CHARACTERISTICS OF TURKEY BREAST MEAT SHOWING DIFFERENT SIGNS OF BURSITIS AND ASCITES

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Received for publication April 15, 2010

Abstract

The amounts of biogenic amines (putrescine, histamine, cadaverine, tyramine, spermidine, and spermine), lactic acid, pH, and number of Enterobacteriaceae, Escherichia coli, and coagulase producing Staphylococci were determined in healthy turkeys and in the fillets of turkey breasts with the signs of ascites and bursitis. The examination of the amines was performed by high performance liquid chromatography; the amount of lactic acid was determined by capillary isotachophoresis method; pH value and microbiological indicators – by standardised methods. All determinations were done after 24, 72, and 120 h after slaughter of the turkeys. The fillets of the breasts were stored in the refrigerator at 4°C. The significant differences in the total amounts of biogenic amines in carcasses of healthy turkeys and carcasses of turkeys with substantial lesions of bursitis and medium or substantial lesions of ascites were determined within 5 d after slaughter (P<0.001). The amounts of biogenic amines in the breast fillets of turkeys with low lesions of ascites and bursitis were very similar to that of the control group during the whole period of maturation. The average amount of lactic acid throughout 5 d after slaughter increased only in the breast fillets of healthy turkey (maximum value was 1.032 mg/100 g) and insignificantly increased in the carcasses with low lesions of ascites and bursitis (maximum value was 0.983 mg/100 g). The results of investigation indicate the breast fillets of turkeys with medium and substantial lesions of ascites and substantial lesions of bursitis are not fit for human consumption. However, in the cases of low lesions of ascites and low and medium lesions of bursitis, the fillets are not fit for maturation, but could be thermally processed in the period of 24 h after slaughter.

Key words: turkey meat, biogenic amines, lactic acid, ascites, bursitis.

Nowadays, in order to get rapid increment in the production of turkey carcasses, the intensive feeding is in use. The density of birds in the flock is high. Therefore, birds are more passive, tending to sit on the ground for a longer time, which causes the increase in occurrence of ascites and bursitis cases.

Bursitis is characteristic to breeds growing fast and having a high body weight (11, 19, 20). Numerous factors, beside genetic ones, such as: flock density, bedding quality, mode of illumination, and others have impact on the formation of lesions on poultry breast skin (12, 18). Genetic factors, conditions of handling, feeding, and others could also be indicated as causes of ascites (2, 4, 7). Rupture of aorta and cardiomyopathy, which causes sudden death, are subsequent consequences of ascites in turkeys (15, 16).

A considerable consumption of nutrients causing metabolism disorder may lead to diseases of the cardiovascular system, as well as defects of the musculoskeletal system in turkeys. Depending on the physical conditions of turkeys and attenuation due to the disease and stress, the resources of glycogen in the muscles may be used up even before slaughter, therefore, the meat is not fit for storage and maturation. Because of intoxication, as for example in the cases of ascites, the carcasses and products are not fit for human consumption.

Potentially toxic biogenic amines may accumulate in the raw meat depending on its quality, chemical composition, parameters, which determine initial maturation process: accumulated (stored) adenosine-triphosphate, level of glycogen, potency of the meat fermentation system, contamination with the microorganisms, storage conditions. The levels of biogenic amines in the raw meat are usually lower compared to matured meat. Usually the level of biogenic amines in diseased, cachectic animals is lower compared to healthy animals (5). Formation of putrescine has been determined to be stimulated by activity of bacteria during processing and improper storage of meat products, while spermidine and spermine get into the products from raw materials (17). A number of scientists underline correlation of meat quality with the accumulation of aliphatic amines in the meat: putrescine.
and cadaverine are known to correlate with microbiological spoilage of the meat, storage temperature, and time (6, 9, 10); the accumulation of tyramine correlates with the enzymatic activity of lactobacteria (1, 21). In order to create efficient prevention system of biogenic amines, scientists continue the research on causes of formation of biogenic amines in the raw meat, because safety of end products depends on the quality and safety of the primary raw material. Frequently, low lesions of ascites or bursitis are found in turkeys, which appear to be healthy, only during postmortem examination. In such cases, after removing the slight lesions, the turkey meat is accepted as suitable by sensorial evaluation and delivered for further processing.

The aim of the study was to evaluate whether the breast fillets of turkeys affected by ascites and bursitis are suitable for human consumption. The evaluation was based on the test results of biogenic amines, lactic acid, and microbiological criteria during maturation period.

Material and Methods

Postmortem examinations of 33,580 turkey carcasses were performed in the slaughterhouse. For the survey, turkeys of the same breed (BIG-6, age of 146 d, males) and raised in the same farm were selected. The turkeys were slaughtered on the same day, under the same conditions. After postmortem examination, the carcasses were divided into the following bursitis (B) or ascites (A) groups: CB group (3,043 carcasses) – control group, no lesions; IB group (6,878 carcasses) – slight lesions of bursitis – a little fluctuation in the area of breastbone, absent or very small round, absence of any calluses; IIB group (4,334 carcasses) – medium lesions of bursitis – round of a fist size with fluctuation or already hardened round, but of 10–20 mm in size; IIIB group (2,654 carcasses) – substantial lesions of bursitis – round of two fists in size with fluctuation or already hardened round, but of more than 25 mm in size; CA group (3,228 carcasses) – control group, no lesions; IA group (5,783 carcasses) – slight lesions of ascites – a little volume of clear fluid in the abdomen and in the sacks of peritoneum, clear fluid in the cardiac sack, rounded heart; IIA group (4,044 carcasses) – medium lesions of ascites – high volume of fluid with threads of fibrin in the abdomen, the cardiac sack thickened and filled with fluids, the heart is hypertrophied, the right ventricle and auricle enlarged, liver enlarged, haemorrhagic with adipose infiltration; IIIA group (3,616 carcasses) – substantial lesions of ascites – high volume of fluids with flakes of fibrin in the abdomen, formation of fibrin in the abdomen, serous involucres conglutinated, the cardiac sack thickened and filled with fluids, the heart hypertrophied, the right ventricle and auricle enlarged, the liver overgrown with connective tissue, the capsule of the liver opaque and thickened, parenchyma of the liver hard, fragile, with bruising and necrosis foci.

From each group, 18 samples of breast fillets (size of the sample – at least half of the fillet of turkey breast) were taken. The physico-chemical and microbiological parameters were evaluated at 24, 72, and 120 h after slaughter under the aerobic condition storage at 4ºC.

Quantitative determinations of biogenic amines (BA): putrescine (PUT), histamine (HIS), cadaverine (CAD), tyramine (TYR), spermidine (SPMD), and spermine (SP) were done by HPLC method. The samples were homogenised and the amines were extracted using perchloric acid of 0.4 mol/L. A part of the extract was derivatised for 45 min by 5-dimethylaminonaphtalene-1-sulfonylechloride at 40ºC. After the derivatisation, the samples were cooled down to room temperature and the remains of dansylchloride in the samples were removed using ammonia (25%). The samples were filtered through a filter of 0.45 µm, injected into the column (20 µl), and analysed by HPLC system using UV detector at wavelength of 245 nm. The identification of the substances was done on the basis of the comparison of suspension period of each biogenic amine under determination with the period of suspension of each reference material of biogenic amines. Quantitative determinations were done according to the method of internal standard by calculating area of peak for defined quantity of the reference material.

The lactic acid was determined by capillary isotachophoresis method using an analyser of capillary isotachophoresis EA 102 (VILLA LABECO, Slovakia). The lactic acid was extracted from meat with distilled water; then the extract was filtered and the solution was used for determinations. The system of electrolytes: mobile electrolyte (LE) 5 mM HCl + 15 mM β-alanine + 0.1% M-HEC (methyl hydroxethylcellulose), pH 3.2; terminator (TE) 5 mM caproic acid + TRIS. The conditions of analysis: V=30 µl, I1=200 µA, I2=50 µA, dilution of the sample 1: 200. The concentration of lactic acid was calculated from calibration curve using ITTPro software.

All above mentioned parameters were calculated from the results of two repeated analysis, and the standard deviation was calculated. Microbiological parameters and pH were determined using the following standardised methods: the number of Enterobacteriaceae in 1 g was determined according to LST ISO 21528-2:2009, the number of Escherichia coli in 1 g according to LST EN ISO 6888-1+A1:2005, the number of coagulase positive Staphylococci in 1 g was determined according to LST EN ISO 6888-1+A1: 2005, and pH – according to ISO 2917:1999.

Statistical evaluation of the data was done using SPSS 13.0 for Windows software. The results of the experiment are presented as mean values (x) and standard deviations (±SD).

Results

Significant differences of biogenic amines levels in the fillets of turkey breasts were demonstrated between groups IIB, IIIA, and IA and control groups (with no changes in the meat) within 5 d after slaughter (P<0.05). In groups IA, IB, and IIB total levels of
Biogenic amines were very similar to the levels in control groups CA and CB during the whole period of maturation (Fig. 1).

In the case of ascites, the highest level of putrescine (726.4 ±14.5 mg/kg) and spermidine (507.0 ±10.1 mg/kg) was determined in group IIIA within 24 h after slaughter (Table 1). In the case of pathological bursitis, the average levels of putrescine (204.1±4.1 mg/kg) and spermine (184.5±3.6 mg/kg) were significantly higher in group IIIB compared to those of other biogenic amines. Total levels of biogenic amines in the fillets of groups IIIA and IIIB were significantly higher compared to the levels of biogenic amines determined in the control groups and in the groups with lower degree of lesions (P<0.05).

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Fig. 1. The dynamics of formation of biogenic amines (BA) in the fillets of turkey breasts with lesions and without lesions during 120 h after slaughter.

Fig. 2. The formation of lactic acid in the fillets of turkey breasts during 120 h after slaughter.

Fig. 3. The average values of pH in the fillets of turkey breasts during 120 h after slaughter.
Fig. 4. The average number of bacteria in the fillets of turkey breasts with or without bursitis within 24 h after slaughter.

Fig. 5. The average number of bacteria in the fillets of turkey breasts with or without ascites within 24 h after slaughter.

During 5 d after slaughter, the average level of lactic acid increased only in the fillets in the control groups ranging from 0.737 mg/100 g to 1.019 mg/100 g and in group IB – from 0.720 mg/100 g to 0.983 mg/100 g. In group IB (bursitis) a slight increase in the level of lactic acid on day 3 after slaughter was noted, but later it stabilised (Fig. 2). In other groups of turkeys, which had more severe signs of ascites and bursitis, the levels of lactic acid varied insignificantly.

During maturation, the average values of pH of fillets of group IIIB decreased insignificantly (from 5.85 to 5.78); the pH in group IIA ranged from 5.79 to 5.77, being significantly higher in comparison to the values in the control groups (P<0.05), (Fig. 3). However, in group IIA (with ascites), though the level of lactic acid was not reported to increase significantly within 5 d after slaughter, the value of pH considerably decreased.

Microbiological parameters such as the numbers of *Enterobacteriaceae* and *Escherichia coli* in 1 g depended on the severity of both pathologies (Figs 4 and 5). In the cases of ascites, coagulase positive *Staphylococci* were detected in group IIA with values up to 1.3 lg CFU/g and in group IIIA with the values up to 3.0 lg CFU/g. In the cases of bursitis, coagulase positive *Staphylococci* were detected only in group IIIB with the values up to 3.3 lg CFU/g.

**Discussion**

Composition of fillets of turkey breasts has an unfavourable relation to capillary density. This implicates that the oxygen supply to the muscle of chickens with a high muscularity can be at a risk, which might affect peri-mortem processes determining meat quality (14). A diminished oxygen supply to the muscle may have negative consequences for pre- and post-slaughter muscle metabolism and thus, for the meat quality. The assumption is that in chickens with a reduced capillary network, the peri-mortem formed lactate will be removed more slowly by the capillaries, after slaughter resulting in faster pH-decline, an increased likelihood of paler colour, and reduced water holding capacity. The breast muscle in chicken is entirely composed of fast glycolytic fibres, so the distribution of fibre type plays no role (22). Growth performance can influence the rate and extent of rigor development in the meat. Dransfield and Sosnicki (8) stated that due to a rapid pH-decline in the pectoral muscle, there is a potential detrimental pale, soft, and exudative (PSE) like effect of fast growing lines. Our investigations indicate that in the fillets of the turkey breasts with medium and significant lesions of bursitis, the meat had no signs of PSE syndrome; pH values were
significantly higher compared to the levels of the control groups. The formation of lactic acid was limited in the 5 d period after slaughter. The results of our investigations indicate that in the cases of the tested pathologies, the meat is not likely to have signs of dark, firm, and dry (DFD) syndrome.

In the case of bursa inflammation in the chest, we refer to a limited enlargement of the bursa with the chest skin inflammation. Secondary infection may result because of such pathogens as Salmonella sp., Pasteurella sp. E. coli, Streptococcus sp., Staphylococcus sp., and Mycoplasma sp. (3, 12, 13). Noll and Kamyab (20) showed that only a small percentage (9%) of bacteriologically tested breast bursa bacteriological changes were positive. Our study showed that a secondary infection was in the case of bursal disease in group IIB and in the case of ascesis in groups IIA and IIIA, especially influenced by coagulase positive staphyloccoci, and this led to a significant increase in total amount of biogenic amines during 5 d period after slaughter. Coagulase positive staphyloccoci were not found in group IIB (in the cases of bursitis with average changes and a lower pH value) as well as in the tested carcasses of other groups (with small pathological lesions).

The turkey carcasses showing ascesis of levels II and III and carcasses showing bursitis of level III were not fit for human consumption. The fillets of II and III and carcasses showing bursitis of level III (small pathological lesions). Asceis of level I and II were not found in group IIB (in the cases of ascites with slight lesions). Considering the post-mortem examination does not indicate that meat of affected turkeys has signs of DFD syndrome.

Depending on the levels of ascesis and bursitis lesions, the turkey meat could be:
- directed for production as canned or boiled meat products in the cases of level I and II bursitis and in the case of level I ascesis,
- utilised in the cases of level III bursitis and level II and III ascesis.

Post-mortem examination in the case of the industrial slaughter increases the possibility of unnoticed ascesis disease with slight lesions. Considering the European Union Commission Regulation (EU) Nr 854/2004 carcass must be recovered (utilised) regarded less of the severity of ascesis lesions. However, the ascesis disease may have different signs and affect different carcass quality changes. Haarmann (13) distinguishes the two cases of avian ascesis, when one of the causes is disturbance of heart function, but the carcass remains without significant liver damage and increased bacteriological contamination. Our results suggest that mistake in the case of ascesis disease with slight lesions observed during post-mortem examination does not cause the risk to human health.

The obtained results in cases of bursitis disease confirm the EU's legislative regulation for carcass evaluation, where removal of localisation alteration is possible, and the carcass remains suitable for recycling.

References