Original Article

Journal of Food Safety and Hygiene

journal homepage: http://jfsh.tums.ac.ir

Effect of carotenoids and chitosan on the oxidative stability of frozen shrimp

Mozhgan Ghorbani [a], Mahdieh Pabast [a], Parisa Sadighara [a*]

[a] *Food Safety Division, Department of Environmental Health Engineering, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran*

ARTICLEINFO

Article history:
Received 09 May. 2017
Received in revised form
24 Jul. 2017
Accepted 06 Aug. 2017

Keywords:
Lipid peroxidation;
Shrimp;
Carotenoids;
Chitosan

ABSTRACT

Common methods in the preservation industry are not always successful in curbing food corruption. Storage of shrimp could be used for preventing the loss of essential fatty acids during storage in cool. The aim of this study was evaluating the effect of carotenoids and chitosan on the oxidative stability of frozen shrimp. In this study, shrimps were dipped in the different concentration of carotenoids and chitosan. Samples were kept at -18 ° C for 15, 30 and 45 days. The oxidative stability of samples was assayed with the TBARS (thiobarbituric acid reactive substance) method. In the first stage, there was no significant difference between the oxidative stability of the samples. But in the second stage, there was a significant difference between the control sample and samples combined with carotenoid. In the third stage, a significant difference observed between the samples with chitosan and carotenoids. Furthermore, there was a significant difference between the control sample in the first stage and the third stage. In this study, carotenoid as a natural antioxidant is recommended instead of using artificial preservatives.

Citation: Ghorbani M, Pabast M, Sadighara P. **Effect of carotenoids and chitosan on the oxidative stability of frozen shrimp.** J Food Safe & Hyg 2017; 3(3-4): 40-43

1. Introduction

Shrimp is one of the most valuable seafood. There are more than eighty species of shrimp in water; however, consumer market knows them by three names: White shrimp, Pink shrimp and Brown shrimp (1). World production of shrimp over the last decade is growing consistently. Shrimp waste constitutes 50% to 70% of its total weight depending on the species. These wastes contain bioactive components such as protein, lipid, chitin/chitosan and astaxanthin; amounts depend on the processing conditions and the species (2).

Shrimp is very perishable seafood that causes three basic mechanisms of enzymatic autolysis, microbial growth and lipid oxidation (3). Lipid oxidation is the main reason for food spoilage. In particular, foods with high lipid content and especially high-grade unsaturated foods are susceptible. Negative effects are off-flavors, typical rancidity, and other negative effects are the formation of toxic aldehydes actually, the oxidative stability of fatty food depends on the balance between antioxidant and oxidizing agents and the loss of nutritional quality because of polyunsaturated fatty acid (PUFA) degradation(4). Shrimp has an amount of fat considerable, so susceptible to lipid oxidation (5).

Astaxanthin is a kind of carotenoid in shrimps. One of the most important characteristics is antioxidant activity. The antioxidant activity of astaxanthin is ten times higher than other carotenoids such as Zea xanthan, lutein, and beta-carotene (6). Furthermore, chitosan extracted from shrimp is a biodegradable material for the packaging of food. In our previous study, the antibacterial effect of chitosan was surveyed (7). Therefore, the object of this study was to evaluate the effect of chitosan and carotenoids on the oxidative stability of frozen shrimp.

* Corresponding author. Tel.: 00982188954914
E-mail address: sadigharar@farabi.tums.ac.ir

2. Materials and methods

2.1. The test materials

The fresh shrimp, Penaeus semisulcatus, were collected from the processing plants (Port of Jask, South of Iran). The samples were transferred to the chemistry laboratory and stored at 2-4^{o}C until use.

2.2. The experimental design

After washing with distilled water, shrimp samples were separated into 3 groups. control group treated with no preservation solution. The second group was immersed in a 5% concentration of carotenoids as a shrimp preservation solution and the third group was immersed in a 1% concentration of chitosan as a shrimp preservation solution. Finally, the samples were wrapped with low-density polyethylene and stored at -18 ° C for15, 30 and 45 days.

2.3. Assay of chitosan and carotenoids power on the oxidative stability in shrimps

Malondialdehyde (MDA) levels, as an index of lipid peroxidation, were measured. MDA reacts with thiobarbituric acid (TBA) and produces a red colored complex with peak absorbance at 532nm (8). The formation of thiobarbituric acid in samples was assessed for the measurement of lipid peroxidation according to an original method (9). The supernatant of the sample homogenate was mixed with 20% trichloroacetic acid and the mixture was centrifuged. Then, TBA was added to the supernatant and heated. The absorbance of the supernatant was measured at 532 nm. The values were expressed in Nmoles MDA, using a molar extinction coefficient of 1.56×10^5 M^{-1} cm^{-1}.

2.4. Statistical analysis

All the experiments were repeated in triplicate. Statically analysis was performed by one-way Analysis of Variance (ANOVA). The data obtained were assessed using the SPSS 21.0 software package.

3. Results

The results of the study are shown in Table 1. Data values were expressed as mean ±SD. The table shows the results of the effect of chitosan and carotenoids on the oxidative stability of frozen shrimp in 15, 30, and 45 days. The statistical analysis was conducted by SPSS software.

In the first stage, there was no significant difference between the oxidative stability of samples. But in the second stage, there was a significant difference between carotenoids group compared to control (P=0.001) and chitosan (P=0.003). In the third stage, the level of lipid oxidation was significantly different between the sample of carotenoids and chitosan (p = 0.001) and carotenoids compared to control (P=0.004).

Furthermore, there was a significant difference between the control sample in the first and third stage (P<0.01).

4. Discussion

This study has evaluated the effect of chitosan and carotenoids on the oxidative stability of frozen shrimp in the period of 15, 30, and 45 days. Comparative results were shown in Table 1. In all groups, lipid peroxidation increased from the first to the third stage during storage. Lipid oxidation definitely has an ascending trend. The difference is that this increase of peroxidation in carotenoids was less than the control sample and chitosan sample. Carotenoid provides more oxidative stability than chitosan in frozen shrimp; therefore, it has more antioxidant compounds than chitosan sample. In this regard, Arancibia and colleague studied on shrimp preservation using chitosan coating and reported that chitosan coating increased antioxidant capacity and thus oxidative stability of frozen shrimp (10). In another study, Chouljenko et al., studied on the application of water-soluble chitosan to shrimp for quality retention and conducted that Water-soluble chitosan lowered oxidation in shrimp during frozen storage (11). A similar study conducted by Farjzadeh and colleague on The effect of chitosan-gelatin coating on the quality of shrimp (Litopenaeus vannamei) under the refrigerated condition and they reported that Chitosan-gelatin coating indicated a significant antioxidant effect on Litopenaeus vannamei shrimp (12). Fish and other

Table 1. The level of lipid oxidation in frozen shrimp samples

Day	Carotenoid (nmol/g)	Chitosan (nmol/g)	Control group (nmol/g)	P = 0.05
After 15 days	0.706±0.17	0.79±0.07	1.13±0.57	P = 0.06
After 30 days	0.79±0.04	1.5±0.33	1.24±0.01	P = 0.002
After 45 days	2.5±0.23	3.4±0.12	3.04±0.18	P = 0.001
P = 0.05	P = 0.001	P = 0.001	P = 0.001	P = 0.001

types of marine-derived foods have been recognized as valuable sources of high nutritional components. These types of food are the key ingredient in many countries diets. They are good sources of long-chain polyunsaturated fatty acids (PUFAs) belonging to the Omega-3 family, including EPA (20:5n3) and DHA (22:6n3) in shrimp tissues.

PUFAs and their derivatives are important for nutraceutical and pharmaceutical targets.

These fatty acids, EPA and DHA, play a major role in several biochemical processes; both in vivo and in vitro. DHA has a positive effect on inhibiting and curing several diseases as coronary heart disease, atherosclerosis and some cancers (10). PUFAs are vulnerable to free radical damages and oxidation. In the current study, a considerable change in the level of lipid oxidation was seen between 15 and 45 days of storage in control groups (Table 1). Presence of antioxidants has an important role in the prevention of oxidative changes in these valuable components.

Regarding previous reports, the coating effects of chitosan and chitosan nanoparticles on the quality of silver carp (hypo-phthalmichthys molitrix) fillets during storage at 4C have indicated that both chitosan and nano-chitosan coating were effective for the preservation of silver carp fillets during refrigerated storage (13). We investigated the oxidative stability of carotenoids is appropriate for keeping shrimp at -18 degrees Celsius. Carotenoid is considered to be a critical role in protection against oxidative damages. They are also usually mixed with food and boost the antioxidant content of food. In our previous, Sadighara, et al., survey carotenoids inhibit lipid peroxidation in the shrimp waste oil (14). Also, carotenoids as natural sources could also inhibit lipid peroxidation in raw sunflower oil (15).

5. Conclusions

Since the consumption of polyunsaturated fatty acids PUFAs has been positively correlated with the inhibition of cardiovascular diseases and also the shrimp and seafood are a good source of omega-3 and carotenoids, the formation of peroxidation during processing and storage of fats reduces their nutritive value and affects the quality of fats. It is well documented that lipid oxidation of fat mostly depends on the storage temperature and storage period.

Storage of materials for fish and shrimp should be used to prevent the loss of these two essential fatty acids during storage in cool. Chitosan and especially carotenoids have this feature. It is better than the use of these edible coatings instead of using artificial preservatives and non-edible coatings. It is suggested that carotenoid protect unsaturated fatty acid against peroxidation during cold storage.

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgments

Authors would like to thank the Laboratory personnel in the Department of Environmental Health, School of Public Health, Tehran University of Medical Sciences.

References

1. Sorgeloos P, Bossuyt E, Laviña E, et al. Decapsulation of Artemia cysts: a simple technique for the improvement of the use of brine shrimp in aquaculture. Aquaculture 1977; 12: 311-5.
2. De Holanda HD, Netto FM. Recovery of components from shrimp (Xiphopenaeus kroyeri) processing waste by enzymatic hydrolysis. J Food Sci 2006; 71: C298-C303.
3. No H, Meyers SP, Prinyawiwatkul W, et al. Applications of chitosan for improvement of quality and shelf life of foods: a review. J Food Sci 2007; 72: R87-R100.
4. Gómez-Estaca J, López-de-Dicastillo C, Hernández-Muñoz P, et al. Advances in antioxidant active food packaging. Trends in Food Sci & Technol 2014; 35: 42-51.
5. Gómez-Estaca J, De Lacey AL, López-Caballero M, et al. Biodegradable gelatin–chitosan films incorporated with essential oils as antimicrobial agents for fish preservation. Food Microbiol 2010; 27: 889-96.
6. Sadighara P, Erfanmanesh A, Haghi E, et al. The antibacterial activity of chitosan between different extraction methods. J Chem and Pharm Sci 2016; 9: 1325-8.
7. Gharibi S, Dilmaghanian A, Sadighara P, et al. The effect of bisphenol on oxidative stress indices and pathological changes in the brain of chicken embryos. World Appl Sci J 2013; 26: 345-51.
8. Sicińska P, Bukowska B, Michałowicz J, et al. Damage of cell membrane and antioxidative system in human erythrocytes incubated with microcystin-LR in vitro. Toxicon 2006; 47: 387-97.
9. Arancibia MY, Lopez-Caballero ME, Gómez-Guillén MC, et al. Chitosan coatings enriched with active shrimp waste for shrimp preservation. Food Control 2015; 54: 259-66.
10. Chouljenko A, Chotiko A, Reyes V, et al. Application of water-soluble chitosan to shrimp for quality retention. LWT-Food Sci and Technol 2016; 74: 571-9.

11. Farajzadeh F, Motamedzadegan A, Shahidi SA, et al. The effect of chitosan-gelatin coating on the quality of shrimp (Litopenaeus vannamei) under refrigerated condition. Food Control 2016; 67: 163-70.
12. López-cervantes J, Sánchez-machado DI, Bueno-solano C, et al. Fatty acid composition and total lipid content in protein hydrolysates of shrimp heads. Int J Pharm Bio Sci 2013 4: (B) 464 – 470.
13. Ramezani Z, Zarei M, Raminnejad N. Comparing the effectiveness of chitosan and nanochitosan coatings on the quality of refrigerated silver carp fillets. Food Control 2015; 51:43-8.
14. Sadighara P, Hariri-Ardabili F, Kazemi V. Extraction of shrimp waste oil and its fortification with shrimp waste pigments. J Food Saf and Hyg 2015; 1: 69-71.
15. Sadighara P, Godarzi S, Bahmani M, et al. Antioxidant activity and properties of walnut brown seed coat extract. J Glob Pharm Technol 2016; 8: 26-30.