COLOR AND OXIDATIVE STABILITY OF GROUND BEEF PATTIES AS AFFECTED BY OXYGEN SCAVENGERS AND MODIFIED ATMOSPHERE PACKAGING DURING REFRIGERATED STORAGE

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Abstract – The effect of modified atmosphere packaging (MAP-70%CO_2+30%N_2) with or without oxygen scavengers (OS) in comparison to AIR control packaging on color and oxidative stability of ground beef patties was investigated during refrigerated storage for 8 days. Thiobarbituric acid (TBA) values of the patties reached 1.97 mg malondialdehyde (MDA)/kg in AIR group while it was 0.57 and 0.56 for MAP and OS groups, respectively at the end of the storage. Metmyoglobin ratio in MAP and OS groups in general, did not show significant change ($p>0.05$) while it increased in AIR control over the refrigerated storage ($p<0.05$). OS application resulted in significantly higher redness (a*) value than AIR control all over the storage periods ($p<0.05$). A significant increase in total color difference (ΔE) was obtained in AIR group during storage and OS treated patties possessed lower ΔE than AIR packaged ones ($p<0.05$). The results of the present study indicated that oxygen scavengers utilized in combination with MAP is a sound active packaging technique in maintaining color and oxidative stability of ground meat patties.

Key Words– Ground beef patties, Oxygen scavengers, Modified atmosphere packaging

I. INTRODUCTION

With increasing consumer demand for minimally processed foods [1], new packaging techniques such as active and intelligent packaging have gained great popularity in the food industry to ensure products with high quality and longer shelf life [2] without using chemical additives. Active packaging was defined as 'changes the condition of the packed food to extend shelf-life or to improve safety or sensory properties, while maintaining the quality of packaged food' [3, 4]. This could be provided by adjusting the packaging gas atmosphere [5]. Modified atmosphere packaging (MAP) technique has been used for this purpose, especially for fresh meat packaging. Oxygen scavengers is one of the active packaging methods [6] which extends the shelf life of product by absorbing the residual oxygen in the package and slowing down the oxidative changes in combination with vacuum and modified atmosphere packaging [7-9].

Ground beef is a highly perishable product which has a short shelf-life [1]. The purpose of the present study was to investigate the effects of modified atmosphere packaging (MAP-70%CO_2+30%N_2) with or without oxygen scavengers (OS) on the pH, lipid oxidation (TBA value), metmyoglobin ratio and instrumental color parameters (L*, a*, b* and ΔE) of ground beef patties as compared with AIR control packaging during 0, 1, 3, 5 and 8 days of refrigerated storage.

II. MATERIALS AND METHODS

Beef rolled rib and *semimembranosus* muscles were purchased from a local market in Ankara. One portion beef rolled rib and two portions beef semimembranosus muscle were ground twice followed by hand mixing for 2 min. Ground beef patties weighing 25 g (±0.5g) each were packaged 1) in Air, 2) with modified atmosphere containing 70% CO_2 and 30% N_2 (MAP), 3) MAP with OS (500BZ). These three groups of packaged ground beef patties were kept at 4ºC and analyzed at days 0, 1, 3, 5 and 8 for pH value, instrumental color (L*, a* and b* values) with Minolta Chroma Meter CR-400 (Minolta Co., Ltd., Osaka, Japan), TBA value [9], metmyoglobin ratio [10]. Total color difference (ΔE) were measured from the equation below [11].

$$\Delta E=\sqrt{(L_0-L)^2+(a_0-a)^2+(b_0-b)^2}$$

Data from two replications were analyzed with analysis of variance procedure of SAS system 9 (SAS, 2002) and mean separation was conducted using Duncan's Multiple Comparison test at $p<0.05$.

III. RESULTS AND DISCUSSION

The initial pH value (pH=5.63) exhibited a significant decrease due to MAP and OS application reaching the pH values of 5.31 and 5.25, respectively at the end of storage (at Day 8) while the increase observed in AIR control at Day 8 (pH=5.99) was not statistically significant (Data not shown).

Instrumental color parameters (L*, a*, b*) are presented in Table 1. Overall, L* and b* values of ground beef patties was not affected by the packaging method with the exception of higher L* value in AIR control than MAP and OS groups at Day 8 ($p<0.05$). Redness (a*) values appeared to decrease in all groups during refrigerated storage. OS incorporation into the package preserved red color of the ground beef patties as compared to AIR control while MAP was only effective in maintaining red color at Day 3.

Data obtained for the total color difference (ΔE) are presented in Fig. 1. ΔE is generally used to characterize the variation of color depending on a given application or processing. Results of ΔE showed that MAP and OS groups maintained the color of the ground beef patties better than the control.

The influence of packaging method on metmyoglobin (MetMb) ratio of beef patties are presented in Fig. 2. Initial MetMb content, which was 21.09%, showed a significant increase ($p<0.05$) in AIR control and reached 59.8% at the end of storage while the MetMb ratio of MAP and OS did not generally show significant changes during storage ($p>0.05$).

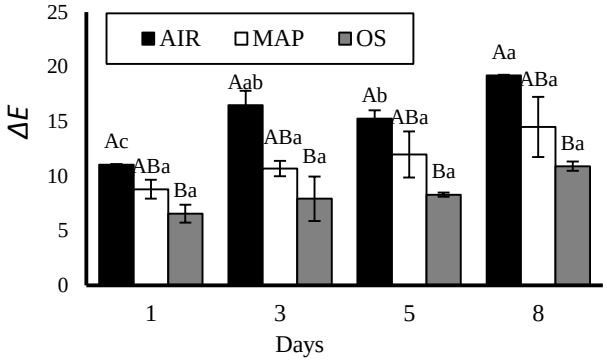

Figure 1. The effect of AIR, MAP and OS packaging on ΔE values of ground beef patties. Bars represent the mean value±standard error. (A, B): Within a day between sample groups, bars with different letters are different ($p<0.05$). (a-b): Within a sample group between storage days, bars with different letters are different ($p<0.05$).

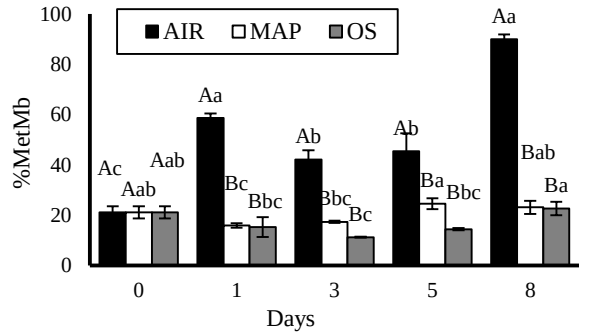

Figure 2. The effect of AIR, MAP and OS packaging on Metmyoglobin (MetMb) ratio of beef patties. Bars represent the mean value±standard error. (A, B): Within a day between sample groups, bars with different letters are different ($p<0.05$). (a-c): Within a sample group between storage days, bars with different letters are different ($p<0.05$).

Table 1. The effect of AIR, MAP and OS packaging on the lightness (L*), redness (a*) and yellowness (b*) values of ground beef patties during refrigerated storage

Storage Periods	L*			a*			b*		
	AIR	MAP	OS	AIR	MAP	OS	AIR	MAP	OS
Initial	44.9 ± 1.5^{Aa}	44.9 ± 1.5^{Aa}	44.9 ± 1.5^{Aa}	25.2 ± 0.7^{Aa}	25.2 ± 0.7^{Aa}	25.2 ± 0.7^{Aa}	16.8 ± 0.4^{Aa}	16.8 ± 0.4^{Aa}	16.8 ± 0.4^{Aa}
Day 1	43.0 ± 1.3^{Aa}	46.1 ± 1.2^{Aa}	44.1 ± 0.6^{Aa}	16.3 ± 1.7^{Bb}	17.8 ± 0.5^{ABb}	21.3 ± 0.1^{Ab}	11.3 ± 0.1^{Ab}	12.3 ± 0.8^{Ab}	12.1 ± 0.4^{Ab}
Day 3	44.4 ± 2.5^{Aa}	45.3 ± 0.1^{Aa}	42.4 ± 0.7^{Aa}	10.2 ± 0.1^{Cdc}	17.0 ± 0.1^{Bb}	20.8 ± 0.3^{Ab}	11.4 ± 1.6^{Ab}	10.1 ± 0.2^{Ac}	10.9 ± 0.4^{Abc}
Day 5	46.9 ± 2.6^{Aa}	44.5 ± 0.3^{Aa}	43.2 ± 1.6^{Aa}	11.5 ± 0.5^{Bc}	15.0 ± 1.7^{ABb}	21.2 ± 2.1^{Ab}	10.3 ± 0.4^{Ab}	10.7 ± 0.5^{Abc}	10.6 ± 0.1^{Ac}
Day 8	49.0 ± 0.1^{Aa}	40.8 ± 0.2^{Bb}	43.7 ± 1.8^{Ba}	7.3 ± 0.3^{Bd}	13.6 ± 2.1^{Ab}	16.7 ± 0.6^{Ac}	11.2 ± 0.2^{Ab}	9.2 ± 0.4^{Bc}	10.1 ± 0.2^{ABc}

*Mean±standard error. (A, B): Within a day between sample groups, bars with different letters are different ($p<0.05$). (a-d): Within a sample group between storage days, bars with different letters are different ($p<0.05$).

Initial TBA value of ground beef patties was 0.73 mg MDA/kg and it showed significant increases ($p<0.05$) during storage reaching 1.97 mg MDA/kg in AIR group at Day 8 (Figure 3). TBA values of OS and MAP groups were significantly lower than AIR group over the storage ($p<0.05$).

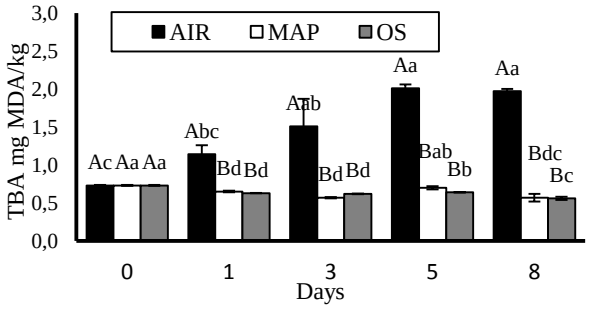

Figure 3.The effect of AIR, MAP and OS packaging on the TBA value of beef patties. Bars represent the mean value±standard error. (A, B): Within a day between sample groups, bars with different letters are different ($p<0.05$). (a-d): Within a sample group between storage days, bars with different letters are different ($p<0.05$).

IV. CONCLUSIONS

Oxygen scavenger utilization with MAP in extending color stability of ground beef patties was an effective application, particularly, when a* and ΔE values are considered. MAP with or without OS was an effective packaging system in retarding lipid oxidation as measured by TBA value. Further research should focus on determination of shelf-life of ground beef packaged with OS plus MAP, and combined effect of OS and natural preservatives.

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