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# Properties of protein-based film from round scad (*Decapterus maruadsi*) muscle as influenced by fish quality

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**Abstract**

The properties of film prepared from round scad (*Decapterus maruadsi*) stored in ice for different times were investigated. Degradation of myosin heavy chain (MHC) was more pronounced with the coincidental increase in total volatile base and trimethylamine contents as the storage time increased ($P<0.05$). Regardless of storage time, no changes in tensile strength (TS) and elongation at break (EAB) of resulting films prepared from unwashed mince were observed ($P>0.05$). For the films prepared from washed mince, TS decreased, whereas EAB increased when the storage time of fish increased ($P<0.05$). However, films prepared from washed mince showed the greater mechanical properties with the lower film solubility and protein solubility than did those from mince ($P<0.05$). Generally, films prepared from fish stored in ice for a longer time became less transparent, darker and more yellowish. The electrophoretic study revealed that similar protein patterns were observed between films, irrespective of storage time of fish and washing. Therefore, the quality of fish did not show the marked impact on the mechanical property of the resulting films, while washing likely affected the film forming ability.


*Keywords:* Fish quality; Film; Ice storage; Round scad; Mechanical properties; Degradation; Muscle proteins

## 1. Introduction

Film and coating from biopolymers such as proteins and polysaccharides have been received the increasing attention since synthetic packaging films have led to the serious ecological problems due to their non-biodegradability. Proteins are important biopolymers possessing good film-forming ability. A variety of proteins, both from plant and animal origins, can be used as film-forming agents. Among proteins, fish proteins including myofibrillar and sarcoplasmic proteins have been used as film forming materials (Chinabhark, Benjakul, & Prodpran, 2007; Cuq, Aymard, Cuq, & Guilbert, 1995; Iwata, Ishizaki, Handa, & Tanaka, 2000; Paschoalick, Garcia, Sorbal, & Habitante, 2003; Shiku, Hamaguchi, & Tanaka, 2003; Shiku, Hamaguchi, Benjakul, Visessanguan, & Tanaka, 2004). Generally, films from different protein types exhibit different properties due to the differences in molecular structure and compositions. In addition, properties of protein-based films depend on various factors such as the source of protein, pH of protein solution, plasticizers, film thickness, the preparation conditions and substances incorporated into the film-forming solutions (Cuq, Gontard, Cuq, & Guilbert, 1996; Park & Chinnan, 1995; Park, Weller, Vergano, & Testin, 1993; Sobral, dos Santos, & Garcia, 2005). Recently, film from the meat of round scad, a dark-fleshed fish, has been prepared and muscle types affected the properties of resulting film (Artharn, Benjakul, Prodpran, & Tanaka, 2007).

The post-harvest biochemical and microbial changes occur in fish tissues, depending upon activity of the endogenous enzymes, the microbial contamination and the conditions after catching (Benjakul, Visessanguan, & Leelapongwattana, 2002). Freshness has been proven to affect the functional properties of fish muscle proteins. During the extended storage in ice, the denaturation and degradation of muscle proteins mainly contributed to the loss of gel-forming ability (Benjakul, Leelapongwattana, & Visessanguan, 2003). Benjakul, Visessanguan and Tueksuban

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(2003) reported that autolytic degradation of lizardfish increased throughout 15 days of iced storage. Lizardfish showed the poorer gel-forming ability with increasing storage time. Breaking force and deformation of gel produced from ice-stored bigeye snapper were lower than those of gel prepared from fresh counterpart (Benjakul, Visessanguan, Riebroy, Ishizaki, & Tanaka, 2002). Apart from the influence of fish quality on gelling properties, Shiku et al. (2004) reported that the quality of surimi affected the property of resulting films. Garcia and Sobral (2005) reported that preheating temperatures of film forming solution affected the mechanical properties of tilapia protein based film. Quality or freshness of fish might affect the film-forming properties of fish muscle. Nevertheless, no information regarding the impact of fish quality on the properties of muscle protein based films have been reported. The objective of study was to elucidate the effect of quality of round scad and washing on the properties of its muscle protein based film.

## 2. Materials and methods

### 2.1. Chemicals

Sodium chloride (NaCl), urea, sodium dodecylsulfate (SDS), β-mercaptoethanol (βME) and thiobarbituric acid were purchased from Sigma (St. Louise, MO, USA). Trichloroacetic acid was obtained from Merck (Darmstadt, Germany). Acrylamide, *N,N,N′,N′*- tetramethylethylenediamine (TEMED) and bis-acrylamide were procured from Fluka (Buchs, Switzerland).

### 2.2. Round scad and its storage in ice

Round scad (*Decapterus maruadsi*) with an average weight of 85–90 g were obtained from Songkhla–Pattani coast along the Gulf of Thailand. The fish were stored in ice and off-loaded approximately 12 h after capture. Fish were transported in ice to the Department of Food Technology, Prince of Songkla University within 2 h. Upon arrival, whole fish were immediately washed and stored in ice with fish/ice ratio of 1:2 (w/w). The mixture of ice and fish were placed in polystyrene boxes, which were kept at room temperature (30–32 °C). The fish were randomly taken for analyses and film preparation at day 0, 7, 14 and 21 of iced storage. To maintain the ice throughout the storage, the molten ice was drained every 2 days and the same amount of ice was replaced. The fish temperatures ranged from 0.5 to 1.5 °C during storage in ice.

### 2.3. Washing of mince from round scad stored in ice

Fish samples of each storage time were filleted manually and minced using a mincer with the hole diameter of 0.5 cm. One portion of mince was subjected to washing according to the method of Benjakul, Leelapongwattana et al. (2003). Fish mince was homogenized with 5 volumes of cold 50 mM NaCl (2–4 °C) at a speed of 13,000 rpm for 2 min using an IKA Labortechnik homogenizer (Selangor, Malaysia), followed by centrifuging at 9600*g* for 10 min at 4 °C using a refrigerated centrifuge (Model RC-B Plus centrifuge Newtown, CT, USA). The washing process was repeated twice. Mince and washed mince obtained were stored on ice until used for analyses or for film preparation.

### 2.4. Chemical analyses

#### 2.4.1. Determination of pH

The pH of fish muscle was determined according to the method of Benjakul, Seymour, Morrissey, and An (1997). Sample was homogenized with 10 volumes of deionized water (w/v), and the pH was measured using a pH meter (CG842 Schott, Germany).

#### 2.4.2. Determination of total volatile base (TVB) and trimethylamine (TMA) contents

TVB and TMA contents were determined using the Conway microdiffusion assay as described by Ng (1987). A sample (2 g) was added to 8 ml of 4% trichloroacetic acid (TCA) (w/v) and homogenized with a homogenizer (IKA Labortechnik, Malaysia) at a speed of 11,000 rpm for 2 min. The homogenate was centrifuged at 3000*g* for 15 min using a Biofuge primo centrifuge (Sorvall, Hanau, Germany) at 4 °C. The supernatant referred to as 'sample extract' (1 ml) was placed in the outer ring of Conway apparatus. The inner ring solution (1% boric acid containing the Conway indicator) was then pipetted into the inner ring. To initiate the reaction, $K_2CO_3$ (1 ml) was mixed with sample extract. The Conway unit was closed and incubated at 37 °C for 60 min. The inner ring solution was then titrated with 0.02 M HCl until the green colour turned to pink. Determination of TMA content was carried out in the same manner except that 1 ml of 10% formaldehyde was added to the sample extract to fix ammonia present in sample prior to the assay.

#### 2.4.3. Determination of TCA-soluble peptide content

The TCA-soluble peptide content was determined according to the method of Green and Babbitt (1990). A sample (3 g) was homogenized with 27 ml of 15% TCA. The homogenate was kept in ice for 1 h and centrifuged at 12,000*g* for 5 min. The soluble peptides in the supernatant were measured by the method of Lowry, Rosebrough, Farr, and Randall (1951) and expressed as μ mol tyrosine/g sample.

#### 2.4.4. SDS-polyacrylamide gel electrophoresis (SDS-PAGE)

Protein patterns of mince and washed mince from round scad stored in ice for different times were determined by SDS-PAGE using 4% stacking gel and 10% running gel according to the method of Laemmli (1970). Minces (3 g) were solubilized in 27 ml of 5% SDS. The mixture was homogenized for 1 min at a speed of 13,000 rpm using an