THE STABILITY OF BIOACTIVE COMPOUNDS IN YELLOWSTRIPE SCAD (Selaroides leptolepis) UNDER SUBATMOSPHERIC PRESSURE STORAGE

Bui Tran Nu Thanh Viêt¹; Toshiaki Ohshima²
¹Faculty of Food Technology, Nha Trang University, Vietnam
²Department of Food Science and Technology, Tokyo University of Marine Science, Japan

ABSTRACT

This present study was conducted to evaluate the contents of coenzyme Q10 (CoQ10), α-tocopherol (TOH), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) and the effects of subatmospheric pressure levels (from 0.2 to 1 atm) on mentioned compounds in Yellowstripe scad. The content of Q10, TOH, EPA, DHA were 26.3 ± 2.89 (µg/g); 21 ± 1.27(µg/g); 27.65 ± 3.28(mg/g) and 16.2 ± 1.72 (mg/g), respectively. All these compounds reduced after 6 days storage. The CoQ10 loss percentage was higher than in TOH, EPA and DHA. The highly reduced pressure level ranged from 0.2 to 0.4 atm had positive effects to stable bioactive compounds compared to low reduced atmospheric pressure (0.8–1 atm). Results also indicated that Yellowstripe scad is good sources of DHA, EPA, Q10, and TOH.

Keywords: Coenzyme Q10; Vitamine E, DHA, EPA, subatmospheric pressure

I. INTRODUCTION

Yellowstripe scad belongs to the small pelagic fishes group which is considered as low value fishes has long been one of plentiful marine sources in Vietnam. This fish are present in whole Vietnam’s sea areas. Some research points out many nutrients and functional compounds that are essential for good health are present in Yellowstripe scad (Wan Rosli W. I, 2012; Vilailak Klompong, 2007). Bases on research of Kolakowska (2002), pelagic fish are an excellent source of high-quality animal protein and fatty acids. Some studies (Elena Orban, 2011; Minh Dieu Huynh, 2009) had evaluated the nutrient profiles of herring, hake, capelin, bogue and horse mackerel. Their agreement that these fishes characterised by rich in unsaturated fatty acid, good protein contents and low cholesterol levels at any season considered. Pelagic fish, in particular, a valuable source of energy and are very rich in micronutrients not usually found in basic foods. In addition to being high in potassium, iron, phosphorus and calcium, the fatty component of fish contains significant amounts of vitamins A and D.

According to the report of Research Institute for Marine Fisheries (Haiphong, Vietnam, 2012) that total production of Yellowstripe scad landing by port from 2005 to 2010 was more than 449 thousand tones. Although the yield of this fish is potentially large but they are usually used for domestic (household) consumption, mainly in low income people, by fresh cooking or making fish cake. The these fishes with lower quality is mainly used for aquaculture feed or cattle feed. The utilization of this raw material in the processing of other products with a higher added value is essential. Many efforts have been made to utilize them as smoked, canned, chilled and frozen these fish products.

Exposure of fresh fish to the atmospheric air normally results to spoilage. Especially, bioactive compounds are unstable and rapidly loss after fishing. Vacuum packaging has been used to minimize these problems and to extend the storage life of meat, reduces losses of weight from evaporation and trimming, preserves visual appearance, improves hygienic control, and enhances palatability during period of distribution and merchandising. Recently, rigid small vacuum chambers accompanied by a cheap vacuum pump
adoptable for vacuum build-up have been introduced into households and are widely used for storing a variety of food products.

The application of these containers brings much more advantages than traditional vacuum package. Hence, their penetration into the households and daily life is widespread. The simple belief that exclusion of oxygen from the atmosphere would be beneficial in food preservation, which is true to some extent. However, the casually adjustment of pressure level and limitation or exclusion of present of air around the products surface in vacuum storage condition may cause other kinds of spoilage. Therefore, the present study was concluded to investigate the contents of some bioactive compounds in Yellowstripe scad in order to consider those could be used industrially and the effect of subatmospheric pressure levels (between 0.2 and 1 atm) on some bioactive compounds.

II. MATERIALS AND METHODS

1. Chemicals

A standard reference of fatty and methyl esters, 68A, for fatty acid analysis was purchased from Nu-Check Prep (Elysian, MN, USA). 2,2,5,7,8-pentamethyl-6-hydroxycroman (PMC), Coenzyme Q10 and α-tocopherol standards were purchased from Sigma-Aldrich (St. Louis, Mo., U.S.A). Methanol, ethanol, chloroform, 1-butanol, 2-propanol, n-hexane, distilled water of HPLC grade were purchased from Kokusan Chemical Co., Ltd., (Tokyo, Japan). All other chemicals of analytical grade were purchased from Wako chemical Co. Ltd., (Osaka, Japan). 2. Preparation of samples and experimental apparatus

Yellowstripe scad (Selaroides leptolepis) was purchased from the local market. Fish muscle was minced thoroughly and packed 100g in each small polystyrene trays. 500g was let for analyse mentioned compounds that was seen 0 day sample. The other samples were then placed in the vacuum chambers (28 x 21.2 x 12.1 cm) set inside a Hitachi model R-S43WM (Tokyo, Japan) at 2.5°C and 80% of relative humidity. The pressure of chambers were set at 0.2, 0.4, 0.6, 0.8 atm, and 1atm as a control sample. Experiments were done in triplicate.

3. Analytical method

3.1. Total lipid content

Total lipids were extracted from 10 g portion of the fish muscle, according to the method of Bligh and Dyer procedure (Bligh and Dyer, 1959).

3.2. Fatty acid composition

Fatty acids analyses were carried out according to the method of AOCS Ce 1b-89 (AOCS, 1991). The prepared samples was analyzed by gas chromatography using a Shimadzu model 14B instrument (Tokyo, Japan) equipped with a Supelcowax-10\textsuperscript{TM} fused silica open tubular capillary column (0.25mm i.d x 30m, 0.25µm in film thickness, Supelco, Bellefonte, PA, USA) and a flame ionization detector.

3.3. Analysis of α-tocopherol

Before total lipids were extracted by the Bligh and Dyer procedure (Bligh & Dyer, 1959), 2,2,5,7,8-pentamethyl-6-hydroxycroman (PMC) was added to the meat as an internal standard. The chloroform used as the solvent was replaced with 10 ml of n-hexane, and the sample was subjected to HPLC with a silica-gel HPLC column (Supelcosil, LC- Si, 250 x 2.1 mm, 5mm) and the mobile phase consisting of a mixture of n-hexane:2-propanol (99.5:0.5, v/v). The intensity of fluorescence with excitation wavelength at 297 nm and an emission wavelength at 327 nm was monitored using a model RF-550 spectrofluorometric detector (Shimadzu).

3.4. Analysis of coenzyme Q10

Extraction of samples was performed using a solvent extraction method according to Mattila et al (2001) and Mattila et al. (2000). Briefly, a 2g fish sample was weighed into an extraction tube and homogenized in 5 mL 0.15 M NaCl. Eight milliliters of ethanol was added to the sample mixtures. After that, 20 mL n-hexane (HPLC grade) was added into a tube and mixed vigorously for 10 min. The tube was quickly centrifuged to separate the layers. Hexane layer was saved and the lower layer was re-extracted twice with 5 mL ethanol and 20 mL n-hexane. The combined n-hexane layer was evaporated with a Rotavapor (30-40°C) and the residue dissolved in 2 mL 2-propanol and filtered with membrane filter (0.2 µm) prior to the HPLC analysis.

The analytical HPLC system consisted of a model RF-550 spectrofluorometric detector (Shimadzu) connect with Chromatopac C-R3A chromatographic integrator (Shimadzu) and a silica-gel HPLC column (Supelcosil, LC- Si, 250 x 2.1 mm, 5mm). The mobile phase consisted of a
mixture of methanol, 2-propanol and ethanol (70 : 15 : 15, all HPLC grade) was pumped to the Shimadzu model LC-10AS HPLC pump at a flow rate of 0.8 ml/min and the injection volume 10 μL. The HPLC analysis was performed at room temperature. Coenzymes Q10 were quantified by an external standard method, and the quantification was based on peak area. The wavelength used for identification and quantification of the coenzymes was 275 nm.

3.5. Statistical analysis

Data analyses were performed in triplicate. The differences among the means were determined by analysis of variance (ANOVA) by Statistica software, version 7 (StatSoft, Inc, USA). Probabilities less than or equal to 0.05 were considered statistically significant. Excel 2007 software was used to make figures and tables.

III. RESULTS AND DISCUSSION

Contents of CoQ10, alpha-tocopherel, DHA and EPA in Yellowstripe scad meat are shown in Table 1. Mattila P (2001) and Kamei (1986) reported similar results in Q10 for fish meat samples. Comparison to study of Nathalie Souchet (2007) and Bui Tran Nu Thanh Viet (2011) who analysed the Q10 in high value fishes including mackerel and tuna found that the Q10 contents in Yellowstripe scad was even higher than lean tuna (15 μg/g) and almost similar with mackerel (28.5 μg/g).

Table 1. Some bioactive compounds in Yellowstripe scad

<table>
<thead>
<tr>
<th>COMPOUNDS</th>
<th>TOH (μg/g)</th>
<th>CoQ10 (μg/g)</th>
<th>DHA (mg/g)</th>
<th>EPA (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21±1.27</td>
<td>26.3±2.89</td>
<td>27.6±3.28</td>
<td>16.2±1.72</td>
</tr>
</tbody>
</table>

Alpha-tocopherel was 26.3±1.27 μg/g (Table 1). Ingrid Undeland B. E.,(1998) found the content of TOH in herring about 15μg/g.

Yellowstrip scad are medium-fat species (2–8%) with a high level of polyunsaturated fatty acids (PUFA). Among PUFA, docosahexaenoic acid C22:6 (n-3) (DHA) were the most abundant about 27.6mg/g (table 1) (equivalent 18±20.5%) followed by eicosapentaenoic acid C20:5(n-3) (EPA) about 16.2 mg/g/ (equivalent 12.59%). Make a comparison with the results of Wan Rosli W. I., (2012) and Nurnadia Abd Aziz, (2013) on the fatty acids content of the same fish species, and with a typical high value- fish, tuna in previous study of (Yoshi, 2007), we interestingly found in this research DHA and EPA contents were higher. Normally, chemical compositions of fish varies greatly from one species and one individual to another depending on age, sex, environment and season.

The trend of CoQ10, α-tocopherol, DHA, EPA loss of the yellowstrip scad meat under different storage conditions are shown in Figure 2, 3 & 4, respectively. These contents significantly decreased in all of the meat samples with prolongation of storage time. The loss of these compounds stored in the atmospheric pressure was much more than the samples stored in the subatmospheric conditions.

The reduced atmospheric pressure had a great effect in loss the α-tocopherol content (Figure 2). The loss percentage of CoQ10 was higher than TOH in the same days storage. The loss rate of TOH and CoQ10 (Figure 1&2) in meat was faster than that in the DHA and EPA (Figure 3&4) during storage time. It is reasonable that the α-tocopherol acts as an antioxidant by protecting lipids from autooxidation by being preceding oxidation its shelf. Numerous data has showed about the inhibition of the oxidation by α-tocopherol and its mechanism has been studied extensively (Frackel, 2005). Where, α-tocopherol (TOH) actually acts as an antioxidant by scavenging lipid peroxyl oxygen radical (LOO•), LOO• + TOH → LOOH + TO•. Hence, the α-tocopherol is reduced before the oxidation of polyunsatured fatty acids.

Patrik Forsmark, et al (1991) also showed that CoQ10, efficiently inhibits lipid peroxidation even when vitamin E is absent. When combination of both CoQ10 and TOH can act synergis antioxidant reactions (Detcho A. Stoyanovsky, 1995). It is also conceivable that the CoQ10 is more sensitive than TOH. In vitro studies on human low density polyprotein, CoQ10 acts more efficiently against lipid peroxidation than does α-tocopherol (Roland Stocker, 1991). CoQ10 and TOH play important roles to protect against the oxidation fatty acids.
After four days storage, the loss percentage of mentioned compounds in 0.8 atm and control sample much higher than that in 0.2-0.4 atm samples. In the fourth day storage, about 25% TOH remained, but CoQ10 compound lost all. After 6 days storage, no more TOH detected. No significant different was found in CoQ10 and TOH.
in samples stored at 0.2 atm, 0.4 atm and 0.6 atm. However, the loss percentage of TOH in sample storing at 0.6 atm was significantly higher than that stored in 0.2 and 0.4 atm. DHA loss rate in sample stored at 0.2 atm was lowest.

Subsequent long-term storage may cause the oxidative rancidity of fish lipids, promote the growth of aerobic bacteria and inhibits the growth of strictly anaerobic bacteria (Arashisar, 2004). Hence, the reduced oxygen concentration near the surface of meat can prevent those undesirable phenomena (Mancini, 2005). In addition, the reduction of atmospheric pressure is not mainly to remove the oxygen only, but also the structure of meat may be expanded (Specialia, 1972), leading to form more wholes and then the oxygen is easier to penetrate into the meat surface and change the meat quality (Mancini, 2005).

The results in the present study revealed that the reduced atmospheric pressure from 0.2 to 0.6 atm had a great effect in declining the bioactive compounds compared to those of the meat stored at the atmospheric pressure of 1 atm.

IV. CONCLUSION

Results indicated that yellowstrip scad is good source of DHA, EPA, Q10, and TOH whose by-products could be used industrially for the extraction of such a high-value biomolecules. The reduced atmospheric pressure under 0.4 atm can be applied to prevent the loss of bioactive compounds during chilling storage time.

Acknowledgements

The author would like to thank Prof. Toshiaki Ohshima (Department of Food Science and Technology, Tokyo University of Marine Science, Japan) for the laboratory facilities.

REFERENCES


