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ALGAE AS PROTEIN SUPPLEMENT

Abubakar Saleh Ahmad[1*], Munkhnasan Enkhbold[1], Arijit Nath[1]

[1]Department of Food Engineering and Process Design, Institute of Food Science and Technology,
Hungarian University of Agriculture and Life Sciences (MATE), Ménesi ut 44, HU-1118 Budapest, Hungary
Email: ahmadabubakarsale@gmail.com

MATE HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES

Introduction

Currently, more than one in seven people do not have access to sufficient protein and energy from their diet, and even more, suffer from some form of micronutrient malnourishment [1]. Moreover, with growing population of vegans, and people on restricted diets, there is a high demand for animal-protein alternatives. Also, there have been many health-related problems linked to some animal proteins, ethical as well as environmental issues that attract more concern regarding saving animals which might add to the usage of plant-based proteins [2]. Algal protein is known to be among the best plant-related protein due to its high protein content. Algae are grown, harvested, extracted, dried, and purified to make efficient protein supplement powder or shakes, aimed at increasing the consumption and tackling protein deficiency.

Aim

Algae used in the production of protein has several benefits over other high protein crops in terms of higher protein content and bioavailability. This poster showed the production process, and nutritional composition of algal protein to be used as nutrient supplement for human needs.

Advantage of Algal biotechnology

- Rapid production, and able to grow across wide range of temperature, light, and environments
- High photosynthetic conversion rate
- Capability for environmental bioremediation, such as carbondioxide or flue gas fixation from atmosphere
- Low production and harvesting cost
- Potential to be used in industrial scale bioprocess and high capacity to produce wide variety of additives
- Can be grown continuously in a reactor
- Non-competitiveness for land with food crops

Production of Algae Protein supplement

There are many methods used in commercial production of algae protein supplements. Cultivation of algae can be done using photobioreactor (PBR). PBR is a culture systems for phototrophs in which a great proportion of the light (>90%) does not impinge directly on the culture surface but pass through the transparent reactor's walls to reach the cultivated cells. Among the types of PBR, include flat or tubular, horizontal, inclined, vertical or spiral, and manifold or serpentine. An operational classification of PBR would air or pump mixed and single-phase reactors. The algal biomass needs to be separated from the culture medium, or cell debris removed following cell disruption for the release of the metabolites of interest [3].

Harvesting and Dehydration

Biomass is harvested by sedimentation, centrifugation or filtration, and an additional flocculation step. Flocculation involves the collection of cells into an aggregate mass by addition of polymers or other flocculants such as ferric chloride, aluminium sulphate. After filtration, centrifugation is carried out to separate the microalgae from the biomass. Filtration, using rotary vacuum drum filters and the chamber filter press are commonly employed type of filters in harvesting. Spray-drying is used for rapid, continuous, drying of the slurries. Pressure or centrifugal disc atomizers or gas–liquid jets are used to generate a fine spray of solution droplets, which are brought into constant contact with hot air in a heating chamber. The dry powder settles to the bottom where it is removed in the cyclone [3].

Cell disruption and Extraction

Protein extraction method involves pre-treatment with cell-disruption techniques aid to breakdown the algal cell wall, increasing the availability of protein for extraction. Some novel protein extraction methods include mechanical methods ultrasound-assisted extraction, PEF, and microwave-assisted extraction [4], and non-mechanical methods, such as freezing, organic solvents and osmotic shock [5]. The second step in a bio-separation is product isolation using a highly dilute aqueous feed and removing most of the water and materials of widely divergent properties compared with the desired product [3].

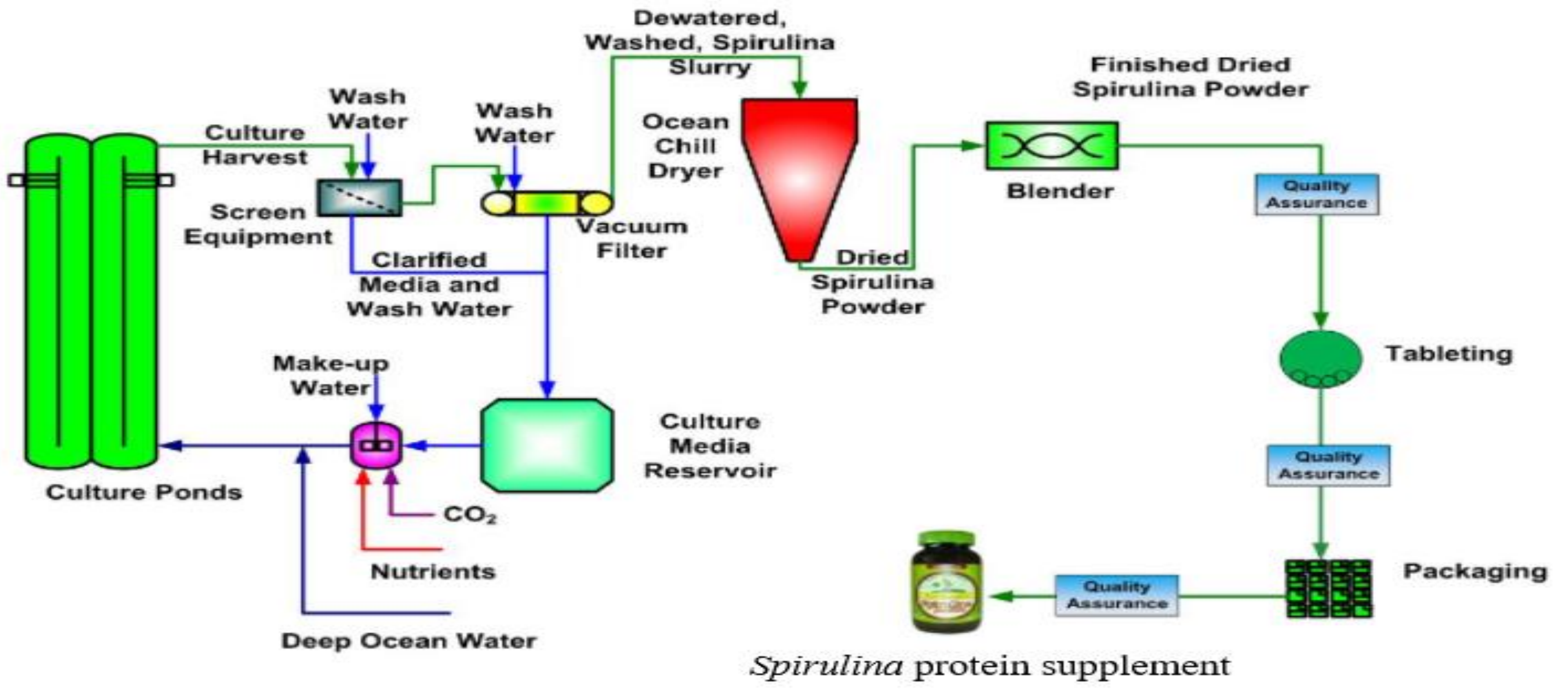

Figure 1: production flow sheet of algal (*Spirulina*) protein supplement

Chemical Composition and Protein Quality of Algae

Table 1 showed various species of algae with their chemical composition. It was reported that there is a high amount of crude protein in green, and blue-green algae (50-71 % dry matter). Some red species algae such as *Porphyra cruentum* contain about 40 % and 25 % dry matter respectively [6].

Table 2 showed the amino acid profile present in six selected algal species in comparison with the equivalent amount of such amino acids in conventional food items, soybeans, and egg and reference data of a well-balanced protein. The result showed that algae proteins have perfect similarities with the reference points of WHO/ FAO as well as the conventional protein foods such as soybean and egg [7]. The species of algae captured in Table 2 below showed that sulfur-containing amino acids (cys and met) are less when compared with the conventional proteins and WHO/FAO reference values. While other essential amino acids contained by the algae especially leu, val, and try can be compared favourably with the reference values and conventional soy and egg amino acids.

Table 1. Composition of Algae (% dw) [8, 9]

Algal strain	Protein	Carbohydrate	Lipids
Anabaena cylindrica	43-56	25-30	4-7
Arthrospira maxima	60-71	13-16	6-7
Chlorella pyrenoidosa	57	26	2
Chlorella vulgaris	51-58	12-17	14-22
Dunaliella bioculata	49	4	8
Dunaliella salina	57	32	6
Porphyridium cruentum	28-39	40-57	9-14
Scenedesmus obliquus	50-56	10-17	12-14
Scenedesmus quadricauda	47	-	1.9
Spirulina maxima	60-71	13-16	6-7
Spirulina plantensis	46-63	8-14	4-9

Table 2. Comparison of Amino acid profile of different algae with conventional major protein sources (g/ 100g protein) [9].

Source	Ile	Leu	Val	Lys	Phe	Tyr	Met	Cys	Try	Thr	Ala	Arg	Asp	Glu	Gly	His	Pro	Ser
WHO/FAO	4.0	7.0	5.0	5.5	6.0		3.5		1.0									
Egg	6.6	8.8	7.2	5.3	5.8	4.2	3.2	2.3	1.7	5.0	-	6.2	11.0	12.6	4.2	2.4	4.2	6.9
Soybean	5.3	7.7	5.3	6.4	5.0	3.7	1.3	1.9	1.4	4.0	5.0	7.4	1.3	19.0	4.5	2.6	5.3	5.8
Chlorella vulgaris	3.8	8.8	5.5	8.4	5.0	3.4	2.2	1.4	2.1	4.8	7.9	6.4	9.0	11.6	5.8	2.0	4.8	4.1
Dunaliella bardawil	4.2	11.0	5.8	7.0	5.8	3.7	2.3	1.2	0.7	5.4	7.3	7.3	10.4	12.7	3.3	1.8	3.3	4.6
Scenesdesmus obliquus	3.6	7.3	6.0	5.6	4.8	3.2	1.5	0.6	0.3	5.1	9.0	7.1	8.4	10.7	3.9	2.1	3.9	3.8
Arthrospira maxima	6.0	8.0	6.5	4.6	4.9	3.9	1.4	0.4	1.4	4.6	6.8	6.5	8.6	12.6	3.9	1.8	3.9	4.2
Spirulina platensis	6.7	9.8	7.1	4.8	5.3	5.3	2.5	0.9	0.3	6.2	9.5	7.3	11.8	10.3	4.2	2.2	4.2	5.1
Aphanizomenon sp.	2.9	5.2	3.2	3.5	2.5	-	0.7	0.2	0.7	3.3	4.7	3.8	4.7	7.8	2.9	0.9	2.9	2.9

Conclusion

Algae have been reported as a valuable protein source that can be used as a protein supplement in food formulations due to their abundant high quality and readily available proteins. Although more awareness and research are needed to encourage the level of production and its application in food and nutrient supplement. There is also a need for further investigation regarding its bioavailability and toxicology in some species to ascertain their safety.

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