J. Fish. Sci. Tech. 4(4), 261~264, 2001

JOURNAL OF
FISHERIES SCIENCE
AND TECHNOLOGY

〈NOTE〉

Seasonal Variation in Fatty Acid Composition in Female Pen Shell (*Atrina Pectinata*)

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(Received June 2001, Accepted December 2001)

Seasonal variation in fatty acid profiles was examined in the visceral mass and the posterior adductor muscle of the female pen shell, *Atrina pectinata*. Total percentages of saturated fatty acids were similar between the two organs, and there was not a prominent seasonal change in both tissues. While the percentages of highly unsaturated fatty acids (HUFAs) in the visceral mass were higher than those in the posterior adductor muscle, monounsaturated fatty acids (MUFAs) were high in the posterior adductor muscle. HUFA contents, especially in 20:5ω3, 22:5ω3 and 22:6ω3, markedly decreased in September in the visceral mass, and this decrease was associated with a corresponding total MUFAs in the same organ. A similar pattern of change in September was noted in the posterior adductor muscle MUFAs and HUFAs. These results indicate that 20:ω3 and 22:ω3 HUFA changes in the visceral mass and posterior adductor muscle reflect the reproductive stages in pen shell.

Key words: Pen shell, fatty acids, HUFA, ω3 fatty acids

Shellfishes are important sources of highly unsaturated fatty acids (HUFA) such as eicosapentaenoic acid (EPA, 20:5ω3) and docosahexaenoic acid (DHA, 22:6ω3). As these HUFA are known to exert a preventive role against cardiovascular diseases in human (Brown and Roberts, 1991), much attention has been paid to the component profiles in shellfish foods. Fatty acid profiles reflect in general the characteristic pattern of phytoplanktons which shellfishes utilize in their food web (Joseph, 1982). As the reproductive activity of pen shell is closely dependent in turn on food availability (Yoo and Yoo, 1984), information in fatty acid changes will help delineate the importance of particular fatty acids in reproductive process of pen shell.

To our best knowledge, however, few studies have dealt with variations of fatty acid percentages in pen shells (Jeong et al., 1998). We conducted this study to obtain data for the estimate of pen shell as a seafood in terms of nutritional value. In addition, as a promising artificial culture species, the knowledge on seasonal variation of fatty acid composition in pen shell is useful for understanding of wild habitat physiology.

Pen shells were collected by scuba diving from the coast off Boryong City, Chungnam, Korea between March and December 1999. Female samples of 23~27 cm long (n=10 each month) were frozen in a deep-freezer until analysis. Tissues of about 1 g were homogenized with 50 mL methanol. Fifty mL chloroform was added, kept at room temperature for 60 min, and filtered. $ZnSO_4$ solution (0.5%) amounting to 40% of total chloroform used was added and the mixture was vigorously shaken in a separatory funnel. The lower phase was retrieved and concentrated in a rotary evaporator (30℃) in vacuo. Equal aliquots of the concentrate from each sample were pooled for trans-methylation. The fatty acids were esterified with 14% BF_3-methanol solution (Met-

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calfe and Schmitz, 1961).

The fatty acid methyl ester composition was analyzed by capillary gas chromatography method with a Varian 3400 gas chromatography coupled with a split/splitless capillary injector and a flame ionization detector. Fatty acid esters were resolved in a silica-coated capillary column (0.25 mm i.d.× 25 m). The column temperature was programmed to be held at 170℃ for 3 min, followed by 4℃/min rate increase to 210℃. Hydrogen was used as carrier gas. Resolved compounds were identified by comparing retention time to those of standards run under the identical condition.

The percentages of saturated fatty acids were almost constant (25.5~29.5%) in all four months in both tissues (Table 1). The predominant fatty acid of these saturated fatty acids, palmitic acid (16:0), or other minor acids like 14:0 or 18:0, did not fluctuate, either. While the nutritional content changes in the visceral mass is reflective of gonadal oogenic activity, the ones of posterior adductor muscle suggest a reserved energy supply process. Thus the overall constancy in saturated fatty acid percentages imply that saturated fatty acids are not direct components for reproductive activity. A similar yearly invariability in saturated fatty acids has also been reported in the gonad of scallops (Besnard et al., 1989).

HUFA percentages were high in the visceral mass, accounting for about 50% all around the year except September (Table 1). While this HUFAs were higher in the visceral mass than the posterior adductor muscle, MUFAs were higher in the posterior adductor muscle. The marked decrease in HUFA contents, especially in EPA, 22:5ω3 (docosapentaenoic acid: DPA) and DHA, markedly decreased in September in the visceral mass, was related to a reciprocal increase in total MUFAs in the same organ. A similar, although minor, pattern of change was observed in the posterior adductor muscle MUFAs and HUFAs in September.

The ω3 fatty acids have been proposed as key lipid constituents essential for oocyte formation, growth and release. For example, it was demonstrated that high proportions of HUFAs, in particular, DHA in released larvae is closely related to better growth in flat oysters (Berntsson et al., 1997). Langdon and Waldock (1981) and Enright et al. (1986) stressed the role of rich 20:5 and 22:6 fatty acids for successful growth in *Crassostrea gigas* and *Ostrea edulis*, respectively. Fatty acids fed in diet to broodstock are transferred to the released larvae (Helm et al., 1991; Frolov and Pankov, 1992; Whyte et al., 1989). It is generally accepted that these ω3 HUFA changes are indicative of microalgal fatty acid compositions on which the bivalves feed (Caers et al., 1997). Thus the high proportion of these fatty acids in the visceral mass of pen shell may indicate the readiness of this bivalve for oogenesis. The high levels of DHA and EPA may eventually result in high levels of these acids in the larvae of pen shell.

From our data and those from other bivalves

Table 1. Seasonal variation in fatty acid compo-sition of the female pen shell, *Atrina pectinata*

Fatty acids	Visceral mass (%)				Posterior adductor muscle (%)			
	Mar.	Jun.	Sep.	Dec.	Mar.	Jun.	Sep.	Dec.
14:0	3.80	3.22	4.12	4.60	5.00	4.31	4.22	3.91
16:0	17.4	16.2	17.8	15.0	18.4	16.1	15.0	16.1
18:0	3.11	3.20	2.60	3.53	3.23	3.31	3.40	4.60
others	4.30	2.92	2.70	5.03	2.92	2.80	5.21	1.02
Σsat	28.6	25.5	27.2	28.1	29.5	26.5	27.8	25.6
16:1	9.92	8.31	9.11	8.60	10.4	12.5	12.6	13.1
18:1	10.2	6.61	8.40	7.54	18.2	16.3	16.2	16.9
20:1	1.12	1.71	2.40	2.00	2.60	2.00	2.50	2.23
22:1	0.15	0.70	2.52	0.82	1.30	nd	1.31	nd
24:1	nd	0.20	0.31	0.18	1.22	nd	1.60	1.64
others	0.15	3.12	7.20	1.30	0.60	3.22	4.21	3.86
Σmono	21.5	20.6	29.9	20.4	34.3	34.0	38.4	37.7
16:3ω3	1.62	3.21	1.60	3.70	1.23	3.62	0.04	2.20
18:2ω6	0.50	0.60	0.22	0.38	0.72	1.63	0.55	0.50
18:4ω3	2.31	2.22	3.40	3.30	1.90	0.37	nd	2.00
20:4ω3	nd	1.13	2.18	0.92	0.58	nd	nd	0.06
20:4ω6	1.32	1.00	5.00	4.02	nd	2.00	0.11	0.14
20:5ω3	18.8	16.3	10.9	12.2	13.1	14.4	11.0	12.6
22:5ω3	8.20	14.3	6.42	12.1	7.21	5.51	5.40	6.91
22:6ω3	13.2	12.4	9.70	11.6	8.90	9.80	6.24	5.41
others	4.00	2.80	3.52	3.30	2.60	2.21	10.5	6.90
Σpoly	49.9	53.9	42.9	51.5	36.2	39.5	33.8	36.7

Lipid extracts from 10 pen shells were pooled prior to gas chromatographic analysis. Injection to the GC column was repeated 3 times and their mean values were used for data. Injection-to-injection variation was within 25% for all fatty acids. Σsat, sum of saturated fatty acids; Σmono, sum of monounsaturated fatty acids (MUFAs); Σpoly, sum of highly unsaturated fatty acids (HUFAs); nd, not detected

(Berntsson et al., 1997; Langdon and Waldock, 1981; Enright et al., 1986), it is reasonable to deduce that the variations of ω3 HUFA are intimately related to the reproductive cycle of pen shell. Baik (1998) observed that spawning of the pen shell inhabiting the study area is completed by September. Thus the ω3 HUFA percentages in the visceral mass might have been decreased when pen shells underwent spawning. It seems that DPA is also important, in addition to EPA and DHA, in pen shell for reproductive process although no one has ever reported the importance of DPA.

In both male and female molluscs, the polar lipid fatty acid composition is important for maintenance of reproductive function in association with membrane integrity (Sargent, 1995). HUFAs such as EPA, DHA and 20:4ω6 in polar lipids are essential for early survival and growth (Trider and Castell, 1980). The impact of these essential fatty acid deficiency in diet is thus closely reflected in the membrane fatty acid composition and reproductive function (Saudant et al., 1996). As we had not performed the separation of different classes of lipids prior to fatty acid analysis, it was not possible to estimate the seasonal trend specifically in polar lipid classes.

In summary, we observed a marked seasonal fluctuation in HUFAs in the visceral mass and an accompanying minor change in the visceral mass. As saturated fatty acids were seasonally invariable, compensation for the HUFA changes occurred as content changes in MUFAs. It is likely that the change in HUFAs mirrors the reproductive stage occurring in pen shell over the year. The high HUFA contents in the posterior adductor muscle, the main edible part, confirm that pen shell is a valuable food source for unsaturated fatty acids.

The present data will be useful for estimating the nutritional value of pen shell captured in the western coast of Korea. They will also provide the information useful for understanding of pen shell ecology inhabiting the area.

Acknowledgements

This work was supported by 『Korea Sea Grant Program』 of the Ministry of Maritime Affairs and Fisheries (MOMAF-2000-102-F6201).

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