The effect of a housing system in slaughter turkeys on mechanical damage to carcass and meat quality

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ABSTRACT: The aim of the experiment was to find out whether the housing of Polish white broad-breasted heavy type turkeys J-22 on slatted floor (group I) and litter floor (group II) has an effect on the final body weight, body weight loss during transportation, mechanical damage to carcass and physical and chemical properties of breast meat. The turkeys were kept in controlled environment: turkey hens for 16 weeks (group I – 29 birds; group II – 30 birds) and turkey cocks for 23 weeks (group I – 21 birds; group II – 28 birds) in compliance with the parameters recommended for this species. The turkey cocks kept on the slatted floor made of metal mesh had lower final body weight (11 929 g), higher body weight losses during transportation (2.41%) and higher number of birds with damaged carcasses (95%) in comparison with the turkey cocks kept on the litter floor (13 307 g, 1.94% and 54%, respectively). Moreover, higher levels of lactic acid (turkey hens 119.83 μM/g; turkey cocks 148.09 μM/g) and larger juice area (6.5 cm^2, 8.27 cm^2, respectively) in breast meat after slaughter were found in the turkeys of both sexes kept on the slatted floor compared to the turkeys kept on the litter floor (108.79 μM/g and 6.25 cm^2, respectively for turkey hens and 128.29 μM/g and 5.23 cm^2, respectively for turkey cocks). The values of meat pH_1, pH_2 and pH_3 for all the groups were typical of good quality meat and ranged between pH_1 6.22–6.27, pH_2 5.85–6.06 and pH_3 5.55–5.64. However the production performance results indicate that the housing of heavy turkeys on slatted floor is not recommended.

Keywords: turkeys; losses; type of floor; mechanical damage; meat quality

Turkey selection for fast growth, high feed conversion ratio and high body weight results in the imbalance between the muscle growth rate and their physiological capacity (Siller, 1985; Sosnicki and Wilson, 1991). Any stress experienced by birds during their life and pre-slaughter handling can disturb the transformation processes occurring in muscles after slaughter (Henckel, 1992). Poultry housing on slatted floors is one of the factors that may cause carcass damage. Turkey legs can also be damaged by disturbances in the skeletal and muscular systems, improper diet or genetic traits. Damaged legs are most frequently observed in the heaviest and fastest growing birds and those originating from populations selected for maximum body and breast muscle weight (Andrews *et al*., 1990; Ferket, 1992; Muirhead, 1992). On the other hand, breast tumours and blisters occur both in birds kept on slatted floors and in birds kept on litter floors (McEwan and Barbut, 1992; Muirhead, 1992).

The aim of this experiment was to determine the effect of the housing of heavy-type turkeys on different floors (slatted and litter) on the production performance, carcass mechanical damage and meat quality.

MATERIAL AND METHODS

The experimental material was Polish white broad-breasted heavy type turkeys J-22: hens (16-week-old) and cocks (23-week-old). The birds were kept on two different types of floor:
group I – slatted, made of metal mesh (wire thickness 3 mm, mesh size 20 × 20 mm), (29 turkey hens and 21 turkey cocks);
group II – litter, made of straw litter (30 turkey hens and 28 turkey cocks).

The birds were kept in controlled environmental conditions in compliance with the husbandry technology presented by Faruga and Jankowski (1996).

The animal hygiene control included the temperature and humidity, air contamination with dust and gas as well as the efficiency of the air conditioning system. The microclimate was measured indoors and outdoors according to the animal hygiene methodology (Dobrzański and Kołacz, 1996).

At the end of the rearing period, the turkeys were weighed individually and transported to a poultry plant, each time ensuring the same technical and organisational transportation conditions. The birds were transported in a vehicle with a standard battery consisting of 70 metal cages 30 × 60 × 90 cm. There were either 5 turkey hens or 3 turkey cocks in each cage.

The turkeys were weighed while unloaded and then slaughtered in compliance with the technology used in poultry plants. After slaughter and after roping, a sanitary inspector evaluated any damage to the carcasses that occurred during turkey rearing.

In order to determine the process taking place in the breast muscles after slaughter, the following parameters were determined in 10 birds from each group: lactic acid level (5 min *post mortem*), pH_1 (15 min *post mortem*), pH_2 (90 min *post mortem*) and pH_3 (24 h *post mortem*). Additionally, the reflectance and water-retaining capacity of breast muscle were evaluated. The samples of breast muscle for the determination of lactic acid were frozen in liquid nitrogen (–195.8°C) and stored at the temperature of –20°C for a period necessary to complete the analyses. The measurements of pH_1 and pH_2 were carried out in the right breast muscle at a depth of 5 cm (at a 3 cm distance from the end of the sternal dorsum and 5 cm to the right from its edge) with a radiometer type 29 ph-meter coupled with a combined electrode GK 2321C. Meat samples for laboratory analyses were taken from cooled carcasses 90 minutes after slaughter. The following sample analyses were completed twenty-four hours after slaughter:

– water-retaining capacity with the use of Grau and Hamm method modified by Pohja and Niinivaraa (1957);
– reflectance with a spectrophotometer SPECOL at the wavelength of 560 nm, using a remission adapter R45/0 – according to the Różyczka *et al*. method (1968);
– final acidity pH_3 in the water homogenate of a disintegrated sample (PN-77/A – 82058).

The lactic acid level was determined by a colorimetric method by oxidising lactic acid to acetic aldehyde, which with hydroquinone gives a colour reaction. Colour intensity was measured with a spectrocolorimeter SPEKOL at the wavelength of 438 nm.

Because the slaughtered turkeys were of different age, the results were statistically analysed separately for turkey hens and for turkey cocks using the *Statisica Pl* software. The arithmetic means ($\bar{x}$), standard deviations (S) and coefficients of variation (v %) were calculated and the significance of differences was determined by a single-factor analysis of variance in the ortho- and unorthogonal systems with the use of Duncan's test.

RESULTS AND DISCUSSION

The macro- and micro-climate characteristics throughout the whole period of turkey rearing are given in Table 1. All the pens were located in the same building and only small differences in the microclimate characteristics were observed between the two types of floor. Slatted-floor pens were found to have slightly lower average air temperature (22.9°C), lower NH_3 concentration (13.78 ppm), slightly higher relative humidity (63.8%), higher cooling rate (21.1 mW/cm^2) and higher CO_2 concentration (0.101%) in the air in comparison with the litter floor. On the other hand, the dust concentration in the air above the slatted floor (147.2 part/cm^3) was statistically lower ($P \leq 0.01$) than above the litter floor (299.4 part/cm^3). Although the environmental conditions of housing varied, they complied with the recommended parameters for this turkey group.

The average body weight of turkey hens kept on the slatted floor was 263 g higher in comparison with the turkey hens of group II, however, this difference was statistically insignificant (Table 2). On the other hand, the effect of slatted floor on the body weight of turkey cocks was more marked as they were 1 378 g lighter than the birds kept on the litter floor. The body weight losses occurring during transportation were 0.52% higher in turkey hens of group II than in the hens kept on the slatted floor. A reverse trend was found in the turkey cocks.

The turkeys kept on the slatted floor had a statistically significantly higher level of lactic acid than the turkeys kept on the litter floor. This was found both in the turkey hens ($P \leq 0.05$; 119.83 and 108.79 μM, respectively for the slatted and litter floor) and in the turkey cocks ($P \leq 0.01$; 148.09 and 128.29 μM, re-

Table 1. Bioclimatic characteristics during turkey rearing

Specification	Statistical variables	Outside	Group I – slatted	Group II – litter
Temperature (°C)	$\bar{x} \pm S$	12.7 ± 5.3	22.9 ±3.8	23.3 ± 3.2
	v (%)	41.73	16.99	13.73
Relative humidity (%)	$\bar{x} \pm S$	52.6 ± 11.2	63.8 ± 13.7	62.2 ± 12.4
	v (%)	21.29	21.47	19.94
Cooling (mW/cm^2)	$\bar{x} \pm S$	54.4 ± 25.3	21.1 ± 4.6	20.5 ± 4.3
	v (%)	46.51	21.80	20.98
Air flow (m/s)	$\bar{x} \pm S$	1.41 ± 1.48	0.22 ± 0.13	0.21 ± 0.14
	v (%)	104.96	59.09	66.67
Amount of dust (part/cm^3)	$\bar{x} \pm S$	–	147.2 ± 63.1	299.4** ± 106.3
	v (%)		42.87	35.50
Concentration of NH_3 (ppm)	$\bar{x} \pm S$	–	13.78 ± 1.32	14.67 ± 1.60
	v (%)		9.58	10.91
Concentration of CO_2 (%)	$\bar{x} \pm S$	–	0.101 ± 0.035	0.096 ± 0.044
	v (%)		34.64	45.83
Size of ventilation (m^3/h/kg)	$\bar{x} \pm S$	–	0.93 ± 0.38	
	v (%)		40.86	

$^{**}P \leq 0.01$

spectively for the slatted and litter floor). The higher level of lactic acid measured in the muscle just after slaughter in the turkeys of group I suggests that the pre-slaughter procedure was somewhat more stressful for them.

Pingel and Birla (1982) and Gardzielewska (1990) claimed that although the rearing conditions did not have a direct effect on the processes after slaughter, they could cause higher susceptibility to the pre-slaughter stress and deviations in the course of glycolysis. Sosnicki and Wilson (1991) reported that during industrial slaughter, the final acidity of 5.7 was obtained even 30–60 minutes after slaughter. Therefore, the physiological state of the muscles is very important during slaughter. Later on, the cooling process is significant in retarding the acidity rate (Henckel, 1992). There was not found any correlation between the floor type and the rate of glycolysis in turkey breast muscles and the obtained values of pH_1, pH_2 and pH_3 fell into the range considered acceptable for poultry muscles (Trojan and Niewiarowicz, 1971; Niewiarowicz, 1985). The turkeys of group I had meat lighter in colour than the birds kept on the litter floor. This difference was statistically significant for the turkey hens ($P \leq 0.05$). In addition, the turkeys kept on the slatted floor exhibited larger juice area in breast meat than the turkeys kept on the litter floor. The differences between the turkey cock groups were highly statistically significant.

The level of lactic acid was statistically significantly higher in turkeys kept on the slatted floor (group I) than in turkeys kept on the litter floor, however, no such correlations were observed in the meat acidity or in the values of pH_1, pH_2 or pH_3. On the other hand, group I had considerably lower water-retaining capacity than group II ($P \leq 0.01$). This suggests that the high level of lactic acid caused an excessive denaturation of sarcoplasm proteins, which in consequence resulted in higher water-retaining capacity in this group of turkeys. Many authors report that it is difficult to present a simple correlation between the qualitative properties of poultry meat and to carry out a proper qualitative analysis (Richardson, 1995; Szałkowska and Meller, 1998; Van Laak *et al.*,

Table 2. Body weight, body weight losses after transportation, and physical and chemical properties of breast muscle of slaughter turkeys

Specification	Statistical variables	Turkey hens		Turkey cocks	
		Group I	Group II	Group I	Group II
		Slatted	Litter	Slatted	Litter
Body weight (g)	$\bar{x} \pm S$	7 176 ± 727	6 913 ± 627	11 929 ± 1 642	13 307 ± 1 872
	v (%)	10.13	9.07	13.76	14.07
Body weight loss (%)	$\bar{x} \pm S$	2.43 ± 1.77	2.95 ± 2.14	2.41 ± 1.49	1.94 ±.22
	v (%)	73.04	72.60	61.94	63.38
Lactic acid (μM/g)	$\bar{x} \pm S$	119.83* ± 14.42	108.79 ± 6.83	148.09** ± 13.50	128.29 ± 13.79
	v (%)	12.03	6.28	9.12	10.75
pH_1 (15 min *post mortem*)	$\bar{x} \pm S$	6.26 ± 0.29	6.26 ±0.25	6.22 ± 0.15	6.27 ± 0.26
	v (%)	4.63	3.99	2.41	4.15
pH_2 (90 min *post mortem*)	$\bar{x} \pm S$	6.06 ± 0.33	6.00 ± 0.21	5.88 ± 0.16	5.85 ± 0.24
	v (%)	5.45	3.50	2.72	4.10
pH_3 (24 h *post mortem*)	$\bar{x} \pm S$	5.55 ± 0.08	5.59 ± 0.08	5.62 ± 0.05	5.64 ± 0.08
	v (%)	1.44	1.43	0.89	1.42
Reflectance (%)	$\bar{x} \pm S$	34.16* ± 2.57	31.98 ± 1.56	28.61 ± 4.51	27.41 ± 5.01
	v (%)	7.52	4.88	15.76	18.28
Water-retaining capacity (cm^2)	$\bar{x} \pm S$	6.50 ± 0.35	6.25 ± 0.40	8.27** ± 1.52	5.23 ± 1.28
	v (%)	5.54	16.00	18.28	19.12

*$P \leq 0.05$; **$P \leq 0.01$

2000; Owens *et al*., 2000; Owens and Sams, 2000). It is so because many stress factors known as pre-slaughter stress syndrome (e.g. transportation duration, year season, temperature, waiting period before unloading, etc.) have an effect on post-slaughter glycolysis. The effect of these factors on the poultry meat quality is not only through the modification of glycolysis but they can also have an indirect influence on the meat quality through an effect on the hypothalamic-hypophysial-adrenaline complex and vascular system (Skrabka-Błotnicka, 1996).

The carcass assessment by a sanitary inspector after slaughter indicated numerous body lesions and injuries that occurred during rearing. Generally, different types of carcass damage were found in the group of turkeys kept on the slatted floor (group I): in 45% of turkey hens and in 95% of turkey cocks, however, in group II kept on the litter floor injuries were found in 17% of turkey hens and in 54% of turkey cocks. Sternal (bedsore muscles and breast blisters) and leg (bruises, inflammations on thighs and second thighs and swelling and deformations of tarsal joints) lesions were found in the experimental turkeys. The turkey hens did not experience bedsore muscles, whereas this lesion occurred in 19.1% and 17.9% of the turkey cocks of group I and group II, respectively (Table 3). The type of floor had a clear effect on the breast blisters. Their incidence was 13.8% in the turkey hens and as much as 47.6% in the turkey cocks both kept on the slatted floor in comparison with the incidence of 3.3% in the turkey hens and 7.1% in the turkey cocks kept on the litter floor. A similar trend was observed in lesions in the legs. Among the birds kept on the slatted floor, 9.5% had the lesions of thighs and second thighs and 85.7% had lesions in tarsal joints and toes. However, among the turkeys of group II these lesions occurred only in 7.1% and 17.9% of birds, respectively. The turkey hens were considerably less susceptible to the damaging effect of the slatted floor due to their shorter rearing period and lower body weight and the prevalence of leg lesions did not exceed 7%.

Table 3. The incidence of mechanical damage to turkey carcasses during rearing (%)

Specification	Sex	Group I – slatted	Group II – litter
Bedsore sternum	turkey hens	–	–
	turkey cocks	19.1	17.9
Breast blisters	turkey hens	13.8	3.3
	turkey cocks	47.6	7.1
Bruises and inflammations on thighs and second thighs	turkey hens	6.9	–
	turkey cocks	9.5	7.1
Swelling and deformations of tarsal joints and toes	turkey hens	3.5	–
	turkey cocks	85.7	17.9

Based on the presented data, both types of flooring – slatted and litter – caused damage to the carcasses. These observations were confirmed by experiments of other authors (Hester *et al*., 1987; Andrews *et al*., 1990; Ferket, 1992; McEwan and Barbut, 1992; Muirhead, 1992). They also found a higher incidence of mechanical damage to the carcasses of turkeys kept on the slatted floor.

CONCLUSION

The turkey cocks kept on the metal wire mesh (group I) were 1 378 g lighter, had higher body weight losses during transportation and a greater prevalence of carcass damage than those kept on the litter floor. Moreover, the birds of both sexes kept on the slatted floor exhibited higher concentrations of lactic acid and larger juice area in breast muscles after slaughter. Although the obtained meat quality indicators are generally typical of good quality products, the above described trends and production results suggest that the housing of heavy turkeys on a slatted floor is not recommended.

REFERENCES

Andrews L.D., Whiting T.S. Stamps L. (1990): Performance and carcass quality of broilers grown on raised floorings and litter. Poultry Sci., *69*, 1644–1651.

Dobrzański Z., Kołacz R. (1996): Przewodnik do ćwiczeń z zoohigieny. AR Wrocław. 188 pp.

Faruga A., Jankowski J. (1996): Indyki. Hodowla i użytkowanie. PWRiL, Warszawa. 250 pp.

Ferket P.R. (1992): Leg problems in turkey toms. Influence of nutrition and management. Turkeys, *40*, 21–26.

Gardzielewska J. (1990): Effect of environmental conditions on performance and meat quality of broiler chickens. Zesz. Nauk. Drob., *7*, 61–70.

Henckel P. (1992): Properties of muscle fibre types as a source of variation in meat quality. In: XIX World's Poultry Congress, Amsterdam, Suppl., 87–92.

Hester P.Y., Sutton A.L., Elkin R.G. (1987): Effect of light intensity, litter source, and litter management on the incidence of leg abnormalities and performance of male turkeys. Poultry Sci., *66*, 666–675.

McEwen S.A., Barbut S. (1992): Survey of turkey downgrading at slaughter: carcass defects and associations with transport, toenail trimming, and type of bird. Poultry Sci., *71*, 1107–1115.

Muirhead S. (1992): Slotted floor in turkey barn reduces ammonia, improves bird health. Feedstuffs, *64*, 12.

Niewiarowicz A. (1985): Światowe i krajowe osiągnięcia naukowe z zakresu technologii drobiarskiej. Gosp. Mięs., *3*, 12.

Owens C.M., Sams A.R. (2000): The influence of transportation on turkey meat quality. Poultry Sci., *79*, 1204–1207.

Owens C.M., Hirschler E.M., McKee S.R., Martinez-Dawson R., Sams A.R. (2000): The characterization and incidence of pale, soft, exudative turkey meat in commercial plant. Poultry Sci., *79*, 553–558.

Pingel H., Birla M. (1982): Untersuchungen zur Fleischbe Beschaffenheit. Geflügel. Arch. Tierzucht, *25*, 65–70.

Pohja N., Niinivaraa F.P. (1957): Die Bestimmung der Wasserbindung des Fleischesmittels der Konstantdrückmethode. Fleischwirtschaft, *9*, 193–195.

Richardson I. (1995): Poultry meat for further processing. In: XII European Symposium on the Quality of Poultry Meat, Zaragoza (Spain),. 351–361.

Różyczka J., Kortz J., Grajewska-Kołczyk S. (1968): A simplified method of objective measurement of colour in fresh pork meat. Rocz. Nauk. Rol. B, *3*, 345–353.

Siller W.G. (1985): Deep pectoral myopathy: A penalty of successful selection for muscle growth. Poultry Sci., *64*, 1591–1595.

Skrabka-Błotnicka T. (1996): Czynniki przedubojowe wpływające na jakość cech technologicznych mięsa i przetworów drobiowych. Mag. Drob., *5*, 43–45.

Sosnicki A.A., Wilson B.W. (1991): Pathology of turkey skeletal muscle: implications for the poultry industry. Food Struct., *10*, 317–326.

Szałkowska H., Meller Z. (1998): The occurrence of PSE and DFD in the meat of chicken broilers. Zesz. Nauk. PTZ, *36*, 343–347.

Trojan M., Niewiarowicz A. (1971): Method of identifying of watery broiler chicken meat and observations on the frequency of this anomaly. Post. Drob., *13*, 47–50.

Van Laack R.L.J.M., Liu C.-H., Smith M.O., Loveday H.D. (2000): Characteristics of pale, soft exudative broiler meat. Poultry Sci., *79*, 1057–1061.

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ABSTRAKT

Vliv způsobu odchovu jatečných krůt na mechanické poškození jatečných trupů a na kvalitu masa

Cílem pokusu bylo zjistit, zda má odchov polských bílých širokoprsých krůt těžkého typu J-22 na roštové podlaze (I. skupina) a na podestýlce (II. skupina) nějaký vliv na konečnou tělesnou hmotnost, ztrátu hmotnosti během přepravy, mechanické poškození jatečného trupu a na fyzikální a chemické vlastnosti prsní svaloviny. Odchov probíhal v regulovaném prostředí: u krůt po dobu 16 týdnů (I. skupina – 29 jedinců; II. skupina – 30 jedinců) a u krocanů po dobu 23 týdnů (I. skupina – 21 jedinec; II. skupiny – 28 jedinců). Ve srovnání s krocany na podestýlce (13 307 g, 1,94 % a 54 %) krocani na roštové podlaze vyrobené z kovové mříže měli nižší konečnou tělesnou hmotnost (11 929 g), vyšší ztráty tělesné hmotnosti během přepravy (2,41 %) a vyšší počet jedinců s poškozením jatečného trupu (95 %). Kromě toho jsme po porážce zaznamenali v prsní svalovině vyšší hladinu kyseliny mléčné (krůty 119,83 μM/g; krocani 148,09 μM/g) a větší plochu volně vázané vody (6,5 cm^2 resp. 8,27 cm^2) u jedinců obou pohlaví, které jsme odchovávali na roštové podlaze, ve srovnání s jedinci na podestýlce (108,79 μM/g resp. 6,25 cm^2 u krůt a 128,29 μM/g resp. 5,23 cm^2 u krocanů). Hodnoty pH_1, pH_2 a pH_3 v mase odpovídaly u všech skupin dobré kvalitě masa a pohybovaly se v rozmezí pH_1 6,22 – 6,27, pH_2 5,85 – 6,06 a pH_3 5,55 – 5,64. Výsledky užitkovosti však naznačují, že odchov těžkých krůt na roštové podlaze nelze doporučit.

Klíčová slova: krůty; ztráty; druh podlahy; mechanické poškození; kvalita masa

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