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Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))
- of inventorship (Rule 4.17(iv))

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(88) Date of publication of the international search report:

13 December 2018 (13.12.2018)

(54) Title: SINGLE CELL PROTEIN PRODUCTS AND AN INTEGRATED METHOD FOR THE PRODUCTION OF ETHANOL AND SINGLE CELL PROTEIN

(57) Abstract: Single cell protein products and an integrated method for the production of ethanol and single cell protein. A single-cell protein product is described including on dry basis between 35% by weight and 45% by weight crude protein, at least 1% by weight butyric acid and at least three of, at least four of or all five of (i) between 1.6% by weight and 2.9% by weight lysine; (ii) between 0.3% by weight and 1.5% by weight methionine; (iii) between 1.4% by weight and 2.7% by weight threonine; (iv) between 1.1% by weight and 2.3% by weight tryptophan and (v) between 7.5% by weight and 12.5% by weight crude fat.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 18/31101

A. CLASSIFICATION OF SUBJECT MATTER
 IPC(8) - C12P 7/06, C12P 7/14 (2018.01)
 CPC - C07C 29/149, C07C 31/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History Document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2007/0141083 A1 (BERGE et al.) 21 June 2007 (21.06.2007) Para [0036]; Para [0069]; Table 2	1-4; 6-9; 11-15; 17-20; 23-26; 28-31; 33-36; 38-41
Y	GAO. "Improved nutritional value of fish feed with plant protein ingredients by means of organic acid salts and solid state fermentation", 2011, Depart. of Animal and Aquacultural Sciences Norwegian University of Life Sciences; pgs. 1-24 Pg. 14, Para [2]; Pg. 20, Full Para [2];	1-4; 6-9; 11-15; 17-20; 23-26; 28-31; 33-36; 38-41
A	US 4,439,525 A (SHAY et al.) 27 March 1984 (27.03.1984) Entire Document	1-4; 6-9; 11-15; 17-20; 23-26; 28-31; 33-36; 38-41
A	US 2005/0163802 A1 (JORGENSEN et al.) 28 July 2005 (28.07.2005) Entire Document	1-4; 6-9; 11-15; 17-20; 23-26; 28-31; 33-36; 38-41
A	US 2009/0291469 A1 (DAVID) 26 November 2009 (26.11.2009) Entire Document	1-4; 6-9; 11-15; 17-20; 23-26; 28-31; 33-36; 38-41
A	US 5,985,336 A (IVEY et al.) 16 November 1999 (16.11.1999) Entire Document	

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

10 July 2018

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 18/31101

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 16, 22
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-4; 6-9; 11-14; 17-20; 23-26; 28-31; 33-36; 38-41, directed to a single-cell protein product comprising crude protein, butyric acid and at least three of, at least four of or all five of lysine; methionine; threonine tryptophan and crude fat.

Continued in Supplemental Box

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-4; 6-9; 11-14; 17-20; 23-26; 28-31; 33-36; 38-41

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Continuation of Lack of Unity

Group II: Claims 5, 10, 15, 21, 27, 32, 37, 42-57 directed to an integrated method for the production of ethanol and a single cell protein product, comprising (i) providing a fermentation medium comprising a carbohydrate and undissolved protein; (ii) culturing yeast in said medium for a specific duration, whereby a fraction of said fermentation medium carbohydrate is metabolized and carbon dioxide and a fermentation liquor are generated, which fermentation liquor comprises ethanol, residual carbohydrate, undissolved protein and optionally byproduct glycerol; (iii) processing said fermentation liquor, which processing comprises distilling, separating solids and evaporating, whereby separated ethanol, a separated protein cake and a syrup are formed, which syrup comprises residual carbohydrate, undissolved protein and optionally byproduct glycerol

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Special Technical Features:

Group II includes the technical feature of an integrated method for the production of ethanol and a single cell protein product, comprising (i) providing a fermentation medium comprising a carbohydrate and undissolved protein; (ii) culturing yeast in said medium for a specific duration, whereby a fraction of said fermentation medium carbohydrate is metabolized and carbon dioxide and a fermentation liquor are generated, which fermentation liquor comprises ethanol, residual carbohydrate, undissolved protein and optionally byproduct glycerol; (iii) processing said fermentation liquor, which processing comprises distilling, separating solids and evaporating, whereby separated ethanol, a separated protein cake and a syrup are formed, which syrup comprises residual carbohydrate, undissolved protein and optionally byproduct glycerol, not required by group I

Group I includes the technical feature of a single-cell protein product comprising crude protein, butyric acid and at least three of, at least four of or all five of lysine; methionine; threonine tryptophan and crude fat, not required by group II

Shared technical features:

Groups I-II share the single-cell protein product comprising on dry basis between 35% by weight and 45% by weight crude protein, at least 1% by weight butyric acid and at least three of, at least four of or all five of (i) between 1.6% by weight and 2.9% by weight lysine; (ii) between 0.3% by weight and 1.5% by weight methionine; (iii) between 1.4% by weight and 2.7% by weight threonine; (iv) between 1.1% by weight and 2.3% by weight tryptophan and (v) between 7.5% by weight and 12.5% by weight crude fat.

However, this shared technical feature does not represent a contribution over prior art as being obvious over US 2007/0141083 A1 to Berge et al. (hereinafter "Berge") in view of the document titled "Improved nutritional value of fish feed with plant protein ingredients by means of organic acid salts and solid state fermentation" to Gao (hereinafter "Gao"). Berge teaches a single-cell protein product (Para [0036]; A preferred embodiment of the invention relates to a feed material comprising the single-cell protein material. The material can for instance be used for feeding agricultural animal. Such as gallinaceous birds, bovine, ovine, caprine or porcine mammals, domestic or pet animal. Such as dog or cat, and fish or shellfish, Such as salmon, cod...) comprising on dry basis crude protein (Para [0069]; A single-cell material having the characteristics given in table 2 is continuously harvested;; See Table 2; on dry weight basis the crude protein content is approx. 70%), and at least three of, at least four of or all five of (i) lysine (Para [0069]; A single-cell material having the characteristics given in table 2 is continuously harvested;; See Table 2; 4.3% by weight of Lysine); (ii) methionine (Para [0069]; A single-cell material having the characteristics given in table 2 is continuously harvested;; See Table 2; 1.9% by weight of Methionine); (iii) threonine (Para [0069]; A single-cell material having the characteristics given in table 2 is continuously harvested;; See Table 2; 3.1% by weight of threonine); (iv) between 1.1% by weight and 2.3% by weight tryptophan (Para [0069]; A single-cell material having the characteristics given in table 2 is continuously harvested;; See Table 2; 1.5% by weight of tryptophan) and (v) between 7.5% by weight and 12.5% by weight crude fat (Para [0069]; A single-cell material having the characteristics given in table 2 is continuously harvested;; See Table 2; 9% by weight of crude fat), but does not specifically teach wherein the weight of the ingredients within the composition is between 35% and 45% of crude protein, between 1.6% and 2.9% of lysine, between .3% and 1.5% methionine, between 1.4% and 2.7% of threonine, and does not teach the presence of butyric acid of at least 1%. However, in a similar invention, Gao teaches the addition of butyric acid to animal feed as it provides beneficial effects on the animals (Pg. 14, Para [2]; The results of these studies indicate that nutrient

Shared Technical Features:

digestibility, growth performance and gut health can be improved by the addition of some organic acids to the diet.... In addition, butyric acid is superior in providing energy for intestinal epithelial growth... and in pH-reducing capacity due to its high pKa value... using formic acid or butyric acid and their salts may have different beneficial effects when fed to fish, and may overcome some negative effects of plant protein sources. Thus, they are already increasingly used in fish feeds; Pg. 20, Full Para [2]; The application of butyric acid or its salts in the diets has been tested on some monogastric animals including pigs ...poultry...and rabbits... The beneficial effects of feeding butyric acid to other animals suggest that it may have potential use in fish feed as an additive). Therefore, it would have been obvious to one of ordinary skill in the art combine the teachings of Berge in view of Gao to produce a single-cell protein product with a high nutritional value because it contains a balanced amino acid profile, as taught by Berge (Para [0036]; Para [0069]; Table 2), and butyric acid which may impart further beneficial effects on the consumer, as taught by Gao (Pg. 14, Para [2]; Pg. 20, Full Para [20]), such as an increase in growth performance and gut health. Further it would have been obvious to one of ordinary skill in the art to determine through routine experimentation the optimum weight of these ingredients present within the composition such that it may be tailored to the consumer, whether it be pets, poultry, fish, or humans, and will, therefore, have the optimum amount of amino and organic acids to provide the most benefit to the consumer.

As the shared technical feature was known in the art at the time of the invention, this cannot be considered a special technical feature that would otherwise unify the groups I-II. Therefore, Groups I-II lack unity under PCT Rule 13.

Note Re: Item 4: Claims 16 and 22 are determined unsearchable because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).