EFFECT OF OZONE TREATMENT (IN WATER, AIR AND MIST) ON METMYOGLOBIN FORMATION AND LIPID OXIDATION OF BEEF

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Background

Due to its high oxidizable characteristic, ozone functions in various fields to pasteurize, deodorize, breach or decompose are utilized.[1, 2)] A number of researches on the effect of ozone treatment have been reported in the microbiological quality of meat.[3, 4)] However, the influence of ozone treatment on discoloration and lipid oxidation of meat have not been deeply studied.[5)] Therefore, the effect of ozone treatment should be interpreted in color change and lipid oxidation, when the treatment is adopted in meat industries.

Objectives

This research was conducted to elucidate the effect on metmyoglobin (MetMb) formation and lipid oxidation of beef by each categorized treatment: ozonated water, ozonated air and ozonated mist.

Methods

We used two sizes of test pieces of beef round in this experiment, one a steak size about 1.5 cm thickness, and the other is the round cut thinly at slices about 2 mm thick. Ozonated water was produced by machine (OZOTOPIA IOP-10 made by Ishikawajima-Harima Heavy Industries Co., Ltd.). For the experiment of ozonated air and ozonated mist, we used the test chamber and the size is 900 x 400 x 500 mm. In the ozonated water experiment test, we put the test pieces in the container, and we treated the test pieces in running ozonated water. The followings are the conditions of the ozonated water treatment;

Quantity of ozonated water: Approx. 2L/min
Concentration of ozonated water: 3 ppm
Temperature: at normal room temperature
Duration of treatment: 1 hour

In the ozonated water experiment test, measurements were performed at following times, just after treatment, or after 24, 48 and 72 hour treatments.

In the ozonated air and ozonated mist experiment tests, we hanged the test pieces in the chamber and treated the test pieces in the ozonated air or ozonated mist flowing. The followings are the conditions of the ozonated air and ozonated mist treatment;

Concentration of ozonated air, ozonated mist: 3 ppm and 6 ppm
Duration of treatment: 30 minutes

In the ozonated air and mist experiments, measurements were conducted after 2, 24, 48 and 72 hour treatments.

The samples after treatment were stored in hermetically sealed plastic containers (volume 400ml) in a cold room at 4°C, and then the samples were evaluated for each analysis. The percentage of MetMb formation was measured by the procedure of Trout (1990) .[6)] Lipid oxidation was determined by the reaction of malonaldehyde with thiobarbituric acid (TBA) as described by Tarladgis et al. (1960).[7)]

Results and discussion

1. Ozonated water treatment test: We treated the test pieces of steak size in ozonated water at 3 ppm concentration of ozonated water for 1 hour. As a result of this treatment, the formation of MetMb just after the 1 hour treatment was under 20%, but the test pieces at 24, 48 and 72 hours after treatment showed the formation of MetMb increasing gradually. The level of TBA of ozonated water treatment samples was relatively high at 0.5 compared with control, but all tests results were not exceeding 2.0 (Fig. 1).
2. Ozonated air treatment test: On the sample of steak size, we exposed the test pieces in ozonated air at 6 ppm for 30 minutes. As a result of this treatment, we found no clear difference of MetMb formation and TBA level. But on the round cut thinly test pieces, we found all test pieces having remarkable inferior of color by the exposure ozonated air at 6 ppm for 30 minutes. And we found significantly high levels of TBA from all test pieces except the case of 72 hours after treatment (Fig. 2). On the other hand, we found very little differences in discoloration and possibility of acceleration of oxidation in lipid by the test at 3 ppm for 30 minutes (Fig. 3).
3. Ozonated mist treatment test: On the round cut thinly test pieces, we found almost the same results of ozonated air treatment test at 6 ppm for 30 minutes. When we treated the thinly test pieces at 3 ppm for 30 minutes, we found inferior of color in the case of 48 hours after treatment but no differences of the level of TBA on all test pieces (Fig. 4). However, we found the myoglobin extracted into water in the case of ozonated mist treatment test.

Conclusions

The three types of ozone treatments were analyzed, i.e. ozonated water, ozonated air and ozonated mist, for the influences on the color change and the lipid oxidation of beef. As a result of our analysis, we couldn't see any significant effect on metmyoglobin formation and lipid oxidation by all the various ozone treatments at the level of ordinary ozone concentration except for the ozonated air treatment to lipid oxidation. Washing by ozonated water or ozonated mist is concluded to be suitable especially for beef carcass treatment, and the treatment of ozonated air is suitable for all other treatment processes.

Pertinent literature

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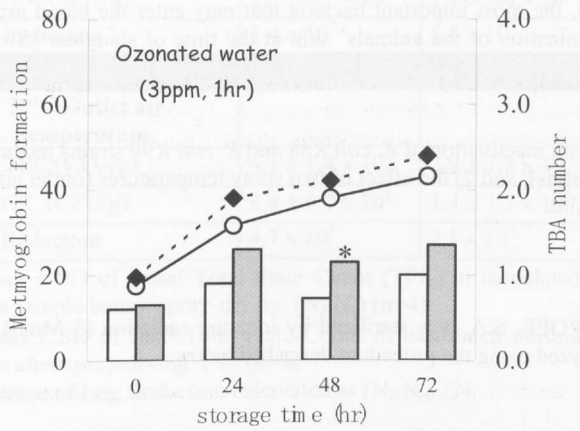

Fig.1. Effect of ozonated water on MetMb formation and TBA number of beef steaks

TBA control
TBA ozonated water
MetMb control
MetMb ozonated water

* significantly ($p<0.05$) different from the control treatment value.

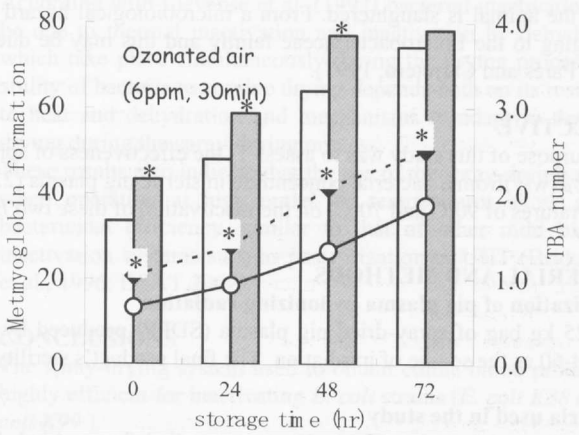

Fig.2. Effect of ozonated air on MetMb formation and TBA number of sliced beef

TBA control
TBA ozonated air(6ppm)
MetMb control
MetMb ozonated air(6ppm)

* significantly ($p<0.05$) different from the control treatment value.

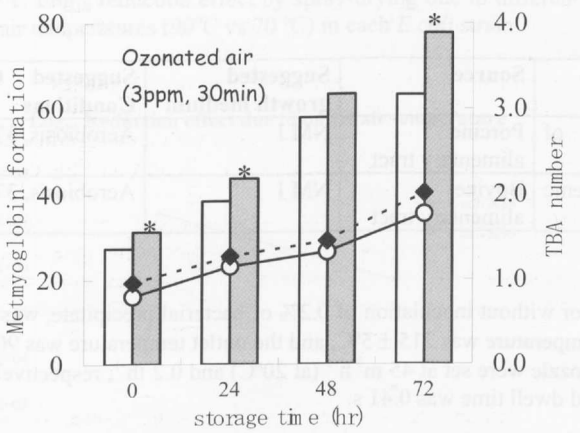

Fig.3. Effect of ozonated air on MetMb formation and TBA number of sliced beef

TBA control
TBA ozonated air(3ppm)
MetMb control
MetMb ozonated air(3ppm)

* significantly ($p<0.05$) different from the control treatment value.

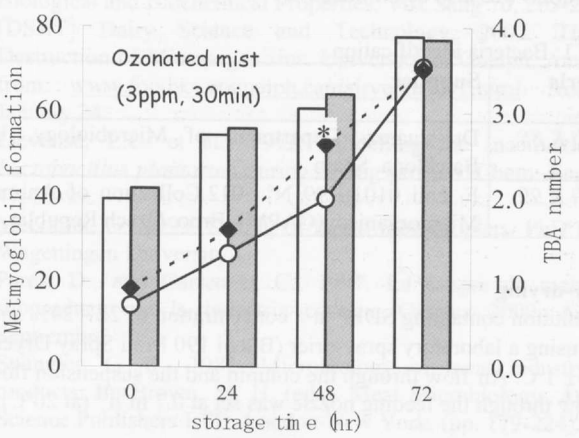

Fig.4. Effect of ozonated mist on MetMb formation and TBA number of sliced beef

TBA control
TBA ozonated mist
MetMb control
MetMb ozonated mist

* significantly ($p<0.05$) different from the control treatment value.