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Comparing the effects of glazing and chitosan-based coating applied on frozen salmon on its organoleptic and physicochemical characteristics over six-months storage

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ABSTRACT

The perishable nature of fish, with an increase in fish consumption in recent years, led to the improvement of fish preservation techniques. Chitosan coatings adds to the traditional water glazing.

The effect of a chitosan solution of 1.5% on the sensory properties of Atlantic salmon (*Salmo salar*) was studied over six months of storage. The sensory properties of the salmon were assessed through the use of a texturometer and a trained panel of judges. Microbiological parameters were studied in the form of Total Volatile Base Nitrogen (TVB-N) and Total Viable Count (TVC) tests.

Microbiological analysis showed that chitosan had an anti-microbiological effect on the salmon samples, reducing the number of microorganisms present, while TVB-N values were maintained stable during experiment.

Textural Profile Analysis (TPA) was performed and the results showed no significant differences between different coatings regarding texture. Sensory analysis by a trained panel showed that chitosan was a better choice in frozen samples, while in thawed and cooked samples no significant differences existed between chitosan-coated and glazed samples. Flavor diffusion from the chitosan coating was assessed, and analysis of the results showed no correlation between coating type and sample flavor, indicating that no flavor diffusion had occurred.

1. Introduction

The consumption of fish has been steadily increasing over the last few years, due to its nutritional characteristics as well as for its benefits to the health of the consumers. According to the latest publication from the Department of Food and Agriculture Organization of the United Nations (FAO), the total amount of world fisheries has been increasing over the past decades with the use of fish for food purposes increasing at an average annual rate of 3.2% (FAO, 2014).

Fresh fish is among the most perishable foods due to some intrinsic characteristics of fish, such as its lipid content, due to microbiological changes in the fish, and also due to external factors such as temperature and exposure time before preservation methods are applied (Huss, 1995). Thereby the improvement in preservation techniques in order to bring the fish product in a safely manner to the consumer, while maintaining its organoleptic characteristics, are a major concern of this industry. In the fishing industry the most widely used are freezing and glazing. Freezing represents the main method of preservation for human consumption and inhibits enzymatic activities, slowing down the growth of microorganisms and reducing the microbial metabolism responsible for the deterioration (González-Méndez et al., 2004; Nielsen and Jessen, 2007).

Glazing is largely used in the fish industry to protect fish from the deterioration of sensory characteristics, and can be defined as the application of a layer of ice in frozen products surface by means of a dipping process, or by spraying in a water bath (Zoldos et al., 2011). Glazing is still the less expensive protection technology, having thus became a widely used process in the fish industry.

An edible coating or film can be defined as primary packaging prepared from edible components. In this type of packaging a thin

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layer of edible material can be directly applied to a food or formed into a film and used as a food wrap (Pascall and Lin, 2012).

Chitosan can be used as an edible coating or film and is one of the most important derivatives of chitin. Chitosan can be defined as a copolymer that is composed by *N*-acetyl-D-glucosamine and D-glucosamine units, which can be distributed throughout the biopolymer either randomly or in blocks, these units are combined by β-(1,4) glucosidic linkages thus forming a long chain linear polymer (Castro and Paulín, 2012; Chen, 2008; Singh and Kumari, 2012). Chitosan is a biomolecule with great potential, presenting properties such as biocompatibility and biodegradability, together with its anti-viral, anti-fungal and anti-microbial activities (Kim, 2014). However it is necessary to assure that no organoleptic changes occur due to the presence of the chitosan coating, so sensory analysis is needed to ensure the possibility of use of chitosan coatings.

Among the sensory testing methods available to assess fish freshness, Quantitative Descriptive Analysis (QDA) allows obtaining a detailed description of organoleptic characteristics present in the product assessed in a quantitative way. Judges are given a wide selection of reference samples and use the samples in order to define a terminology that accurately describes the product in question (Lawless and Heymann, 2010).

The objective of this work was assess the sensory (using QDA) and physico-chemical effects of a chitosan coating on frozen salmon samples over a six month period and compare them with water glazed samples under the same conditions.

2. Materials and methods

2.1. Fish preparation

Frozen Atlantic salmon (*Salmo salar*) supplied by the company Vanibru – Comércio de produtos alimentares, Braga, Portugal) was used. Each salmon was cut into several pieces, with about 2 cm of thickness, using a vertical bone sawing machine (FK 32, BIZERBA, Germany). This process was carried out in a refrigerated room (with temperature between 5 °C and 8 °C) in order to reduce the heat uptake and the corresponding temperature fluctuation. The samples were separated according to the intended use and intended coating and stored in plastic bags in an industrial freezing chamber (−25 °C) until further use or transportation.

2.2. Coating solutions

The chitosan solutions used were prepared using chitosan from Golden-shell Biochemical Co. Ltd. (China) with a 91% degree of deacetylation. In a 5 L Erlenmeyer a 2 L solution of chitosan (1.5% (w/v) (Soares et al., 2016)) was prepared dissolving 30 g ± 0.01 g with 22.2 mL of a 1% lactic acid solution (90% (w/w) purity) and the volume was completed up to 2 L with distilled water. The solution was stirred with a magnetic stirrer in a heating plate (VWR; Model: VMS-C7 Advanced) at 70 °C, until complete dissolution of the chitosan. The temperature was then turned off and the solution remained in agitation overnight. The solution was then transferred to a closed glass container and stored at 8 °C.

2.3. Sample preparation

Samples of frozen salmon were removed from the industrial freezing chamber and were weighed (RADWAG WLC 6/A2/C/2, Poland), and dipped in a 1.5% (w/v) chitosan solution at 8 °C (measured using an infrared Pronto Plus thermometer (HANNA Instruments, HI99556-10, Romania) with the respective probe (HANNA Instruments, HI765PW, Romania)) during 10 s and then drained for 2 min, before being weighed again and stored in the industrial freezing chamber until further use. The dipping process was performed in a pilot-scale glazing tank, previously built for this effect, with the help of a stainless steel mesh used to hold the fish. The salmon samples intended for water glazing were weighed before dipping in water for 40 s and then drained for 1 min, before being weighed again and stored in an industrial freezing chamber until further use (Soares et al., 2016). The dipping process was performed with the pilot-scale glazing tank and mesh mentioned above. The control samples did not require any additional treatment other than the cutting of the salmon and storage in an industrial freezing chamber.

2.4. Samples storage and transport

The salmon samples were stored in polyethylene bags and separated by coating in different corrugated boxes.

Samples intended for sensory analysis were transported by a freezer truck to the Instituto Politécnico de Viana de Castelo – Escola Superior de Tecnologia e Gestão (IPVC-ESTG) facilities, where all of the sensory tests were performed, and where they were maintained at −18 °C until further use. The samples used for the microbiological tests were maintained in an industrial freezing chamber set to −18 °C until they were sent for microbiological analysis.

2.5. Samples analyses

2.5.1. Percentage of glazing or coating

In order to calculate the percentage of glazing or coating, the salmon pieces were weighed before (W_{salmon}) and after (W_i) being dipped. Percentage of glazing or coating was then calculated using Equation (1).

$$\%\ Glazing = \frac{Wi - Wsalmon}{Wi} * 100 \quad (1)$$

2.5.2. Determination of total volatile based nitrogen (TVB-N)

The TVB-N values for coated and uncoated samples were determined by the Conway method, as referenced in the NP 2930:2009 standard (IPQ, 2009). The results for all salmon samples, coated or uncoated, were expressed in mg of nitrogen per 100 g of sample.

2.5.3. Determination of Total Viable Count

The determination of Total Viable Count was estimated and performed according to the procedure based on the ISO 4833-1:2013 standard (ISO, 2013). Samples of coated salmon, glazed salmon, and uncoated salmon were analyzed in quadruplicate. The results were reported as the number of log of microorganisms per gram of sample.

2.5.4. Determination of texture

Texture was assessed using a texturometer (TA.XT *plus* Texture Analyser, Stable Micro Systems Ltd.) equipped with a 10 mm diameter cylinder DELRIN probe. A texture profile analysis (TPA) was performed on salmon samples (thawed and cooked chitosan coated and water glazed). Each sample was tested at least in six points, for a minimum of 18 test points for each coating or glazing.

The parameters retained with this test were the peak positive force of the first cycles, the area to positive peak of the first and second cycles, and the distance (from the beginning to the maximum peak – obtained by manually marking in the