The JSFS 85th Anniversary-Commemorative International Symposium
"Fisheries Science for Future Generations"

Symposium Proceedings, No. 10024

Original article

Characterization of composition and lipid in various deep sea fish species from Suruga Bay

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Keywords: Effective utilization; Deep sea fish; Muscle; Proximate composition; Wax-ester; Fatty acid composition.

Received: 18 July 2017 / Accepted: 8 September 2017
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Introduction

It was not until the recent century that fisheries has delved into a previously alien space, namely the deep sea zone, a territory which human beings still do not know much about. Within the previous decades, it has widely become known that marine resources have been over-exploited and are undergoing a steady decline throughout general regions of the globe. Therefore, in light of this trend, it is imperative that effective utilization, sustainability, and alternatives of marine bioresources be prioritized.

Japan possesses one of the biggest fishing industry, and at the same time, produces huge numbers of bycatches [1]. Amongst those bycatches, deep sea fish species such as escolar *Lepidocybium flavobrunneum*, oilfish *Ruvettus pretiosus*, and Amami grenadier *Coryphaenoides marginatus* count as a few amongst other bycatches in several small-scale fisheries [2]. Moreover, oilfish and escolar are banned for consumption or sale, in three countries including Japan due to the risks of food poisoning. This is due to a particular chemical compound known as wax-ester, which induces keriorrhea along with other gastro-intestinal symptoms [3]. Therefore, these fishes are not used not only for food material in general, but also for other commercial purposes in Japan. However, another deep sea species possessing similar biochemical compound, orange roughy *Hoplosthetus atlanticus*, is praised for its extracted oil quality for industrial purposes [4].

These two fishes are rich in fat, which amounts to 20% of the wet weight of muscle. While, through direct consumption, it is not viable to intake nutrition, extraction of the useful lipid components may be possible. Wax ester itself is an important component which are naturally found in a few selected organisms. In the case of terrestrial natural sources, it can be found abundantly in jojoba plant, and the oil possesses characteristics similar to that of orange roughy oil [5]. Therefore, the aim of this study was to investigate the lipid profiles in the two major species.

Materials and methods

Each species was represented by two individuals. Chum salmon *Oncorhynchus keta* collected from Kawabukuro River, Akita Pref. in December 2015, was used as a representative of shallow water species, whereas the deep sea fishes were collected in September 2014 from Suruga Bay. All the samples were kept at -40ºC until use. Ordinary muscles were subsequently excised and freeze dried for 4 days. For the dried samples, proximate analyses were performed (moisture, ash content, crude protein, crude ash).

Lipid was extracted from the ordinary muscles with chloroform/methanol (2:1). Lipid class was determined using thin layer chromatography (TLC), where the components were separated throughout various steps of chemical processes (hydrolysis using KOH solution, esterification with boron trifluoride esterification agent, and acetate derivation using mix of pyridine/acetic anhydride). The final separated components were then analyzed by using a gas chromatography apparatus (Shimadzu GC-14A and GC-17A).

Results and discussion

The proximate analyses showed that the grenadier in particular had high moisture content (Fig. 1), especially relative to its body size. This in turn created especially soft texture of its flesh, which led to a lower protein content. Moisture content was lower in escolar and oil fish, whereas crude fat was higher. Ash and crude protein contents showed no considerable differences. Lower moisture content was recognized in escolar and oilfish, whereas there were no significant differences in ash content among species.

Lipid class for oilfish and escolar occupied with large amounts of wax ester, whereas in rattail and salmon, triglyceride was shown to be abundant (Fig. 2). Oleic acid was the major constituent of wax ester, and rattail uniquely possessed arachidonic acid. Such differences in lipid composition could display a unique physiological trait, where instead of breaking down the wax ester, they instead accumulated it as energy source or buoyancy control.

For fatty alcohol content, oil fish display large amounts of C16 and 18, whereas escolar had large amounts of C22:1 and 20:1. The abundance of fatty alcohol can be used for hydrogenation or sulfurization process to create lubricants, cosmetics, emulsifiers, etc. On the other hand, phospholipids of both species showed high amounts of polyunsaturated fatty acids (PUFA), which can be utilized commercially as a viable nutritional supplement for human consumption and aquaculture feed. As for fatty acid contents of wax ester, large amounts of monounsaturated fatty acids (MUFA), which can reduce blood cholesterol levels. However, as wax esters cannot be digested by humans, this can be utilized as fish feed, where the wax esters might be metabolized into fatty alcohol and fatty acids.

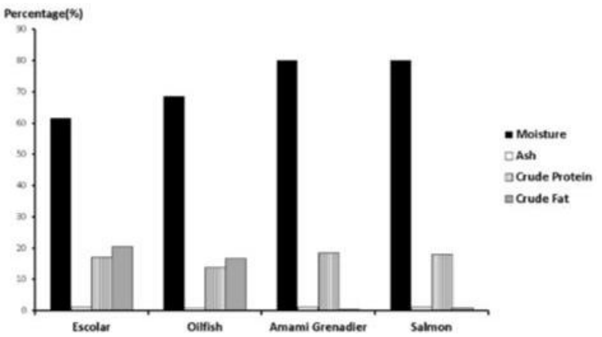

Fig. 1. Proximate compositions of the ordinary muscles from deep sea species.

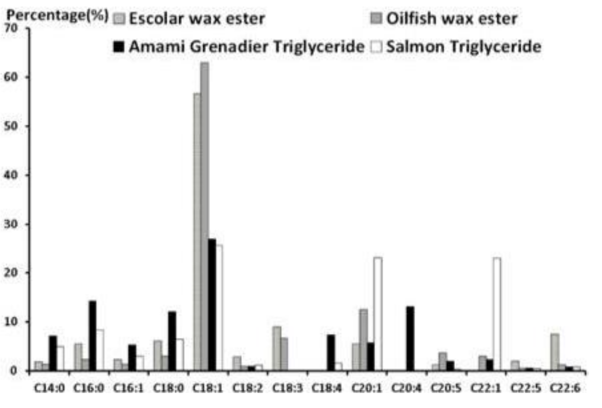

Fig. 2. Fatty acid compositions of wax ester and triglyceride from deep sea species.

Conclusions

High amounts of PUFA and MUFA were detected in both escolar and oilfish wax ester in addition to fatty alcohol. The wax ester composition of both fishes have similar composition to that of the jojoba oil, and thus can act as a good alternative source. Their contents of MUFA and PUFA are similar to each other and had a variety of possible uses in commercial industries. From their proximate analyses, the processing of escolar and oilfish might pose a problem from their low moisture content. While the actual population stock is not known, the potential uses of these studied species might be counterbalanced from yearly catch and quota restrictions.

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