Improvement of the beef shelf-life by combination of modified atmosphere packaging and superficial treatment with natural dihydroquercetin extract Preliminary study

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Abstract

The possibility for the extension of shelf life of two types of beef: trimmings and knuckle disks by a combination of modified atmosphere packaging and preliminary superficial treatment with a spray of natural dihydroquercetin concentrate of Siberian larch *(Larix sibirica Ledeb)* was studied. For the purposes of the study a sensory analysis was used and the changes of the raw meat surface colour and the grilled meat taste and flavour were analyzed. It was determined that when the beef was treated in advance with a solution of dihydroquercetin combined with modified atmosphere packaging the shelf life at $0^{O}C$ increased approximately two times and reached 10 days.

Introduction

Extension of the shelf-life of meat was one of the technology necessities to meet the demands of consumers. In this respect, increasing attention was put on packaging techniques. Modified atmosphere packaging (MAP) was recent innovation that has been gaining importance as preservation technique to improve the shelf-life of meat. Retention of meat colour was better in MAP than in either vacuum packaging or in air (Narasimha Rao & Sachindra, 2002). Djenane et al. (2004) suggested MAP packaging of beef steaks to be presided by spraying with natural antioxidant such as carnosine, carnetine and L-ascorbic acid solutions. They concluded that combination of carnosine with ascorbic acid provided the best antioxidative protection with regard to meat deterioration. The same authors proposed also an extension of shelf-life of beef steaks packaged in MAP by treatment with rosemary and displayed under UV-free lighting (Djenane et al, 2003).

The objective of the study was to enhance the shelf-life of beef using combination of MAP with preliminary superficial spraying treatment with natural concentrate of 2R,3R-dihydroquercetin, obtained from Siberian larch *(Larix sibirica Ledeb).*

Materials and methods

The beef was supplied, carved, boned, the tendons removed and sorted in the company "Unitemp" Ltd, Voyvodinovo, Plovdiv region. The experiments were carried out using eight samples as follows: *Control sample No1/0* - Beef trimming 90/10%, packaged in air atmosphere and not treated with 5 % alcohol solution of 1 $g.l^{-1}$ DHQ. Experimental sample *No1/1* - Beef trimming 90/10%, packaged in modified atmosphere (MA) 80 % O_2 : 20 % CO_2, and not treated with a solution of natural antioxidant. *Experimental sample No1/2* - Beef trimming 90/10%, packaged in air atmosphere and treated with 5 % alcohol solution of 1 $g.l^{-1}$ dihydroquercetin (DHQ). *Experimental sample No 1/3* - Beef trimming 90/10%, packaged in MA and treated with 5 % alcohol solution of 1 $g.l^{-1}$ DHQ. *Control sample No 2/0* – Beef knuckle with bone, packaged in air atmosphere and not treated with a solution of natural antioxidant. *Experimental sample No2/1*- Beef knuckle with bone, packaged in MA and not treated with a solution of natural antioxidant. *Experimental sample No2/2* - Beef knuckle with bone, packaged in air atmosphere and treated with 5 % alcohol solution of 1 $g.l^{-1}$ DHQ. *Experimental sample No 2/3* - Beef knuckle with bone, packaged in modified atmosphere and treated with 5 % alcohol solution of 1 $g.l^{-1}$ DHQ.

(2R,3R)-Dihydroquercetin solution preparation. Powder concentrate of dihydroquercetin, extracted from Siberian larch *(Larix sibirica Ledeb)* and produced by the company "Flavit" Ltd., Pushtino (Russia) was used in the experiment. The concentrate contained: 96 % DHQ, 3 % dihydrokempferol and traces of naringenin. In 50 cm^3 96 % ethyl alcohol 1 g of DHQ was diluted and filled up to 1 dm^3 with 950 cm^3 bidistillated water. The surface of the samples was treated by spraying. With 1 dm^3 solution of DHQ 50 kg meat was treated. The meat temperature during the superficial treatment was 3.2°C. The meat samples were drained and tempered for 60 min in a refrigerator at 1.2°C, after which were packaged in transparent polymer bags with sizes 10/28 cm. The packaging room temperature was 7.5°C. The packaged samples were put into plastic boxes, labeled and stored for 10 d at 0°C.

Organoleptic characteristics determination. The sensory analysis of the beef samples was carried out according the method, described by King & Bosch (1990). The members of the panel were chosen under the Wheeler's recommendations (1982). The sensory analysis scale of beef consisted of 5 ratings (Larick & Turner, 1990; Raharjo et al., 1993). The raw meat colour and the taste and flavour of the grilled beef were evaluated.

Statistical analysis. Nine repetitions (n = 9) for each sample were carried out. Data were subjected to analysis of variance (ANOVA) (Draper & Smith, 1998). The Fischer's test with significant difference at $P \leq 0.05$ was used to compare sample means. Significant differences between means less than 0.05 were considered statistically significant (Kenward, 1987).

Results and discussions

It was ascertained that the control sample No 1/0 changed its colour towards dark brown-red after the 3-rd d. No tissue liquid was available out of the pad paper. Until the 10-th d this sample darkened and turned green. The taste and flavour of the baked sample indicated for probable putrefactive deterioration. Turbid meat juice appeared out of the pad paper. On the package walls condensate was found out. In the sample No 1/1, packaged in MA without antioxidant till the 6-th d no visible change in the bright flame-red colour was found out, but the pad paper grew moist. On the 10-th d of the refrigerated storage very weak colour darkening and condensate formation on the package walls were ascertained. In the sample No 1/2, packaged in air atmosphere and treated with DHQ after the 4-th d gradual darkening started, which at the later stage developed into grey, yellow-green colour of the surface, mucus appearance and deterioration.

Table 1. Sensory evaluation of beef samples during 10 d storage at $0^{O}C$

Time, D	**Average ratings of beef trimmings 90 / 10 % sensory analysis**											
	Xav. ± SD.(n-1) for colour				**Xav. ± SD.(n-1) for taste**				**Xav. ± SD.(n-1) for flavour**			
	Samples				**Samples**				**Samples**			
	№1/0	**№1/1**	**№ 1/2**	**№1/3**	**№1/0**	**№1/1**	**№ 1/2**	**№1/3**	**№1/0**	**№1/1**	**№ 1/2**	**№1/3**
0	**5,00**^{a} ± 0,20	**4,99**^{a} ± 0,26	**4,97**^{a} ± 0,22	**5,00**^{a} ± 0,15	**5,00**^{a} ± 0,15	**4,98**^{a} ± 0,16	**4,99**^{a} ± 0,17	**4,98**^{a} ± 0,21	**5,00**^{a} ± 0,26	**4,99**^{a} ± 0,24	**4,96**^{a} ± 0,20	**4,98**^{a} ± 0,13
3	**3,25**^{b} ± 0,12	**4,87** ^{a} ± 0,17	**4,88**^{a} ± 0,19	**4,98** ^{a} ± 0,18	**4,07** ^{e} ± 0,18	**4,97** ^{a} ± 0,24	**4,96** ^{a} ± 0,22	**4,98** ^{a} ± 0,14	**4,21** ± 0,19	**4,87** ^{a} ± 0,16	**4,78** ^{a} ± 0,18	**4,97** ^{a} ± 0,11
6	**2,14** ^{c} ± 0,17	**4,76** ^{a} ± 0,21	**3,22** ^{b} ± 0,15	**4,96** ^{a} ± 0,16	**3,38** ^{b} ± 0,17	**4,76** ^{a} ± 0,13	**3,46** ^{b} ± 0,18	**4,96** ^{a} ± 0,14	**3,67** ± 0,15	**4,81** ^{a} ± 0,19	**3,57** ± 0,14	**4,96** ^{a} ± 0,16
10	**1,27** ^{d} ± 0,11	**3,04** ^{b} ± 0,22	**2,21** ^{c} ± 0,14	**4,95** ^{a} ± 0,20	**1,05** ^{d} ± 0,22	**2,25** ^{c} ± 0,12	**1,56** ^{d} ± 0,15	**4,94** ^{a} ± 0,27	**1,11** ^{d} ± 0,16	**2,45**^{c} ± 0,22	**2,30** ^{c} ± 0,14	**4,93** ^{a} ± 0,12
	Average ratings of beef knuckle with bones discs sensory analysis											
	Samples				**Samples**				**Samples**			
	№2/0	**№2/1**	**№ 2/2**	**№2/3**	**№2/0**	**№2/1**	**№ 2/2**	**№2/3**	**№2/0**	**№2/1**	**№ 2/2**	**№2/3**
0	**4,96**^{a} ± 0,25	**4,95**^{a} ± 0,21	**4,98**^{a} ± 0,14	**4,99**^{a} ± 0,18	**4,90**^{a} ± 0,17	**4,94**^{a} ± 0,22	**4,96**^{a} ± 0,26	**4,98**^{a} ± 0,19	**4,96**^{a} ± 0,23	**4,98**^{a} ± 0,15	**4,99**^{a} ± 0,16	**5,00**^{a} ± 0,14
3	**2,47** ^{b} ± 0,14	**4,94** ^{a} ± 0,10	**2.94** ± 0,10	**5,00** ^{a} ± 0,15	**2,54** ^{b} ± 0,11	**4,95** ^{a} ± 0,13	**2,64** ^{a} ± 0,17	**5,00** ^{a} ± 0,10	**3,57** ± 0,12	**4,85** ^{a} ± 0,18	**3,00** ± 0,17	**4,98** ^{a} ± 0,21
6	**2,06**^{b} ± 0,12	**4,78** ^{a} ± 0,25	**1,91** ^{b} ± 0,27	**4,91** ^{a} ± 0,29	**1,74** ± 0,14	**4,79** ^{a} ± 0,17	**1,98** ± 0,18	**4,95** ^{a} ± 0,22	**2,29** ^{b} ± 0,31	**4,76** ^{a} ± 0,24	**2,54** ^{b} ± 0,20	**4,93**^{a} ± 0,26
10	**1,04** ^{c} ± 0,23	**2,28** ^{b} ± 0,30	**1,21** ^{c} ± 0,20	**4,89** ^{a} ± 0,24	**1,23** ^{c} ± 0,25	**2,92** ^{b} ± 0,33	**1,07** ^{c} ± 0,22	**4,91** ^{a} ± 0,28	**1,39** ^{c} ± 0,21	**2,22** ^{b} ± 0,31	**1,60** ^{c} ± 0,32	**4,84** ^{a} ± 0,17

Mathematic-statistical conclusions: *Al compared average values of the sensory ratings in rows were statistically different with the exception of these marked with letter index:* ^{a}, ^{b}, ^{c} *and* ^{d}.

Condensate in a form of very small drops on the walls of the package was found out. Sample No 1/3, packaged in MA and treated with DHQ till the 10^{-th} d showed no visible negative changes in the colour. After the initial turning pale, the meat of this sample gained stable bright red colour. The pad paper grew moist and formation of condensate in a form of tiny drops on the internal walls of the package was determined.

The control sample No 2/0 changed its colour to dark brown-red yet on the 2^{-nd} d of the storage. Till this moment no meat juice out of the pad paper was observed. On the 7^{-th} d the control sample No 2/0 darkened completely and its taste and flavour evidenced for deep autolysis and probable putrefycation. Yellow-green mucus appeared on the surface. Condensate on the package walls was observed. Sample No 2/1, packaged in MA without antioxidant did not show visible changes in the formed bright flame-red colour till the 6^{-th} d of the storage. The pad paper grew moist slightly. On the 10^{-th} d the edges of the bones darkened and the parts out of the pad paper turned dark green. Condensate on the package walls was observed. The colour of the sample No 2/2 packaged in air atmosphere and treated with DHQ after the 2^{-nd} d of the refrigerated storage darkened. On the 4^{-th} d intensive darkening started, developing later into yellow-green colour of the surface, accompanied by abundant mucus appearance. Drops of condensate were observed on the package walls. Sample No 2/3, packaged in MA and superficially treated with DHQ till the 10^{-th} d did not show visible indicators of colour negative change. After the initial turning pale the product gained stable bright red colour. The pad paper grew moist and condensate in a form of tiny drops on the package internal walls was formed after 10 d storage at 0^{O}C.

Conclusions

The results obtained and their analysis let a conclusion to be made that the packaging of beef in modified atmosphere 80 % O_2 : 20 % CO_2, combined with preliminary superficial treatment of the meat with 5 % alcohol solution of 1 $g.l^{-1}$ dihydroquercetin allowed the organoleptic characteristics to be preserved and its refrigerated storage to be extended till 10 d.

Acknowledgements

The author expresses his gratitude to the technological team of the company “Unitemp” Ltd, Voyvodinovo, Plovdiv region, as well as the management of the company “Vitalife” Ltd. , Sofia for the co-operation and support rendered.

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