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(54) **Method to convert insects or worms into nutrient streams and compositions obtained thereby.**

(57) The present invention provides a method to convert insects or worms into nutrient streams, such as a fat-containing, an aqueous protein containing and a solid-containing fraction. The method comprises the steps of: (a) squashing insects or worms thereby obtaining a pulp, (b) heating the pulp to a temperature of 70-100°C, and (c) subjecting the heated pulp to a physical separation step, preferably decanting and/or centrifuging, with the proviso that the method does not comprise enzymatic treatment of the pulp, The fat-containing fraction comprises at least 80 wt.% insect or worm fat of which at least 40 wt.% are saturated fats. The aqueous protein fraction can be dried to obtain dried protein material, which contains at least 40 wt.% insect or warm protein-derived matter and at most 25.wt% insect or worm fat based on dry weight, and the protein has a pepsin digestibility of at least 50%. The resulting nutrient streams can be used in food, petfood, feed and pharmaceutical industry.

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Title: Method to convert insects or worms into nutrient streams and compositions obtained thereby

The invention relates to the field of obtaining nutrients, feed and foodstuffs from insects or worms. In particular, the invention presents a method to convert insects or worms into nutrient streams, encompassing a fat-containing fraction, an aqueous protein fraction and/or a solid-containing fraction.

In the past decades, there has been a growing interest to use insects and worms as a food source, especially in view of the growth of global population and malnutrition in the developing world. Since insects and worms are rich in proteins and sometimes fats, they represent a relatively high caloric value. Although in some populations it is common to consume insects and worms, *e.g.* in Africa, Asia, Australia, these are usually eaten as such, be it as a whole or in parts, or used in the preparation of dishes.

However, it is desirable to be able to process insects and worms on an industrial scale to produce nutrients, which subsequently may be used in the preparation of food or feed products.

From several publications, it is known to obtain some particular nutrients from insects, such as proteins or fats.

JP2009254348 A concerns obtaining proteins from bee larvae. Dried larvae are suspended in water, whereto a lypolytic enzyme is added to decompose the lipids. After that, a proteolytic enzyme is added to hydrolyse proteins and the resulting mixture is filtered and the protein is collected. RU 2345139 C2 describes the recovery of chitin from cultivated larvae. WO 2008/091137 concerns an ethanol extract from house fly larvae, which is obtained by drying the larvae, dissolving these in an organic solvent to remove fats and mixing the residue with ethanol to obtain the extract. WO 2011/006276 describes obtaining fatty acids from insect larvae, wherein the fatty acids are extracted using organic solvent.

It is however not known to fully utilise insects or worms and to convert these into several nutrient streams, such as proteins, fats and chitin, from which streams the nutrients can optimally and easily be recovered.

An object of the present invention is therefore to provide a method that converts insects or worms into nutrient streams, and preferably into two or three nutrient streams, being a fat-containing stream and a protein containing stream, which can further be separated into an aqueous protein stream and a solids-containing stream, such as chitin.

Another object of the invention is to provide a processing method for insects or worms that results in nutrients that are not contaminated with toxic substances and are safe to be used in preparation of various food or feed products and pharmaceuticals.

Yet another object of the invention is to provide a method that is simple, does not require costly equipment or reagents and can easily be scaled up in a large production facility.

Accordingly, the invention provides, in a first aspect, a method to convert insects or worms into nutrient streams, comprising the steps of:

(a) obtaining a pulp from insects or worms,

(b) heating the pulp to a temperature of 70-100°C, and

(c) subjecting the heated pulp to a physical separation step thereby obtaining a fat fraction, an aqueous protein fraction and a solid-containing fraction,

with the proviso that the method does not comprise enzymatic treatment of the pulp.

In another aspect, the present invention provides a fat-containing composition comprising at least 80 wt.% insect or worm fat based on dry weight, wherein at least 40 wt.% of total fat are saturated fats, the fat comprising at least 7 wt.% lauric acid C12:0, 5-30 wt.% palmitic acid C16:0, and 8-40 wt.% oleic acid C18:1 based on the total fat weight.

In yet another aspect, the invention provides a composition comprising at least 40 wt.% protein and at most 25 wt.% fat based on dry weight, wherein the protein and the fat are derived from insects or worms and the protein has a pepsin digestibility of at least 50%, as measured by the pepsin-HCl method.

In a further aspect, the invention provides the use of the compositions in food, petfood, feed or pharmaceutical products.

The method according to the invention converts insects or worms into nutrient streams. The term "insects" refers to insects in any development stage, such as adult insects, insect larvae and insect pupae. Preferably, insect larvae or worms are used. A large variety of insects and worms can be used. Preferably, edible insects or edible worms are used. More preferably, the insects are flies, bugs, mosquitos, butterflies, moths, cicadas, termites, bees, ants, wasps, beetles, grasshoppers, or crickets. More preferably, the insects belong to the species: black soldier fly (Hermetia illucens), house fly (Musca domestica), morio worm (Zophobas Morio), mealworm (Tenebrio Molitor) or cricket (Gryllida). In a preferred embodiment, the insects belong to the species black soldier fly. The insects and worms are preferably cultivated, *e.g.* in an insect farm. The cultivation allows to control and reduces the risks associated with diseases of insects and with the toxicity of insect-derived foodstuffs, *e.g.* due to the presence insecticides, in contrast to insects harvested in the nature. The conversion of the insects or worms into nutrient streams can suitably be carried out in a reactor vessel.

In step (a) a pulp from insects or worms is obtained. Preferably, the insects or worms are squashed to obtain a pulp. More preferably, the insects or worms are reduced in size. This results in a homogeneous starting material of viscous consistency. The squashing and reducing in size can conveniently be done in a micro-cutter mill, although other suitable techniques can also be used. During this step, the particle size of the insect or worm remains in the pulp is preferably less than 1 mm (the largest size to be determined using a

microscope), more preferably less than 0.5 mm. The particle size can be controlled by selection of a specific knife and plate combination and rotating speed; for example one can use a single or double knife in combination with a sieve mesh of at least 4 mm, preferably around 6 mm. The rotating speed could vary between 1000 and 3000 rpm. A skilled person can find suitable conditions in order to reach a desired particle size. A small particle size is advantageous as it facilitates fat extraction, however a too small particle size could create an emulsion making it more difficult to separate the fat in the next steps. The reduction in size can also be carried out as a separate step, preceding the heating step.

In the following step, step (b), the pulp is heated to a temperature in the range from 60 to 100°C, preferably in the range 80-95°C. The heating assures that the majority of fats is liquefied in order to prepare a suitable mixture for the following separation step. Preferably, the heating is affected under mixing conditions to promote separation of different phases. A skilled person will be able to determine suitable heating time. Preferably, the pulp is heated during 0.1-4 hours. Typically, the pulp is heated gradually in 1-4 hours, preferably 1-3 hours towards 90°C.

In step (c), the heated pulp is subjected to a physical separation step to obtain nutrient streams. In the physical separation step different phases (oil, water, solid) are separated. Preferably, the nutrient streams are a fat-containing fraction, an aqueous protein fraction and a solid-containing fraction. The physical separation preferably encompasses decanting, centrifuging, or a combination of the two methods.

In a preferred embodiment, first, a fat fraction is separated by decanting, and the remaining mixture is further separated into an aqueous protein fraction and a solid-containing fraction by decanting or centrifugation. However, the fat, protein and solid-containing fractions can also be obtained in a different order, or simultaneously, *e.g.* by using a 3-phase decanter. In

another preferred embodiment, the physical separation into three phases is carried out by using a 3-phase decanter.

In a further preferred embodiment, a fat fraction is separated first, e.g. by decanting, and the remaining mixture is not further separated but subjected to drying. The remaining mixture therefore combines both the solid fraction and the aqueous protein fraction. In this embodiment, the non-fat phases are preferably further dried to produce dried material. The dried material is protein-rich and contains both the protein-rich material from the aqueous protein fraction and solids from the solid-containing fraction.

Drying can be effected by different methods, such as air drying, drum drying, disc drying, flash drying or spray drying. The aqueous protein fraction is preferably dried by spray drying. The solid-containing fraction is preferably dried by drum drying, although flash drying or other methods are also possible. If spray drying is used for drying the combined protein and solids material, it may be necessary to reduce the solid particles present in the mixture first to a required size. This can suitably be done by a micro-cutter mill using a relatively small sieve mesh, for example 1 mm. When using a micro-cutter, to obtain a suitable mixture of the aqueous protein fraction and solid fraction for further drying, both fractions could be dosed together into the micro-cutter; other mixing methods are also possible. The drying of the two (mixed) fractions together is preferably performed by spray drying.

The method according to the invention does not comprise enzymatic treatment of the pulp. In this way, the presented method does not require costly materials such as enzymes and is simple and economic in practice.

As a result of the phase separation in the last step, preferably a fat fraction, an aqueous protein fraction and a solid-containing fraction are obtained. In this way, the method results directly in several nutrient streams. Under nutrients streams in the present description streams are understood that contain nutrients, such as fats, protein and protein-derived material,

carbohydrates, minerals and/or chitin. For the purposes of the present description, chitin is also considered a nutrient.

The fat-containing fraction predominantly contains insect or worm fat. Under "predominantly containing", e.g. fat, it is understood that based on the dry weight, the stream contains more fat (on a weight basis) than any other component, or in other words, that fat constitutes the major part of all ingredients based on dry weight. Generally, "predominantly containing" means a content of at least 40 wt.% dry matter, more preferably at least 50 wt.% dry matter. The aqueous protein fraction predominantly contains protein.

The fat-containing fraction obtainable by the method according to the invention, preferably comprises at least 80 wt.%, more preferably at least 85 wt.%, yet more preferably 90-100 wt.% of insect or worm fat based on the dry weight of the fat fraction. The insect or worm fat in the fat fraction comprises at least 40 wt.% and preferably 50-80 wt.% saturated fats, based on the total weight of the fat. The amount of unsaturated fats is 60 wt.% or less, preferably less than 50 wt.% and more preferably 20-40 wt.%, based on the total weight of the fat. The amount of mono unsaturated fatty acids (cis) is preferably from 10 to 45 wt.%, more preferably from 15 to 30 wt.%, while the amount poly unsaturated fatty acids is preferably from 1 to 20 wt.%, more preferably from 5 to 15 wt.%.

In a preferred embodiment, the insect or worm fat contains at least 7 wt.%, preferably 8-60 wt.%, more preferably 15-55 wt.%, yet more preferably 30-50 wt.% of lauric acid C12:0. The insect or worm fat preferably contains 5-30 wt.%, more preferably 10-20 wt.% of palmitic acid C16:0. Further, the insect or worm fat may further comprise omega-9 fatty acids, preferably in an amount 5-45 wt.%, more preferably 10-30 wt.%. Under omega-9 fatty acids, the sum of the following acids is understood: oleic acid C18:1, eicosenoic acid C20:1, mead acid C20:3, erucic acid C22:1, nervonic acid C24:1. In particular, the insect or worm fat preferably contains 8-40 wt.% oleic acid C18:1, more preferably, 10-35 wt.%, yet more preferably 13-20 wt.%. Omega-6 fatty acids

are preferably present in an amount 2-20 wt.%, more preferably 5-10 wt.%. Under omega-6 fatty acids, the sum of the following acids is understood: linoleic acid C18:2, gamma-linolenic acid C18:3, eicosadienoic acid C20:2, dihomo-gamma-linolenic acid C20:3, arachidonic acid C20:4, docosadioenoic acid C22:2, adrenic acid C22:4, docosapentaenoic acid C22:5, tetracosatetraenoic acid C24:4, tetracosapentaenoic acid C24:5. For example, linoleic acid C18:2 is preferably present in an amount 5-15 wt.%. The amount of trans fatty acids is lower than 0.5 wt.%, preferably lower than 0.2 wt.%. Under trans fatty acids unsaturated fatty acids are meant with at least one carbon-carbon double bond with a trans configuration, e.g. elaidic acid C18:1. The amounts of fatty acids are based on the weight of the insect or worm fat, which is the fat component of the fat-containing fraction. The fatty acid composition is determined by a standard method NEN-EN-ISO 5508+5509, BF3.

Another fraction obtained in the separation step is an aqueous protein fraction. Apart from protein, this fraction may comprise other proteinaceous matter such as peptides, amino acids and/or other protein-derived compounds. The aqueous protein fraction can further be dried to obtain dried protein material. This dried material can itself be used as a food or feed ingredient, or it can further be processed, *e.g.* to isolate amino acids. The aqueous fraction is preferably dried by spray drying.

The dried protein material contains at least 40 wt.%, preferably at least 45 wt.%, more preferably 50-85 wt.% of insect or worm protein. Under "insect or worm protein" and "insect or worm fat" respectively protein and fat derived from insects or worms are meant. The amount of fat present in the protein material may vary and depends in particular on the degree of phase separation of the heated pulp by decanting or other physical methods. The degree of fat separation from the heated pulp depends, amongst others, on the cutting-size of the insects, the heating temperature and time of the pulp and the (three-phase) decanter settings. An experienced operator can find the right

combinations of settings to maximize the fat separation without harming the proteins and other nutrients. It is preferred to limit the fat content of the protein material to at most 25 wt.%, preferably at most 20, yet more preferably at most 10 wt.% of insect or worm fat, based on dry weight. In particular, higher temperatures and longer times during step (b) may be applied to improve the separation of fats from the aqueous phase and, consequently, to increase the protein content in the final dried protein material. The dried protein material is preferably in the form of powder and may further comprise residual moisture, minerals and/or carbohydrates. Preferably, the powder contains less than 8 wt.% moisture, more preferably less than 5 wt.%, most preferably less than 2 wt.%. Preferably, the protein does not comprise hydrolysed protein matter. The protein is preferably in a substantially intact form, that is, at least 90% and more preferably at least 95% of the protein is intact, that is, not in the form of peptides or amino acids, which is determined by mass spectrometry.

The insect or worm protein in the composition above has preferably a pepsin digestibility of at least 50% as determined by a standard "pepsin-HCl" laboratory test such as following the guideline in the Third Commission Directive 72/199/EEC of 27 April 1972.

In a preferred embodiment, the dried protein material contains at least 50 wt.% insect or worm protein, which protein has a protein digestibility of at least 70%, preferably 80-95%. Preferably, the protein material contains one or more amino acids selected from asparagine, lysine, isoleucine, methionine and tryptophan. In a preferred embodiment, the protein material is characterized by an amino acid profile, containing 2-7 wt.% lysine, preferably 2.5-4 wt.%, based on the total dry weight of the protein material.

In a particularly preferred embodiment, the protein material contains lysine and further isoleucine 0.4-0.8, threonine 0.5-0.8, tryptophan 0.1-0.3 and valine 0.5-1.2, as a weight ratio relative to the lysine content. Yet more preferably, the protein material has the following amino acid profile:

alanine 1-1.2, asparagine 0.7-0.9, aspartic acid 1.4-1.7, cysteine 0.08-0.15, glutamic acid 1.5-3.5, glycine 0.8-1.1, histidine 0.4-0.7, isoleucine 0.4-0.8, leucine 0.6-1.3, methionine 0.05-0.4, phenylalanine 0.4-1.5, proline 1-1.2, serine 0.5-0.8, threonine 0.5-0.8, tryptophan 0.1-0.3, tyrosine 0.5-1.2, valine 0.5-1.2, the values being the weight ratio relative to lysine. This amino acid profile is particularly suitable for various food and feed applications as a protein or amino acids source. The amino acid profile is determined according to the method NEN-EN-ISO 13903.

In another preferred embodiment, the dried protein material further contains minerals such as calcium and/or phosphorus. Preferably, the calcium content of the protein material is at least 4,500, more preferably 60,000-30,000 mg/kg, based on dry weight of the protein material. The phosphorus content of the protein material is preferably at least 5000 mg/kg, based on dry weight. The calcium and phosphorus content is determined by the OCP-OES method.

The dried protein material may contain limited amounts of fats; preferably, the composition of this fat fraction is the same as described above for the fat-containing stream separated from the pulp. In particular, the fat fraction of the protein material preferably comprises at least 40 wt.% and preferably 50-80 wt.% saturated fats, based on the total weight of the fat. The amount of unsaturated fats is 60 wt.% or less, preferably less than 50 wt.% and more preferably 20-40 wt.%, based on the total weight of the fat. The amount of mono unsaturated fatty acids (cis) is preferably from 10 to 45 wt.%, more preferably from 15 to 30 wt.%, while the amount poly unsaturated fatty acids is preferably from 1 to 20 wt.%, more preferably from 5 to 15 wt.%. In a preferred embodiment, the insect or worm fat contains at least 7 wt.%, preferably 8-60 wt.%, more preferably 15-55 wt.%, yet more preferably 30-50 wt.% of lauric acid C12:0. The insect or worm fat preferably contains 5-30 wt.%, more preferably 10-20 wt.% of palmitic acid C16:0. Further, the insect or worm fat may further comprise omega-9 fatty acids, preferably in an amount

5-45 wt.%, more preferably 10-30 wt.%. Omega-6 fatty acids are preferably present in an amount 2-20 wt.%, more preferably 5-10 wt.%. The amount of trans fatty acids is lower than 0.5 wt.%, preferably lower than 0.2 wt.%. If desired, the fat fraction of the protein material can be isolated for further use.

The remaining solid-containing fraction obtained in the separation step (d), which step encompasses for example decanting or centrifugation, represents a wet pulp, or a suspension. This wet pulp can easily be distinguished and separated from the aqueous protein fraction. The wet pulp contains solids such as chitin and chitin-derivatives. Preferably, the solid-containing fraction contains 2-50 wt.%, preferably 5-40 wt.% chitin, based on dry weight. The wet pulp may further comprise protein and/or fat-containing matter. The protein matter preferably has the composition as described herein-above for the aqueous protein fraction, and the protein has a pepsin digestibility of the protein-derived matter in the range 50-95%, preferably 70-90% as can be determined by a standard "pepsin-HCl" laboratory test; and particularly by following the guideline in the Third Commission Directive 72/199/EEC of 27 April 1972. The fat-containing matter preferably has the composition as described above for the fat-containing fraction obtained after physical separation of the pulp.

The solid-containing fraction can further be dried to obtain solid material. Preferably, air drying is used. The solid-containing fraction can also be further processed to isolate chitin. Chitin is a polysaccharide that can be used in various applications. In food industry, chitin can be used as an additive to thicken and stabilise foods and pharmaceuticals. It can also be used in animal feed as a nutrient source.

The advantage of the method of the invention is that by simple physical separation the bulk of insect of worm mass is separated into valuable nutrient streams, of which the fat fraction and the dried protein material may be of particular value. These streams are not contaminated with chemicals and are ready for use in further application without purification. The isolated

nutrient streams can further be used in the preparation of food or feed, or of food or feed additives, or in pharmaceutical industry. Preferably, the compositions are used in an animal feed product. For example, the protein material and the fat fraction can, respectively, be used in animal feed as a crude protein and a crude fat source. The obtained streams can also be processed further, *e.g.* to isolate specific ingredients such as hydrolysed protein, amino acids, or specific fatty acids.

The invention is now illustrated in the following, non-limiting examples.

Example 1

1000 kg fresh larvae of black soldier fly are squashed and cut in a micro-cutter mill to obtain insect pulp with an average particle size less than 0.5 mm. The pulp is introduced in a reaction vessel and is heated to 90°C during 1 hour and then brought into a decanter. From the decanter a fat fraction and a combined protein fraction are obtained. The combined protein fraction contains "larvae water" with mostly insect protein and a solid residue.

The composition of the fat fraction after disc centrifugation is given in Table 1. The fatty acids composition of the crude fat is given in Table 2, wherein the percentage is based on the weight of the crude fat. The fatty acids composition was determined by NEN-EN-ISO 5508+5509, BF3 method. The fatty acids are referred to as Cn:m, wherein n is the amount of carbon atoms, and n is the amount of unsaturated carbon-carbon bonds.

Table 1

Component	Content (wt.%)
Moisture (after disc centrifuge)	n/a

Crude protein (Dumas, N x 6.25)	<0.5
Crude fat (petroleum-ether extraction)	99.1
Crude fiber (long method)	<0.3
Crude ashes (550°C)	0.2

Table 2

Fatty acid	Content (wt.%)
C10:0	1.3
C12:0	43.1
C14:0	7.3
C14:1	0.3
C15:0	0.2
C16:0	14.6
C16:1	2.9
C17:0	<0.1
C18:0	2.0
C18:1	17.0
C18:1 cis	0.3
C18:2	8.3
C18:3n3	1.1
C20:5	0.3
trans fatty acids	<0.1
saturated fatty acids	68.7
mono unsaturated fatty acids	20.4
poly unsaturated fatty acids	9.8
unsaturated fatty acids	30.2
omega-3 fatty acids	1.5
omega-6 fatty acids	8.3
omega-9 fatty acids	17.0

omega-3/omega-6	0.2

The combined protein fraction is further separated by decanting, into larvae water and a solid-containing fraction. The larvae water is spray-dried to obtain protein material with the composition as shown in Table 3. The fat composition of the crude fat fraction of the protein material is given in Table 4, wherein the percentages refer to percentages by weight based on the total weight of the crude fat fraction. The amino acid composition of the crude protein is given in Table 5, wherein the percentages refer to percentages by weight based on the total weight of the dried protein material. The amino acid profile is determined according to the method NEN-EN-ISO 13903.

Table 3

Component	Content (wt.%)
Moisture (dry matter at 103°C)	7.7
Crude protein (Dumas, N x 6.25)	58
Crude fat (after pre-extraction and hydrolysis)	4.6
Crude ashes (550°C)	13.2
Crude fiber (long method)	<0.3
Phosphorus, mg/kg	6000
Calcium, mg/kg	7300

Table 4

Fatty acid	Content (wt.%)
C8:0	<0.1
C10:0	1.3
C12:0	40.9
C14:0	7
C14:1	0.2

C15:0	0.2
C16:0	15.0
C16:1	2.8
C17:0	0.1
C18:0	2.4
C18:1	17.7
C18:1 cis	0.3
C18:2	8.3
C18:3n3	1.0
C20:0	0.2
C20:3n3	0.1
C20:5	0.3
C22:0	0.2
trans fatty acids	<0.1
saturated fatty acids	67.4
mono unsaturated fatty acids	21.0
poly unsaturated fatty acids	9.7
unsaturated fatty acids	30.8
omega-3 fatty acids	1.5
omega-6 fatty acids	8.3
omega-9 fatty acids	17.8
omega-3/omega-6	0.2

Table 5

Amino acid	Content (wt.%)	Content relative to lysine (wt/wt)
Alanine	3.29	1.12
Asparagine	2.32	0.79
Aspartic acid	4.32	1.47

Cysteine	0.30	0.10
Glutamic acid	10.05	3.43
Glycine	2.58	0.88
Histidine	1.97	0.67
Isoleucine	1.42	0.48
Leucine	1.84	0.63
Lysine	2.93	1.00
Methionine	0.17	0.06
Phenylalanine	1.29	0.44
Proline	3.21	1.10
Serine	1.80	0.61
Threonine	1.77	0.60
Tryptophan	0.61	0.21
Tyrosine	1.86	0.63
Valine	1.96	0.67

The composition of the air-dried solid fraction (using drum drying) is given in Table 6. The fat composition of the crude fat fraction is given in Table 7, wherein the percentages refer to percentages by weight based on the total weight of the crude fat fraction. The amino acid composition of the crude protein is given in Table 8, wherein the percentages refer to percentages by weight based on the total weight of the dried solid fraction. Chitin and chitin-derivatives are comprised in the crude fiber and partly in crude fiber in Table 6.

Table 6

Component	Content (wt.%)
Moisture (dry matter, 103°C)	1.3
Crude protein (Dumas, N x 6.25)	53.5

Crude fat (after pre-extraction and hydrolysis)	22.8
Crude ashes (550°C)	12.2
Crude fiber (long method)	13.6
Energy value, kJ/100 g	1762
Phosphorus, mg/kg (ICP-OES)	12300
Calcium, mg/kg (ICP-OES)	38000

Table 7

Fatty acid	Content (wt.%)
C8:0	<0.1
C10:0	1.0
C12:0	36.4
C14:0	6.4
C14:1	0.2
C15:0	0.2
C16:0	16.9
C16:1	2.9
C17:0	0.1
C18:0	3.0
C18:1	19.4
C18:1 cis	0.4
C18:2	9.0
C18:3n3	1.0
C20:0	0.2
C20:1	<0.1
C20:3n3	0.2
C20:5	0.3
C22:0	0.2
trans fatty acids	<0.1

saturated fatty acids	64.4
mono unsaturated fatty acids	23.1
poly unsaturated fatty acids	10.5
unsaturated fatty acids	33.6
omega-3 fatty acids	1.5
omega-6 fatty acids	9.0
omega-9 fatty acids	19.5
omega-3/omega-6	0.2

Table 8

Amino acid	Content (wt.%)	Content relative to lysine (wt/wt)
Alanine	3.53	1.12
Asparagine	2.50	0.80
Aspartic acid	4.74	1.51
Cysteine	0.42	0.13
Glutamic acid	4.99	1.59
Glycine	3.19	1.02
Histidine	1.44	0.46
Isoleucine	2.05	0.65
Leucine	3.58	1.14
Lysine	3.14	1.00
Methionine	0.99	0.32
Phenylalanine	1.99	0.63
Proline	3.22	1.03
Serine	2.31	0.74
Threonine	2.09	0.67
Tryptophan	0.76	0.24
Tyrosine	3.21	1.02

Valine	3.21	1.02

Example 2

Example 1 was repeated except that the larvae water and solid containing fraction were combined, further reduced in size and then spray-dried to obtain a combined protein meal with the composition as shown in Table 9.

The fat composition of the crude fat fraction of the protein material is given in Table 10, wherein the percentages refer to percentages by weight based on the total weight of the crude fat fraction. The amino acid composition of the crude protein is given in Table 11, wherein the percentages refer to percentages by weight based on the total weight of the dried protein material. The amino acid profile is determined according to the method NEN-EN-ISO 13903.

Table 9

Component	Content (wt.%)
Moisture (dry matter, 103°C)	4.0
Crude protein (Dumas, N x 6.25)	54.7
Crude fat (after pre-extraction and hydrolysis)	10.2
Crude ashes (550°C)	12.9
Crude fiber (long method)	10.9
Energy value, kJ/100 g	1350

Table 10

Fatty acid	Content (wt.%)

C10:0	1.2
C12:0	42.5
C14:0	7.5
C14:1	0.3
C15:0	0.2
C16:0	15.6
C16:1	2.8
C17:0	<0.1
C18:0	2.3
C18:1	17.5
C18:1 cis	0.2
C18:2	7.8
C18:3n3	1.0
C20:5	0.3
trans fatty acids	<0.1
saturated fatty acids	69.3
mono unsaturated fatty acids	20.8
poly unsaturated fatty acids	9.1
unsaturated fatty acids	29.9
omega-3 fatty acids	1.3
omega-6 fatty acids	7.8
omega-9 fatty acids	17.5
omega-3/omega-6	0.2

Table 11

Amino acid	Content (wt.%)	Content relative to lysine (wt/wt)
Alanine	3.40	1.10
Asparagine	2.72	0.88

Aspartic acid	5.02	1.62
Cysteine	0.42	0.12
Glutamic acid	6.39	2.07
Glycine	2.94	0.95
Histidine	1.65	0.53
Isoleucine	2.42	0.78
Leucine	3.84	1.24
Lysine	3.09	1.00
Methionine	0.94	0.30
Phenylalanine	4.55	1.47
Proline	3.36	1.09
Serine	2.26	0.73
Threonine	2.20	0.71
Tryptophan	0.78	0.25
Tyrosine	3.52	1.14
Valine	3.40	1.10

Gewijzigde conclusies

1. Werkwijze om insecten of wormen in voedingsstromen om te zetten, omvattende de stappen van:

(a) verkrijgen van een pulp van insecten of wormen en reduceren van de deeltjesgrootte van insect- of wormresten in de pulp tot kleiner dan 1 mm,

(b) verwarmen van de pulp tot een temperatuur van 70-100°C, en

(c) onderwerpen van de verwarmde pulp aan een fysische scheidingsstap waarbij een vetfractie, een waterige eiwitfractie en een vaste stof omvattende fractie worden verkregen,

waarbij de werkwijze geen enzymatische behandeling van de pulp omvat.

2. De werkwijze volgens conclusie 1, waarbij de insecten volwassen insecten, larven of poppen zijn.

3. De werkwijze volgens conclusie 1 of 2, waarbij de insecten tot de soort huisvlieg, zwarte soldaat vlieg, morio worm, meelworm of krekel behoren, en bij voorkeur tot zwarte soldaat vlieg.

4. De werkwijze volgens één van de voorgaande conclusies, waarbij het verwarmen in stap (b) gedurende 0.1 tot en met 4 uur wordt bewerkstelligd.

5. De werkwijze volgens één van de voorgaande conclusies, waarbij de fysische scheiding decanteren en/of centrifugeren omvat.

6. De werkwijze volgens één van de voorgaande conclusies, waarbij de waterige eiwitfractie en de vaste stof omvattende fractie samen na stap (c) worden gedroogd, bij voorkeur door middel van sproeidrogen.

7. De werkwijze volgens een der conclusies 1-4, waarbij de waterige eiwitfractie en de vaste stof omvattende fractie apart na stap (c) worden gedroogd.

8. De werkwijze volgens conclusie 7, waarbij de waterige eiwitfractie wordt gesproeidroogd.

9. De werkwijze volgens conclusie 7, waarbij de vaste stof omvattende fractie in de lucht wordt gedroogd.

10. De werkwijze volgens één van de voorgaande conclusies, waarbij de deeltjesgrootte van insect- of wormresten in de pulp wordt gereduceerd tot kleiner dan 0,5 mm voor stap (b).

11. Een vet omvattende samenstelling omvattende ten minste 80 gew.% insecten- of wormenvet gebaseerd op droog gewicht, waarbij ten minste 40 gew.% van het totale vet verzadigde vetten zijn, waarbij het vet ten minste 7 gew.% laurierzuur C12:0, 5-30 gew.% palmitinezuur C16:0, en 8-40 gew.% oliezuur C18:1 gebaseerd op het totale vetgewicht, omvat.

12. De samenstelling volgens conclusie 11, omvattende ten minste 85 gew.% insecten- of wormenvet gebaseerd op droog gewicht.

13. De samenstelling volgens conclusie 11 of 12, waarbij het insecten- of wormenvet 45-80 gew.% verzadigde vetten omvat.

14. De samenstelling volgens één van conclusies 11 tot en met 13, waarbij het vet 8-60 gew.% laurierzuur C12:0 omvat.

15. De samenstelling volgens één van conclusies 11 tot en met 14, waarbij het vet 5-15 gew.% linolzuur C18:2 omvat.

16. Een samenstelling omvattende ten minste 50 gew.% eiwit en ten hoogste 25 gew.% vet gebaseerd op droog gewicht, waarbij het eiwit en het vet zijn afgeleid van insecten of wormen, en het eiwit een pepsineverteerbaarheid van ten minste 50% heeft, gemeten met de pepsine-HCl methode.

17. De samenstelling volgens conclusie 16, omvattende 50-85 gew.% eiwit gebaseerd op droog gewicht.

18. De samenstelling volgens een der conclusies 16 of 17, omvattende ten hoogste 10 wt.% vet gebaseerd op droog gewicht.

19. De samenstelling volgens een der conclusies 16-18, omvattende ten minste 50 gew.% eiwit, waarbij het eiwit een pepsineverteerbaarheid van ten minste 70% heeft, gemeten met de pepsine-HCl methode.

20. De samenstelling volgens één van conclusies 16-19, voorts omvattende ten minste 4.500 mg/kg Ca gebaseerd op droog gewicht.

21. De samenstelling volgens één van conclusies 16-20, waarbij de samenstelling 2-7 gew.% lysine omvat.

22. De samenstelling volgens conclusie 21, waarbij de samenstelling voorts isoleucine 0.4-0.8, threonine 0.5-0.8, tryptofaan 0.1-0.3 en valine 0.5-1.2, als een gewichtsverhouding tot het lysinegehalte, omvat.

23. Toepassing van de samenstelling volgens een der conclusies 11-22 in voedingsmiddelen, huisdierenvoer, voer of farmaceutische producten.

24. De toepassing volgens conclusie 23, waarbij de samenstelling wordt gebruikt in een dierenvoerproduct.

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	P100045NL00
Nederlands aanvraag nr. **2010268**	Indieningsdatum **07-02-2013**
	Ingeroepen voorrangsdatum

Aanvrager (Naam)

Protix Biosystems B.V.

Datum van het verzoek voor een onderzoek van internationaal type	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr.
06-07-2013	**SN 60344**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

A23L1/48 **A23J3/00** **A23L1/29**
C11B1/12 **A23K1/00**

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**C11B** **A23J** **A23L** **A23K**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	☐ **GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	☐ **GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2010268

A. CLASSIFICATIE VAN HET ONDERWERP
INV. A23L1/48 A23J3/00 A23L1/29 C11B1/12 A23K1/00
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
C11B A23J A23L A23K

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, BIOSIS, COMPENDEX, FSTA, IBM-TDB, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	DATABASE WPI week 201337 Thomson Scientific, London, GB; AN 2013-G66578 XP002715376, & CN 102 827 689 A (ZHEJIANG GOVERNOR TRIANGLE CYCLE ECONOMI) 19 december 2012 (2012-12-19) * samenvatting * ----- -/--	1-24

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
28 oktober 2013	
Naam en adres van de instantie	**De bevoegde ambtenaar**
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Granet, Nicolas

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ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2010268

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	S. KROECKEL ET AL: "When a turbot catches a fly: Evaluation of a pre-pupae meal of the Black Soldier Fly (Hermetia illucens) as fish meal substitute - Growth performance and chitin degradation in juvenile turbot (Psetta maxima)", AQUACULTURE, deel 364-365, oktober 2012 (2012-10), bladzijden 345-352, XP055085217, ISSN: 0044-8486, DOI: 10.1016/j.aquaculture.2012.08.041 * alinea [02.1] - alinea [02.2]; tabellen 1-3 *	1-24
X	Larry Newton ET AL: "USING THE BLACK SOLDIER FLY, Hermetia illucens, AS A VALUE-ADDED TOOL FOR THE MANAGEMENT OF SWINE MANURE", , 6 juni 2005 (2005-06-06), XP055085218, Gevonden op het Internet: URL:http://www.urbantilth.org/wp-content/uploads/2008/09/soldierfly-swine-manure-management.pdf [gevonden op 2013-10-21] * bladzijde 16, alinea 1 - alinea 2; figuur 2; tabel 1 *	1-24
A	WO 2010/104908 A1 (LIVEFUELS INC [US]; WU BENJAMIN CHIAU-PIN [US]; STEPHEN DAVID [US]; MO) 16 september 2010 (2010-09-16) * alinea [0090] *	1-24
A	DATABASE WPI week 201115 Thomson Scientific, London, GB; AN 2010-Q15355 XP002715377, & CN 101 880 590 A (UNIV SUN YET-SEN) 10 november 2010 (2010-11-10) * samenvatting *	1-24
A	DATABASE WPI week 201118 Thomson Scientific, London, GB; AN 2010-Q15354 XP002715378, & CN 101 880 591 A (UNIV SUN YET-SEN) 10 november 2010 (2010-11-10) * samenvatting *	1-24

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2

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2010268

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
A	DATABASE WPI week 201118 Thomson Scientific, London, GB; AN 2010-Q15352 XP002715379, & CN 101 880 593 A (UNIV SUN YET-SEN) 10 november 2010 (2010-11-10) * samenvatting * -----	1-24
A	CN 101 117 612 A (XI AN LIGHT INDUSTRY INST [CN] XI AN LIGHT INDUSTRY INST) 6 februari 2008 (2008-02-06) * het gehele document * -----	1-24

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2010268

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
CN 102827689	A 19-12-2012	GEEN	
WO 2010104908	A1 16-09-2010	US 2012058542 A1	08-03-2012
		WO 2010104908 A1	16-09-2010
CN 101880590	A 10-11-2010	GEEN	
CN 101880591	A 10-11-2010	GEEN	
CN 101880593	A 10-11-2010	GEEN	
CN 101117612	A 06-02-2008	GEEN	

OCTROOICENTRUM NEDERLAND

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN60344	07.02.2013		NL2010268

International Patent Classification (IPC)
INV. A23L1/48 A23J3/00 A23L1/29 C11B1/12 A23K1/00

Applicant
Protix Biosystems B.V.

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

	Examiner
	Granet, Nicolas

Application number

WRITTEN OPINION

NL2010268

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	6-10
	No:	Claims	1-5, 11-24
Inventive step	Yes:	Claims	
	No:	Claims	1-24
Industrial applicability	Yes:	Claims	1-24
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1 DATABASE WPI
week 201337
Thomson Scientific, London, GB;
AN 2013-G66578
& CN 102 827 689 A (ZHEJIANG GOVERNOR TRIANGLE CYCLE ECONOMI) 19 december 2012 (2012-12-19)

D2 S. KROECKEL ET AL: "When a turbot catches a fly: Evaluation of a pre-pupae meal of the Black Soldier Fly (Hermetia illucens) as fish meal substitute - Growth performance and chitin degradation in juvenile turbot (Psetta maxima)",
AQUACULTURE,
deel 364-365, 1 oktober 2012 (2012-10-01), bladzijden 345-352, XP055085217,
ISSN: 0044-8486, DOI: 10.1016/j.aquaculture.2012.08.041

D3 Larry Newton ET AL: "USING THE BLACK SOLDIER FLY, Hermetia illucens, AS A VALUE-ADDED TOOL FOR THE MANAGEMENT OF SWINE MANURE",
, 6 juni 2005 (2005-06-06), XP055085218,
Gevonden op het Internet:
URL:http://www.urbantilth.org/wp-content/uploads/2008/09/soldierfly-swine-manure-management.pdf

D4 WO 2010/104908 A1 (LIVEFUELS INC [US]; WU BENJAMIN CHIAU-PIN [US]; STEPHEN DAVID [US]; MO) 16 september 2010 (2010-09-16)

D5 DATABASE WPI
week 201115
Thomson Scientific, London, GB;
AN 2010-Q15355
& CN 101 880 590 A (UNIV SUN YET-SEN) 10 november 2010 (2010-11-10)

D6 DATABASE WPI
week 201118
Thomson Scientific, London, GB;
AN 2010-Q15354
& CN 101 880 591 A (UNIV SUN YET-SEN) 10 november 2010 (2010-11-10)

D7 DATABASE WPI
week 201118
Thomson Scientific, London, GB;
AN 2010-Q15352
& CN 101 880 593 A (UNIV SUN YET-SEN) 10 november 2010 (2010-11-10)

D8 CN 101 117 612 A (XI AN LIGHT INDUSTRY INST [CN] XI AN LIGHT INDUSTRY INST) 6 februari 2008 (2008-02-06)

1 Novelty

The present application does not meet the criteria of patentability, because the subject-matter of claims 1-5 and 11-24 is not novel.

1.1 D1 discloses (see abstract; see automatic translation) a process to convert black soldier larvae into nutrient streams comprising the steps of:

a) obtaining a pulp form insects (maggots are squeezed)

b) heating the pulp for 5 to 10 min at 100-120°C

c) subjecting the heating pulp to a physical separation (pressing and centrifugating) thereby obtaining a fat fraction, an aqueous protein fraction and a solid containing fraction. D1 further discloses that the solid fraction is processed into a powder said method not comprising enzymatic treatment.

Moreover, since similar processes lead to similar products, D1 implicitly discloses compositions as disclosed in claims 11-22. Moreover, the thus obtained oil is used in D1 as a possible pharmaceutical product (see page 1, par.3, of the automatic translation annexed to this communication).

D1 therefore removes novelty from the subject-matter of claims 1-5 and 11-23.

1.2 D2 discloses (see par.2.1-2.2; tables 1-3) a defatted dried hermetia meal, said meal comprising 47.6 wt% proteins, 11.8 wt% fat, 6.5 mg/kg calcium, 3.38 wt% lysine (71.2 g/kg of proteins, said hermetia meal comprising 47.6 wt% of proteins), isoleucine 0.73, threonine 0.65, valine 1.01 as a weight ratio relative to lysine. Moreover, even though tryptophan has not been measured, it is highly believed that its amount is within the range disclosed in claim 22, as black soldier meals implicitly comprise tryptophan within the range disclosed in claim 22 (see for instance D3, table 1).

D2 does not specifically discloses the digestibility of the proteins. However, unless the applicant manages to show that the diet disclosed in D2 has a protein digestibility that does not fall within the range of claims 16-22, it will be considered that D2 implicitly discloses a protein digestibility of 50% as measured by the pepsin method.

The method of D2 consists in separating the oil from the protein fraction. Therefore, D2 implicitly discloses an oil fraction which is believed to contain at least 80 wt% of worm fat. Moreover, the lipid fraction from the hermetia meal has been analyzed, therefore, the oil fraction has been implicitly separated to a purity close to 100%. Said oil fraction comprises 71.6 wt % of saturated fatty acids, 47% lauric acid C12:0, 15% palmitic acid C16:0, 14% oleic acid C18:1n-9, and 9.4% linoleic acid C18:2n-6.

D2 further discloses the use of the hermetia meal as a feedstuff for fishes.

D2 therefore removes novelty from the subject-matter of claims 11-24.

2 Inventive step

The present application does not meet the criteria of patentability, because the subject-matter of claims 6-10 does not involve an inventive step.

2.1 Claims 6-9 relating to the drying steps

The drying of the protein fraction either alone or together with the solid fraction is one of the alternatives a person skilled in the art would consider depending on the properties of the final product he wishes to obtain.

Similarly the choice of drying methods either by air or spray-dried are obvious alternatives for a person skilled in the art.

2.2 Claim 10 relating to the particle size

The size of particles do not seem to provide for any unexpected to the product thus obtained. Therefore, depending of the final properties and the final use of the product he wishes to obtain, a person skilled in the art would consider of grinding the obtained products to mean size of less than 1 mm.

3 Other documents

3.1 D3 discloses (see p.16; fig.2) a process wherein oil should be separated from high protein meal using an expeller process, i.e a hot pressing process in order to obtain more valuable products.

D3 is therefore relevant for assessing inventive activity of claims 1-24.

3.2 D4 discloses (see par.90) discloses a typical method for obtaining fishmeal and fish oil from a fish, said method not comprising any enzymatic steps and consisting of heating, and physically separating the oil from the proteins.

3.3 D5-D7 (see abstracts) disclose methods to obtain oils from insect larvae by hot pressing larvae pulp)

3.4 D8 discloses (an automatic translation is annexed to this communication) a method to manufacture an edible insect oil wherein supercritical carbon dioxide is used to extract the oil fraction from an insect pulp in order to recover and edible insect oil.

This invention involves a kind of edible insect's oil. Mainly the insect represented by edible insects such as Cicadae, Chinese shrimp, Locustamigratoria (Linnaeus) and silkworm chrysalis,etc.. The product that is already developed on the domestic and international markets at present mainly has special animal feed and edible insect's dining table cooked food, a certain amount of insect raw materials are used as pet's feed. There is no report both at home and abroad as to edible insect oil mode of production and application. This invention makes a edible insect's oil and its preparation method and application, realize the large-scale production of industrialization.The craft is to cultivate, purchase, screen, remove and mix, expel toxin, soak and put cure treatment in the hot water through industrialization, vacuuming lyophilize, pulverizing, supercritical COProcess of extracting etc., get the edible insect's health promoting oil product. The advantage is that an edible insect's oil extraction rate can be up to 30%, its achievement can be used in health promoting edible oil and functional food, medicines and cosmetic additive of the special function.

A edible insect's oil and its preparation method and application

A field

This invention involves a method for preparing edible insect's oil, edible insect's oil and employs (use). Mainly the insect represented by edible insects such as Cicadae, Tenebrio Molitor Linne, Locustamigratoria (Linnaeus) and silkworm chrysalis,etc..

Second, background technology

The direction of domestic and foreign study on insect's resource development, mainly in order to seek cultivating and industrialized productive insect of low cost at present; Study the functional substance that the insect has the potentiality to be exploited in vivo. The product that is already developed on the domestic and international markets mainly has special animal feed and edible insect's dining table cooked food, a certain amount of insect exit West European, South Korea and Japan of raw materials are used as pet's feed every year, wherein it is mainly Tenebrio Molitor Linne, Cicadae and silkworm chrysalis. There is no report both at home and abroad as to edible insect oil mode of production and application.Determine, the edible insect's protein content is 35.3%-71.4%, unsaturated fatty acid is very tall in content according to modern scientific research, belong to the high-quality edible fat; The content of Natural Vitamin E is extremely abundant; And have abundant Mineral element calcium, potassium, sodium, magnesium,etc. and micro-Mineral element iron, zinc, copper, manganese, chromium, selenium,etc., so can be used as the new fat raw materials of health food and cosmetic.

Third, invention content

, mainly use edible insect as raw materials, through removing technology such as mixing, expellent treatment technology and lyophilizing at low temperature, extract protein lyophilized powder with various active ingredients and make protein beverage and granule, make edible insect's series food with the whole flour, utilize the abundant fat to extract the nutrient oil as the functional oil of special type in vivo, utilize the epidermis to extract, transform chitosan, as medicine and health product raw materials. Realize industrialization is manufactured on a large scale.

Edible insect's technology is a novel dietary engineering, it is to take edible insect as raw materials, from cultivating to the safety preconditioning, from pest pupa to nit and his imago, it is humoral to reach from crust, can reach the comprehensive utilizing and developing, is suitable for the new resources of multistep edible insect from protein to fat, its achievement can be used in various fields such as food, health product, medicines and cosmetic.

In order to achieve the above-mentioned goal technological solution of this invention:

Characteristic of a edible insect's oil is: Edible insect on the basis of black Cicada, Locustamigratoria (Linnaeus), Antheraea pernyi, Bombyx mori, Tenebrio Molitor Linne, cultivate, purchase, screen, remove mixing, expels toxin, cure treatment, vacuuming lyophilize, pulverizing, extracting through industrialization, get edible insect health promoting oil primary products, extract, get transparent, edible insect's oily liquids of yellow while being secondary, extract in addition, still get ashen powder protein raw materials;

Nutrient oil technical indicator: Oranoleptic indicator: Color and luster, Luo link bright colorimetric trough 133.4mm, less than or equal to Y22 R2.2, clarify, not transparent, have peculiar smell, mouthfeel kind;

Physicochemical index: The acid value (KOH) is less than or equal to 3.0mg/g; Moisture and volatile matter content, are less than or equal to 3.0%; Peroxide value is less than or equal to 10m0l/Kg; The impurity is less than or equal to 0.05; The level of residue of solvent does not get detection mg/Kg; Lead is less than or equal to 0.5mg/Kg; Arsenic is less than or equal to 0.5mg/Kg;

Microbial indicator: The bacteria in total is less than or equal to 100 / ml; The coli group is less than or equal to 6 / 100ml; The pathogens does not get detection; Yellow, clear and transparent, the content of unsaturated fatty acid is above 55%, P/S value is up to 0.9, (ideal P/S value is 1, the pig oil fat P/S value is that 0.2) contains abundant Natural Vitamin E.

The technological solution of this invention also includes:

A method for preparing edible insect's oil, the edible insect on the basis of black Cicada, Locustamigratoria (Linnaeus), Antheraea pernyi, Bombyx mori, Tenebrio Molitor Linne, cultivate, purchase, screen, remove and mix, expel toxin, warm spleen-stomach to soak putting the cure treatment of one minute-10 minutes at [deg.C]50-100 [deg.C] water in industrialization through the preconditioning, its characteristic is:The edible insect after removing and mixing, expelling toxin, solidifying is that 0.01MPa-0.08MPa, chilling temperature will be-30 [deg.C] in vacuum degree --80 [deg.C], chilling time in order to vacuum lyophilize under the condition of 2h-50h, pulverize in the pure machine of powder, supplies pulverize, in extraction pressure 10MPa-40MPa, extraction temperature 30 [deg.C]-60 [deg.C], extract time supercritical CO2 extracts under the terms of 1h-4h, get the edible insect's health promoting oil primary products; The extraction for two times of primary products of oil, its purified process conditions:

Pressure: 20MPa-50MPa

Temperature: 40 [deg.C]-80 [deg.C]

Time: 2h-8h

Apparatus: Over-critical extraction equipment

Said a method for preparing edible insect's oil, collect said black Cicada, Locustamigratoria (Linnaeus) on the tissue of insect pest spot with every summer and autumn, raw materials preconditioning of confirming in the field, wash and rinse with rinsing well, often thrusting down, the temperature is in order to soak for one minute-10 minutes at 60 [deg.C]-100 [deg.C] water, inactivate cure treatment, then spill worm weight amount whether 2%-10% salt amount carry on brine salting, by confirm, pack, rapid cryopreservation is for use at-10 Celsius-20 [deg.C]condition.

Said a method for preparing edible insect's oil and application, its characteristic is: Said Antheraea pernyi, Bombyx mori are after silk reeling, cutting the callus fetches the living pupa, living pupa's direct cryopreservation is for use.

Said a method for preparing edible insect's oil, its characteristic is that said Tenebrio Molitor Linne produces and cultivates in an industrialized way, utilize animal husbandry to cultivate compound microorganism (EM) and lactic acid bacteria fermenting technology productive straw fermented feed in the research results in the culture, complement and process into five kinds of granulated feed of stadium of different worms with the traditional Tenebrio Molitor Linne's feed, often thrust down at room temperature, through removing and is mixed, expelling toxin and feeding the process of safety 5 days-30 days, reach variety quality specification: Each hectogram population is counted and smaller than 600, breeding amount, in 100 times-380 times, less than five generations have no phenomenon of degradating, can pass the standard of measurement of food safety of new resource.

The productive edible insect's oil is regarded as the application of pharmacy, food, health product, cosmetic and chemical products additive, its characteristic is: The ones that got are as novel special oil resource edible insect's oils, it is 5%-30% to it can be used for pharmacy, food, health product, cosmetic and additive dosage of chemical products.

The beneficial results of this invention:

(1)This invention is to mainly use edible insect as raw materials, adopt bioengineering to confirm that develop serial nutritive food and edible insect's technology of the health food. Through demonstration and qualification of domestic nutritionist and his insect expert, have carried on careful nutrient value analysis and assessment, think the edible insect's quantity various in style is large, distributed widely and breeding fast, it has high protein, high-load offering and fatty acid, low cholesterol, trophic structure are rational, meat fiber few, apt outstanding advantages of absorbing etc., superior to the vegetable protein. It has already had certain markets that the edible insect is regarded as feed and dining table cooked food, but has not developed utilizing it for the nutrient product of high added value yet.The edible insect can be expected to become the dietary nutrient source of advanced animality of human new resource, also one of the directions of the international dietary industrial development in the 21st century.

(2)This invention is on the basis of chronic theoretical research and application research, through modern scientific and technological means, extract and separate the process technology, combine together while being modern biochemical engineering, dietary project, pharmaceutical engineering, dietetics, represented by edible insects such as Cicadae, Chinese shrimp, Locustamigratoria (Linnaeus) and silkworm chrysalis,etc., develop the new resource food with human nutritive materials, have substituted the edible insect's stem body as the primary products of the feed, the product shape that have changed, have expanded kind and its added value of the product, has raised the quality of the product, lengthen the shelf life of the product, promote the edible insect's commercial process of cultural technique, will bring good social benefit and economic benefits.

(3)Apply supercritical CO 2 Extraction technology, can reduce the fracture of the active material effectively, the extraction rate is high, not producing residual solvent, no environmental pollution, it is safe to use, quality is reliable, are suitable for extraction of the active material, high value added product in this invention, the edible insect's oil extraction rate can be up to 30%, can extract the oily liquids of the transparent, yellow, main material protein ashen powder after extracting, the separation efficiency is good.

In particular:

1). The extraction rate is high

2). There is no solvent to remain

3). No denaturalization will occur in the protein that raw materials contain after extracting, can continue extracting the highly purified protein

4). It is best in quality to extract the oil, the appearance is clear

5). Without environmental pollution, the operational process is safe

(4)The edible insect's fat content is in 7.19-40.5%, wherein contain abundant unsaturated fatty acid and lipid-soluble Natural Vitamin E. Take shrimp of Chinese as examples, its P/S value is 0.9, can develop for health promoting edible oil and functional cosmetic additive of the special function.

(5)Determine through the applicant, nutrient oil technical indicator:

Oranoleptic indicator: Color and luster, Luo link friend colorimetric trough 133.4mm, less than or equal to Y22 R2.2, clarify, not transparent, have peculiar smell, mouthfeel kind.

Physicochemical index: The acid value (KOH) is less than or equal to 3.0mg/g; Moisture and volatile matter content, are less than or equal to 3.0%; Peroxide value is less than or equal to 10mol/Kg; The impurity is less than or equal to 0.05; The level of residue of solvent does not get detection mg/Kg; Lead is less than or equal to 0.5mg/Kg; Arsenic is less than or equal to 0.5mg/Kg.

Microbial indicator: The bacteria in total is less than or equal to 100 / ml; The coli group is less than or equal to 6 / 100ml; The pathogens does not get detection.

(6)This invention has confirmed the technology through the test, has established the basis for the industrialization of the edible insect's technological achievement. The vacuum freeze drying technology in the technology of this invention, the lyophilized purpose is for keeping living beings, chemical constitution and its activity of the product. Edible insect heat-sensing substance in protein, will change color and luster heat, and dissolubility drop, adopt and lyophilize protein preparation of productive edible insect of technology, has not merely kept amino acids not being fractured, also kept fundamental characteristics against fungus peptide, has also protected the function property of other active material, for instance SOD superoxide dismutase,etc., has also kept the proteinic color and luster and mouthfeel effectively.The supercritical CO2 extraction technology in the technology of this invention is the novel superfine extracting and separating purification technique in medicine, chemical industry, dietary field development in more than 20 years in the past, it has overcome the solvent residue problem in the traditional solvent extraction method, can well protect the heat-sensing substance. In this project, it is pressure, temperature and determination of time that supercritical CO2 extracts the technical key, its recovery rate can be up to 30%.The oil of edible insect is the high value added nutriment, extract the oil with this technology, having fully guaranteed high purity and high quality of the oil, the hazardous and noxious substances of free of; Operating at low temperature will not make the nutrient component polymerize and loss; The operational process is short, it is high in efficiency to separate, save heat energy, and leach the method to compare with expression, it has good advantages.

Fourth, specific embodiment

The Example 1: The edible insect taking black Cicada, Locustamigratoria (Linnaeus) as example, this raw materials are mainly by the nature when this pest occurs, catch and purchase in the spot, for example area within the Pass area of Shaanxi Province can purchase Cicadae's pupa and Locustamigratoria (Linnaeus) in enormous quantities in July-August of every year. Raw materials collect the scheme: Purchase the network on the tissue of insect pest spot, train the persons who purchase, allocate the processing unit and store the apparatus each purchase spot. According to the occuring amount that year, confirmed the purchasing price immediately, strict check sum controlled and purchased quality.The pre-treating process of raw materials: Confirm in the field-wash-at [deg.C]50-

100 [deg.C]Water of optional temperature warms spleen-stomach and soaks to put for 1-10 minutes between (, 100 [deg.C] such as 50, 55, 60, 65, 70, 75, 80, 85, 90, 95), carry on enzyme-removal cure treatment-spill worm weight amount 2% ' and 10% salt amount of (optional content in range) carry on brine salting, through confirming and packing the rapid cryopreservation-at the-10 Celsius-20 [deg.C](the optional temperature in range) condition for use.

Cryopreservation black Cicada, Locustamigratoria (Linnaeus) until vacuum degree 0.01-0.08MPa (optional vacuum degree under range) and chilling temperature-30 [deg.C] edible insect for use --80 [deg.C](the optional temperature in range), chilling time to vacuum lyophilize as the condition of the 2h-50h (the optional time in range), pulverize in the pure machine of powder, the supplies after pulverizing are in extraction pressure 10MPa-30 or 40MPa (the optional pressure in range), extraction temperature 30 [deg.C]-60 [deg.C], supercritical CO2 extract under the terms to extract time 1h-4h (the optional time in range), get the edible insect's health promoting oil primary products.The extraction for two times of primary products of oil, its purified process conditions: Pressure: 20MPa-50MPa; Temperature: 40 [deg.C]-80 [deg.C]; Time: 2h-8h; Apparatus: Over-critical extraction equipment. Get the edible insect's oily liquids of the transparent, yellow after secondary extraction; In addition still get ashen powder protein raw materials.

The Example 2: The edible insect taking Tenebrio Molitor Linne (also known as shrimp of Chinese) as example, produces and cultivates in an industrialized way, through the seed selection of more than nearly ten years, select a more ideal man's shrimp's worm's group, the quality specification of its variety is: Each hectogram population is counted and less than 600 (each hectogram population of ordinary worm's group is counted and greater than 700), active and strong, the disease resistance is good, the feed has a good adaptability, with low costs, the breeding amount is in 150 --380 times, less than 5 generations have no phenomenon of degradating. Until industrialization is cultivated, set up and produce cultivating with the breeding plant, produce the articles kind and cultivate to 3 generations and change worm kind once each time, have guaranteed the product quality cultivated.Utilize animal husbandry to cultivate EM (compound microorganisms) and fermenting technology of the lactic acid bacteria in the research results and produce the fermented feed of straw in the culture, complement and process into 5 kinds of granulated feed of stadium of different worms with the traditional man's shrimp's feed, reduced cost of feed more than 30%, improved resistance against diseases of the polypide at the same time. The comprehensive aquaculture cost of the fresh worm is for 2800 yuan / ton (suck the manpower and feed).Worm's group of Chinese shrimp that screened, cultivate through industrialization, It screen, not remove let's mix, expel toxin, at 50 [deg.C]-water be soaked and lasted times optional to be warmed spleen-stomach) cure treatment 100 [deg.C](temperatures optional in range), it is that 0.01MPa-0.08MPa (the optional pressure in range), chilling temperature are-30 [deg.C] in vacuum degree --80 [deg.C](the optional temperature in range), chilling time to vacuum lyophilize as the condition of the 2h-50h (the optional time in range), pulverize in the pure machine of powder, the supplies after pulverizing are in extraction pressure 10MPa-40MPa (the optional pressure in range), extraction temperature 30 [deg.C]-60 [deg.C], supercritical CO2 extract under the terms to extract time 1h-4h (the optional time in range), get edible insect health promoting oil primary products,extract while being secondary and its basically ditto whole craft, extract the edible insect's oily liquids of the transparent, yellow,

Implement 3: The edible insect taking Antheraea pernyi, Bombyx mori as example, trains peasant households and the collective sericulture, carry on the preconditioning as requested, collect. It is discredited that the silkworm chrysalis after silk reeling contains industrial alkali and pupa, used as food processing directly, influence the product quality.

So Antheraea pernyi and Bombyx mori as dietary raw materials, should cutting the callus fetches the pupa living under producing the situation of cooperation with the sericulture. Antheraea pernyi living output of pupa relatively old, some save have 300 more than raw materials every year. It is more convenient to fetch living pupa's direct cryopreservation. Antheraea pernyi, Bombyx mori after silk reeling, cut callus, fetch living pupa, living pupa for use direct cryopreservation.The same, through screening, warming spleen-stomach to soak putting the cure treatment of one minute-10 minutes at [deg.C]50-100 [deg.C] water, it is that 0.01MPa-0.08MPa, chilling temperature are-30 [deg.C] in vacuum degree --80 [deg.C], chilling time in order to vacuum lyophilize under the condition of 2h-50h, pulverize in the pure machine of powder, supplies pulverize, in extraction pressure 10MPa-30MPa, extraction temperature 30 [deg.C]-60 [deg.C], extract time supercritical CO2 extracts under the terms of 1h-4h, get edible insect health promoting oil primary products, extract while being secondary and its basically ditto whole craft, extract the edible insect's oily liquids of the transparent, yellow.

[Claims]

1.Characteristic of a edible insect's oil is: Edible insect on the basis of black Cicada, Locustamigratoria (Linnaeus), Antheraea pernyi, Bombyx mori, Tenebrio Molitor Linne, cultivate, purchase, screen, remove mixing, expels toxin, cure treatment, vacuuming lyophilize, pulverizing, extracting through industrialization, get edible insect health promoting oil primary products, extract, get transparent, edible insect's oily liquids of yellow while being secondary, extract in addition, still get ashen powder protein raw materials;

Nutrient oil technical indicator: Oranoleptic indicator: Color and luster, Luo link friend colorimetric trough 133.4mm, less than or equal to Y22 R2.2, clarify, not transparent, have peculiar smell, mouthfeel kind;

Physicochemical index: The acid value (KOH) is less than or equal to 3.0mg/g; Moisture and volatile matter content, are less than or equal to 3.0%; Peroxide value is less than or equal to 10mol/Kg; The impurity is less than or equal to 0.05; The level of residue of solvent does not get detection mg/Kg; Lead is less than or equal to 0.5mg/Kg; Arsenic is less than or equal to 0.5mg/Kg;

Microbial indicator: The bacteria in total is less than or equal to 100 / ml; The coli group is less than or equal to 6 / 100ml; The pathogens does not get detection; Yellow, clear and transparent, the content of unsaturated fatty acid is above 55%, P/S value is up to 0.9, (ideal P/S value is 1, the pig oil fat P/S value is that 0.2) contains abundant Natural Vitamin E.

2.A method for preparing edible insect's oil, the edible insect on the basis of black Cicada, Locustamigratoria (Linnaeus), Antheraea pernyi, Bombyx mori, Tenebrio Molitor Linne, cultivate, purchase, screen, remove and mix, expel toxin, warm spleen-stomach to soak putting the cure treatment of one minute-10 minutes at [deg.C]50-100 [deg.C] water in industrialization through the preconditioning, its characteristic is:The edible insect after removing and mixing, expelling toxin, solidifying is that 0.01MPa-0.08MPa, chilling temperature will be-30 [deg.C] in vacuum degree --80 [deg.C], chilling time in order to vacuum lyophilize under the condition of 2h-50h, pulverize in the pure machine of powder, supplies pulverize, in extraction pressure 10MPa-40MPa, extraction temperature 30 [deg.C]-60 [deg.C], extract time supercritical CO2 extracts under the terms of 1h-4h, get the edible insect's health promoting oil primary products; The extraction for two times of primary products of oil, its purified process conditions:

Pressure: 20MPa-50MPa
Temperature: 40 [deg.C]-80 [deg.C]
Time: 2h-8h
Apparatus: Over-critical extraction equipment.

3.A method for preparing edible insect's oil of claim 2, collect said black Cicada, Locustamigratoria (Linnaeus) on the tissue of insect pest spot with every summer and autumn, raw materials preconditioning of confirming in the field, wash and rinse with rinsing well, often thrusting down, the temperature is in order to soak for one minute-10 minutes at 60 [deg.C]-100 [deg.C] water, inactivate cure treatment, then spill worm weight amount whether 2%-10% salt amount carry on brine salting, by confirm, pack, rapid cryopreservation is for use at-10 Celsius-20 [deg.C]condition.

4.A method for preparing edible insect's oil and application of claim 2, its characteristic is: Said Antheraea pernyi, Bombyx mori are after silk reeling, cutting the callus fetches the living pupa, living pupa's direct cryopreservation is for use.

5.A method for preparing edible insect's oil of claim 2, its characteristic is that said Tenebrio Molitor Linne produces and cultivates in an industrialized way, utilize animal husbandry to cultivate compound microorganism (EM) and lactic acid bacteria fermenting technology productive straw fermented feed in the research results in the culture, complement and process into five kinds of granulated feed of stadium of different worms with the traditional Tenebrio Molitor Linne's feed, often thrust down at room temperature, through removing and is mixed, expelling toxin and feeding the process of safety 5 days-30 days, reach variety quality specification: Each hectogram population is counted and smaller than 600, breeding amount, in 100 times-380 times, less than five generations have no phenomenon of degradating, can pass the standard of measurement of food safety of new resource.

6.The productive edible insect's oil is regarded as the application of pharmacy, food, health product, cosmetic and chemical products additive, its characteristic is: The ones that got are as novel special oil resource edible insect's oils, it is 5%-30% to it can be used for pharmacy, food, health product, cosmetic and additive dosage of chemical products.