thermal treatment process, purification method), as well as nutritional values (*e.g.*, amino acid composition, protein digestibility corrected amino acid scores (PDCAAS) when comparing animal proteins compared with plant proteins (McClements, *et al.*, *Comprehensive Reviews in Food Science and Food Safety*, *18*(6), 2047-2067; 2019).

[0005] Therefore, there is a need for plant-based dairy alternative products with a sensory profile and functional performance more closely reproducing that of animal-based dairy products.

SUMMARY

[0006] The present disclosure describes improved dairy alternative food products prepared from casein or casein subunit(s) combined with plant-based protein(s). The disclosed food products include, but are not limited to, cheese, yogurt, milk, ready-to-drink (RTD) beverages, cheese sauce, ice cream and refrigerated or frozen desserts, snack bars, confectioneries, and dry blend powders for a variety of food uses. The disclosed food products exhibit improved qualities relative to other dairy food substitutes, in that they provide a creamier texture, smoother mouthfeel, and exhibit other sensory properties and functional performance more closely approximating those of animal-based dairy products.

[0007] In various ~~aspect~~examples, the disclosed dairy alternative food products comprise at least one casein subunit, which may be created using fermentation processes; multiple casein subunits may be used and may comprise one or more casein or casein subunit proteins derived from microbial fermentation. A casein subunit may be or may comprise any one or more of α-casein, αs1-casein, αs2-casein, β-casein, κ-casein, para-κ-casein or any combination thereof. In various ~~aspect~~examples, at least one casein subunit may comprise one or more casein subunits that is free from or substantially free from one of the other subunits, for example comprising α-casein, κ-casein (and/or para-κ-casein), and/or a combination thereof, free, or substantially free of β-casein; alternatively, the casein subunit(s) may comprise α-casein, β-casein, and/or a combination thereof, free of κ-casein or para-κ-casein.

[0007a] In one aspect, the present disclosure provides a dairy alternative cheese analog composition, comprising: (a) 0.1% to 25% by weight of at least one casein subunit; (b) 1% to 28% by weight of at least one plant protein; (c) at least one non-dairy fat; and (d) at least one stabilizer component.

[0007b] In another aspect, the present disclosure provides a dairy alternative food composition, comprising: (a) 0.1% to 25% by weight of at least one casein subunit; (b) 1% to 28% by weight of at least one plant protein; (c) at least one plant-based or non-animal fat; (d) at least one stabilizer component; and (e) at least one sugar and/or sweetener.

[0008] Accordingly, in one ~~aspect~~example the present disclosure provides a dairy alternative cheese analog composition comprising about 0.1% to about 25% by weight of at least one casein subunit, about 1% to about 28% by weight of at least one plant protein, at least one fat, and at least one stabilizer component.

[0009] In some ~~aspect~~examples, a casein subunit comprises α-casein, αs1-casein, αs2-casein, β-casein, κ-casein, para-κ-casein or any combination thereof.

[0010] In some ~~aspect~~examples, at least one plant protein comprises one or more proteins derived from cereals, pseudo-cereals, legumes, pulses, nuts, or flours thereof, and/or a combination thereof.

[0011] In some ~~aspect~~examples, at least one fat comprises at least one non-dairy fat in an amount of about 15% to about 40% by weight of the composition.

[0012] In some ~~aspect~~examples, at least one stabilizer component comprises at least one starch, at least one gum (such as pectin), and/or any combination thereof.

[0013] In some ~~aspect~~examples, any of the dairy alternative cheese analog compositions disclosed herein may further comprise at least one organic or inorganic acid.

[0014] In some ~~aspect~~examples, any of the dairy alternative cheese analog compositions disclosed herein may further comprise at least one emulsifying salt.

[0015] In some ~~aspect~~examples, any of the dairy alternative cheese analog compositions disclosed herein may further comprise at least one antimicrobial component.

[0016] For any of the dairy alternative cheese analog compositions disclosed herein, improved stretchability, meltability and/or mouthfeel are positively impacted compared to a plant-based dairy-free cheese product not comprising at least one casein subunit.

[0017] In some ~~aspect~~examples, the dairy alternative cheese analog compositions disclosed herein may comprise about 0.3% to about 2% by weight of α-casein subunit. In some ~~aspect~~examples, these compositions may further comprise about 0.3% to about 2% by weight of β-casein subunit. Still in some ~~aspect~~examples, these compositions may further comprise about 0.3% to about 2% by weight of κ-casein subunit.

[0018] In another ~~aspect~~example, the present disclosure provides a dairy alternative yogurt analog composition. Such composition comprises about 0.1% to about 25% by weight of at least one protein derived using microbial fermentation such as at least one casein subunit, about 1% to about 28% by weight of at least one plant protein, at least one fat, at least one stabilizer component, and a yogurt culture.

[0019] For any of the dairy alternative yogurt analog compositions disclosed herein, in some ~~aspect~~examples, the at least one casein subunit comprises α-casein, αs1-casein, αs2-casein, β-casein, κ-casein, para-κ-casein or any combination thereof.

[0020] In some ~~aspect~~examples, at least one plant protein comprises one or more proteins derived from cereals, pseudo-cereals, legumes, pulses, nuts, or flours thereof, and/or a combination thereof.

[0021] In some ~~aspect~~examples, the at least one fat comprises at least one plant-based fat in an amount of about 1% to about 20% by weight of the composition.

[0022] In some ~~aspect~~examples, the at least one stabilizer component comprises at least one starch, at least one gum (such as pectin), and/or any combination thereof.

[0023] In some ~~aspect~~examples, any of the dairy alternative yogurt analog compositions disclosed herein may further comprise at least one organic or inorganic acid.

[0024] In some ~~aspect~~examples, any of the dairy alternative yogurt analog compositions disclosed herein may further comprise at least one emulsifying salt.

[0025] In some ~~aspect~~examples, any of the dairy alternative yogurt analog compositions disclosed herein may further comprise at least one sugar and/or sweetener.

[0026] In some ~~aspect~~examples, any of the dairy alternative yogurt analog compositions disclosed herein may further comprise at least one antimicrobial component.

[0027] For any of the dairy alternative yogurt analog compositions disclosed herein, it has an improved mouthfeel compared to a plant-based yogurt not comprising at least one casein subunit.

[0028] In another ~~aspect~~example, the present disclosure provides a dairy alternative food composition. Such composition comprises at least about 0.1% to about 25% by weight of at least one casein subunit (derived from microbial fermentation), at least about 1% to about 28% by weight of at least one plant protein; at least one fat; at least one stabilizer component; and at least one sugar and/or sweetener.

[0029] For any of the dairy alternative food compositions disclosed herein, in some ~~aspect~~examples, at least one plant protein comprises one or more proteins derived from cereals, pseudo-cereals, legumes, pulses, nuts, or flours thereof, and/or a combination thereof.

[0030] In some ~~aspect~~examples, the dairy alternative food composition further comprises at least one flavoring component and/or nutritional additive.

[0031] In some ~~aspect~~examples, the food composition is a dairy alternative milk formulation, and the at least one stabilizer component comprises at least one alginate, at least one gelatin, at least one starch, at least one gum, at least one pectin, and/or any combination thereof.

[0032] In some ~~aspect~~examples, the food composition is a dairy alternative milk formulation, and the at least one fat comprises soybean oil, corn oil, coconut oil, canola oil, sunflower oil, coconut cream, palm oil, avocado oil, coconut butter, olive oil, hazelnut oil, sesame oil, walnut oil, almond oil, cocoa butter, grapeseed oil, hemp oil, safflower seed oil, vegetable oil, high oleic fatty acid oil, and/or any combination thereof.

[0033] In some ~~aspect~~examples, the food composition is a dairy alternative ice cream, ice milk, or sherbet formulation, and the at least one stabilizer component comprises at least one alginate, at least one gelatin, at least one starch, at least one gum, at least one pectin, and/or a combination thereof.

[0034] In some ~~aspect~~examples, the food composition is a dairy alternative ice cream or ice milk formulation, and at least one fat comprises soybean oil, corn oil, coconut oil, canola oil, sunflower oil, coconut cream, palm oil, avocado oil, coconut butter, olive oil, hazelnut oil, sesame oil, walnut oil, almond oil, cocoa butter, grapeseed oil, hemp oil, safflower seed oil, vegetable oil, high oleic fatty acid oil, and/or any combination thereof.

[0035] In some ~~aspect~~examples, the food composition is a ready-to-drink beverage.

[0036] In some ~~aspect~~examples, the food composition is a frozen dessert.

[0037] In some ~~aspect~~examples, the food composition is a cheese sauce.

[0038] In some ~~aspect~~examples, the food composition is a snack bar.

[0039] In some ~~aspect~~examples, the food composition is a dry blend powder.

[0040] In some ~~aspect~~examples, the food composition is a confectionery.

[0041] In some ~~aspect~~examples, any of the dairy alternative food compositions disclosed herein may further comprise water and/or a plant-based milk in an amount providing the balance of the composition by weight.

[0042] In another ~~aspect~~example, the present disclosure provides a method of producing a dairy alternative food composition. Such method comprises adding about 1% to about 25% by weight of at least one casein subunit (protein) derived from microbial fermentation to a plant-based food matrix.

[0043] In another ~~aspect~~example, the present disclosure provides use of at least one fermentation derived casein subunit in combination with at least one plant protein to produce a dairy alterative food composition.

[0044] Other ~~aspect~~examples and features of the disclosure are detailed below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] **FIG. 1** is a schematic of natural cheese, a plant-based cheese analog, and a plant-based cheese analog comprising casein.

[0046] **FIG. 2** shows images of different plant-based cheese analog samples (top) and yogurt analog samples (bottom) each comprising different amounts of casein and pea proteins.

WHAT IS CLAIMED IS:

1. A dairy alternative cheese analog composition, comprising:

   (a) ~~about~~ 0.1% to ~~about~~ 25% by weight of at least one casein subunit;

   (b) ~~about~~ 1% to ~~about~~ 28% by weight of at least one plant protein;

   (c) at least one non-dairy fat; and

   (d) at least one stabilizer component.

2. The dairy alternative cheese analog composition of claim 1, wherein the at least one casein subunit comprises α-casein, αs1-casein, αs2-casein, β-casein, κ-casein, para-κ-casein or a combination thereof.

3. The dairy alternative cheese analog composition of any preceding claim, wherein the at least one non-dairy fat is in an amount of ~~about~~ 15% to ~~about~~ 40% by weight of the composition.

~~4. The dairy alternative cheese analog composition of claim 3, wherein the at least one non-dairy fat comprises soybean oil, corn oil, coconut oil, canola oil, sunflower oil, coconut cream, palm oil, avocado oil, coconut butter, olive oil, hazelnut oil, sesame oil, walnut oil, almond oil, cocoa butter, grapeseed oil, hemp oil, safflower seed oil, vegetable oil, high oleic fatty acid oil, and/or a combination thereof.~~

~~5. The dairy alternative cheese analog composition of any preceding claim, wherein the at least one stabilizer component comprises at least one starch, at least one gum, at least one pectin, and/or a combination thereof.~~

~~6. The dairy alternative cheese analog composition of claim 5, wherein the at least one starch is selected from the group consisting of potato starch, corn starch, tapioca starch, rice starch, plantain starch, and/or a combination thereof, and wherein the at least one gum is selected from the group consisting of xanthan gum, locus bean gum, guar gum, agar, konjac gum, gum acacia, gum arabic and a combination thereof.~~

~~7. The dairy alternative cheese analog composition of any preceding claim, further comprising at least one organic or inorganic acid, and/or at least one emulsifying salt.~~

~~8. The dairy alternative cheese analog composition of claim 7, wherein the at least one organic or inorganic acid comprises citric acid, lactic acid, malic acid, tartaric acid, a phosphoric acid, and/or a combination thereof, and wherein the at least one emulsifying salt is selected from the group consisting of sodium citrate, trisodium citrate, tetrasodium pyrophosphate, sodium tripolyphosphate, sodium hexametaphosphate, disodium orthophosphate, and/or a combination thereof.~~

~~9~~4. The dairy alternative cheese analog composition of any preceding claim, wherein the composition has improved stretchability, meltability and/or mouthfeel compared to a plant-based dairy-free cheese analog product not comprising casein or at least one casein subunit.

~~10~~5. The dairy alternative cheese analog composition of any preceding claim, wherein the composition comprises ~~about~~ 0.3% to ~~about~~ 2% by weight of α-casein.

~~11~~6. The dairy alternative cheese analog composition of claim ~~10~~5, further comprising ~~about~~ 0.3% to ~~about~~ 2% by weight of β-casein.

~~12~~7. The dairy alternative cheese analog composition of claim ~~11~~6, further comprising ~~about~~ 0.3% to ~~about~~ 2% by weight of κ-casein.

~~13. The dairy alternative cheese analog composition of any preceding claim, further comprising at least one plant protein.~~

~~14. The dairy alternative cheese analog composition of claim 13, wherein the at least one plant protein comprises one or more proteins derived from oat, rice, corn, quinoa, wheat, buckwheat, soy, pea, faba (fava) bean, canola (rapeseed), lupin, lentil, chickpea, peanuts, almond, cashew, macadamia, hazelnut, walnut, mushrooms, mushroom mycelium, duckweed, rapeseed (canola), and/or algae.~~

~~15~~8. A dairy alternative yogurt analog composition, comprising:

(a) ~~about~~ 0.1% to ~~about~~ 25% by weight of at least one casein subunit;

(b) ~~about~~ 1% to ~~about~~ 28% by weight of at least one plant protein;

(c) at least one non-dairy fat;

(d) at least one stabilizer component; and

(e) a yogurt culture.

~~16~~9. The dairy alternative yogurt analog composition of claim ~~15~~8, wherein the at least one casein subunit comprises α-casein, αs1-casein, αs2-casein, β-casein, κ-casein, para-κ-casein and/or a combination thereof.

~~17~~10. The dairy alternative yogurt analog composition of claim ~~15~~ 8 or ~~16~~9, wherein the at least one non-dairy fat comprises at least one plant-based fat in an amount of ~~about~~ 1% to ~~about~~ 20% by weight of the composition.

~~18~~11. The dairy alternative yogurt analog composition or the dairy alternative cheese analog composition of ~~claim~~ any preceding claim~~17~~, wherein the at least one non-dairy fat comprises soybean oil, corn oil, coconut oil, canola oil, sunflower oil, coconut cream, palm oil, avocado oil, coconut butter, olive oil, hazelnut oil, sesame oil, walnut oil, almond oil, cocoa butter, grapeseed oil, hemp oil, safflower seed oil, vegetable oil, high oleic fatty acid oil, and/or a combination thereof.

~~19~~12. The dairy alternative yogurt analog composition or the dairy alternative cheese analog composition of any preceding claim~~any one of claims 15 to 18~~, wherein the at least one stabilizer component comprises at least one alginate, at least one gelatin, at least one starch, at least one gum, at least one pectin, at least one emulsifying salt, and/or a combination thereof.

~~20~~13. The dairy alternative yogurt analog composition or the dairy alternative cheese analog composition of claim ~~19~~12, wherein the at least one gum is selected from the group consisting of xanthan gum, locus bean gum, guar gum, agar, konjac gum, gum acacia, and/or a combination thereof, and wherein the at least one starch is selected from the group consisting of potato starch, corn starch, tapioca starch, rice starch, plantain starch, and/or a combination thereof.

~~21~~14. The dairy alternative cheese or yogurt analog composition of any preceding claim~~dairy alternative yogurt analog composition of any one of claims 15 to 20~~, further comprising at

least one organic and/or inorganic acid, at least one emulsifying salt, and/or at least one sugar and/or sweetener.

~~22~~15. The dairy alternative cheese or yogurt analog composition of any preceding claim~~dairy alternative yogurt analog composition of claim 21~~, wherein at least one organic or inorganic acid comprises citric acid, lactic acid, malic acid, tartaric acid, a phosphoric acid, and/or a combination thereof.

~~23~~16. The dairy alternative cheese or yogurt analog composition of any preceding claim~~dairy alternative yogurt analog composition of claim 21~~, wherein the at least one emulsifying salt is selected from the group consisting of sodium citrate, trisodium citrate, tetrasodium pyrophosphate, sodium tripolyphosphate, sodium hexametaphosphate, disodium orthophosphate, and/or a combination thereof.

~~24~~17. The dairy alternative cheese or yogurt analog composition of any preceding claim~~dairy alternative yogurt analog composition of claim 21~~, wherein the at least one sugar or sweetener comprises a monosaccharide, a disaccharide, and/or a combination thereof.

~~25~~18. The dairy alternative cheese or yogurt analog composition of any preceding claim~~dairy alternative yogurt analog composition of claim 21~~, wherein the at least one sugar and/or sweetener comprises a non-caloric sugar and/or sweetener, an artificial sugar and/or sweetener, a natural sugar and/or sweetener, a plant-based sugar and/or sweetener, and/or a combination thereof.

~~26~~19. The dairy alternative yogurt analog composition of claim ~~24~~ 17 or ~~25~~18, wherein the at least one sugar or sweetener is at a concentration of ~~about~~ 1% to ~~about~~ 12%, from ~~about~~ 3% to ~~about~~ 8%, or from ~~about~~ 4% to ~~about~~ 7% by weight of the composition.

~~27~~20. The dairy alternative yogurt analog composition of claim ~~26~~19, wherein the at least one sugar or sweetener is at a concentration of about 6% by weight of the composition.

~~28~~21. The dairy alternative yogurt analog composition of any one of claims ~~15~~ 8 to ~~27~~20, wherein the yogurt has improved mouthfeel compared to a plant-based yogurt not comprising at least one casein subunit.

~~29~~22. The dairy alternative cheese~~-~~ or yogurt analog composition of any preceding claim, wherein the at least one plant protein comprises one or more proteins derived from cereals, pseudo-cereals, legumes, pulses, nuts, or flours thereof, and/or a combination thereof.

~~30~~23. The dairy alternative cheese- or yogurt analog composition of any preceding claim, further comprising at least one antimicrobial component.

~~31~~24. The dairy alternative cheese or yogurt analog composition of claim ~~30~~23, wherein the at least one antimicrobial component comprises nisin, lactobacillus microorganisms, or potassium sorbate.

~~32. The dairy alternative yogurt analog composition of any preceding claim, further comprising at least one plant protein.~~

~~33~~25. The dairy alternative yogurt analog composition or the dairy alternative cheese analog composition of any preceding claim~~of claim 32~~, wherein the at least one plant protein comprises one or more proteins derived from oat, rice, corn, quinoa, wheat, buckwheat, soy, pea, faba (fava) bean, canola (rapeseed), lupin, lentil, chickpea, peanuts, almond, cashew, macadamia, hazelnut, walnut, mushrooms, mushroom mycelium, duckweed, rapeseed (canola), and/or algae.

~~34~~26. A dairy alternative food composition, comprising:

(a) ~~about~~ 0.1% to ~~about~~ 25% by weight of at least one casein subunit;

(b) ~~about~~ 1% to ~~about~~ 28% by weight of at least one plant protein;

(c) at least one plant-based or non-animal fat;

(d) at least one stabilizer component; and

(e) at least one sugar and/or sweetener.

~~35. The dairy alternative food composition of claim 34, wherein the at least one plant protein comprises one or more proteins derived from cereals, pseudo-cereals, legumes, pulses, nuts, or flours thereof, and/or a combination thereof.~~

~~36. The dairy alternative food composition of claim 35, wherein the plant protein comprises one or more proteins derived from oat, rice, corn, quinoa, wheat, buckwheat, soy, pea, fava, bean, lupin, lentil, chickpea, peanuts, almond, cashew, macadamia, hazelnut, walnut, mushrooms, mushroom mycelium, duckweed, rapeseed (canola), and/or algae.~~

~~37. The dairy alternative food composition of any one of claims 34 to 36, further comprising at least one flavoring component and/or nutritional additive.~~

~~38. The dairy alternative food composition of claim 37, wherein the nutritional additive is calcium, vitamin D, and/or a combination thereof.~~

~~39. The dairy alternative food composition of claim 34, wherein the at least one stabilizer component comprises at least one alginate, at least one gelatin, at least one starch, at least one gum, at least one pectin, and/or a combination thereof.~~

~~40. The dairy alternative food composition of claim 39, wherein the at least one gum is selected from the group consisting of xanthan gum, locus bean gum, guar gum, agar, konjac gum, gum acacia, and/or a combination thereof, and wherein the at least one starch is selected from the group consisting of potato starch, corn starch, tapioca starch, rice starch, plantain starch, and/or a combination thereof.~~

~~41. The dairy alternative food composition of claim 34, wherein the at least one plant-based or non-animal fat comprises soybean oil, corn oil, coconut oil, canola oil, sunflower oil, coconut cream, palm oil, avocado oil, coconut butter, olive oil, hazelnut oil, sesame oil, walnut oil, almond oil, cocoa butter, grapeseed oil, hemp oil, safflower seed oil, vegetable oil, high oleic fatty acid oil, and/or a combination thereof.~~

~~42. The dairy alternative food composition of any one of claims 34 to 41, wherein the food composition is a dairy alternative milk formulation, a dairy alternative ice cream- or ice milk-like formulation, a ready-to-drink beverage, a frozen dessert, a cheese sauce, a dry blended powder, a snack bar-type food, or a confectionery.~~

~~43. The dairy alternative food composition of any one of claims 34 to 42, further comprising water and/or a plant-based milk in an amount providing the balance of the composition by weight.~~

~~44. The dairy alternative food composition of claim 43, wherein the plant-based milk is selected from the group consisting of coconut milk, almond milk, oat milk, soy milk, cashew milk, barley milk, rice milk, and/or a combination thereof.~~

~~45. A method of producing a dairy alternative food composition, comprising adding about 0.1% to about 25% by weight of at least one casein subunit to a plant-based food matrix.~~

~~46. A dairy alternative food composition produced by the method of claim 45.~~

~~47. Use of at least one casein subunit in combination with at least one plant protein to produce a dairy alterative food composition.~~