Short Paper

Content and Composition of Glyceryl Ethers in the Pyloric Ceca and Ovaries of the Starfish *Distolasterias nippon*, *Asterina pectinifera*, and *Lysastrosoma anthosticta*

Kenji Hayashi

Faculty of Fisheries, Hokkaido University, Hakodate, Hokkaido 041-8611, Japan

(Received November 27, 1997)

Key words: starfish, pyloric cecum, ovary, lipid, diacyl glyceryl ether, glyceryl ether, batyl alcohol

Glyceryl ethers (GE) of marine origin are made useful as natural surface-active or softening agents in cosmetics and ointments. It is now known that the starfish *Asterias rubens*,¹⁾ *A. lincki*,²⁾ *Ctenodiscus crispatus*,²⁾ and *Pteraster militaris*,²⁾ all contain significant amounts of GE present in the form of diacyl glyceryl ethers (DAGE) in the pyloric cecal and/or gonadal lipids. Recently, we have found another species of the starfish *Solaster paxillatus* and *A. amurensis* that have relatively high levels of those two lipid types in both the pyloric cecal and ovarian lipids.³⁾ These species are a good source of GE.⁴⁾ In this paper, a further study was made for the lipid content and class composition and GE content and composition of the pyloric ceca and ovaries in the starfish *Distolasterias nippon*, *Asterina pectinifera*, and *Lysastrosoma anthosticta*. Additionally, in order to clarify the direct accumulation of GE from the dietary sources, the content and composition of these compounds in the tissues of *D. nippon* were compared with those in the hepatopancreas of the scallop *Patinopecten yessoensis*, which was food for *D. nippon*.

Seven female specimens of *D. nippon* were caught from a depth of 40 m off Oumu of Hokkaido Prefecture in September 1993. Eighteen female specimens of *A. pectinifera* and thirty-eight of *L. anthosticta* were collected from the tideland at Toi and at Usujiri near Hakodate in July and in April of the same year, respectively. Forty specimens of *P. yessoensis* were collected from the fishing ground of *D. nippon* in October 1989. These species were kept frozen at -20°C for a few months until analysis. The pooled tissue samples of each of the pyloric ceca and ovaries of the starfish species and the hepatopancreas of the scallop were used individually for lipid extraction (Table 1). Lipid extraction and analysis were performed as described in previous reports.^{5–7)}

Lipid content and class composition of the different tissues of the starfish *D. nippon*, *A. pectinifera*, and *L. anthosticta* and the scallop *P. yessoensis* are listed in Table 1. Table 1 also shows the content and composition of unsaponifiable matter isolated from the tissue neutral lipids of the above four species. The pyloric ceca of *D. nippon* and *A. pectinifera* yielded 5.5% and 5.0% of lipids on a wet weight basis, respectively, being relatively higher than those in *L. anthosticta* (2.2%). In comparing the pyloric cecal lipids, its contents of the examined starfish appeared to

be lower than those in *S. paxillatus* (12.8%)³⁾ and *A. amurensis* (7.7%).³⁾ On the other hand, those of the ovarian lipids (1.7–2.2%) of the examined starfish, closely similar to those in *A. amurensis* (2.1%),³⁾ were relatively lower than those in *S. paxillatus* (11.2%).³⁾

The pyloric cecal lipids of *D. nippon* studied contained a relatively high percentage of triglycerides (TG: 56.0%) with phospholipids (PL: 15.9%) and DAGE (13.4%). Conversely, the ovarian lipids of this species were characterized as being rich in PL (45.9%) and TG (30.2%) but poor in DAGE (6.0%). Whereas, both different tissue lipids of *A. pectinifera* and *L. anthosticta* examined had a remarkably high percentage of PL (32.9–44.4% for the former species; 43.6–50.2% for the latter ones) with TG (7.6–15.5%; 15.4–22.3%) and DAGE (0.9–3.2%; 4.6–5.6%). The DAGE contents (13.4%) of the pyloric cecal lipids of *D. nippon*, similar to those in *A. amurensis* (13.8%),³⁾ were low compared with those in *S. paxillatus* (26.6%).³⁾ Also, the contents of these compounds (3.2–6.0%) of the ovarian lipids of the examined starfish were somewhat similar to those in *A. rubens* (10.9%)¹⁾ and *A. amurensis* (8.6%)³⁾ but were lower than those in *A. paxillatus* (86.0%),³⁾ *C. crispatus* (over 70%),²⁾ *P. militaris* (66%),²⁾ and *A. lincki* (40%).²⁾

The unsaponifiable matter isolated from the tissue neutral lipids of the examined starfish accounted 18.1–29.0%, having much higher concentrations of sterols (54.3–91.3%) with considerable amounts of GE (6.6–28.2%) and alkenyl types (0.8–14.3%). The GE contents of the pyloric cecal unsaponifiable matter of *D. nippon* (28.2%) showed a relatively low percentage compared with those in *S. paxillatus* (72.0%),³⁾ *A. forbesi* (62%),⁸⁾ and *A. amurensis* (58.7%).³⁾

The GE compositions of the pyloric ceca and ovaries of *D. nippon*, *A. pectinifera*, and *L. anthosticta* are given in Table 1. Between both tissues of *D. nippon* and *A. pectinifera* the components of GE were similar in composition, respectively. Even, as opposed to odd, numbers of carbon atoms, ranging from C_{14} to C_{20} , prevailed for the alkyl moiety. The most predominant component found was 18:0 (batyl alcohol: 41.0–42.2% for *D. nippon*; 51.5–61.8% for *A. pectinifera*) followed by 16:0 (chimyl alcohol: 22.7–23.5%; 11.3%) and 20:1 (19.8–19.9%; 10.7–16.8%), indicating a high level of saturated moieties

Table 1. Lipid content and class composition and glyceryl ether composition of the different tissues of the starfish *Distolasterias nippon*, *Asterina pectinifera*, and *Lysastrosoma anthosticta* and of the scallop *Patinopecten yessoensis*

Species	Starfish						Scallop
	<i>D. nippon</i>		<i>A. pectinifera</i>		<i>L. anthosticta</i>		<i>P. yessoensis</i>
Tissue (g)	Pyloric cecum (392.7)	Ovary (58.1)	Pyloric cecum (68.4)	Ovary (93.6)	Pyloric cecum (15.2)	Ovary (7.6)	Hepatopancreas (152.0)
Lipid content %* ¹	5.5	1.8	5.0	2.2	2.2	1.7	3.7
<i>Lipid component</i> %* ²							
Diacyl glyceryl ethers	13.4	6.0	0.9	3.2	5.6	4.6	0.3
Triglycerides	56.0	30.2	7.6	15.5	15.4	22.3	64.5
Free fatty acids	6.9	0.3	45.1	21.1	23.1	11.1	3.4
Sterols	4.4	11.7	7.7	13.3	8.4	8.5	3.4
Phospholipids	15.9	45.9	32.9	44.4	43.6	50.2	19.5
Others* ³	3.4	5.9	5.8	2.4	3.9	3.3	8.9
Unsaponifiable matter content %* ⁴	18.1	27.0	18.5	23.5	25.0	29.0	10.7
<i>Unsaponifiable matter component</i> %* ⁵							
Sterols	54.3	84.2	91.3	90.0	81.0	82.0	94.9
Alkenyl glyceryl ethers	14.3	4.5	0.8	1.3	4.8	2.5	0.5
Glyceryl ethers	28.2	9.9	6.6	8.1	11.0	8.9	1.7
Others* ⁶	3.2	1.4	1.3	0.6	3.2	6.6	2.9
<i>Glyceryl ether component</i> %							
14:0* ⁷	0.9	1.0	0.3	0.4	0.6	1.0	4.9
16:0	22.7	23.5	11.3	11.3	33.7	41.4	32.9
17:0	5.2	5.5	2.8	3.6	5.5	6.7	2.5
18:0	42.2	41.0	61.8	51.5	51.4	36.2	19.5
19:0	1.0	0.9	3.4	3.8	0.1	tr	tr
16:1	1.2	1.4	0.1	0.4	0.6	tr	8.8
18:1	2.5	2.5	4.6	5.7	0.5	4.1	4.9
19:1	0.4	0.4	0.8	2.9	nd	nd	nd
20:1	19.9	19.8	10.7	16.8	2.8	2.9	15.8
Br17:0	1.1	1.0	1.4	1.2	3.3	4.5	4.1
Br18:0	1.6	1.5	0.2	0.2	0.4	0.4	2.5
Br20:0	nd	nd	1.3	0.7	0.3	1.2	nd
Others* ⁸	1.3	1.5	1.3	1.5	0.8	1.6	4.1

*¹ % to wet weight basis of the pooled tissue samples.*² % to total lipids.*³ Consisted of steryl esters and partial glycerides.*⁴ % to neutral lipids, which were freed of phospholipids from total lipids.*⁵ % to unsaponifiable matter.*⁶ Consisted of hydrocarbons and polar compounds.*⁷ Indicated by chain length and double bond of alkyl moiety.*⁸ Consisted of 15:0, 20:0, 18:2, Br15:0, Br16:0, and Br19:0.

Abbreviations: Br, branched glyceryl ethers; tr, trace (less than 0.05%); nd, not detected.

(73.0%; 71.6–80.6%). On the other hand, of the different tissues of *L. anthosticta*, these components consisted mainly of 18:0 (36.2–51.4%) and 16:0 (33.7–41.4%). The branched chain GE also occurred in considerable amounts (2.6–6.4%) in the different tissues of the previous three species. The component GE in the pyloric ceca and ovaries of *D. nippon*, *A. pectinifera*, and *L. anthosticta* was characteristically rich in 18:0 (36.2–61.8%). The result was in agreement with those of *A. lincki* (64.4%),⁹⁾ *A. amurensis* (48.3%),³⁾ *P. militaris* (44.1%),⁹⁾ *S. paxillatus* (40.9%),³⁾ and *C. crispatus* (30.9%).⁹⁾

Of the scallop *P. yessoensis*, the hepatopancreas lipids and their neutral lipid unsaponifiable matter contained minute amounts of DAGE (0.3%) and GE (1.7%), respectively. On the other hand, in the composition of the latter compounds, the most predominant component found was 16:0 (32.9%) followed by 18:0 (19.5%) and 20:1 (15.8%). Consequently, the content and composition of GE in the starfish *D. nippon* differed from those in *P. yessoensis*, which was diet for *D. nippon*. It was likely that *D. nippon* itself was capable of GE synthesis, as has been reported for the tissues of another starfish species *A. forbesi*.¹⁰⁾ The biological role of GE in marine invertebrates, however, is

not well known.

Tentatively, it may be concluded that GE originated from DAGE are present in the pyloric ceca and/or ovaries of the various starfish species although their relative proportions in content and composition are quite different.

References

- 1) W. V. Allen: *J. Mar. Biol. Ass. U.K.*, **48**, 521–533 (1968).
- 2) I.-B. Falk-Petersen and J. R. Sargent: *Mar. Biol.*, **69**, 291–298 (1982).
- 3) K. Hayashi and H. Kishimura: *Fisheries Sci.*, **63**, 944–948 (1997).
- 4) K. Hayashi: *Fisheries Sci.*, **64**, 174–175 (1998).
- 5) K. Hayashi, T. Takagi, and M. Kitagawa: *Nippon Suisan Gakkaishi*, **49**, 777–782 (1983).
- 6) K. Hayashi: *Nippon Suisan Gakkaishi*, **55**, 1383–1387 (1989).
- 7) K. Hayashi, H. Kishimura, and Y. Sakurai: *Nippon Suisan Gakkaishi*, **56**, 1635–1639 (1990).
- 8) M. L. Karnovsky and A. F. Brumm: *J. Biol. Chem.*, **216**, 689–701 (1955).
- 9) J. R. Sargent, I.-B. Falk-Petersen, and A. G. Calder: *Mar. Biol.*, **72**, 257–264 (1983).
- 10) F. Snyder, B. Malone, and M. L. Blank: *Biochim. Biophys. Acta*, **187**, 302–306 (1969).