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(71) We, THE BRITISH PETROLEUM COMPANY LIMITED, of Britannic House, Moor Lane, London, EC2Y 9BU, a British Company, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:

The present invention relates to a process for the production of solid water dispersible lipid enriched single cell microbial protein compositions and to the compositions produced by the process.

Water dispersible compositions containing single cell microbial protein as a constituent are known. These compositions are simple mixtures of the components. For example "milk replacer" compositions containing single cell microbial protein e.g. yeast have been described in the literature and are available for use as animal feedstuffs. These compositions are free flowing powders which can be mixed with water to give aqueous feeds which can be used as a substitute for milk. The aqueous feeds are used to replace milk in the diet of young mammals such as for example calves, piglets, lambs and kids.

The single cell microbial protein which is a component of these compositions is either the product of traditional fermentation processes using carbohydrates as the carbon substrate or the product of recently developed fermentation processes using hydrocarbons e.g. liquid n-paraffins as the carbon substrate. The product of these processes is usually in the form of a free flowing powder the particles of which are aggregates of microbial cells. This type of product tends to settle out readily from aqueous suspensions or dispersions and in consequence it is not entirely satisfactory for use in liquid "milk replacer" diets.

In British Patent Application numbered 1,438,286 The British Petroleum Company Limited have described and claimed a process for the production of solid non-sticky, free flowing lipid enriched single cell microbial protein composition which have a beneficial effect on the suspension properties of aqueous animal feeds that are made up from the compositions. In relation to the dispersion and nutritional characteristics of the compositions the present invention is an improvement in or modification of the invention described and claimed in British Patent Application numbered 1,438,286.

According to the present invention there is provided a process for the production of a solid water dispersible lipid enriched single cell microbial protein composition which comprises forming an emulsion of a lipid in water containing separately a single cell microbial protein and a carrier which is soluble in or which is capable of forming a stable dispersion in cold water wherein the proportion by weight of the lipid to the total weight of single cell protein, carrier and lipid is in the range 10 to 50 percent, the proportion by weight of the carrier to the total weight of single cell protein, carrier and lipid is at least 16 percent and the proportion by weight of single cell protein to the total weight of single cell protein, carrier and lipid is in the range 20 to 84 percent and thereafter drying the emulsion.

The relative proportion of lipid, carrier and protein present in the emulsion are the same as those present in the product composition. The proportion will depend upon the nature of the carrier and lipid and the intended use of the composition. The optimum proportion required to impart improved suspension characteristics in the composition will vary with the nature of the carrier, lipid and protein, and can be determined in each case by simple comparative experimentation.

The proportion by weight of lipid to the total weight (dry weight) of microbial protein, carrier and lipid in the composition is preferably in the range 20 to 45 percent and more usually in the range 20 to 35 percent. Normally young mammals and in particular calves require in their diet at least 20 percent by weight of lipids. Consequently the minimum proportion of lipid to the total weight of microbial protein, carrier and lipid is preferably 20 percent.

The proportion by weight of carrier to the total weight (dry weight) of microbial protein, carrier and lipid in the material can be in the range 35 to 60 percent. Most suitably the proportion is in the range 20 to 50 percent and preferably is in the range 30 to 40 percent, depending on the nature of the carrier.

Most suitably the proportion by weight of single cell protein to the total weight of single cell protein, carrier and lipid can be in the range 30 to 40 percent and preferably in the range 30 to 35 percent. Preferably the protein is present in the emulsion and product composition in a finely divided state. Most suitably the particle size of the protein is 50 microns or less. Preferably less than 1.5 percent by weight of the protein should have a particle size in excess of 40 microns. Particularly suitably at least 95 percent and preferably 98 percent by weight of the microbial protein has a particle size which does not exceed 20 microns.

Preferably the emulsion and the product composition comprises 30 percent by weight of single cell protein, 30 to 40 percent by weight of carrier and 30 to 40 percent by weight lipid in relation to the total weight of single cell protein, carrier and lipid present. The protein is preferably present as a yeast, the carrier is preferably whey and the lipid is preferably a blend of a saturated and an unsaturated fat such as for example a blend comprising tallow, lard, coconut oil and optionally an emulsifier e.g. lecithin. Some examples of specific emulsions and product compositions comprise yeast 30 and 37 percent (dry weight), whey 30 to 37 percent by weight and lipid 26 to 40 percent by weight; yeast 35 to 43 percent (dry weight), lactose 25 to 31 percent by weight and lipid 26 to 40 percent by weight, or yeast 0.1 to 15 percent (dry weight), whey 0.1 to 15 percent, skim milk 45 to 95 percent and lipid 5 to 25 percent.

The carrier must be soluble in or capable of forming a stable dispersion in cold water. The stable dispersion can be in the form of a gel or colloidal suspension. By cold water is meant water at or near ambient temperature for example in the range 5°C to 45°C. The carrier can be any nutritionally acceptable water soluble or dispersible carbohydrate or proteinaceous material. Some examples of water soluble carbohydrates or proteinaceous materials are acid or sweet whey, lactose, soluble starch, dextrin, dextrose or mixtures thereof. Some examples of carriers which are capable of forming stable dispersions in cold water are pregelatinised or partially hydrolysed polysaccharides, skim milk, buttermilk, whole milk or commercially available fat-filled milks. Methods for the gelatinisation or partial hydrolysis of polysaccharides are known and polysaccharides which have been treated by any of the known methods are suitable for use as a carrier in the present process. For example where the polysaccharide is a starch it can be gelatinised by heating in the presence of water at a temperature in the range 50°C to 80°C for a period of time in the range 10 to 90 minutes depending on the type of starch. Some examples of gelatinised or partially hydrolysed polysaccharides are colloidal dextrins and pregelatinised starches derived from maize, wheat, potato or tapioca.

The lipid can be any fatty material which is acceptable in feedstuffs. Some examples of suitable lipids are corn, palm, coconut or ground nut oil, tallow, lard, copra and mixtures thereof. A nutritionally acceptable emulsifier such as soyabean lecithin can be present in the lipid.

The protein can be the product of any industrial process for the production of single cell microbial protein. Some examples of such processes have been described previously in this specification. A preferred type of microbial protein is a yeast which has been produced by a fermentation process using a hydrocarbon, oxidised hydrocarbon or a conventional carbohydrate as the carbon substrate. Some examples of hydrocarbon or oxidised hydrocarbon utilising yeasts are species of the genus Candida, e.g. Candida lipolytica or tropicalis. An example of a yeast produced by conventional processes using a carbohydrate as the carbon substrate is Saccharomyces cereviseae. This type of protein is usually in the form of a powder, the particles of which consist of aggregates of whole cells of the process micro-organism. As hereinbefore stated the suspension characteristics of this untreated protein in liquid feeds is not entirely satisfactory.

The microbial protein can be in the form of a purified water insoluble protein fraction isolated from a single cell micro-organism. Methods for preparing protein isolate are known. These methods usually involve solubilising the protein by treating the whole or ruptured microbial cell with an aqueous alkali and then precipitating the solubilised protein by treatment with an acid.

The emulsion of the lipid in water containing separately the single cell microbial protein and the carrier can be formed by subjecting an aqueous suspension of the protein, lipid and carrier to a homogenising technique and removing water from the emulsion by evaporation to give a solid matrix comprising the carrier and the lipid with the protein dispersed therein.

The suspension can be formed by adding the carrier and lipid to a fermentation broth fraction containing the single cell microbial protein in the form of whole microbial cells. The carrier can be added as a dry powder or as an aqueous solution or suspension. Most suitably the emulsion should be homogenous before it is dried to ensure that the components are evenly dispersed in the product composition.

The lipid can be added in the molten state or as an emulsion in water. Most suitably the suspension can be subjected to vigorous agitation to emulsify the lipid and ensure the formation of a homogeneous suspension before drying. This can be done by passing the suspension through a homogeniser.

It is desirable for commercial reasons that the size of the homogeniser and more particularly the size and/or the energy requirement of drying apparatus should be as small as possible. Consequently to achieve this end the solids content of suspension and emulsion should be as high as possible so that the quantity of liquid passed through the equipment is kept to a minimum. The suspension and emulsion most suitably have solids content in the range 50 to 70 percent by weight. The solids content is usually 50 percent by weight. In addition, to facilitating pumping operations, the viscosity of the suspension and emulsion should be kept as low as possible. High solid content emulsions tend to have a high viscosity. The viscosity of the emulsion can be lowered by elevating the temperature. Most suitably the temperature of the emulsion can be in the range 60°C to 65°C. Operation at an elevated temperature is particularly desirable where the lipid component of the suspension and emulsion is normally solid at the ambient temperature. A convenient technique is to form an aqueous suspension containing a fraction only of the water, microbial protein and carrier together with all of the lipid. The suspension can then be emulsified by passage through a homogeniser. The remaining water, microbial protein and carrier can then be added. Preferably about 50 percent of the water, microbial protein and carrier can be homogenised with all the lipid in this way.

Preferably where the protein is in the form of a fermented broth containing microbial cells, the broth can be subjected to a centrifugation or decantation treatment to increase the solids content before adding the carrier and lipid. Centrifuged broth typically has a solids content in the range 15 - 25 percent (dry weight). Alternatively an aqueous suspension of the microbial protein, carrier and lipid can be formed by adding separately dry protein e.g. in the form of a spray dried powder of microbial cells or finely divided protein isolate and carrier and lipid to the water. Where the protein is in the form of protein isolate the carrier and lipid can be added to an aqueous alkaline solution of the protein and thereafter precipitating the protein by adding acid. Alternately the carrier and lipid can be added after the protein has been precipitated. Water insoluble carriers can be pregelatinised i.e. treated to induce the gel forming properties before mixing with water to form the suspension. However the gelating property can be induced by subjecting the carrier to heat in the presence of water during formation of the emulsion.

A convenient technique for inducing gel forming properties in an unmodified polysaccharide such as starch is to hold the emulsion at a temperature in the range 50 to 80°C for a period of time in the range 10 to 90 minutes before evaporating to give the solid material. The preferred temperature is in the range 60 to 70°C and the preferred time is in the range 30 to 40 minutes.

Any known technique for drying the emulsion can be employed in the present process. Most suitably the temperature used should not adversely affect the nutritional properties of the protein. Some examples of suitable drying techniques are spray, flash, fluidised bed and drum drying. The product composition is preferably in the form of a powder to facilitate blending with other solid materials to form feedstuff compositions. However where the composition is produced as a cake or block it should be comminuted before blending. Most suitably the particle size of the powdered or comminuted composition is less than 150 microns and preferably less than 100 microns. The powdered or comminuted composition is particularly suitable for use as or as a component of compositions which are to be hydrated to form liquid feeds such as for example "milk replacer" compositions or as a substitute for milk in any formulation where the latter is employed. Spray drying is the preferred drying technique because it gives a product composition in the form of a fine powder which can be readily blended with other feedstuffs by means of conventional mixing techniques. Where a spray drying technique is used the inlet temperature can be in the range 140 to 310°C and the outlet temperature can be in the range 70 to 95°C. Preferably the inlet temperature should be in the range 180° to 200° and the outlet temperature should be in the range 80°C to 85°C. The principal factors which determine these temperatures are the nature and quantity of the carrier and lipid and the solids content of the feed stream to the drier.

The solid water dispersible lipid enriched single cell microbial protein compositions produced by the present process are particularly suitable for use in "milk replacer" compositions where they can replace a substantial quantity of milk protein without having any appreciable adverse effect on the physical appearance of the solid composition or the hydrated feed. The hydrated feeds have improved suspension and dispersion characteristics and colour in comparison with similar feeds containing the known type of single cell protein. The compositions are non-sticky and when in the form of powders are free flowing.

The present invention is described further with reference to the following examples.

Example 1

A broth fraction from a yeast fermentation of "yeast cream" having a solids content of 15 percent by weight (dry weight) was prepared in the following manner. A straight chain hydrocarbon utilising strain of the yeast Candida lipolytica C.B.S. Number 6331 was cultivated continuously in an aerated broth comprising an aqueous nutrient medium in the presence of a mixture of straight chain petroleum hydrocarbons boiling in the gas oil range as the carbon source.

Broth containing the yeast was passed to a centrifuge where it was separated on the one hand into a cream containing the bulk of the yeast and on the other hand into mainly aqueous nutrient medium. The yeast cream had a solids content of 15 percent by weight (dry weight). 23 kilograms of the yeast cream were mixed with 10 kilograms of a sweet whey concentrate having a solids content of 36 percent by weight. The mixture was heated to 60°C and then blended to form a suspension in a Silverson mixer (Silverson is a registered Trade Mark) with 3 kilograms of a molten fat mixture consisting of tallow, lard, coconut oil and an emulsifier. The proportions by weight of tallow, lard, oil and emulsifier present in the fat mixture were 55; 25; 17 and 3 percent respectively. The hot suspension was homogenised by two passes through a Rannie homogeniser (Rannie is a registered Trade Mark). The pressure on the first pass was 2000 pounds per square inch and 500 pounds per square inch on the second pass. The emulsion thus formed had a solids content of 28 percent by weight. The emulsion was dried in a spray drier having an inlet temperature of 160°C and an outlet temperature of 90°C to give a solid composition (A). Composition (A) was a non-sticky off white free flowing powder consisting of 34.2 percent by weight of yeast, (dry weight), 35.6 percent by weight of whey and 29.7 percent by weight of fat. The particle size of the powder was in the range 10 to 150 microns. A suspension consisting of 20 litres of the yeast cream previously described, 3 kilograms of sweet whey powder and 2.5 kilograms of molten fat was prepared using the same constituents and the same technique as that described above. The suspension was homogenised by passage through a Dynomill Model KD5 homogeniser at a rate of 80 litres per hour and at a temperature of 60°C. The homogenised emulsion thus formed had a solids content of 33 percent by weight. The emulsion was dried in a spray drier having an inlet temperature of 185°C and an outlet temperature in the range 80 to 85°C to give a solid composition B. Composition B was a non-sticky, off white free flowing powder consisting of 35 percent by weight yeast (dry weight), 35 percent by weight of whey and 30 percent by weight of fat. The powder had a particle size in the range 10 to 150 microns.

A solid composition C was prepared in accordance with the procedure hereinbefore described in relation to Composition B with the exception that the 3 kilograms of sweet whey powder was replaced by 3 kilograms of colloidal dextrin. (Starch Products Ltd). Composition C was a non-sticky off-white free flowing powder consisting of 35 percent by weight of yeast, 35 percent by weight of dextrin and 30 percent by weight of fat. The powder had a particle size in the range 10 to 150 microns.

A solid Composition D was prepared in accordance with the procedure hereinbefore described in relation to Composition B except that the 3 kilograms of sweet whey powder were replaced by 2.14 kilograms of lactose powder and the quantity of the molten fat mixture was increased to 3.43 kilograms. The emulsion of fat, lactose and yeast had a solids content of 34 percent by weight. Composition D was a non-sticky free flowing off white powder consisting of 35 percent by weight of yeast (dry weight), 25 percent by weight of lactose and 40 percent by weight of fat. The powder had a particle size in the range 10 to 150 microns.

A solid Composition E was prepared in accordance with the procedure hereinbefore described in relation to Composition B with the exception that the yeast cream was replaced by a dispersion of 3 kilograms of a spray dried yeast in 20 litres of water. Composition E was a non sticky off white powder having the same particle size and compostion as Composition B. The yeast was obtained by spray drying the yeast cream prepared in accordance with the procedure described in the first paragraph of this Example.

An aqueous suspension consisting of 20 kilograms of yeast cream, 8.3 litres of a sweet whey concentrate (36 percent by weight solids), 6 kilograms of skim milk powder and 3 kilograms of the fat mixture was prepared in accordance with the procedure hereinbefore described in relation to Composition A. The skim milk powder was mixed with the yeast cream and whey concentrate before the fat mixture was added. The suspension was homogenised by passage through a Manton Gaulin homogeniser at a pressure of 4000 pounds per square inch at a flow rate of 40 litres/hour. The homogenised emulsion thus formed had a solids content of 40 percent. The emulsion was dried in a spray drier having an inlet temperature of 185°C and an outlet temperature of 85°C to give a solid Composition F. Composition F was a solid non-sticky off white free flowing powder consisting of 20 percent by weight of yeast (dry weight), 20 percent by weight of whey, 40 percent by weight of skim milk and 20 percent by weight of fat. The powder had a particle size in the range 10 to 150 microns.

A solid Composition G was prepared in accordance with the procedure hereinbefore described in the previous paragraph in relation to Composition F except that the skim milk powder and fat mixture were replaced by 9 kilograms of a commercial fat filled milk having a fat content of 25 percent by weight. Composition G was a non sticky solid off white free flowing powder consisting of 20 percent by weight of yeast, (dry weight), 45 percent by weight of skim milk and 15 percent by weight of fat. The powder had a particle size in the range 10 to 150 microns.

To illustrate the dispersion characteristics in aqueous feedstuffs of Compositions A to G the compositions were incorporated as constituents of "milk replacer" compositions A to G. The compositions were then hydrated to form aqueous feeds and the sedimentation times of the feeds were then assessed. The "milk replacer" compositions had the following formulation.

Solid powdered lipid enriched composition	35.3 percent by weight
Fat filled milk powder (25 percent by weight of fat)	30 percent by weight
Spray dried whey powder	24.7 percent by weight
Skim milk powder	10.0 percent by weight

By way of comparison and control a typical "milk replacer" Composition X and a "milk replacer" Composition Y containing a known type of untreated dried yeast were made up in accordance with the following formulations.

"Milk replacer" Composition X.

Fat filled milk powder	70 percent by weight
Spray dried whey powder	25 percent by weight
Spray dried skim milk powder	5 percent by weight

"Milk replacer" Composition Y.

Fat filled milk powder	65 percent by weight
Spray dried whey powder	23 percent by weight
Untreated dried yeast	12 percent by weight

The untreated dried yeast used as a constituent of Composition Y was obtained by spray drying the yeast cream described in the first paragraph of the Example. The conditions for operating the drier were the same as those described in the preparation of lipid enriched yeast Composition A.

The "milk replacer" compositions were added with stirring to water at a temperature of 40°C to give aqueous feeds A to G, X and Y having a concentration of 100 grams per litre. A second aqueous feed A having a concentration of 180 grams per litre was made up in the foregoing manner from milk replacer Composition A.

The dispersion characteristics of the feeds were assessed by stirring a 250 millilitre sample of each feed in a glass measuring cylinder and measuring the depth of sediment formed on standing without further agitation in unit time.

The results are given in the following table.

Feed	Sediment in millimeter formed on standing for time in minutes			
	15	30	45	60
A	Nil	Nil	Nil	Nil
A1	"	"	"	"
B	"	"	"	"
C	"	"	"	"
D	"	"	"	"
E	"	"	"	"
F	"	"	"	"
Controls (X	"	"	"	"
(Y	2	4	6	7

These results demonstrate that over the limited period of the trial that the dispersion characteristics in aqueous feeds made up from "milk replacer" compositions having as a constituent solid water dispersible lipid enriched yeast compositions in accordance with the present invention are similar to aqueous feeds based on a typical known "milk replacer" composition which does not contain single cell protein and are superior to aqueous feeds based on "milk replacer" compositions containing a known untreated single cell protein.

Example 2

A sample of dried yeast was prepared in the follow manner. A straight chain hydrocarbon utilising strain of the yeast Candida lipolytica C.B.S. 6331 was cultivated continuously in an aerated broth comprising an aqueous nutrient medium in the presence of a mixture of straight chain petroleum hydrocarbons boiling in the gas oil range as the carbon source. Broth containing the yeast was passed to a centrifuge where it was separated on the one hand into a cream containing the bulk of the yeast and on the other hand into mainly aqueous nutrient medium. The yeast cream had a solids content of 15 percent by weight (dry weight). The cream was dried in a spray dryer to give a powder consisting of aggregates of yeast cells.

0.9 kilograms of the spray dried yeast were dispersed in 2.5 litres of water at a temperature of 65°C. 0.96 kilograms of dried whey were added to the aqueous suspension of yeast and the whey dissolved. 1.14 kilograms of molten tallow at a temperature of 65°C were then added to the suspension of yeast in the aqueous solution of whey to give a total solids content of 50 percent. The suspension was then mixed by hand to disperse the tallow. The suspension was passed at a temperature of 65°C at a rate of 40 litres per hour through a Manton-Gaulin homogeniser at a pressure of 5000 pounds per square inch. The resulting emulsion was passed to a spray drier having an inlet temperature of 185°C and an outlet temperature of 85°C to give a solid composition. The emulsion was maintained at a temperature in the range 60 to 65°C throughout the operation.

The product composition was a non-sticky, off white free flowing powder consisting of 30 percent by weight of yeast, 32 percent by weight of whey and 35 percent by weight of lipid in relation to the total weight of yeast, whey and lipid.

The procedure described previously in this Example was repeated with the exception that the quantity of water was reduced to 2.2 litres. The solids content of both the suspension and emulsion was thus increased to 60 percent by weight. The characteristics of the product composition were the same as those described previously for the composition produced from the emulsion containing 50 percent by weight of solids.

The procedure described previously in this Example was again repeated with the exception that the quantity of water was further reduced to 1.5 litres to give a suspension and emulsion having a solids content of 70 percent by weight. The characteristics of the product composition were the same as those previously described for the composition produced from the emulsion containing 50 percent by weight of solids.

This example illustrates that a satisfactory composition can be prepared from suspension and emulsions having solids contents in the range 50 to 70 percent by weight. The high solids content suspensions and emulsions facilitate cost savings in both homogenising and drying apparatus and a very considerable saving in the energy requirement of the drying apparatus with a consequent considerable improvement in the economics of the process.

WHAT WE CLAIM IS:

1. A process for the production of a solid water dispersible lipid enriched single cell microbial protein composition which comprises forming an emulsion of a lipid in water containing separately a single cell microbial protein and a carrier which is soluble in or which is capable of forming a stable dispersion in cold water wherein the proportion by weight of the lipid to the total weight of single cell protein, lipid and carrier is in the range 10 to 50 percent, the proportion by weight of the carrier to the total weight of single cell protein, lipid and carrier is at least 16 percent and the proportion by weight of single cell protein to the total weight of single cell protein, carrier and lipid is in the range 20 to 84 percent and thereafter drying the emulsion.

2. A process as claimed in claim 1 in which the proportion by weight of the lipid to the total weight of single cell protein, lipid and carrier is in the range 20 to 45 percent.

3. A process as claimed in either claim 1 or 2 in which the proportion by weight of carrier to the total weight of single cell protein, lipid and carrier is in the range 20 to 50 percent.

4. A process as claimed in any one of the preceding claims in which the proportion by weight of single cell protein to the total weight of single cell protein, lipid and carrier is in the range 30 to 40 percent.

5. A process as claimed in any one of the preceding claims in which the proportion by weight of single cell protein is 30 percent, the proportion by weight of carrier is in the range 30 to 40 percent and the proportion by weight of lipid is in the range 30 to 40 percent in relation to the total weight of the single cell protein, carrier and lipid present in the emulsion.

6. A process as claimed in any one of the preceding claims in which the single cell microbial protein is in the form of whole cells of a single cell micro-organism.

7. A process as claimed in claim 5 in which the cells are present in a fermentation broth.

8. A process as claimed in claim 6 in which the broth is subjected to centrifugation to give a broth fraction containing microbial cells and having a solids content in the range 15 to 25 percent (dry weight).

9. A process as claimed in any one of the preceding claims 1 to 5 in which the single cell microbial protein is in the form of a purified water insoluble protein isolated from a single cell micro-organism.

10. A process as claimed in any one of the preceding claims 6 to 8 in the single cell micro-organism is a yeast.

11. A process as claimed in claim 10 in which the yeast is a hydrocarbon or an oxidised hydrocarbon utilising yeast.

12. A process as claimed in claim 10 to 11 in which the yeast is a species of the genus Candida.

13. A process as claimed in claim 12 in which the yeast is Candida lipolytica.

14. A process as claimed in claim 12 in which the yeast is Candida tropicalis.

15. A process as claimed in any one of the preceding claims in which the single cell microbial protein present in the emulsion has a particle size of 50 microns or less.

16. A process as claimed in claim 15 in which less than 1.5 percent by weight of the single cell microbial protein has a particle size in excess of 40 microns.

17. A process as claimed in claim 15 or 16 in which at least 95 percent by weight of the single cell protein has a particle size which does not exceed 20 microns.

18. A process as claimed in any one of the preceding claims in which the emulsion has a solids content in the range 50 to 70 percent by weight.

19. A process as claimed in any one of the preceding claims in which the temperature of the emulsion is in the range 60°C to 65°C.

20. A process as claimed in any one of the preceding claims in which the emulsion is formed by subjecting an aqueous suspension of the lipid, single cell protein and carrier to a homogenising technique.

21. A process as claimed in any one of the preceding claims in which the emulsion is formed by adding the lipid to an aqueous suspension containing the single cell protein and the carrier and subjecting the suspension to agitation to emulsify the lipid.

22. A process as claimed in claim 21 in which the lipid is added in the molten state to the aqueous suspension of single cell protein and carrier.

23. A process as claimed in any one of the preceding claims in which the emulsion is formed by adding the lipid as an emulsion in water to an aqueous suspension of single cell protein and carrier.

24. A process as claimed in claim 20 in which the aqueous suspension is formed by adding the lipid and carrier to an aqueous alkaline solution of the microbial protein and thereafter adding an acid to precipitate the protein.

25. A process as claimed in any one of the preceding claims in which the carrier is a water

soluble carbohydrate.

26. A process as claimed in claim 25 in which the carbohydrate is lactose, soluble starch, dextrin, dextrose, or a mixture thereof.

27. A process as claimed in any one of the preceding claims 1 to 24 in which the carrier is a water soluble or water dispersible proteinaceous material.

28. A process as claimed in claim 27 in which the material is an acid or sweet whey.

29. A process as claimed in any one of the preceding claims 1 to 24 in which the carrier is a colloidal dextrin or a pregelatinised starch derived from maize, wheat, potato or tapioca.

30. A process as claimed in any one of the preceding claims in which the lipid is corn, palm, coconut or ground nut oil, tallow, lard or copra or a mixture thereof.

31. A process as claimed in any one of the preceding claims in which the lipid comprises a blend of tallow, lard and coconut oil.

32. A process as claimed in any one of the preceding claims in which the emulsion is dried by spray drying in a spray dryer or dried in a drum dryer, flash dryer or fluidised bed.

33. A process as claimed in claim 32 in which the inlet temperature of the spray dryer is in the range 140°C to 310°C and the outlet temperature is in the range 70°C to 95°C.

34. A process as claimed in claim 1 and as hereinbefore described with reference to Example 1.

35. A process as claimed in claim 1 and as hereinbefore described with reference to Example 2.

36. A lipid enriched single cell microbial protein composition when produced by the process as claimed in any one of the preceding claims.

For the Applicants,
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