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Fatty Acid Profile of Yellowfin Tuna Eye (*Thunnus albacares*) and Oil Sardine Muscle (*Sardinella longiceps*)

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Abstract

In the present study, fatty acid profile of yellowfin tuna eye (YFTE) was investigated. Proximate analysis of YFTE revealed the presence of high fat content (12.0%) and moderate protein content (10.2%). A comparison was made between the fatty acid composition of YFTE and sardine oil. Higher poly unsaturated fatty acid content was found in YFTE (48.8%) compared to oil sardine (30.0%). Ratio of docosahexaenoic acid (DHA) content to the total fatty acids of YFTE was 36.72% which was higher compared to oil sardine (8.67%). However, EPA content of oil sardine was higher (16.8%) than YFTE (7.07%). DHA/EPA ratio and n-3/n-6 ratio of YFTE were 5.25 and 8.97 respectively. Palmitoleic acid was the principal mono unsaturated fatty acid (MUFA) present in YFTE and oil sardine. The present study revealed that yellow fin tuna eye could be a potential source of omega-3 fatty acids.

Key words: Fatty acid profile, yellowfin tuna eye, oil sardine, EPA and DHA

Introduction

Fish processing industry is a major economic source for many countries worldwide and fish is an essential source of nutrients especially in developing countries. It is estimated that globally one billion people depend on producing, processing and trading fish for their livelihood (Halweil & Nierenberg, 2008). Seafood industries generate more than 60% of the raw material as processing waste which includes head, skin, trimmings, fins, frames, viscera and roes (Dekkers et al., 2011). The seafood processing waste in developing countries is disposed or converted into animal feed, fish meal and fertilizer (Kristinsson & Rasco, 2000). Disposal of fish processing waste is under strict regulation due to environmental concerns and adds to the operational cost of seafood industry. Hence, utilization of fish processing waste in an efficient way is gaining importance. Recent research reports that fish processing waste is a good source of high value bioactive compounds such as omega-3 polyunsaturated fatty acids (PUFA), bioactive peptides, polysaccharides, minerals, vitamins, antioxidants and enzymes (Kim & Wijesekara, 2010). The extraction of bioactive compounds from fish waste is one of the major promising research areas. Several techniques have been developed to recover the essential nutrients and bioactive compounds from these nutrient rich fish processing discards that would help in improvement of human health, maximize economic benefits and reduce environmental pollution. With the growing market for sashimi grade tuna and tuna loins/steaks, the use of yellowfin tuna as sashimi is increasing with an annual worldwide production of 3 400 000 MT (Woo et al., 2008). Yellowfin tuna industrialization generates large quantity of waste by removal of skin, bones and fins compared to other processing methods like canning. Generally, tuna gut and gonads contribute 8% of the total body weight and the remaining head, fin, mid bone, tail and gills accounts 25% (Das et al., 2011). The head alone contributes to around 21% of the total body weight of fish (Waterman, 1979).

The present study is the first report on the fatty acid profile of the eye from yellowfin tuna. This study focused to characterize the nutritional composition of yellow fin tuna eye, which constitutes a significant amount of discards from tuna processing industry. A comparative analysis on the fatty acid composition of tuna eye with body oil of sardine was performed.

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Materials and Methods

Yellowfin tuna heads were collected in pre-monsoon season from a processing plant at Aroor, Kerala. The oil sardines were bought from a nearby fish market in Cochin and the average yield of oil was 40-45%. The tuna head samples were brought to the laboratory in iced condition and upon arrival the eyes were collected by cutting in the fold of the skin surrounding the eyes. The average weight of the eye ball was 120±3 g. The optic nerve was cut off which caused the eyeball and the surrounding tissue to pop out. The samples were stored at -20°C until use.

Moisture, protein, lipid and ash content of yellow fin tuna eye were determined by AOAC (2000) methods. Moisture content was determined by hot air oven method. Total nitrogen content was determined by Kjeldahl method. Fat content was estimated by extracting the lipids using petroleum ether. Ash content was determined using moisture free samples by incinerating in a muffle furnace. Results are expressed in percentage on wet weight basis. All the analyses were carried out in triplicate.

Lipid content of the samples was extracted by the method of Folch et al. (1957). Fatty acid methyl esters (FAMEs) were prepared according to Metcalfe et al. (1966). The fatty acid compositions of tuna eye and oil sardine were analyzed using Gas Chromatography- Mass Spectrometry (GC-MS). FAME was volatilized before GC-MS analysis. The samples were taken in 10 ml glass vials and stored at 4°C until further analysis. Fatty acids were separated using GC-MS (Perkin Elmer Autosystem XL-Gas Chromatograph-Turbomass Gold Mass Spectrophotometer, Norwalk, CTO 6859, USA) equipped with an Elite 225 (30m × 0.25mm ID; 0.25µm film thickness) capillary column. Peaks were identified by comparison of their retention times with FAMEs standards (Supelco). Individual fatty acids were expressed as weight percentage of total fatty acids.

Results and Discussion

Proximate composition of tuna eye is shown in figure 1. Crude fat and protein content of YFTE were 12.04 and 10.17% respectively, which indicate that tuna eye is a good source of major nutrients. The lipid content of tuna eye is higher than the lipid content reported for the eye of lean fishes such as saithe, cod, redfish, and gulper shark (Stoknes et al., 2004). Water and lipid content of eye together accounted for 83% of total wet mass. The results indicated that there was an inverse relation between water and lipid content in fish eyes, as previously demonstrated for fish muscle (Suzuki, 1981). He stated that water and lipid are inversely related so that the sum is approximately constant (70-80%). Investigations on the moisture content of eye from cod, salmon, trout, red fish, Portuguese dogfish, black dogfish and leaf scale gulper shark have shown a wide variation from 90.3% to 42.2% (Stoknes et al., 2004).

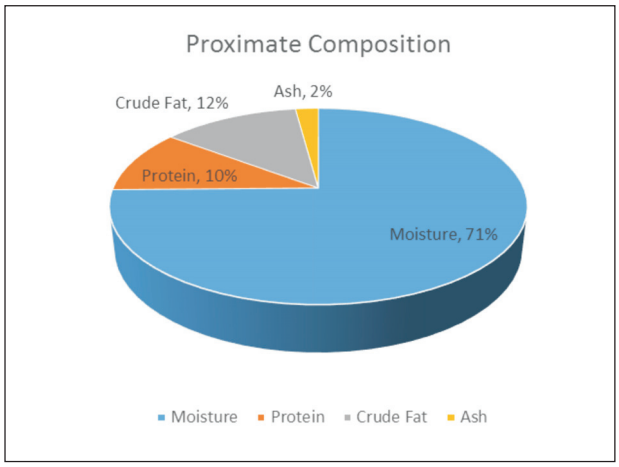

Fig. 1. Proximate composition of yellowfin tuna eye

Fatty acid compositions of tuna eye and oil sardine are presented in table 1. About 15 major fatty acids found in oil extracted from YFTE and oil sardine include C14:0, C16:1, C18:1n9, C20:1, C18:2n6c, C20:4n6, C 20:5n3, C22:6n3. The most abundant fatty acid in YFTE was the docosahexaenoic acid (DHA), which constitutes about 36.72% of total fatty acids. It is two times higher than the reported DHA value of yellowfin tuna muscle which is 16.91% (Peng et al., 2013). In both the samples, PUFA content was more than 30%. Palmitoleic acid was the principal MUFA in the tuna eye and oil sardine. DHA/EPA ratio of 5.25 and n-3/n-6 ratio of 8.97 were found in YFTE. The higher fatty acid content may be due to the higher ratio of triacylglycerol and phospholipid content of eye ball than the surrounding tissues (Stoknes et al., 2004). Bell & Ghioni (1993) reported that EPA and DHA were the most abundant fatty acids from the eyes of American and European lobsters. Southern fishes and long lived fishes are reported to have higher percentage of DHA than EPA (Ackman et al., 1980). Fatty acid analyses of eye from teleosts revealed that eye contained high ratio of DHA to EPA and high ratios of n-3 fatty acids to n-6 fatty acids. DHA/EPA ratio of eyes of teleosts

Table 1 Fatty acid profile of oils extracted from yellowfin tuna eye and *Sardinella longiceps*

Fatty acids		Yellowfin tuna Eye (%)	Oil Sardine Muscle (%)
Saturated fatty acids (SFA)			
C14:0	Myristic acid	2.50±0.02	12.02 ±0.03
C16:0	Palmitic acid	3.02±0.05	25.22 ±0.92
C18:0	Stearic acid	3.42±0.51	4.08 ±0.02
C20:0	Arachidic acid	3.20±0.05	0.86 ±0.01
	Total SFA	12.14±0.63	42.18±0.98
Mono-unsaturated fatty acids (MUFA)			
C16:1	Palmitoleic acid	17.12±0.74	14.47 ±0.97
C18:1	Oleic acid	18.11±0.18	8.81 ±0.08
C20:1	Gadoleic acid	2.85±0.11	0.33 ±0.01
	Total MUFA	38.08±1.03	23.61±0.08
Poly-unsaturated fatty acids (PUFA)			
C18:2	Linoleic acid	1.25±0.14	1.24 ±0.01
C18:3n3	á-Linolenic acid	0.14±0.01	0.73 ±0.02
C18:3n6	ë-Linolenic acid	0.02±0.04	0.61±0.01
C20:2n6	Eicosadienoic acid	0.03±0.06	0.15±0.00
C20:3n3	Eicosatrienoic acid	0.01±0.02	0.18±0.01
C20:4	Arachidonic acid	3.51±0.12	1.56±0.06
C20:5	Eicosapentaenoic acid	7.07±0.09	16.85±0.90
C22:6	Docosahexaenoic acid	36.72±1.11	8.67±0.82
	Total PUFA	48.75±1.59	30.00±0.27
	PUFA/SFA	4.01	0.71
	n-3	43.94	26.43
	n-6	4.79	2.95
	DHA/EPA	5.2	0.51

ranged from 1.4-3.8 and the n-3/n-6 ratio was reported as 2.6 -15.3 (Stoknes et al., 2004). The major saturated fatty acid in oil sardine was palmitic acid (25 %) while in the YFTE it was stearic acid (3.4%). DHA/EPA ratio of YFTE was 10 times more than the body oil of sardine. The PUFA/SFA ratio obtained in this study was 4.01 revealing that YFTE was one of the good sources of PUFAs. The fatty acid composition of fish species is influenced by season, area of catch and maturity (Ozogul & Ozogul, 2007).

The present study on fatty acids composition of yellowfin tuna eye showed the presence of significant amount of omega-3 fatty acids with better ratio of EPA/DHA and n-3/n-6. Introducing a new processing line into the tuna processing industry for the recovery of oil and other bioactive nutrients from the eye may boost the industry to the next level and may help in optimum use of available resources.

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