Marina Mesopotamica Volume 18, Number 1, pp. 1 – 8 (2003)

The Biochemical Composition of Some Micro-Algal Species Isolated From the Shatt al-Arab River

A. A. Hantouch and K. K. Hreeb
Marine Science Centre, University of Basrah, Basrah, Iraq.

Abstract

The approximate biochemical composition (protein, carbohydrate, fat and minerals) of three algal species *Oscillatoria* sp., *Schizothrix* sp. and *Chlorella vulgaris* that were isolated from the Shatt Al-Arab River were determined. The species *C. vulgaris* contained the highest level of protein, while *Schizothrix* sp. contained the highest level of fats and carbohydrates. The *C. vulgaris* analysis, showed highest level of calcium and magnesium, while *Schizothrix* sp. showed highest level of phosphorus. The biochemical composition is a possible factor determining the nutritional quality of the algae.

Introduction

THE TERM ALGAE covers a wide range of aquatic plants, from microscopic organisms to large forms of seaweed. The ancient algae are considered the source of the more than 30,000 different species of algae in existence today. The algae play a very important role, direct or indirect, in the diet of both marine and freshwater fishes (Tilden, 1968). But, brine shrimp and rotifers are the most frequently used live food for cultured larval marine fishes and crustaceans, and their culture depends on the production of unicellular algae (Napolitano, et al., 1990). Lipids, proteins, minerals and carbohydrates are the basic components of aquatic organisms, and all have important roles. Microalgal lipid composition has been suggested as more critical than protein and carbohydrate composition for promoting optimal growth and development in bivalve larvae (Napolitano, et al., 1990). Lewin (1974) stated that the lipids of algae comprise photosynthetic pigments – chlorophylls and carotenes and other compounds which may be saponifiable (such as wax esters, glycerides, phospholipids, sulpholipids and glycolipids) or not saponifiable (hydrocarbons, steroids, etc.). The role of lipids in photosynthetic carbon fixation is not obvious though the photosynthetic apparatus depends on certain fatty acids and lipid classes (Gurr and Harwoods, 1991).

The oil drop hangs on the outside of the chloroplastid. It increases in quantity in the light and decreases in the dark, and it is thought that the formation of oil is preceded by a carbohydrate (Tilden, 1968). In many cases protein is undoubtedly stored in amorphous form in the algae, as in the higher plants, and it appears rather commonly in crystalloid form (Tilden, 1968). Gurr and Harwoods (1991) obtained that the proteins do not seem important in primitive organisms. Simple sugar carbohydrates are the smallest sugar molecules and easily digested and absorbed. Energy is measured in calories. The calorie is defined as the amount of heat required to raise temperature of 1 gram of water only

1°C, and because this amount of heat is so small, it is common to describe energy requirements and the energy content of foods in kilocalories. The objective of this study was to determine the chemical composition of the algal species (*Oscillatoria* sp., *Schizothrix* sp. and *Chlorella vulgaris*) and their nutritive values to the consumers.

Materials and Methods

Culture: The samples of algae *Oscillatoria* sp., *Schizothrix* sp. and *Chlorella vulgaris* Beijernick had been collected, isolated, purified and identified from the Shatt al-Arab River at al-Garma (Figure 1). They were maintained aerobically in media (Chu No. 10) at 32 °C under continuous illumination. The pH of the media was adjusted to 7.5 before and after autoclaving.

Chemical analysis: The water suspensions of each algal species were filtered through pre-weighted glass filter fibers (GF/F). The filter paper was oven-dried for 24 hours at 100 °C. The carbohydrates were measured according to the Land and Eynon method as described by A.O.A.C. (1970). Ash was determined according to A.O.A.C (1984). The percentage of protein was determined by the Lowry, et al., (1951) method. Total lipids were extracted overnight with 100 ml of ether following the method described by I.U.P.A.C. (1979). The minerals calcium, phosphorus and magnesium were estimated using the method of Cresser and Parsons (1979). The total and true calorific values were calculated as described by Zaitsev, et al., (1969).

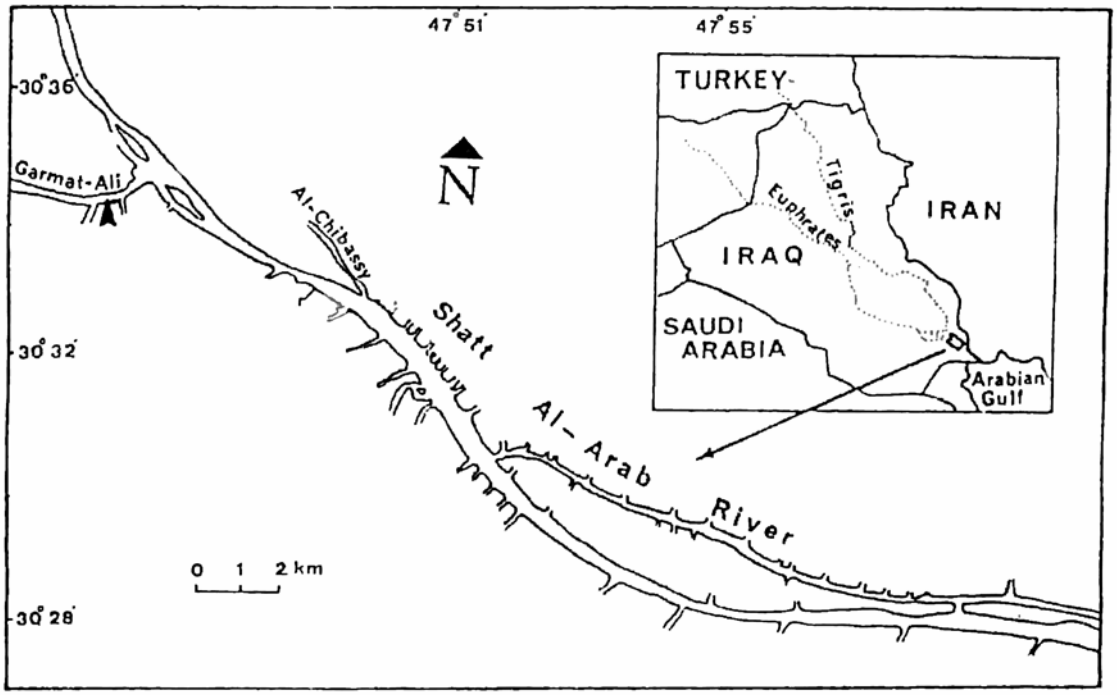

Figure 1. The map of the sampling area.

Results and Discussion

The biochemical compositions of microalgae (*Oscillatoria* sp., *Schizothrix* sp. and *Chlorella vulgaris*) are shown in Figure 2. The percentage of protein in *C. vulgaris* was high (61.062 % of dry weight) while the total amount of lipid was high (7.435 % of dry weight) in *Schizothrix* sp. The maximum level of carbohydrate recorded in *Schizothrix* sp. was 23.509 % of dry weight and the maximum level of ash was recorded in *Oscillatoria* sp. (7.375 % of dry weight).

In relation to nutritional value, Abdulla and Rajab (1998) determined that *C. vulgaris* contains about 30-50 % more protein and lipid contents than other Cyanophyceae and Chlorophyceae. The concentration of fatty acids in the particulate matter during the plankton bloom reflects the different biochemical compositions of phytoplankton during the developmental stages (Kattner,et al., 1983).

The fat content may have been affected by different solvent extraction (Ackman, 1989); another factor that may affect the complete lipids extraction is autooxidation (Chuecas and Riley, 1969).

Compared nutritionally to other blue green algae, *Chlorella* has more fiber content due to its hard cell wall, and the dietary fibers are carbohydrate, which are not completely digestible (Atkinson, et al., 1972). The highest level of total calorific value higher of the studied species was found in *C. vulgaris* (Figure 2) (339.604 Kcal / 100 gm of dry weight). Tilden (1968) obtained the sum total of energy expended by marine and freshwater fishes and thought that the amount of food required to supply this energy seemed incredible. All the proteins, carbohydrates, fats and vitamins had their origin in the microscopic cells of marine algae. Figure 3 shows that *C. vulgaris* was richer in calcium and magnesium (6.5 and 2.9 mg/g of dry weight), while *Schizothrix* sp. contained the maximum amounts of phosphorus (4.1 mg/g of dry weight).

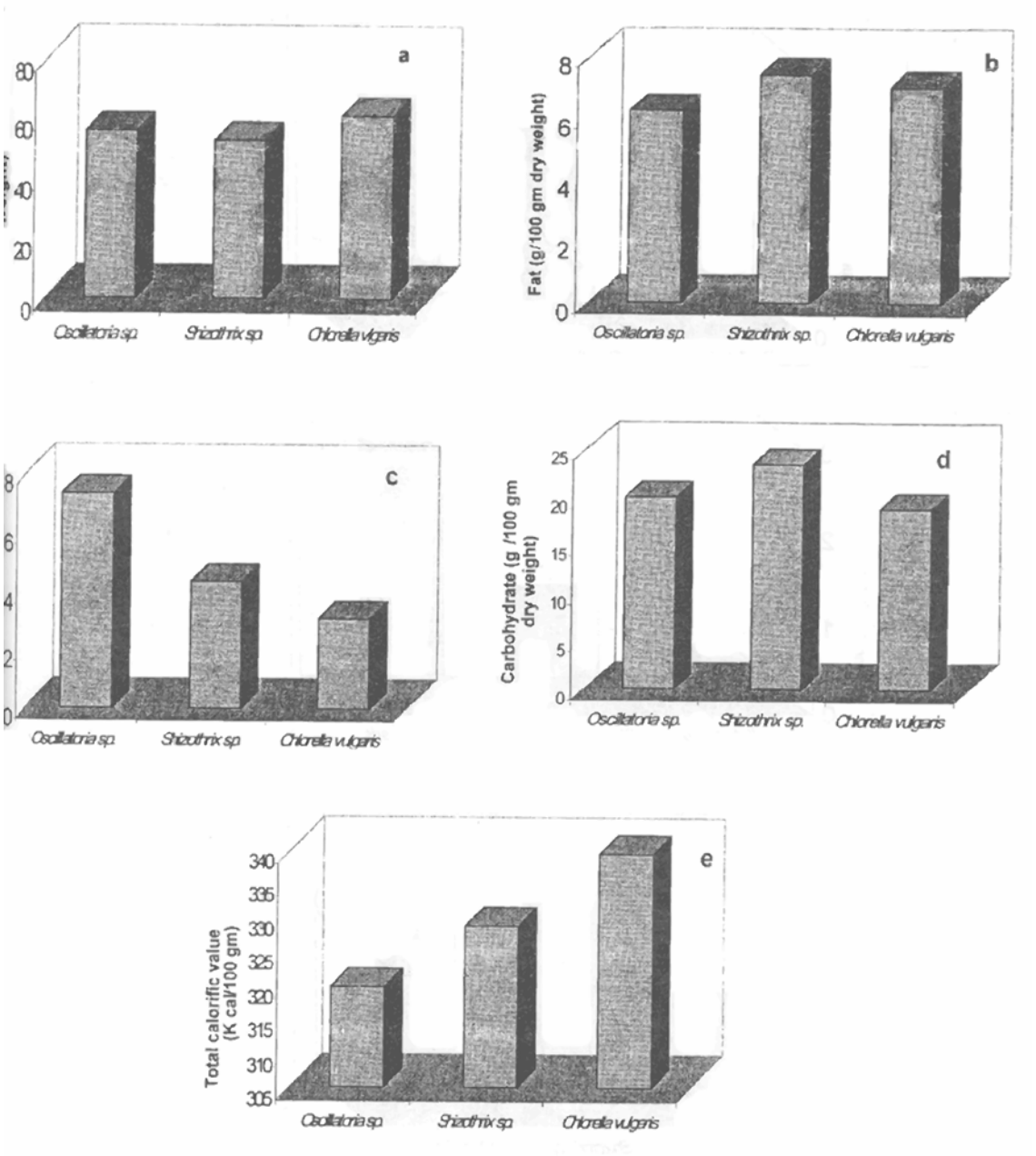

Figure 2. Approximate chemical composition (a. protein, b. fat, c. ash, and d. carbohydrate) and e. total calorific value (expressed as dry weight) of the studied algal species.

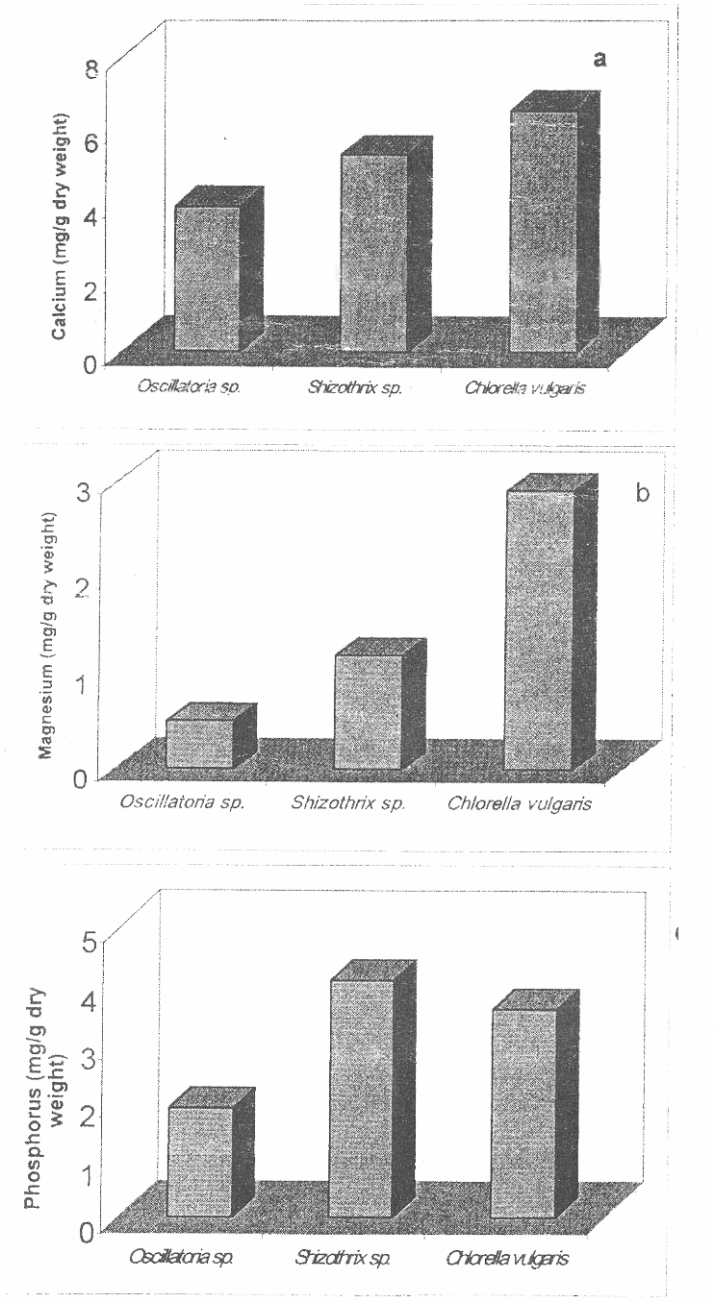

Figure 3. Minerals: a. calcium, b. magnesium and c. phosphorus (expressed as dry weight) in the studied algal species.

References

Abdulla, D.S. and Rajab, T.M.A. 1998. Chemical composition of *Chlorella vulgaris* Beijemick isolated from Shatt al-Arab River. *Marina Mesopotamica*, 13(1): 121-127.

Ackman, R.G. 1989. Nutritional composition of fats in seafood. Prog. Food. Nutri. Sci., 13: 161-241.

A.O.A.C. 1970. Official methods of analysis. 14th ed. Association of Official Analytical Chemists, Washington, D.C. 910 pp.

A.O.A.C. 1984. Official methods of analysis. 14th ed. Association of Official Analytical Chemists, Inc. S. Williams, ed., U.S.A. 1141 pp.

Atkinson, A. W.; Gunning, B. E. S. and John, P. C. I. 1972. Sporopollenin in the cell wall of *Chlorella* and other algae: Ultrastructure Chemistry, and incorporation of C^{14} acetate, studied in synchronous cultures. Planta (Berl.) 107: 1- 32.

Chuecas, L. and Riley, J.P. 1969. Component fatty acids of the total lipids of some marine phytoplankton. J. Mar. Biol. Ass. U.K., 49: 97-116.

Cresser, M. S. and Parsons,W. 1979. Sulfuric and perchloric acids digestion of plant material for the determination of nitrogen, phosphorus, potassium, calcium and magnesium. Annual. Chem. Acta., 109: 431-436.

Gurr, M.I. and Harwoods, J.L. 1991. Lipid biochemistry: an introduction, 4th ed. London, Chapman and Hall.

I.U.P.A.C. 1979. Standard methods for the analysis of oils, fats and ' derivatives, 6th ed. International Union of Pure and Applied Chemistry. Pergamon Press. C. Paquot, U.K., 170 pp.

Kattner, G.; Gerchen, G. and Eberlein, K. 1983. Development of lipids during spring plankton bloom in the Northern North Sea. 1- Particulate fatty acids. Marine Chemistry, 14: 149-162.

Lewin, R.A. 1974. Biochemical taxonomy. In "Algal physiology and biochemistry" W.D.P. Stewart, ed. Blackwell Scientific Publications, Oxford and London., 989 pp.

Lowry, O.H.; Rosebrough, N.J.; Farr, A.L. and Randall, R.J. 1951. Protein measurement with the folin phenol reagent. J. BioI. Chern., 193: 263-275.

Napolitano, G.E.; Ackman, R.G. and Ratnayake, W.M.N. 1990. Fatty acid composition of three-cultured algal species (*Isochrysis galbana, Chaetoceros gracilis* and *Chaetoceros calcitrans*) used as food for bivalve larvae. J. World Aqucult. Soci. 21(2): 122-130.

Tilden, J.E. 1968. The algae and their life relations, fundamentals of physiology. Hafner Publishing Co., New York and London, 550 pp.

Zaitsev, V.; Kizevetter, I.; Langunov, L.; Makarova, T.; Minder, L. and Podsevalov, V. 1969. Fish curing and processing. (Translated from Russian by A. Dermindol). Mir Publishers, Moscow.

المحتوى الكيميائي الحياتي لبعض الأنواع الطحلبية الدقيقة المعزولة من شط العرب

عباس عادل حنتوش و خديجة كاظم حريب

مركز علوم البحار، جامعة البصرة ، البصرة – العراق

الخلاصـــــة

تـــم تقديـــــر المحتوى الكيميائي الحياتي (البروتين، الكربوهيدرات ،الدهن والعناصـــــــر المعدنـــية) فـــي ثلاثـــــــة أنـــواع مـــن الطحالـــــــب (*Oscillatoria* sp.، *Schizothrix* sp. و *Chlorella vulgaris*) المعـــزولة مـــن نهـــر شـــط العرب . فقد لوحظ احتواء طحلب الكلوريلا *C . vulgaris* على أعلى معدل للبروتين ، فيما احتوى طحلب *Schizothrix* sp. على أعلى نسبة مـــن الدهن والكربوهيدرات. أما بالنسبة للمعادن فقد أحتوى طحلب الكلوريلا *C .vulgaris* علـــى أعلى مستوى للكالسيوم والمغنيسيوم بينما أحتوى طحلب *Schizothrix* sp. على أعلى قيمة للفسفور .يعتبر التركيب الكيميائي الحياتي عامل محتمل في تقدير القيمة الغذائية للطحالب.