Characteristics and Gel-forming Ability of Surimi from Oxeye Scad (*Selar boops*) and Shrimp Scad (*Alepes djedaba*)

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Abstract

This study aimed to investigate the characteristics and gel properties of surimi prepared from oxeye scad and shrimp scad muscles. The pH and protein solubility of shrimp scad surimi were higher than those of oxeye scad surimi (p<0.05). The Ca^{2+}-ATPase activity, sulfhydryl (SH) group and disulfide bond contents were greater in natural actomyosin (NAM) extracted from shrimp scad surimi than oxeye scad surimi (p<0.05). However, kamaboko gel (40°C, 30 min/90°C, 20 min) of oxeye scad surimi had a higher breaking force and deformation (p<0.05) than shrimp scad surimi. Oxeye scad surimi contained larger contents of myoglobin and metmyoglobin resulting in a lowered whiteness of gel compared to shrimp scad surimi (p<0.05). Surimi from oxeye scad showed a superior gel forming ability with an inferior whiteness to shrimp scad. Thus, strategies to improve color of oxeye scad surimi gel should be further studied.

Keywords: shrimp scad, oxeye scad, gel-forming ability, surimi, physicochemical properties

Introduction

Due to the lack of lean fish, which are commonly used for surimi production, dark-fleshed fish have recently received more attention as the raw material for surimi production. In 2009, the catch of pelagic fish in the Gulf of Thailand was approximately 384.9 metric tons (Department of Fisheries 2009). Oxeye scad and shrimp scad are abundant dark-fleshed fish species commonly caught in Southern Thailand, especially in the Thasala coast of Nakhon Si Thammarat. Therefore, the use of these pelagic fish for surimi production is one of a major challenge ways to transform the underutilized fish protein resources into human foods, particularly protein gel-based products. The characteristics of surimi gel depended on the properties of myofibrillar proteins, which were affected by the species and freshness of the fish, as well as on the processing parameters (Niwa 1992). However, no information regarding the characteristics of surimi gel produced from oxeye scad and shrimp scad has been reported. Therefore, the objective of this study was to investigate the characteristics and gel-forming ability of surimi prepared from both species.

Materials and Methods

Preparation and chemical analysis of surimi and surimi gel

Oxeye scad with an average weight of 110-120 g and shrimp scad with an average weight of 125-140 g obtained from the fishing port in Thasala along the coast of the Gulf of Thailand were used for this study. The fish were washed, filleted manually and minced to uniformity. Surimi was prepared by conventional washing process using a cold water (4 ^{o}C) /mince ratio of 3:1 (v/w) (Chaijan and others 2004). To prepared the gel, surimi (80% moisture) was ground with 2.5% (w/w) NaCl to obtain the homogenous sol. The sol was incubated at 40 ^{o}C, 30 min/90 ^{o}C, 20 min for kamaboko gel (Chaijan and others 2004). Modori gel was prepared by incubating the sol at 60 ^{o}C, 30 min/90 ^{o}C for 20 min (Jiang 2000). The physicochemical properties of surimi and surimi gels were determined. The pH, myoglobin content, metmyoglobin content and protein solubility were determined by the method of Benjakul and others (1997), Benjakul and Bauer (2001), Hansen and Sereika (1969) and Benjakul and Bauer (2000), respectively. Ca^{2+}-ATPase activity, reactive SH group and disulfide bond content of NAM were determined according to the method of Benjakul and others (1997), Ellman (1959), Thannhauser and others (1987), respectively. Breaking force and deformation of surimi gel were measured using the texture analyzer equipped with a spherical plunger (diameter 5 mm, depression speed of 60 mm/min). Surimi gel color was determined using a colorimeter. L^*, a^* and b^* were measured and whiteness was calculated as described by Park (1994).

Results and discussion

Oxeye scad muscle contained a larger amount of myoglobin and metmyoglobin when compared to shrimp scad muscle (p<0.05). This indicated that the contents of myoglobin and metmyoglobin of fish muscle were depended on fish species. The metmyoglobin formation suggested that myoglobin underwent more oxidation (Benjakul and Bauer 2001). The pH of shrimp scad surimi was higher than that of oxeye scad surimi (Table 1, p<0.05). The differences in pH between the two species might be due to the differences in chemical compositions as well as the buffering capacity of muscle. From the results, the lower pH exhibited the higher relative metmyoglobin content, which was presumably greater in oxeye scad surimi. Shrimp scad surimi showed a greater protein solubility in 0.6 M KCl than oxeye

scad surimi (Table 1). The solubility of a protein is primarily determined by the preponderance of charged groups and of hydrophobic groups that are exposed to the solvent (Walstra 2003). Oxeye scad surimi might contain the greater proportion of hydrophobic groups on the surface of a protein leading to its lowered solubility. A larger proportion of charged groups might be found in shrimp scad protein and the solubility was enhanced. The Ca^{2+}-ATPase activity was greater in NAM extracted from shrimp scad surimi than oxeye scad surimi (Table 1, $p<0.05$). Ca^{2+}-ATPase has been used as an indicator of myosin integrity (Benjakul and others 1997). Differences protein integrity among fish species were possibly caused by different susceptibility to denaturation of muscle protein (Benjakul and others 2005). Shrimp scad surimi showed greater contents of SH group and disulfide bond compared with oxeye scad surimi (Table 1, $p<0.05$). Benjakul and others (2003) reported that the difference in SH content among species was caused by the differences in susceptibility to SH oxidation of myofibrillar proteins.

Table 1 Physicochemical properties of surimi from shrimp scad and oxeye scad

Properties	Shrimp scad	Oxeye scad
Myoglobin (mg/g)	1.28 ± 0.15	2.48 ± 0.11
Relative metmyoglobin (A630/A525)	0.62 ± 0.01	0.71 ± 0.03
pH	6.83 ± 0.04	6.33 ± 0.02
Protein solubility (%)	89.39 ± 1.58	30.55 ± 1.52
Ca^{2+}-ATPase (µmol Pi/mg protein/min)	0.19 ± 0.01	0.15 ± 0.01
Sulfhydryl contents (mol/10^5 g protein)	5.03 ± 0.19	4.31 ± 0.18
Disulfide bond contents (mol/10^5 g protein)	4.79 ± 0.07	4.16 ± 0.19

Values are given as mean ± SD from triplicate determinations.

The breaking force and deformation of kamaboko and modori gels from oxeye scad surimi were higher than shrimp scad surimi (Figure 1, $p < 0.05$). Protein denaturation was an important step for thermal gelation of surimi and it can influence the property of resulting gel. Since protein of shrimp scad surimi contains a greater disulfide bond content leading to a compact structure of its native conformation. Presumably, the protein of shrimp scad surimi underwent partial unfolding upon heating. Protein from oxeye scad surimi contained a lower amount of disulfide bond. Thus, it might be susceptible to heat denaturation. Heating of protein releases hydrophobic groups and exposures of some buried SH groups (Belitz and Grosch 1999). From the result, the more denaturation, the more exposed hydrophobic and SH groups can be obtained. As a consequence, hydrophobic interaction and intermolecular disulfide bond can be formed in oxeye scad surimi gel to a greater extent resulting in higher breaking force and deformation. In addition, the gel strength and elasticity can be influenced

by the pH of the surimi. The pH of oxeye scad surimi was closer to the pI of fish myofibrillar protein (~5.5) than that of shrimp scad surimi. Thus, a more protein-protein interaction can be taken place in oxeye scad surimi gel.

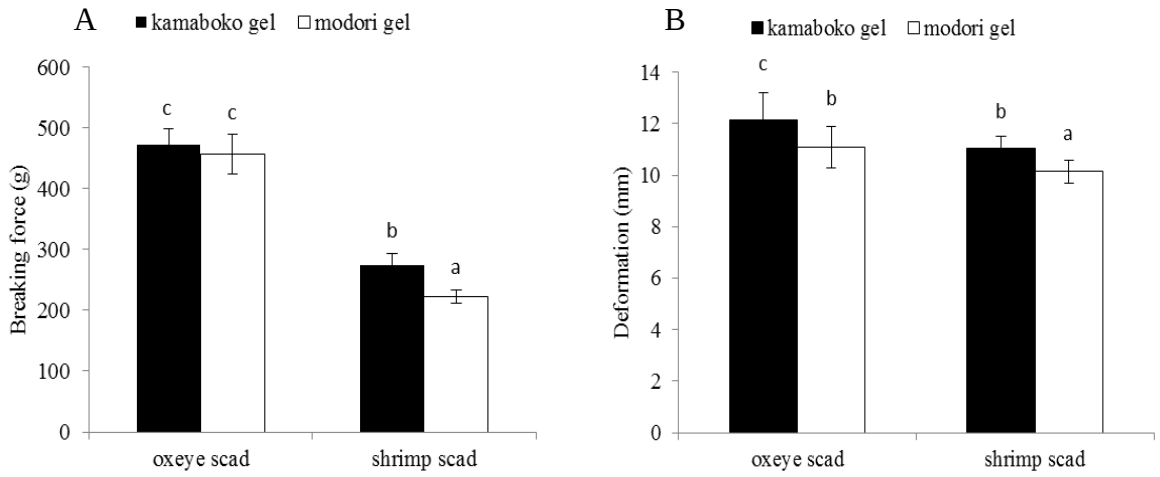

Figure 1 Breaking force (A) and deformation (B) of surimi gels prepared from oxeye scad and shrimp scad. Bars represent the standard deviation from seven determinations for breaking force and deformation. Different letters indicate significant differences ($p < 0.05$).

Gels from shrimp scad generally showed a higher whiteness than those from oxeye scad (Figure 2, $p<0.05$). Oxeye scad surimi contained larger contents of myoglobin and metmyoglobin resulting in a lowered whiteness of gel compared to shrimp scad surimi. Due to the higher content of myoglobin in oxeye scad surimi, the greater oxidation might take place in this species, compared with shrimp scad. Metmyoglobin formation, caused by oxidation process, possibly resulted in the darker color of oxeye scad surimi gel.

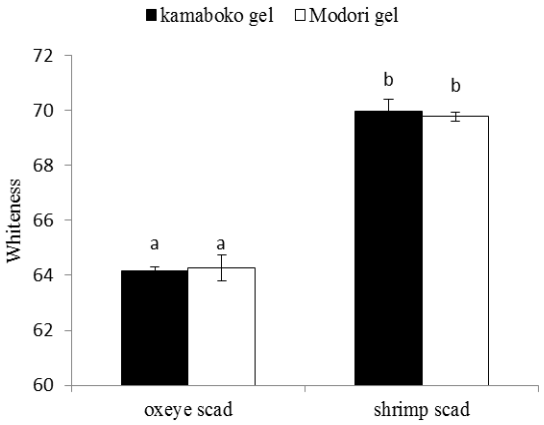

Figure 2 Whiteness of surimi gels prepared from oxeye scad and shrimp scad. Bars represent the standard deviation from triplicate determinations for breaking force and deformation. Different letters indicate significant differences ($p < 0.05$).

Conclusion

The physicochemical properties of surimi gel were species-dependent. Oxeye scad surimi gel exhibited the higher breaking force and deformation with lower whiteness than that of shrimp scad surimi gel.

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