Determination of the Effect of Coconut Shell Extracted Carbon Monoxide on the Quality of Frozen Yellow Fin Tuna (*Thunnus albacares*) Products

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Introduction

Seafood provides the world's prime source of high-quality protein to the consumers and processed frozen and fresh fish products account for major portion of the diets. Prolonged shelf life and fine quality give the advantages to the frozen fish products in the market and bright red color is used as an indicator of high quality in yellow fin tuna (*Thunnus albacares*). Carbon monoxide (CO) either alone or as part of a filtered process, is being applied to seafood to maintain the desirable color attributes. CO complexes with the heme-iron of myoglobin, forms a stable red pigment, carboxymyoglobin. The heme-proteins are strong catalysts of lipid oxidation in muscles and reduced heme-protein may suppress the lipid oxidation and other off odour and flavour production (Faustman *et al*., 1989). CO or filtered smoke is capable of retarding the microbial growth of the muscle (Kristinsson *et al*., 2008). In Sri Lankan context, coconut shells can be used for processing of filtered smoke with CO. The present study evaluates the effect of coconut shell extracted filtered smoke, a low cost source of CO on the chemical, physical, microbiological and sensory quality attributes of yellow fin tuna (*Thunnus albacares*).

Methodology

The study was carried out in a specially designed experimental laboratory of the Global Sea Foods (Pvt) Ltd. Imported grade "A" frozen yellow fin tuna (*Thunnus albacares*) from 57 Food and Agriculture Organization of the United Nations (FAO) area caught by long lines was used for the study. Average thickness and weight of the processed steaks for the experiment were respectively 22±1.2 mm and 170±6 g. CO was extracted from coconut shells following the Kowalski and William (1999) (United States Patent 5972401) process of making super purified smoke using organic material. CO free, 15%, 30%, 45%, 60% and 75% CO concentrations were used as treatments and CO injected steaks were stored under 4 ˚C for 48 hours and subsequently individually vacuum packed. Complete randomized design (CRD) was adopted for the experiment. Random number table (SLS, 428) was adopted to select the steaks for treatment in five replicates.

Treated steaks were stored under -18 ˚C for 2 days and frozen steaks were subjected to analysis for chemical, physical, microbiological and sensory attributes. 15 trained panelists were used for sensory analysis and standards and criteria that were developed by the National Oceanic and Atmospheric Administration and U.S. Department of Commerce (USDC/NOAA) seafood analysts were adopted.

All results were reported as means and the significance of the differences were determined by one-way analysis of variance (ANOVA) followed by tukey's tests for the comparison of data with 5% level of significance. Minitab 16 statistical software and Microsoft Excel 2010 (Microsoft Corp) were used for the statistical analysis.

Results and Discussion

Chemical, physical, microbiological and sensory quality attributes were analyzed to determine the effect of coconut shell extracted CO on the quality of frozen Yellow fin tuna products. Result showed that there was no significant difference among the histamine level of different

CO concentration treated frozen steaks ($p>0.05$) indicating that decomposition of histidine in to histamine was not affected by the treatment of coconut shell extracted CO smoke.

Table 1. Color values (L*(Lightness), a*(Redness) and b*(Yellowness) of the treated yellow fin tuna steaks

	CO concentration					
	No CO	15% CO	30% CO	45% CO	60% CO	75% CO
L* Value	32.26 ±1.6	28.13 ± 1.5	26.41± 2.5	23.78± 3.6	21.06 ± 0.9	20.9 ± 2.8
a* Value	4.28 ± 0.3	5.47 ± 0.5	7.07 ± 0.6	8.12 ± 0.7	9.09 ± 0.5	9.29 ± 1.0
b* Value	5.89 ± 0.5	1.82 ± 0.3	1.25 ± 0.4	0.82 ± 0.3	0.34 ± 0.1	0.28 ± 0.1

As indicated by table 1, CO concentration of the coconut shell smoke has significantly affected for the color of tuna. L*, a* and b* value were significantly affected by the CO concentration ($p<0.05$). L* and b* values have significantly decreased whereas a* value has significantly increased with the increasing CO level in the smoke. For all values, there were no significant differences between 60% and 75% treatments indicating that heme iron of myoglobin was saturated with CO to make stable redness.

Firmness of the treated frozen tuna steaks were not significantly different with the CO concentration of the smoke ($p>0.05$). Sensory scores was not significantly different for the different treatment ($p>0.05$), therefore results concluded that coconut shell extracted CO smoke has not modified the firmness and sensory properties at any level of CO concentration. CO concentration of the smoke has significantly modified the thiobarbituric acid (TBA) value of the treated frozen tuna ($p<0.05$). Increasing CO concentration of the extracted smoke was negatively affected for the lipid oxidation.

Treated CO concentration of the coconut shell extracted smoke significantly modified the growth of the microorganisms in the frozen tuna steaks $p<0.05$). Total Plate Count (TPC) has significantly decreased with the increase of CO concentration in the coconut shell smoke.

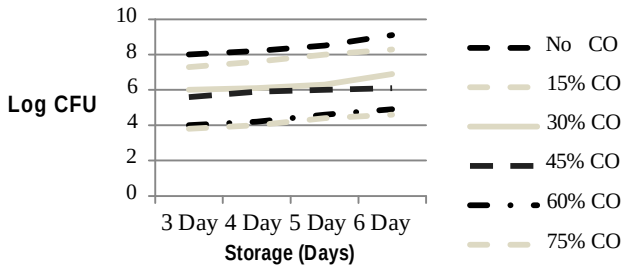

Figure 1. Changes in TPC variation with the different CO concentration in the coconut shell extracted smoke over frozen storage

Conclusions

Coconut shell extracted filtered CO smoke treatment has significantly improved the cherry red color of the product which appreciated by the consumer during purchasing and recorded reduced oxidation. It may reduce the decomposition of important omega-3-fatty acids in the fish. Suppressed microbial growth of the treated steaks helps for prolong product shelf life of the CO treated frozen yellow fin tuna products. 60% and 75% concentration gives similar qualities for many parameters. Hence, coconut shell extracted filtered CO smoke can be successfully used for industrial treatment for the grade "A" frozen yellow fin tuna.

References

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