Extraction and characterization of gelatin from skin of Cobia (*Rachycentron canadum*) and Cynoglossus (*Cynoglossus cynoglossus*)

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Abstract Gelatin was extracted from the skins of Cobia (*Rachycentron canadum*) and Cynoglossus (*Cynoglossus cynoglossus*) and their physicochemical properties were measured. The skin of Cobia and Cynoglossus yielded 13.8 and 10.3% gelatin, respectively. The gel strength of Cobia gelatin was found to be higher (176.5 g) than Cynoglossus skin gelatin (164.1 g). Similarly, viscosity, setting point, water holding capacity of Cobia skin gelatin was in general better than the Cynoglossus skin gelatin. The amino acid analysis showed that Glycine content in each type of gelatin is far higher than any other amino acids.

Key words: Rachycentron canadum, Cynoglossus cynoglossus, gelatin, amino acids.

1. Introduction

Gelatin is a polypeptide with a high molecular weight and an important hydrocolloid, broadly used to improve stability, elasticity and consistency in food products. It is also known as the denatured and partially hydrolyzed collagen and obtained from the skin, connective tissue and bones of animals. The worldwide production amount of gelatin is about 300,000 tons per year and its global demand has been increasing over the years (Schrieber & Gareis 2007).

Due to the increasing demand for non-mammalian gelatin for halal and kosher food markets, greater interest and focus was generated on development of methods for efficient utilization of fish by-products to produce fish gelatin as replacements for mammalian sources (Karim & Bhat 2009). Fish skin contains a large amount of collagen and can be considered as a potential source of gelatin. Furthermore, the utilization of skin for the extraction of gelatin can significantly address the problem of waste disposal in the fish processing industry.

The quality of gelatin depends on its physicochemical properties, which were greatly influenced, not only by the origin of raw material, but also by the processing methods and parameters (Cheow et al. 2007). The main problem of fish gelatins is that their gels tend to be less stable and have poorer gelling properties than gelatins from mammals and this may limit their application. Based on the previous studies, this is true in the case of cold-water fish species, such as cod, salmon and Alaska Pollock. However, researchers have pointed out that tropical and sub-tropical warm-water fish species (tilapia, Nile perch, catfish) might have similar physicochemical properties to that of mammalian gelatins, depending on the species, type of raw material and processing conditions (Gilsenan & Ross-Murphy 2000; Gomez-Guillen et al. 2002; Jamilah & Harvinder 2002; Muyonga et al. 2004).

Fish used as human food accounts for 78% of the total fish fish catch, leaving about 21% for non-food uses (Vannuccini, 2004). Processing leads to the generation of a large biomass of fish waste (e.g., skin, bones, and fins), which is generally discarded (~7.3 million tons / year) (Kelleher, 2005). Consequently, research has been initiated to investigate an increased utilization of collagenous fish waste for the production of gelatin.

Fish skin will form a major portion of the fishery waste, particularly in the case of production of mince-based and fillet-based value-added products. Hence, the objective of this study is to extract gelatin from the skins of Cobia and...
Cynoglossus and determine their physicochemical characteristics.

2. Materials and methods

2.1 Raw material

The species used for the study were Cobia (Rachycentron canadum) and Cynoglossus (Cynoglossus Cynoglossus). The samples were procured from Kalamukku Harbour in Cochin, Kerala. The fish was brought to the laboratory in iced condition. The samples were then filleted and the skin was manually removed. It was then cleaned by removing the scales, washed and blast frozen and stored at -20°C until used for extraction and analysis and maximum storage of less than 2 months before use. For all analysis, samples were taken in triplicate.

2.1.1 Preparation of the fish skin for gelatin extraction

Frozen skins were thawed at 4°C for about 20 h, chopped into small pieces (about 2 to 3 cm) and washed thoroughly with tap water to remove the superfluous material. The cleaned fish skins were drained using cheesecloth for 5 min and the cheesecloth containing the skins were squeezed manually to remove liquid.

2.1.2 Gelatin extraction

The gelatin extraction procedure followed was essentially as described by Gudmundsson and Hafsteinsson (1997) with slight modifications. The cleaned and drained fish skins were given a pretreatment with an alkaline solution followed by an acid solution. Cleaned skins were soaked with 0.2% (w/v) sodium hydroxide solution for 45 min. It was followed by soaking with 0.2% (w/v) sulphuric acid for 45 min. This was followed by soaking with 1.0% (w/v) citric acid. After each treatment, the skins were washed under running tap water until they had a pH near to 7. Each soaking and washing treatment was repeated two times. The ratio of skin-to-alkali/acid solution was 250 g wet weight of skin to 1.5 L of solution. The skins were then subjected to a final wash with distilled water before the final extraction. The final extraction was carried out in distilled water at controlled temperature of 45°C using a water bath for 10 h. The ratio used was 250 g wet weight of the skin to 1.5 L of distilled water. The clear extract obtained was filtered in a Buchner funnel with a Whatman filter paper (No.4) and then evaporated under vacuum in a vacuum chamber (Heraeus vacutherm, Langenselbold, Germany). The gelatin sample was finally prepared by freeze-drying in a freeze drier.

2.1.3 Determination of Yield

The yields of the gelatin obtained were calculated as:

\[
\% \text{ Yield (wt. wt. basis)} = \frac{\text{Dry wt. of gelatin}}{\text{Wet wt. of skins}} \times 100
\]

2.1.4 Determination of proximate composition and pH of gelatin

The moisture (oven-drying procedure), crude protein (Kjeldahl method), ash and fat content (Soxhlet extraction) of the raw fish skin and extracted gelatin were estimated by the AOAC official method (AOAC 2005). The analysis were replicated three times. The pH of gelatin solution was measured using the British Standard Institution method, BSI (1975).

2.1.5 Determination of amino acid composition

Samples (100-200mg tissue) were hydrolyzed using 10.0 ml of 6M HCl containing 2% phenol at 110°C for 24 hrs in heat sealed tubes after flushing with Nitrogen and were finally filtered using Whatman No:1. The hydrolyzed sample solutions thus obtained were subjected to derivatization using PITC (phenyl isothiocyanate). Briefly 5μl of each of the above filtered sample solutions were transferred to 1 ml sample tube and dried under vacuum to remove all traces of HCl. The samples in the test tubes were treated with 20μl of redrying solution by gentle vortexing and dried under vacuum. Subsequently, the amino acids were derivatized by addition of 10μl of derivatization solution to the above dried samples by gentle vortexing for 20 minutes at room temperature. The sample derivatization solution was further removed by drying under vacuum for 30 minutes. After derivatization, one ml of sample diluent solution was added and mixed by vortexing for a few seconds and filtered using 0.45μm Nylon filters (Whatman, Maidstone, England). For chromatographic analysis, 10μl each of the above samples were injected into the HPLC.

HPLC system (Waters Model 2487) equipped with a Binary Pump model M515, a 600 Gradient mixer solvent delivery system and a 5μm Pico-Tag Reversed Phase Column (3.9 mm i.d ×150 mm length) was used for the analysis of amino acids. The equipment is provided with column oven (TCM Waters), a dual λ absorbance
detector (UV/VIS Model 484) and a manual injector. Data analysis was performed using EMPOWER 2 chromatography software.

2.1.6 Determination of gel strength (Jelly strength, Bloom) (BS757: 1975)

The gel strength (Bloom) was determined by the British Standard 757:1975 method (BSI 1975) using a texture analyzer (Lloyd Instruments, Model LRX Plus, Sussex, U. K). 7.50±0.01g gelatins were weighed into the Bloom bottle and 105 ± 0.2 ml deionized water was added and stirred. The bottle was covered with a rubber stopper and the sample was allowed to stand at room temperature for 4 hours. The bottles were then placed in water bath at 45°C for about 20 min with occasional shaking for complete dissolution. The bottles were allowed to cool for about 15 min. at room temperature, and then placed in chilled condition at 2-4°C for 17 h. For determining the gel strength, the plunger of the Texture Analyzer was set to move a distance 4 mm into the gel with a speed of 0.5 mm/sec. The sample bottle was removed from the chill condition and immediately placed at the centre of the platform of the Texture Analyzer so that the plunger contacts the sample as nearly at its midpoint as possible and the measurement was taken. The value given by the Texture Analyzer was the gel strength (Bloom).

2.1.7 Determination of Viscosity

Viscosity was measured as per the method described by Cho et al. (2006). The viscosity (cP) of 10 mL of the gelatin solution of 6.67% (w/v) was determined using Brookfield digital viscometer (Model DV E, Brookfield Engineering Laboratories Inc., Middleboro, MA) equipped with a No. 1 spindle at 30 ± 0.5C.

2.1.8 Determination of melting point of gelatin

The melting point measurement was done according to the method of Wainewright (1977). Gelatin solutions, 10% (w/v), were prepared and a 5 ml aliquot of each sample was transferred to a small culture tube (12×75 mm). The samples were degassed in vacuum desiccators (Heraeus vacutherm, Hohenpriesnitz, Sachsen, Germany) for 5 min. The tubes were then covered with parafilm (Pechiney Plastic Packaging, Inc., Chicago, IL, USA) and heated in a water bath at 60°C for 15 min. The tubes were immediately cooled in ice-chilled water and matured at 10°C for 18 hr. Five drops of a mixture of 75% chloroform and 25% red food colour (Magnil Dye Chem, Mumbai, Maharashtra, India) was placed on the surface of the gel. The gels were put in a water bath (Haake D3, Lab Extreme, Inc., Kent City, MI, USA) at 10°C and the bath was heated at the rate of 0.2°C/m in. The temperature at which the dye drops began to move freely down the gel was taken as the melting point.

2.1.9 Determination of setting point and setting time

The method used for the determination of setting point (SP) and setting time (ST) of gelatin was that described by Muyonga et al. (2004). Gelatin solutions of 10% (w/v) dissolved in thin wall (12×75 mm) test tubes were prepared in the same way as described for the Bloom samples. For setting point determination, the dissolved samples from the warm water bath were transferred to a circulating water bath held at 40°C (Haake D3). The bath was then cooled at the rate of 2°C/min. A thermometer was inserted into the sample and lifted out at 15 sec intervals. The temperature of the mixture at which the gelatin solution no longer dripped from the tip of the thermometer was recorded as the setting temperature.

Setting time was determined on samples prepared in the same way as those for the determination of the setting temperature. Samples were transferred to the water bath maintained at 10°C (Haake D3). A rod was inserted into the gelatin solution and raised at intervals of 15 sec. The time at which the rod could not detach from the gelatin sample was recorded as the setting time.

2.1.10 Determination of foaming properties

Foam formation ability (FA) and foam stability (FS) of gelatin were determined by the procedure of Cho et al. (2004). Gelatin solution, 1g/100 ml was put in a beaker and swelled at 60°C. The foam was prepared by homogenizing at 10,000 rpm for 5 min in a homogenizer (Euro Turrax T20b, IKA Labortechnik, Staufen, Germany). The homogenized solution was then poured into a 250 ml measuring cylinder. The FA was calculated as the ratio of volume of foam to the initial volume of liquid. The foam stability was calculated as the ratio of the initial volume of foam to the final volume of foam after 30 min.

2.1.11 Determination of water holding capacity and fat binding capacity

Fat binding capacity (FBC) and water holding capacity (WHC) of gelatin were determined as per the procedure of Cho et al. (2004). For measuring FBC, 1g of gelatin powder was placed in a centrifuge tube and weighed (tube
with gelatin). Then, 10 ml sunflower oil was added, and held at room temperature for 1 hr. During this period, the gelatin solutions were mixed with a Vortex mixer (CM - 101 Plus, REMI Instruments, Maharashtra, India) for 5 sec every 15 min. The gelatin solutions were then centrifuged at 450 ×g (Model CPR 24, REMI Instruments, Maharashtra, India) for 20 min with cylinder bottom centrifuge of 20 ml capacity (REMI Instruments, Maharashtra, India). The upper phase was removed by tilting the centrifuge tube to 45° angle and draining on to a filter paper for 30 min. The FBC was calculated as the weight of the contents of the tube after draining divided by the weight of the dried gelatin, and expressed as the weight % of dried gelatin.

For measuring WHC, 1 g of gelatin powder was placed in a centrifuge tube and weighed (tube with gelatin). Distilled water (50 ml) was added, and held at room temperature for 1 hr. During this period, the gelatin solutions were mixed with a Vortex mixer (CM - 101 Plus, REMI Instruments, Maharashtra, India) for 5 sec every 15 min. The gelatin solutions were then centrifuged at 450 ×g (Heraeus Multifuge3SR Plus, Thermo Scientific, MK, Buckinghamshire, England) for 20 min with 600 ml bucket centrifuge (Thermo Scientific, MK, Buckinghamshire, England). The upper phase was removed and the centrifuge tube was drained for 30 min on a filter paper after tilting to 45° angle. WHC was calculated as the weight of the contents of the tube after draining divided by the weight of the dried gelatin, and expressed as the weight % of dried gelatin.

2.1.12 Statistical Analysis

Three packs from each batch were used for each analysis. Results were expressed as mean ± standard deviation. Experimental data were analyzed using the software SPSS version 20.00 (SPSS; 2000). For data analysis, mean, standard deviation and analysis of variance (ANOVA) were used.

2.2 Results and Discussion

2.2.1 Proximate analysis

The skin gelatin of the two species showed high values for protein and low values for moisture and fat, indicating efficient removal of water and fat from the skin. Freeze-dried gelatin samples had a protein content of 90.21% for Cobia skin gelatin and 89.46% for Cynoglossus skin gelatin (Table 1). Jongjareonrak et al. (2006) reported a protein content of 87.9 and 88.6% for freeze-dried gelatin from the skin of bigeye snapper and brown eye snapper, respectively. Freeze-dried gelatin from the skin of adult Nile perch contained 88% protein when extracted at 50°C (Muyonga et al. 2004).

Moisture content in the Cobia and Cynoglossus skin gelatin samples were 8.12% and 8.61%, respectively, which is less than the limit prescribed for edible gelatin, i.e., 15% (GME 2008). Freeze-drying of the gelatin samples could be the reason for very low content of moisture. The ash content in the samples were in the range of 1.18–1.22% (Table 1), much less than the recommended maximum limit of 2.6% and the limit set for edible gelatin (2%) (GME 2008). The different mineral contents between the skins of the species might be between the skins of the species might be associated with the varying ash contents obtained. Moreover, the skins used for the preparation of gelatin were rescaled thoroughly prior to extraction which might have significantly reduced the ash content of gelatin.

A study on the extraction of gelatin from the skin and bone of Nile perch by Muyonga et al. (2004) has showed that the skin gelatins were generally low in ash, with most having ash content lower than the recommended maximum of 2.6%. The bone gelatins, however had much higher ash content (3-10%), indicating that the leaching process was inadequate. The gelatin extracted from Grass carp skin had 0.12% ash (Kasankala et al. 2007).

2.2.2 Chemical properties

2.2.2.1 pH value

The pH of the gelatins is in the range of 4.03–4.07 (Table 1). The values of pH for gelatin samples are outside the range prescribed for type A gelatin (pH 6.0–9.5) and type B gelatin (pH 4.7–5.6).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cobia</th>
<th>Cynoglossus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>8.12±0.12</td>
<td>8.61±0.11</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>90.21±0.75</td>
<td>89.46±0.74</td>
</tr>
<tr>
<td>Lipid (% dry weight basis)</td>
<td>0.49±0.03</td>
<td>0.71±0.04</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>1.18±0.04</td>
<td>1.22±0.03</td>
</tr>
<tr>
<td>pH</td>
<td>4.07±0.04</td>
<td>4.03±0.06</td>
</tr>
</tbody>
</table>

Values are given as mean ± standard deviation of triplicate.
This is because the pretreatment method employed during the extraction process involves both alkaline and acid treatments. Choi and Regenstein (2000) observed that the gel strength of the fish and pork gelatins decreased markedly below pH 4 and slightly above pH 8. The pH reported for gelatin extracted from the skin of red tilapia was 3.05 and 3.91 for black tilapia (Jamilah and Harvinder 2002).

2.2.2 Amino acid composition

The amino acid composition of the gelatin extracted from Cobia and Cynoglossus are given in Table 2. Glycine (Gly) content in each type of gelatin is far higher than any other amino acids. Glycine was the most abundant amino acid in both of gelatin sample and it was about 19-21% of total amino acids.

Table 2: Amino acid composition of gelatin from Cobia and Cynoglossus skin

<table>
<thead>
<tr>
<th>Amino acids</th>
<th>Source of fish skin Gelatin</th>
<th>Cobia</th>
<th>Cynoglossus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspartic acid</td>
<td>2.21</td>
<td>1.93</td>
<td></td>
</tr>
<tr>
<td>Threonine</td>
<td>3.68</td>
<td>2.06</td>
<td></td>
</tr>
<tr>
<td>Serine</td>
<td>4.59</td>
<td>4.32</td>
<td></td>
</tr>
<tr>
<td>Glutamic acid</td>
<td>10.22</td>
<td>8.64</td>
<td></td>
</tr>
<tr>
<td>Proline</td>
<td>11.68</td>
<td>7.23</td>
<td></td>
</tr>
<tr>
<td>Glycine</td>
<td>20.89</td>
<td>19.11</td>
<td></td>
</tr>
<tr>
<td>Alanine</td>
<td>2.26</td>
<td>1.13</td>
<td></td>
</tr>
<tr>
<td>Cysteine</td>
<td>ND</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>Valine</td>
<td>2.56</td>
<td>1.79</td>
<td></td>
</tr>
<tr>
<td>Isoleucine</td>
<td>0.42</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Leucine</td>
<td>2.54</td>
<td>1.26</td>
<td></td>
</tr>
<tr>
<td>Methionine</td>
<td>3.81</td>
<td>1.28</td>
<td></td>
</tr>
<tr>
<td>Tyrosine</td>
<td>0.32</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>0.86</td>
<td>0.39</td>
<td></td>
</tr>
<tr>
<td>Histidine</td>
<td>0.49</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Lysine</td>
<td>2.16</td>
<td>1.42</td>
<td></td>
</tr>
<tr>
<td>Arginine</td>
<td>3.73</td>
<td>2.01</td>
<td></td>
</tr>
<tr>
<td>Hydroxyproline</td>
<td>ND</td>
<td>ND</td>
<td></td>
</tr>
</tbody>
</table>

Values are given as mean ± standard deviation of triplicate.

ND- Not Detected

The important amino acid besides the glycine is proline. In this study, hydroxyproline could not be detected. Gomez-Guillin et al. (2002) reported that the amino acid composition gelatin from the skin of sole, megrim, cod, hake and squid had more than 30% glycine and ~17% imino acids. Cho et al. (2004) reported that content of glycine was much higher 32.1% whereas proline content was 12% in yellowfin tuna gelatin.

However, Jamilah and Harvinder (2002) reported that the the proline contents of the gelatin from red and black tilapia was very low and nearly not detectable. The amino acid composition plays main role in the physical properties of gelatin. However, the physical properties of the gelatin depends not only on the amino acid composition, but also on the relative content of components and higher molecular weight aggregates, as well as on the presence of lower molecular weight protein fragments. Thus, in addition to the source or species, gelatin properties will also strongly depend on the preservation of raw materials.

2.2.3 Physical properties of gelatin

2.2.3.1 Gelatin yield

The yield of gelatin obtained from the skin of Cobia and Cynoglossus were 13.8 and 10.3% respectively (Table 3). This is a comparatively better yield when compared with the gelatin yield reported for many other fish species viz, sole (8.3%), megrim (7.4%), cod (7.2%), hake (6.5%) (Gomez- Guillen et al. 2002), red and black tilapia (7.8 and 5.4 % respectively) (Jamilah and...
Harvinder 2002), big eye snapper and brown stripe red snapper (6.5 and 9.4% respectively) (Jongjareonrak et al. 2006).

The yield of gelatin obtained from the skin of rohu and Common carp were 12.93 and 12% respectively (Ninan et al. 2009).

The gelatin yields have been reported to vary among the fish species, mainly due to the differences in collagen content, the compositions of skin as well as the skin matrix. Pretreatment with alkali and acid resulted in good swelling of fish skins. This indicated a better yield due to the opening of cross-links during the swelling. The yield observed for the species in this study is comparatively better which offers scope for commercially viable extraction of gelatin.

2.2.3.2 Viscosity

<table>
<thead>
<tr>
<th>Properties</th>
<th>Cobia</th>
<th>Cynoglossus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gelatin Yield (%)</td>
<td>13.8±0.28</td>
<td>10.3±0.14</td>
</tr>
<tr>
<td>Viscosity</td>
<td>6.02±0.07</td>
<td>5.92±0.13</td>
</tr>
<tr>
<td>Melting Temperature(°C)</td>
<td>25.13±0.06</td>
<td>27.35±0.05</td>
</tr>
<tr>
<td>Setting Temperature(°C)</td>
<td>17.8±0.01</td>
<td>16.34±0.12</td>
</tr>
<tr>
<td>Setting Time (Seconds)</td>
<td>86.1±2.48</td>
<td>92.01±1.25</td>
</tr>
</tbody>
</table>

Values are given as mean ± standard deviation of triplicate

2.2.3.3 Melting temperature

The melting point of gelatin obtained from Cynoglossus (27.35°C) was slightly higher than that of Cobia (26.13°C) (Table 3). The melting points are higher than that reported for many other species viz., 8-10 °C for cod skin gelatin (Gudmunsson & Hafsteinsson, 1997); 24.9°C for yellow fin tuna gelatin, 21.4 - 26.5°C for gelatin from the skin and bone of Nile perch (Muyonga et al. 2004); 22.5 to 29.9°C for tilapia skin gelatin (Jamalih and Harvinder, 2002).

The melting temperature of gelatin has been found to correlate with the proportion of the imino acids proline and hydroxyproline in the original collagen (Ledward, 1986; Piez & Gross, 1960). This is typically 24% for mammals and 16-18% for most fish species (Norland, 1990). Cold water fish, for example cod, has a very low hydroxyproline content and coupled with this has a very low gelling and melting temperature.

The comparatively high amount of imino acid content can be a contributory factor for the high melting point characteristics of gelatins from these species. Gomez - Guillen et al. (2002) correlated the thermal stability of gelatin to the number and stability of proline rich region in collagen or gelatin molecules, which are high in fresh warm water fish and mammalian species. Gudmundsson (2002) observed that gelatins with high melting temperature formed stronger gels.

2.2.3.4 Setting temperature and setting time

Setting (gelling) temperature denotes the gelling process which involves the transition from random coil to triple helical structure gelatins. The imino acid content stabilizes the ordered conformation when gelatin forms the gel network during gelling. A critical amount of regenerated halices are required to form the gel network. Gelling and melting temperatures are also influenced by the change in ionic strength. This suggests that the junction zones and the gel network may be stabilized by both hydrogen bonds and electrostatic bonding (Haug et al. 2004).
The setting (gelling) temperature observed for the gels from Cynoglossus and Cobia skins were in the range of 16.0\(^0\)C to 18.0\(^0\)C. Cobia had the highest setting temperature (17.8\(^0\)C) and the lowest was for Cynoglossus (16.34\(^0\)C). The Cobia gel showed a significantly slower setting time of 86.1 seconds when compared to Cynoglossus which had the faster setting time of 92.01 seconds (Table 3).

Muyonga et al. 2004 reported setting temperature of 19.5\(^0\)C and a setting time of 60 seconds for the gelatin from the skin of adult Nile perch extracted at 50\(^0\)C. Gudmundsson (2002) compared the rheological properties of fish gelatins (tuna, tilapia, cod and megrim) with conventional bovine and porcine gelatins. The gelatin obtained from silver carp waste called fitofague gelatin had setting temperature of 7.0\(^0\)C and setting time of 180 seconds.

The gelling (setting) and melting points of tilapia gelatin (18.2\(^0\)C and 25.8\(^0\)C respectively) were the highest among the fish gelatins and was comparable to low molecular weight porcine and bovine gelatins. Cold water fish gelatins i.e., gelatins from the skins of cod and megrim had very low melting and gelling points when compared with gelatins from warm water fish and animal sources mainly due to the low imino acid content.

### 2.2.4 Functional properties

#### 2.2.4.1 Gel strength

Bloom strength of the gelatin gels is shown in Table 4. Cobia skin gelatin gel exhibited higher bloom strength (176.5 g) than that of Cynoglossus skin gelatin (164.1 g) tested, suggesting the difference in gel forming ability of the two specific gelatins used. The quality of gelatin is generally determined by the gel strength or bloom value, including low (<150), medium (150–220) and high bloom (220–300). The difference in bloom strength among species is possibly due to the different composition, particularly in terms of amino acid composition and size of protein chains (Muyonga et al. 2004). Gel strength is one of the most important functional properties of gelatin and fish gelatin typically has less gel strength than mammalian gelatin.

Gelatin with different bloom strength were reported for Atlantic salmon (108 g), cod (71 g) (Arnesen & Gildberg 2007), sin croaker (125 g), shortfin scad (177 g) (Cheow et al. 2007), bigeye snapper (105.7 g), brownstripe red snapper (218.6 g) (Jongjareonrak et al. 2006), young and adult Nile perch (217 g and 240 g respectively) (Muyonga et al. 2004). Protein degradation fragments, if present, may reduce the ability of \(\alpha\)-chains to anneal correctly by hindering the growth of the existing nucleation sites. As a result, functional properties such as bloom strength, foam ability, foam stability and viscosity of gelatins might be decreased.

Gel strength is a function of complex interactions determined by amino acid composition and the ratio of \(\alpha\)-chain and the amount of \(\beta\)-component. Gel structure of gelatin is more stable when the imino acid content is higher, and the amount of aggregates of higher molecular weight is less (Gomez-Guillen et al. 2002). It is well known that the hydrogen bonds between the water molecules and free hydroxyl groups of amino acids in gelatin are essential for gelatin gel strength (Babel 1996).

<table>
<thead>
<tr>
<th>Properties</th>
<th>Cobia</th>
<th>Cynoglossus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gel strength (Bloom) (g)</td>
<td>176.5±2.01</td>
<td>164.1±1.51</td>
</tr>
<tr>
<td>Foam formation ability</td>
<td>2.28±0.03</td>
<td>2.35±0.04</td>
</tr>
<tr>
<td>Foam stability</td>
<td>1.93±0.02</td>
<td>1.86±0.01</td>
</tr>
<tr>
<td>Water holding capacity (%)</td>
<td>179.26±3.30</td>
<td>169.34±4.01</td>
</tr>
<tr>
<td>Fat binding capacity (%)</td>
<td>369.78±4.67</td>
<td>389.90±5.12</td>
</tr>
</tbody>
</table>

Values are given as mean ± standard deviation of triplicate
2.2.4.2 Foam formation ability and foam stability

FA is an important functional property of gelatin for commonly used foods such as marshmallows. FAs of Cobia and Cynoglossus skin gelatins are given in Table 4. FA of Cobia was 2.28 (the ratio of foam volume/liquid volume), significantly lower than the 2.35 of Cynoglossus gelatin. The FS of Cobia skin gelatin 1.93 (the ratio of the initial volume of foam/initial volume after 30 min) was significantly higher than the 1.86 of Cynoglossus gelatin. The reduced foam formation and stability may be due to aggregation of proteins which interfere with interactions between the protein and water needed for foam formation (Kinsella 1977). Cho et al. (2004) reported FA of 2.6 and 2.9 and FS of 1.5 and 1.4 for gelatin from shark cartilage and porcine skin, respectively.

2.2.4.3 Water holding and fat binding capacity

WHC and FBC are functional properties that are closely related to texture by the interaction between components such as water, oil and other components. WHC and FBC of the gelatins are given in Table 4. Significant differences are observed in the FBCs of the gelatins. Cobia skin gelatin had the highest WHC; it had the lowest FBC. FBC depends on the degree of exposure of the hydrophobic residues inside gelatin. As shown in Table 3, the hydrophobic amino acid, tyrosine, made up 0.32% of Cobia gelatin which was higher than that of Cynoglossus skin gelatin (0.12%). The high amount of tyrosine is probably responsible for the high FBC of Cobia skin gelatin. WHC is believed to be affected by the amount of hydrophilic amino acids.

Conclusion

It may be concluded that there are considerable differences between yield and functional properties of gelatin from the skins of Cobia and Cynoglossus. The characteristics of gelatin extracted through this process indicate that they have good yield and functional properties. There is, therefore, a potential for exploitation of processing waste for gelatin extraction from these species. The potential is higher for Cobia skin than Cynoglossus skin because Cobia skin give higher gelatin yield and showed better gelling properties. The ability to form weak gels may find new applications for fish gelatin and it could possibly used in refrigerated products and in products where low gelling temperature are required.

References

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