTKMEERKIKVYLPR MKIEEKYNLT SVLTSLGITDLFSSSANLSGISSAEKLVSSAFHEASMEIYEAGNKV VGSTGAGVDDTSVSEEFVRDPFLFLIKHNPSNSIFFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Buceros rhinoceros silvestris</i>]	55	MGSIGAASAEFCVDVFKELKDQHVNNIVFSPLMIISALSMVNIGAREDTRAQIDKV VHFDKITGYGESIESQCGTSGIYFSLKDAFTQITKPSDNYSLSFASKLY AEETYPI PEYLKCVKELYKGGLETISFQTAADQARELINSWVESQTNGMIKNILQPSSVDPQT EMVLVNAIYFKGLWEKAFKDEDTQAVPFRITEQESKPVQMMYQIGSFKVAVIASE KIKILELPYASGQLSLVLLPDDVSGLEQLES AITSEKLEWTNPNIMEERKTKVYL PRMKIEEKYNLT SVLVALGITDLFSSSANLSGISSAEGLKLSDAVHEAFVEIYEAGR EVVGSSEAGVEDSSVSEEFKADRPFI FLIKHNPTNGILYFGRIYSP
PREDICTED: Ovalbumin-like [<i>Cariama cristata</i>]	56	MGSIGAANTDFCFDVFKELKVH HANENIFYSPLSIVSALAMVYL GARENTRAQID KALHFDKILGFGETVESQCDTSVSVHTSLKDMLIQITKPSDNYSFASKIYTEETY PILPEYLQCVKELYKGGVETISFQTAADQAREVINSWVESHTNGMIKNILQPGSVD PQTKMVLVNAVYFKGIWEKAFKEEDTQEMPFRINEQESKPVQMMYQIGSFKLT AASENLKILEFPYASGQLSMMVILPDEVSGLKQLETSITSEKLIKWTSSNTMEERKI RVYLP RMKIEEKYNLKS VLMALGITDLFSSSANLSGISSAESLKMSEAVHEAFVEI YEAGSEVTSSGTMEAE NVSEEFKADHPFLFLIKHNPTDSIVFFGRCMSP
Ovalbumin [<i>Manacus vitellinus</i>]	57	MGSIGPLSVEFCCDVFKELRIQHARENIFYSPVTIISALSMVYL GARDNTKAQIEKA VHFDKIPGFGEIESQCGTSLSIHTSLKDIFTQITKPSDNYTVGIASRLY AEEKYPILP EYLQCIKELYKGGLEPISFQTAAEQARELINSWVESQTNGMIKNILQPSSVNPETD MVLVNAIYFKGLWEKAFKDESTQTPFRITEQESKPVQMMFQIGSFRVAEIASEKI RILELPYASGQLSLWVLLPDDISGLEQLETAITFENLKEWTSSTKMEERKIKVYLPR MKIEEKYNLT SVLTSLGITDLFSSSANLSGISSAERLKVSSAFHEASMEIYEAGSRV VEAGVDDTSVSEEFVRDPFLFLIKHNPSNSIFFFGRCFSP
Ovalbumin-like [<i>Empidonax traillii</i>]	58	MGSIGPVSTEFCCDIFKELRIQHARENIFYSPVTIISALSMVYL GARDNTKAQIEKAV HFDKIPGFGEIESQCGTSLSIHTSLKDILTQITKPSDNYTVGIASRLY AEEKYPILSE YLQCIKELYKGGLEPISFQTAAEQARELINSWVESQTNGMIKNILQPSSVNPETDM VLVNAIYFKGLWEKAFKDEGTQTPFRITEQESKPVQMMFQIGSFKVAEITSEKIR ILELPYASGKLSLWVLLPDDISGLEQLETAITFENLKEWTSSTRMEERKIKVYLPR MKIEEKYNLT SVLTSLGITDLFSSSANLSGISSAERLKVSSAFHEVFVEIYEAGSKV EGSTGAGVDDTSVSEEFRAHPFLFLVKHNPSNSIIFFGRCYLP
PREDICTED: Ovalbumin-like	59	MGSTGAASMEFCFALFRELKVQHVNENIFFSPVTIISALSMVYL GARENTRAQLD KVAPFDKITGFGETIGSQCSSTASSHTSLKDVFTQITKASDNYSLSFASRLY AEETY

Name	SEQ ID	Sequence
[<i>Leptosomus discolor</i>]		PILPEYLQCVKELYKGGLESISFQTAADQARELINSWVESQTNGMIKDILRPSSVDP QTKIILITAIYFKGMWEKAFKEEDTQAVPFRMTEQESKPVQMMYQIGSFKVAVIPS EKLKILELPYASGQLSMLVILPDDVSGLEQLETAITTEKLKEWTSPSMMKERKMK VYFPRMRIEEKYNLTSVLMALGITDLFSPSANLSGISSAESLKVSEAVHEASVDIDE AGSEVIGSTGVGTEVTSVSEEIRADHPFLFLIKHKPTNSILFFGRCFSP
Hypothetical protein H355_008077 [<i>Colinus virginianus</i>]	60	MEHAQLTQLVNSNMTSNTCHEADEFENIDFRMDSISVTNTKCFDVFNEMKVHH VNENILYSPLSILTALAMVYLGARGNTESQMKKALHFDSITGAGSTTDSQCGSSE YIHNLFKEFLTEITRTNATYSLEIADKLYVDKTFTVLPEYINCARKFYTGGVEEVN FKTAAEEARQLINSWVEKETNGQIKDLLVPSSVDFGTMVMFINTIYFKGIWKTAF NTEDTREMPFSMTKQESKPVQMMCLNDTFNMATLPAEKMRIELPYASGELSML VLLPDEVSGLEQIEKAINFEKLREWSTNAMEKKSMMKVYLPRMKIEEKYNLTSTL MALGMTDLFSRSANLTGISSVENLMISDAVHGAFMEVNEEGTEAAGSTGAIGNIK HSVEFEEFRADHPFLFLIRYNPTNVILFFDNSEFTMGSIGAVSTEFCDVFKELRVH HANENIFYSPFTVISALAMVYLGAKDSTRQINKVVRFDKLPFGFGDSIEAQCGTSA NVHSSLRDILNQITKPNDIYSFSLASRLYADETYTILPEYLQCVKELYRGGLESINF QTAADQARELINSWVESQTSIIRNVLPSSVDSQTAMVLVNAIYFKGLWEKGFK DEDTQAMPFRVTEQENKSVQMMYQIGTFKVASVASEKMKILELFPASGTMSMW VLLPDEVSGLEQLETTISIEKLTEWTSSSVMEERKIKVFLPRMKMEEKYNLTSVLM AMGMTDLFSSSANLSGISSTLQKKGFRSQELGDYAKPMLESPALTPQVTAWDN SWIVAHPA AIEPDL CYQIMEQKWKPFDPDFRLPMRVSCRFRTEALNKANTSF ALDFFKHECQEDDDENILFSPFSSSALATVYLGAKGNTADQMAKTEIGKSGNIHA GFKALDLEINQPTKNYLLNSVNQLYGEKSLPFSKEYLQLAKKYSAEPQSVDFLG KANEIRREINSRVEHQTEGKIKNLLPPGSIDSLTRLVLVNALYFKGNWATKFEAED TRHRPFRINMHTTKQVPMYLRDKFNWYTVESVQTDVLELPYVNNDLSMFILLP RDITGLQKLINELTFEKLSAWTSPELMEKMKMEVYLPRTVEKKYDMKSTLSKM GIEDAFTKVDSCGVTNVEITTHIVSSKCLELKHQINKKLCKNAVAMEQVSASI GNFTIDLFNKLNETSRDKNIFFSPWSVSALALTSAAKGNTAREMAEDPENEQA ENIHSGFKELMTALNKPRNTYSLKSANRIYVEKNYPLLPTYIQLSKKYYKAEPYK VNFKTAPEQSRKEINNWVEKQTERKIKNFLSSDDVKNSTKSILVNAIYFKAEEWEE KFQAGNTDMQPFRMSKNKSKLVKMMYMRHTFPVLIMEKLNFKMIELPYVKREL SMFILLPDDIKDSTTGLEQLERELTYEKLSEWADSKKMSVTLVDLHLPKFSMEDR YDLKDALKSMGMASAFNSNADFSGMTGFQAVPMESLSASTNSFTLDLYKKLDET SKGQNIFFASWSIATALAMVHLGAKGDTATQVAKGPEYEETENIHSGFKELLSAI NKPRNTYLMKSANRLFGDKTYPLLPKFLELVARYYQAKPQAVNFKTDAEQARA QINSWVENETESKIQNLLPAGSIDSHTVLVLVNAIYFKGNWEKRFLEKDTSKMPF RLSKTETKPVQMMFLKDTFLIHHERTMKFKIIELPYVGNELSAFVLLPDDISDNTT GLELVERELTYEKLAEWSNSASMMKAKVELYLPKLKMEENYDLKSVLSDMGIRS AFDPAQADFTRMSEKKDLFISKVIHKAFVEVNEEDRIVQLASGRLTGRCRTLANK ELSEKNRTKNLFFSPFSSSALSMILLGSKGNTEAQIAKVLSSLKAEDA HNGYQSL SEINNPDTKYILRTANRLYGEKTFEFLSSFDSSQKFYHAGLEQTD FKNASEDSRKQ

Name	SEQ ID	Sequence
		INGWVEEKTEGKIQKLLSEGIINSMTKLVLVNAIYFKGNWQEKFDKETTKEMPFKI NKNETKPVQMMFRKGKYNMTYIGDLETTVLEIPYVDNELSMILLPDSIQDESTGL EKLRELTYEKLMDWINPNMMDSTEVRVSLPRFKLEENYELKPTLSTMGMPDAF DLRTADFSGISSGNELVLSEVVHKSFVEVNEEGTEAAAATAGIMLLRCAMIVANF TADHPFLFFIRHNKTNSILFCGRFCSP
PREDICTED: Ovalbumin isoform X2 [<i>Apteryx australis mantelli</i>]	61	MGSIGTASTEFCFDMFKEMKVQHANQNIIFSPLTIISALSMVYLGARDNTKAQME KVIHFDKITGFGESVESQCGTSVSIHTSLKDMLSEITKPSDNYSLASRLYAEETY PILPEYLQCMKELYKGGLETVSFQTAADQARELINSWVESQTNGVIKNFLQPGSV DPQTEMVLVNAIYFKGMWEKAFKDEDTQEVPRITEQESKPVQMMYQVGSFKV ATVAAEKMKILEIPYTHRELSMFVLLPDDISGLEQLETTISFEKLTWTSNNMEE RKVKVYLPHMKIEEKYNLTSVLMALGMTDLFSPSANLSGISTAQTLMMSEAIHG AYVEIYEAGREMASSTGVQVEVTSVLEEV RADKPFLFFIRHNPTNSMVVFGRYMS P

Name	SEQ ID	Sequence
Hypothetical protein ASZ78_006007 [<i>Callipepla squamata</i>]	62	MTSNTCHEADEFENIDFRMDSISVTNTKFCFDVFNEMKVHHVNENILYSPLSILTA LAMVYLGARGNTESQMKKALHFDSITGGGSTTDSQCGSSEYIHNLFKEFLTEITRT NATYSLEIADKLYVDKTFITVLPEYINCARKFYTGGEVEEVNFKTAAEEARQLMNS WVEKETNGQIKDLLVPSSVDFGTMMVFINTIYFKGIWKTAFNTEDTREMPPFSMTK QESKPVQMMCLNDTFNMVTLPAEKMRIELPYASGELSMLVLLPDEVSGLERIEK AINFEKLREWSTNAMEKKSMMKVYLPRMKIEEKYNLTSTLMALGMTDLFERSAN LTGISSVDNLMISDAVHGAFMEVNEEGTEAAGSTGAIGNIKHSVEFEFRADHPFL FLIRYNPTNVILFFDNSEFTMGSIGAVSTFCFDVFKELRVHHANENIFYSPFTIISA LAMVYLGAKDSTRTQINKVVRFDKLPFGGDSIEAQCGTSANVHSSLRDILNQITKP NDIYSFSLASRLYADETYITLPEYLQCVKELYRGGLSINFQTAADQARELINSWV ESQTSGIHRNVLPSSVDSQTAMVLVNAIYFKGLWEKGFKDEDQTAIPFRVTEQEN KSVQMMYQIGTFKVASVASEKMKILELPFASGTMSMWVLLPDEVSGLEQLETTIS IEKLTETWSSSVMEERKIKVFLPRMKMEEKYNLTSLMAMGMTDLFSSSANLSGI SSTLQKKGFRSQELGDKYAKPMLESPALTPQATAWDNSWIVAHPPAIEPDLYYQI MEQKWKPFDPDFRLPMRVSCRFRTEALNKANTSFALDFKHECEDDSENIL FSPFSISSALATVYLGAKGNTADQMAKVLHFNEAEGARNVTTTIRMQVYSRTDQ QRLNRRACFQKTEIGKSGNIHAGFKGLNLEINQPTKNYLLNSVNQLYGEKSLPFSSK EYLQLAKKYYSAEPQSVDFVGTANEIRREINSRVEHQTEGKIKNLLPPGSIDSLTRL VLVNALYFKGNWATKFEAEDTRHRPFRINTHTTKQVPMMYLSDKFNWTVYESV QTDVLELPYVNNDLSMFILLPRDITGLQKLINELTFEKLSAWTSPELMEKMKMEV YLPRFTVEKKYDMKSTLSKMGIEDAFTKVDNCGVTNVEITIHVVPKCLELKHI QINKELKCNKAVAMEQVSASIGNFTIDLFNKLNETSRDKNIFFSPWSVSSALALTS LAAKGNTAREMAEDPENEQAENIHSGFNELLTALNKPRNTYSLKSANRIYVEKN YPLLPTYIQLSKKYYKAEPHKVNFKTAPEQSRKEINNWVEKQTERKIKNFLSSDD VKNSTKLILVNAIYFKAEEWEEKFQAGNTDMQPFRMSKNKSKLVKMMYMRHTFP VLIMEKLNFKMIELPYVKRELSMFILLPDDIKDSTTGLEQLERELTYEKLSEWADS KKMSVTLVDLHLPKFSMEDRYDLKDALRSMGMASAFNSNADFSGMTGERDLVI SKVCHQSFVAVDEKGTEAAAATAVIAEAVPMESLSASTNSFTLDLYKKLDETSKG QNIFFASWSIATALTMVHLGAKGDTATQVAKGPEYEETENIHSGFKELLSALNKP RNTYSMKSANRLFGDKTYPLLPKTKPVQMMFLKDTFLIHHERTMKFKIHELPMY GNELSAFVLLPDDISDNTTGLELVERELTYEKLAEWSNSASMMKVVELYLPKL KMEENYDLKSALSDMGIRSAFDPAQADFTRMSEKKDLFISKVIHKAFFEVEEEDR IVQLASGRLTGNTAQIAKVLSLSKAEDAANGYQSLLSEINNPDTKYILRTANRLY GEKTFEFLSSFDSSQKFYHAGLEQTDFFKNASEDSRKQINGWVEEKTEGKIQLLS EGIIINSMTKLVLVNAIYFKGNWQEKFDKETTKEMPFKINKNETKPVQMMFRKGK YNMTYIGDLETTVLEIPYVDNELSMIILLPDSIQDESTGLEKLERELTYEKLMDWIN PNMMDSTEVRVSLPRFKLEENYELKPTLSTMGMPDAFDLRTADFSGISSGNEVL SEVVHKSFEVNEEGTEAAAATAGIMLLRCAMIVANFTADHPFLFFIRHNKTNLSIL FCGRFCSP

Name	SEQ ID	Sequence
PREDICTED: Ovalbumin-like [<i>Mesitornis unicolor</i>]	63	MASIGAASTFCFDVFKELKTQHVKENIFYSPMAIISALSMVYIGARENTRAEIDK VVHFDKITGFGNAVESQCGPSVSVHSSLKDLITQISKRSNDYSLSYASRIYAEETYP ILPEYLQCVKEVYKGGLESISFQTAADQARENINAWVESQTNGMIKNILQPSSVNP QTEMVLVNAIYLKGMWEKAFKDEDQTQMPFRVTQQESKPQVMYQIGSFKVAV IASEKMKILELPYTSQQLSMLVLLPDDVSGLEQVESAITAEKLMEWTSPSIMEERT MKVYLPRMKMVEKYNLTSVLMALGMTDLFTSVANLSGISSAQGLKMSQAIHEA FVEIYEAGSEAVGSTGVGMEITSVSEEFKADLSFLFLIRHNPTNSIIFGRCISP
Ovalbumin, partial [<i>Anas platyrhynchos</i>]	64	MGSIGAASTFCFDVFREL RVQHVNNIFYSPFSIISALAMVYLGARDNTRTQIDKI SQFQALSDEHLVLCIQLGEFFVCTNRERREVTRYSEQTEDKTQDQNTGQIHKIV DTCMLRQDILTQITKPSDNFSLSFASRLYAEETYAILPEYLQCVKELYKGGLESISF QTAADQARELINSWVESQTNGIKNILQPSSVDSQTTMVLVNAIFYKGMWEKAFK DEDTQAMPFRMTEQESKPQVMYQVGSFKVAMVTSEKMKILELPFASGMMMSMF VLLPDEVSGLEQLESTISFEKLTEWTSSTMMEEERRMKVYLPRMKMEEKYNLTSVF MALGMTDLFSSSANMSGISSTVSLKMSEAVHAACVEIFEAGR DVVGSAGMDV TSVSEEFRA DHPFLFFIKHNPTNSILFFGRWMSP
PREDICTED: Ovalbumin-like [<i>Chaetura pelagica</i>]	65	MGSIGAAAEFCLDIFKELKVQHVNNIIFSPMTIISALSLVYLGAKEDTRAQIEKV VPFDKIPGFGEIVESQCPKSASVHSSIQDIFNQIIRSDNYSLSLASRLYAEESYPIRP EYLQCVKELDKEGLETISFQTAADQARQLINSWVESQTNGMIKNILQPSSVNSQTE MVLVNAIFYRGLWQKAFKDEDTQAVPFRITEQESKPQVMYQIGSFKVAEIAS KMKILELPYASGQLSMLVLLPDDVSGLEKLESSITVEKLEWTSSNLTEERNVKVY LPRLKIEEKYNLTSVLAALGITDLFSSSANLSGISTAESLKLRAVHESFVEIQEAGH EVEGPKEAGIEVTSALDEFVRDPRFLFVTKHNPTNSILFLGRCLSP
PREDICTED: Ovalbumin-like [<i>Apaloderma vittatum</i>]	66	MGSISAASGEFCLDIFKELKVQHVNNIFYSPMVIVSALSLVYLGARENTRAQIDK VIPFDKITGSSEAVESQCGTPVGAHISLKDVFQAIAKRSNDYSLSFVNRLYAEETYP ILPEYLQCVKELYKGGLETISFQTAADQAREIINSWVESQTDGKIKNILQPSSVDPQ TKMVLVSAIFYKGLWEKSKFDEDTQAVPFRVTEQESKPQVMYQIGSFKVAAIA AEKIKILELPYASEQLSMLVLLPDDVSGLEQLEKKISYEKLTEWTSSSVMEKKIK VYLPRMKIEEKYNLTSLMSLGITDLFSSSANLSGISSTKSLKMSEAVHEASVEIYE AGSEASGITGDGMEATSVFGEFKVDHPFLFMKHKPTNSILFFGRCISP
Ovalbumin-like [<i>Corvus cornix cornix</i>]	67	MGSIGPVSTEVCCDIFRELRSQSVQENVCYSPLLIISTLSMVYIGAKDNTKAQIEKA IHFDKIPGFGESTESQCGTSVSIHTSLKDIFTQITKPSDNYSISIARRLYAEKYPILPE YIQCVKELYKGGLESISFQTAAEKSRELINSWVESQTNGTIKNILQPSSVSSQTD MV LVSAIFYKGLWEKAFKEEDTQTIPFRITEQESKPQVMMSQIGTFKVAEIPSEKCRIL ELPYASGRSLWVLLPDDISGLEQLETAITFENLKEWTSSSKMEERKIRVYLPRMK IEEKYNLT SVLKSLGITDLFSSSANLSGISSAESLKVSAAFHEASVEIYEAGSKGVG SSEAGVDGTSVSEIRADHPFLFLIKHNPSDSILFFGRCFSP
PREDICTED: Ovalbumin-like [<i>Calypte anna</i>]	68	MGSIGAASTFCFDVFKELKVQHVNNIIISPLSIISALSMVYLGAREDTRAQIDKV VHFDKITGFGAIESQCPTSESVHASLKETFSQLTKPSDNYSLAFASRLYAEETYP LPEYLQCVKELYKGGLETINFQTA AEQARQVINSWVESQTDGMIKSLLPSSVDP QTEMILVNAIFYRGLWERAFKDEDTQELPFRITEQESKPQVMMSQIGSFKVAVVA

Name	SEQ ID	Sequence
		SEKVKILELPYASGQLSMLVLLPDDVSGLEQLESSITVEKLIIEWISSNTKEERNIKV YLPRMKIEEKYNLTSVLVALGITDLFSSSANLSGISSAESLKISEAVHEAFVEIQEA GSEVVGSPGPEVEVTSVSEEWKADRPFLFLIKHNPTNSILFFGRYISP
PREDICTED: Ovalbumin [<i>Corvus brachyrhynchos</i>]	69	MGSIGPVSTEVCCDIFRELRSQSVQENVCYSPLLIISTLSMVYIGAKDNTKAQIEKA IHFDKIPGFGESTESQCGTSVSIHTSLKDIFTQITKPSDNYSSISARRLYAEEKYPILQ EYIQCVKELYKGGLESISFQTA AEKSRELINSWVESQTNGTIKNILQPSSVSSQTD VLVSAIYFKGLWEKAFKEEDTQTIPFRITEQESKPVQMMSQIGTFKVAEIPSEKCR LLELPYASGRLSLWVLLPDDISGLEQLETSITFENLKEWTSSSKMEERKIRVYLPRM KIEEKYNLTSVLKSLGITDLFSSSANLSGISSAESLKVS AVFHEASVEIYEAGSKGV GSSEAGVDGTSVSEIRADHPFLFLIKHNPSDSILFFGRFCFSP
Hypothetical protein DUI87_08270 [<i>Hirundo rustica rustica</i>]	70	MLNLMHPKQFCCTMGSIGPVSTEVCCDIFRELRSQSVQENVCYSPLLIISTLSMVYI GAKDNTKAQIEKA IHFDKIPGFGESTESQCGTSVSIHTSLKDIFTQITKPSDNYSSIS SRLYAEEKYPILPEYIQC VKELYKGGLESISFQTA AEKSRELINSWVESQTNGTIKN ILQPSSVSSQTDMLVLSAIYFKGLWEKAFKEEDTQTVPFRITEQESKPVQMMSQIG TFKVAEIPSEKCRILELPYASGRLSLWVLLPDDISGLEQLETTAITSNENLKEWTSSSK MEERKIKVYLPRMKIEEKYNLTSVLKSLGITDLFSSSANLSGISSAESLKVS GAFHE AFVEIYEAGSKAVGSSGAGVEDTSVSEIRADHPFLFFIKHNPSDSILFFGRFCFSP
Ostrich OVA sequence as secreted from pichia	71	EAEAGSIGTASAEFCFDVFKELKVHHVNENIFYSPLSIISALSMVYLGARENKTQ MEKVIHFDKITGLGESMESQCGTGVSHTALKDMLSEITKPSDNYSLSLASRLYAE QTYAILPEYLQCIKELYKESLETVSFQTAADQARELINSWIESQTNGVIKNFLQPGS VDSQTELVLVNAIYFKGMWEKAFKDEDTEQVFPFRITEQESRPVQMMYQAGSFKV ATVAAEKIKILELPYASGELSMLVLLPDDISGLEQLETTISFEKLTETWTSSNMED RNMKVYLPRMKIEEKYNLTSVLIALGMTDLFSPAANLSGISAAESLKMSEAIHAA YVEIYEADSEIVSSAGVQVEVTS DSEEFVRVDHPFLFLIKHNPTNSVLFFGRICISP
Ostrich construct (secretion signal + mature protein)	72	MRFPSIFTAVLFAASSALAAPVNTTTEDETAQIPAEAVIGYSDLEGDFDVAVLPFS NSTNNGLLFINTTASIAAKEEGVSLEKREAEAGSIGTASAEFCFDVFKELKVHHV NENIFYSPLSIISALSMVYLGARENKTQMEKVIHFDKITGLGESMESQCGTGVSHT TALKDMLSEITKPSDNYSLSLASRLYAEQTYAILPEYLQCIKELYKESLETVSFQTA ADQARELINSWIESQTNGVIKNFLQPGSVDSQTELVLVNAIYFKGMWEKAFKDED TQEVFPFRITEQESRPVQMMYQAGSFKVATVAAEKIKILELPYASGELSMLVLLPD DISGLEQLETTISFEKLTETWTSSNMEDRNMKVYLPRMKIEEKYNLTSVLIALGM TDLFSPAANLSGISAAESLKMSEAIHAA YVEIYEADSEIVSSAGVQVEVTS DSEEF VRVDHPFLFLIKHNPTNSVLFFGRICISP
Duck OVA sequence as secreted from pichia	73	EAEAGSIGAASTEFCFDVREL RVQHV NENIFYSPFSIISALAMVYLGARDNTRTQI DKVVHFDKLPFGGESMEAQCGTSVSVHSSLRDILTQITKPSDNFSLSFASRLYAE TYAILPEYLQCVKELYKGGLESISFQTAADQARELINSWVESQTNGIKNILQPSSV DSQTTMLVLSAIYFKGMWEKAFKDEDTQAMPFRMTEQESKPVQMMYQVGSFK VAMVTSEKMKILELPFASGMMSMFVLLPDEVSGLEQLESTISFEKLTETWTSSMM EERRMKVYLPRMKIEEKYNLTSVFMALGMTDLFSSSANMSGISSTVSLKMSEAV

Name	SEQ ID	Sequence
		HAACVEIFEAGRDVVGSAEAGMDVTSVSEEFRADHPFLFFIKHNPTNSILFFGRWMSP
Duck construct (secretion signal + mature protein)	74	MRFPSIFTAVLFAASSALAAPVNTTTEDETAQIPAEAVIGYSDLEGDFDVAVL PFS NSTNNGLLFINTTIIASIAAKEEGVSLEKREAEAGSIGAASTEFCDV FRELRVQHVN ENIFYSPFSIISALAMVYLGARDNTRTQIDKVVHFDKLP GFGE SMEAQC GTSVSVH SSLRDILTQITKPSDNFSLSFASRLYAEETYAILPEYLQCVKELYKGGLESISFQTAA DQARELINSWVESQTNGIHKNILQPSSVDSQTTMVLVNAIYFKGMWEKAFKDEDT QAMPFRMTEQESKPVQMMYQVGSFKVAMVTSEKMKILELPFASGMMSMFVLLP DEVSGLEQLESTISFEKLTEWTSSTMMEERRMKVYLPRMKMEEKYNLTSVFMAL GMTDLFSSSANMSGISSTVSLKMSEAVHAACVEIFEAGRDVVGSAEAGMDVTSV SEEFRADHPFLFFIKHNPTNSILFFGRWMSP

[0163] Expression of rOVA in a host cell, for instance a *Pichia* species, a *Saccharomyces* species, a *Trichoderma* species, a *Pseudomonas* species may lead to an addition of one or more amino acids to the OVA sequence as part of post-transcriptional or post-translational modifications. Such amino acids may not be part of the native OVA sequences. For instance, expressing an OVA sequence in a *Pichia* species, such as *Komagataella phaffii* and *Komagataella pastoris* may lead to addition of one or more amino acids at the N-terminus or C-terminus. In some cases, four amino acids EAEA (SEQ ID NO: 75) is added to the N-terminus of the OVA sequence upon expression in a host cell as shown in SEQ ID NO:1. For example, chicken rOVA may be provided encoding SEQ ID NO: 1, and following expression and secretion, rOVA has the amino acid sequence of SEQ ID NO:2.

[0164] An rOVA can be a non-naturally occurring variant of an OVA. Such variant can comprise one or more amino acid insertions, deletions, or substitutions relative to a native OVA sequence.

[0165] Such a variant can have at least 70%, 75%, 80%, 85%, 90%, 95%, 96%, 97%, 98%, or 99% sequence identity to SEQ ID NOs: 1-74. The term “sequence identity” as used herein in the context of amino acid sequences is defined as the percentage of amino acid residues in a candidate sequence that are identical with the amino acid residues in a selected sequence, after aligning the sequences and introducing gaps, if necessary, to achieve the maximum percent sequence identity, and not considering any conservative substitutions as part of the sequence identity. Alignment for purposes of determining percent amino acid sequence identity can be achieved in various ways that are within the skill in the art, for instance, using publicly available computer software such as BLAST, BLAST-2, ALIGN, ALIGN-2 or Megalign (DNASTAR) software, with BLAST being the preferable alignment algorithm. Those skilled in the art can determine appropriate parameters for measuring alignment, including any algorithms needed to achieve maximal alignment over the full-length of the sequences being compared.

[0166] Depending on the host organism used to express the rOVA, the rOVA can have a glycosylation, acetylation, or phosphorylation pattern different from wildtype OVA. For example, the rOVA herein may or may not be glycosylated, acetylated, or phosphorylated. An rOVA may have an avian, non-avian, microbial, non-microbial, mammalian, or non-mammalian glycosylation, acetylation, or phosphorylation pattern.

[0167] In some cases, rOVA may be deglycosylated (e.g., chemically, enzymatically, Endo-H, PNGase F, O-Glycosidase, Neuraminidase, β 1-4 Galactosidase, β -N-acetylglucosaminidase), deacetylated (e.g., protein deacetylase, histone deacetylase, sirtuin), or dephosphorylated (e.g., acid phosphatase, lambda protein phosphatase, calf intestinal phosphatase, alkaline phosphatase). Deglycosylation, deacetylation or dephosphorylation may produce a protein that is more uniform or is capable of producing a composition with less variation.

[0168] An rOVA is recombinantly expressed in a host cell. As used herein, a “host” or “host cell” denotes here any protein production host selected or genetically modified to produce a desired product. Exemplary hosts include fungi, such as filamentous fungi, as well as bacteria, yeast, plant, insect, and mammalian cells. A host cell may be *Arxula* spp., *Arxula adeninivorans*, *Kluyveromyces* spp., *Kluyveromyces lactis*, *Komagataella phaffii*, *Pichia* spp., *Pichia angusta*, *Pichia pastoris*, *Saccharomyces* spp., *Saccharomyces cerevisiae*, *Schizosaccharomyces* spp., *Schizosaccharomyces pombe*, *Yarrowia* spp., *Yarrowia lipolytica*, *Agaricus* spp., *Agaricus bisporus*, *Aspergillus* spp., *Aspergillus awamori*, *Aspergillus fumigatus*, *Aspergillus nidulans*, *Aspergillus niger*, *Aspergillus oryzae*, *Bacillus subtilis*, *Colletotrichum* spp., *Colletotrichum gloeosporioides*, *Endothia* spp., *Endothia parasitica*, *Escherichia coli*, *Fusarium* spp., *Fusarium graminearum*, *Fusarium solani*, *Mucor* spp., *Mucor miehei*, *Mucor pusillus*, *Myceliophthora* spp., *Myceliophthora thermophila*, *Neurospora* spp., *Neurospora crassa*, *Penicillium* spp., *Penicillium camemberti*, *Penicillium canescens*, *Penicillium chrysogenum*, *Penicillium (Talaromyces) emersonii*, *Penicillium funiculosum*, *Penicillium purpurogenum*, *Penicillium roqueforti*, *Pleurotus* spp., *Pleurotus ostreatus*, *Rhizomucor* spp., *Rhizomucor miehei*, *Rhizomucor pusillus*, *Rhizopus* spp., *Rhizopus arrhizus*, *Rhizopus oligosporus*, *Rhizopus oryzae*, *Trichoderma* spp., *Trichoderma altroviride*, *Trichoderma reesei*, or *Trichoderma virens*. A host cell can be an organism that is approved as generally regarded as safe by the U.S. Food and Drug Administration.

[0169] An rOVA protein can be recombinantly expressed in yeast, filamentous fungi or a bacterium. In some embodiments, rOVA protein is recombinantly expressed in a *Pichia* species (*Komagataella phaffii* and *Komagataella pastoris*), a *Saccharomyces* species, a *Trichoderma* species, a *Pseudomonas* species or an *E.coli* species.

[0170] Expression of an rOVA can be provided by an expression vector, a plasmid, a nucleic acid integrated into the host genome or other means. For example, a vector for expression can include:

(a) a promoter element, (b) a signal peptide, (c) an OVA sequence heterologous to the host cell, and (d) a terminator element.

[0171] Expression vectors that can be used for expression of OVA include those containing an expression cassette with elements (a), (b), (c) and (d). In some embodiments, the signal peptide (b) need not be included in the vector. In general, the expression cassette is designed to mediate the transcription of the transgene when integrated into the genome of a cognate host microorganism.

[0172] To aid in the amplification of the vector prior to transformation into the host microorganism, a replication origin (e) may be contained in the vector (such as PUC_ORIC and PUC (DNA2.0)). To aid in the selection of microorganism stably transformed with the expression vector, the vector may also include a selection marker (f) such as URA3 gene and Zeocin resistance gene (ZeoR). The expression vector may also contain a restriction enzyme site (g) that allows for linearization of the expression vector prior to transformation into the host microorganism to facilitate the expression vectors stable integration into the host genome. In some embodiments the expression vector may contain any subset of the elements (b), (e), (f), and (g), including none of elements (b), (e), (f), and (g). Other expression elements and vector element known to one of skill in the art can be used in combination or substituted for the elements described herein.

[0173] Exemplary promoter elements (a) may include, but are not limited to, a constitutive promoter, inducible promoter, and hybrid promoter. Promoters include, but are not limited to, acu-5, adh1+, alcohol dehydrogenase (ADH1, ADH2, ADH4), AHSB4m, AINV, alcA, α -amylase, alternative oxidase (AOD), alcohol oxidase I (AOX1), alcohol oxidase 2 (AOX2), AXDH, B2, CaMV, cellobiohydrolase I (cbh1), ccg-1, cDNA1, cellular filament polypeptide (cfp), cpc-2, ctr4+, CUP1, dihydroxyacetone synthase (DAS), enolase (ENO, ENO1), formaldehyde dehydrogenase (FLD1), FMD, formate dehydrogenase (FMDH), G1, G6, GAA, GAL1, GAL2, GAL3, GAL4, GAL5, GAL6, GAL7, GAL8, GAL9, GAL10, GCW14, gdhA, gla-1, α -glucoamylase (glaA), glyceraldehyde-3-phosphate dehydrogenase (gpdA, GAP, GAPDH), phosphoglycerate mutase (GPM1), glycerol kinase (GUT1), HSP82, invl+, isocitrate lyase (ICL1), acetohydroxy acid isomeroreductase (ILV5), KAR2, KEX2, β -galactosidase (lac4), LEU2, melO, MET3, methanol oxidase (MOX), nmt1, NSP, pcbC, PET9, peroxin 8 (PEX8), phosphoglycerate kinase (PGK, PGK1), pho1, PHO5, PHO89, phosphatidylinositol synthase (PIS1), PYK1, pyruvate kinase (pki1), RPS7, sorbitol dehydrogenase (SDH), 3-phosphoserine aminotransferase (SER1), SSA4, SV40, TEF, translation elongation factor 1 alpha (TEF1), THI11, homoserine kinase (THR1), tpi, TPS1, triose phosphate isomerase (TPI1), XRP2, YPT1, and any combination thereof.

[0174] A signal peptide (b), also known as a signal sequence, targeting signal, localization signal, localization sequence, signal peptide, transit peptide, leader sequence, or leader peptide, may support secretion of a protein or polynucleotide. Extracellular secretion of a recombinant or

heterologously expressed protein from a host cell may facilitate protein purification. A signal peptide may be derived from a precursor (e.g., prepropeptide, preprotein) of a protein. Signal peptides can be derived from a precursor of a protein other than the signal peptides in native OVA. An example of secretion protein is a *S. cerevisiae* alpha factor pre pro sequence shown bolded and underlined in SEQ ID NO: 1.

[0175] Any nucleic acid sequence that encodes OVA can be used as (c). Preferably such sequence is codon optimized for the host cell.

[0176] Exemplary transcriptional terminator elements include, but are not limited to, *acu-5*, *adh1+*, alcohol dehydrogenase (ADH1, ADH2, ADH4), AHSB4m, AINV, *alcA*, α -amylase, alternative oxidase (AOD), alcohol oxidase I (AOX1), alcohol oxidase 2 (AOX2), AXDH, B2, CaMV, cellobiohydrolase I (*cbh1*), *ccg-1*, cDNA1, cellular filament polypeptide (*cfp*), *cpc-2*, *ctr4+*, CUP1, dihydroxyacetone synthase (DAS), enolase (ENO, ENO1), formaldehyde dehydrogenase (FLD1), FMD, formate dehydrogenase (FMDH), G1, G6, GAA, GAL1, GAL2, GAL3, GAL4, GAL5, GAL6, GAL7, GAL8, GAL9, GAL10, GCW14, *gdhA*, *gla-1*, α -glucoamylase (*glaA*), glyceraldehyde-3-phosphate dehydrogenase (*gpdA*, GAP, GAPDH), phosphoglycerate mutase (GPM1), glycerol kinase (GUT1), HSP82, *inv1+*, isocitrate lyase (ICL1), acetohydroxy acid isomeroreductase (ILV5), KAR2, KEX2, β -galactosidase (*lac4*), LEU2, *melO*, MET3, methanol oxidase (MOX), *nmt1*, NSP, *pcbC*, PET9, peroxin 8 (PEX8), phosphoglycerate kinase (PGK, PGK1), *pho1*, PHO5, PHO89, phosphatidylinositol synthase (PIS1), PYK1, pyruvate kinase (*pki1*), RPS7, sorbitol dehydrogenase (SDH), 3-phosphoserine aminotransferase (SER1), SSA4, SV40, TEF, translation elongation factor 1 alpha (TEF1), THI11, homoserine kinase (THR1), *tpi*, TPS1, triose phosphate isomerase (TPI1), XRP2, YPT1, and any combination thereof.

[0177] Exemplary selectable markers (f) may include, but are not limited to: an antibiotic resistance gene (e.g. zeocin, ampicillin, blasticidin, kanamycin, nourseothricin, chloroamphenicol, tetracycline, triclosan, ganciclovir, and any combination thereof), an auxotrophic marker (e.g. *ade1*, *arg4*, *his4*, *ura3*, *met2*, and any combination thereof).

[0178] In one example, a vector for expression in *Pichia* sp. can include an AOX1 promoter operably linked to a signal peptide (alpha mating factor) that is fused in frame with a nucleic acid sequence encoding OVA, and a terminator element (AOX1 terminator) immediately downstream of the nucleic acid sequence encoding OVA.

[0179] In another example, a vector comprising a DAS1 promoter is operably linked to a signal peptide (alpha mating factor) that is fused in frame with a nucleic acid sequence encoding OVA and a terminator element (AOX1 terminator) immediately downstream of OVA.

[0180] A recombinant protein described herein may be secreted from the one or more host cells. In some embodiments, rOVA protein is secreted from the host cell. The secreted rOVA may be

isolated and purified by methods such as centrifugation, fractionation, filtration, ion exchange chromatography, affinity purification and other methods for separating protein from cells, liquid and solid media components and other cellular products and byproducts. In some embodiments, rOVA is produced in a *Pichia* Sp. and secreted from the host cells into the culture media. The secreted rOVA is then separated from other media components for further use.

[0181] The present disclosure contemplates modifying glycosylation of the recombinant OVA to alter or enhance one or more functional characteristics of the protein and/or its production. In some embodiments, the change in rOVA glycosylation can be due to the host cell glycosylating the rOVA. In some embodiments, rOVA has a glycosylation pattern that is not identical to a native ovalbumin (nOVA), such as a nOVA from chicken egg. In some embodiments, rOVA is treated with a deglycosylating enzyme before it is used as an ingredient in an rOVA composition, or when rOVA is present in a composition. In some embodiments, the glycosylation of rOVA is modified or removed by expressing one or more enzymes in a host cell and exposing rOVA to the one or more enzymes. In some embodiments, rOVA and the one or more enzymes for modification or removal of glycosylation are co-expressed in the same host cell.

[0182] Native ovalbumin (nOVA), such as isolated from a chicken or another avian egg, has a highly complex branched form of glycosylation. The glycosylation pattern comprises N-linked glycan structures such as N-acetylglucosamine units, galactose and N-linked mannose units. See, e.g., **FIG. 1A**. In some cases, the rOVA for use in a herein disclosed consumable composition and produced using the methods described herein has a glycosylation pattern which is different from the glycosylation pattern of nOVA. For example, when rOVA is produced in a *Pichia* sp., the protein may be glycosylated differently from the nOVA and lack galactose units in the N-linked glycosylation. **FIG. 1B** illustrates the glycosylation patterns of rOVA produced by *P. pastoris*, showing a complex branched glycosylation pattern. In some embodiments of the compositions and methods disclosed herein, rOVA is treated such that the glycosylation pattern is modified from that of nOVA and also modified as compared to rOVA produced by a *Pichia* sp. without such treatment. In some cases, the rOVA lacks glycosylation.

[0183] The molecular weight of rOVA may be different as compared to nOVA. The molecular weight of the protein may be less than the molecular weight of nOVA or less than rOVA produced by the host cell where the glycosylation of rOVA is not modified. In embodiments, the molecular weight of an rOVA may be between 40kDa and 55kDa. In some cases, an rOVA with modified glycosylation has a different molecular weight, such as compared to a native OVA (as produced by an avian host species) or as compared to a host cell that glycosylates the rOVA, such as where the rOVA includes N-linked mannosylation. In some cases, the molecular weight of rOVA is

greater than the molecular weight of the rOVA that is completely devoid of post-translational modifications, or an rOVA that lacks all forms of N-linked glycosylation.

DEFINITIONS

[0184] The terminology used herein is for the purpose of describing particular cases only and is not intended to be limiting.

[0185] As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0186] The terms “including”, “includes”, “having”, “has”, “with”, or variants thereof are used in either the detailed description and/or the claims, such terms are intended to be inclusive in a manner similar to the term “comprising”.

[0187] Ranges can be expressed herein as from “about” or “approximately” one particular value, and/or to “about” or “approximately” another particular value. When such a range is expressed, another case includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent “about” or “approximately”, it will be understood that the particular value forms another case. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint. The term “about” or “approximately” as used herein refers to a range that is 15% plus or minus from a stated numerical value within the context of the particular usage. For example, about 10 would include a range from 8.5 to 11.5. The term “about” or “approximately” also accounts for typical error or imprecision in measurement of values.

[0188] Any aspect or embodiment described herein can be combined with any other aspect or embodiment as disclosed herein.

EXAMPLES

Example 1: Preparation of recombinant ovalbumin

[0189] A *Gallus gallus* OVA coding sequence was fused in-frame with the alpha mating factor signal sequence downstream of the promoter sequence (SEQ ID NO:1). A promoter was placed upstream of the signal sequence OVA coding sequence and a transcriptional terminator was placed downstream of the OVA sequence. The expression construct was placed into a Kpas-URA 3 vector.

[0190] The expression constructs were transformed into *Pichia pastoris*. Successful integration was confirmed by genomic sequencing.

[0191] *Fermentation*: Recombinant OVA was produced in a bioreactor at ambient conditions. A seed train for the fermentation process begins with the inoculation of shake flasks with liquid

growth broth using 2ml cryovials of *Pichia pastoris* which are stored at -80°C and thawed at room temperature prior to inoculation.

[0192] The inoculated shake flasks were kept in a shaker at 30°C for 24 hours, after which the grown *Pichia pastoris* was transferred to a production scale reactor.

[0193] The culture was grown at 30°C, at a set pH and dissolved oxygen (DO). The culture was fed with a carbon source. At the end of the fermentation, the target OVA protein was harvested from the supernatant.

[0194] Cell debris was removed, protein was purified and lyophilized to a dry powder. The OVA produced was used in the examples described below.

Example 2: Preparation of an eggless cake using recombinant ovalbumin

[0195] An eggless pound cake can be prepared with the following ingredients. A first ingredient composition made by mixing 2% to 5% recombinant ovalbumin and 0.05% to 0.5% sunflower lecithin. To prepare the pound cake, up to 4% of the dry first ingredient composition is added to 22 - 26% of unsalted butter, 20 - 25% of all-purpose flour, 18 - 26% of water, 20 - 25% sugar, 4 - 6% of sour cream, 1.2% of baking powder, 0.4% of vanilla flavor, 0.05 to 1.5% gums and starch and 0.18% of salt and all ingredients are then mixed to create a batter. For this recipe recombinant ovalbumin may be used at 2-5% and sunflower lecithin from 0.05 to 0.5%.

[0196] In one example, pound cakes with rOVA and with whole egg (as a comparison) were made as follows:

Table 2: Cake with rOVA+ Xanthan gum

Ingredients	% w/w
Lecithin	0.09
All-purpose Flour	22.61
Granulated Sugar	22.61
Unsalted butter	25.63
Sour cream	5.03
Coarse salt	0.18
Baking powder	1.21
vanilla extract	0.37
rOVA	3.41
Water	18.74
Xanthan gum	0.05
Marigold yellow	0.06

Total	100.00
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Table 3: Control Pound Cake with whole Egg

Ingredients	% w/w
Flour	23.34
Sugar	23.34
Whole egg	23.34
unsalted butter	23.34
Sour cream	5.19
baking powder	1.25
Vanilla	0.38
coarse salt	0.21
Total	100.00

Table 4: Cake with rOVA+ Potato Starch+ Xanthan gum

Ingredients	% w/w
Flour	20.73
Sugar	20.73
Unsalted butter	22.08
Sour cream	4.61
Coarse salt	0.16
Baking powder	1.11
Vanilla	0.34
rOVA	3.10
Potato starch	1.48
Xanthan gum	0.09
Lecithin	0.05
water	25.45
Marigold yellow	0.05
Total	100.00

[0197] For each of the recipes, the batter was baked at 325°F until cooked such time that a toothpick, when inserted at the middle of the cake, came out clean.

Table 5: Results from using rOVA in pound cake compositions

	rOVA + Xanthan gum	rOVA + Potato Starch + Xanthan gum	Control Egg pound cake
Cohesiveness	*0.6 ± 0.02 a	0.64 ± 0.02 a	0.62 ± 0.02 a
Resilience	0.31 ± 0 a	0.36 ± 0.05 a	0.32 ± 0.01 a
Hardness (g)	73.9 ± 2.1 a	75.5 ± 7.5 a	75.6 ± 12.7 a
Chewiness (mJ)	1.48 ± 0.04 a	1.78 ± 0.3 a	1.63 ± 0.5 a
Springiness (mm)	3.41 ± 0 a	3.72 ± 0.21 a	3.48 ± 0.32 a
Cake height (cm)	30.08 ± 1.4 a	30.07 ± 1.04 a	30.64 ± 1.01 a
*Similar letters within each marker indicate there is no significant difference between the samples (mean ± std dev; p>0.05)			
Sensory	Appearance: good yellow crumb, compact crumb, light brown crust. Good rise and volume. Aroma: butter, cakey Flavor: buttery, cakey Texture: more moist texture than control cake with egg, not as cohesive as egg control.	Appearance: pale crust color, good yellow crumb color, open pores in crumb like the Control, good rise/volume Aroma: buttery, cakey Flavor: cakey, sweet Texture: more moist texture than egg control, more cohesive than control cake with egg.	Appearance: open pores, golden crust, good yellow crumb color Texture: good chewy, slightly dry Flavor: cakey, buttery Aroma: cakey buttery

[0198] Texture qualities such as cohesiveness, resilience, hardness, chewiness and springiness were measured using a Brookfield CT3 Texture analyzer, 1500g load cell. No significant difference was observed between the Control Egg cakes and cakes made with rOVA in terms of textural

properties and cake height. The sensory properties were comparable to the Control cake made with whole egg.

[0199] The rOVA in the pound cake demonstrated several functional features with utility in baked goods, as well as for other food products and ingredients. Results are shown in FIG. 2.

Table 6: Functional features provided by rOVA in pound cakes

Functionality	Evidence
Foaming	Air cells formed, evident in the crumb structure (cross section photo)
Whipping	Air incorporation during mixing of batter, evident from air cells in crumb structure
Gelling	Protein coagulation upon heating. Creates structure of cake.
Binding	Binds with other ingredients, giving strength and structure to cake. Evident from texture and sensory measurements.
Springiness	Texture measurement
Texturizer	Provides structure while baking, evidenced by textural characteristics: chewiness, hardness, resilience, cohesiveness

Example 3: rOVA applications in meringue

[0200] This example examined the feasibility of making meringue with rOVA in the recipe without using cream of tartar.

[0201] Material: rOVA (pH: 4.12 as is), nOVA (pH: 6.06 as is), Fresh egg white (pH: 9 as is), Xanthan gum, Sodium lauryl sulfate (SLS), Cream of tartar, Granulated sugar, Flavor.

[0202] Equipment: Kitchen Aid, Classic Plus, Breville BOV800XL Smart Electric Oven.

[0203] Method: Separated egg white from the egg yolk carefully at the refrigerator temperature and then let egg whites get to room temperature before whipping. Egg white was used to make Control meringue sample. nOVA or rOVA was used to make test samples. Egg white or nOVA or rOVA solution (10% solution) was transferred to a mixer bowl and whipped for 30 seconds at medium speed (to obtain a homogeneous solution), then cream of tartar was added (for egg-whites only) and mixed at high speed until soft peaks form. While beating constantly, sugar was added gradually and beaten at high speed after each addition until sugar was dissolved completely. Continued mixing until a glossy and firm peak was formed and at the end, flavors were added. The soft meringue mix was transferred into the pan. An oven was preheated to 250°F, and meringues were baked for 50 minutes (or until an internal temperature of 160°F). After cooling, meringues were stored in an airtight container.

[0204] Exemplary meringue recipes using rOVA can include rOVA between 5-10%, sugar at about 26-32%, flavoring (e.g., 1-4%), water at about 59-64%, xanthan gum at about 0.01-0.5%, sodium

lauryl sulfate at about 0.01-0.1% (all w/w). One such exemplary recipe, and comparison recipes with fresh egg white or with native OVA or with rOVA was constructed as shown below:

Table 7: Recipes

		Meringue with rOVA and nOVA (same recipe)	
Ingredients	% w/w	Ingredients	% w/w
Fresh egg white	68.19	nOVA and/or rOVA	8.14
Cream of tartar	1.14	Sugar	28.28
Sugar	28.41	Flavor	2.26
Flavor	2.26	Water	61.12
Total weight	100	Xanthan gum	0.1
		SLS (Sodium lauryl sulfate)	0.1
		Total weight	100

Table 8: Results of meringue recipes

	Egg white meringue	nOVA meringue	rOVA meringue
weight loss %	*51 ± 1 b	60 ± 14.6 a	40 ± 4.5 c
volume (ml)	6.9 ± 1.94a	7.82 ± 1.5a	8.05 ± 2.16a
Density (g/ml)	0.1 ± 0.06 a	0.07 ± 0.01ab	0.06 ± 0.01b
1/density	9.14	13.78	16.65
fluffiness	100	150.5	182.1

*Samples with different letters across a row are significantly different (p<0.05; mean ± std dev).

[0205] Conclusion: Lowest weight loss was observed in meringue with rOVA. Furthermore, rOVA meringue indicated the highest fluffiness compared to the egg control and nOVA. Results are presented in FIG. 3.

[0206] The rOVA usage in meringue demonstrates several functional features of rOVA.

Table 9: Functional features provided by rOVA in meringues

Functionality	Evidence
Foaming	Increased foam capacity compared to egg white
Whipping	Whips easily - Reduced whipping/whisking time compared to egg white
Aeration	Holds air bubbles, soft peak

Fluffing	Provides increased volume and fluffiness
Gelling	Protein coagulation upon heating, provides structure to the meringue sample

Example 4: Comparison of foam capacity and foam stability

[0207] This example evaluated the foam capacity/stability and coagulation properties of rOVA and compared it to fresh whole egg, egg white and nOVA.

[0208] Materials: store-bought egg, nOVA (Bioceutica), rOVA.

[0209] Method: A stock solution of OVA (nOVA or rOVA) was made by mixing 0.7 g OVA in 9.3g distilled water (total volume 10 ml). Cream of tartar was used (see Table 10 below) to adjust pH. Foam was made using a Dremel at speed 3. The time of whisking was recorded. Gel was made by heating 1 ml of sample at 72°C for 10min using a heat block.

Table 10: pH adjustments to rOVA, nOVA and egg white compositions

pH adjustment				
	Initial pH	Temperature	Amount of cream of tartar added (g)	pH after adding cream of tartar
rOVA solution	3.86	21	0	3.86
nOVA solution	5.45	20.7	0.1	4.01
Fresh egg white	8.57	20	2	4.64

[0210] Results of the foam capacity and stability are shown in the Table 11 below. In this set, pH was not adjusted.

[0211] *Foam capacity% = [Initial liquid Vol. (ml)/Foam Vol. (ml)]*100

[0212] **Foam stability% = [(Initial liquid Vol. (ml)-Liquid drainage Vol. at 30 min (ml))/Initial liquid Vol. (ml)]*100

Table 11: Results of foam capacity and stability

	Whole egg	Egg white	nOVA
*Foam capacity%	210 ± 14.1 a	300 ± 0 b	338.5 ± 2.2 c
**Foam Stability%	56 ± 2.8 b	71 ± 1.4 a	59.3 ± 0.92 b
time of whisking	>120	80	19

(second)			
pH as is	7.6	9.1	5.9

[0213] Conclusion: nOVA at pH 6 indicated the highest foam capacity compared to the egg white; however, its foam stability was lower than the egg white. Results are presented in FIG, 4

[0214] The experiment was repeated using cream of tartar to adjust the pH.

Table 12: Results of foam capacity and stability after pH adjustment using cream of tartar

	Egg white	nOVA	rOVA
Foam capacity%	316.3 ± 5.3 b	457.9 ± 31.2 a	367.9 ± 2.9 b
Foam Stability%	83.6 ± 6.2 a	65.1 ± 1.3 b	60.5 ± 0.7 b
time of whisking (second)	64	19	32
Initial pH (as is)	8.57	5.45	3.86
Final pH (after adjusting with cream of tartar)	4.65	4.01	3.86

[0215] Conclusion: The foam capacity of nOVA after reducing pH was still higher than egg white. The foam capacity of rOVA was higher in value compared to that of fresh egg white. The whisking time for rOVA was half that required for fresh egg white. Results are shown in FIG. 5

Example 5: Preparation of recombinant chicken ovalbumin expression strain

[0216] *Expression Constructs* Seven expression cassettes were created for expression of *Gallus gallus* OVA (SEQ ID NO: 2) in *Pichia pastoris*.

Table 13: Expression Cassettes of Interest

Strain	Cassette	Promoter	Terminator
Chicken OVA	GgOVA-A1	K phaffii AOX1 promoter	K phaffii AOX1 transcriptional terminator
Chicken OVA	GgOVA-A2	K phaffii AOX1 promoter	K phaffii AOX1 transcriptional terminator

Chicken OVA	GgOVA-A3	K phaffii AOX1 promoter	K phaffii AOX1 transcriptional terminator
Chicken OVA	GgOVA-D1	K pastoris DAS promoter	K phaffii AOX1 transcriptional terminator
Chicken OVA	GgOVA-F2	K pastoris FLD1 promoter	K phaffii AOX1 transcriptional terminator
Chicken OVA	GgOVA-F3	K pastoris FLD1 promoter	K phaffii AOX1 transcriptional terminator
Chicken OVA	HF-1	K phaffii PEX11 promoter	K phaffii AOX1 transcriptional terminator

[0217] The first three cassettes were made to express a chicken OVA that comprises the amino acid sequence of chicken OVA (SEQ ID NO:2) fused in-frame with a nucleic acid encoding a secretion signal sequence; the expressed fusion protein has the amino acid sequence of (SEQ ID NO: 1). In each of the three cassettes, the Alcohol oxidase 1 (AOX1) promoter was placed upstream of the secretion signal sequence and a *K phaffii* AOX1 transcriptional terminator was placed downstream of the OVA-encoding sequence. These cassettes were labeled GgOVA-A1, GgOVA-A2, and GgOVA-A3 and combined into a first plasmid.

[0218] The fourth cassette included a chicken OVA coding sequence (which encodes SEQ ID NO: 2) fused in-frame with a nucleic acid encoding a secretion signal sequence (thereby encoding SEQ ID NO: 1) but with a dihydroxyacetone synthase (DAS2) promoter placed upstream of the secretion signal sequence and a *K phaffii* AOX1 transcriptional terminator placed downstream of the OVA-encoding sequence. This construct was labeled GgOVA-D1.

[0219] The fifth and sixth cassettes included the chicken OVA coding sequence (which encodes SEQ ID NO: 2) fused in-frame with a nucleic acid encoding a secretion signal sequence (thereby encoding SEQ ID NO: 1) but with a formaldehyde dehydrogenase (FLD) promote placed upstream of the secretion signal sequence and a *K phaffii* AOX1 transcriptional terminator placed downstream of the OVA-encoding sequence. These cassettes were labeled GgOVA-F1 and GgOVA-F2 and were combined with GgOVA-D1 in a second plasmid.

[0220] The seventh cassette included the peroxisome biogenesis (PEX11) promoter placed upstream of a Helper factor protein HAC1 coding sequence and a *K. phaffii* AOX1 transcriptional terminator placed downstream of the Helper factor sequence. This cassette was labeled HF-1 and was transformed into a third plasmid.

[0221] The three plasmids were transformed stepwise into a background strain of *Pichia pastoris*. Genomic sequencing confirmed integration of the expression constructs and copy number of each construct is shown in Table 14 below.

Table 14: Strain Genomic Composition

Strain	Cassette	Copies integrated
Chicken OVA	GgOVA-A1	1
	GgOVA-A2	1
	GgOVA-A3	1
	GgOVA-D1	2
	GgOVA-F2	2
	GgOVA-F3	2
	HF-1	8

Example 6: Preparation of recombinant ovalbumin expression strains for Duck and Ostrich

[0222] *Expression Constructs*: one cassette for expression of *Anas platyrhynchos* (duck) OVA and one cassette for expression of *Struthio camelus* (ostrich) OVA were created for expression in *Pichia pastoris*.

Table 15: Expression cassettes of interest

Strain	Cassette	Promoter	ORF	Terminator
Duck OVA	ApdOVA	K phaffii AOX1 promoter	Duck OVA	K phaffii AOX1 transcriptional terminator

Ostrich OVA	ScOVA	K phaffii AOX1 promoter	Ostrich OVA	K phaffii AOX1 transcriptional terminator
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[0223] One expression cassette was created for the expression of ostrich OVA. A nucleic acid encoding *Struthio camelus* OVA (SEQ ID NO: 71) was fused in-frame with a nucleic acid encoding a secretion signal sequence (thereby encoding SEQ ID NO: 72). The ostrich construct included the Alcohol oxidase 1 (AOX1) promoter placed upstream of the secretion signal sequence and a K phaffii AOX1 transcriptional terminator was placed downstream of the OVA sequence. This expression cassette called ScOVA was transformed into *Pichia pastoris*. Successful integration of four copies of the ostrich OVA construct was confirmed by genomic sequencing. See Table 15.

[0224] One expression cassette was created for the expression of duck OVA. A nucleic acid encoding *Anas platyrhynchos* OVA (SEQ ID NO: 73) was fused in-frame with a nucleic acid encoding a secretion signal sequence (thereby encoding SEQ ID NO: 74). The duck cassette included the Alcohol oxidase 1 (AOX1) promoter placed upstream of the secretion signal sequence and a K phaffii AOX1 transcriptional terminator was placed downstream of the OVA sequence. This expression cassette called ApdOVA was transformed into *Pichia pastoris*. Successful integration of two copies of the duck OVA construct was confirmed by genomic sequencing. See, Table 16.

Table 16: Strain genomic composition

Strain	Cassette	Copies integrated
Duck OVA	ApdOVA	2
Ostrich OVA	ScOVA	4

Example 7: Fermentation and production of rOVA

[0225] *Fermentation:* Strains for fermenting recombinant OVA (rOVA) were each cultured in a bioreactor at ambient conditions. A seed train for the fermentation process began with the inoculation of shake flasks with liquid growth broth. The inoculated shake flasks were kept in a shaker after which the grown *P. pastoris* was transferred to a production-scale reactor.

[0226] To expand production, a seed vial of rOVA *P. pastoris* seed strain was removed from cryo-storage and thawed to room temperature. Contents of the thawed seed vials were used to inoculate liquid seed culture media in baffled flasks which were grown at 30°C in shaking incubators. These seed flasks were then transferred and grown in a series of larger and larger seed fermenters (number to vary depending on scale) containing a basal salt media, trace metals, and glucose. Temperature

in the seed reactors was controlled at 30°C, pH at 5, and dissolved oxygen (DO) at 30%. pH was maintained by feeding ammonia hydroxide, which also acted as a nitrogen source. Once sufficient cell mass was reached, the grown rOVA *P. pastoris* was inoculated into a production-scale reactor containing basal salt media, trace metals, and glucose.

[0227] Like in the seed tanks, the culture was also controlled at 30°C, pH5 and 30% DO throughout the process. pH was again maintained by feeding ammonia hydroxide. During the initial batch glucose phase, the culture was left to consume all glucose and subsequently-produced ethanol. Once the target cell density was achieved and glucose and ethanol concentrations were confirmed to be zero, the glucose fed-batch growth phase was initiated. In this phase, glucose was fed until the culture reached a target cell density. Glucose was fed at a limiting rate to prevent ethanol from building up in the presence of non-zero glucose concentrations. In the final induction phase, the culture was co-fed glucose and methanol which induced it to produce rOVA via the pAOX promoters. Glucose was fed at an amount to produce a desired growth rate, while methanol was fed to maintain the methanol concentration at 1% to ensure that expression was consistently induced. Regular samples were taken throughout the fermentation process for analyses of specific process parameters (e.g., cell density, glucose/methanol concentrations, product titer, and quality). After a designated amount of fermentation time, secreted rOVA was collected and transferred for downstream processing.

[0228] The fermentation broth containing the secreted rOVA was subjected to centrifugation at 12,000rpm. The supernatant was clarified using microfiltration. To concentrate the protein and remove excess water, ultrafiltration at room temperature was used. An appropriately sized filter was used to retain the target rOVA while the compounds, salts, and water smaller than rOVA passed through the filter. To reduce the final salt content and conductivity in preparation for chromatography, the concentrated rOVA retentate was dialyzed at pH 3.5 until the final conductivity of the material was 1.7mS/cm. The bulk of the purification was done using cation exchange chromatography at pH 3.5. Citrate buffer containing a high salt concentration of sodium chloride was used to elute the bound rOVA from the resin. To remove the excess salts, the eluant was finally dialyzed to make a final protein solution containing about 5-10% protein and 85-95% water. The final solution was sterilized by passing it through a 0.2um bioburden filter. The water was evaporated using a spray dryer/lyophilizer at appropriate temperatures to produce a final powder containing about 80% protein.

Example 8: Preparation of Solubilized rOVA

[0229] In this example, hydrophobic recombinant chicken rOVA was solubilized and passed through a 0.2µm filter.

[0230] Recombinant rOVA was purified through ion exchange chromatography at pH 3.5 and was found to be insoluble. Sodium hydroxide was added to the solution to change the pH to 12.5 and solubilize the rOVA. The rOVA solution at pH 12.5 was passed through a 0.2µm filter. Following filtration, the pH was returned to 6.5 using hydrochloric acid and the rOVA was spray dried or lyophilized. This dried chicken rOVA was then used in the Examples below.

Example 9: Glycosylation of *Gallus gallus* rOVA

[0231] In this example, *Pichia*-secreted rOVA was analyzed for glycosylation patterns.

[0232] Native ovalbumin (nOVA) has two potential N-linked glycosylation sites (**FIG. 1A**). A single site of glycosylation at Asn-292 is found in the egg white. MALDI-TOF analysis has shown that the typical glycans on native OVA are organized as (Man)₅(GlcNAc)₅(Gal)₁ (**FIG. 1A**) (Harvey et al., 2000). Analysis of glycans on rOVA showed a typical glycosylation pattern shown in (**FIG. 1B**).

[0233] *Pichia* secreted chicken rOVA from the above Example was analyzed by gel electrophoresis migration and observed in three distinct forms (three white arrows pointing to rOVA in the “Input” lane below a) glycosylation-free, b) mono-glycosylated and c) di-glycosylated. Both the mono- and di-glycosylated glycosyl chains were cleaved from the mature rOVA protein using either of the endoglycanases EndoH or PNGaseF. Both the “denatured” or “native” deglycosylation protocols were used (as described in the NEB catalog). The green arrow indicates exogenous EndoH and the purple arrow indicates exogenous PNGaseF added to the *in vitro* reactions (**FIG. 6A**).

[0234] *Pichia* secreted chicken rOVA was subjected to standard analysis using Mass spectrometry. It was found to have five versions of N-linked Glycans (ManGlcNAc): high-mannose glycans of Man₉ (~40%), Man₁₀ (~47%) or Man₁₁ (~13%) type of N-glycan structures (**FIG. 6B**).

Example 10: Comparison of foaming functionalities of various species rOVA

[0235] In this example, chicken rOVA, duck rOVA and ostrich rOVA were evaluated for properties of foaming ability and foam retention.

[0236] rOVA from ostrich and duck were produced, purified and lyophilized using methods similar to those set forth in Example 5 to 7. The ostrich rOVA and duck rOVA remained close to the acidic pH used for purification. Chicken rOVA was produced as set forth in Example 5 and solubilized at pH 12 before removing bioburden and returned to pH 6 before drying as set forth in Example 7.

[0237] Lyophilized rOVA samples were blended into distilled water. Clarity and solubility of the rOVA solutions were then assessed visually. All samples were compared to chicken nOVA and chicken rOVA.

[0238] Eleven mL of solution (7% w/v of protein) was created for each ostrich rOVA, chicken rOVA, and chicken nOVA. A 6mL solution (7% w/v of protein) was created for duck rOVA due to limited availability of sample. Percent protein of the powders was used in the calculations to determine the amount necessary for a 7% solution. One mL of each solution was reserved before validation in a microtube for later use to test gelation. The samples were divided into 5mL aliquots to be tested for foam capacity and stability.

[0239] Each 5mL aliquot was pipetted into a beaker and whipped using the Dremel on speed 3. After a stiff foam was achieved, the foaming time was recorded as well as the initial volume of the foam. Foam capacity was determined by measuring the initial volume of foam following the whipping and comparing against the initial volume of 5mL. Foam Capacity (%) = (volume of foam / initial volume)*100.

[0240] The drainage was measured in 10 minute increments for 30 minutes to gather data for foam stability. The drained volume after 30 minutes was compared to the initial liquid volume (5mL). Foam Stability (%): (Initial volume - drained volume) / initial volume*100.

[0241] Chicken rOVA and ostrich rOVA were adjusted to pH 6 and tested again to ascertain effect of pH.

[0242] Chicken nOVA quickly formed stiff white foam. Ostrich rOVA foamed after 15 seconds. Duck rOVA foamed after 20 seconds.

Table 17: Foaming Parameters for rOVA in various species

Sample	pH	Foaming Time (s)	Foam Capacity (%)	Foam Stability (%)
Chicken nOVA	5.87	16	415	66.5
Chicken rOVA	6.49	101	257	61
Chicken rOVA	6.08	21	417	66.7
Chicken rOVA	3.5	28	472	100
Ostrich rOVA	3.7	22	490	81.5
Ostrich rOVA (pH adjusted)	5.73	55	275	58
Duck rOVA	4.3	26	400	70
Egg White	9.01	66.5	267.9	76.6

[0243] Table 17 shows the results for foaming time, foaming capacity, foam stability for chicken nOVA, at pH 5.87, chicken rOVA at pH 6.49 and pH 6.08, ostrich rOVA at pH 3.7 and pH 5.73, duck rOVA at pH 4.3 and egg white OVA at pH 9.0. Recombinant OVA from chicken, duck and ostrich generally had a similar or improved foaming capacity and foam stability as compared to egg white and these recombinant OVA proteins provided foaming capacity and foam stability between at least pH 3.5 and 6.5. Foam capacity and foam stability of rOVAs provide utility in compositions such as baked compositions.

Example 11: Comparison of gelation of various rOVA species

[0244] In this example, chicken, duck, and ostrich rOVA protein were evaluated for gelation properties. Gelation properties provide utility in applications such as cooked egg compositions.

[0245] One mL of each OVA solution was reserved for use to test gelation. After the Dremel procedure and foaming test in Example 10 was completed, another 1mL sample was extracted from the drained liquid (containing the OVA) and pipetted into another microtube. Both the fractions collected, before and after foaming, were placed in a water bath and heated to 72°C for 10 minutes. Samples were observed for gel formation.

[0246] FIG. 7 shows the results for gelation before and after foaming for chicken nOVA, at pH 5.87, chicken rOVA at pH 6.49 and pH 6.08, ostrich rOVA at PH 3.7 and pH 5.73, duck rOVA at pH 4.3 and egg white OVA at pH 9.0. Duck rOVA showed better gelation characteristics compared to chicken rOVA. Duck rOVA had gelation functionality close to that of natural egg white.

[0247] These data showed that the favorable properties disclosed above for the recombinant chicken OVA (see Example 10) are also obtainable with recombinant OVAs from other species.

Example 12: Comparison of foaming rOVA solutions

[0248] In this example, rOVA (chicken), solutions were compared to fresh egg white and evaluated for properties of foaming ability and foam retention.

[0249] Lyophilized samples were blended into aqueous solution (distilled water) at different concentrations and pHs. Clarity and solubility of the solutions was then assessed visually for foaming ability and foaming retention.

[0250] Protein solutions were created for each 4% rOVA, 7% rOVA, Fresh Egg White (12% protein), and 12% rOVA. Percent protein of the powders was used in the calculations to determine the amount necessary for each solution. 1 mL of each solution was reserved before validation in a microtube for later use to test gelation. The samples were divided into 5mL aliquots to be tested for foam capacity and stability.

[0251] Each 5mL aliquot was pipetted into a beaker and whipped using the Dremel on speed 3. After a stiff foam was achieved, the foaming time was recorded as well as the initial volume of the

foam. Foam capacity was determined by measuring the initial volume of foam following the whipping and compare against the initial volume of 5mL. Foam Capacity (%) = (volume of foam / initial volume)*100.

[0252] The drainage was measured in 10-minute increments for 30 minutes to gather data for foam stability. The drained volume after 30 minutes was compared to the initial liquid volume (5mL). Foam Stability (%): (Initial volume - drained volume) / initial volume*100.

Table 18: Foaming functionality for chicken rOVA

Protein Combination	pH	Foaming Capacity (%)	Foam Stability (%)	Time Spent Foaming (s)
Fresh Egg White (12% protein)	9.01	268	77	67
4% OVA	6.05	333	57	25
7% OVA	6.03	333	66	19
12% OVA	6.05	313	69	18

[0253] rOVA at 4%, 7% and 12% has greater foaming capacity, more foaming stability, and forms a foam more quickly than fresh egg white.

Example 13: Browning and sheen properties of rOVA

[0254] In this example, the film formation properties of browning and sheen were evaluated for functionality of rOVA in a bread application. The functionality of rOVA for film formation was evaluated regarding the visual (sensory) characteristics of bread.

[0255] Baking instructions: Yeast, sugar and warm water were mixed together in a small bowl and left to sit for five minutes. Flour was mixed into the yeast solution (30 seconds) until a firm dough was formed (mixed for 2 minutes at speed 3). Dough was kneaded on a floured board, placed into a greased bowl and left to rise for 45 minutes at 80°F. Dough was kneaded again, shaped into a 25g mini loaf, and placed in a greased pan. The mini loaf was covered and allowed to rise for 30 minutes at room temperature. A volume of 0.75g of the appropriate wash was applied to the top of the dough balls. Mini loaves were baked at 350°F for eight minutes or until golden brown. Bread loaves' locations were switched in the oven at four minutes to achieve even baking of all samples.

[0256] Lists of ingredients and their proportions used in the control bread and other samples are presented in the Table 19 below.

Table 19: Bread Ingredients

Ingredients	%
DI Water	41.77
Granulated Sugar	2.94
Bakers Yeast	1
All-Purpose Flour	53.62
Salt	0.67
Total	100.00

The formulations used for protein of interest are shown in Table 20.

Table 20: Ingredients used in wash formulations:

	Egg White Powder	rOVA
Ingredient	%	%
DI water	90.67	91.30
Film forming agent	9.33	8.7

[0257] Colorimetric assay: Individual sample pictures were analyzed for color data in the RGB spectrum using the Colorgrab application (Loomatix). Sample values were generated using a 2x2 cm cross-section taken from the center of the bread surface. RGB data was then converted to a CIELAB system using the online software www.colormine.org. CIELAB model is a color space system that expresses color in 3 values: L* for the lightness from black (0) to white (100), a* from green (-) to red (+), b* from blue (-) to yellow (+).

Table 21: CIELAB results for bread post baking:

	L*	a*	b*
Negative Control	63.669	1.10972	25.4527
Whole egg	62.255	8.39894	45.57611
Commercial egg wash substitute	68.349	0.04763	34.7033
8% Egg white protein	76.831	2.58977	31.1123
8% rOVA	80.135	3.24212	31.53948

[0258] rOVA and egg white protein samples had a higher L* value suggesting higher brightness or luminance. Control (no egg wash), commercial egg wash substitute and egg white protein samples had a low a* value suggesting lower redness or brownness as compared to whole egg, and rOVA samples. 8% egg white protein and rOVA samples also had similar b* values, suggesting similar yellow hues as compared to the other samples.

[0259] Visual Inspection: The control sample looked pale, wrinkly and had no shine. The sample with whole egg had good browning, great sheen and a smooth surface. The commercial egg wash substitute sample had a smooth surface, slight noticeable sheen but lacked on browning. nOVA samples had good brown, smooth skin but lacked shine/sheen. Similarly, for rOVA samples, it had good browning, smooth skin but lacked shine/sheen. Photographs of the samples are shown in FIG. 8. In conclusion, rOVA was able to form a film comparable to a commercial egg wash substitute and nOVA.

Example 14: Adhesive properties of rOVA

[0260] In this example, rOVA was evaluated for the film formation property of adhesiveness functionality in a bread application creating a uniform film to aid addition of toppings (e.g., sesame seeds).

[0261] Retention of sesame seeds: Retention of any topping on cake, bread, bagels or other baked goods is an intended consequence of an egg wash. Sesame seeds were used to evaluate the toping retention function of each film forming agent after baking.

[0262] Dough balls and protein of interest were prepared as Example 13. Ten sesame seeds were applied to each dough ball after the application of wash and before baking. Retention of these sesame seeds was calculated based on the amount of seeds stuck to the bread after baking.

[0263] The following results were obtained: The control sample with no egg wash had no binding capacity for the sesame seeds and zero sesame seeds were retained on the surface after baking. All other film-forming agents retained all 10 seeds post baking suggesting a 100% retention rate for toppings.

Table 22: Retention levels of sesame seeds

Samples	Negative Control	Commercial egg wash	Whole egg	Egg white protein (EWP)	rOVA 8%
Retention level	0%	100%	100%	100%	100%

Example 15: Combined proteins rOVA emulsions

[0264] In this example, the emulsification functionality of recombinant proteins individually and in

combination was observed in a salad dressing application.

[0265] Lists of ingredients and their proportions used in the control dressing and other samples are presented in the Table 23 below.

Table 23: List of Ingredients

Ingredients for Salad dressing
Canola oil
DI water
Vinegar
Proteins of interest to be tested: nOVA - 90% Protein content rOVA - 92% Protein Content Egg white protein powder - 85.71% Protein content

[0266] Water, vinegar and protein of interest were combined in a mixer for 30 seconds. Oil was gradually added for 30 seconds and mixed for an additional 2.5 minutes. Samples were prepared without vinegar to test the emulsification capabilities of the proteins at neutral pH. pH of the solutions was adjusted using 1N sodium hydroxide. The emulsion was homogenized with a L5M-A homogenizer (Silverson) Square Hole shear head mixer for 9 minutes at 4000rpm at ambient temperature.

[0267] All emulsion samples were transferred into glass tubes, sealed with a plastic cap, and stored at 4°C or ambient temperature for 3 days. The stability of the samples was evaluated by visually monitoring the height of the visible serum separation at the bottom phase with storage time. Physical stability was monitored for 3 days at both ambient and refrigerated conditions. The stability of the emulsion was expressed as: Creaming Index (CI) = (Ht/H0)*100. Where (H0) represents the initial emulsion height and the height of visible serum separation layer (Ht).

[0268] List of ingredients and their proportions used in the control and other salad dressing samples with specific protein of interest are presented in Table 25.

Table 24: List of Ingredients

	Acidic pH				Neutral pH		
	Egg white protein (EWP) 8%	nOVA 8%	rOVA 8%	Negative control	Egg white protein 8%	rOVA 8%	Negative control
Ingredient	%	%	%	%	%	%	%
Canola oil	30	30	30	30	30	30	30
Water	54.67	55.11	55.30	64	60.67	61.30	70
Vinegar	6	6	6	6	0	0	0
Emulsifier	9.33	8.89	8.70	0	9.33	8.70	0
Total	100	100	100	100	100	100	100

Table 25: Creaming Index

	Acidic pH				Neutral pH		
	8% EWP	8% nOVA	8% rOVA	Negative control	8% EWP	8% rOVA	Negative control
Day 0	0	0	0	40	0	0	40
Day 1 Ambient	40	50	5	60	-	-	-
Day 1 Refrigerated	40	50	5	90	-	-	-
Day 2 Ambient	40	50	10	70	-	-	-

Day 2 Refrigerated	40	50	10	90	-	-	-
Day 3 Ambient	40	50	15	70	38	41	39
Day 3 Refrigerated	40	50	15	90	38	40	43

[0269] Acidic pH results: On day 0, all samples except the negative control showed good emulsification properties. Thereafter, the samples were stored in ambient temperature or refrigerated temperatures to monitor stability. Samples with egg white protein (EWP) had a slight yellow appearance and separated on day 1 for both conditions of storage. Control samples separated immediately on day 1 for both conditions of storage. Eight percent nOVA also exhibited emulsion breakage on day 1, however, recombinant OVA exhibited good emulsion properties with only minimally noticeable separation. The emulsion remained equally stable until day 3 without any further separation observed. Overall, 8% rOVA performed significantly better than 8% nOVA. rOVA also exhibited better emulsion stability than EWP. Photographs of the samples are shown in **FIG. 9A**.

[0270] Neutral pH results: Emulsion stability of rOVA was comparable to egg white proteins on day 0 and 3. Neither rOVA, nor egg white proteins were able to maintain emulsion stability over three days in refrigerated form or at ambient temperature. Photographs of the samples are shown in **FIG. 9B**.

Example 16: Foaming functionality

[0271] In this example, the foaming functionality of rOVA was observed in an alcohol-based drink (e.g., such as a Whiskey Sour which includes a foaming agent).

[0272] Bourbon whisky, fresh lemon juice, simple syrup, and protein of interest were combined in a cocktail shaker and shaken for 15 seconds. Ice was added to the cocktail shaker and the mixture shaken for another 15 seconds. Shaken mixture was poured into a glass and observed.

[0273] Formulations: Control formulation included natural egg white. The negative formulation was prepared without any egg white.

Table 26: List of ingredients and the formulations

Ingredient	Ounces	mL
Bourbon Whiskey	2	59
Fresh Lemon Juice	0.75	22.125
Simple syrup	0.5	14.75
Egg white	0.5	14.75
Total	3.75	110.625

The proteins of interest were used to substitute the natural egg white protein and the following formulations were used:

Table 27: Protein formulation

Ingredients	7% rOVA	12% rOVA
rOVA	8.40	14.41
Water	91.60	85.59
Total	100	100

[0274] The pH of the rOVA solutions was adjusted to pH 6 (with 1M NaOH) to provide optimal foaming performance.

[0275] Original recipe used 0.5 oz egg white and the same proportion was used for recombinant protein testing. rOVA at 7% and 12% foamed well but no significant difference was observed between the two levels.

[0276] Photographs of craft cocktails prepared with the samples are shown in **FIG. 10**.

Example 17: Burger Binding

[0277] In this example, texture analysis was used to observe hardness attributes along with cohesiveness, springiness and chewiness of both raw and cooked vegan burgers made with rOVA and other binding agents.

[0278] The objective of this example was to evaluate the binding functionality of rOVA. Parameters such as appearance (how well the burger held together), textural aspects such as cohesiveness, springiness, chewiness and hardness were evaluated and compared against egg white, nOVA and commercially used non-protein binder.

[0279] *Materials:* Dry base ingredients: Extruded soy protein 1 (Arcon T U172 (158172)), Extruded soy protein 2 (Arcon T Caramel Crumble 240 (158225)), Extruded soy protein 3 (Arcon T U-118 (158118)), Binding agent/Protein of interest. Wet ingredients: Canola oil, coconut oil, Water. Binding agents of interest to be tested: Natural egg white protein ("NEW"), Methylcellulose ("MC"), nOVA 90% Protein content, rOVA (chicken) 92% Protein Content.

[0280] *Mixing:* Extruded soy protein 1 was mixed with 1/3rd amount of water for 2.5 min. The remaining extruded samples and water were combined with the previous mix for another 7.5 min. The blend was chilled in the freezer for 10 minutes. The binding agent was added and mixed in for 30 seconds. Canola and coconut oil blend was added and mixed for 30 seconds. The mixture was chilled in the freezer for 5 minutes, then molded into 5g burger forms and frozen.

[0281] *Cooking:* The frozen burger samples were thawed in the refrigerator to a 4°C internal temperature. The samples were cooked on a griddle set at 350°F for 5-6 min until an internal temperature of 165°F was reached.

[0282] *Formulations:* List of ingredients and their proportions used in the control and other experimental burger samples, with specific protein of interest, are presented below in Table 28.

Table 28: List of Ingredients.

	<i>Control - Methylcellulose</i>	<i>Natural Egg White</i>	<i>nOVA</i>	<i>rOVA</i>
Ingredients	%	%	%	%
Extruded soy protein 1	5	5	5	5
Extruded soy protein 2	13	13	13	13
Extruded soy protein 3	8	8	8	8
Binding agent	0.7	25	5	5
Canola oil	12	12	12	12
Coconut oil	6.5	6.5	6.5	6.5
Water	54.8	30.5	50.5	50.5
Total	100.00	100.00	100.00	100.00

[0283] *Texture Analysis:* Texture analysis was performed to analyze the attributes of vegan burgers against the control. Texture analysis was used to quantify hardness attributes along with cohesiveness, springiness and chewiness.

[0284] The textural properties of vegan burgers were measured using a CT3 Brookfield Texture Analyzer (1500 g load cell). The test parameters were used are presented in Table 29.

Table 29: Test parameters used for three-point bend test to measure hardness of vegan burgers using a CT3 Brookfield Texture Analyzer

Test type	Texture Profile Analysis (TPA)
Probe	TA52 (Mohrs shear blade)
Base Fixture	TA-Base Fixture
Target type	Distance
Target value	5 mm
Trigger load	15 g
Test speed	0.5 mm/s
Post test speed	4.5 mm/s
Textural properties	Hardness 1 (g), Hardness 2 (g), Cohesiveness, Springiness, Chewiness
Average Sample dimensions (Diameter*Height)	25 mm *12.5 mm

[0285] The frozen samples were thawed in the refrigerator to a 4°C internal temperature and tested for raw binding. The thawed samples were also cooked and used to measure the cooked binding values.

[0286] *Findings for raw binding:* In terms of hardness, rOVA was significantly higher than methylcellulose and natural egg white and no difference was observed between nOVA and rOVA. All the samples were similar in terms of cohesiveness and springiness. rOVA exhibited significantly more chewiness than methylcellulose and natural egg white. Results are presented in Table 30.

[0287] Table 30: Texture (TPA) results for raw binding in terms of hardness, cohesiveness, springiness and chewiness. Data that does not share the same letter within a specific attribute is significantly different from each other ($p < 0.05$). The results were averaged over $n=3$.

Table 30: Texture (TPA) results for raw binding in vegan burgers

Sample	Hardness 1 (g)	Hardness 2 (g)	Cohesiveness	Springiness	Chewiness
methylcellulose 0.7%	58.27 ± 10.17 (a)	40.53 ± 9.59 (a)	0.12 ± 0.07 (a)	0.42 ± 0.05 (a)	3.0 ± 1.56 (a)
natural egg white 25%	45.27 ± 9.45 (a)	33.20 ± 5.02 (a)	0.21 ± 0.03 (a)	0.34 ± 0.1 (a)	3.33 ± 1.26 (ab)

nOVA 5%	81 ± 4.39 (ab)	44.27 ± 6.45 (a)	0.18 ± 0.01 (a)	0.46 ± 0.04 (a)	6.93 ± 1.12 (bc)
rOVA 5%	145.07 ± 52.85 (b)	62.80 ± 21.70 (a)	0.13 ± 0.01 (a)	0.47 ± 0.04 (a)	8.23 ± 1.86 (c)

[0288] *Findings for cooked binding:* rOVA exhibited significantly higher hardness values than methylcellulose and natural egg white. All the samples were similar to each other in terms of cohesiveness. For springiness, methylcellulose samples exhibited significantly lower values than natural egg white, nOVA and rOVA. Both nOVA and rOVA samples exhibited higher values chewiness values than methylcellulose. Results are presented in Table 31.

[0289] Table 31: Texture (TPA) results for cooked binding in terms of hardness, cohesiveness, springiness and chewiness. Data that does not share the same letter within a specific attribute is significantly different from each other ($p < 0.05$). The results are averaged over $n=3$.

Table 31: Texture (TPA) results for cooked binding in vegan burgers

Sample	Hardness 1 (g)	Hardness 2 (g)	Cohesiveness	Springiness	Chewiness
Methylcellulose 0.7%	281.73 ± 154.7 (a)	215.80 ± 161.84 (a)	0.37 ± 0.07 (a)	0.69 ± 0.05 (a)	76.03 ± 55.15 (a)
Natural egg white 25%	390.33 ± 158.15 (a)	304.27 ± 55.83 (a)	0.57 ± 0.11 (a)	0.80 ± 0.03 (b)	178.07 ± 65.85 (ab)
nOVA 5%	617.07 ± 197.49 (ab)	464.07 ± 135.33 (ab)	0.56 ± 0.08 (a)	0.81 ± 0.05 (b)	285.5 ± 104.72 (bc)
rOVA 5%	922.0 ± 96.71 (b)	712.33 ± 78.23 (b)	0.51 ± 0.08 (a)	0.86 ± 0.02 (b)	398.13 ± 44.37 (c)

Example 18: Egg white patty

[0290] In this example, the suitability of inclusion of native and recombinant protein OVA in an egg white patty application as an example of cooked egg systems was evaluated. Parameters such as nutritional value of fresh egg white when substituted by OVA and effects on texture (in terms of functionality) and appearance were evaluated.

[0291] Table 32: List of ingredients used to prepare egg white patties

Ingredients
Dry base ingredients: Gellan gum (LT100 - Modernist pantry), baking powder (Trader Joe's), salt (The spice club), Sodium Alginate (CP Kelco), Psyllium (CFF)
Wet ingredients: Coconut oil, canola oil (Crisco), tapioca syrup (Ciranda) , pineapple yellow AET color (Sensient), water
Proteins of interest to be tested: - Natural egg white - nOVA (Neova Technologies) - 90% Protein content - rOVA (Clara Foods: 008USU_CW) - 86.1% Protein Content

[0292] *Mixing:* The dry ingredients from Table 32, except sodium alginate were mixed together. The tapioca syrup, sodium alginate and lemon-yellow color were blended separately in water. All ingredients were mixed with oil and vortexed till all ingredients are dissolved. The mixture was allowed to equilibrate by allowing to stand for 10 minutes.

[0293] *Cooking:* A griddle was used to cook the samples. The griddle was set to 250 °F and ½ inch diameter ring molds were used to cook samples. The molds were sprayed with oil and the mixture was poured into the molds. 1/2 ice cubes were added to the molds to generate steam. The patties were allowed to cook and another ice cube was added. The patties were cooked for 5 minutes and the lid was opened. The ring molds with the cooked samples to serving plates.

[0294] The textural properties of egg white patties were measured using a CT3 Brookfield Texture Analyzer (1500 g load cell). A TPA compression test was used to compress and measure the hardness of egg white patties. Four samples from each set were analyzed to compare. The following test parameters were used:

Table 33: Test parameters used for TPA test to measure textural properties of patty:

Test type	TPA
Test parameters	50% deformation
Probe	TA4 (38mm diameter cylinder)
Base Fixture	Base fixture
Trigger load	5 g
Test speed	2 mm/s
Textural properties	Hardness (g), Adhesiveness, Cohesiveness,

	Chewiness, Gumminess
Sample dimension (Height) * (Diameter)	~12mm * 12mm

Results:**Table 34: Texture Analyzer results**

Sample/ Attribute	Hardness 1 (g)	Hardness 2 (g)	Adhesiveness	Fracturability	Cohesiveness	Gumminess	Chewiness
Natural egg white	726.3 ± 6.65 a	652 ± 15.56 a	0.375 ± 0.11 a	726.7 ± 7.21 a	0.765 ± 0.05 a	555.1 ± 44.55 a	33.75 ± 0.0 ab
nOVA	817.6 ± 174.51 a	761.3 ± 171.54 a	0.315 ± 0.02 a	817.6 ± 174.51 a	0.71 ± 0.01 a	583.55 ± 133.86 a	50.95 ± 9.4 a
rOVA	869.9 ± 58.12 a	747.1 ± 50.49 a	0.185 ± 0.16 a	869.9 ± 58.12 a	0.55 ± 0.04 a	484.65 ± 3.46 a	25.53 ± 3.8 b

Data that does not share the same letter for a given attribute is significantly different from each other ($p < 0.05$)

[0295] Findings: All the samples, natural egg white, nOVA and rOVA were statistically similar in terms of hardness, adhesiveness, fracturability, cohesiveness and gumminess. For chewiness, natural egg white patty was similar to nOVA and rOVA individually, however, nOVA and rOVA were statistically different from each other. nOVA had higher chewiness values as compared to other samples. Overall, OVA protein, in both native and recombinant form, provides a good substitute to natural egg white in a non-animal patty (cooked egg application). rOVA liquid formulation was thicker in viscosity than nOVA sample and egg white sample. Results are shown in **FIG. 11**.

Example 19: Meringue

[0296] The functionality of rOVA in a meringue food system compared to fresh egg white was evaluated in this example.

[0297] Material:

- rOVA (Lyo 008; pH: 6.7 as is)
- Fresh egg white (pH: 9 as is)
- Sugar (C&H Sugar, Pure Cane, Granulated white)
- Xanthan - pre hydrated Ticaxan - Tic Gums
- TEC (**Triethyl Citrate**)
- SLS (Sodium lauryl sulfate)

- Kitchen Aid, Classic Plus
- Breville BOV800XL Smart Electric Oven

[0298] Method: Egg white was separated from the egg yolk carefully at the refrigerator temperature and let egg whites get to the room temperature before whipping. rOVA powder, SLS, Xanthan gum and TEC were reconstituted in DI water at the room temperature. The mixture was whipped for 30 seconds at speed 5 (to obtain a homogeneous solution), then mixed at speed 8 until soft peaks formed. While beating constantly, sugar was added gradually and beat at high speed after each addition until sugar was dissolved before adding the next. Mixing was continued until a glossy and firm peak was formed. Oven (Breville BOV800XL Smart Electric Oven) was heated to 200°F; meringues were baked for 70 minutes (or until light and crisp but not brown. After cooling, meringues were stored in an airtight container. Whipping time to produced firm foam for each protein solution was recorded.

Table 35: Formulations

Fresh egg white		rOVA8.3% + SLS + Xanthan gum		rOVA8.3% + TEC + Xanthan gum	
Ingredients	Percentage %	Ingredients	Percentage %	Ingredients	Percentage %
Fresh egg white	70.6	rOVA	9.5	rOVA	9.5
Sugar	29.4	Sugar	29	Sugar	29
-	-	Water	61.3	Water	61.3
-	-	Xanthan gum	0.1	Xanthan gum	0.1
-	-	SLS	0.1	TEC	0.048
Total weight	100	Total weight	100	Total weight	100

Table 36: Physical parameters of meringues

Parameter	Fresh egg white	rOVA 8.3% + SLS + Xanthan gum	rOVA 8.3% + TEC + Xanthan gum
weight loss %	* 60 ± 2	60 ± 1.1	58 ± 2.5
volume (ml)	7 ± 1.5	7.3 ± 1.5	7.9 ± 2

foam density (g/ml)	0.19	0.2	0.22
Meringue density (g/ml)	0.056 ± 0.014	0.074 ± 0.02	0.064 ± 0.018

*Average ± standard deviation (n=6)

[0299] *Findings:* rOVA produces meringue that is comparable to fresh egg white sample in terms of physical parameters. The appearance of rOVA meringues were visually better than fresh egg white controls. The ridges were more well defined in rOVA meringue and the samples were whiter compared to the fresh egg white control. Results are shown in **FIG. 12**.

Example 20: Effect of pH on gelation characteristics

[0300] The effects of different pH conditions on the gelation characteristics of rOVA compositions in comparison to fresh egg white was evaluated in this example.

Table 37: Materials:

Ingredients
DI water, 1N Hydrochloric acid, 1N Sodium hydroxide, 3N Sodium hydroxide
Proteins of interests - rOVA (008USU_CW - 86.1% protein content) - Egg white protein (Modernist pantry - 85.71% protein content)

[0301] Method:

1. 7% protein solution was prepared for both rOVA and egg white protein
2. Based on the native pH, the pH of the solution was adjusted to pH 3,4,5,6 with 1N HCl
3. pH was also adjusted to the alkaline spectrum of pH 7, 8, 9, 10, 11 and 12 with microliter amounts of 1N and 3N sodium hydroxide
4. All solutions were gelled at 85°C for 5min and then cooled at room temperature
5. All the gels/solutions were taken out and evaluated visually for gel characteristics

Table 38: Results: pH was recorded as follows before any pH adjustments:

Sample	pH
7% EWP	6.98
7% rOVA	6.82

[0302] *Findings:* Egg white protein exhibited gelling properties at all pH's while forming firm gels at pH 4-10. The solutions for both EWP and rOVA at pH 11 and pH 12 were clear liquids, however, only EWP gelled into clear gels, while rOVA remained in solution at pH 11 and 12. rOVA 7% solutions gelled at pH 6, 7, 8 and 9. Dramatic increase in viscosity was observed for rOVA solutions at pH 5 and lower. All EWP gels had a strong egg-like smell, while for rOVA, only solutions/gels for pH 9-12 had an egg-like smell. pH 3.5- 8 for rOVA did not have any characteristic smell properties. EWP and rOVA both gelled at pH 6-9; however, EWP gels were stronger and firmer than rOVA gels. Overall, although EWP exhibited better gelling properties than rOVA over a broader pH spectrum, it came with the presence of a strong egg-like smell. rOVA provided gelling properties in the pH 6-8 range and provided sensory neutrality (e.g., no smell). At pH 8 and 9, rOVA provided clear firm gel which can have unique value proposition in embodiments requiring transparent visual appearance.

Example 21: Protein Bars

[0303] rOVA was used as a protein source in a protein bar application and compared to egg white proteins and nOVA.

[0304] Preparation instructions:

[0305] In a small mixer, dates, nuts were chopped/blended. Dates, nuts, cocoa and the protein of interest were added in a mixing bowl till a homogenous mixture was formed. The mixture was split into two equal parts and one part was tested as the unbaked version. The other half was baked in an oven at 350F for 10 minutes.

Table 39: List of Ingredients and their proportions used in control formulation:

Ingredients	Amount (%)
Dates	78.53
Nuts	17.47
Cocoa	4
Total	100

[0306] For formulations with inclusion of protein powders, the dates and nuts inclusion was reduced, however keeping the dates: nuts ratio constant at a 4.5 level.

Table 40: List of Ingredients and their proportions used in egg white protein formulations:

Ingredients	4% protein	8% protein	12% protein	16% protein	23% protein
Dates	74.73	70.93	67.13	63.27	56.62

Nuts	16.60	15.73	14.87	14.07	12.54
Cocoa	4	4	4	4	4
Protein powder	4.67	9.33	14	18.67	26.84
Total	100	100	100	100	100

Table 41: List of Ingredients and their proportions used in nOVA formulations:

Ingredients	4% protein	8% protein	12% protein	16% protein	23% protein
Dates	75.02	71.25	67.67	64.01	57.72
Nuts	16.54	15.86	13.33	14.20	12
Cocoa	4	4	4	4	4
Protein powder	4.45	8.89	15	17.78	28.75
Total	100	100	100	100	100

Table 42: List of Ingredients and their proportions used in rOVA formulations:

Ingredients	4% protein	8% protein	12% protein	16% protein	23% protein
Dates	74.60	70.66	66.76	62.86	55.92
Nuts	16.6	15.73	14.83	13.93	12.52
Cocoa	4	4	4	4	4
Protein powder	4.8	9.60	14.40	19.21	27.57
Total	100	100	100	100	100

[0307] Texture analysis: The textural properties of the protein bar (baked and unbaked) were measured using a CT3 Brookfield Texture Analyzer (1500 g load cell). A three point bend test was

used to snap, bend and measure the hardness of the protein bar. One sample for each protein inclusion level was analyzed. The following test parameters were used:

Table 43: Test parameters used for three-point bend test to measure hardness of crackers using a CT3 Brookfield Texture Analyzer

Test type	Rupture test
Probe	TA7 blade
Base Fixture	TA-TPB
Trigger load	5 g
Correction load	30 g
Test speed	3 mm/s
Sample rate	30 points/sec
Distance between support arms	2.5 cm
Textural properties	Hardness (g)

Table 44: Texture analysis test results for unbaked protein bar samples: (n=1)

Sample	Hardness (g) for protein inclusion levels					
	Control (0%)	4%	8%	12%	16%	23%
Egg white protein	113.9	168.8	319.2	422.8	475	597.8
nOVA		204.8	231	408	420.05	443.8
rOVA		182	222.6	314.4	418	689.8

Table 45: Texture analysis test results for baked protein bar samples: (n=1)

Sample	Hardness (g) for protein inclusion levels					
	Control (0%)	4%	8%	12%	16%	23%
Egg white	902.7	1499.6	1484	1561	1553.4	1609.4

protein						
nOVA		1505.4	1523.8	1542.2	1585	1662.8
rOVA		1485.2	1530	1561	1522.4	1552.8

[0308] For the unbaked samples, the control sample with no protein had the lowest hardness values. For all the proteins of interest, EWP, nOVA and rOVA, hardness values increased with increasing protein content. Egg white protein samples had higher hardness values than nOVA and rOVA samples at 8, 12, 16 and 23%. nOVA samples had minimal increase in hardness from 12-23% protein inclusion. nOVA and rOVA sample hardness was comparable at 4, 8, 12 and 16%. However, rOVA had a much higher hardness value for 23% protein inclusion.

[0309] Overall, the hardness of the baked samples was much higher than the unbaked samples. The control sample had the lowest hardness. All the samples with protein inclusions were much harder even at lower protein inclusion rates. The upper threshold limit (load cell) for the TA unit is 1500 g. All the baked protein samples reached the threshold value making it difficult to identify subtle differences between the samples. nOVA and rOVA sample hardness was comparable at 4, 8, 12 and 16% for both, unbaked and baked protein bar. Photos are shown in **FIG. 13**.

[0310] While preferred embodiments of the present invention have been shown and described herein, it will be obvious to those skilled in the art that such embodiments are provided by way of example only. Numerous variations, changes, and substitutions will now occur to those skilled in the art without departing from the invention. It should be understood that various alternatives to the embodiments of the invention described herein may be employed in practicing the invention. It is intended that the following claims define the scope of the invention and that methods and structures within the scope of these claims and their equivalents be covered thereby.

INCORPORATION BY REFERENCE

[0311] All publications, patents, and patent applications mentioned in this specification are herein incorporated by reference to the same extent as if each individual publication, patent, or patent application was specifically and individually indicated to be incorporated by reference.

[0312] 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 embodiments of the present disclosure are shown and described. As will be realized, the present disclosure is capable of other and different embodiments, 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.