CLAIMS

What is claimed is:

~~1. A recombinant fusion protein comprising:~~

~~(i) a first milk protein; and~~

~~(ii) a second milk protein.~~

~~2. The recombinant fusion protein of claim 1, wherein at least one of the first milk protein and the second milk protein is α-S1-casein, α-S2-casein, β-casein, κ-casein, para-κ-casein, β-lactoglobulin, α-lactalbumin, lysozyme, lactoferrin, lactoperoxidase, serum albumin, or an immunoglobulin.~~

~~3. The recombinant fusion protein of claim 1, wherein at least one of the first milk protein and the second milk protein is β-lactoglobulin.~~

~~4. The recombinant fusion protein of claim 1, wherein at least one of the first milk protein and the second milk protein is α-S1-casein, α-S2-casein, β-casein, κ-casein, or para-κ-casein.~~

~~5. The recombinant fusion protein of claim 1, wherein:~~

~~i) the first milk protein is α-S1-casein, α-S2-casein, β-casein, κ-casein, or para-κ-casein; and~~

~~ii) the second milk protein is α-S1-casein, α-S2-casein, β-casein, κ-casein, or para-κ-casein.~~

~~6. The recombinant fusion protein of claim 1, wherein at least one of the first milk protein and the second milk protein is κ-casein and comprises the sequence of SEQ ID NO: 4, or a sequence at least 90% identical thereto.~~

~~7. The recombinant fusion protein of claim 1, wherein at least one of the first milk protein and the second milk protein is para-κ-casein and comprises the sequence of SEQ ID NO: 2, or a sequence at least 90% identical thereto.~~

~~8. The recombinant fusion protein of claim 1, wherein at least one of the first milk protein and the second milk protein is β-casein and comprises the sequence of SEQ ID NO: 6, or a sequence at least 90% identical thereto.~~

~~9. The recombinant fusion protein of claim 1, wherein at least one of the first milk protein and the second milk protein is α-S1-casein and comprises the sequence SEQ ID NO: 8, or a sequence at least 90% identical thereto.~~

~~10. The recombinant fusion protein of claim 1, wherein at least one of the first milk protein and the second milk protein is α-S2-casein and comprises the sequence SEQ ID NO: 84, or a sequence at least 90% identical thereto.~~

~~11. The recombinant fusion protein of claim 1, wherein the first milk protein and the second milk protein are different proteins.~~

~~12. The recombinant fusion protein of claim 1, wherein the first milk protein and the second milk protein are the same proteins.~~

~~13. The recombinant fusion protein of any one of claims 1-12, which is plant-expressed.~~

~~14. The recombinant fusion protein of claim 13, which is expressed in a soybean plant.~~

~~15. The recombinant fusion protein of any one of claims 1-14, which comprises a protease cleavage site.~~

~~16. The recombinant fusion protein of claim 15, wherein the protease cleavage site is a chymosin cleavage site.~~

~~17. A nucleic acid encoding the recombinant fusion protein of any one of claims 1-16.~~

~~18. The nucleic acid of claim 17, which is codon-optimized for expression in a plant.~~

~~19. The nucleic acid of claim 18, which is codon-optimized for expression in a soybean.~~

~~20. An expression vector comprising the nucleic acid molecule of any one of claims 17-19.~~

~~21. A host cell comprising the nucleic acid of any one of claims 17-19 or the expression vector of claim 20.~~

~~22. The host cell of claim 21, wherein the cell is a plant cell, bacterial cell, fungal cell, or mammalian cell.~~

~~23. The host cell of claim 22, wherein the plant cell is a soybean cell.~~

~~24. A plant stably transformed with the nucleic acid of any one of claims 17-19 or the expression vector of claim 20.~~

~~25. The plant of claim 24, wherein the fusion protein is expressed in an amount of 1% or higher per total protein weight of soluble protein extractable from the plant.~~

~~26. A method for making a fusion protein, the method comprising:~~

~~(a) transforming a host cell with the nucleic acid of any one of claims 17-19 or the expression vector of claim 20; and~~

~~(b) growing the transformed host cell under conditions wherein the fusion protein is expressed.~~

~~27. The method of claim 26, which comprises co-expressing in the host cell a protein capable of forming a protein body.~~

~~28. The method of claim 27, wherein the protein capable of forming a protein body is a prolamin selected from a gliadin, a hordein, a secalin, a zein, a kafirin, or an avenin.~~

~~29. The method of claim 26, which comprises expressing a kinase in the host cell.~~

~~30. The method of claim 26, wherein expression of one or more proteases is knocked down or knocked out in the cell.~~

~~31. The method of any one of claims 26-30, wherein the fusion protein is expressed in an amount of 1% or higher per total protein weight of soluble protein extractable from the plant.~~

~~32. A transgenic plant comprising the recombinant fusion protein of any one of claims 1-16, the nucleic acid of any one of claims 17-20, or the expression vector of claim 20.~~

~~33. The transgenic plant of claim 32, which is a soybean plant.~~

~~34. A method for stably expressing the recombinant fusion protein of any one of claims 1-16 in a plant, the method comprising:~~

~~(i) transforming a plant with a plant transformation vector comprising an expression cassette comprising a nucleic acid molecule encoding the fusion protein; and~~

~~(ii) growing the transformed plant under conditions wherein the recombinant fusion protein is expressed.~~

~~35. The method of claim 34, wherein the fusion protein is expressed in an amount of 1% or higher per total protein weight of soluble protein extractable from the plant.~~

~~36. A seed processing composition, comprising the fusion protein of any one of claims 1-16.~~

~~37. A food composition comprising the fusion protein of any one of claims 1-16.~~

~~38. The food composition of claim 37, which is selected from the group consisting of cheese and processed cheese products, yogurt and fermented dairy products, directly acidified counterparts of fermented dairy products, cottage cheese dressing, frozen dairy products, frozen desserts, desserts, baked goods, toppings, icings, fillings, low-fat spreads, dairy-based dry mixes, soups, sauces, salad dressing, geriatric nutrition, creams and creamers, analog dairy products, follow-up formula, baby formula, infant formula, milk, dairy beverages, acid dairy drinks, smoothies, milk tea, butter, margarine, butter alternatives, growing up milks, low-lactose products and beverages, medical and clinical nutrition products, protein/nutrition bar applications, sports beverages, confections, meat products, analog meat products, meal replacement beverages, weight management food and beverages, cultured buttermilk, sour cream, yogurt, skyr, leben, lassi, kefir, powder containing a milk protein, and low-lactose products.~~

~~39. The food composition of claim 37, which is a cheese composition.~~

~~40. The food composition of claim 39, wherein the cheese composition has the ability to stretch to at least 3 cm in length without breaking, as determined by heating a 100 gram mass of the composition at a temperature of 225°C for 4 minutes and cooling to about 90°C and pulling with a fork placed beneath the mass.~~

~~41. The food composition of claim 39 or 40, comprising a total amount of casein protein; wherein about 32% to 100% by weight of the total amount of casein protein in the food composition is beta-casein.~~

~~42. A method of making a food composition, comprising combining the fusion protein of any one of claims 1-16 into a food composition.~~

1~~43~~. An alternative dairy food composition comprising:

A) a plant-expressed recombinant fusion protein comprising:

(i) a first casein milk protein ~~the recombinant fusion protein of any one of claims 1-16~~; and

(ii) a second casein milk protein and/or a zein protein; and~~at least one lipid,~~

B) at least one lipid.

~~wherein the recombinant fusion protein confers on the alternative dairy food composition one or more characteristics of a dairy food product selected from the group consisting of: taste, aroma, appearance, handling, mouthfeel, density, structure, texture, elasticity, springiness, coagulation, binding, leavening, aeration, foaming, creaminess and emulsification.~~

~~44. The alternative dairy food composition of claim 43, wherein the alternative dairy food composition does not comprise any other milk proteins.~~

2. The alternative dairy food composition of claim 1, wherein the first casein milk protein and/or the second casein milk protein is a protein selected from the group consisting of α-S1 casein, α-S2 casein, β-casein, κ-casein, and para-κ-casein.

3. The alternative dairy food composition of claim 1, wherein the alternative dairy food composition does not comprise any non-transgenic animal milk proteins.

4. The alternative dairy food composition of claim 1, wherein the alternative dairy food composition does not comprise any non-casein animal milk proteins.

5~~45~~. The alternative dairy food composition of claim ~~43 or 44~~1, which comprises calcium at a concentration of about 0.01 to about 2% by weight.

6~~46~~. The alternative ~~diary~~ dairy food composition of ~~any one of claims 43-45~~claim 1, comprising a total amount of casein protein;

wherein about 32% to 100% by weight of the total amount of casein protein in the alternative dairy food composition is beta-casein.

7~~47~~. The alternative ~~diary~~ dairy food composition of ~~any one of claims 43-46~~claim 1, wherein the composition has a pH of about 5.2 to about 5.9.

8. The alternative dairy food composition of claim 1, wherein the plant-expressed recombinant fusion protein confers on the alternative dairy food composition one or more characteristics of a dairy food product selected from the group consisting of: taste, aroma, appearance, handling, mouthfeel, density, structure, texture, elasticity, springiness, coagulation, binding, leavening, aeration, foaming, creaminess, and emulsification.

9~~48~~. The alternative ~~diary~~ dairy food composition of ~~any one of claims 43-47~~claim 1, which is selected from the group consisting of: cheese and processed cheese products, yogurt and fermented dairy products, directly acidified counterparts of fermented dairy products, cottage cheese dressing, frozen dairy products, frozen desserts, desserts, baked goods, toppings, icings, fillings, low-fat spreads, dairy-based dry mixes, soups, sauces, salad dressing, geriatric nutrition, creams and creamers, analog dairy products, follow-up formula, baby formula, infant formula, milk, dairy beverages, acid dairy drinks, smoothies, milk tea, butter, margarine, butter alternatives, growing up milks, low-lactose products and beverages, medical and clinical nutrition products, protein/nutrition bar applications, sports beverages, confections, meat products, analog meat products, meal replacement beverages, weight management food and beverages, cultured buttermilk, sour cream, yogurt, skyr, leben, lassi, kefir, powder containing a milk protein, and low-lactose products.

10~~49~~. The alternative ~~diary~~ dairy food composition of ~~any one of claims 43-47~~claim 1, which is a cheese composition.

11~~50~~. The alternative dairy food composition of claim 10~~A solid phase, protein-stabilized emulsion comprising the fusion protein of any one of claims 1-16~~, wherein the ~~emulsion~~ cheese has the ability to stretch to at least 3 cm in length without breaking, as determined by heating a 100 gram mass of the ~~emulsion~~ cheese to a temperature of about 225°C for 4 minutes and cooling to about 90°C and pulling with a fork placed beneath the mass.

12~~51~~. The alternative dairy food composition of claim 1,~~A colloidal suspension comprising the fusion protein of any one of claims 1-16;~~ wherein the alternative dairy food composition~~colloidal~~

~~suspension~~ has at least one~~, at least two, or at least three~~ characteristic~~s~~ that ~~are~~ is substantially similar to bovine milk selected from taste, appearance, mouthfeel, structure, texture, density, elasticity, springiness, coagulation, binding, leavening, aeration, foaming, creaminess, and emulsification.

13. The alternative dairy food composition of claim 1, wherein the first casein milk protein and/or the second milk protein is κ-casein and comprises the sequence of SEQ ID NO: 4, or a sequence at least 90% identical thereto.

14. The alternative dairy food composition of claim 1, wherein the first casein milk protein and/or the second casein milk protein is para-κ-casein and comprises the sequence of SEQ ID NO: 2, or a sequence at least 90% identical thereto.

15. The alternative dairy food composition of claim 1, wherein the first casein milk protein and/or the second casein milk protein is β-casein and comprises the sequence of SEQ ID NO: 6, or a sequence at least 90% identical thereto.

16. The alternative dairy food composition of claim 1, wherein the first casein milk protein and/or the second casein milk protein is α-S1 casein and comprises the sequence SEQ ID NO: 8, or a sequence at least 90% identical thereto.

17. The alternative dairy food composition of claim 1, wherein the first casein milk protein and/or the second casein milk protein is α-S2 casein and comprises the sequence SEQ ID NO: 84, or a sequence at least 90% identical thereto.

18. The alternative dairy food composition of claim 1, wherein the first casein milk protein and the second casein milk protein are different.

19. The alternative dairy food composition of claim 1, wherein the first casein milk protein and the second casein milk protein are the same.

20. The alternative dairy food composition of claim 1, wherein the first casein milk protein and/or the second casein milk protein is α-S1 casein.

21. The alternative dairy food composition of claim 1, wherein the first casein milk protein and/or the second casein milk protein is α-S2 casein.

22. The alternative dairy food composition of claim 1, wherein the first casein milk protein and/or the second casein milk protein is β-casein.

23. The alternative dairy food composition of claim 1, wherein the first casein milk protein and/or the second casein milk protein is κ-casein.

24. The alternative dairy food composition of claim 1, wherein the first casein milk protein and/or the second casein milk protein is para-κ-casein.

25. The alternative dairy food composition of claim 1, wherein the first casein milk protein is β-casein and the second casein milk protein is β-casein.

26. The alternative dairy food composition of claim 1, wherein the first casein milk protein is β-casein and the second milk protein is α-S1 casein or α-S2 casein.

27. The alternative dairy food composition of claim 1, wherein the first casein milk protein is α-S1 casein or α-S2 casein and the second milk protein is α-S1 casein or α-S2 casein.

28. The alternative dairy food composition of claim 1, wherein the first casein milk protein is κ-casein or para-κ-casein and the second milk protein is β-casein.

29. The alternative dairy food composition of claim 1, wherein the alternative dairy food composition does not comprise an organoleptically functional amount of β-lactoglobulin.

30. The alternative dairy food composition of claim 1, wherein the zein protein is selected from the group consisting of α zein, β zein, δ zein, and γ zein.