



EFFECT OF ANTIOXIDANTS ON COLOR CHANGE AND LIPID OXIDATION OF SLICED ROAST BEEF

Okayama, T.¹, Iwanaga, S.¹, Kamisoyama, H.¹, Numata, M.², Sakata, R.³ and Muguruma, M.⁴

¹Faculty of Agriculture, Kobe University, Nada-ku, Kobe 657-8501, Japan

²Central Research Institute, ITOHAM FOODS Inc., 1-2-1 Kubogaoka, Moriya 302-0104, Japan

³School of Veterinary Medicine, Azabu University, Sagami-hara 229-8501, Japan, ⁴Faculty of Agriculture, University of Miyazaki, Miyazaki 889-2192, Japan

Background

Roast beef is a meat product which has gained a lot of popularity in recent years. Its predominately bright red centre is one of its important characteristics. However, the reddening effect does not remain throughout the centre of the meat but fades as the meat is sliced. As a consequence, the marketing of sliced roast beef is very difficult.

Objectives

This research was conducted to elucidate the effect of antioxidants (rosemary + sage extract, grape seed polyphenol, vitamin E, water-soluble astaxanthin, astaxanthin oil, water-soluble catechin, oil-soluble catechin, butylated hydroxy toluene (BHT), oil-soluble rosemary extract + V.E, water-soluble rosemary extract) on color change and lipid oxidation of sliced roast beef.

Materials and methods

Sample : A commercial roast beef (manufactured by ITOHAM FOODS Inc., Japan) was used for the experiments. Topside grass-fed chilled Aussie beef was used for model roast beef as a raw material.

Antioxidants : We selected ten antioxidants with expected strong antioxidant effects. These were as follows : 1) rosemary + sage extract (Stabiloton WS, RAPS Japan Co., Ltd.), 2) grape seed polyphenol (Gravinol, Kikkoman Co., Ltd.), 3) vitamin E (E-mix, Eisai, Co., Ltd.), 4) water-soluble astaxanthin (Astareal, Fuji Chem. Co., Ltd.), 5) astaxanthin oil (Astareal oil, Fuji Chem. Co., Ltd.), 6) water-soluble catechin (Sunkatol W-5, Taiyo Kagaku Co., Ltd.), 7) oil-soluble catechin (Sunkatol No.1, Taiyo Kagaku Co., Ltd.), 8) butylated hydroxy toluene (BHT ; Sustane emulsion, Nikki-Universal, Co., Ltd.), 9) oil soluble rosemary extract + V.E (RM-21E, Mitsubishi-kagaku Foods Co., Ltd.), 10) water-soluble rosemary extract (RM-21A, Mitsubishi-kagaku Foods Co., Ltd.).

Model roast beef preparation : The preparation of model roast beef was as follows : after cutting and trimming of raw material, and then salting with salt and spices (2g/100g meat), and the surface of raw beef material was burnt by a Bunsen burner. The sample placed into polyethylene bag and cooked to an internal temperature of 57°C, for 43 min in a water bath and cooled.

Analysis : Judgements with the naked eye, the sense of smell, and panel test were carried out as far as possible to sliced roast beef sample. The percentage of metmyoglobin (MetMb) formation was measured by the procedure of Trout (1990). Lipid oxidation was determined by the reaction of malonaldehyde with thiobarbituric acid (TBA) as described Siu and Draper (1974) modified of the "filtration method" of Tarladgis *et al.* (1964). The absorbance value measured by the procedure was expressed as TBA reactive substances (TBARS).

Results and discussion

At first this experiment was undertaken for obtaining information on the changes in MetMb formation and TBARS of sliced roast beef during storage. Sliced roast beef about 3 mm thick was placed at 15 cm (about 3.400 Lux.) from the 15W white fluorescent lamp in refrigerator. A comparison to imitate the lighting used by supermarket displays in storage units was hard to accomplish. The changes in MetMb formation and TBARS of sliced roast beef during storage was shown in Fig. 1. The percentage of MetMb formation during storage increased with each additional storage day. The samples after 2 and 3 days storage reached a MetMb level of 38% and 51%, respectively. The TBARS value of samples increased linearly during storage. These



results indicated that the MetMb formation and TBARS value increased under these storage conditions. And the same condition was adopted to get the remarkable difference of sliced roast beef sample during storage. Screening tests 1 and 2 were carried out to ten kinds of antioxidants. Screening test 1 was as follows : 1% antioxidants were applied to surface of sliced roast beef, and MetMb formation was determined after 3 days storage. Fig. 2 showed the effect of antioxidants on MetMb formation of sliced roast beef after 3 days storage. Grape seed polyphenol and water-soluble rosemary extract treatment samples exhibited a MetMb level under 30% after 3 days storage. Screening test 2 was as follows : The surface of sliced roast beef under the same condition of screening 1 were judged with the naked eye. Table 1 showed that rosemary + sage extract and vitamin E was acceptable but the water-soluble rosemary extract was much better. It was then agreed that the water-soluble rosemary extract (WSRE) from ten different antioxidants was chosen as a result of these screening tests.

Recently, there were several reports [Ahn *et al.* (2002), Coronade *et al.* (2002), Djeane *et al.* (2003), Tanabe *et al.* (2002), Yu *et al.* (2002)] concerning the oxidation effect of rosemary extract on the oxidation stability of meat and meat products. Yu *et al.* (2002) have already reported that rosemary extract acts as an inhibitor of lipid oxidation and color change in cooked turkey products during refrigerated storage. However, WSRE have not been evaluated for their effects to prevent color change and lipid oxidation of sliced roast beef.

The following experiment was conducted to determine the potential benefits of WSRE on color change and lipid oxidation of roast beef. Model roast beef was prepared by dry or wet salting containing 1% WSRE. After slicing, sample was stored under the same condition as previously stated above. Fig. 3 showed the effect of dry- and wet-salting on MetMb formation of sliced roast beef during storage. The percentage of MetMb formation in dry salted sliced roast beef was slightly higher than that in wet sample after 1 day of storage. But after 3 days of storage, the dry salted sample had a much lower level than that of the wet salted sample. The dry salting method was then used in subsequent experiments for roast beef preparation. Fig. 4 showed the effect of salting time on MetMb formation and TBARS value of roast beef. Model roast beef prepared for 0, 1, 3 and 5 days salting containing 1% WSRE, and after slicing, samples were stored under the above mentioned conditions. After 1 day storage, the percentage of MetMb formation of the sample 3 days salting was higher than those of 0, 1 and 5 salting days. But, after 3 days storage, the sample of 3 and 5 days salting were low level of MetMb formation than those of 0 and 1 day salting samples. The TBARS value of samples salting 3 and 5 days were slightly lower than those of 0 and 1 day salting samples.

From separate experiment, the color of sliced roast beef salted sample containing 1% WSRE for 3 days was much better than those of samples added 1% WSRE just after cooking by judgement of naked eye (data not shown).

More detail investigations are necessary to clarify the effect of WSRE on color change and lipid oxidation of sliced roast beef.

Conclusions

The effect of antioxidants on color change and lipid oxidation of sliced roast beef was investigated. The water-soluble rosemary extract was chosen as a result of the screening tests. Changes were measured in metmyoglobin formation and thiobarbituric acid-reactive substances of roast beef samples containing 1% water-soluble rosemary extract. It was suggested that the water-soluble rosemary extract showed protection of color change and lipid oxidation of sliced roast beef.

Acknowledgements

We gratefully thank Ms. Atuko Sone in our lab., Kobe Univ., who carried out the experiments in this study. We would like to thank Mr. Toru Ito, ITOHAM FOODS Inc., for donating the beef sample. We are also deeply grateful to Mr. Roy Shrigley for his useful comments in reading this paper.

References

- Ahn, J., Grun, I.U. and Fernando, L.N. 2002. Antioxidant properties of natural plant extracts containing polyphenolic compounds in cooked ground beef. *J. Food Sci.*, 67:1364-1369.
- Coronade, S.A., Trout, G.R., Dunshea, F.R. and Shah, N.P. 2002. Antioxidant effects of rosemary extract and whey powder on the oxidative stability of wiener sausages during 10 months frozen storage. *Meat Sci.* 62:217-224.



Djenane, D., S-Escalante, A., Beltran, J.A. and Roncales, P. 2003. Extention of the shelf life of beef steaks packaged in a modified atmosphere by treatment with rosemary and dispalyed under UV-free lighting. *Meat Sci.* 64:417-426.

Siu, G.M. and Draper, H.H. 1978. A survey of the malonaldehyde content of retail meats and fish. *J. Food Sci.* 43:1147-1149.

Tanabe, H., Yoshida, M. and Tomita, N. 2002. Comparison of the antioxidant activities of 22 commonly used culinary herbs and spices on the lipid oxidation of pork meat. *Animal. Sci. J.* 73:389-393.

Tarladgis, B.G., Pearson, A.M. and Dugan, L.R. 1964. Chemistry of the 2-thiobarbituric acid test for determination of oxidative rancidity in foods. II. Formation of the TAB-malonaldehyde complex without acid-heat treatment. *J. Sci. Food & Agric.* 15:602-607.

Trout, G.R. 1990. The rate of metmyoglobin formation in beef, pork, and turkey meat as influenced by pH, sodium chloride, and sdium tripolyphosphate. *Meat Sci.* 28:203-210.

Yu, L., Scanlin, L., Wilson, J. and Schmidt, G. 2002. Rosemary extracts as inhibitors of lipid oxidation and color change in cooked turkey products during refrigerated storage. *J. Food Sci.* 67:582-585.

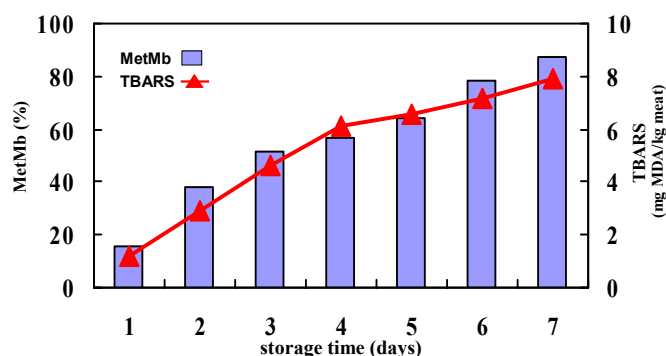


Fig. 1 Changes in MetMb formation and TBARS of sliced roast beef during storage

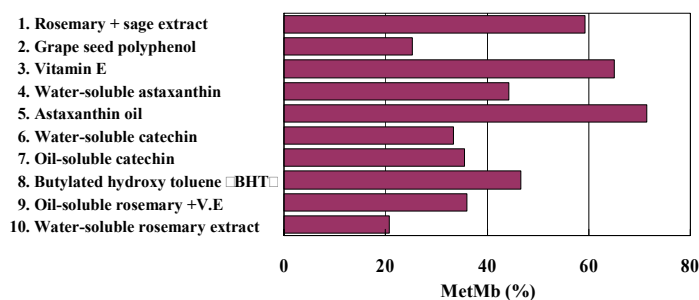


Fig. 2 Effect of antioxidants on MetMb formation of sliced roast beef



Table 1 Effect of antioxidants on surface color of sliced roast beef

Antioxidant	Judgement with the naked eye
1. Rosemary + sage extract	□
2. Grape seed polyphenol	×
3. Vitamin E	□
4. Water-soluble astaxanthin	×
5. Astaxanthin oil	×
6. Water-soluble catechin	×
7. Oil-soluble catechin	×
8. Butylated hydroxy toluene (BHT)	×
9. Oil-soluble rosemary + V.E	×
10. Water-soluble rosemary extract	○

○ □ Good, □ □ Not bad, × □ Bad

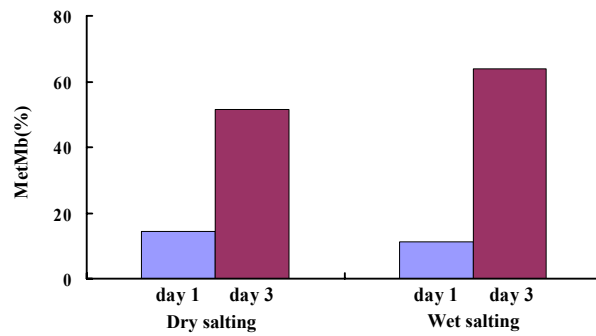


Fig. 3 Effect of dry and wet salting on MetMb formation of roast beef

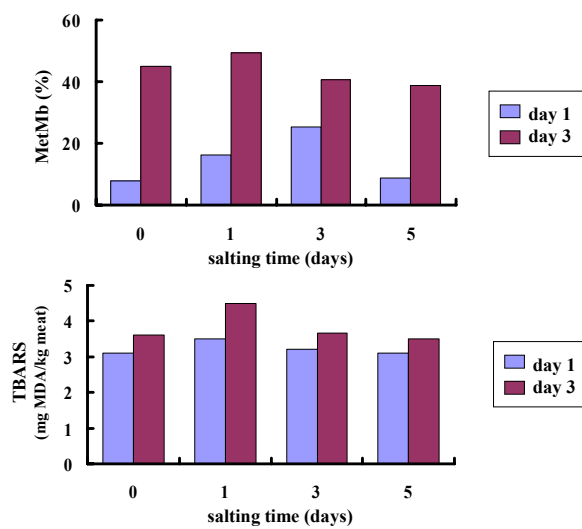


Fig. 4 Effect of salting time on MetMb formation and TBARS of roast beef