Short Communications

Chemical composition of sewage-grown *Spirulina platensis*[1]

P.N. Saxena, M.R. Ahmad[2], R. Shyam and P.S. Misra

Algal Biotechnology Laboratory, National Botanical Research Institute, Lucknow-226001 (India), 7 June 1982

Summary. Spirulina platensis has been grown in an outdoor pilot production unit, with an exposed surface area of 450 m^2, on a medium consisting of raw domestic sewage supplemented with sodium bicarbonate and nitrate or urea fertilizer. The chemical composition and yield of the biomass grown on sewage-nitrate was comparable to that grown on synthetic medium. The protein content was much lower in the alga cultivated in sewage-urea medium.

Among the filamentous blue-green algae, *Spirulina* is a particularly attractive source of single cell protein because of its high nutritive value, and because the large spiral filaments make it relatively easy to harvest by simple cloth filtration[3,4]. *S. platensis* grows abundantly in brackish soda lakes and ponds in Central Africa and has, traditionally, been used as food by the tribal people living in the vicinity of Lake Chad[5].

A biotechnology for cultivating *Spirulina* in raw sewage coupled with pisciculture and irrigation water has been developed and tested in an integrated open ponding system to realize the dual aim of harvesting proteinaceous biomass for poultry feed and water reclamation[6]. No information is available on the chemical composition of *Spirulina* grown on raw sewage. The present communication evaluates the chemical constituents and amino acid profile of *S. platensis* grown in an outdoor pilot plant using raw municipal sewage supplemented with sodium bicarbonate as the carbon source and sodium nitrate or urea to provide nitrogen.

Table 1. Chemical composition and yield of *S. platensis* cultivated in different media

	Synthetic medium	Sewage-nitrate	Sewage-urea
Protein	55-60%	50-55%	35-40%
Carbohydrates	9-12%	18-20%	16-20%
Lipids	7-9%	6.5-9%	6-9%
Nucleic acids	3.06-4.5%	3.3-4.95%	3.3-5.2%
Yield ($g\ m^{-2}day^{-1}$)	8.4-10	7.3-9.5	7.5-9.7

Table 2. Amino acid composition (g/16 g N) of *S. platensis* grown on synthetic medium and sewage, and compared with FAO pattern

Amino acids	Synthetic medium	Sewage-nitrate	Sewage-urea	FAO pattern
Essential				
Threonine	5.40	5.41	5.60	4.00
Valine	9.08	6.86	5.89	4.96
Methionine	2.53	1.52	2.65	3.52
Isoleucine	8.02	3.91	6.37	4.00
Leucine	7.62	8.30	7.45	7.04
Tyrosine	2.34	2.10	2.24	6.08[a]
Phenylalanine	4.30	2.76	3.50	
Lysine	5.57	3.94	4.72	5.44
Nonessential				
Aspartic acid	8.81	12.51	8.69	
Serine	5.67	7.21	4.33	
Glutamic acid	8.60	10.44	11.60	
Proline	4.94	5.35	4.92	
Glycine	7.86	7.78	10.07	
Alanine	7.30	9.76	11.96	
Histidine	1.60	1.87	1.85	
Ammonia	5.00	6.14	3.75	
Arginine	5.31	4.06	4.33	

[a] Value of tyrosine + phenylalanine.

Materials and methods. The alga was grown, as described earlier[6], in a 450 m^2 mass culture unit with a capacity for holding 60,000 l of sewage at 15 cm operative depth. For harvesting, the algal suspension was delivered onto a polyester cloth screen. The filtered biomass was repeatedly washed with fresh water to remove the salts, spread thinly on plastic sheets and sun-dried. The dried algal flakes were used for chemical analysis.

Protein content was computed from Kjeldahl nitrogen values. Carbohydrates were determined by the phenol-sulphuric acid method[7] and lipids by the acid dichromate method[8]. Amino acid analysis was done using an LKB 4101 automatic amino acid analyzer. DNA and RNA were estimated by the diphenylamine[9] and orcinol[10] methods respectively.

Results and discussion. Chemical composition of the alga cultivated in different media showed that the protein content of the biomass varied considerably depending upon the source of nitrogen used for sewage fortification (table 1). However, other chemical constituents remained unaffected. The alga grown on sewage-nitrate had a protein content ranging from 50 to 55% which compares favorably with that cultured in synthetic medium[11] under the same growth conditions. Sewage-urea grown biomass had a much lower protein content, indicating that urea is not an ideal nitrogen source for maintaining the optimal protein level in the alga.

Peak long-term yields in the outdoor mass production unit were almost the same in sewage-nitrate and sewage-urea media, and varied between 7.3 and 9.7 $g\ m^{-2}day^{-1}$. These values are only slightly lower than the yields attained in synthetic medium.

Despite variation in the protein content, the composition of amino acids in the *S. platensis* biomass is very similar in different media (table 2). The alga grown on sewage has a well-balanced amino acid spectrum comparable to the FAO pattern[12], but is deficient in sulphur-containing amino acids.

1 NBRI Research Publication No. 143 (NS).
2 To whom reprint requests should be addressed.
3 Clement, G., Annls Nutr. Aliment. *29* (1975) 477.
4 Santillan, C., Experientia *38* (1982) 40.
5 Léonard, J., Nature *209* (1966) 126.
6 Saxena, P.N., Ahmad, M.R., Shyam, R., and Amla, D.V., Biotechnology of *Spirulina* cultivation in sewage. Economic Botany Information Service, National Botanical Research Institute, Lucknow, India 1981.
7 Dubois, M., Gilles, K.A., Hamilton, J.K., Rebers, P.A., and Smith, F., Analyt. Chem. *28* (1956) 350.
8 Amenta, J.S., J. Lipid Res. *5* (1964) 270.
9 Burton, K., in: Methods in enzymology, vol. 12, part B, p. 163. Eds L. Grossman and K. Moldave. Academic Press, New York 1968.
10 Lin, R.I., and Schjeide, O.A., Analyt. Biochem. *27* (1969) 473.
11 Zarrouk, C., Thesis. University of Paris, Paris 1966.
12 Anonymous, Energy and protein requirements. Report of a Joint FAO/WHO Ad Hoc Expert Committee, No. 52. Rome 1973.