JMBFS

Journal of Microbiology, Biotechnology and Food Sciences

International peer-reviewed scientific online journal

Published by Faculty of Biotechnology and Food Sciences

OXIDATIVE STABILITY OF CHICKEN MEAT AFTER APPLICATION PHYTOGENIC ADDITIVES IN THEIR DIET

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doi: 10.15414/jmbfs.2015.4.special3.14-17

ARTICLE INFO

Received 2. 12. 2014
Revised 10. 12. 2014
Accepted 11. 12. 2014
Published 2. 2. 2015

Regular article

OPEN ACCESS

ABSTRACT

The aim of the study was to evaluate the oxidative stability (TBARS method) of breast and thigh muscle after application of feed mixtures enriched by phytogenic additives. The experiment started with 250 pieces one-day-old chicks of Cobb 500 hybrid combination. They were divided into one control (C) and four experimental groups (1st EG, 2nd EG, 3rd EG, 4th EG). Each group included 50 chicks. In experimental groups, feed additives were applied as followed: 100 mg kg^{-1} Agolin Poultry (in the 1st EG), 500 mg kg^{-1} Agolin Tannin Plus (in the 2nd EG), 1000 mg kg^{-1} Biostrong 510 + FortiBac (in the 3rd EG) and 1000 mg kg^{-1} Agolin Acid (in the 4th EG). We recorded positive influence on chicken meat oxidative stability in all experimental groups with application of plant feed additives. Experimental broiler chickens were fed during 42 days by *ad libitum*. Chicken meat samples of breast and thigh muscle were analyzed in the 1st, 3rd, 5th and 7th day of storage in cold conditions at 4 °C. Obtained results showed that applied phytogenic additives had positive influence on oxidative stability of breast and thigh muscles. At the end of cold store (in 7th day), we found higher malondialdehyde (MDA) values and lower oxidative stability ($P<0.05$) of breast muscle in control group (0.157 mg kg^{-1}) compared to experimental groups (from 0.124 mg kg^{-1} in the 3rd EG to 0.133 mg kg^{-1} in the 1st EG). In the thigh muscle, we found similar tendency of oxidative changes as in the breast muscle. At the end of cold store (in the 7th day), MDA average values of thigh muscle were higher ($P<0.05$) in control group (0.179 mg kg^{-1}) compared to experimental groups (from 0.136 mg kg^{-1} in the 4th EG to 0.141 mg kg^{-1} in the 1st EG). Significant differences ($P<0.05$) between the control and experimental groups were found from the 5th day of storage in thigh muscle in contrast to breast muscle. Obtained results indicate positive influence of phytogenic additives applied in chicken nutrition, namely on stabilization of fatty substance to degradation processes.

Keywords: Phytogenic additives, chicken meat, oxidative stability

INTRODUCTION

Oxidation is the main cause of food deterioration during its processing and storage. Poultry and poultry products are particularly sensitive to oxidative processes of lipids and proteins, because of relatively high concentration of unsaturated lipids, pigments, metal catalysts and various oxidizing agents (**Botsgolou and Botsgolou, 2010**).

Lipid oxidation is primary process, which causes a decreasing of product quality. Products of lipid oxidation can negatively influence the structure, colour, taste, nutritional value and health harmlessness of meat and meat products **(Ladikos and Lougovois, 1990; Lahučký *et al.*, 2010**). Similarly, **Richardson and Mead (1999)** stated that lipid peroxidation in stored fresh meat leads to development of stale smell and taste as well as to durability decreasing. **Pipek *et al.* (1995)** stated that oxidation is caused by free radicals; superoxides are formed at low temperatures as the main products, which act as reaction catalysts. Their catalytic effect arises from one-molecular and bimolecular breakdown to peroxyl and alkoxyl radical. Lipid oxidation is undesirable process, which decreases the sensory and nutritional value of fats and unpleasant taste and odour are mainly caused by the present aldehydes and ketones. In addition, peroxides and fatty acid of low molecular weight are accumulated in fat as the oxidation intermediate products.

The deceleration of fat oxidation can be achieved by oxygen limiting during the storage or by antioxidants application (**Nollet, 2007**). The new antioxidants are various feed additives like aromatic herbs, their extracts and essential oils (**Brenes *et al.*, 2010**). For example, plant oils (peppermint, oregano), spices (black pepper, chilli and garlic), medicinal herbs (cloves *Caryphyllus aromaticus*, wormwood *Artemisia absinthium* and bloodroot *Sanguinaria* sp.), plants (yucca *Yucca schigera*, quillay *Quillaja saponaria*), chestnuts, linseed and citrus fruits are used as phytogenic additives (**Nehasilová, 2003**). Phytogenic additives positively influence a lot of physiological processes in animal organisms (e. g. they increase the digestive juices secretion, improve the blood circulation and cell membrane permeability, decrease the ammonia formation, promote the intestinal peristalsis, affect against bacteria and promote the feed consumption) through the matters containing essential oils, flavonoids, tannins, saponins or alkaloids. Plant additives are often applied into the feed mixtures, because they improve the taste and odour of feed and subsequently, body weight gain and feed intake are increased and feed conversion is improved, too (**Angelovičová *et al.*, 2010**). Antioxidant effects of plant extracts may be used to slow or prevent the fat oxidation in food products (**Rababah *et al.*, 2004**). Application of oils and plant extracts in poultry nutrition is important for health state of animals and animal performance as well as for oxidative stability of produced meat (**Frankič *et al.*, 2009**). Antioxidant activity of plants and their extracts is directly correlated with phenols content (**Chrpová *et al.*, 2010**). Several studies about phytogenic additives in poultry nutrition were published, mainly about application of aromatic herbs like a cloves (**Isabel and Santos, 2009**), a rosemary (**Šperňáková *et al.*, 2007**), a cinnamon (**Ciftci *et al.*, 2010**), an anise (**Al-Kassie, 2008**), an oregano (**Fiková *et al.*, 2009**) and a salvia (**Hernandez *et al.*, 2004**).

The aim of the experiment was to determine the oxidative stability in the most valuable parts of chicken carcasses (Cobb 500 hybrid combination) during the

cold store (7 days) after application of phytogenic feed additives Agolin Poultry, Agolin Tannin Plus, Biostrong 150 + Fortibac and Agolin in their nutrition.

MATERIAL AND METHODS

Animals and diets

The experiment was undertaken in poultry test station Zamostie Company. The experiment started with 50 pieces of one-day-old hybrid chicks Cobb 500, which were divided into 5 groups (n=50): control (C) and 4 experimental groups (1st EG, 2nd EG, 3rd EG and 4th EG).

Experimental broiler chickens were fed during 42 days by *ad libitum* system with feed mixtures: BR1 starter feed mixture (until the 10th day of age), BR2 growth feed mixture (from 11th to 20th day of age), BR3 growth feed mixture (from 21st to 35th day of age) and BR4 final feed mixture (from 36th to 42nd day of age). Feed mixtures were produced with coccidiostats in powder form.

Nutritional value (Table 1) of feed mixture was the same in each group during the whole experiment. However, the diet of broiler chickens in experimental groups were supplemented by feed additives on base of acids and plant essential oils: Agolin Poultry at a dose of 100 mg kg^{-1} (1st EG); Agolin Tannin Plus at a dose of 500 mg kg^{-1} (2nd EG); Biostrong 510+FortiBac at a dose of 1000 mg kg^{-1} (3rd EG) and Agolin Acid at a dose of 1000 mg kg^{-1} (4th EG).

Sample analysis

Slaughtering and cutting of chickens were undertaken in the Department of animal products evaluation and processing. For each group, the samples of breast and thigh muscles were taken from six randomly selected chickens. Samples were stored in cold conditions at 4 °C during 7 days.

TBARS analysis

TBA value expressed in number of malondialdehyde (MDA) was measured in the 1st, 3rd, 5th and 7th storage day. TBA number was determined according to **Marcinčák *et al.* (2006)**. Absorbance of samples was measured at a wavelength of 532 nm on UV-VIS spectrophotometer T80 (PG Limeted Instruments, UK). Results were calculated as the amount of MDA in 1 kg of sample. The calibration curve obtained was as follows: y=2,744x-0,012; R2=0.9986.

Table 1 Composition of the basal feed mixtures

Ingredients (%)	Starter (1st to 10th day of age)	Grower I (11th to 20th day of age)	Grower II (21st to 35th day of age)	Finisher (36th to 42nd day of age)
Maize	46.33	48.50	50.05	50.91
Wheat	14.00	15.00	15.00	15.00
Soybean meal (45% CP[1])	30.00	26.60	28.00	26.70
Fish meal (72% CP[1])	2.50	2.00		
Dried blood	2.00	2.00		
Soybean oil	1.00	1.80	2.80	3.00
Monocalcium phosphate	1.60	1.25	1.30	1.48
Calcium carbonate	1.37	1.55	1.50	1.56
Fodder salt	0.20	0.30	0.35	0.35
Lysine	0.27	0.15	0.15	0.16
Methionine	0.27	0.18	0.17	0.20
Threonine	0.09	0.10	0.08	0.07
Vitamin premix	0.05	0.04	0.04	0.03
Micromineral premix	0.04	0.04	0.04	0.04
Enzyme phytase	0.015	0.015	0.015	0.015
Wheat meal	0.215	0.12	0.10	0.135
Maxiban (Narasin+Nicarbasin)	0.05			
Sacox (salinomycin sodium)		0.055	0.055	
Analyzed composition (g kg^{-1})				
Crude protein	220.00	207.00	197.00	188.00
Fibre	20.00	24.00	28.00	29.00
Lysine	14.00	12.50	12.50	11.50
Methionine	6.00	5.20	5.20	5.00
Ca	9.00	8.50	8.50	8.50
P (non-phytate)	4.20	4.00	4.00	4.00
Na	1.60	1.60	1.60	1.60
[2]ME_N (MJ kg^{-1})	12.30	12.75	13.15	13.15

Legend: [1]CP - Crude protein, [2]ME_N - Metabolizable energy

Statistical analysis

The results of experiment were assessed in statistical programme Statgraphics Plus version 5.1 (AV Trading, Umex, Dresden, Germany). The variable statistical values (arithmetic mean, standard deviation) were calculated. A variance analysis with subsequent Scheffé's test was used to determine the significant differences among groups.

RESULTS AND DISCUSSION

Degradation processes of fatty substances belong to the main causes of human food deterioration and this factor is responsible for the unpleasant odour, losses of taste, consistency, appearance and nutritional value in food and it increases drip loss and losses of pigment, fat-soluble vitamins, it reduces the quality of meat intended for human consumption and then the stability, storability and safety of meat is reduced (**Avila Ramos *et al.*, 2013)**. Results of oxidative stability in stored breast and thigh muscles of Cobb 500 broiler chickens (4 °C / 7 days) are recorded in the table 2. MDA is the main secondary product of polyunsaturated fatty acids breakdown and low MDA values indicate oxidative stability. MDA values after carcass processing and one day of cold store were low in all samples regardless of the group, which is in accordance with the findings of **Marcinčák *et al.* (2010)**. In all groups, we recorded the gradual increase of MDA in breast and thigh muscles during the cold store compared to 1st storage day. Obtained results are in accordance with statements of other authors **(Onibi and Osho, 2007; Imik *et al.*, 2010; Rahimi *et al.*, 2011)**, who found gradual decreasing of chicken meat oxidative stability during the storage in cooling or freezing conditions. We evaluated the oxidative stability of Cobb 500 hybrid combination broiler chicken meat at the end of cold storage (7th day) and in the breast muscle, we recorded the higher MDA values ($P<0.05$) and lower oxidative stability in control group (0.157 mg kg^{-1}) compared to experimental groups (from 0.124 mg kg^{-1} in the 3rd EG to 0.133 mg kg^{-1} in the 1st EG). Between the MDA values in the experimental groups, very low variability was found. Similar tendency of oxidative changes was found in the evaluation of thigh muscle. At the end of cold storage (7th day), higher MDA average values ($P<0.05$) and lower oxidative stability was recorded in the thigh muscle of control group (0.179 mg kg^{-1}) compared to experimental groups (from 0.136 mg kg^{-1} in the 4th EG to 0.141 mg kg^{-1} in the 1st EG). Evaluating of thigh muscle

oxidative stability showed significant (P<0.05) between the control and experimental groups from the 5th storage day. Higher content of MDA in thigh muscle compared to breast muscle was caused by the higher fat content in the thigh muscle. Similar findings were achieved by **Botsogolou *et al.* (2007)**, who stated, that higher antioxidants concentration in poultry meat results in decreasing of lipid oxidation and subsequently the TBARS value in cooling and freezing conditions. It was confirmed in the evaluation of Coob 500 chicken breast and thigh muscles by this experiment, too. **Mikulski *et al.* (2009), Ahadi *et al*. (2010), Marcinčák *et al*. (2010)** and **Karaalp and Genc (2013)** pointed out to possibility of various alternative feed additives application in chicken nutrition, mainly of the additives, which contain various antioxidant active substances and then stop the degradation changes of fatty substance in poultry nutrition and increase oxidative stability of meat during the cooling and freezing storage.

Table 2 Effect of cold store (4 ºC) on the concentration of MDA (malondialdehyde; mg kg^{-1}) in breast and thigh muscle after feeding of Cobb 500 broiler chickens

Time of storage	C	1st EG	2nd EG	3rd EG	4th EG
Breast muscle					
1st	0.108±0.009[a]	0.101±0.010[a]	0.098±0.008[a]	0.099±0.007[a]	0.100±0.015[a]
3th	0.124±0.016[a]	0.117±0.014[a]	0.115±0.011[a]	0.112±0.016[a]	0.118±0.011[a]
5th	0.141±0.014[a]	0.126±0.010[a]	0.123±0.009[a]	0.126±0.019[a]	0.128±0.013[a]
7th	0.157±0.010[a]	0.133±0.013[b]	0.130±0.011[b]	0.124±0.004[b]	0.127±0.012[b]
Thigh muscle					
1st	0.129±0.013[a]	0.125±0.011[a]	0.120±0.008[a]	0.118±0.008[a]	0.120±0.004[a]
3th	0.143±0.006[a]	0.128±0.017[a]	0.130±0.015[a]	0.126±0.015[a]	0.129±0.016[a]
5th	0.163±0.018[a]	0.137±0.017[b]	0.132±0.011[b]	0.131±0.007[b]	0.132±0.009[b]
7th	0.179±0.021[a]	0.141±0.015[b]	0.138±0.012[b]	0.137±0.012[b]	0.136±0.012[b]

Legend: Mean values in the same columns with different superscripts (a, b) are significantly different at P<0.05 level

CONCLUSION

In the experiment, we applied phytogenic additives (Agolin Poultry, Agolin Tannin Plus, Biostrong 510 + FortiBac and Agolin Acid) in the nutrition of Cobb 500 hybrid combination chickens and evaluated their influence on oxidative stability of breast and thigh muscles stored by cooling at 4 °C during 7 days. Obtained results showed the positive influence of phytogenic additives application on decreasing of oxidation processes in the chicken breast and thigh muscles during the whole storage period. Significant differences (P<0.05) of MDA values between the control and experimental groups were found in the breast muscle at the end of testing (in the 7th day of storage) and in the thigh muscle from the 5th day of storage. The phytogenic additives applied in chicken nutrition in this experiment have the influence on the stabilization of chicken meat fatty substance against the degradation processes of lipids.

Acknowledgments: This work was supported by grant VEGA č. 1/0630/13 and VEGA 1/0129/13.

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