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Comparison of lipid classes and fatty acid compositions of farmed and wild pacific oysters, *Crassostrea gigas*, in Nha Trang, Vietnam

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Abstract
Lipid classes and fatty acid compositions of the farmed (F-*C. gigas*) and wild (W-*C. gigas*) pacific oysters, *Crassostrea gigas,* in Nha Trang, Vietnam were investigated for the first time. The results indicated that the lipid classes and fatty acid components of these oysters were insignificantly different. The total lipid of both studied oysters included six lipid classes, namely phospholipid (PL), sterol (ST), free fatty acid (FFA), triacylglycerol (TG), monoalkyldiacylglycerol (MADG), and hydrocarbon-wax (HW) in which TG and PL were dominated with the values of 48.4%, 41.8% for TG and 19.0%, 20.3% for PL in F-*C. gigas* and W-*C. gigas*, respectively. The fatty acids (FAs) content of F-*C. gigas* and W-*C. gigas* was similar. The saturated fatty acids (SFAs) content was 48.2% in total fatty acids (TFAs) of the F-*C. gigas* and 44.7% in TFAs of W-*C. gigas,* in which 16:0 was dominated in SFAs of both oysters with the value of 24.2% in F-*C. gigas* and 22.0% in W-*C. gigas.* The contents of monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) were 18.3%, 20.5% for MUFAs and 31.7%, 34.7% for PUFAs respectively in F-*C. gigas* and W-*C. gigas*. These MUFAs compositions contained 16:1n-7, 16:1n-5, 18:1n-9, 18:1n-7, 20:1n-11, 20:1n-9 and 20:1n-7, among them fatty acids 16:1n-7 (7.2% in F-*C. gigas,* 6.3% in W-*C. gigas*) and 18:1n-7 (6.6% in F-*C. gigas*, 7.4% in W-*C. gigas*) were the main MUFAs. PUFAs in these two oysters consisted of long-chain n-3 and n-6 fatty acids, in which 20:5n-3 (EPA) and 22:6n-3 (DHA) were dominated with the values of 12.7%, 13.9% for EPA in F-*C. gigas* and 6.5%, 6.0% for DHA in W-*C. gigas.*

Keywords: Lipid classes, FAs, the pacific oyster, *Crassostrea gigas*.

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INTRODUCTION

The investigation of sustainable exploitation and the use of marine resources has always been a topic of concern for scientists around the world, including scientists in Vietnam. With a coastline of over 3.260 km and a total area of over 1 million km^2, Vietnam sea is considered to be a place with abundant and diverse marine life resources [1–4]. In recent years, Vietnamese scientists have been doing scientific researches on these material resources. The results obtained from bioactive-oriented chemistry studies from marine organisms in Vietnam have demonstrated the high applicability of natural marine compounds in the fields of medicine, pharmacy, and life [5–6]. Many natural active substances originated from marine organisms are known, for example, omega-3 is an active ingredient that supports the heart, regulates metabolism; alkylglycerol mitigates harmful effect when exposed to radiation, stimulates the production of red blood cells, boosts immunity,... In addition, many functional foods and nutritional supplements are originated from marine organisms (for example: Salamine-sea ginseng capsules, Arostin from sea fish peptide, Glucosamine, Halisotis capsule from abalone,...).

Oysters are one of the most valued seafoods as they consist of a rich source of fatty acids, amino acids and minerals [7]. For the purpose of finding safe and sustainable material resources for functional foods and nutritional supplements and overcoming the disadvantageous factors for people who work in special conditions, such as in the mine, in the submarine, or in space,... in the present study, we conducted the assessment of nutritional value through the analysis of the composition and content of lipid and fatty acids in the farmed and wild pacific oysters collected at Nha Trang sea, Khanh Hoa province, Vietnam.

EXPERIMENTAL

General experimental procedures

The extraction of total lipids was conducted according to Bligh and Dyer [8]. The total lipid content was determined by gravimetry after lipid extract evaporated under reduced pressure.

Fatty acids were converted to fatty acid methyl esters (FAMEs) as described by Carreau and Dubacq (1978) [9], purified by thin-layer chromatography using benzene as solvent.

The fatty acid profile was analysed using Trace GC Ultra with a BPX70 column (30 m × 0.3 mm × 0.25 µm). Injection and detection (FID) temperatures were set at 240^{o}C, respectively and nitrogen was used as the carrier gas with a column flow rate of 15 ml/min. Individual peaks of FAMEs were identified by comparing the retention times and equivalent chain length values (Christie 1988) with those of authentic standards.

Lipid classes were separated by one-dimensional silica gel TLC. The pre-coated Sorbfil PTLC-AFV (Sorbfil, Krasnodar, Russia) and the solvent system $CHCl_3$/MeOH/28% NH_4OH (65:35:5, by vol) were used. Plates were sprayed with 10% H_2SO_4/MeOH and heated at 180^{o}C for 10 min. The chromatograms were scanned by an image scanner Epson Perfection 2400 PHOTO (Nagano, Japan) in a grayscale mode. The software used for scanning was Adobe Photoshop (Adobe Systems, San Jose, CA). Percentages of lipid contents were determined based on band intensity using the image analysis program Sorbfil TLC Videodensitometer DV (Krasnodar, Russia). The units were calibrated using known standards for each lipid class.

Marine materials

Farmed and wild pacific oysters, *Crassostrea giga,* were collected from Nha Phu lagoon, Nha Trang, Khanh Hoa province in March 2018 and were identified by Prof. Dr. Do Cong Thung, Institute of Marine Resources and Environment. Their specimens were deposited at Institute of Natural Products Chemistry, VAST, Vietnam.

RESULTS AND DISCUSSION

Fatty acid composition of total lipid

The fatty acids (FAs) profile of F-*C. gigas* and W-*C. gigas* were identified (table 2). The results showed insignificant differences in the component and content of FAs in both studied oysters. Some FAs that were identified in the wild oyster, such as 16:1n-5 (0.2%), 20:0

(0.1%), 20:1n-7 (0.2%), and 21:3n-3 (0.2%) were not detected in the farmed oyster. Only *i*-16:0 (0.2%) present in the farmed oyster was not detected in the wild oyster. However, these lacking FAs in each oyster had the minor amount.

Table 1. FAs content of the farmed and wild pacific oysters

No.	FA	Content (%)	
		F-*C. gigas*	W-*C. gigas*
1	14:0	7.2	5.1
2	i-15:0	0.3	0.1
3	15:0	1.4	0.8
4	i-16:0	0.2	0.0
5	16:0	24.2	22.0
6	16:1n-7	7.2	6.3
7	16:1n-5	0.0	0.2
8	i17:0	0.8	0.3
9	a17:0	0.4	0.1
10	17:0	2.1	1.7
11	16:3n-3	0.8	2.4
12	i-18:0	0.2	0.2
13	18:0	4.6	6.0
14	18:1n-9	1.9	2.3
15	18:1n-7	6.6	7.4
16	18:2n-6	1.5	1.4
17	18:3n-6	0.4	0.4
18	18:3n-3	1.3	1.0
19	18:4n-3	1.7	1.4
20	20:0	0.0	0.1
21	20:1n-11	1.1	1.6
22	20:1n-9	0.0	0.2
23	20:1n-7	1.5	2.7
24	20:2-nmi	0.3	0.3
25	20:3n-6	0.2	0.3
26	20:4n-6	3.8	3.5
27	20:4n-3	0.3	0.3
28	**20:5n-3 (EPA)**	**12.7**	**13.9**
29	21:3n-3	0.0	0.2
30	22:2nmi	1.3	2.2
31	21:5n-3	0.7	0.8
32	22:4n-6	0.3	0.3
33	22:5n-6	0.4	0.5
34	22:5n-3	1.0	1.0
35	**22:6n-3 (DHA)**	**6.5**	**7.0**
	others	1.7	0.1
	SFA	48.2	44.7
	MUFA	18.3	20.5
	PUFA	31.7	34.7
	W3	21.9	25.6
	W6	6.3	6.0
	Total	100.0	100.0

The saturated fatty acids (SFAs) content in total fatty acids of the farmed oyster (48.2%) was slightly higher than these contents in the TL of the wild oyster (44.7%). The main SFAs of these two oysters were 14:0; 16:0, and 18:0, in which 16:0 was dominated with value of 24.2% in F-*C. gigas* and 22.0 % in W-*C. gigas.*

The content of monounsaturated fatty acids (MUFAs) was not significantly different for both studied oysters (18.3% and 20.5% in

F-*C. gigas* and W-*C. gigas*). These MUFAs compositions contained 16:1n-7, 16:1n-5, 18:1n-9, 18:1n-7, 20:1n-11, 20:1n-9 and 20:1n-7, among them fatty acids 16:1n-7 (7.2% in F-*C. gigas*, 6.3% in W-*C. gigas*) and 18:1n-7 (6.6% in F-*C. gigas*, 7.4% in W-*C. gigas*) were the main MUFAs. The exhibited 16:1, 18:1; 20:1 showed that oysters seemed to be able to elongate 16 carbon monounsaturated fatty acids into the corresponding 18 and 20 carbon fatty acids. This result was consistent with the previously reported one by F. Piveteau et al., [10].

Polyunsaturated fatty acids (PUFAs) represented 31.7% of total fatty acids in the farmed oyster and 34.7% of total fatty acids in the wild oyster. PUFAs in these two oysters consisted of long-chain n-3 (F-*C. gigas* - 21.9%, W-*C. giga s*- 25.6%) and n-6 (F-*C. gigas* - 6.3%, W-*C. gigas* - 6.0%) fatty acids, which were dietary lipids with an array of health benefits throughout life. The major PUFAs were 20:5n-3 (EPA) (12.7% and 13.9% in F-*C. gigas*, respectively) and 22:6n-3 (DHA) (6.5% and 7.0% in W-*C. gigas*, respectively).

Lipid composition of farmed and wild pacific oysters

The lipid composition of two examined oysters was listed in table 2.

Table 2. Lipid class composition of F-*C. gigas* and W-*C. gigas*

No.	Sym. Sample	Lipid class contents (%)							
		PL	ST	FFA	TG	MADG	HW	other	Total
1	F-*C. gigas*	19.0	8.7	1.7	48.4	9.9	10.0	2.3	100
2	W-*C. gigas*	20.3	8.3	1.9	41.8	12.1	8.9	6.7	100

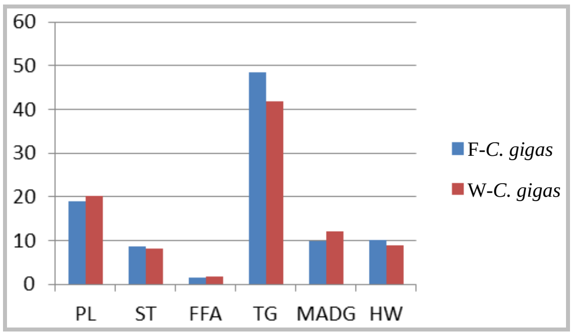

Figure 1. Lipid classes to total lipid ratio in F-*C. gigas* and W-*C. gigas* (weight % to total lipid)

The result of this study indicated that both studied oysters appeared to have similar lipid compositions with six classes, namely PL, ST, FFA, TG, MADG and HW. The total lipid of the farmed oyster contained about 78% NL and was dominated by TG, which made up 62% of NL. Meanwhile, NLs accounted for around 73% of TL of the wild oyster and were dominated by TG (~42% of NLs). Contents of ST, FFA, MADG, and HW were 8.7%, 1.7%, 9.9% and 10.0% of TL in the farmed oyster and 8.3%, 1.9%, 12.1% and 8.9% of TL in the wild oyster, respectively.

PL classes had a quite high content in total lipids which accounted for 19.0% and 20.3% in the farmed and wild oysters, respectively.

CONCLUSION

The present study provides the research result of comparing the lipid and fatty acid compositions of the farmed and wild pacific oysters, *Crassostrea gigas*, collected in Nha Trang, Khanh Hoa province, Vietnam. The result showed that the total lipid of both the farmed oyster and the wild oyster consisted of six lipid classes, namely phospholipid (PL), sterol (ST), free fatty acid (FFA), triacylglycerol (TG), monoalkyldiacylglycerol (MADG) and hydrocarbon-wax (HW). The main lipid classes were TG and PL, which accounted for 48.4%, 41.8% for TG and 19.0%, 20.3% for PL in F-*C. gigas* and W-*C. gigas*, respectively.

The FAs profile of F-*C. gigas* and W-*C. gigas* was insignificantly different. SFAs content in total fatty acids of F-*C. gigas* (48.2%) was slightly higher than these contents in the TL of W-C.*gigas* (44.7%). 16:0 fatty acid was dominated in SFAs with a value of 24.2% in F-*C. gigas* and 22.0% in W-*C. gigas*. The contents of MUFAs and PUFAs in F-*C. gigas* and W-*C. gigas* were similar. However, when comparing these contents in F-*C. gigas* with those in W-*C. gigas*, MUFA and PUFA exhibited a slight increase in W-*C. gigas*. The MUFAs composition contained 16:1, 18:1, and 20:1. Meanwhile, fatty acids, 16:1n-7 and 18:1n-7 were the main MUFAs. PUFAs represented 31.7% of total fatty acids in F-*C. gigas* and 34.7% of total fatty acids in W-*C. gigas*. PUFAs in these two oysters consisted of long-chain n-3 and n-6 fatty acids, which were dietary lipids with an array of health benefits throughout life. The major PUFAs were 20:5n-3 (EPA) (12.7% and 13.9% in F-*C. gigas*, respectively) and 22:6n-3 (DHA) (6.5% and 7.0% in W-*C. gigas*, respectively). The insignificant difference between lipid and fatty acid components between the farmed and wild pacific oysters in this study suggested that their nutrition was similar.

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