

## **SURVEY ON TOTAL LIPID CONTENT AND COMPOSITION OF FATTY ACIDS FROM HEAD AND VISCERA OF TUNA**

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### **ABSTRACT**

In this study, 16 samples including 8 head samples and visceral samples of tuna species in central Vietnam coast are collected and surveyed the composition and content of fatty acids in the total lipid. The obtained results show that the total lipid content in the head samples range from 4.5 % to 11.7 % weight of fresh samples, particularly, the total lipid content of MT1 (head of *Thunnusobesus*) and VV1 (head of *Thunnusalbacares*) reached 14.2 % and 14.8 %. In visceral samples, the total lipid content ranges from 2.3 % to 6.5 % compared with the weight of fresh sample. We also identified 37 kinds of fatty acids, in which head samples of tuna are rich in fatty acids in the omega-3 group (from 24.7 % to 37.8 %). Especially DHA ranges from 19.3 % to 27.8 % and EPA ranges from 4.4 % to 8.4 %. Analysis results showed that omega-3 content in visceral samples less than head samples of tuna, their contents only reach from 16.0 % to 31.4. The fatty acids content in the omega-6 group are the lowest and reach from 4.7 % to 10.8 %.

*Keywords:* tuna, total lipid, fatty acids, DHA, EPA.

### **1. INTRODUCTION**

In recent years, the fish industry, especially tuna, has been developing more and more strongly in Vietnam as well as the large quantities of fish exploited. The tuna processing industry produces more than 60 % by wasting products including head, skin, fins, frames and viscera [1]. These wastes products are normally used for reproducing food for animal. Recently, some worldwide researches show that the head and viscera tuna contain high amounts of lipid and fatty acids with abundant bioactivity, in which the fatty acids mentioned belong to  $\omega$ 3 and  $\omega$ 6 groups[2 - 6]. The results indicated clearly the potential direction of enhancing the value from waste products of tuna through full exploitation of components lipids and fatty acids, which are rich of activity, for creating healthy products and serving human life.

## 2. MATERIALS AND METHODS

### 2.1. Materials

Materials are 16 samples of waste products, include head and viscera of 8 tuna species: *Auxisrochei*, *Auxisthazard*, *Euthynnusaffinis*, *Thunnustonggol*, *Sardaorientalis*, *Katsuwonuspelamis*, *Thunnusalbacares*, *Thunnusobesus*. Materials were collected from May to September 2015 from Binh Dinh to Khanh Hoa province and storage in standard conditions at INPC.

### 2.2. Methods

Determination of total lipid content: according to the method of E. G Blighand W.J Dyer [7].

Determination of fatty acids components: according to standard of ISO 659:2009 [8].

## 3. RESULTS AND DISCUSSION

### 3.1. The analysis results of total lipid content

Table 1. The total lipid content of the material samples.

	Scientific name	Symbol	Part	Collecting date	Total lipid content (%)
1	<i>Auxisrochei</i> (Risso, 1810)	O1	head	02/06/2015	4.5 ± 0.2
		O2	viscera		2.3 ± 0.2
2	<i>Auxisthazard</i> (Lacepede, 1803)	C1	head	02/06/2015	5.1 ± 0.3
		C2	viscera		2.6 ± 0.2
3	<i>Euthynnusaffinis</i> (Canner, 1850)	NC1	head	25/09/2015	5.5 ± 0.1
		NC2	viscera		3.3 ± 0.2
4	<i>Thunnustonggol</i> (Bleeker, 1851)	B1	head	08/05/2015	11.7 ± 0.3
		B2	viscera		5.4 ± 0.3
5	<i>Sardaorientalis</i> (Temminck & Schlegel, 1844)	SD1	head	08/05/2015	8.0 ± 0.2
		SD2	viscera		3.8 ± 0.1
6	<i>Katsuwonuspelamis</i> (Linnaeus, 1758)	V1	head	11/09/2015	7.2 ± 0.2
		V2	viscera		4.8 ± 0.2
7	<i>Thunnusalbacares</i> (Bonnaterre, 1788)	VV1	head	13/08/2015	14.2 ± 0.3
		VV2	viscera		6.3 ± 0.3
8	<i>Thunnusobesus</i> (Lowe, 1839)	MT1	head	13/08/2015	13.8 ± 0.5
		MT2	viscera		6.5 ± 0.3

The data analyzed in Table 1 indicates that:

In each species, the total lipid content in the head sample is greater than the viscera sample.

Total lipid content of the material sample and viscera samples are directly proportional increasing with the size of species. Total lipid content is higher in the larger tuna species such as *Thunnusalbacares* (size 500-2000 mm), and *Thunnusobesus* (size 600 – 1800mm) out lower in the small tuna species such as *Auxisrochei* (size 140-310 mm), and *Auxisthazard* (size 150-310 mm).

In the head samples of tuna, the total lipid content ranged from 4.5 % to 14.2 %; for viscera samples, total lipid content ranged from 2.3 % to 6.5 %. In which the *Thunnus obesus* species is the highest content and *Auxis rochei* species is the lowest content.

### 3.2. Composition and content of fatty acids in the total lipids

#### 3.2.1. Components and fatty acids content of the head samples of tuna

Table 2. Composition and fatty acids content in the head samples of tuna.

No	Acids name	Head samples of tuna(%)							
		O1	C1	NC1	V1	B1	SD1	VV1	MT1
1	14:0	2.8±0.2	0.8±0.1	0.7±0.1	1.7±0.2	3.5±0.2	3.1±0.2	2.7±0.2	3.3±0.2
2	15:0	0.9±0.2	0.7±0.1	0.7±0.1	0.9±0.1	1.2±0.1	1.1±0.1	0.8±0.1	1.1±0.1
3	16:1n-9	5.9±0.3	0.2±0.1	2.4±0.1			0.2±0.1	0.2±0.1	
4	16:1n-7		2.1±0.2		3.1±0.2	6.0±0.2	4.8±0.2	5.3±0.2	5.1±0.3
5	16:2n-3						0.7±0.1	0.7±0.1	
6	16:0	22.3±0.4	2.7±0.1	23.0±0.2	20.0±0.3	18.4±0.3	19.5±0.3	13.8±0.2	22.9±0.4
7	17:1n-9	1.0±0.1		1.1±0.1	0.8±0.1	1.1±0.2	0.8±0.1	0.8±0.1	
8	17:1n-7	0.9±0.2		0.6±0.1	0.6±0.1	0.8±0.1	0.8±0.1	0.8±0.1	
9	17:0	0.9±0.1	1.5±0.1	1.5±0.1	1.7±0.2	1.5±0.2	1.5±0.2	0.8±0.1	1.4±0.1
10	18:4n-3					0.5±0.1	0.5±0.1	0.97±0.1	
11	18:2n-6	2.1±0.2	1.0±0.1	1.4±0.2	1.1±0.1	1.0±0.2	1.2±0.1	1.5±0.2	1.3±0.2
12	18:1n-9	22.0±0.3	16.4±0.2	16.4±0.3	12.3±0.3	16.3±0.3	13.1±0.3	14.9±0.2	10.1±0.2
13	18:1n-7	3.1±0.2	3.8±0.2	3.8±0.2	3.0±0.2	3.2±0.2	2.9±0.1	2.7±0.1	3.2±0.2
14	18:0	6.0±0.3	11.5±0.2	11.9±0.2	12.6±0.2	7.9±0.2	8.7±0.2	4.3±0.2	8.4±0.2
15	19:0	0.2±0.1	0.3±0.1	0.3±0.1	0.5±0.1	0.4±0.1	0.4±0.1	0.2±0.1	
16	<b>20:5n-3 (EPA)</b>	<b>4.5±0.2</b>	<b>4.6±0.2</b>	<b>4.7±0.2</b>	<b>5.2±0.2</b>	<b>5.9±0.3</b>	<b>6.3±0.2</b>	<b>8.4±0.2</b>	<b>5.9±0.2</b>
17	20:4n-6	1.9±0.1	4.3±0.2	4.4±0.2	4.4±0.2	3.0±0.2	2.7±0.2	3.1±0.2	2.1±0.1
18	20:4n-3		0.3±0.1		0.4±0.1	0.6±0.1	0.5±0.1		
19	20:3n-6					0.2±0.1		0.2±0.1	0.2±0.1
20	20:2n-6		0.3±0.1	0.3±0.1	0.4±0.1	0.6±0.1	0.4±0.1	0.8±0.1	
21	20:1n-9	2.4±0.1	1.1±0.1	0.9±0.1	0.9±0.1	1.6±0.3	1.0±0.2	2.7±0.2	0.27±0.1
22	20:0	0.3±0.1	0.2±0.1	0.3±0.1	0.5±0.1	0.4±0.1	0.4±0.1	0.2±0.1	0.3±0.1
23	<b>22:6n-3 (DHA)</b>	<b>20.3±0.4</b>	<b>21.3±0.3</b>	<b>19.0±0.3</b>	<b>22.9±0.3</b>	<b>20.3±0.3</b>	<b>23.4±0.3</b>	<b>27.8±0.4</b>	<b>27.3±0.4</b>
24	22:5n-6	0.5±0.1							

25	22:5n-3		0.9±0.1	1.0±0.1	1.8±0.2	2.1±0.1	2.0±0.2	3.0±0.2	1.6±0.1
26	22:3n-6	1.2±0.1	2.1±0.2	2.3±0.2					0.2±0.1
27	22:4n-6	0.8±0.1	1.2±0.1	1.5±0.2	2.3±0.2	1.5±0.2	1.8±0.1	1.9±0.2	2.0±0.1
28	22:1n-9						0.2±0.1	1.0±0.1	0.4±0.1
29	22:0			0.2±0.1	0.5±0.1	0.2±0.1	0.3±0.1		
30	24:1n-9		0.7±0.1	0.7±0.1	1.9±0.2	0.7±0.1	0.8±0.1	0.4±0.1	
31	24:0			0.2±0.1	0.4±0.1		0.2±0.1		
unknown		0	0	0.2±0.1	0.25±0.1	0.5±0.1	0.4±0.1		2.7±0.2
SFA		33.4±0.3	39.6±0.4	39.04±0.3	38.6±0.2	33.8±0.3	35.5±0.3	22.7±0.4	37.6±0.3
UFA		66.6±0.3	60.4±0.3	60.8±0.2	61.3±0.3	65.8±0.2	64.2±0.2	77.3±0.3	59.6±0.2
ω3		24.7±0.2	27.2±0.2	24.9±0.2	30.3±0.2	29.4±0.2	33.3±0.3	37.8±0.2	34.8±0.3
ω6		6.6±0.2	8.9±0.1	9.9±0.1	8.2±0.2	6.3±0.1	6.2±0.2	10.5±0.2	5.8±0.1
ω9		31.3±0.3	18.3±0.2	21.5±0.2	15.8±0.3	19.9±0.2	16.1±0.2	20.1±0.3	10.7±0.2

Table 2 indicates the analysis results of head samples: there are 31 kinds of long-chain fatty acids from C14 to C24 are discovered in total lipids. Some unknown component has content from 0 % to 2.7 %.

Samples have total saturated fatty acids content ranged from 22.7 % to 39.6 % in which the highest is in the *Auxisthazard* tuna sample (39.5 %) and the lowest is in *Thunnusalbacares* tuna sample (22.7 %).

Content of unsaturated fatty acids in samples is quite high, ranged from 59.6 % to 77.3 %. In which the highest is in *Thunnusalbacares* tuna samples (77.3 %) and the lowest is in *Thunnusobesus* tuna samples (59.6 %).

3 groups of polyunsaturated fatty acids are rich of biological activity are ω3, ω6, ω9; they contain content respectively: ω3 (24.7 % - 37.8 %), ω6 (5.8 % - 10.5 %) and ω9 (10.7 % - 31.3 %).

In polyunsaturated fatty acids group, there are 2 types of fatty acids typically rich of activity which are DHA (22: 6n-3) and EPA (20: 5n-3) have relatively high contents. DHA content accounts for 19.0 % - 27.8 %, the highest content belongs to *Thunnusalbacares* tuna samples and the lowest content belongs to *Euthynnusaffinis* tuna sample. EPA content accounts for 4.5 % - 8.4 %, the highest content belong to *Thunnusalbacares* tuna samples and the lowest content belongs to *Auxisrochei* tuna sample.

### 3.2.2. Results of the survey components and fatty acids content of the viscera samples

Table 3. Composition and fatty acids content of viscera samples of tuna.

No	Acids name	Viscera samples of tuna							
		O2	C2	NC2	V2	B2	SD2	VV2	MT2
1	14:0	1.2±0.2	1.2±0.1	3.5±0.2	1.0±0.1	1.1±0.1	1.8±0.1	3.0±0.2	3.5±0.2
2	15:0	0.6±0.1	0.7±0.1	0.9±0.1	0.7±0.1	0.7±0.1	0.9±0.1	0.9±0.1	1.1±0.1

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4	16:1n-9	2.9±0.2	2.5±0.2	7.4±0.2	2.0±0.2	2.1±0.2			3.9±0.2
5	16:1n-7					0.5±0.1	3.3±0.2	7.1±0.2	2.4±0.2
6	16:0	23.4±0.4	24.2±0.4	23.5±0.3	26.5±0.3	20.2±0.3	19.2±0.3	24.7±0.3	26.1±0.3
7	17:1n-9	1.5±0.2	1.4±0.2		1.1±0.1	0.8±0.1	0.8±0.1	1.3±0.2	0.7±0.1
8	17:1n-7	0.5±0.1	0.6±0.1		0.5±0.1	0.6±0.1	0.7±0.1	1.0±0.1	0.7±0.1
9	17:0	1.2±0.1	1.4±0.2	0.8±0.1	1.5±0.1	1.5±0.1	1.5±0.1	0.9±0.1	0.9±0.1
10	18:2n-6	1.5±0.2	1.1±0.2	6.1±0.2	1.6±0.2	0.9±0.1	1.1±0.1	0.8±0.1	0.6±0.1
11	18:1n-9	17.8±0.3	17.±0.3	25.0±0.4	14.4±0.3	14.5±0.2	11.8±0.3	22.9±0.3	20.0±0.2
12	18:1n-7	3.7±0.2	3.9±0.1	2.9±0.2	3.7±0.2	3.3±0.1	4.3±0.2	3.4±0.2	6.9±0.2
13	18:0	15.3±0.4	15.9±0.4	9.1±0.2	15.8±0.3	14.3±0.2	11.6±0.2	6.1±0.2	6.6±0.2
14	19:0	0.5±0.1	0.3±0.1		0.5±0.1	0.6±0.1	0.4±0.1	0.2±0.1	0.2±0.1
<b>15</b>	<b>20:5n-3 (EPA)</b>	<b>2.4±0.2</b>	<b>2.3±0.2</b>	<b>4.3±0.1</b>	<b>3.4±0.2</b>	<b>4.3±0.2</b>	<b>5.5±0.2</b>	<b>4.8±0.2</b>	<b>3.9±0.2</b>
16	20:4n-6	5.7±0.2	5.1±0.2	1.7±0.1	5.8±0.2	6.2±0.2	4.4±0.2	2.5±0.2	2.2±0.1
17	20:4n-3						0.3±0.1		
18	20:2n-6	0.3±0.1	0.4±0.1		0.2±0.1	0.5±0.1	0.4±0.1	0.3±0.1	0.4±0.2
19	20:1n-9	1.1±0.1	1.1±0.1		0.5±0.1	1.1±0.1	0.7±0.1	1.9±0.2	1.7±0.2
20	20:0	0.3±0.1	0.4±0.1		0.3±0.1	0.4±0.1	0.4±0.1	0.2±0.1	0.2±0.1
<b>21</b>	<b>22:6n-3 (DHA)</b>	<b>13.3±0.2</b>	<b>12.2±0.3</b>	<b>13.4±0.2</b>	<b>15.3±0.3</b>	<b>16.8±0.2</b>	<b>23.0±0.3</b>	<b>16.3±0.3</b>	<b>16.0±0.4</b>
22	22:5n-3	1.1±0.1	0.9±0.1		0.8±0.1	0.8±0.2	1.8±0.1		0.3±0.1
23	22:3n-6	1.0±0.1	0.8±0.1	0.9±0.1	1.2±0.1			1.1±0.2	0.9±0.1
24	22:4n-6	1.8±0.1	1.9±0.1	0.5±0.1	2.0±0.1	2.1±0.1	2.3±0.1	0.6±0.1	0.7±0.1
25	22:4n-3					1.5±0.1			
26	22:0	0.2±0.1	0.3±0.1		0.2±0.1	0.6±0.1	0.3±0.1		
27	24:1n-9	1.5±0.1					1.5±0.1		
28	24:1n-7		2.2±0.1		0.7±0.1	2.6±0.1			
29	24:00	0.3±0.1	0.3±0.1		0.2±0.1	0.6±0.1	0.4±0.1		
	unknow	0.9±0.1	0.9±0.1	0	0.4±0.1	1.1±0.1	0.6±0.1	0	0.1±0.1
	SFA	42.9±0.2	44.7±0.2	37.8±0.3	46.7±0.2	40.3±0.3	36.7±0.3	36.0±0.2	38.6±0.2
	UFA	56.1±0.3	54.3±0.3	62.2±0.3	53.2±0.3	58.6±0.3	62.6±0.3	64.0±0.3	61.3±0.3
	ω3	16.8±0.2	16.0±0.2	17.7±0.2	19.6±0.2	23.4±0.2	31.5±0.3	21.1±0.2	20.2±0.2
	ω 6	10.2±0.2	9.3±0.1	9.3±0.2	10.8±0.2	9.7±0.2	8.1±0.2	5.4±0.2	4.7±0.2
	ω 9	24.9±0.3	22.4±0.2	32.3±0.2	17.9±0.2	18.5±0.2	14.8±0.2	26.1±0.2	26.4±0.2

Table 3 shows the analysis results of viscera samples. There are 29 kinds of long chain fatty acids from C14 to C24 in total lipids.

Total contents of saturated fatty acids of the samples range from 36.0 % to 46.7 % in which the sample has the highest content is *Katsuwonus pelamis* sample (56.7 %) and the lowest content is *Thunnus albacares* sample (36.0 %).

Total contents of unsaturated fatty acids of the samples are quite high, range from 53.2 % to 64.0 % in which the highest content belongs to *Thunnus albacares* tuna samples (64.0 %) and the lowest content belongs to *Katsuwonus pelamis* tuna samples (53.2 %).

In three groups of polyunsaturated fatty acids, which are rich of biological activity are  $\omega$ 3,  $\omega$ 6,  $\omega$ 9; they contain content respectively:  $\omega$ 3 (16,0 % - 31,5 %),  $\omega$ 6 (4,7 % - 10,8 %) and  $\omega$ 9 (14,8 % - 32,3 %).

In polyunsaturated fatty acids group, there are 2 types of fatty acids typically rich of activity, are DHA (22: 6n-3) and EPA (20: 5n-3) which have relatively high contents. DHA content accounts for 12,2 % - 23,0 %, EPA content accounts for 4.5 % - 8.4 %. Both DHA and EPA contents achieve the highest content in *Sarda orientalis* tuna samples and the lowest *Auxis thazard* tuna samples.

#### 4. CONCLUSIONS

Total lipid content of the head samples of tuna ranged from 4.5 % to 14.8 %; for viscera samples are 2.3 % to 6.5 % by weight of fresh sample.

Determined 37 fatty acids in the head samples and 31 fatty acids in the viscera samples in the total lipid of of tuna. In which there are some fatty acids that appear in all of the head and viscera samples such as C14: 0; C15: 0; C16: 0; C17: 1n-9; C17: 1n-7; C17: 0; C18: 0; and C18: 1n-9. Especially, two fatty acids, which have highly bioactive, are EPA and DHA account for quite high content of size able accounts. EPA content is 4.5 % - 8.4 %, DHA is 19.0 % - 27.8 % in the head samples; In the viscera samples, EPA content achieves 2.3 % - 5.5 %; DHA is 12.2 % - 23.0 % of the total lipid content.

The fatty acids content belongs to groups  $\omega$ 6 and  $\omega$ 9 in the head and viscera samples do not have large difference. In the all two material samples,  $\omega$ 6 content ranged from 4.7 % - 10.8 %,  $\omega$ 9 content ranged from 10.7 % - 32.3 %. However,  $\omega$ 3 content in the head samples, which ranged from 24.7 % - 37.8 % is out standing compare to viscera samples, which has  $\omega$ 3 content ranged from 16.0 % - 31.5 %.

The results show that two kinds of materials of tuna contain highly total lipid content. In which content of polyunsaturated fatty acids accounted for bulk of total lipids. Especially, fatty acids are rich of activity belong to groups  $\omega$ 3,  $\omega$ 6,  $\omega$ 9 have dominant superiority. Thus, the utilization and exploitation of these materials are workable, which enhance economic efficiency for tuna processing industry of Vietnam in the future.

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### TÓM TẮT

#### KHẢO SÁT HÀM LƯỢNG LIPID TỔNG VÀ THÀNH PHẦN CÁC AXIT BÉO CỦA ĐẦU VÀ NỘI QUAN CÁ NGỪ

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Kết quả khảo sát hàm lượng lipit tổng và thành phần các axit béo trong 16 mẫu nguyên liệu gồm đầu và nội quan của 8 loài cá ngừ được thu tại Nha Trang - Việt Nam cho biết hàm lượng lipit tổng trong các mẫu đầu và nội quan lần lượt dao động từ 4,5 % - 14,2 % và 2,3 % - 6,5 % tính theo trọng lượng mẫu tươi.

Kết quả khảo sát cũng đã xác định được lần lượt 37 và 31 loại axit béo có trong đầu và nội quan cá ngừ. Đối với mẫu đầu, tổng hàm lượng axit béo no và không no dao động lần lượt từ 22,7 % - 39,6 % và 60,4 % - 77,3 %. Đối với mẫu nội quan, tổng hàm lượng axit béo no và không no dao động lần lượt từ 36 % - 46,7 % và 53,2 % - 64 %.

Hàm lượng axit béo nhóm  $\omega 3$  dao động từ 24,7 % - 37,8 % và 16 % - 31,5 %, nhóm  $\omega 6$  dao động từ 5,8 % - 10,5 % và 4,7 % - 10,8 % và nhóm  $\omega 9$  dao động từ 10,7 % - 31,3 % và 14,8 % - 32,3 % lần lượt đối với mẫu đầu và nội quan cá ngừ.

*Từ khoá:* cá ngừ, lipit tổng, axit béo, DHA, EPA.