CHARACTERIZATION OF GELATINS EXTRACTED FROM SALTWATER FISH SKINS

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ABSTRACT
This research work aimed at characterizing gelatins obtained from three saltwater fish skins, namely, yellowfin tuna (*Thunnus albacares*), blue shark (*Prionace glauca*) and Greenland halibut (*Reinhardtius hippoglossoides*), dried at either 45 and/or 80 ºC. Rheology and textural analyses were performed in order to assess differences in physical properties of the resulting gelatins. Differences between fish species were registered, with gelatins extracted from yellowfin tuna skins showing overall less variation between gelatins than the ones obtained from blue shark skins. As extraction temperature is concerned, differences were also reported among gelatins, with an increase in such temperature being translated into a decrease in both melting and gelling temperatures, and in bloom values. Gelatins extracted at 45 ºC showed more physical resilience. Gelatin from Greenland halibut skin was the softest gelatin, presenting slow transitions between solid and liquid phases. Gelatins physical properties depend on both the fish species and temperatures utilized in the production processes.

Keywords: Wastes, fish skins, gelatin

INTRODUCTION
Waste utilization/valorization is extremely important, as it decreases the environmental impact of production processes, and can also increase the economic performance of the industries. The fishing industry is a field where many wastes are produced and, as such, has a great potential for waste utilization/valorization. The residues of fish processing created by the offal separation, which are constituted by skins, heads, backbone, fins, scales and swim bladders, constitute 36% (and may represent up to 60%) of the raw material mass [1,2]. In order to minimize the environmental impact, these wastes have to either be submitted to appropriate treatment, or then be utilized in some way [2]. One product that can be obtained from fish skins is gelatin. Gelatin has been utilized in several different industrial fields, such as food, pharmacy and photography [3]. In recent years, there have been many studies focusing on methodologies to obtain gelatin from those wastes, as well as on the properties of such gelatins [1-7].
The aim of the present study was to characterize the physical (rheological and textural) properties of six gelatins extracted from fish skins of three saltwater fish species, namely, yellowfin tuna (*Thunnus albacares*), blue shark (*Prionace glauca*) and Greenland halibut (*Reinhardtius hippoglossoides*).

MATERIAL AND METHODS

Gelatins preparation

The gelatins utilized were obtained from the skins of yellowfin tuna (*Thunnus albacares*), blue shark (*Prionace glauca*) and Greenland halibut (*Reinhardtius hippoglossoides*). The preparation of all skins, previous to thermal extraction, was performed by a combination of alkaline and acid washes. Subsequently, water extraction of gelatins was carried out at 45 ºC/16 h (tuna, shark and halibut treated skins) or at 80 ºC/2 h (tuna and shark). Finally, gelatin solutions were dried by oven in all cases (50 ºC/72 h) or by freeze-dried (tuna). Yellowfin tuna gelatins were either dried at 45 ºC, dried at 45 ºC and freeze-dried, or dried at 80 ºC. Blue shark gelatins were dried at 45 and at 80 ºC, and Greenland halibut gelatin was dried at 45 ºC.

Gelatin samples were prepared by dissolving 6.67 %(w/v) gelatin in deionized water at room temperature for 30min, followed by 30min in a water bath at 60 ºC (with constant magnetic stirring). The gelatin solutions were then left to cool in a refrigerator at 4 ºC, for 16-18h, prior to analysis.

Rheology measurements

Rheological analyses were performed on a Gemini Advanced Rheometer (Bohler Instruments, UK), coupled with a peltier unit. The viscoelastic properties of the gelatins were measured during heating and cooling from 5 to 40 ºC and from 40 to 5 ºC (with a 10 min interval between the ramps), respectively, with a heating/cooling ramp of 1 ºC/min and a frequency of 1 Hz. The phase angle (degrees) was plotted as function of temperature. Two replicas of each gelatin were analysed, in duplicate.

Texture analysis

The texture profiles were analysed in a TA.XT*plus* Texture Analyzer (Stable Micro Systems, UK) with a 5 Kg load cell, equipped with a 0.5 in diameter teflon probe. A trigger force of 4 g and a penetration speed of 1 mm/s were utilized, with a penetration depth of 4 mm. Analyses were performed in two replicas, in duplicate. Bloom, rupture strength, adhesiveness and brittleness were measured.

RESULTS AND DISCUSSION

Results showed differences between the different gelatins according to the species from which the extraction was performed, and also according to the extraction temperature employed. Rheology results (Fig. 1) showed the melting temperature, which corresponds to a sharp increase in phase angle (Fig. 1a), to decrease with the increase of extraction temperature. The lower melting temperature was observed for yellowfin tuna gelatin extracted at 80 ºC (21.9 ºC), which was similar to blue shark gelatin extracted at 80 ºC (22 ºC). Blue shark gelatin extracted at 45 ºC presented the highest value (28.1 ºC) and Greenland halibut the second highest (25.3 ºC), values which were similar to those obtained for gelatins from the skins of red tilapia (27.8 ºC) and walking catfish (25 ºC) [6].

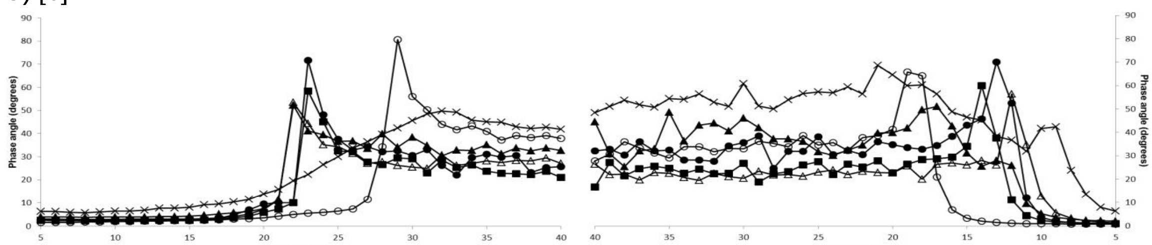

Figure 1. Phase angle evolution with increasing (a) and decreasing (b) temperature, of the different gelatins. Yellowfin tuna gelatin extracted at 45 ºC (●), extracted at 45 ºC and freeze-dried (■), and extracted at 80 ºC (▲); blue shark gelatin extracted at 45 ºC (○) and at 80 ºC (∆); and Greenland halibut gelatin extracted at 45 ºC (x).

Regarding the gelling temperature, which can be observed by a sharp decrease in phase angle [8] (Fig. 1b), there was also a decrease registered with the increase of extracting temperature. The lowest value was found to be that of Greenland halibut gelatin extracted at 45 ºC (11.2 ºC), followed by yellowfin tuna gelatin extracted at 80 ºC (11.7 ºC). The highest gelling temperature was registered for yellowfin tuna gelatin, extracted at 45 ºC (19.5 ºC), which is slightly higher than that of bigeye snapper (16.8 ºC) [7].
Results pertaining to textural analysis (Table 1) showed blue shark gelatin extracted at 45 ºC to be the gelatin with the highest bloom value (189). Yellowfin tuna gelatin extracted at 45 ºC presented an intermediate bloom (107) and Greenland halibut gelatin had the lowest (14). The values obtained in this study were similar to the ones obtained for walking and striped catfish skins (239 and 147, respectively) [6] and bigeye snapper (108) [7]. The bloom values obtained correlated with the rupture strength, as expected, as the higher the bloom, the more force has to be applied for the gelatin to rupture. These parameters were also related to the brittleness, which is the tendency of the material to fracture or fail. Adhesiveness was similar among the gelatins from yellowfin tuna and blue shark, and Greenland halibut gelatin presented a considerably lower adhesiveness.

Table 1 – Textural analysis of the different gelatins

Gelatin	Bloom			Rupture Strength [g]			Adhesiveness [g]			Brittleness [Kg/sec]		
Yellowfin tuna 45 ºC	107	±	10	380	±	35	-38	±	5	3,6	±	0,1
Yellowfin tuna 45 ºC freeze-dried	134	±	6	450	±	28	-43	±	6	3,8	±	0,4
Yellowfin tuna 80 ºC	97	±	13	342	±	73	-43	±	7	3,0	±	0,7
Blue shark 45 ºC	189	±	1	653	±	11	-39	±	12	6,7	±	0,2
Blue shark 80 ºC	64	±	1	251	±	15	-37	±	1	2,1	±	0,2
Greenland halibut 45 ºC	14	±	0	46	±	5	-2	±	2	0,6	±	0,1

CONCLUSION

Gelatins obtained from saltwater fish skins from different fish species, extracted at different temperatures, have different physical properties. Yellowfin tuna gelatins showed less variation between gelatins than within the blue shark samples. Gelatins extracted at higher temperatures have lower melting and gelling temperatures, and bloom values, and gelatins dried at lower temperatures are more resilient. Greenland halibut gelatin was the softest gelatin. Both the fish species and extracting temperature variables have to be taken into consideration when selecting a gelatin for a particular application.

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