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54 Titre : **Complementary food preparation.**

57 **Abrégé** : The invention relates to a method for manufacturing a spirulina preparation having improved taste and odor, in particular having a reduced ocean taste and odor or a reduced sea taste and odor, and also to such a spirulina preparation. The invention also relates to a solid, semi-solid or liquid complementary food preparation, in particular a ready-to-use complementary food (RUCF) preparation or ready-to-use therapeutic food (RUTF) preparation, comprising such a spirulina preparation, and also other components chosen from at least two of the groups formed by (a) cereal plants, notably the flours of cereal plants; (b) leguminous plants and/or the seeds of leguminous plants, notably soybeans, chick peas, lentils, peas, black-eyed peas, mung beans, pigeon peas, haricot beans and/or lupin; and (c) flours and protein products based on oleaginous plant seeds that are not part of groups (a) or (b). Other aspects relate to these complementary food preparations for use in the prevention or treatment of malnutrition, in particular moderate acute malnutrition (MAM) or severe acute malnutrition (SAM), and to the use of spirulina for the manufacture of such complementary food preparations.

COMPLEMENTARY FOOD PREPARATION

Field of the invention

[0001] The present invention relates to supplementary food preparations, in particular for the prevention or treatment of malnutrition.

5 Background of the invention

[0002] The latest edition of "The State of Food Security and Nutrition in the World", published in July 2020, estimates that almost 690 million people suffered from hunger in 2019, an increase of 10 million compared with 2018, and of nearly 60 million in five years. Due to high costs and limited financial means, billions of people are unable to
10 adopt a healthy or nutritious diet.

[0003] Today, various specialist supplementary food preparations provide different levels of energy, micronutrients and macronutrients necessary for growth and health in order to prevent or treat malnutrition.

[0004] Supplementary food preparations intended to prevent or treat malnutrition are
15 taken to mean foods to be administered during a period of supplementary feeding. These preparations are specially formulated with an appropriate nutritional quality to provide additional energy and nutrients to supplement family foods from the local diet, and provide nutrients which are absent or present in insufficient quantities.

[0005] All supplementary food preparations intended to prevent or treat malnutrition
20 must be formulated in accordance with guidelines drawn up by the FAO and WHO.

[0006] During the manufacture of supplementary food preparations, all processing operations should be carried out in such a way as to preserve protein quality, limit micronutrient losses and maintain overall nutritional value.

[0007] The quality of the proteins provided by the various ingredients and raw
25 materials, and therefore their essential amino acid concentration, is a crucial factor in the formulation of supplementary food preparations intended to prevent or treat malnutrition.

[0008] Amino acids are the basic building blocks of proteins. There are a huge number of different amino acids, but only twenty are used by the body to make proteins ("proteinogenic" amino acids). Among these 20 amino acids, eleven can be produced by the human body and the nine others are said to be essential as the body is unable to synthesise them in sufficient quantities to meet its needs. Protein quality is therefore assessed on the basis of their ability to supply the nine essential amino acids (EAA) - lysine, sulfur-containing AA (methionine, cysteine), threonine, tryptophan, branched AA (leucine, isoleucine, valine), aromatic AA (phenylalanine, tyrosine) and histidine.

[0009] These amino acids must therefore be supplied by diet. The amino acid composition of proteins is taken into account when assessing the protein quality of our diet.

[0010] At present, the main supplementary food preparations used are RUSF (ready-to-use supplementary food) and RUTF (ready-to-use therapeutic food) respectively developed to treat moderate and severe acute malnutrition in children and adults.

[0011] The main feature of these preparations is their ease of use, as they are ready-to-use and do not require the use of water or other biological fluids to reconstitute them, so avoiding secondary bacterial contamination.

[0012] What should be noted is that in these and other preparations, for the time being, the main source of essential amino acids is supplied by ingredients of animal origin, and in particular certain cow's milk derivatives (whole or skimmed milk powder, whey protein concentrate, whey permeate). Cow's milk derivatives also provide a range of essential micronutrients.

[0013] This is due to the fact that currently used ingredients of vegetable origin, in particular cereals, leguminous plants and leguminous plant seeds, flours and protein products based on oilseeds, are unable alone to provide sufficient concentrations of essential amino acids as required (according to the guidelines drawn up by the FAO and WHO) in the supplementary food preparations to prevent or treat malnutrition.

[0014] In order to ensure the essential amino acid concentrations required by the guidelines, the main supplementary food preparations contain between 25 and 40% of cow's milk derivatives (whole or skimmed milk powder, whey protein concentrate,

wey permeate) and only between 5 and 25% of vegetable ingredients (cereals, leguminous plants and leguminous plant seeds together with flours and protein products based on oilseeds).

5 [0015] The proteins present in ingredients of animal origin and therefore in milk derivatives have a higher biological value than proteins of vegetable origin and are easy to incorporate into supplementary food preparations, but on the other hand, their production costs are high, and their carbon footprint is not inconsiderable. It is also important to note that around 25% of malnourished individuals, more particularly infants, are lactose intolerant. Lactose intolerance is a frequent reason for diarrhoea
10 in malnourished infants and a cause of treatment failure. Lactose is present in a content of between 10 and 80% in the cow's milk derivatives ordinarily used in supplementary food preparations. Other drawbacks include allergies to cow's milk proteins. Allergies to cow's milk proteins are a form of food allergy which mainly affects infants and children under the age of three. Caseins and β -lactoglobulin are most often
15 implicated, but any protein can be implicated. Casein is involved in long-term allergies. There are various types of casein, all of which have the particularity of remaining stable, even when subjected to conditions liable to denature them, such as for example heat.

[0016] To date, no viable alternative has yet been proposed to reduce, let alone
20 replace, the use of ingredients of animal origin in the supplementary food preparations intended to prevent or treat malnutrition.

Object of the invention

[0017] One object of the present invention is consequently to identify one or more ingredients which could advantageously enter into the formulation of supplementary
25 food preparations in general, but also in particular for ready-to-use supplementary food preparations (RUSF) or ready-to-use therapeutic food preparations (RUTF), ideally for significantly reducing, or even eliminating, the need to resort to ingredients of animal origin. Furthermore, these ingredients should not have a taste or odour likely to reduce consumer acceptance of the resulting preparations. Advantageously, it should be
30 possible to produce this or these ingredients at a favourable cost, but above all also with a reduced carbon footprint.

General description of the invention

[0018] In order to achieve the above-mentioned object, the present invention proposes, in a first aspect, a method for manufacturing a spirulina preparation having an improved taste and odour, in particular having a reduced ocean taste and odour or a reduced sea taste and odour, the method comprising:

- a first preparation step during which 10 to 70% by weight, based on the spirulina preparation, of dry spirulina is mixed with 0.1 to 20% by weight, based on the spirulina preparation, of a mineral premix using a rotary mixer rotating at 2500 to 3500 revolutions/minute, preferably at approximately 3000 revolutions/minute, for 15 to 25 minutes, preferably for approximately 20 minutes,
- a second incorporation step during which 10 to 80% by weight, based on the spirulina preparation, of a sugar preparation is incorporated into the mixture from the first step and during which the mixture is subjected to the action of the rotary mixer rotating at 2500 to 3500 revolutions/minute, preferably at approximately 3000 revolutions/minute, for 10 to 20 minutes, preferably for approximately 15 minutes, and
- a third step during which 0.1 to 10% by weight, based on the spirulina preparation, of a preparation of lecithins is incorporated into the mixture from the second step and during which the resultant mixture is subjected to the action of the rotary mixer rotating at 1500 to 2500 revolutions/minute, preferably at approximately 2000 revolutions/minute, for 5 to 15 minutes, preferably for approximately 10 minutes,

wherein the mineral premix comprises between 400 and 800 mg of calcium, from 1 to 2.5 mg of copper, from 20 to 200 µg of iodine, from 8 to 15 mg of iron, from 130 to 250 mg of magnesium, from 1 to 2.5 mg of manganese, from 400 to 800 mg of phosphorus, from 700 to 1500 mg of potassium, from 15 to 50 µg of selenium and from 10 to 15 mg of zinc, wherein the sugar preparation comprises glucose, fructose, saccharose, lactose or mixtures thereof, in the form of granulated sugar, raw sugar,

very fine sugar, pearl sugar, liquid sugar, invert liquid sugar, brown sugar, icing sugar, table syrup, and/or molasses, and wherein the preparation of lecithins is vegetable lecithins, preferably soy or sunflower lecithins.

[0019] A second aspect relates to a spirulina preparation having an improved taste and/or odour, in particular having a reduced ocean taste and odour or a reduced sea taste and odour, preferably obtained in accordance with the method according to claim 1 or 2, comprising 10 to 70% by weight of dry spirulina mixed with 0.1 to 20% by weight of a mineral premix, 10 to 80% by weight of a sugar preparation, and 0.1 to 10% by weight of a preparation of lecithins, wherein the mineral premix comprises between 400 and 800 mg of calcium, from 1 to 2.5 mg of copper, from 20 to 200 µg of iodine, from 8 to 15 mg of iron, from 130 to 250 mg of magnesium, from 1 to 2.5 mg of manganese, from 400 to 800 mg of phosphorus, from 700 to 1500 mg of potassium, from 15 to 50 µg of selenium and from 10 to 15 mg of zinc, wherein the sugar preparation comprises glucose, fructose, saccharose, lactose or mixtures thereof, in the form of granulated sugar, raw sugar, very fine sugar, pearl sugar, liquid sugar, invert liquid sugar, brown sugar, icing sugar, table syrup, and/or molasses, and wherein the preparation of lecithins is vegetable lecithins, preferably soy or sunflower lecithins.

[0020] A third aspect of the invention proposes a supplementary food preparation, in particular a ready-to-use supplementary food (RUSF) preparation or ready-to-use therapeutic food (RUTF) preparation, comprising, or being composed of, (1) a spirulina preparation obtained by the method according to the first aspect or a spirulina preparation according to the second aspect in an appropriate/sufficient quantity to obtain a proportion of 5 to 20% by weight, preferably of 7.5 to 17.5% by weight, of spirulina in the total supplementary food preparation and (2) two or more components selected from at least two of the groups formed by (a) cereals, in particular cereal flours; (b) leguminous plants and/or leguminous plant seeds, in particular soy beans, chickpeas, lentils, peas, cowpeas, mung beans, pigeon peas, haricot and/or lupin beans; and (c) flours and protein products based on oilseeds which are not part of groups (a) or (b).

[0021] This is because the inventors have found that the advantages of using spirulina for these supplementary food preparations are numerous and they will be explained

in greater detail in the following description. That said, one important advantage is that spirulina has an exceptionally complete composition of nutritional elements. Furthermore, and this is a particularly important advantage, it does not contain any antinutritional factors and therefore does not have to undergo any pre-processing to
5 remove them. An additional benefit is that it can advantageously partially or entirely replace the ingredients of animal origin, which makes it possible to achieve a significant reduction in the carbon footprint of the supplementary food preparations. Finally, and most importantly, spirulina can be produced using simple, low-cost processes.

10 [0022] Unfortunately, the inventors have had to acknowledge that, despite spirulina's substantial advantages, it has a disadvantage which can make its use less attractive, or even difficult, namely its taste and/or odour. This is because spirulina, even when obtained under controlled cultivation conditions, always has a certain "ocean" or "sea" taste and/or odour. This characteristic does, however, jeopardise the very purpose of
15 a supplementary food preparation, such as in particular a ready-to-use supplementary food (RUSF) preparation or a ready-to-use therapeutic food (RUTF) preparation. This is because, if consumers are repelled by the taste and/or odour, they may well not take the advised rations and therefore the supplementary food preparations would ultimately be incapable of achieving their objective.

20 [0023] The inventors have consequently attempted to find a way of making the taste and odour of spirulina as neutral as possible by pre-processing which would then enable it to be used without disadvantages in supplementary food preparations. The inventors' tests and studies have led to the method for manufacturing a spirulina preparation having an improved taste and odour, in particular having a reduced ocean
25 taste and odour or a reduced sea taste and odour according to the first aspect of the invention and spirulina preparations having an improved taste and odour, in particular having a reduced ocean taste and odour or a reduced sea taste and odour, which may be used in supplementary food preparations according to the third aspect of the invention.

30 [0024] In spirulina preparations, it is generally advantageous for calcium to be added in the form of calcium phosphate, tricalcium phosphate, calcium carbonate or mixtures thereof; copper to be added in the form of anhydrous copper sulfate, copper gluconate,

or mixtures thereof; iodine to be added in the form of potassium iodide, iron to be added in the form of dried ferrous sulfate monohydrate, ferrous sulfate, ferrous fumarate, or mixtures thereof; magnesium to be added in the form of magnesium sulfate monohydrate, magnesium gluconate citrate, or mixtures thereof; manganese
5 to be added in the form of manganese sulfate monohydrate, phosphorus to be added in the form of anhydrous dibasic calcium phosphate, tricalcium phosphate, or mixtures thereof; potassium to be added in the form of a mixture of 50% by weight of potassium chloride and 50% by weight of tripotassium citrate, selenium to be added in the form of sodium selenite, sodium selenate, or mixtures thereof, and/or zinc to be added in
10 the form of zinc sulfate.

[0025] The supplementary food preparations according to the invention generally comprise, other than the spirulina preparation, peanut paste; a mixture of vegetable oils; one or more components selected from soy flour, chickpea flour, black lentil flour and, skimmed milk powder, or combinations thereof; and/or a mixture of vitamins;
15 optionally agave syrup.

[0026] In particular, a supplementary food preparation according to the invention may therefore comprise, for example: 5 to 20% by weight of spirulina; 15 to 25% by weight, preferably 17.5 to 22.5% by weight, of peanut paste; 17.5 to 27.5% by weight, preferably 19 to 21% by weight, of a mixture of vegetable oils; 12.5 to 25% by weight,
20 preferably 14 to 21% by weight, of sugar; 7.5 to 25% by weight, preferably 8.5 to 21% by weight, of soy flour, chickpea flour, black lentil flour and/or skimmed milk powder; 3 to 6% by weight, preferably 3.25 to 5.75% by weight, of sunflower lecithin; and/or 2.5 to 5% by weight, preferably 2.75 to 4.75% by weight, of vitamins and minerals. Optionally, the supplementary food preparation may further comprise 5 to
25 15% by weight, preferably 17.5 to 22.5% by weight, preferably 18 to 22% by weight of agave syrup.

[0027] The supplementary food preparations according to the invention further comprise, as required, 0.01 to 5% by weight, preferably 0.1 to 3% by weight, of other ingredients serving in particular to improve the composition in terms of consistency,
30 presentation, colour, etc.

[0028] In certain advantageous embodiments, the supplementary food preparations according to the invention do not comprise any components of animal origin, i.e. comprise at most trace quantities, in particular less than 0.2% by weight, preferably less than 0.1% by weight, and advantageously less than 0.05% by weight thereof.

5 [0029] A fourth aspect of the present invention is a ready-to-use therapeutic food (RUTF) preparation as described for use in the prevention or treatment of malnutrition, in particular for treating moderate acute malnutrition (MAM) or severe acute malnutrition (SAM).

[0030] A fifth aspect of the invention proposes the use of a spirulina preparation
10 obtained by a method according to the first aspect or a preparation according to the second aspect for manufacturing a solid, semi-solid or liquid supplementary food preparation, in particular a ready-to-use supplementary food (RUSF) preparation or a ready-to-use therapeutic food (RUTF) preparation, preferably in an appropriate quantity of spirulina preparation to obtain an (effective) proportion of 5 to
15 20% by weight of (dry) spirulina in the total supplementary food preparation.

[0031] This use may be considered for considerably reducing the use of ingredients of animal origin in the supplementary food preparation, particularly preferably for reducing the proportion of ingredients of animal origin in the supplementary food preparation to less than 20% by weight, preferably to less than 10% by weight, in the
20 present case to less than 5% by weight, particularly preferably for entirely replacing the ingredients of animal origin, i.e. the ingredients of animal origin would only be present in quantities at most representing trace quantities, in particular less than 0.2% by weight, preferably less than 0.1% by weight, advantageously less than 0.05% by weight of the total preparation.

25 [0032] As a variant or in addition, such use may be considered for reducing the presence of antinutritional factors in the supplementary food preparation without any particular pre-processing.

[0033] As a variant or in addition, such a use may be considered for reducing the total carbon footprint of the food preparation.

TOTAL PROTEINS (g/100 g)	6.5	8.1	8.2	12.6	16.9	25.8	26.4
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[0038] Table 1 (continued)

	LENTILS	MILK (skimmed)	SOY BEAN	LUPIN	SPIRULINA	EGG WHITE
Histidine	1.14	1.36	1.65	1.30	0.94	1.13
Isoleucine	1.25	1.89	1.69	1.24	1.74	1.77
Leucine	1.14	1.48	1.37	1.10	1.30	1.28
Lysine	1.23	1.39	1.30	0.85	0.93	1.19
Sulfur-containing AA	0.65	1.27	1.22	0.90	1.17	2.23
Aromatic AA	1.42	1.86	1.93	1.39	1.79	1.87
Threonine	1.02	1.46	1.56	1.10	1.67	1.47
Tryptophan	1.15	1.66	1.91	0.97	1.90	1.45
Valine	1.16	1.56	1.29	0.89	1.42	1.48
TOTAL PROTEINS (g/100 g)	27.0	36.2	36.5	37.6	52	81.1

Data sources: USDA Food Composition Databases, FAO/INFOODS Global Database, Tanzania Food Composition Table, Feedipedia Nutritional Tables, Appenroth et al. 2018.

- 5 [0039] Amino acid score = mg of amino acid in 1 g of evaluated protein/mg of amino acid in 1 g of requirement pattern.

[0040] The amino acid score is calculated as above and stated either as a ratio per unit (recommended) or on a percentage scale (WHO 1991).

Interpretation of amino acid score	
0-0.49	Very inadequate
0.5-0.89	Inadequate
0.90->1	Adequate

- 10 [0041] These index values based on chemical scores are, by nature of the principle, highly dependent not only on protein composition but also on the human amino acid requirement profile, which was most recently updated in 2007.

[0042] The adult protein requirement (RDA = recommended dietary allowance) is 0.83 g/kg/d.

[0043] Table 2 shows the essential amino acid (AA) requirements in mg/g crude protein as a function of age and (or) developmental stage.

[0044] Table 2

Age	Essential amino acids								
	Aro-matic AA	Histi-dine	Iso-leucine	Leu-cine	Lysine	Sulfur-containing AA	Threo-nine	Trypto-phan	Valine
6 months	52	20	32	66	57	27	31	8.5	43
1-2 years	46	18	31	63	52	25	27	7	41
3-14 years	41	16	30	61	48	23	25	6.6	40
15-18 years	40	16	30	60	47	23	24	6.3	40
> 18 years	38	15	30	59	45	22	23	6	39

Human essential AA requirements (mg/g crude protein) as a function of age and/or developmental stage.

AA = amino acids

[0045] Recommended protein intake is higher in children and adolescents. The growth requirement must be met in addition to the maintenance requirement. In these cases, the protein RDA is 2.82 g/kg/d.

10 [0046] Two forms of malnutrition can be distinguished, severe acute malnutrition (SAM) and moderate acute malnutrition (MAM).

[0047] In the case of SAM in infants and children of 6 months to 5 years, the protein and amino acid requirements needed to ensure catch-up growth are stated in Table 3.

15 [0048] The supplementary food preparation must be capable of supplying 2.82 g/kg/day of protein (0.82 g/kg/day for maintenance and 2.00 g/kg/day for growth) with a concentration of essential AA (stated in mg/kg/day) capable of ensuring catch-up weight gain of 10 g/kg/day.

[0049] Table 3

Essential amino acids (mg/kg/day)								
Aro-matic AA	Histidine	Iso-leucine	Leucine	Lysine	Sulfur-containing AA	Threonine	Tryptophan	Valine
177	66	95	198	183	88	103	29	130

[0050] Supplementary food preparations which meet these criteria fall into the category of RUTF (ready-to-use therapeutic foods) which are designed and intended primarily for treating uncomplicated severe acute malnutrition. RUTF are used for emergency feeding of malnourished children or to supplement the diets of people with special nutritional requirements, such as the elderly.

[0051] Moderate acute malnutrition (MAM) is treated by adding a nutrient-rich supplementary food which supplies the recommended daily nutritional intake of all micronutrients in addition to the child's usual diet.

10 [0052] In the case of MAM in infants and children of 6 months to 5 years, the protein and amino acid requirements needed to ensure catch-up growth are stated in Table 4.

[0053] The supplementary food preparation must be capable of supplying approximately 2 g/kg/day of protein with a concentration of essential AA (stated in mg/kg/day) capable of ensuring catch-up weight gain of 5 g/kg/day.

15 [0054] Table 4

Essential amino acids (mg/kg/day)								
Aro-matic AA	Histidine	Iso-leucine	Leucine	Lysine	Sulfur-containing AA	Threonine	Tryptophan	Valine
104	39	60	123	110	53	61	17	81

[0055] AA requirements for catch-up weight gain of 5 g/kg/day were established using the values provided by the FAO of 10 g/kg/day for severe acute malnutrition (SAM). A factorial approach was used to calculate the requirements for catch-up weight gain of 5 g/kg/day to better reflect MAM treatment goals. (Food and Agriculture Organization of the United Nations, 2017; Food and Nutrition Board, 2005; WHO/FAO/UNU Joint Expert Consultation, 2007).

[0056] Supplementary food preparations which meet these criteria fall into the category of RUSF (ready-to-use supplementary foods), designed and intended primarily for treating moderate acute malnutrition. RUSF is a food supplement intended to be consumed for two to three months as part of a nutritional programme.

- 5 [0057] The technical specifications required for RUSF and RUTF are stated in Table 5:

[0058] Table 5

Nutrients and nutritional values per 100 g finished product	Unit	Minimum	Label	Maximum
Energy	kcal	510	XX ⁷	560
Added sugar	% Energy	-	-	20
Protein ⁸	g	11	XX	16
Dry skimmed milk protein ⁹	g	3.6	-	-
Fat ¹⁰	g	26	XX	36
ω -3 fatty acids ¹¹	g	0.30	-	1.80
ω -6 fatty acids	g	2.6	-	6.10
Retinol (Vit. A)	mcg	700	700	1600
Thiamine (Vit. B1)	mg	1.0	1.0	-
Riboflavin (Vit. B2)	mg	2.1	2.1	-
Niacin (Vit. B3)	mg	13	13	-
Pantothenic Acid (Vit. B5)	mg	4.0	4.0	-
Pyridoxine (Vit. B6)	mg	1.8	1.8	-
Biotin (Vit. B7)	mcg	60	60	-
Folates (Vit. B9)	mcg DFE	330	330	-
Cobalamin (Vit. B12)	mcg	2.7	2.7	-
Ascorbate (Vit. C)	mg	80 ¹²	80	220
Cholecalciferol (Vit. D)	mcg	15	15	20
Vitamin E	mg aTE	16	16	-
Phytomenadione (Vit. K)	mcg	27	27	-
Calcium (Ca)	mg	535	535	750
Copper (Cu)	mg	1.4	1.4	1.9
Iodine (I)	mcg	100	100	190
Iron (Fe)	mg	10	10	14
Magnesium (Mg)	mg	150	150	225
Manganese (Mn)	mg	1.2	1.2	2.4
Phosphorus (P)	mg	450	450	750
Potassium (K)	mg	800	800	1400
Selenium (Se)	mcg	20	20	45
Sodium (Na)	mg	-	-	270

Zinc (Zn)	mg	11	11	140
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[0059] According to the technical specifications, RUSF and RUTF formulations (Table 5) must provide:

[0060] a) an energy intake of between 510 and 560 kcal,

[0061] b) a protein intake of between 11 and 16 grams,

5 [0062] c) a fat intake of between 26 and 36 grams,

[0063] d) a minimum of 3.6% of skimmed milk powder, with no upper limit, in order to supplement the concentration of essential amino acids (AA), as a function of age and (or) developmental stage, according to Tables 1, 2, 3 and 4.

10 [0064] Current average compositions of supplementary food preparations intended to prevent or treat malnutrition:

[0065] Example A

Peanut paste (g/100 g)	10
Extruded soy flour (g/100 g)	4
Skimmed milk powder (g/100 g)	24
Whey permeate (g/100 g)	15
Sugar (g/100 g)	17
Vegetable oils (g/100 g)	26.5
Vitamin and mineral premix	3.5
Total (%):	100
Per 100 g of preparation	
Energy (kcal/100 g)	530
Fat (g/100 g)	33
Crude protein (g/100 g)	13.5
Milk protein (g/100 g)	9
Lactose (g/100 g)	26

[0066] Example B

Peanut paste (g/100 g)	19
Whey protein concentrate (g/100 g)	10
Whey permeate (g/100 g)	23.5
Sugar (g/100 g)	23
Vegetable oils (g/100 g)	21
Vitamin and mineral premix	3.5
Total (%):	100

Per 100 g of preparation	
Energy (kcal/100 g)	537
Fat (g/100 g)	33
Crude protein (g/100 g)	13.5
Milk protein (g/100 g)	7.5
Lactose (g/100 g)	22

[0067] In the present context, the following terms are defined as follows: peanut paste: made from roasted peanuts (Spanish and/or Virginia and/or runner and/or Valencia varieties) using a rotary mixer rotating at a speed of 3000 rpm for between 15 min and 30 min; mixture of vegetable oils: the mixture may be prepared from two or more oils, specifically rapeseed oil, olive oil, sunflower oil, palm oil, peanut oil, coconut oil, sesame oil, walnut oil, hazelnut oil, grapeseed oil; sugar: cane and/or beet sugar; agave syrup: produced from a number of agave species, including *Agave tequilana*, the syrup used must contain at least 70% fructose; vitamin and mineral premix: the vitamin/mineral premix is used to adjust the concentration of vitamins and minerals in 100 grams of supplementary food preparation in accordance with the technical specifications required for formulating RUSF and RUTF (Table 5). The average composition of the vitamin and mineral premix is stated in the following table:

Average composition of the vitamin and mineral premix				
			Per 100 grams of preparation	
Premix	Unit	Source	min	max
Vit. A	µg	Retinol palmitate or retinol acetate	700	1400
Vit. B1	mg	Thiamin mononitrate or thiamin hydrochloride	0.7	1.5
Vit. B2	mg	Riboflavin	1.3	2.6
Vit. B3	mg	Niacinamide	8	16
Vit. B5	mg	Calcium D-pantothenate	2.5	5
Vit. B6	mg	Pyridoxine hydrochloride	1	2.2
Vit. B7	µg	Biotin	30	65
Vit. B9	µg	Folic acid	250	500
Vit. B12	µg	Vitamin B12	1.5	3
Vit. C	mg	Ascorbic acid	90	130
Vit. D	µg	Vitamin D3	9	18
Vit. E	mg	Vit. E acetate (50% tocopherol DL-α-acetate)	10	20
Vit. K	µg	Vitamin K (5%)	13	27
Calcium	mg	Anhydrous dibasic calcium phosphate or tricalcium phosphate	200	415
Copper	mg	Anhydrous copper sulfate or copper gluconate	0.6	1.2

Average composition of the vitamin and mineral premix				
			Per 100 grams of preparation	
Premix	Unit	Source	min	max
Iodine	µg	Potassium iodide	50	110
Iron	mg	Ferrous sulfate or ferrous fumarate	0.5	5
Magnesium	mg	Magnesium sulfate monohydrate or magnesium citrate or gluconate	5	100
Manganese	mg	Manganese sulfate monohydrate	0.5	1
Phosphorus	mg	Anhydrous dibasic calcium phosphate or tricalcium phosphate	150	315
Potassium	mg	50% potassium chloride + 50% tripotassium citrate	150	350
Selenium	µg	Sodium selenite or sodium selenate	10	20
Zinc	mg	Zinc sulfate	5	11

[0068] Having identified the potential usefulness of spirulina, the next objective of the present invention was therefore to demonstrate that spirulina can indeed be used for formulating supplementary food preparations preferably intended to prevent or treat malnutrition and to considerably reduce, if not entirely replace, the use of ingredients of animal origin. Spirulina could thus ensure the intake of essential amino acids as well as other necessary micronutrients.

[0069] Spirulina is rich in essential amino acids in a sufficient quantity to enable optimum synthesis of body proteins.

[0070] Spirulina is rich in natural vitamins and minerals, particularly provitamin A (β -carotene), group B vitamins, iron and magnesium.

[0071] In general, the term "spirulina", as used in the present context, denotes a certain number of different cyanobacteria of the genus *Arthrospira*, in particular *Arthrospira platensis* (sometimes denoted *Spirulina platensis*), but also *Arthrospira maxima*, *Arthrospira pacifica*, etc. This term also denotes preparations based on these cyanobacteria, specifically as a food, but also as food supplements, for example in the dried and compressed form. In the context of the present invention, the term "spirulina" may equally well denote the cyanobacteria or preparations containing them depending on the context, it being understood that quantitative statements relating to spirulina relate to the effective dry weight of cyanobacteria of the genus *Arthrospira*.

[0072] As a general rule, spirulina is cultivated in ponds in the open air or accommodated in greenhouses.

[0073] Ponds are easily implemented cultivation systems. They are adapted to only a few species which can tolerate pond cultivation. They are generally rectangular with rounded corners. A partition divides them in the middle to incorporate a stirring system such as a paddle wheel. These systems require a large area of land, consume large volumes of water and are heavily dependent on the weather and seasons, in particular in terms of temperature and sunlight. Spirulina has poor access to light and productivity is therefore also low. When ponds are in the open air, contamination must also be controlled so that good quality algae can be supplied.

[0074] Spirulina may also be cultivated using photobioreactor technology.

[0075] Photobioreactors are closed cultivation systems which are optimised for cultivating all species of microalgae and protected from any external contamination. Cultivation parameters such as pH, temperature or light are monitored by a smart computer system. This production tool is less bulky and makes it easier to initiate and monitor cultivation and to harvest the crop. It also meets desired quantity and quality requirements.

[0076] In the present invention, the spirulina used in the spirulina preparation formulations used in the supplementary food preparations intended to prevent or treat malnutrition is preferably cultivated using photobioreactor technology and exhibits the nutritional characteristics stated in Table 6.

[0077] Table 6

Spirulina	
kcal (100 g)	329
	g/100 g
Proteins	52
Carbohydrates	23.2
Fibre	11.3
Fat	5.6

Vitamins	mg/kg
Vit. B1 (thiamine HCl)	1.89
Vit. B1 (thiamine base)	1.49
Vit. B2 (riboflavin)	2.2
Vit. PP (B3 or niacin)	18.7
Vit. B5	0.537
Calcium pantothenate	0.584
Vit. B6	3.26
Choline	34.9

Ash	11.96
Salt	6.9
Sodium	2.6
<i>Trace elements</i>	mg/kg
Copper	3.98
Calcium	641
Iron	487
Magnesium	1730
Manganese	24
Potassium	11000
Zinc	14.7
Iodine	<0.2
Phosphorus	8720
Selenium	<0.20
<i>Vitamins</i>	$\mu\text{g}/100\text{ g}$
Vit. A (retinol)	<21
K1	537
Beta carotene	46600
Vit. B12	7.24
Vit. H (biotin)	< 1
Vit. B9	105

	mg/100 g
Vit. E (alpha-tocopherol)	1.23
<i>Amino acids</i>	g/100 g
Tryptophan	1
Threonine	3.37
Aspartic acid	6.33
Serine	3.19
Lysine	3.19
Valine	3.93
Proline	2.38
Alanine	4.92
Phenylalanine	2.93
Isoleucine	3.63
Glycine	3.2
Tyrosine	2.88
Arginine	4.27
Leucine	5.72
Histidine	1.06
Glutamic acid	8.96
Methionine	1.45
Cystine	0.55

[0078] In the present invention, spirulina may be used in combination with ingredients of vegetable origin, namely cereals, leguminous plants and leguminous plant seeds, flours and protein products based on oilseeds, for supplementary food preparation formulations intended to prevent or treat malnutrition.

5 [0079] In order to make the taste and/or odour of the spirulina more neutral and therefore improve it, in particular to reduce its ocean (sea) taste and/or odour, the (dry) spirulina is firstly subjected to special processing, specifically to the following method, wherein it is important to observe the order of the steps. The explanations provided regarding the mode of action of the ingredients are inventors' hypotheses and, even
10 should they prove to be incomplete or inaccurate, in no way diminish the observed effect of taste and/or odour reduction:

- 1) mixing the spirulina with a mineral premix,
- spirulina has a negative ion charge,

- the minerals of the premix comprise calcium, magnesium, manganese, potassium, iron and zinc which have positive ion charges,
- the negatively charged spirulina thus attracts the positively charged minerals,
- the spirulina is thus completely encapsulated by the minerals,
- 5 - this therefore makes it possible to achieve a remarkable reduction in the "sea" taste and odour, i.e. the taste and odour of seaweed,
- at the end of this first step, the spirulina has a neutral, slightly salty taste,
- mixing is preferably carried out using a rotary mixer rotating at approximately 3000 revolutions/minute, for 15 to 25 minutes, generally for approximately 10 20 minutes,
- 2) second step of incorporating sugar,
- the spirulina encapsulated in this manner is then mixed with a sugar preparation in order to obtain a somewhat sweet taste, specifically to obtain a salty taste with hints of caramel,
- 15 - mixing is carried out, for example, in the same rotary mixer rotating at approximately 3000 revolutions/minute, for 10 to 20 minutes, generally for approximately 15 minutes,
- 3) third step of incorporating lecithin by mixing,
- mixing is preferably carried out in the same rotary mixer rotating at 20 approximately 2000 revolutions/minute, for 5 to 15 minutes, generally for approximately 10 minutes.

[0080] The resultant spirulina preparation with reduced taste and odour is then used for preparing solid, semi-solid or liquid supplementary foods, in particular ready-to-use supplementary food (RUSF) preparations or ready-to-use therapeutic food (RUTF) 25 preparations according to the third aspect of the invention.

[0081] Cereals

[0082] Any ground cereals suitable for human consumption may be used in association with spirulina for formulating preparations. Other than carbohydrates (essentially starch), cereals contain considerable amounts of protein (8-12 percent), 30 but have low contents of lysine and threonine, and high contents of sulfur-containing amino acids (methionine, cysteine). Adding spirulina can help rebalance the essential

amino acid composition of supplementary food preparations intended to prevent or treat malnutrition.

5 [0083] Cereals are pre-processed in order to reduce and, if possible, remove antinutrients such as phytates, tannins and other phenolic materials, lectins, trypsin and chymotrypsin inhibitors capable of reducing protein quality and digestibility, amino acid bioavailability and mineral absorption.

[0084] Leguminous plants and leguminous plant seeds

[0085] Leguminous plants and leguminous plant seeds may be used in association with spirulina for formulating preparations.

10 [0086] Leguminous plants and leguminous plant seeds, and in particular soy beans, chickpeas, lentils, peas, cowpeas, mung beans, pigeon peas, haricot and lupin beans contain at least 20 percent protein on a dry weight basis.

15 [0087] Leguminous plant seed proteins have relatively high contents of lysine and threonine, and a relatively low content of sulfur-containing amino acids (methionine, cysteine) and tryptophan.

[0088] Leguminous plants and leguminous plant seeds are pre-processed in order to reduce as far as possible the antinutritional factors which are normally present therein, such as phytates, lectins (haemagglutinins) and trypsin and chymotrypsin inhibitors. Defatted flours and protein isolates based on oilseeds may be good sources of protein
20 (50-95%).

[0089] Flours and protein products based on oilseeds

[0090] Flours, protein concentrates and protein isolates originating from oilseeds may be used in association with spirulina.

25 [0091] Flours and protein products based on oilseeds are pre-processed in order to bring about a sufficient reduction in antinutritional factors and undesirable toxic substances such as trypsin and chymotrypsin inhibitors and gossypol.

[0092] Using solely cereals, leguminous plants and leguminous plant seeds, flours and protein products based on oilseeds does not provide sufficient concentrations of

essential amino acids as required in the supplementary food preparations for preventing or treating malnutrition.

[0093] In the present invention, the spirulina in the spirulina preparation makes it possible to supply quality proteins and therefore essential amino acids in a sufficient
5 quantity in order to supplement the concentration of amino acids provided by the cereals, leguminous plants and leguminous plant seeds and flours and protein products based on oilseeds.

[0094] Spirulina does not contain antinutritional factors and therefore does not have to undergo any pre-processing in order to eliminate them.

10 [0095] In the present invention, the spirulina (preparation) is used in combination with ingredients of vegetable origin in the formulation of supplementary food preparations, preferably intended to prevent or treat malnutrition, ideally in order to entirely replace ingredients of animal origin.

[0096] Nevertheless, in the present invention, the spirulina (preparation) may also be
15 used in combination with ingredients of animal origin in the formulation of supplementary food preparations intended to prevent or treat malnutrition, in order to reduce concentrations of ingredients of animal origin to less than 20% of total weight, preferably to less than 10% by weight or even less.

[0097] In the present invention, the spirulina (preparation) is used for formulating
20 supplementary food preparations for preventing or treating malnutrition, in a percentage of between 5 and 20% of total weight.

[0098] The present invention will now be illustrated with the assistance of the following non-limiting examples.

[0099] In the present invention, the spirulina (preparation) may further be used in
25 combination with ingredients of vegetable origin, namely cereals, leguminous plants and leguminous plant seeds, flours and protein products based on oilseeds, for formulating other supplementary food preparations intended to supplement the normal diet of humans and animals.

EXAMPLES

[00100] EXAMPLE: PREPARATION OF SPIRULINA WITH IMPROVED TASTE/ODOUR

[00101] The following spirulina preparations T1 to T5 were prepared by mixing the spirulina with a mineral premix using a rotary mixer rotating at approximately 3000 revolutions/minute for 20 minutes. In a second step, sugar was incorporated into the previous mixture in a rotary mixer rotating at approximately 3000 revolutions/minute for approximately 20 minutes and, in a third step, lecithin was added by mixing in the same rotary mixer rotating at approximately 2000 revolutions/minute for 10 minutes.

INGREDIENTS	COMPOSITIONS				
	T1	T2	T3	T4	T5
SPIRULINA %	23	40	26	25	20
SUGAR %	56	43	56	54	63
MINERAL PREMIX %	14	11	11	13	11
LECITHINS %	7	7	7	8	6

[00102] Test carried out on a panel of 30 people aged between 18 and 65.

[00103] The results obtained are as follows:

CRITERIA	T1	T2	T3	T4	T5
Texture	Semi-solid	Semi-solid	Semi-solid	Powder	Powder
Particle size	100% smooth	100% smooth	100% smooth	95% grainy 5% slightly grainy	100% grainy
Taste	100% somewhat salty	70% somewhat salty 30% sweet-salty	100% sweet	95% somewhat salty 5% salty-sweet	100% sweet
Odour	100% odourless	100% odourless	100% odourless	100% odourless	100% odourless
Colour	100% greenish	100% greenish	100% greenish	100% greenish	100% greenish

Stickiness	100% non-sticky	95% non-sticky 5% sticky	100% non-sticky	70% non-sticky 30% slightly sticky	80% non-sticky 20% slightly sticky
Dissolution in the mouth	95% melting 5% slightly melting	90% melting 10% slightly melting	97% melting 3% slightly melting	100% slow dissolution	100% slow dissolution
Flavours	95% not identified 5% slightly caramel	15% not identified 85% vegetal	100% not identified	100% not identified	90% not identified Slightly vegetal
Overall assessment	100% good	100% moderately good	70% good 30% moderately good	100% good	100% good

[00104] Preparations T1, T4 and T5 have an overall assessment of 100% "Good". In these three preparations, the percentage of spirulina is between 20 and 25% by weight, the percentage of premix is between 11 and 13% by weight and the percentage of sugar is between 54 and 63% by weight. Preparation T3 has an overall assessment of 70% "Good". Preparation T4 has an overall assessment of 0% "Good" and 100% "Moderately good". In these two preparations, the percentage of spirulina is between 26 and 40% by weight, the percentage of premix is 11% by weight and the percentage of sugar is between 43 and 56% by weight.

[00105] On the basis of the results obtained with preparations T1, T4 and T5, the inventors were able to conclude that in order to obtain preparations with assessment scores of greater than 70% "Good", the percentage of spirulina should generally be no more than approximately 30% by weight, the percentage of sugar should generally be no less than 50% by weight and the quantity of mineral premix should generally be no less than 11% by weight.

15 [00106] EXAMPLE 1

[00107] Supplementary food preparations for preventing or treating moderate acute malnutrition (MAM).

[00108] Table 7A - Spirulina preparation manufactured in accordance with the method of the first aspect of the invention

SPIRULINA PREPARATION PER 1000 GRAMS	
Sugar	56%
Spirulina	23%
Sunflower lecithin	7%
Mineral premix	14%

[00109] Table 7B - Composition of the supplementary food preparation (the four rows highlighted in grey below indicate the spirulina preparation)

Composition per 1000 grams	
Sugar	20%
Spirulina	8%
Sunflower lecithin	2.5%
Mineral premix	5%
Peanut paste	22.2%
Vegetable oil mixture	22.3%
Soy flour	10%
Agave syrup	9%
Vitamin premix	1%
Total (%)	100
Per 100 g of preparation	
Energy (kcal)	511
Fat (g/100 g)	35.5
Crude protein (g/100 g)	14.7
Carbohydrates (g/100 g)	31

5 [00110] Table 8

Essential amino acids	Per 100 g of preparation mg/gram	mg/g of crude protein	mg/kg/day	<i>Reference values for MAM (Table 4)</i>
				<i>Essential AA requirement mg/kg/day for catch-up growth of 5 g/kg/day</i>
Histidine	350	23.7	47.4	39
Isoleucine	711	48.3	96.6	60
Leucine	1178	80.7	161.4	123
Lysine	837	57	114	110

Sulfur-containing AA	433	29.5	59	53
Aromatic AA	1392	94.7	189.4	104
Threonine	660	44.9	89.8	61
Tryptophan	201	13.7	27.4	17
Valine	778	52.9	105.8	81

[00111] In the present invention, the supplementary food preparation of Example 1 contains no ingredients of animal origin.

[00112] In the present invention, the supplementary food preparation of Example 1 is capable of supplying a concentration of essential AA (stated in mg/kg/day) which is required for catch-up weight gain of 5 g/kg/day (Table 8 and Table 9).

[00113] Table 9

Example 1 - Essential amino acid score			
	SOY BEAN	PEANUTS	SPIRULINA
Histidine	1.65	1.26	0.94
Isoleucine	1.69	1.10	1.74
Leucine	1.37	0.98	1.30
Lysine	1.30	0.63	0.92
Sulfur-containing AA	1.22	0.93	1.17
Aromatic AA	1.93	1.81	1.79
Threonine	1.56	1.10	1.67
Tryptophan	1.91	1.14	1.90
Valine	1.29	0.98	1.42

[00114] In the present invention, mixing of the spirulina preparation and the other ingredients can be performed either cold or hot.

10 [00115] When mixing is performed cold, the peanuts and soy flour will be pre-processed before mixing in order to reduce antinutritional factors as far as possible.

[00116] When mixing is performed hot, the cooking time and temperatures used must ensure that antinutritional factors are reduced as far as possible.

[00117] In the present invention, mixing of the spirulina preparation and the various other ingredients in the composition of Example 1 results in a homogeneous paste which can be packaged in ready-to-use 100 gram heat-sealed pouches.

[00118] The preparation of the present invention may also comprise other ingredients serving in particular to improve the composition in terms of consistency, presentation, colour, etc. These ingredients may be selected from those generally known in the field, depending on the desired type of preparation and the intended purpose.

[00119] EXAMPLE 2

10 [00120] Supplementary food preparations for preventing or treating moderate acute malnutrition (MAM).

[00121] Table 10A - Spirulina preparation manufactured in accordance with the method of the first aspect of the invention

SPIRULINA PREPARATION PER 1000 GRAMS	
Sugar	43%
Spirulina	40%
Sunflower lecithin	7%
Mineral premix	11%

15 [00122] Table 10B - Composition of the supplementary food preparation (the four rows highlighted in grey below indicate the spirulina preparation)

Composition per 1000 grams	
Sugar	16%
Spirulina	15%
Sunflower lecithin	2.5%
Mineral premix	4%
Peanut paste	20.5%
Vegetable oil mixture	22%
Chickpea flour	11%
Agave syrup	8%
Vitamin premix	1%
Total (%):	100
Per 100 g of preparation	
Energy (kcal/100 g)	510

Fat (g/100 g)	33.6
Crude protein (g/100 g)	16
Carbohydrates (g/100 g)	36

[00123] Table 11

Essential amino acids	Per 100 g of preparation mg/gram	mg/g of crude protein	mg/kg/day	Reference values for MAM (Table 4)
				Essential AA requirement mg/kg/day for catch-up growth of 5 g/kg/day
Histidine	341	21.4	42.8	39
Isoleucine	793	49.7	99.4	60
Leucine	1305	81.8	163.6	123
Lysine	950	59.5	119	110
Sulfur-containing AA	473	29.6	59.2	53
Aromatic AA	1474	92.3	184.6	104
Threonine	738	46.2	92.4	61
Tryptophan	214	13.4	26.8	17
Valine	868	54.4	108.8	81

[00124] In the present invention, the supplementary food preparation of Example 2 contains no ingredients of animal origin.

[00125] In the present invention, the supplementary food preparation of Example 2 is capable of supplying a concentration of essential AA (stated in mg/kg/day) which is required for catch-up weight gain of 5 g/kg/day (Table 12 and Table 13).

[00126] Table 12

Example 2 - Essential amino acid scores			
	CHICKPEAS	PEANUTS	SPIRULINA
Histidine	1.46	1.26	0.94
Isoleucine	1.30	1.10	1.74
Leucine	1.12	0.98	1.30
Lysine	1.17	0.63	0.92
Sulfur-containing AA	0.95	0.93	1.17
Aromatic AA	1.71	1.81	1.79

Threonine	1.19	1.10	1.67
Tryptophan	1.21	1.14	1.90
Valine	0.97	0.98	1.42

[00127] In the present invention, mixing of the spirulina preparation and the other ingredients of Example 2 can be performed either cold or hot.

[00128] When mixing is performed cold, the peanuts and chickpea flour will be pre-processed before mixing in order to reduce antinutritional factors as far as possible.

[00129] When mixing is performed hot, the cooking time and temperatures used must ensure that antinutritional factors are reduced as far as possible.

[00130] In the present invention, mixing of the spirulina preparation and the various other ingredients in the composition of Example 2 results in a homogeneous paste which can be packaged in ready-to-use 100 gram heat-sealed pouches.

[00131] The preparation of the present invention may also comprise other ingredients serving in particular to improve the composition in terms of consistency, presentation, colour, etc. These ingredients may be selected from those generally known in the field, depending on the desired type of preparation and the intended purpose.

[00132] EXAMPLE 3

[00133] Supplementary food preparations for preventing or treating severe acute malnutrition (SAM).

[00134] Table 13A - Spirulina preparation manufactured in accordance with the method of the first aspect of the invention

SPIRULINA PREPARATION PER 1000 GRAMS	
Sugar	56%
Spirulina	26%
Sunflower lecithin	7%
Mineral premix	11%

[00135] Table 13B - Composition of the supplementary food preparation (the four rows highlighted in grey below indicate the spirulina preparation)

Composition per 1000 grams	
Sugar	20%
Spirulina	9.5%
Sunflower lecithin	2.5%
Mineral premix	4%
Peanut paste	18%
Vegetable oil mixture	23%
Black lentil flour	22%
Mineral premix	1%
	100%
Per 100 g of preparation	
Energy (kcal)	510
Fat (g/100 g)	32
Crude protein (g/100 g)	15.7
Carbohydrates (g/100 g)	39

[00136] Table 14

Essential amino acids	Per 100 g of preparation mg/gram	mg/g of crude protein	mg/kg/day	Reference values for SAM (Table 3)
				Essential AA requirement mg/kg/day for catch-up growth of 10 g/kg/day
Histidine	387	24.65	69.5	66
Isoleucine	739	46.9	132.25	95
Leucine	1317	83.7	236	198
Lysine	1021	65	183	183
Sulfur-containing AA	495	31.5	89	88
Aromatic AA	1479	93.9	264.5	177
Threonine	739	46.9	132.25	103
Tryptophan	197	12.5	35.25	29
Valine	869	54.2	152.84	130

[00137] In the present invention, the supplementary food preparation of Example 3 contains no ingredients of animal origin.

[00138] In the present invention, the supplementary food preparation of Example 3 is capable of supplying a concentration of essential AA (stated in mg/kg/day) which is required for catch-up weight gain of 10 g/kg/day (Table 16 and Table 17).

5 [00139] Table 15

Example 3 - Essential amino acid scores			
	LENTILS	PEANUTS	SPIRULINA
Histidine	1.14	1.26	0.94
Isoleucine	1.25	1.10	1.74
Leucine	1.14	0.98	1.30
Lysine	1.23	0.63	0.92
Sulfur-containing AA	0.65	0.93	1.17
Aromatic AA	1.42	1.81	1.79
Threonine	1.02	1.10	1.67
Tryptophan	1.15	1.14	1.90
Valine	1.16	0.98	1.42

[00140] In the present invention, mixing of the spirulina preparation and the other ingredients of Example 3 can be performed either cold or hot.

[00141] When mixing is performed cold, the peanuts and lentil flour will be pre-processed before mixing in order to reduce antinutritional factors as far as possible.

10 [00142] When mixing is performed hot, the cooking time and temperatures used must ensure that antinutritional factors are reduced as far as possible.

[00143] In the present invention, mixing of the spirulina preparation and the various other ingredients in the composition of Example 3 results in a homogeneous paste which can be packaged in ready-to-use 100 gram heat-sealed pouches.

15 [00144] The preparation of the present invention may also comprise other ingredients serving in particular to improve the composition in terms of consistency, presentation, colour, etc. These ingredients may be selected from those generally known in the field, depending on the desired type of preparation and the intended purpose.

20 [00145] EXAMPLE 4

[00146] Supplementary food preparations for preventing or treating severe acute malnutrition (SAM).

[00147] Table 16A - Spirulina preparation manufactured in accordance with the method of the first aspect of the invention

SPIRULINA PREPARATION PER 1000 GRAMS	
Sugar	54%
Spirulina	25%
Sunflower lecithin	8%
Mineral premix	13%

5 [00148] Table 16B - Composition of the supplementary food preparation (the four rows highlighted in grey below indicate the spirulina preparation)

Composition per 1000 grams	
Sugar	17%
Spirulina	8%
Sunflower lecithin	2.5%
Mineral premix	4%
Peanut paste	20%
Vegetable oil mixture	22%
Agave syrup	9%
Skimmed milk powder	16.5%
Vitamin premix	1%
Total (%)	100%
Per 100 g of preparation	
Energy (kcal)	510
Fat (g/100 g)	35.5
Crude protein (g/100 g)	15.7
Carbohydrates (g/100 g)	28

[00149] Table 17

Essential amino acids	Per 100 g of preparation mg/gram	mg/g of crude protein	mg/kg/day	<i>Reference values for SAM (Table 3)</i>
				<i>Essential AA requirement mg/kg/day for catch-up growth of 10 g/kg/day</i>
Histidine	375	23.8	67.1	66
Isoleucine	830	52.7	148.6	95

Leucine	1373	87.2	245.9	198
Lysine	1045	66.6	187.8	183
Sulfur-containing AA	506	32.1	90.5	88
Aromatic AA	1509	95.8	270	177
Threonine	713	45.3	127.75	103
Tryptophan	214	13.6	38.35	29
Valine	928	58.9	166	130

[00150] In the present invention, the supplementary food preparation of Example 4 contains less than 20% (more specifically 16.5% of the total weight) of an ingredient of animal origin (skimmed milk powder).

[00151] In the present invention, the supplementary food preparation of Example 4 is capable of supplying a concentration of essential AA (stated in mg/kg/day) which is required for catch-up weight gain of 10 g/kg/day (Table 20 and Table 21).

[00152] Table 18

Example 4 - Essential amino acid scores			
	MILK POWDER (skimmed)	PEANUTS	SPIRULINA
Histidine	1.36	1.26	0.94
Isoleucine	1.89	1.10	1.74
Leucine	1.48	0.98	1.30
Lysine	1.39	0.63	0.92
Sulfur-containing AA	1.27	0.93	1.17
Aromatic AA	1.86	1.81	1.79
Threonine	1.46	1.10	1.67
Tryptophan	1.66	1.14	1.90
Valine	1.56	0.98	1.42

[00153] In the present invention, mixing of the spirulina preparation and the other ingredients of Example 4 can be performed either cold or hot.

[00154] When mixing is performed cold, the peanuts will be pre-processed before mixing in order to reduce antinutritional factors as far as possible.

[00155] When mixing is performed hot, the cooking time and temperatures used must ensure that antinutritional factors are reduced as far as possible.

[00156] In the present invention, mixing of the spirulina preparation and the various other ingredients in the composition of Example 4 results in a homogeneous
5 paste which can be packaged in ready-to-use 100 gram heat-sealed pouches.

[00157] The preparation of the present invention may also comprise other ingredients serving in particular to improve the composition in terms of consistency, presentation, colour, etc. (glycerine, xanthan gum, guar gum, gelatins, glucose syrup, emulsifiers, invertase, colourants, flavours, etc.). These ingredients may be selected
10 from those generally known in the field, depending on the desired type of preparation and the intended purpose.

[00158] EXAMPLE 5

[00159] Supplementary food preparations for preventing or treating moderate acute malnutrition (MAM).

15 [00160] Table 19A - Spirulina preparation manufactured in accordance with the method of the first aspect of the invention

SPIRULINA PREPARATION PER 1000 GRAMS	
Sugar	63%
Spirulina	20%
Sunflower lecithin	6%
Mineral premix	11%

[00161] Table 19B - Composition of the supplementary food preparation (the four rows highlighted in grey below indicate the spirulina preparation)

Composition per 1000 g	
Sugar	25%
Spirulina	8%
Sunflower lecithin	2.5%
Mineral premix	4.5%
Vegetable oil mixture	22%
Skimmed milk powder	16%
Peanut paste	13%

Wheat flour	8%
Vitamin premix	1%
Total (%)	100
Per 100 g of preparation	
Energy (kcal)	510
Fat (g/100 g)	31
Crude protein (g/100 g)	14.1
Carbohydrates (g/100 g)	46

Table 20

Essential amino acids	Per 100 g of preparation mg/gram	mg/g of crude protein	mg/kg/day	Reference values for MAM
				Essential AA requirement mg/kg/day for catch-up growth of 5 g/kg/day
Histidine	346	24.4	48.8	39
Isoleucine	784	55.4	110.8	60
Leucine	1297	91.6	183.2	123
Lysine	856	60.5	121	110
Sulfur-containing AA	465	32.8	65.6	53
Aromatic AA	1369	96.7	193.4	104
Threonine	747	52.8	105.6	61
Tryptophan	206	14.6	29.2	17
Valine	877	62	124	81

[00162] In the present invention, the supplementary food preparation of Example 4 contains less than 20% (more specifically 16% of the total weight) of an ingredient of animal origin (skimmed milk powder).

- 5 [00163] In the present invention, the supplementary food preparation of Example 2 is capable of supplying a concentration of essential AA (stated in mg/kg/day) which is required for catch-up weight gain of 5 g/kg/day (Table 19 and Table 20).

[00164] Table 21

1. Essential amino acid scores

	MILK (skimmed)	PEANUTS	SPIRULINA	WHEAT
Histidine	1.36	1.26	0.94	1.13
Isoleucine	1.89	1.10	1.74	1.14
Leucine	1.48	0.98	1.30	1.03
Lysine	1.39	0.63	0.92	0.47
Sulfur- containing AA	1.27	0.93	1.17	1.54
Aromatic AA	1.86	1.81	1.79	1.49
Threonine	1.46	1.10	1.67	0.93
Tryptophan	1.66	1.14	1.90	1.49
Valine	1.56	0.98	1.42	1.03

[00165] In the present invention, mixing of the spirulina preparation and the other ingredients of Example 5 can be performed either cold or hot.

[00166] When mixing is performed cold, the peanuts will be pre-processed before mixing in order to reduce antinutritional factors as far as possible.

5 [00167] When mixing is performed hot, the cooking time and temperatures used must ensure that antinutritional factors are reduced as far as possible.

[00168] In the present invention, mixing of the spirulina preparation and the various other ingredients in the composition of Example 5 results in a homogeneous paste which can be packaged in ready-to-use 100 gram heat-sealed pouches.

10 [00169] The preparation of the present invention may also comprise other ingredients serving in particular to improve the composition in terms of consistency, taste, presentation, colour, etc. These ingredients may be selected from those generally known in the field, depending on the desired type of preparation and the intended purpose.

Vegetable oil mixture	22%
Skimmed milk powder	16%
Peanut paste	13%
Wheat flour	8%
Vitamin premix	1%
Total (%)	100
Per 100 g of preparation	
Energy (kcal)	510
Fat (g/100 g)	31
Crude protein (g/100 g)	14.1
Carbohydrates (g/100 g)	46

Table 20

Essential amino acids	Per 100 g of preparation mg/gram	mg/g of crude protein	mg/kg/day	Reference values for MAM
				Essential AA requirement mg/kg/day for catch-up growth of 5 g/kg/day
Histidine	346	24.4	48.8	39
Isoleucine	784	55.4	110.8	60
Leucine	1297	91.6	183.2	123
Lysine	856	60.5	121	110
Sulfur-containing AA	465	32.8	65.6	53
Aromatic AA	1369	96.7	193.4	104
Threonine	747	52.8	105.6	61
Tryptophan	206	14.6	29.2	17
Valine	877	62	124	81

[00162] In the present invention, the supplementary food preparation of Example 4 contains less than 20% (more specifically 16% of the total weight) of an ingredient of animal origin (skimmed milk powder).

- 5 [00163] In the present invention, the supplementary food preparation of Example 2 is capable of supplying a concentration of essential AA (stated in mg/kg/day) which is required for catch-up weight gain of 5 g/kg/day (Table 19 and Table 20).

[00164] Table 21

1. Essential amino acid scores				
	MILK (skimmed)	PEANUTS	SPIRULINA	WHEAT
Histidine	1.36	1.26	0.94	1.13
Isoleucine	1.89	1.10	1.74	1.14
Leucine	1.48	0.98	1.30	1.03
Lysine	1.39	0.63	0.92	0.47
Sulfur- containing AA	1.27	0.93	1.17	1.54
Aromatic AA	1.86	1.81	1.79	1.49
Threonine	1.46	1.10	1.67	0.93
Tryptophan	1.66	1.14	1.90	1.49
Valine	1.56	0.98	1.42	1.03

[00165] In the present invention, mixing of the spirulina preparation and the other ingredients of Example 5 can be performed either cold or hot.

[00166] When mixing is performed cold, the peanuts will be pre-processed
5 before mixing in order to reduce antinutritional factors as far as possible.

[00167] When mixing is performed hot, the cooking time and temperatures used must ensure that antinutritional factors are reduced as far as possible.

[00168] In the present invention, mixing of the spirulina preparation and the various other ingredients in the composition of Example 5 results in a
10 homogeneous paste which can be packaged in ready-to-use 100 gram heat-sealed pouches.

[00169] The preparation of the present invention may also comprise other ingredients serving in particular to improve the composition in terms of consistency, taste, presentation, colour, etc. These ingredients may be selected
15 from those generally known in the field, depending on the desired type of preparation and the intended purpose.

Claims

1. Method for manufacturing a spirulina preparation having an improved taste and odour, including a reduced ocean taste and odour or a reduced sea taste and odour, the method comprising:
 - 5 a) a first preparation step during which 10 to 70% by weight, based on the spirulina preparation, of dry spirulina is mixed with 0.1 to 20% by weight, based on the spirulina preparation, of a mineral premix using a rotary mixer rotating at 2500 to 3500 revolutions/minute, for 15 to 25 minutes,
 - 10 b) a second incorporation step during which 10 to 80% by weight, based on the spirulina preparation, of a sugar preparation is incorporated into the mixture from the first step and during which the mixture is subjected to the action of the rotary mixer rotating at 2500 to 3500 revolutions/minute, for 10 to 20 minutes, and
 - 15 c) a third step during which 0.1 to 10% by weight, based on the spirulina preparation, of a preparation of lecithins is incorporated into the mixture from the second step and during which the resultant mixture is subjected to the action of the rotary mixer rotating at 1500 to 2500 revolutions/minute, for 5 to 15 minutes,
- 20 wherein the mineral premix comprises between 400 and 800 mg of calcium, from 1 to 2.5 mg of copper, from 20 to 200 μ g of iodine, from 8 to 15 mg of iron, from 130 to 250 mg of magnesium, from 1 to 2.5 mg of manganese, from 400 to 800 mg of phosphorus, from 700 to 1500 mg of potassium, from 15 to 50 μ g of selenium and from 10 to 15 mg of zinc,
- 25 wherein the sugar preparation comprises glucose, fructose, saccharose, lactose or mixtures thereof, in the form of granulated sugar, raw sugar, very fine sugar, pearl sugar, liquid sugar, invert liquid sugar, brown sugar, icing sugar, table syrup, and/or molasses, and wherein the preparation of lecithins is vegetable lecithins.
- 30 2. Method for manufacturing a spirulina preparation according to claim 1, wherein the calcium is added in the form of calcium phosphate, tricalcium

- phosphate, calcium carbonate or mixtures thereof; copper is added in the form of anhydrous copper sulfate, copper gluconate, or mixtures thereof; iodine is added in the form of potassium iodide, iron is added in the form of dried ferrous sulfate monohydrate, ferrous sulfate, ferrous fumarate, or mixtures thereof; magnesium is added in the form of magnesium sulfate monohydrate, magnesium gluconate citrate, or mixtures thereof; manganese is added in the form of manganese sulfate monohydrate, phosphorus is added in the form of anhydrous dibasic calcium phosphate, tricalcium phosphate, or mixtures thereof; potassium is added in the form of a mixture of 50% by weight of potassium chloride and 50% by weight of tripotassium citrate, selenium is added in the form of sodium selenite, sodium selenate, or mixtures thereof; and zinc is added in the form of zinc sulfate.
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3. Method for manufacturing a spirulina preparation according to either claim 1 or claim 2, wherein, in the first preparation step, the dry spirulina is mixed with the mineral premix using a rotary mixer rotating at 3000 revolutions/minute for 20 minutes.
 4. Method for manufacturing a spirulina preparation according to any one of claims 1 to 3, wherein, in the second incorporation step, the sugar preparation is incorporated into the mixture from the first step while the mixture is subjected to the action of the rotary mixer rotating at 3000 revolutions/minute for approximately 15 minutes.
 5. Method for manufacturing a spirulina preparation according to any one of claims 1 to 4, wherein, in the third incorporation step, the preparation of lecithins is incorporated into the mixture from the second step while the resultant mixture is subjected to the action of the rotary mixer rotating at approximately 2000 revolutions/minute, for approximately 10 minutes.

6. Method for manufacturing a spirulina preparation according to any one of claims 1 to 5, wherein the vegetable lecithins include soy or sunflower lecithins.
- 5 7. Spirulina preparation having an improved taste and odour, including a reduced ocean taste and odour or a reduced sea taste and odour, comprising
10 10 to 70% by weight of dry spirulina mixed with 0.1 to 20% by weight of a mineral premix, 10 to 80% by weight of a sugar preparation, and 0.1 to 10% by weight of a preparation of lecithins,
wherein the mineral premix comprises between 400 and 800 mg of calcium, from 1 to 2.5 mg of copper, from 20 to 200 µg of iodine, from 8 to 15 mg of iron, from 130 to 250 mg of magnesium, from 1 to 2.5 mg of manganese, from 400 to 800 mg of phosphorus, from 700 to 1500 mg of potassium, from 15 to 50 µg of selenium and from 10 to 15 mg of zinc,
15 wherein the sugar preparation comprises glucose, fructose, saccharose, lactose or mixtures thereof, in the form of granulated sugar, raw sugar, very fine sugar, pearl sugar, liquid sugar, invert liquid sugar, brown sugar, icing sugar, table syrup, and/or molasses, and wherein the preparation of lecithins is vegetable lecithins.
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8. Spirulina preparation according to claim 7, wherein the calcium is in the form of calcium phosphate, tricalcium phosphate, calcium carbonate or mixtures thereof; the copper is in the form of anhydrous copper sulfate, copper gluconate, or mixtures thereof; the iodine is in the form of potassium iodide, the iron is in the form of dried ferrous sulfate monohydrate, ferrous sulfate, ferrous fumarate, or mixtures thereof; the magnesium is in the form of magnesium sulfate monohydrate, magnesium gluconate citrate, or mixtures thereof; the manganese is in the form of manganese sulfate monohydrate, the phosphorus is in the form of anhydrous dibasic calcium phosphate, tricalcium phosphate, or mixtures thereof; the potassium is in the form of a mixture of 50% by weight of potassium chloride and 50% by weight of tripotassium citrate, the
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selenium is in the form of sodium selenite, sodium selenate, or mixtures thereof; and the zinc is in the form of zinc sulfate.

9. Spirulina preparation according to either claim 7 or claim 8, wherein the spirulina preparation is obtained in accordance with the method according to any one of claims 1 to 6.
10. Spirulina preparation according to any one of claims 7 to 9, wherein the vegetable lecithins include soy or sunflower lecithins.
11. Solid, semi-solid or liquid supplementary food preparation, including a ready-to-use supplementary food (RUSF) preparation or ready-to-use therapeutic food (RUTF) preparation, comprising
- two or more components selected from at least two of the groups formed by (a) cereals, including cereal flours; (b) leguminous plants and/or leguminous plant seeds, including soy beans, chickpeas, lentils, peas, cowpeas, mung beans, pigeon peas, haricots and/or lupin beans; and (c) flours and protein products based on oilseeds which are not part of groups (a) or (b);
 - in combination with a spirulina preparation obtained by the method according to one of claims 1 to 6 or a spirulina preparation according to one of claims 7 to 10, in an appropriate quantity to obtain a proportion of 5 to 20% by weight of spirulina in the total supplementary food preparation.
12. Solid, semi-solid or liquid supplementary food preparation according to claim 11, comprising, other than the spirulina preparation, peanut paste; a mixture of vegetable oils; one or more components selected from soy flour, chickpea flour, black lentil flour and skimmed milk powder, or combinations thereof; and/or a mixture of vitamins.
13. Solid, semi-solid or liquid supplementary food preparation according to claim 12, comprising agave syrup.

14. Solid, semi-solid or liquid supplementary food preparation according to claim 11, comprising, other than the spirulina preparation, 15 to 25% by weight of peanut paste; 17.5 to 27.5% by weight of a mixture of vegetable oils; 7.5 to 25% by weight of soy flour, chickpea flour, black lentil flour and/or skimmed milk powder; and/or 2.5 to 5% by weight of a mixture of vitamins.
15. Solid, semi-solid or liquid supplementary food preparation according to claim 14, comprising 5 to 15% by weight of agave syrup.
16. Solid, semi-solid or liquid supplementary food preparation according to any one of claims 11 to 15, further comprising 0.01 to 5% by weight of other ingredients serving to improve the composition in terms of consistency, presentation and/or colour.
17. Solid, semi-solid or liquid supplementary food preparation according to any one of claims 11 to 16, comprising no components of animal origin.
18. Solid, semi-solid or liquid supplementary food preparation according to any one of claims 11 to 17 for use in the prevention or treatment of malnutrition, including moderate acute malnutrition (MAM) or severe acute malnutrition (SAM).
19. Use of a spirulina preparation obtained by the method according to one of claims 1 to 6 or of a spirulina preparation according to one of claims 7 to 10 for manufacturing a solid, semi-solid or liquid supplementary food preparation, including a ready-to-use supplementary food (RUSF) preparation or a ready-to-use therapeutic food (RUTF) preparation, in an appropriate quantity of spirulina preparation to obtain a proportion of 5 to 20% by weight of spirulina in the total supplementary food preparation.
20. Use of a spirulina preparation according to claim 19 for reducing or entirely replacing the use of ingredients of animal origin in the supplementary food preparation, including reducing the proportion of ingredients of animal origin in the supplementary food preparation to less than 20% by weight.

21. Use of a spirulina preparation according to either one of claims 19 or 20 for reducing the presence of antinutritional factors in the supplementary food preparation without pre-processing.
 22. Use of a spirulina preparation according to any one of claims 19 to 21 for reducing the total carbon footprint of the food preparation.
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Abstract

The invention relates to a method for manufacturing a spirulina preparation having an improved taste and odour, in particular having a reduced ocean taste and odour or a reduced sea taste and odour, and also to such a spirulina preparation. The invention

5 also relates to a solid, semi-solid or liquid supplementary food preparation, in particular a ready-to-use supplementary food (RUSF) preparation or ready-to-use therapeutic food (RUTF) preparation, comprising such a spirulina preparation, together with other components selected from at least two of the groups formed by (a) cereals, in particular cereal flours; (b) leguminous plants and/or leguminous plant seeds, in

10 particular soy beans, chickpeas, lentils, peas, cowpeas, mung beans, pigeon peas, haricot and/or lupin beans; and (c) flours and protein products based on oilseeds which are not part of groups (a) or (b). Other aspects relate to these supplementary food preparations for use in the prevention or treatment of malnutrition, in particular moderate acute malnutrition (MAM) or severe acute malnutrition (SAM), and to the

15 use of spirulina for the manufacture of such supplementary food preparations.