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Extension of Fish Shelf Life by Ozone Treatment

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Abstract**—**The shelf life of fish was extended using disinfection properties of ozone. For this purpose, Trout specimens were exposed to ozone in the aqueous media for two hours and their microbial growth and biochemical properties were measured over time. Microbial growth of ozone treated fish was significantly slower than control sample, resulting in lower counts of bacteria. According to the biochemical tests; ozone treatment had no negative effects on fat, protein and humidity of fish. Peroxide and TVN (Total Volatile Nitrogen) measurements showed that treatment by ozone increased the trout shelf life from 4 days to 6 days. According to the sensory analysis, no changes were observed in color or flavor of the ozone treated trout.

Keywords**—**Fish, Ozone, Shelf life, Trout.

I. Introduction

FISH is one of the important resources of the human food. Fish is extremely perishable which restricts its consumption in a reasonably fresh state to the immediate vicinity of where it is caught. Bacteria degrade fish constituents, particularly non-protein nitrogenous compounds, typically associated with fish spoilage [1]. As mentioned by Whittle [2] the nature of fish species, handling and storage conditions are key parameters which affect fish spoilage.

Different technologies have been applied in order to reduce the perishability of fish and hence increase its short shelf life. It was demonstrated elsewhere [3, 4, 5, 6] that the use of slurry ice extends the shelf life of sardine and non-fat fish species, such as Farmed Sea Bream, European Hake and shrimp. Since 1920s the scientists have tried to apply the powerful disinfection properties of ozone to slow down the spoilage and improve the safety of fishery products. Ozone (O_3) is generated from oxygen (O_2) by either ultraviolet (UV) radiation or a high voltage electrical discharge. Ozone kills microorganisms by oxidizing and destroying their cell wall. It has the advantage of being able to kill resistant microorganisms such as bacterial spores, cysts and viruses at relatively low concentrations, without requiring a long exposure time.

The United States Food and Drug Administration [7] granted "Generally Recognized As Safe" (GRAS) status for use of ozone in bottled water in 1982. Ozone was approved by the US Department of Agriculture [8] for reconditioning the recycled poultry chilling water in 1997. Various reports [9] explained the possibility of use of ozone to disinfect the food surfaces.

In the present research, samples of caught trout were immersed in ozonated water for two hours time in order to achieve a better microbial control and improve the shelf life.

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II. Materials and Methods

Freshly caught trout specimens were obtained from local fish farms. The specimens were about 25 cm in size and their average weight was about 300gr. Ozone was generated by a compact ozone generator (Arda, Ozoneuf, Model COG 40A, France) which used atmospheric air as the source of oxygen. The produced combination of ozone and air was injected into the bottom of water container by a suitable internal pump. Ozone concentration in the water reached to 0.1mg/lit in 20 minutes of ozonation and was kept constant during the experiments. When ozone concentration reached to 0.1 mg/lit the experiments began by immersing the fish specimens in this ozone treated water. After two hours exposure to ozone the trout was taken and put in isolated containers stored at 5 ºC.

The microbial tests were performed on trout sample exactly when ozone treatment finished in accordance with "MICRO-ORGANISMS OF FOOD, published by the International Commission on Microbiological Specification for Foods (ICMSF)". In microbiology, Colony-Forming Unit (CFU) is a measure of viable bacteria numbers. By convenience the results are given as CFU/ml which measures viable cells (Colony Forming Unit per milliliter). Generally, log(CFU/ml) or log (CFU/Cm^2) are used for calculations..

Based on the test method, the microbial tests were performed at different concentrations (Dilutions). Brine 5% was used as the diluting agent. For the current research, three dilutions of the main sample were prepared (0.1, 0.01, 0.001). Then the bacteria growths in these samples were measured.

On the days of 1, 3, 5, 7 and 9 after treatment, samples were taken from the ozone treated fish specimens for biochemical tests i.e., humidity, Protein, Peroxide Number, TVN (Total Volatile Nitrogen) and Free Fat according to the international standards:

1- Humidity: International Organization for Standardization R – 1442,
2- Free Fat: ISO 1444- 1998 Meat and meat products, determination of free fat content,

3- Peroxide Value: A.O.C.S (American Oil Chemists' Society), 2003, Official method, No.cd.8-53 , peroxide value, acetic acid-chloroform method)
4- TVN, (I.S.O.R. meat and meat products Determination of Reference method)
5- Protein, the Association Of Analytical Communities, A.O.A.C 1965.

The aim of these measurements was to investigate the effect of ozone on biochemical properties of fish flesh. All tests were repeated three times, and the average results were reported.

III. Results

Results of microbial growth measurement on the skin of ozone treated trout (storage at 4 °C) are depicted in Fig. 1. This figure shows that control fish allowed notable increase in the microbial population, whereas for ozone treated fish, microbial growth was significantly slower, resulting in lower counts of bacteria.

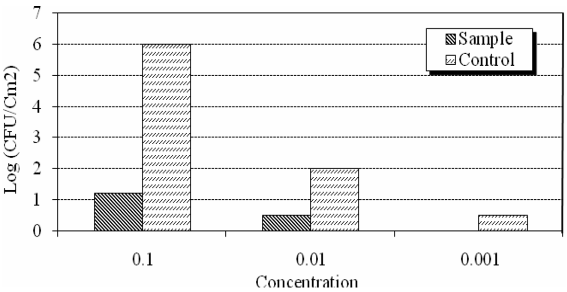

Fig. 1 Microbial measurements for the ozone treated fish sample and control

Figs. 2 to 4 show that ozone treatment has no destroying effect on the fish biochemical properties. Humidity and Free Fat of control fish and ozone treated samples are equal as depicted in Fig. 2. The results of protein measurement are shown in Fig. 3. This diagram shows the protein of ozone treated fish is slightly higher than control. Ozone removes the contaminants which can destroy the protein resulting in detecting better level of protein compared to control. Nonetheless, small observed changes can be because of experimental errors.

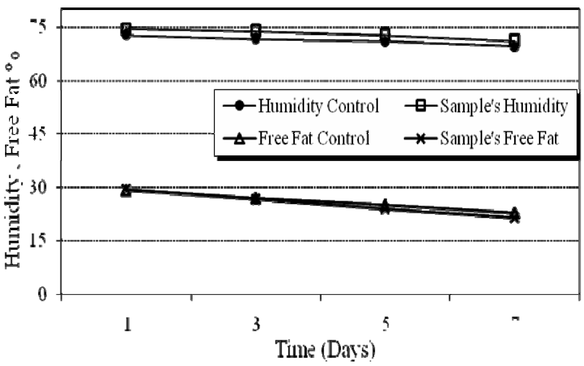

Fig. 2 Humidity and Free Fat changes in the ozone treated fish sample and control

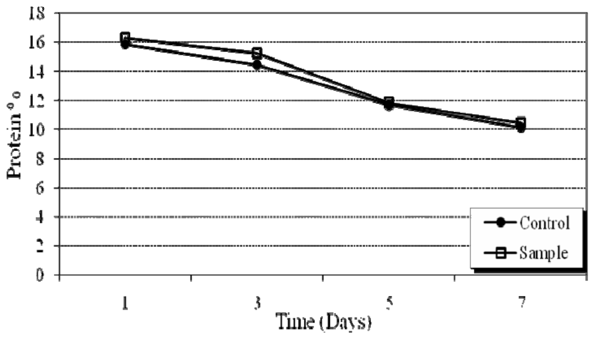

Fig. 3 Changes in the protein of the ozone treated fish sample and control

TVN and peroxide tests (Fig. 4) show that ozone treatment increases the shelf life of trout from 4 days to 6 days as compared to the control fish.

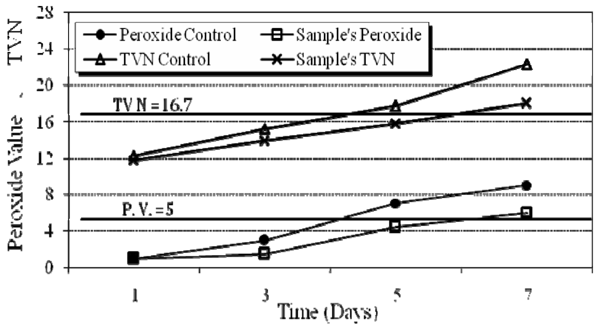

Fig. 4 Variations in peroxide No. and TVN of ozone treated fish sample and control

III. Discussion

This research attempted to identify the effect of ozone treatment on the shelf life of fish. It was found that suitable treatment by ozone before any storage; improves the microbiological and biochemical qualities of fish specimens and consequently prolongs their shelf life. Combination of ozone treatment and cold storage (at 4 °C) will increase the fish shelf life considerably. A summary of the results of measurements are as follows:

- Ozone treatment of fish slows down its bacterial growth significantly, resulting in lower counts of bacteria.
- Ozone removes the contaminants from the fish skin causes to higher protein number.
- Ozone treatment increases the shelf life of fish and helps in longer preservation time.
- Ozone has no negative impact on the biochemical properties of fish such as humidity, protein and free fat.
- Ozone leaves no residue on the fish and creates no changes on its color and flavor.

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