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Full Length Research Paper

Exploring the Lipid Profile of Wedge Clam (*Donax cuneatus*): Implications for Nutrition

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The fatty acid composition of the wedge clam *Donax cuneatus* collected from the sandy beach of Cuddalore (southeast coast of India) was determined. In the analysis, the fatty acid profile by gas chromatography revealed the presence of higher amount of saturated fatty acids (35.28%) than mono (12.71%) and polyunsaturated (11.72%) fatty acids. Among the saturated fatty acids, the stearic acid contributed the maximum amount of 15.68%. Whereas the monounsaturated fatty acids (MUFA) were accounted for 26.57% with mostly 16:1ω7c (12.71%), fatty acid. Among the PUFA 20:4 ω6c (6.75%) and 18:2 ω6c (2.41%) acid contents were high. Omega – 6 fatty acids accounted for 10.74% of total PUFA and omega – 3 fatty acids were accounted for 0.48%. Thus the present study enlightens the possible role of this clam in the field of human nutrition.

Key words: Fatty acids, SFA, MUFA, PUFA, *Donax cuneatus*

INTRODUCTION

Three quarters of the children who die worldwide of malnutrition–related causes are mildly to moderately malnourished and betray no outward signs of problems (Unicef report, 1998). Anemia, vitamin A and iodine deficiency are often encountered in malnutrition, but a shortage of EFA and its metabolites may also be involved. For example, a dry skin and impairment of the immune sys-tem are clinical symptoms of both malnutrition and essential fatty acids deficiency (EFD) (Linscheer and Vergroesen, 1994; Torun and Chew, 1994). Bivalve molluscs comprise major marine fishery resources that also include Gastropoda and Cephalopoda. In India, among the molluscs, several species of gastropods and bivalves are traditionally fished for food and shell, particularly in coastal rural areas. In shallow estuaries and bays, women and children also participate in collecting them as a source of nutritious food. The annual production of gastropods and bivalves is estimated at about 1, 00,000 tonnes. The annual production of cephalopods is about 1, 05,000 tonnes and the export earnings are over 24000 US dollars. Fishing for molluscs provides employment and income to 100 thousands of people, particularly to those living in coastal rural areas. The farming of bivalves is fast picking up, and during 2002, the production of oysters was estimated at 350 tonnes and mussels 1250 tonnes (Narasimham, 2005). In recent years, the polyunsaturated fatty acids (PUFAs) have been recognized as effective factors in human health and nutrition, especially for cardiovascular diseases (Bruckner, 1992; Dyerberg, 1986; Kinsella, 1987a; Kinsella, 1987b). The molluscs are excellent sources of PUFAs such as 20:5 n-3 and 22:6 n-3. In order to fulfill the demand for malnutrition and medicinal point of view, the present study was carried out to analyze the fatty acid composition of the wedge clam *Donax cuneatus*.

MATERIALS AND METHOD

Specimens of *D. cuneatus* were collected from Cuddalore (Lat.11^{0}43'N: Long 79^{0}49'E). The animals were isolated by removing the shells and kept for complete drying. The dried tissue materials were finely powdered for estimation of fatty acid content. An extraction procedure for fatty acid was followed from Bligh and Dyer (1959). Identification and quantification of fatty acids were done using Agilent Technologies 6890 N, Network GC system.

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Table 1. Fatty acid profile (% of total fatty acids) from *D. cuneatus.*

S/No	Fatty acids	% composition
SATURATED FATTY ACIDS (SFA)		
1.	12:0	0.30%
2.	13:0	1.14%
3.	14:0	7.15%
4.	15:0 ISO	0.33%
5.	15:0 ANTEISO	0.46%
6.	15:0	2.21%
7.	16:0 ISO	0.35%
8.	16:0 2OH	0.49%
9.	17:0 ISO	1.23%
10.	17:0 ANTEISO	0.63%
11.	17:0	2.86%
12.	17:0 ANTEISODMA	0.17%
13.	18:0	15.68%
14.	18:0 2OH	0.43%
15.	19:0	0.56%
16.	19:0 2OH	0.14%
17.	20:0	0.75%
18.	21:0	0.20%
19.	22:0	0.60%
20.	23:0	0.20%
21.	24:0	0.40%
MONOUNSATURATED FATTY ACIDS (MUFA)		
22.	14:1ω8c	0.28%
23.	16:1ω7c	12.71%
24.	16:1ω5c	0.35%
25.	17:1ω8c	0.56%
26.	18:1ω9c	11.18%
27.	19:1ω11c	0.22%
28.	19:1ω8c	0.43%
29.	21:1ω11c	0.36%
30.	21:1ω7c	0.46%
POLYUNSATURATED FATTY ACIDS (PUFA)		
31.	16:2ω6c	1.05%
32.	18:3ω6c	0.76%
33.	18:2ω6c	2.41%
34.	20:4ω6c	6.75%
35.	22:3ω3c	0.48%
36.	24:2ω6c	0.27%

RESULT AND DISCUSSION

Fatty acids are the fundamental structural components of practically all forms of lipids. Essential fatty acids (EFA) are important components of structural lipids and contribute to the regulation of membrane properties like fluidity, flexibility, permeability and modulation of membrane bound proteins. The term 'essential' implies that they must be supplied in the diet because they are required by the human body and cannot be endogenously synthesized.

In the present study, 36 individual fatty acids were identified. Among them the saturated fatty acids were the dominant fatty acids (35.28%) and most of which were 18:0 (15.68%) and 14:0 (7.15%) (Table1). The monounsaturated fatty acids (MUFA) were the next most common fatty acids (26.57%) with the higher levels of 16:1ω7c (12.71%) and 18:1ω9c (11.18%). The PUFA occupying the third position contributed 11.72% of total fatty acids, represented by 20:4 (6.75%) and 18:2 (2.41%) together accounted for about 90% of the PUFA (Table 1). At the same time the Omega – 6 and omega - 3 fatty acids accounted for 10.74% and 0.48% of the total PUFA.

In the freeze dried and frozen samples of green lipped mussels of *Perna canaliculus*, among the 30 individual fatty acids, polyunsaturated fatty acids were found to be dominant (40 – 41% of total PUFA) (Murphy et al., 2003). Likewise in abalones (both wild and cultured), the saturated, MUFA and PUFA contributed 31 – 32%, 19 – 22% and 47 – 49% respectively (Dunstan et al., 1996). In the present study also more or less the same saturated and MUFA content is reported. But there is a drastic difference found in the PUFA level.

PUFA tends to reduce the blood cholesterol levels and is considered a "good" fat. In the present study arachidonic acid (C 20:4) contributed 6.75% of the total PUFA content. Among the various nutrients supplied by the diet, PUFA with 20 and 22 carbons and more than three double bonds, which are sparingly, or not at all, biosynthesized by bivalves, are essential for survival, growth and reproduction of the molluscs (Delaunay et al., 1993; Langdon and Waldock, 1981; Trider and Castell, 1980). These 20- or 22-carbon PUFA, notably 22:6(*n*-3), 20:5(*n*-3) and 20:4(*n*-6), are of particular importance in membrane phospholipids. Arachidonic acid has been proved effective in improving egg quality (Uki et al., 1986) and survival at the early life stages of fish (Sargent et al., 1999; Uki et al., 1986; Castell et al., 1994). Since *D. cuneatus* is reported to be having 6.75% of arachidonic acid, it could be contributed as a good source of these fatty acids.

Further some of the polyunsaturated fatty acids are found to be needed for better growth and survival of the cultivably important finfishes. In common carp *Cyprinus carpio*, one of the most important cultured fish showed an EFA requirement of 1% each of both 18:3ω3 and 18:2ω6 for the best weight gain and feed conversion (Watanabe et al., 1975). The eel (*Anguilla japonica*), another important cultured warm water fish also reported a requirement for both 18:3ω3 and 18:2ω6 at the level of 0.5% each (Takeuchi et al., 1980). A tropical herbivore, *Tilapia zilli* was found to require ω6 rather than ω3 fatty acids. The dietary requirement of 18:2ω6 or 20:4ω6 was about 1% in the diet (Kanazawa et al., 1980). In the present study 2.41 and 6.75% of 18:2ω6 and 20:4ω6 fatty acids were reported in *D. cuneatus* and hence it could be suggested that *D. cuneatus* is a good source of these polyunsaturated fatty acids which might be used as a good seafood for fisher folk and also by the aquaculturists for formulating feed. Coldwater fish are likely to be more demanding in ω3 and ω6 requirements for essential fatty acids than warm water fish because constraints imposed in maintaining membrane fluidity are greater at low temperature (Hazel, 1979). Holman (1998) described ω3FA deficiency in patients with neuropathy, while in an interesting review article Yoshida et al. (1998) report on low DHA levels in patient suffering from schizophrenia, depression, dementia, parkinsonism and other behavioural disorders. They describe that in some of the cases ω3FA supplementation had positive effects on the neurological symptoms. Hence dietary intake of omega – 3 fatty acids is helpful in pronouncing less inflammatory responses towards bronchial asthma, lupus erythematosus multiple sclerosis, psoriasis and kidney diseases and also inhibit the development of cancer cells. In this study ω3FA has been estimated to be 0.48%. So intake of this animal (*D*. *cuneatus*) may help neurological symptoms as reported by Holman (1998).

The ω3 and ω6 long chain poly unsaturated fatty acids (LCPUFA) contents in brain increased up to at least 2 years of age (Yoshida et al., 1998). Next to ω3 and ω6 LCPUFA there is after birth also a high demand for ω9FA, because ω9FA are high in myelin, which is formed very rapidly in the early postnatal period (Martinez, 1992; Crawford et al., 1981; Clandinin et al., 1980; Martinez and Mougan, 1998). Maternal FA metabolism is crucial for foetal growth and development, and the foetus is completely dependent on the mother for its EFA supply. This is also primarily the case for LCPUFA accumulation. Although it is generally accepted that foetal conversion of parent EFA to LCPUFA does occur, this process is most probably insufficient to meet the very high needs (Uauy et al., 2000; Chambaz et al., 1985; Poisson et al., 1993). Holman et al. (1982) described a case of ALA deficiency involving neurological abnormalities in a 6 years old girl. In this study ω9FA was recorded 11.18% from *D. cuneatus*. From this investigation it is clearly understood that *D. cuneatus* might be used as alternative cheap sources of ω3 and LCPUFA, as this content have been used as it increase up to at least 2 years of age, demand of after birth and prevent the neurological abnormalities.

The EFA requirements of infants and children are presumably higher than for adults because of the need for structural lipid synthesis associated with growth (Innis, 1991). The estimated daily LA requirements range from 1 to 4.5% of energy intake (en %) (Innis, 1991) . Skin changes can possibly be ascribed to deficiency of LA *per se*, or to the lower levels of PG precursors 20:3ω6 and AA (Linscheer and Vergroesen, 1994; Horrobin, 1990; Hansen et al., 1963). Recent studies indicate that EFA regulate cell adhesion by modifying the expression of cell adhesion molecules, suggesting that EFAD induces pathological features in the skin (Jiang et al., 2000).

In the present study also the linoleic acids were recorded 2.41%. In future the consumption of *D. cuneatus* might fulfill the daily requirements of LA and prevent the skin changes. Holman et al. (1982) calculated the mi-nimal ALA requirement at 0.54% en% for a 7-year-old girl. In the present study α - linoleic acid was found in 0.76%. This requires a better knowledge of the nutrition of this species (*D. cuneatus*).

The second type of fat is MUFA. These fats are often referred to as “good” fats because studies have shown that they help reduce blood cholesterol levels and protect against heart disease. These suggested fats are all mono unsaturated or polyunsaturated fats because of their benefits to health. In the present study MUFA was recorded at 26.57%, among the MUFA 16:1ω7c (12.71%) and 18:1ω9c (11.18%) was dominant. Gastropods have been found to contain 18: 1 major fatty acid (Ackman et al., 1971; Johns et al., 1980). Oleic acid (18:1) contributed more than 10% in *Chlamys tehuecha* (Pollero et al., 1979). In the present investigation *D. cuneatus* showed 18:1ω9c acid levels of (11.18%). But in the earlier studied the MUFA content was reported as 23% in the FD and frozen Green Lipped mussel in *P. canaliculus* (Murphy et al., 2003)

In the present study, saturated fatty acids such as lauric acid, tridecanoic, myristic, pendecanoic, palmitic, heptadecanoic, stearic, nonadecanoic, arachidic, heneicosanoic, behenic, tritricosanoin and lingoceroyl acid were found in *D. cuneatus* and collectively the saturated fatty acids were present in much greater quantity than unsaturated ones. Among the SFA, stearic acid occurred in largest quantity among all the fatty acids quantified. It is the highest molecular weight SFA occurring abundantly in fats and oils. SFA such as capric, lauric, tridecylic and myristic acids were especially active in antisporulation (Hardwick et al., 1951) and also the recent uses of lauric acid are in the manufacture of soaps, shampoos and other surface active agents, including special lubricants. Lauric acid has monoglyceride properties and it may play a role in combating lipid – coated RNA and DNA viruses. In the present study the lauric acid ranks fifth position among the SFA reported as far as its’ quantity (0.30%) is concerned.

The water soluble esters of lauric acid and of palmitic acid (Tween 20 - polyoxyethylene sorbitan monolaurate), G2144 and Tween 40 (polyoxyethylene sorbitan monopalmitate) exhibited appreciable bacteriostatic and bactericidal activity against tubercle bacilli in concentrations of 0.01 to 0.001%, but esters of stearic and oleic acid (Tween 60 (polyoxyethylene sorbitan monostearate) and Tween 80 (PSM, polyoxyethylene sorbitan monoleate) were found inhibitory only at higher concentrations (Dubos, 1947). In this study lauric and palmitic acid was recorded 0.30 and 0.35%. Therefore *D. cuneatus* would be a better alternative source (against tubercle bacilli and bactericidal effect), since it contains (0.30 and 0.35%) both palmitic and lauric acids.

In an earlier study, the sum of the saturated fatty acids was found to be ranging from 16.8 to 22.5% in five species of bivalves and among the individual components, 16:0 and 18:0 fatty acids contributed more (Zhukova and Stetashve, 1986) Whereas in the present study saturated fatty acids was recorded still higher (35.28%) with a contribution of 16.11% by the 18:0 fatty acids. In general, seafood is one of the most nutritionally balanced foods. The seafood diet helps to control weight and goes a long way towards preventing heart diseases. Studies on fatty acid composition of commercial sea foods in India are limited. This might be due to the lack of awareness on benefits of these nutrients particularly from molluscan meat. The nutritional values of bivalves are not being brought to the limelight so far, so consumption of these nutrient rich molluscs is still as reserved food source. The results of the present study provides not only the information about the fatty acid composition but also recommended the consumption of this wedge clam *D. cuneatus* since they are rich in stearic, linoleic, omega – 3 and arachidonic acid. It could also be added that the consumption of marine bivalves is a nutritional assurance to millions of malnourished hungry people. The malnutrition problem in our country can be overcome by effective utilization of nutrient rich molluscan seafood. Further the presence of 18:3ω3 and 18:2ω6 fatty acids in this wedge clam adds more value on this wedge clam *D. cuneatus* through the possibility of utilizing this clam in the aquaculture feed Industry also as a non–conventional ingredient.

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