Brief Summary

[0005] Disclosed herein are methods of reducing a pathogenic microorganism population in a powdered nutritional food composition which includes a fat, a protein, and a carbohydrate. The method includes the steps of forming an emulsion of the powdered nutritional food composition and extruding the emulsified powdered nutritional food composition at a temperature of less than about 100°C. In some aspects, the methods also include the step of adding a probiotic. The methods produce at least a 5 log reduction of the pathogenic microorganism population in the extruded powdered nutritional food composition, the extruded powdered nutritional food composition having a water activity level of about 0.3 to about 0.95.

[0005a] In one aspect, there is provided a method of reducing a pathogenic microorganism population in a powdered nutritional food composition comprising a fat, a protein, and a carbohydrate, the method comprising the steps of:

a) forming an emulsion of the powdered nutritional food composition; and

b) extruding the emulsified powdered nutritional food composition in an extruder at a temperature of less than about 100°C, whereby there is at least about a 5 log reduction in the pathogenic microorganism population in the extruded powdered nutritional food composition, and wherein the extruded powdered nutritional food composition has a water activity level of about 0.3 to about 0.95

[0005b] In one aspect, there is provided a method of reducing a pathogenic microorganism population in a powdered nutritional food composition comprising a fat, a protein, and a carbohydrate, the method comprising the steps of:

a) forming an emulsion of the powdered nutritional food composition;

b) adding a probiotic to the emulsified powdered nutritional food composition to form a mixed powdered nutritional food composition; and

c) extruding the mixed powdered nutritional food composition at a temperature of less than about 100°C, whereby at least about 80% of the added probiotic is retained in the extruded powdered nutritional food composition, and whereby there is at least about a 5 log reduction in the pathogenic microorganism population in the extruded powdered nutritional food composition, wherein the extruded powdered nutritional food composition has a water activity level of about 0.3 to about 0.95.

Detailed Description

[0006] It has now been discovered that the temperature at which extrusion of nutritional food compositions takes place has a direct impact on the extent to which pathogenic microbial populations are present in resultant products. For instance, extruding a nutritional composition at a temperature of below about 100°C may decrease the presence of pathogenic microbial populations in the resulting extrudate. Nutritional food compositions and related methods for producing the nutritional food compositions with decreased pathogenic microbial populations are disclosed herein.

[0007] The elements or features of the various embodiments are described in detail hereinafter.

[0008] The terms "nutritional composition," "nutritional product," "nutritional food composition," and "nutritional formula," as used herein, refer to a nutritional formulation, which is designed for infants, children, or adults to contain sufficient protein, carbohydrate, fat, vitamins, minerals, and other nutrients to potentially serve as the sole source of

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[0005] Disclosed herein are methods of reducing a pathogenic microorganism population in a powdered nutritional food composition which includes a fat, a protein, and a carbohydrate. The method includes the steps of forming an emulsion of the powdered nutritional food composition and extruding the emulsified powdered nutritional food composition at a temperature of less than about 100°C. In some aspects, the methods also include the step of adding a probiotic. The methods produce at least a 5 log reduction of the pathogenic microorganism population in the extruded powdered nutritional food composition, the extruded powdered nutritional food composition having a water activity level of about 0.3 to about 0.95.

[0005a] In one aspect, there is provided a method of reducing a pathogenic microorganism population in a powdered nutritional food composition comprising a fat, a protein, and a carbohydrate, the method comprising the steps of:

a) forming an emulsion comprising the fat, the protein, the carbohydrate, and water;

b) extruding the emulsion in an extruder at a temperature of from about 60 °C to less than about 100°C to form an extruded nutritional food composition;

c) drying the extruded nutritional food composition; and

d) milling the dried extruded nutritional food composition to form the powdered nutritional food composition,

wherein there is at least about a 5.5 log reduction in the pathogenic microorganism population in the powdered nutritional food composition, and wherein the powdered nutritional food composition has a water activity level of about 0.3 to about 0.95.

[0005b] In one aspect, there is provided a method of reducing a pathogenic microorganism population in a powdered nutritional food composition comprising a fat, a protein, and a carbohydrate, the method comprising the steps of:

a) forming an emulsion comprising the fat, the protein, the carbohydrate. and water;

b) adding a probiotic to the emulsion;

c) extruding the emulsion in an extruder at a temperature of from about 60 °C to less than about 100 °C to form an extruded nutritional food composition;

d) drying the extruded nutritional food composition; and

e) milling the dried extruded nutritional food composition to form the powdered nutritional food composition,

wherein at least about 80% of the added probiotic is retained in the powdered nutritional food composition, and whereby there is at least about a 5.5 log reduction in the pathogenic microorganism population in the powdered nutritional food composition, wherein the powdered nutritional food composition has a water activity level of about 0.3 to about 0.95.

Detailed Description

[0006] It has now been discovered that the temperature at which extrusion of nutritional food compositions takes place has a direct impact on the extent to which pathogenic microbial populations are present in resultant products. For instance, extruding a nutritional composition at a temperature of below about 100°C may decrease the presence of pathogenic microbial populations in the resulting extrudate. Nutritional food compositions and related methods for producing the nutritional food compositions with decreased pathogenic microbial populations are disclosed herein.

[0007] The elements or features of the various embodiments are described in detail hereinafter.

[0008] The terms "nutritional composition," "nutritional product," "nutritional food composition," and "nutritional formula," as used herein, refer to a nutritional formulation, which is designed for infants, children, or adults to contain sufficient protein, carbohydrate, fat, vitamins, minerals, and other nutrients to potentially serve as the sole source of

What is claimed is:

1. A method of reducing a pathogenic microorganism population in a powdered nutritional food composition comprising a fat, a protein, and a carbohydrate, the method comprising the steps of:

a) forming an emulsion of the powdered nutritional food composition; and

b) extruding the emulsified powdered nutritional food composition in an extruder at a temperature of less than about 100°C, whereby there is at least about a 5 log reduction in the pathogenic microorganism population in the extruded powdered nutritional food composition, and wherein the extruded powdered nutritional food composition has a water activity level of about 0.3 to about 0.95.

2. The method of claim 1, wherein the emulsion is formed within the extruder.

3. The method of any one of claims 1-2, wherein the powdered nutritional food composition comprises at least about 20% fat.

4. The method of any one of claims 1-3, wherein the pathogenic microorganism population comprises microorganisms selected from the group consisting of *Listeria monocytogenes, E. coli, Salmonella Enteritidis, Cronobacter sakazakii, Enterbacteriacea*, and combinations thereof.

5. The method of claim 4, wherein the pathogenic microorganism population comprises *Listeria monocytogenes.*

6. The method of claim 5, wherein there is at least about a 5.5 log reduction in the pathogenic microorganism population.

7. The method of claim 6, wherein there is at least about a 5.7 log reduction in the pathogenic microorganism population.

8. The method of any one of claims 1-7, wherein the Z-value for the pathogenic microorganism population is greater than about 10°F.

9. The method of claim 8, wherein the Z-value for the pathogenic microorganism population is greater than about 15°F.

10. The method of any one of claims 1-9, wherein the method occurs over a temperature range of about 20°C.

11. The method of any one of claims 1-9, wherein the method occurs at a temperature of less than about 95°C.

12. The method of claim 11, wherein the method occurs at a temperature of less than about 90°C.

13. The method of any one of claims 1-12, further comprising adding a probiotic to the emulsified powdered nutritional food composition.

14. The method of any one of claims 1-13, wherein the powdered nutritional food composition is in the extruder for a residence time of about 2.5 to about 10 minutes.

15. The method of any one of claims 1-14, wherein the emulsified powdered nutritional food composition is extruded at a maximum pressure of about 1500 psig.

16. The method of any one of claims 1-15, wherein the powdered nutritional food composition further comprises at least one of vitamins, minerals, and other nutrients.

17. The method of any one of claims 1-16, wherein the powdered nutritional food composition comprises from about 10% to about 15% protein, from about 30% to about 50% carbohydrate, and from about 20% to about 50% fat.

18. The method of any one of claims 1-17, wherein the extruded powdered nutritional food composition, when reconstituted in liquid form, comprises from about 54 to about 108 g/l of carbohydrate, from about 20 to about 54 g/l of fat, and from about 7 to about 24 g/l of protein.

19. The method of any one of claims 1-18, further comprising the step of drying the extruded powdered nutritional food composition to a moisture content of less than about 5%.

20. The method of claim 19, further comprising the steps of milling the dried powdered nutritional food composition and reconstituting the milled powdered nutritional food composition to a ready-to-feed state.

21. A method of reducing a pathogenic microorganism population in a powdered nutritional food composition comprising a fat, a protein, and a carbohydrate, the method comprising the steps of:

a) forming an emulsion of the powdered nutritional food composition;

b) adding a probiotic to the emulsified powdered nutritional food composition to form a mixed powdered nutritional food composition; and

c) extruding the mixed powdered nutritional food composition at a temperature of less than about 100°C, whereby at least about 80% of the added probiotic is retained in the extruded powdered nutritional food composition, and whereby there is at least about a 5 log reduction in the pathogenic

microorganism population in the extruded powdered nutritional food composition, wherein the extruded powdered nutritional food composition has a water activity level of about 0.3 to about 0.95.

What is claimed is:

1. A method of reducing a pathogenic microorganism population in a powdered nutritional food composition comprising a fat, a protein, and a carbohydrate, the method comprising the steps of:

a) forming an emulsion comprising the fat, the protein, the carbohydrate, and water;

b) extruding the emulsion in an extruder at a temperature of from about 60 °C to less than about 100°C to form an extruded nutritional food composition;

c) drying the extruded nutritional food composition; and

d) milling the dried extruded nutritional food composition to form the powdered nutritional food composition,

wherein there is at least about a 5.5 log reduction in the pathogenic microorganism population in the powdered nutritional food composition, and wherein the powdered nutritional food composition has a water activity level of about 0.3 to about 0.95.

2. The method of claim 1, wherein the emulsion is formed within the extruder.

3. The method of any one of claims 1-2, wherein the powdered nutritional food composition comprises at least about 20% fat.

4. The method of any one of claims 1-3, wherein the pathogenic microorganism population comprises microorganisms selected from the group consisting of *Listeria monocytogenes, E. coli, Salmonella Enteritidis, Cronobacter sakazakii, Enterbacteriacea*, and combinations thereof.

5. The method of claim 4, wherein the pathogenic microorganism population comprises *Listeria monocytogenes.*

6. The method of any one of claims 1-5, wherein there is at least about a 5.7 log

reduction in the pathogenic microorganism population.

7. The method of any one of claims 1-5 or 6, wherein the Z-value for the pathogenic microorganism population is greater than about 5.6 °C (10 °F).

8. The method of claim 7, wherein the Z-value for the pathogenic microorganism population is greater than about 8.3 °C (15 °F).

9. The method of any one of claims 1-5 or 6-8, wherein the method occurs over a temperature range of about 20 °C.

10. The method of any one of claims 1-5 or 6-9, wherein the method occurs at a temperature of less than about 95 °C.

11. The method of claim 10, wherein the method occurs at a temperature of less than about 90 °C.

12. The method of any one of claims 1-5 or 6-11, further comprising adding a probiotic to the emulsion.

13. The method of any one of claims 1-5 or 6-12, wherein the emulsion is in the extruder for a residence time of about 2.5 to about 10 minutes.

14. The method of any one of claims 1-5 or 6-13, wherein the emulsion is extruded at a maximum pressure of about 10.3 MPa (1500 psig).

15. The method of any one of claims 1-5 or 6-14, wherein the powdered nutritional food composition further comprises at least one of vitamins, minerals, and other nutrients.

16. The method of any one of claims 1-5 or 6-15, wherein the powdered nutritional food composition comprises from about 10% to about 15% protein, from about 30% to about

50% carbohydrate, and from about 20% to about 50% fat.

17. The method of any one of claims 1-5 or 6-16, wherein the powdered nutritional food composition, when reconstituted in liquid form, comprises from about 54 to about 108 g/L of carbohydrate, from about 20 to about 54 g/L of fat, and from about 7 to about 24 g/L of protein.

18. The method of any one of claims 1-5 or 6-17, wherein the powdered nutritional food composition has a moisture content of less than about 5%.

19. The method of any one of claims 1-5 or 6-18, further comprising the step of reconstituting the powdered nutritional food composition to a ready-to-feed state.

20. A method of reducing a pathogenic microorganism population in a powdered nutritional food composition comprising a fat, a protein, and a carbohydrate, the method comprising the steps of:

a) forming an emulsion comprising the fat, the protein, the carbohydrate. and water;

b) adding a probiotic to the emulsion;

c) extruding the emulsion in an extruder at a temperature of from about 60 °C to less than about 100 °C to form an extruded nutritional food composition;

d) drying the extruded nutritional food composition; and

e) milling the dried extruded nutritional food composition to form the powdered nutritional food composition,

wherein at least about 80% of the added probiotic is retained in the powdered nutritional food composition, and whereby there is at least about a 5.5 log reduction in the pathogenic microorganism population in the powdered nutritional food composition, wherein the powdered nutritional food composition has a water activity level of about 0.3 to about 0.95.

21. The method of any one of claims 1-5 or 6-20, further comprising the step of introducing an oil blend into the extruder before extruding the emulsion.

22. The method of any one of claims 1-5 or 6-21, wherein the powdered nutritional food composition is an infant nutritional composition.