PII: S0308-8146(97)00177-5

ELSEVIER

Proximate composition and caloric value of the mussel *Perna perna*, cultivated in Ubatuba, São Paulo State, Brazil

M. Tavares,[a]* M. R. P. do Amaral Mello,[a] N. C. Campos,[a] C. de Morais[b] & S. Ostini[c]

[a]Oils, Fats and Spices Section, Bromatology and Chemistry Division, Adolfo Lutz Institute, PO Box 1783, 01059-970, São Paulo, SP, Brazil
[b]Fishery Section, Food Technology Institute, Guarujá, SP, Brazil
[c]Pilot Farm of Mitiliculture, Fishery Institute, Ubatuba, SP, Brazil

Mussels of the genus *Perna perna*, cultivated in Ubatuba, São Paulo State, were analyzed for proximate composition and caloric value, month by month, during a year. From the nutritional point of view the proteins were outstanding (mean: 20.5% on a wet basis). The average contents of fats, ash and carbohydrates were, respectively, 3.24%, 2.24%, and 1.70%. The medium caloric value was 118 kcal 100 g^{-1}. There were no marked variations, in the different months of the year for the proximate composition, except for the carbohydrates. This constant in the composition of the cultivated mussels indicates that there is a possibility to exploit mussels on a commercial basis. © 1998 Elsevier Science Ltd. All rights reserved

INTRODUCTION

The regional farming of mussels began in France more than 700 years ago, it being a commercial activity growth in Europe and Asia (Marques and Pereira, 1988; Marques *et al.*, 1991). However, in Brazil, special attention was paid only recently to the farming of mussels (Marques *et al.*, 1991).

Mussel rearing has a promising future in Brazil, especially in the Ubatuba Municipality, north coast of São Paulo State, due to its propitious geographic and environmental conditions, favouring mussels growth. This has been noted in experiments by the Fishery Institute of the Agriculture and Provision Secretary of the São Paulo State and in private rearings, with *Perna perna* species (Marques and Pereira, 1989).

Taxonomically, mussels belong to the *Mytilidae* family, the genus *Perna* being one of the most important from a commercial point of view (Marques and Pereira, 1988). The species *Perna perna* is a dioecious mussel, from oceanic water, that occurs from the Espirito Santo to Rio Grande do Sul States of coastal Brazil (Marques and Pereira, 1988).

In spite of the extensive Brazilian coast, fish contributes little to food in Brazil (Silva, 1992). Despite its great nutritious value, there is insufficient information about its chemical composition, establishment of

*To whom correspondence should be addressed.

balanced diets for selected groups and the providing of important subsidies to the fish processing industry (Itô *et al.*, 1969; Mustafa and Medeiros, 1985).

Therefore, considering the promising perspective for the utilization of the mussel *Perna perna*, cultivated in the Ubatuba/SP region, on an industrial scale, and the need for knowledge of its chemical composition, this work explores its proximate composition and caloric value.

MATERIAL AND METHODS

Prime matter

During a year, mussels *Perna perna* cultivated in floating structures (long line) were collected monthly at the Pilot Farm of Mitiliculture of the Fishery Institute, in Ubatuba, São Paulo State.

Sample preparation

After harvesting, the mussel of a commercial size, that is 5–6 cm long, were thoroughly washed in running water to remove crust and mud. They were transferred to the Fishery Institute laboratory within 30 min. Upon arrival, the adductor muscle was scraped off the shells with a sharp knife. To make the flesh separate more easily, the shells were scalded with steam to the point at which

they tended to open. When heating was completed the mussels were removed from the shells and rinsed in tap water.

Shucked mussels were packed in plastic bags holding 1.0 kg and stored at −20°C for further analyses at the Oils, Fats and Spices Section of the Adolfo Lutz Institute, São Paulo City.

Determination of the proximate composition and caloric value calculation

From the properly homogenised samples the ash and proteins were determined according to AOAC (1995) methods n°938.08 and 928.08 (11), respectively (AOAC, 1995), carbohydrates, according to the Somogy-Nelson method (Aued *et al.*, 1990) and fat, according to Bligh and Dyer (Bligh and Dyer, 1959). The volatile substances content at 105°C (moisture) was expressed by difference. The caloric value was calculated by the Atwater factors (De Angelis, 1977), that is, proteins, 4.0, carbohydrates, 4.0, fat 9.0.

RESULTS AND DISCUSSION

Table 1 presents the values, obtained monthly during a year, for the proximate composition and caloric value of the mussel *Perna perna*, cultivated in Ubatuba/SP, with the respective mean and standard-deviations.

Major components were moisture, fat and proteins, that presented values within the variation band cited in the literature (Hart and Fischer, 1971) for fish. However, this did not occur with the minority components (ash and carbohydrates) (Hart and Fischer, 1971; Castro, 1988).

Although not marked, the seasonal variation of the chemical composition of the mussel meat studied must be affected, singly or together, by the different factors that act on it, e.g. the type of food (Castro, 1988; Barkati and Ahmed, 1990).

The minor content of fat (2.5%) and the major content of moisture (74.15%) were found in April, while the minor content of moisture (64.64%) was found in December, along with the second largest content of fat (3.69%). The mean value of fat (3.24%) indicates that the mussel *Perna perna* cultivated in Ubatuba/SP, is a fish of the semi-fat category (Jacquot, 1961; Castro, 1988).

It was noted that the maximum value of proteins (21.9%) occurred in October and the minimum (19.1%) in February, with a mean of 20.5%. Taking into account this mean, and that of the fat, it is possible to classify the analysed mussels into the D diet category, that is especially preferred for its low content of fat — less than 5% — and its very high content of proteins (more than 20%) (Stansby, 1973).

For ash, there was no marked variation in the contents obtained, if they were compared with results obtained for moisture and fat, as they varied from 2.16%, minimum, in December, to 2.74%, maximum, in July. It is necessary to point out that this band was higher than that reported for mussel — 1.0% to 1.5% (Hart and Fischer, 1971; Watt and Merrill, 1975). This may be explained by the significant content of mineral salts of the meat of this mollusc, mainly potassium and calcium (Watt and Merrill, 1975).

The maximum value found for the carbohydrates was reached in March (3.15%) and the minimum in August (0.63%), both being beyond reported limits 1.0% to 3.0% (Castro, 1988). This seasonal fluctuation in the carbohydrates content is directly related to the reproductive cycle (Fraga, 1958).

The fat content and the caloric value have significant correlation (Rocha *et al.*, 1982), as was verified for the minimum contents of them which occurred in April. The same can be said for the maximum values, as the second major fat values very near to the maximum and the caloric value as observed in December.

The literature reports about the proximate composition and the caloric value is not abundant, especially for

Table 1. Proximate composition and caloric value of the mussel, *Perna perna*, meat cultivated in the region of Ubatuba, São Paulo State, Brazil, during one year

	Moisture[a] (%)	Ash (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Caloric value (kcal 100 g^{-1})
January	70.61	2.31	3.49	21.2	2.36	126
February	72.58	2.26	3.36	19.1	2.67	117
March	71.38	2.31	3.78	19.4	3.15	124
April	74.15	2.36	2.56	19.6	1.38	107
May	73.23	2.66	2.69	20.5	0.9	110
June	71.83	2.45	3.11	21.6	1.04	118
July	73.48	2.74	3.18	19.7	0.90	111
August	73.12	2.23	3.36	20.7	0.63	115
September	72.37	2.70	3.35	20.8	0.81	116
October	70.77	2.29	3.58	21.9	1.42	126
November	72.24	2.60	170	19.9	2.52	114
December	69.64	2.16	3.69	21.9	2.62	131
Mean	72.12	2.42	3.24	20.5	1.70	118
Standard Deviation	1.33	0.20	0.40	0.99	0.90	7

[a]Calculated by difference.

the *Perna perna* species. Only one article was found in the bibliography consulted (Marques and Pereira, 1988) and it reports the mean content of proteins (9.9%) of the species, but not the region of the harvest of the mussel. The mussels studied in this work had a protein content higher than that obtained by Marques and Pereira. Also, the value is higher than that of species *Perna viridis*, harvested in India, that is 12.8% (George *et al.*, 1988) and that of *Mytilus edulis* of the Atlantic, or *Mytilus californianus* of the Pacific, whose value is 14.4% (Watt and Merrill, 1975).

These two species, had carbohydrate and moisture values higher than the *Perna perna* ones, but lower fat, ash and calorie values.

CONCLUSIONS

On the basis of mean values found for fat and proteins, the mussels analysed in this work can be classified at the D category for diets, that is especially chosen for low fat content and very high protein value.

The mean value of fat obtained shows that the mussel *Perna perna*, cultivated in Ubatuba, São Paulo State, is a fish of the semifat category.

The band of values found for ash, higher than the reported for mussels, can be explained by the significant content of mineral salts of the meat of this mussel.

The minimum and maximum contents of carbohydrates obtained are probably associated with seasonal fluctuations during the reproductive cycle.

The slight seasonal variation of the proximate composition of the mussel meat studied must be affected by the composition of the food (phytoplankton) at the cultivation region.

The proximate composition uniformity of the mussels cultivated in Ubatuba São Paulo State, at the different months of the year, indicates the possibility of commercial utilisation.

REFERENCES

AOAC. (1995) *Official Methods of Analysis of AOAC International.* (16th ed.), Vol. 11. Association of Official Analytical Chemists, Arlington.

Aued, S., Carvalho, J. B. de, Tavares, M., Zanelatto, A. M. and Bacetti, L. B. (1990) Determinação de amido em salsichas: comparação entre os métodos de Fehling e o de Somogyi-Nelson e avaliação de metodologia para extração do amido. *Rev. Inst. Adolfo Lutz*, 50(1/2), 251–256.

Barkati, S. and Ahmed, M. (1990) Cyclical changes in weight and biochemical composition of *Mytilus edulis* L. from Lidaspoliene, Western Norway. *SARSA* 75(3), 217–222.

Bligh, E. G. and Dyer, W. J. (1959) A rapid method of total lipid extraction and purification. *Canadian Journal of Biochemistry and Physiology* 37(8), 911–917.

Castro, L. A. B. de (1988) Bioquímica do pescado. I—Composição química. *Bol. Téc. Inst. Pesca*, 2(2), 1–16.

De Angelis, R. C. (1977) *Fisiologia da nutrição: fundamentos para nutrição e desnutrição*, Vol. 1, p. 44, EDUSP, São Paulo.

Fraga, F. (1958) Variacion estacional de la composición química del mejillon (*Mytilus edulis*). *Inst. Invest. Pesq.* 11, 33–37.

George, C., Gopakumar, K. and Rajagopalanunnithan, G. (1988) Muscle meat with reference to age and chemical constituents. *Indian Journal of Animal Science*. 58(10), 1252–1255.

Hart, F. L. and Fischer, H. J. (1971) *Análisis moderno de los alimentos.* Zaragoza, Acribia, p. 249.

Itô, Y., Sanches, L. and Silva, D. R. da (1969) Seasonal variation of the chemical composition of sardine. *Constrções Institute of Oceanography, University of Sao Paulo*,(6), 1–18. (Série Tecnologia).

Jacquot, R. (1961) Organic constituents of fish and other aquatc animal foods. In *Fish as food*, ed. G. Borgstrom, Vol. 1, pp. 145–209, Academic Press, New York.

Marques, H. L. de A. and Pereira, R. T.L (1988) Mexilhões: biologia e criação. *Bol. Téc. Inst. Pesca* 12, 1–32.

Marques, H. L. de A. and Pereira, R. T. L. (1989) Levantamento e dimensionamento preliminares das áreas mais favoráveis para a prática da Mitilicultura no litoral do Município de Ubatuba, Estado de São Paulo (23°26'S. 045°04'W). *Bol. Téc. Inst. Pesca* 13, 1–10.

Marques, H. L. de A., Pereira, R. T. L. and Correa, B. C. (1991) Crescimento de mexilhão *Perna perna* (LINNAEUS, 1758) em populações naturais no litoral de Ubatuba (SP), Brasil. *Bol. Inst. Pesca* 18 (único), 61–72.

Mustafa, F. A. and Medeiros, D. M. (1985) Proximate composition, mineral content and fatty acids of catfish (*Ictalurus punctatus*, Rafinesque) for different seasons and cooking methods. *Journal of Food Science* 50, 585–588.

Rocha, Y. R. da, Aguiar, J. P. L., Marinho, H. A. and Shrimpton, R. (1982) Aspectos nutritivos de alguns peixes da Amazônia. *Acta Amazônica* 12(4), 787–794.

Silva, S. M. C. S. da. (1992) *Efeitos do processamento sobre ácidos graxos polinsaturados da fração lipídica de duas espécies de peixes*, p. 136. Tese—Mestrado—Faculdade de Ciências Farmacêuticas da Universidade de São Paulo, São Paulo.

Stansby, M. E. (1973) Polyunsaturates and fat in fish flesh. *Journal of American Diet Association* 63, 625–630.

Watt, B. K. and Merrill, A. L. (1975) *Handbook of Nutritional Contents of Foods.* Dover, New York.