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Influence of Modified Atmosphere Packaging on Freshness Parameters of Organic Chicken Meat – Short Communication

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Abstract

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The effect of modified atmosphere packaging (MAP1 80% O_2/20% CO_2 and MAP2 70% N_2/30% CO_2) on the selected parameters (ammonia, thiobarbituric acid reactive substances /TBARS/) and antioxidant capacity in chilled meat (2 ± 2°C) of organic chickens (breast and thigh) was evaluated. Control samples were packaged using a polyolefin film. The experiment was conducted on day 2 and repeated on day 7, 10, and 14 of storage. TBARS of samples in MAP1 were higher than in samples stored in MAP2. Ammonia in meat in MAP2 was constant during storage. In general, the DPPH inhibition percentage of meat in MAP1 was lower than that in meat in MAP2. Results of the present study indicated that MAP2 could be preferable for the packaging of organic chicken meat.

Keywords: ecological product; poultry; shelf life; meat quality; antioxidant capacity

The main commonly applied method for extending the shelf life of meat is modified atmosphere packaging (MAP) (Paramithiotis *et al.* 2009). Prolongation of meat freshness by MAP has many advantages including: decrease of aerobe proliferation and increased oxidative stability of meat as a result of oxygen elimination (Arvanitoyannis & Stratakos 2012). MAP with high oxygen concentration (70–80%) is used increasingly for fresh meat packaging. Quality and acceptability of meat are limited by lipid oxidation (Balamatsia *et al.* 2007). An advantage of high-oxygen atmosphere is that it preserves the bright red colour of meat (Lund *et al.* 2007). Poultry meat and particularly that from outdoor birds is susceptible to oxidation processes due to high content of PUFA (n = 3) and high peroxidation index (Dal Bosco *et al.* 2016). The aim was to compare the effect of two types of modified atmosphere packaging (MAP1 80% O_2/20% CO_2, and MAP2 70% N_2/30% CO_2) on the selected chemical parameters of poultry chilled meat (muscle of breasts and thighs) from an organic production system.

MATERIAL AND METHODS

A total of 96 carcasses of fresh chickens (Color yield hybrid) were obtained from an organic production farm one day post slaughter. Of the total number of carcasses 48 carcasses were sealed into a protective sheet [film Ergo.top-11mod/120 µm/flat-film, 5-layer coex film with the structure: PA/Tie/EVOH/Tie/PE (Vepak, s.r.o., Czech Republic)] filled with a mixture of gases [24 samples with MAP1 80% O_2 + 20% CO_2, 24 samples with MAP2 30% CO_2 + 70% N_2 (Linde Gas a.s., Czech Republic)] using the Turbovac 320-ST-S

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packing machine for MAP1 (HFE Vacuum Systems, The Netherlands) and Vac-Star S-223 GX (Vac-Star AG, Switzerland) for MAP2. As a control (24 samples for either type of MAP) 48 samples were packaged using a polyolefin film stretched over the tray (AIR). All the samples were stored in a cooling chamber with regulated temperature (2 ± 2°C) for 14 days. The experiment was conducted on day 2 and repeated on day 7, 10, and 14 of storage.

Measurement of gases. Concentrations of O_2/CO_2 (%) in MAP were measured using a Check Point II oximeter (PBI Dansensor AS, Denmark). Ammonia content (mg/100 g) was determined by the Conway method. Thiobarbituric acid reactive substances (TBARS) (mg/kg) were determined by the distillation method (Castellini *et al.* 2002). Antioxidant capacity (%) was according to Heilerova *et al.* (2003). Samples were taken from the same site of muscle (breast – *m. pectoralis major*, thigh – *m. biceps femoris*).

Statistical data. Means ± SD were determined using Microsoft Office Excel 2003. Statistical significance ($P < 0.05$) was estimated by *t*-test and ANOVA, with post hoc Tukey's test for finding differences using SPSS v20 (IBM Corporation, USA).

RESULTS AND DISCUSSION

At the beginning of MAP application, the content of active gases in the gas mixture atmosphere was at a certain excess in order to have a sufficient partial pressure during the entire storage period and fulfil its function. After packaging of samples, a reduction that occurs and particularly in CO_2 content in MAP results from its conversion to carbonic acid. During our experiment, significant differences ($P < 0.05$) in the content of these gases were observed between both types of MAP after 7 days of storage, but their partial pressures were sufficiently high to keep effectively the muscle tissue in an acceptable condition. The ammonia amount in chicken meat in MAP2 was constant during the cold storage period contrary to samples in MAP1 and AIR. Production of ammonia increased due to deamination of amino acids during the process of spoilage (Balamatsia *et al.* 2007). The

Table 1. Selected storability parameters of organic chickens in MAP1, MAP2, and AIR

Parameters			2^{nd} day	7^{th} day	10^{th} day	14^{th} day
Ammonia (mg/100g)	breast	MAP1	20.00 ± 4.47	19.52 ± 3.06	20.76 ± 5.28^{A}	22.12 ± 3.22^{A}
		MAP2	21.33 ± 3.39	22.75 ± 2.93	21.307 ± 2.70^{A}	23.44 ± 5.05^{A}
		AIR	22.63 ± 5.25^{a}	22.07 ± 4.26^{a}	27.83 ± 5.08^{Bb}	38.41 ± 6.36^{Bc}
	thigh	MAP1	18.04 ± 5.12^{a}	18.02 ± 1.71^{Aa}	18.64 ± 3.01^{Aa}	22.70 ± 3.79^{Ab}
		MAP2	19.32 ± 4.34	21.67 ± 6.05^{AB}	19.399 ± 1.52^{A}	20.52 ± 2.67^{A}
		AIR	18.76 ± 3.11^{a}	23.36 ± 5.88^{Ba}	33.17 ± 10.44^{Bb}	47.71 ± 9.86^{Bc}
TBARS (mg/kg)	breast	MAP1	1.73 ± 1.03^{a}	5.72 ± 1.34^{Bb}	10.95 ± 2.42^{Bc}	13.42 ± 3.69^{Bc}
		MAP2	1.20 ± 0.30^{a}	2.56 ± 1.27^{Ab}	1.89 ± 1.01^{Aab}	2.47 ± 0.91^{Ab}
		AIR	1.74 ± 0.90^{a}	3.54 ± 2.37^{Aab}	2.94 ± 2.29^{Aab}	4.35 ± 2.50^{Ab}
	thigh	MAP1	2.07 ± 1.45^{Ba}	4.84 ± 1.21^{Ba}	11.38 ± 3.55^{Bb}	16.91 ± 6.53^{Bc}
		MAP2	1.14 ± 0.16^{Aa}	1.74 ± 0.80^{Aa}	1.68 ± 0.72^{Aa}	2.50 ± 0.65^{Ab}
		AIR	1.37 ± 0.61^{ABa}	3.12 ± 2.06^{Ab}	2.55 ± 1.76^{Aab}	3.37 ± 2.31^{Ab}
Antioxidant capacity (%)	breast	MAP1	27.00 ± 3.60	25.05 ± 1.82^{A}	26.59 ± 2.39	25.65 ± 0.92^{A}
		MAP2	26.72 ± 2.81^{a}	31.22 ± 5.40^{Bb}	26.45 ± 1.68^{a}	27.18 ± 1.65^{Ba}
		AIR	25.92 ± 1.75^{a}	28.61 ± 5.25^{ABb}	27.18 ± 1.77^{ab}	26.43 ± 2.08^{ABab}
	thigh	MAP1	29.01 ± 2.50^{Aab}	30.15 ± 2.57^{Ab}	29.73 ± 2.27^{Aab}	27.21 ± 1.98^{Aa}
		MAP2	33.36 ± 5.24^{Bab}	37.75 ± 5.27^{Bb}	31.64 ± 1.36^{Ba}	31.84 ± 2.91^{Ba}
		AIR	31.01 ± 3.38^{ABa}	33.08 ± 4.78^{Aa}	31.73 ± 2.11^{Ba}	31.06 ± 3.22^{Ba}

$^{a–c}$values in the same row significantly different between 2^{nd}, 7^{th}, 10^{th}, and 14^{th} day of storage; $^{A–C}$values in the same column are significantly different between MAP1, MAP2 and AIR, $P < 0.05$

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organic meat is characterised by a high TBARS level, which could be due to the high percentage of PUFAs (Dal Bosco *et al.* 2016). An increase in TBARS in all analysed samples was observed during fourteen days of storage. This elevation was significant ($P < 0.05$) and more pronounced in samples stored in MAP1 and AIR than in MAP2 (Table 1). Similarly to the present results, Jongberg *et al.* (2014) reported that high-oxygen MAP increased the TBARS values of chicken meat during chill storage. The organic chicken meat stored without oxygen (MAP2) was found not to be fully protected from the formation of secondary lipid oxidation products during the 14 days of chill storage. Jongberg *et al.* (2014) reported that even storage in vacuum may not prevent lipid oxidation, indicating that the formation of rancid off-flavours is actually more dependent on storage time than on packaging atmosphere.

Natural grazing is an important source of bioactive substances such as antioxidants (Descalzo & Sancho 2008). Bioactive components including antioxidants from pasture enhance the oxidative stability of the meat (Dal Bosco *et al.* 2016). In this study, the mixture of gases in MAP has a more pronounced effect on antioxidant capacity than storage time (Table 1). In general, DPPH percentage inhibition values of meat samples in MAP1 were lower than in chicken meat in MAP2. Lower DPPH percentage inhibition values of chicken samples in MAP1 may be due to destruction of endogenous antioxidants, such as vitamins (tocopherols), by the process of oxidation (Clausen *et al.* 2009). The DPPH percentage inhibition value of thigh muscle was higher than that of breast muscle. The effect of storage time on the antioxidant capacity of organic chicken meat in MAP2 was observed on day 10 of storage, which led to a significant reduction in DPPH percentage inhibition values.

CONCLUSIONS

Despite the known fact that packaging in high-oxygen atmosphere is suitable only for myoglobin-rich meat to get an attractive colour, it is used by the producer (Biopark farm) for packaging their organic chicken meat. In comparison with high-oxygen MAP, the oxygen-free MAP had a higher tendency to protect freshness parameters of chicken meat and had a more positive influence on ammonia content, TBRAS values and antioxidant capacity. Based in these results, oxygen-free modified atmosphere is preferable for the packaging of organic chicken meat. Thus, the producer should use it for packaging chicken meat produced organically instead of high-oxygen MAP.

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