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Effect of chitosan edible coating on the quality of double filleted Indian oil sardine (*Sardinella longiceps*) during chilled storage

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ABSTRACT

The effectiveness of edible chitosan coating (1 and 2%) on the quality changes of Indian oil sardine (*Sardinella longiceps*) in iced condition was assessed. The chitosan prepared in the study had higher degree of deacetylation (83%). Edible coating with chitosan was effective in inhibiting bacterial growth and reduced the formation of volatile bases and oxidation products significantly. The muscle pH increased with the storage period for all the samples. On the day of sensory rejection for untreated samples, the formation of total volatile base nitrogen and trimethylamine nitrogen was less by 14.9 and 26.1% for 1% chitosan treated sardine and 32.7 and 49% for 2% chitosan treated samples respectively. The chitosan coating improved the water holding capacity, drip loss and textural properties significantly compared to untreated sample. The eating quality was maintained up to ~8 and 10 days for 1 and 2% chitosan treated sardine respectively, compared to only 5 days for untreated samples.

1. Introduction

Fish quality is very subjective in nature and is very complex concept (Bremner, 2000; Nielsen, Hyldig, & Larsen, 2002), which includes nutritional, microbiological, biochemical and physiochemical attributes. The freshness of fish degrades after death due to various biochemical reactions (changes in protein and lipid fractions, the formation of biogenic amines and hypoxanthine) and microbiological spoilage. This results in the deterioration of sensory quality and nutritional value of fish. Preservation of fish assumes greater importance to prevent the loss of this nutritionally rich natural resource.

Indian oil sardine (*Sardinella longiceps*) is a pelagic species belongs to the family Clupeidae is found naturally and very abundantly in the west coast of India. The oil sardine fishery off the west coast of India is a commercially important fishery due to food value and industrial uses for sardine oil, fertilizer and canning. It contributes 15–20% to the total marine fish landings of India and forms the mainstay of Indian pelagic fishery along the west coast. High content of healthy fat, its taste and relatively lower price are the major attributes which attract consumers. Normally, consumers prefer the freshly landed or iced sardines over the frozen or canned sardines. However, during the times of glut catches, it becomes increasingly difficult to preserve the freshness of fish as it is highly susceptible to spoilage due to its high fat content and hence needs at-most attention to preserve the quality of fish for longer duration. Of the various preservation techniques, fish preserved by icing is the most preferred by the consumers as it maintains the freshness compared to other preservation methods. However, ice storage does not completely inhibit biochemical reactions that lead to quality deterioration of fish. To improve quality and increase shelf life of food products during storage, antioxidants such as butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) and other chemical preservatives have been commonly used by the food industry, particularly for fatty fishes. Numerous studies are currently focused on using natural ingredients to enhance food quality and shelf life and to meet consumer demands for safer foods in order to avoid the use of synthetic preservatives.

Chitosan which is a derivative of chitin is one such natural biodegradable polysaccharide which can be used to coat fish to suppress quality changes during storage. Chitin is a copolymer of

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N-acetylglucosamine and glucosamine residues linked by β-1, 4-glycosidic bonds and insoluble in dilute acids. Chitosan [β-(1,4)-2-amino-2-deoxy-D-glucopyranose] is the deacetylated form of chitin and in most cases, will be soluble in dilute acid. It is the second most abundant natural polymer in nature after cellulose (Shahidi, Arachchi, & Jeon, 1999). Fungi synthesize chitin and chitosan in their cell walls, while the shells of crabs and shrimps and the bone plates of squids and cuttlefish are composed of chitin only (Ng, Hein, Ogawa, Chandrkrachang, & Stevens, 2007; Nwe et al., 2002; Toan, Ng, Aye, Trang, & Stevens, 2006). Pure chitosan is non-toxic, free of antigenic effects, biocompatible, biodegradable and polar in nature (VandeVord, Matthew, DeSilva, Mayton, Wu, & Wooley, 2002). Chitosan has been reported to have a number of functional properties that make it useful in nutrition (Gallaher et al., 2002; Shahidi et al., 1999). These include its antimicrobial activity and its ability to form protective films (Cuero, 1999; Jeon, Kamil, & Shahidi, 2002), its texturizing (Benjakul, Visessanguan, Phatchrat, & Tanaka, 2003), and binding action (No, Lee, & Meyers, 2000); and its antioxidant activity (Kamil, Jeon, & Shahidi, 2002). Many workers have studied chitosan as edible coating material for fishery products to enhance quality. Jeon et al. (2002) demonstrated that chitosan-coated Atlantic cod and herring reduced moisture loss and lipid oxidation. Augustini and Sedjati (2007) reported that chitosan treatment significantly reduced the bacterial counts of salted dried anchovy and improved the shelf life. Although various studies indicated the efficiency of chitosan in improving the quality of fish in different preservation methods, there is very little or no reports on the effect of edible coating on the quality of Indian oil sardine. Hence the present work was undertaken with the objective of studying quality changes of chitosan-coated double filleted Indian oil sardine under chilled conditions.

2. Materials and methods

2.1. Fish sample preparation and storage

Freshly landed Indian oil sardine (*Sardinella longiceps)* weighing 35–40 g each with an average body length of 16–18 cm, were procured from a commercial fish landing centre, Thoppumpady, Cochin, India for this study. Fishes were brought to the laboratory within 45 min in iced condition in an insulated high density polyethylene (HDPE) container. Up on arrival, fishes were dressed in double filleted style. For this, fishes were washed with potable chilled water (1–2 °C), fins, scales and entrails were removed and washed again with chilled potable water (1-2 °C). Fishes were filleted from the posterior end retaining head. The back bone was separated retaining head and fillets intact which reduces the preparation time for the consumer. These double filleted sardines were divided into three batches for edible coating with chitosan. For this, chitosan was prepared from Indian white shrimp (*Fenneropenaeus indicus*) shell waste following the method of Madhavan and Nair (1974) and parameters like moisture, ash, protein and degree of deacetylation were determined by standard methods. From three batch fishes, two batches were given a edible coating separately by dipping in 1 and 2% chitosan solution (w/v in 1% acetic acid) in 1:2 ratio (fish to treatment solution) at chilled condition (1–2 °C) for 10 min each. The third batch was treated with chilled distilled water for equal time interval and used as untreated control sample. After stipulated time interval, the fishes were allowed to drain for 5 min on a clean plastic wire mesh screen. Four to five fish pieces from each batch, weighting 100 ± 5 g were packed in indigenous high impact polypropylene (HIPP) trays (Size 12.5 × 8.5 × 2.5 l × b × h, with 270 ± 5 cc volume) of 0.88 mm thickness with oxygen transmission rate of 13.2 cc m^{-2} 24 h^{-1} at 1 atm pressure and water vapor transmission rate of 0.89 g m^{-2} 24 h^{-1} at 37 °C and 92% RH, manufactured using thermoforming machine, (KL Thermoformers, New Delhi, India). The trays were sealed and placed in an insulated HDPE container alternatively with flake ice for maintaining the temperature of 1–2 °C throughout the storage period. Re-icing was done every day by draining out the ice melt water. Three trays from each batch were drawn randomly at regular intervals (0, 3, 5, 7, 9 and 11 d) and subjected to sensory, microbial, biochemical and physical quality assessment.

2.2. Properties of chitosan

Chitosan prepared was analyzed for sensory appearance to assess its color as white or yellowish. Moisture, protein and ash content were determined according to the method of AOAC (2000). Degree of deacetylation of the chitosan was determined following the method of Shigemassa, Matsuura, and Sashiwa (1996).

2.3. Fish quality assessment

2.3.1. Sensory analysis

Sensory analysis of the stored double filleted sardine was carried out by twelve semi-trained researchers. The samples were served in a coded and covered plate after cooking for 10 min in a microwave oven and cooling for 1–2 min. A glass of water was provided to restore the taste sensitivity. The sensory attributes evaluated were appearance, color and odor. The panelists were asked to assign a score of 1–9 as prescribed by Meilgaard, Civille, and Carr (1999). The overall impression of the product on the assessor was estimated as overall acceptability, by adding the scores for all the attributes and dividing by the total number of attributes. A high score (9–7) was given to fish with no off-odors, a score 5 to fish with a flat and neutral odor and scores below 5 to fish with off-odors. An overall acceptability score of below 5 corresponded to unacceptable quality.

2.3.2. Microbiological analysis

Double filleted sardine sample (10 g) was transferred aseptically to a stomacher bag (Seward Stomacher circulator bag, Model No. 400, England) to which 90 ml of sterile normal saline (0.85%) was added and homogenized for 60 s at 230 rpm using a lab stomacher blender (Seward Stomacher 400 Circulator, England). Tenfold serial dilution was prepared with normal saline (1:10 with 0.85%) and used for total mesophilic counts analysis. For this, fish homogenate sample (0.5 mL) of appropriate dilutions were spread evenly on the surface of dry plate count agar media (PCA, HiMedia, HiMedia Laboratories Pvt. Ltd., Mumbai, India). Total mesophilic count was determined after incubating the plates at 37 °C for 48 h as per Townley and Lanier (1981).

2.3.3. Biochemical quality evaluation

Moisture content was determined by drying a known amount of homogenized sample to constant weight in an air oven at 105 ± 2 °C for 16 h (AOAC, 2000). Percentage crude protein was determined by total nitrogen method (AOAC, 2000). Crude fat content was extracted with petroleum ether using AOAC method (2000). Ash content was determined by heating at 550 ± 2 °C in a muffle furnace (AOAC, 2000). Total volatile base nitrogen (TVB-N) and trimethylamine nitrogen (TMA-N) analysis was carried out according to the method proposed by Conway (1950). Oxidation stability of the samples as thiobarbituric acid (TBA) value was assessed spectrophotometrically by the method of Tarladgis, Watts, and Younathan (1960). Free fatty acid (FFA) value was determined as per AOCS (1989) to assess the hydrolytic rancidity. pH was measured by homogenizing the sample in distilled water (1:5 w/v) by using a glass electrode digital pH meter (Cyberscan 510, Eutech Instruments, Singapore) as described in IS 2168 (1971).