Effects of different concentrations of Sodium alginate as an edible film on chemical changes of dressed Kilka during frozen storage

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Abstract

The aim of this study was to investigate the effects of Sodiume alginate edible coating with concentrations of 0/25, 1/25, 0/75 and 1/75% (W/V) on chemical changes of dressed Kilka during frozen storage. Prepared samples of Kilka fish have been coated for 1 h with the dipping method. Coated and uncoated samples have been packed in polyethylene dishes with selphon coverage (75 packs of 250 g). Chemical parameters (moisture, ash, protein, TVN and lipid) were examined in frozen storage at -18^{o}C for 4 months. SPSS Statistical Software was used for data analysis, using One Way ANOVA test. Significant reduction was found (P<0.05) in moisture value with increase of Sodiume alginate concentration during the study. Significant differences were found in TVN values during the third and fourth months but there were no significant differences (P<0.05) in ash and protein content. The highest content of TVN was found in control samples and use of Sodiume alginate edible coating affected the reduction of TVN, prevented the lipid oxidation, increased the shelf-life of Kilka and reduced the moisture.

Keywords: Kilka fish, Edible coating, Sodiume alginate, Shelf-life

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Introduction

Kilka is a chief valuable economic species of the Clupeidae family living in the Caspian Sea, and it naturally has a very significant status among other foodstuffs for vitamin rich oils and various types of mineral material. Evidently, less than 10% of the fishery is nourished directly by humanity for poor packing and unhealthy supply and 90% of the product is being powdered for consumption. Preferably, singular nutritious Kilka must directly be consumed more by humanity and some solutions must be developed to add value to the economy consumption of Kilka (Moradi, 2001). Regarding the consumer demand for marine nutrition, some studies have been carried out on natural additives to enhance shelf-life and quality of food rather than synthetic preservers. Biocompatible edible films and coatings are developed as a new system to be replaced by synthesis materials to reduce their application, nourishment films and coatings control moisture, oxygen, carbon dioxide, lipid, aroma and flavor of additives to enhance shelf-life quality of foodstuffs (Mir Nezami Ziabari, 2002; Cutter, 2006). Alginates are potential biopolymers with their unique features to enhance emulsion durability; they produce jell, create suspension and increase the thickness of the film (Draget et al., 1998). Alginate as a natural product has the ability to produce alginic that could be developed and applied for disintegrable nourishment packing films (Lazarus et al., 1976; Williams et al., 1978; Pavlath et al., 1999). Sodium alginate, the resinous toxicant is like sodium carbonate obtained from brown marine wrack named *Macrocystis pyrifera* (Phaeophyceae). It has a durable construction and is a suitable product coating, the glazing films preserve aroma, flavor, taste and color, add value and enhance nourishment quality of the product such as essential vitamin and amino acides, it prevents the activity of enzymes, it is the best film and could be better than similar synthetic protein films. (Ranken and keil, 1999; Kazemi islamian, 2003). Sodium alginate films' water resistance feature is the most important physical and mechanical property of alginates (Rhim, 2004). Enhancement of peaches' shelf-life by sodium alginate and methyl cellulose are based on basic nutrition alginate films and nutrition coating researches (Maftoonazad et al., 2008). Alginate nutrition films are anti – microbus factors for shelf-life quality enhancement of sliced melon (Raybaudi-Massilia et al., 2008). Use of alginate and gelan based coatings for improving the barrier, texture and nutritional properties of fresh-cut papaya was reported by Tapia et al., 2008. Oms-Oliu et al., 2008 has reported the use of Polysaccharide-based edible coatings to enhance the quality and antioxidant properties of fresh-cut melon.Kilka is a highly abundant fish in the Caspian Sea and constitutes a good share in the annual catch of this sea. In addition to fresh use of this fish for human consumption, nowadays the production of coated Kilka has been increased. The number of researches on using sodium alginate as an edible coating on Kilka is negligible, therefore this study aimed to investigate the effects of sodium alginate as an edible coating on chemical properties of Kilka and to select the most appropriate concentration of sodium alginate for coating.

Materials and methods

Twenty kg of fresh early morning caught Kilkas were purchased from Anzali harbor in special motor boats, first they were transported with specific fish transportation tanks (CSW) to the National Research Fish Processing Center based on health conditions. Then they were promptly washed with fresh and cool water to eliminate surface mucus and probable pollutants. They were deheaded, their fins were removed and dressed to remove haem compounds (to eliminate oxidation of fats and to preserve natural form of proteins). Research treatments included treatment 1 (uncoated Kilka) and treatments 2, 3, 4, and 5 were respectively designed with 0.25, 0.57, 1.25 and 1.75 sodium alginate packed with selphon covered polyethylene utensils.Sodium alginate nutritional coatings (Product No: 650.0489) were prepared with a little difference with the method used by Maftoonazad et al. (2008) and Hasanzati et al.(2010). Regarding the specified percentile weighted 0.25, 0.75, 1.25 and 1.75, sodium alginate powder, 50, 150, 250 and 350 grams were separated and gradually added to a 20-liter water tank and stirred orderly until an even solution of sodium alginate was obtained. The required amounts of the sample of coating prepared samples were soaked for 1 hour in aquatic solution of sodium alginate with a specified density and 3.5 ˚C temperature. The samples were removed into the baskets for a minute to clean the remnant solution on Kilka samples. Then they were packed in polyethylene disposable selphon utensils. All tested and testifier treated samples were transported to a -18˚C fridge (275 packs of 250 g Kilka). Chemical analyses (measuring the moisture, ash, protein, TVN and other factors) were carried out on the initial material at months 1, 2, 3 and 4. Moisture and ash were measured by (A.O.A.C, 2000) standard method, protein by method of digestion, titration and distillation by Kajedal (Pearson, 1997) and fat by Soxhlet method (Parveneh, 1998). Obtained raw data were analyzed with SPSS $_{16}$ software, and one way ANOVA test (one-way variance analysis) and Tukey test were used with a confidence interval of 5%.

Results

The effect of treatments and frozen storage period on moisture content as seen in Figure 1, showed a 5% statistical difference in the whole treatment with the time of frozen storage. Study of the treatment effect does not show a 5% statistical difference for the average ash of different treatments at months 1, 2, 3 and 4 when compared to day zero (Figure 2). There were no statistical differences ($p<0.05$) in the protein content between different treatments (Figure 3). The frozen storage also does not have any significant effect on protein content (Figure 3). There was a 5% statistical difference in TVN content between different treatments at months 3 and 4 (Figure 4). TVN content increased significantly ($p<0.05$) in all treatments at months 3 and continued till the end of the storage period. The lipid content decreased gradually with the time of storage in all treatments (Figure 5). There were significant differences ($p<0.05$) in lipid content of treatments only at months 4 and 5. The lowest lipid content was found in the treatment coated with 0.25% of sodium alginate which was followed by control (Uncoated) samples.

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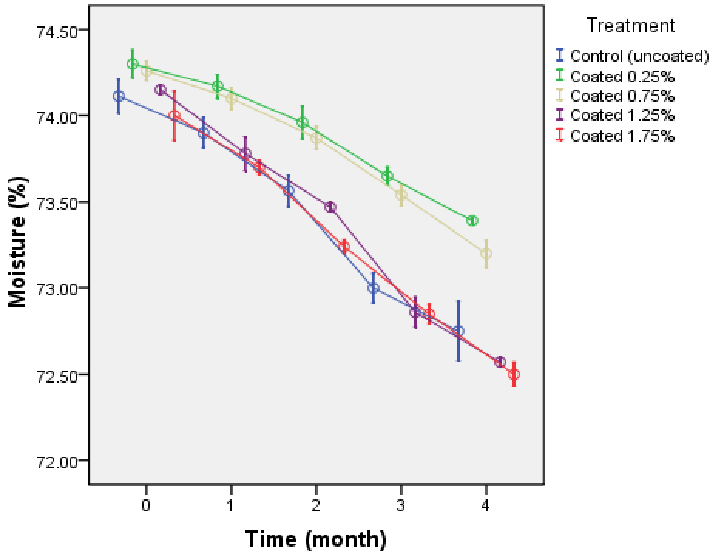

Figure 1: The effect of time and treatment on moisture data of uncoated and coated samples with sodium alginate

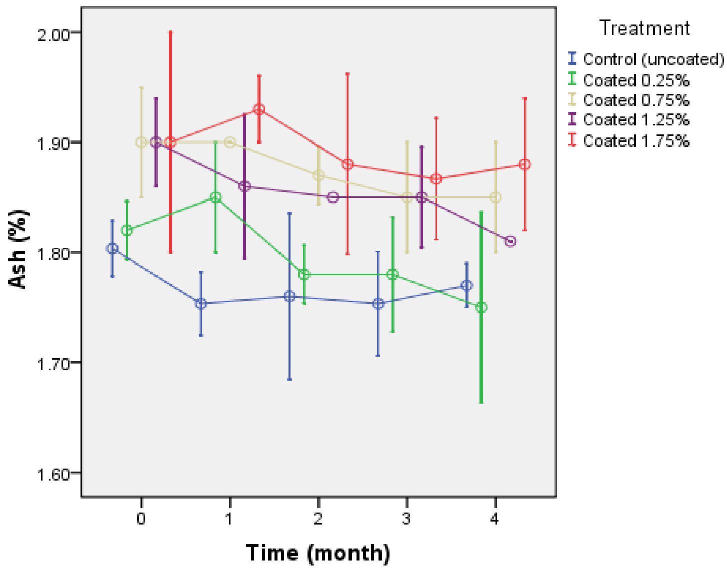

Figure 2: The effect of time and treatment on ash data of uncoated and coated samples with sodium alginate

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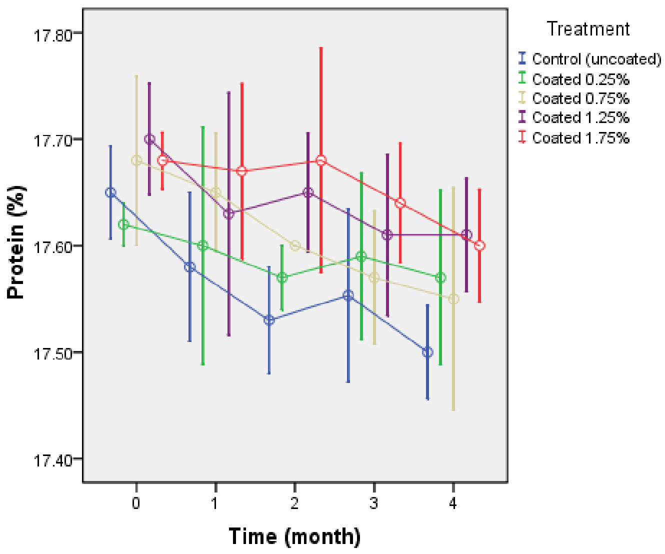

Figure 3: The effect of time and treatment on protein data of uncoated and coated samples with sodium alginate

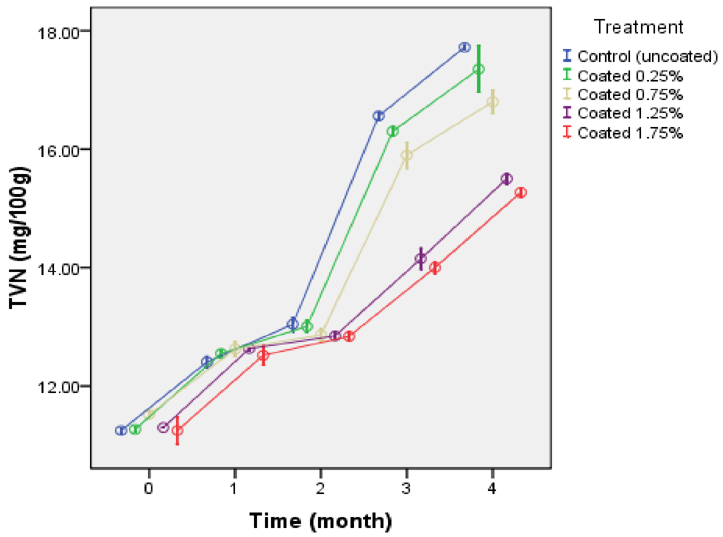

Figure 4: The effect of time and treatment TVN data of uncoated and coated samples with sodium alginate

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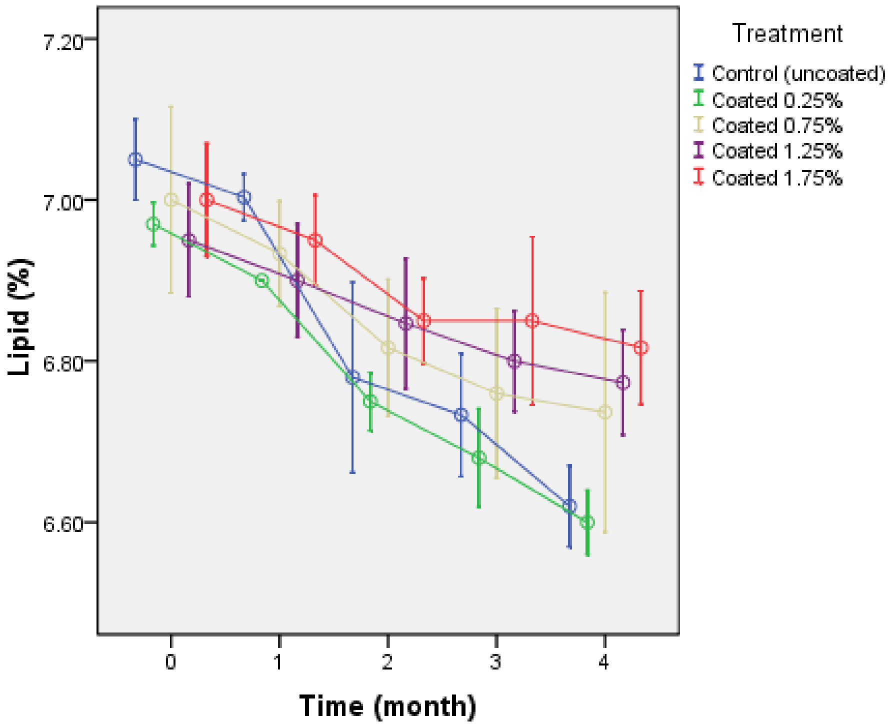

Figure 5: The effect of time and treatment on lipid data of uncoated and coated samples with sodium alginate

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Discussion

The results showed that the storage period of 4 months has a significant ($p<0.05$) effect on chemical parameters of coated and uncoated Kilka. It was also found that the content of sodium alginate existing in coated film has a significant effect on moisture content. Treatments 2 and 3 (with 0.25 and 0.75 % sodium alginate) had higher moisture content in comparison to control samples, while treatments 4 and 5 (with 1.25 and 1.75 % sodium alginate) had lower and higher moisture content respectively compared to control samples. Moisture content was reduced significantly in all treatments at months 0, 1, 2, 3 and 4 of storage period. Since polysaccharide films are hydrophilic, absorbing more moisture and less inhibiting transportation of moisture (Cutter, 2006), therefore sodium alginate as an edible coating has little effectiveness in moisture reduction, but it could not maintain the moisture contents of Kilka individually. The studies have demonstrated that linked coatings and alginate films with $CaCl_2$ increase water resistance qualities, but applied alginate coatings increase steam permeability and consequently reduce the moisture (Rhim, 2004). The increased resistance of coated samples rather than uncoated samples is due to increased lipid to improve the water resistant quality of alginate and gelan coatings (Rojas-Grau et al., 2007). Tapia et al. (2008) observed that gelan coatings resist better against steam than that of alginate.

They proposed that applied higher density rates of alginate (2%) than gelan

(0.5%) may be the cause of the reduction of water resistant quality of coated Kilka when the moisture is reduced. According to the studies of Maftoonazad et al. (2008) on peach, shelf-life increased with applying the sodium alginate and methyl cellulose. They observed that moisture reduction of the coated fruits with sodium alginate has been more than that of coated fruits with methyl cellulose. Lazarus (1976) studied coating effectiveness of alginate calcium and protective plastic cover to control the reduced body weight of sheep. He observed that nutritional film of calcium alginate increased weight of the hot body up to 270g. In fact, it is a moisture extractor rather than moisture barrier. Research results showed that ash content in different treatments at months 0, 2, 3 and 4 did not have statistical differences, but coating samples with higher density of sodium alginate solution had a higher rate of ash.

According to the obtained results, the protein content of various treatments at months 0, 1, 2, 3 and 4 did not remarkably change in 0 to 4 months, but coated samples have generally had more proteins than testifiers. Although a significant difference of the mean of protein in various times and different treatments was not observed, but it was reduced a little in the 0, 1st, 2nd, 3rd and 4th month. As alginate is a poly anion and easily reacts to cations, and poly cations produce a structure named Egg box, when a network of resembling cavities is formed, the network prohibits proteins heavier than 100KD to pass (Mortazavi, 2006). Thus, sodium alginate coating prevents water contained proteins from degradation.

Preservers can prevent growth of ice crystals and migration of water molecules of protein, thus, they preserve the natural form of protein during the freeze process (Yoon and Lee, 1990) .The TVN content of all treatments showed an increment during the frozen storage period, which was insignificant only in months 1-2. Sodium alginate had a significant effect on TVN content. The control sample had higher TVN content at the end of the storage period compared to other treatments. A negative relation was found between TVN content and sodium alginate density. TVN content of coated and uncoated samples increased during frozen storage, but its rate did not reach the allowable limit. Accidental irremovable parts of the digestion system and the kidney of Kilka have caused an increase in enzyme corruption and volatile alkaline nitrogen during maintenance of phase 4; it has reduced the flavor and decreased the taste of frozen Kilka.

Obtained statistical results of the research showed that lipid median of phases 0, 1, 2, 3 and 4 do not differ significantly in all treatments, but it was significantly different in the 4th month of maintenance ($p<0.05$). 1st and 2nd treatments had the least lipid, and the increased density of sodium alginate had also increased lipid percentile. Increase in percent of lipid simultaneously accompanied with reducing the percent of the moisture. Since 80% of the fillet weight belongs to water and lipid, difference in the percentile of water has effective behavior in muscles lipid and has changed its content (Razavi Shirazi, 2001). A positive preventive effect of sodium

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alginate was found on lipid reduction of samples. Lipid preventive property of sodium alginate is not due to reduced oxidation lipid because alginate coatings cannot prevent gas distribution, but it is due to reduced internal lipolytic enzyme activity during the maintenance, because phosphor lipids are small parts of contained lipid in fish muscles. Reduction of preserved Kilka phospho-lipids is probably due to their decomposition by internal lipolitics during preservation period (Jeong et al., 1990). Decomposition prevention of the lipids by enzymes may increase preservation of Kilka during frozen storage.

According to the chemical tests, it was demonstrated that sodium alginate coating has not statistically increased ash and protein content, but increasing density of sodium alginate solution has statistically reduced moisture, TVN, and fat content of Kilka samples. Finally, 1.25% density of sodium alginate (4th treatment) has been chosen as the most effective one and it is recommended that lipid based materials must be used in the compound of sodium alginate nutritional film to prevent moisture reduction of Kilka when it is preserved in the freezer.

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مطالعه اثرات غلظت‌های مختلف پوشش خوراکی سدیم آلژینات بر عمر ماندگاری سردخانه‌ای ماهی کیلکای شکم خالی

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چکیده

در این تحقیق که در مرکز ملی تحقیقات فرآوری آبزیان انجام شد، گروه شاهد به عنوان تیمار۱ در نظر گرفته شد و اثر پوشش خوراکی سدیم آلژینات با غلظت‌های ۰/۲۵ در صد W/V(تیمار۲)، ۰/۷۵ درصد W/V(تیمار۳)، ۱/۲۵ درصد W/V(تیمار4) و ۱/۷۵ درصد W/V(تیمار5) بر عمر ماندگاری ماهی کیلکای شکم خالی در سردخانه بررسی شد. نمونه‌های آماده شده ماهی کیلکا به مدت یک ساعت به روش غوطه‌وری پوشش داده شدند.نمونه های بدون پوشش وپوشش دار در ۷۵ بسته ۲۵۰ گرمی با پوشش سلوفان قرار گرفتند و آزمایشات شیمیایی شامل اندازه گیری درصد رطوبت، خاکستر، پروتئین ، مواد ازته فرار(TVN) و درصد چربی در فاز صفر، ۱، ۲، ۳ و ۴ ماه نگهداری در سردخانه با دمای $-18^{\circ}c$ انجام شد. برای تجزیه و تحلیل داده‌ها از نرم افزار آماری $SPSS_{16.0}$، تست ONE WAY ANOVAو آزمون توکی در سطح معنی‌داری ۵ درصد استفاده شد. بر اساس نتایج بدست آمده میانگین درصد رطوبت نمونه‌ها در طی فاز صفر، ۱، ۲، ۳ و ۴ ماه کاهش معنی‌دار وحتی با افزایش غلظت سدیم آلژینات نیز کاهش معنی‌داری نشان داد $(p<0.05)$. میانگین درصد خاکستر و پروتئین نمونه‌ها فاقد اختلاف معنی دار بوده است $(p>0.05)$. میانگین TVN نمونه‌ها در طی فاز ۳ و ۴ دارای اختلاف معنی‌دار بود و نمونه‌های شاهد دارای بیشترین مقدار TVN بوده و همواره با افزایش غلظت سدیم آلژینات، کاهش معنی‌داری در مقدار TVN مشاهده شد $(p<0.05)$. میانگین درصد چربی نمونه‌ها در فاز ۴ دارای اختلا ف معنی‌دار بود $(p<0.05)$ و تقریباً با افزایش غلظت سدیم آلژینات، بر مقدار چربی نمونه‌ها افزوده شد. با توجه به اینکه استفاده از پوشش خوراکی سدیم آلژینات در بسته‌بندی ماهی کیلکا بدلیل کاهش تولید TVN و ممانعت از کاهش چربی سبب افزایش عمر ماندگاری ماهی کیلکا می‌شود و با در نظر گرفتن این نکته که غلظت‌های بالای سدیم آلژینات سبب افزایش افت رطوبت می‌شود، بنابراین مناسب ترین غلظت مورد استفاده، غلظت ۱/۲۵ درصد W/V انتخاب شد.

واژگان کلیدی: ماهی کیلکا، پوشش‌های خوراکی، سدیم آلژینات، عمر ماندگاری

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