

Claims

1. A method for producing a biomass comprising at least 65% protein of total biomass by dry weight from hydrogen-oxidising microorganisms using one or more input streams comprising one or more gaseous substrates, comprising hydrogen and oxygen, comprising contacting the microorganisms in a liquid phase with a nutrient composition comprising nitrogen and phosphorous-comprising compounds and the gaseous substrates, wherein the one or more gaseous substrates comprises carbon dioxide or the nutrient composition comprises carbon-comprising compounds, wherein the input stream and nutrient composition are controlled and wherein the biomass is produced at a rate of more than 10 g/l/d, wherein controlling the input stream comprises adding a molar ratio of hydrogen : oxygen to the liquid phase of from 1 : 1 to 10 : 1.
2. The method according to claim 1, wherein controlling the input stream comprises adding hydrogen in a concentration of from 70 to 100 % (v/v), oxygen in a concentration of from 20 to 100 % (v/v) and carbon dioxide in a concentration of from 5 to 100 % (v/v) to the liquid phase, individually or as any premixed combination thereof.
3. The method according to claim 1 or claim 2, wherein controlling the input stream and nutrient composition comprises maintaining a specific growth rate of the microorganisms of from 1.0 to 8.0 d⁻¹ or from 0.04 to 0.3 h⁻¹.
4. The method according to any one of claims 1 to 3, wherein controlling the input stream and nutrient composition comprises maintaining a concentration of the microorganisms in the liquid phase of the bioreactor of at least 10 g/l, preferably of from 10 to 100 g/l.
5. The method according to any one of claims 1 to 4, wherein controlling the input stream comprises adding a molar ratio of hydrogen : oxygen : carbon dioxide of from 3.88 to 51.94 : 0.85 to 2 : 0.75 to 2 to the liquid phase.
6. The method according to any one of claims 1 to 5, wherein controlling the input stream comprises maintaining a molar ratio of dissolved hydrogen : oxygen : carbon dioxide of from 3.183 to 12.748 : 0.795 to 4.25 : 0.75 to 2.0 in the liquid phase.

7. The method according to any one of claims 1 to 6, wherein controlling the input stream comprises maintaining a concentration of hydrogen of from 0.5 to 20 mg/l, a concentration of oxygen of from 0.5 to 80 mg/l and a concentration of carbon dioxide of from 20 to 2000 mg/l in the liquid phase at a temperature of from 28 to 45 °C and at a pressure in the gaseous phase of from 100 to 2000 kPa.
8. The method according to any one of claims 1 to 7, wherein controlling the input stream comprises maintaining hydrogen at a transfer rate of from 0.03 to 1.2 mol/l/h in the liquid phase and/or oxygen at a transfer rate of from 0.003 to 0.4 mol/l/h in the liquid phase.
9. The method according to any one of claims 1 to 8, wherein controlling the input stream preferably comprises maintaining a molar ratio of hydrogen : oxygen gas hold-up in the liquid phase of from 0.5 : 1 to 7 : 1, preferably of from 1 : 1 to 3.5 : 1.
10. The method according to any one of claims 1 to 9, wherein the microorganisms utilise the hydrogen at a rate of from 0.05 to 0.5 mol/g/h, the oxygen at a rate of from 0.04 to 0.18 mol/g/h, and the carbon dioxide at a rate of from 0.03 to 0.13 mol/g/h.
11. The method according any one of claims 1 to 10, wherein the carbon dioxide is derived from the exhaust gas of a production or combustion process, preferably wherein the carbon dioxide is purified and concentrated to a concentration of from 40 to 100 % (v/v).
12. The method according to any one of claims 1 to 11, wherein comprising contacting the microorganisms in a liquid phase with a nutrient composition comprises adding a nutrient composition which is adjusted to a pH of from 1 to 4 prior to adding, wherein the nutrient composition preferably comprises DSMZ medium for chemolithotrophic growth 81 (H-3) without NaHCO₃ and wherein preferably prior to adding the medium is supplemented with an additional 1.5 g/L ammonium chloride, 3 x 10⁻⁴ g/L NiCl₂ x 6H₂O, and 1.5 x 10⁻³ g/L ZnSO₄ x 7H₂O, and 1.5 x 10⁻⁴ g/L CuCl₂ x 2H₂O, and 0.15 g/L Ferric ammonium citrate. .
13. The method according to any one of claims 1 to 12, wherein the microorganisms comprise bacteria selected from: *Rhodopseudomonas* sp.; *Rhodospirillum* sp.; *Rhodococcus* sp.; *Rhodobacter* sp.; *Rhizobium* sp.; *Thiocapsa* sp.; *Pseudomonas* sp.; *Nocardia* sp.; *Hydrogenomas* sp.; *Hydrogenobacter* sp.; *Hydrogenovibrio* sp.;

Helicobacter sp.; *Xanthobacter* sp.; *Hydrogenophaga* sp.; *Bradyrhizobium* sp.;
Ralstonia sp.; *Gordonia* sp.; *Mycobacteria* sp.; *Alcaligenes* sp.; *Cupriavidus* sp.;
Variovorax sp.; *Acidovorax* sp.; *Anabaena* sp.; *Scenedesmus* sp.; *Chlamydomonas* sp.;
Ankistrodesmus sp.; *Rhaphidium* sp. or *Arthrobacter* sp., and combinations thereof.

- 5 14. The method according to any one of claims 1 to 13, wherein the microorganisms
comprise bacteria selected from the genus *Cupriavidus* sp, preferably the species
Cupriavidus necator.
15. A method of producing biomass from bacteria selected from the genus
Cupriavidus sp, preferably the species *Cupriavidus necator*.
- 10 16. A method of isolating the biomass produced according to any of claims 1 to 15
and removing the nutrient composition, comprising dewatering and/or drying the
biomass such that the biomass comprises a water content of less than 5 % by weight.
- 15 17. The biomass obtainable by the method according to any of claims 1 to 16
comprising protein comprising an amino acid content comprising a histidine content
of from 0.9 to 4.8 % of total biomass dry weight protein content, an isoleucine
content of from 2.0 to 6.9 % of total biomass dry weight protein content, a leucine
content of from 3.8 to 12.0 % of total biomass dry weight protein content, a lysine
content of from 3.0 to 11.1 % of total biomass dry weight protein content, a
methionine content of from 1.1 to 5.4 % of total biomass dry weight protein content,
20 a phenylalanine content of from 1.7 to 8.5 % of total biomass dry weight protein
content, a threonine content of from 1.6 to 6.9 % of total biomass dry weight protein
content, a tryptophan content of from 0.4 to 3.9 % of total biomass dry weight
protein content, and a valine content of from 1.7 to 9.3 % of total biomass dry
weight protein content.
- 25 18. The biomass obtainable by the method according to any of claims 1 to 16,
comprising a lipid content of from 2.3 to 18 % of total biomass dry weight comprising
a fatty acid content comprising a C16:0 palmitic acid content of from 23 to 60 % of
total biomass dry weight fatty acid content, a C16:1 palmitoleic acid content of from
3.8 to 22.3 % of total biomass dry weight fatty acid content, and a C17:1
30 heptadecenoic acid content of from 23 to 60 % of total biomass dry weight fatty acid
content.

19. Use of the nutrient composition obtained by the method according to claim 16 as a nutrient composition for producing biomass according to any of claims 1 to 15.

20. Use of the biomass obtained by the method according to any of claims 1 to 15 or the biomass according to claim 17 or 18 to feed or provide nutrition to one or more organisms, preferably wherein the organisms comprise fish, crustaceans, molluscs, poultry, pigs and cattle.

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