Some valuable fatty acids exposed from wedge clam

Donax cuneatus (Linnaeus)

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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 system 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°43’N: Long 79°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.
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%) (Table 1). 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) and 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 polyunsatur-
ted fatty acids which might be used as a good seafood for
tisher folk and also by the aquaculturists for formulating
feed. Coldwater fish are likely to be more demanding in
\( \omega 3 \) and \( \omega 6 \) requirements for essential fatty acids than
warm water fish because constraints imposed in main-
taining membrane fluidity are greater at low temperature
(Hazel, 1979). Holman (1998) described \( \omega 3 \)FA 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, demen-
tia, parkinsonism and other behavioural disorders. They
describe that in some of the cases \( \omega 3 \)FA supplemen-
tation had positive effects on the neurological symptoms.
Hence dietary intake of omega – 3 fatty acids is helpful in
pronouncing less inflammatory responses towards bron-
chial asthma, lupus erythematosus multiple sclerosis,
psoriasis and kidney diseases and also inhibit the de-
velopment of cancer cells. In this study \( \omega 3 \)FA has been es-
imated to be 0.48%. So intake of this animal (D. cunea-
tus) may help neurological symptoms as reported by

The \( \omega 3 \) and \( \omega 6 \) 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 \( \omega 3 \) and \( \omega 6 \)
LCPUFA there is after birth also a high demand for \( \omega 9 \)FA,
because \( \omega 9 \)FA are high in myelin, which is formed very
rapidly in the early postnatal period (Martinez, 1992;
Crawford et al., 1981; Claudinin et al., 1980; Martinez
and Mougan, 1998). Maternal FA metabolism is crucial
for foetal growth and development, and the foetus is com-
pletely dependent on the mother for its EFA supply. This
is also primarily the case for LCPUFA accumulation. Al-
though 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).
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Holman et al. (1982) described a case of ALA deficiency
involving neurological abnormalities in a 6 years old girl.
In this study \( \omega 9 \)FA was recorded 11.18% from D. cunea-
tus. From this investigation it is clearly understood that D.
cuneatus might be used as alternative cheap sources of
\( \omega 3 \) and LPFUFA, 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 pre-
sumably 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 20:3\( \omega 6 \) and AA
(Linscheer and Vergroesen, 1994; Horrobin, 1990; Han-
sen et al., 1963). Recent studies indicate that EFA regu-
late cell adhesion by modifying the expression of cell
adhesion molecules, suggesting that EFAD induces pa-
thological features in the skin (Jiang et al., 2000).

In the present study also the linoleic acids were record-
ed 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 \( \alpha \) - 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 be-
nefits to health. In the present study MUFA was recorded
at 26.57%, among the MUFA 16:1\( \omega 7c \) (12.71%) and
18:1\( \omega 9c \) (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 teheucha (Pollero et al.,
1979). In the present investigation D. cuneatus showed
18:1\( \omega 9c \) 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 lau-
ric acid, tridecanoic, myristic, palmitic, heptadecanoic,
stearic, nonadecanoic, arachidic, heneicosanoic,
behenic, triticosanoin and lignoceroyl acid were found in
D. cuneatus and collectively the saturated fatty
acids were present in much greater quantity than unsatu-
rated ones. Among the SFA, stearic acid occurred in larg-
est 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, tridecylc 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 lubri-
cants. 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 - poloxymethylene sorbitan monola-urate),
G2144 and Tween 40 (poloxymethylene sorbitan mono-
palmitate) exhibited appreciable bacteriostatic and bac-
tericial activity against tubercle bacilli in concentrations
of 0.01 to 0.001%, but esters of stearic and oleic acid
were found inhibitory only at higher concentrations (Du-
bos, 1947). In this study lauric and palmitic acid was rec-
ored 0.30 and 0.35%. Therefore D. cuneatus would be a
better alternative source (against tubercle bacilli and bac-
tericial 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 (Zukova 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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