Pakistan Veterinary Journal

ISSN: 0253-8318 (PRINT), 2074-7764 (ONLINE)
Accessible at: www.pvj.com.pk

RESEARCH ARTICLE

Influence of Stocking Density on Health Condition in Meat Turkey Flocks under Field Conditions

Hafez, HM[1]*, N Hagen[1] and Tamer S Allam[2]

[1]Institute of Poultry Diseases, Free University Berlin königsweg 63,14163 Berlin, Germany; [2]Department of Clinical pathology, Faculty of Veterinary Medicine, University of Sadat city, Egypt
*Corresponding author: Hafez.Mohamed@fu-berlin.de

ARTICLE HISTORY (15-356)

Received: July 24, 2015
Revised: November 22, 2015
Accepted: November 30, 2015
Published online: January 22, 2016

Key words:
Haematology
Immune response
Stocking density
Stress
Turkey

ABSTRACT

The objective of the present study was to determine the effect of the stocking density on health condition, haematology, immune response and application of medicaments in male meat turkey flocks reared under field conditions. Three different stocking densities namely 25, 48 and 58 kg/m^2 were compared. The stocking density was calculated according to expected body weight at slaughter. Clinical signs, treatments, daily weight gains and mortalities were recorded. In addition blood samples were collected from each group at week 7, 12, 16 and 20 for haematological and serological investigations. The results revealed that the stocking density in all groups and farms didn't influence the frequencies and durations of the treatments. The haematological results showed that there is no stocking density cause significant difference of hematocrit, red blood cells count, hemoglobin, mean corpuscular volume (MCV), mean corpuscular hemoglobin amount (MCH), mean corpuscular hemoglobin concentration (MCHC), thrombocytes count, total leukocytes count and differential leukocytes. Also no significant difference could be determined by the calculation of Heterophils/Lymphocytes ratio, which is used as stress indicator. The immune response to applied vaccines such as Newcastle disease (ND) and/or to field infections with avian metapneumovirus (AmPV) and Ornithobacterium Rhinotracheale (ORT) were measured at several points using ELISA for ND and for TRT and ORT as well as haemagglutination inhibition test. The obtained results showed that there were no stocking density specific differences. On the other hand the daily weight gain on both farms was slightly higher in the 25 kg/m^2-groups compared to other groups.

To Cite This Article: Hafez, HM, Hagen N and Allam TS, 2016. Influence of stocking density on health condition in meat turkey flocks under field conditions. Pak Vet J, 36(2): 134-139.

INTRODUCTION

In poultry, rearing management is considered to be major determinants of health status, animal welfare and production efficiency (Charuta *et al.,* 2012). Rearing management in poultry business means all factors which influenced the bird health and welfare and can including several factors such as house structure, climatic conditions (ventilation, temperature, litter condition), stocking density, feed and water supply, hygienic condition as well as the knowledge and qualification of the stockman. These factors affect each other and can promote or inhibit the health condition of the flock. The interactions between these factors result in each house and each rearing form to different constellations with various effects on animal health. Currentla, there is no clear definition of turkey welfare. The well-known five freedoms have been adopted by an Farm Animal Welfare Council (FAWC) in England (Anon, 1995) and are often taken as an overall framework for all recommendations at the European level. The "Five Freedoms" are the freedoms from hunger and thirst, from discomfort, from pain, injury and disease, to express normal behaviour and from fear and distress, respectively. More recently, it has been considered that the welfare of any animal is dependent on the overall balance of factors contributing to its physical and mental state and that the animal can adjust, a concept which takes into consideration the extent of poor welfare and its duration. It cannot be too strongly emphasized that birds kept under any system can be prone to stress, injury and disease if management and husbandry are not of a high standard. Within the

present limits of scientific knowledge it is not possible to relate stocking rate to welfare in any simple manner. Stocking density is only one aspect of a complex situation involving such things as breed, strain and type of bird, colony size, temperature, ventilation, lighting and quality of housing. The observance of any particular rate cannot, by itself, ensure the welfare of the birds (Hafez, 1999; Sarwar *et al*., 2015).

Therefore the objective of the present study was to determine the effect of the stocking density on health condition, application of medicaments, haematology and immune response of turkey flocks reared under field conditions.

MATERIALS AND METHODS

Birds: In two farms male turkey poults of the line British United Turkey's (BUT – Big6) were reared at different stocking densities. The stocking density was calculated according to expected body weight at slaughter. In farm 1 all birds were kept during the first 5 weeks of age in a one rearing house. Then after were divided in several separate groups in two houses. House 1 with two groups (25 and 58 kg/m^2). In house two groups were kept at stocking density of 48 and 58 kg /m^2 in the same barn. The birds on farm 2 were reared from first day in two different houses. House 1 with the bird were kept at stocking density of 25 Kg/m^2 and barn 2 58 Kg/m^2. The number of the birds per farm and group are show in table 1. All groups were reared in floor pens and had *ad libitum* access to feed and water. A balanced commercial pellet feed was used for all bird at the same farm. Management was similar to that used on the farms in previous flocks. The birds were vaccinated against several diseases such Newcastle disease (ND) using a double dose of LaSota strain and against Hemorrhagic Enteritis using live attenuated vaccines as well as avian metapneumovirus (AmPV) using live attenuated vaccine (Table 2).

Investigated parameters: The mortalities, applied treatments and duration of the treatment we rerecorded for each group during the entire rearing period and economic parameters were calculated at the end of the investigation. In addition, 20 blood samples were collected from each group at week 7, 12, 16 and 20 for haematological and serological investigations.

Haematological examinations: The evaluated haematological parameters in the study included estimation of the haematocrit (Hct) or packed cell volume (PCV), Haemoglobin concentration (Hb), Erythrocyte and Leukocyte count (RBCs & WBCs), Thrombocyte and Differential Leukocytic count (DLC). Mean corpuscular volume (Mcv = Hct/RBCs x 10) [fl]), Mean corpuscular hemoglobin (McH = Hb/RBCs x 10) [pg]) and Mean corpuscular hemoglobin concentration (McHc = (Hb/Hct x 100) [%]) were calculated mathematically from the results of the above-mentioned analyses. The H/L ratio (heterophil/lymphocyte) as a stress indicator was determined by dividing the number of heterophiles by the number of lymphocytes. Haematological parameters measured according to Campbell (2004).

Table 1: Used stocking densities and number of birds

Groups	Farm 1		Farm 2	
	House 1	House 2	House 1	House 2
58 kg/m^2	2968	2968	n.d.	3563
48 kg/m^2	n.d.	2394	n.d.	n.d.
25 kg/m^2	1288	n.d.	1700	n.d.

n.d.: not done

Table 2: Vaccination schedule

Farm 1		Farm 2	
Age in weeks	Vaccine	Age in weeks	Vaccine
2	ND	3	TRT
4	HE	6	HE
5	ND	9	ND
8	ND	12	TRT
12	ND		

ND: Newcastle disease; HE: Hemorrhagic Enteritis; TRT: Turkey rhinotracheitis

Serological examinations: Haemagglutination inhibition (HI) test for detection of antibodies against ND (Terrestrial manual, 2008). For detection of antibodies against avian metapneumovirus double well ELISA with positive/negative coating was used (Hafez and Löhren, 1990) and detection of antibodies against ORT self-made ELISA as described by Hafez and Sting (1999) was used.

Statistical analysis: All data were presented as mean±SD and were subjected to analysis by using statistic-program SPSS windows version 11 and Mann-Whitney-U-Test. Means were compared by the least significant difference test (LSD) at 0.05 level of probability.

RESULTS

Treatment: The results revealed that the stocking density in all groups and farms didn't directly strongly influence the frequencies and durations of the treatments (Table 3).

Mortality: The total mortality rates on farm 1 were 10.04 and 11.82% in groups 58 and 48 kg/m^2, respectively. In the 25 kg/m^2 group the mortality rate was higher and reached 15.99%. At this department feather pecking and cannibalism were observed at 13 weeks of age. This was pronounced and accompanied with high mortality in the 25 kg/m^2 group (Table 4).

On farm 2 the mortality rate during the entire rearing period was 16.87% in the 58 kg/m^2 group, while only 8.09% in the 25 kg/m^2 group. In this farm both groups suffered from severe coccidiosis at 5th week of age followed by necrotic enteritis at week 9 to week 11 (Table 4).

Technical and economic parameters in two farms: The parameters are shown in table 5. There were not significant differences in between the groups within the farm. However, the daily weight gain on both farms was slightly higher in 25 kg/m^2 groups compared to other groups. In farm 2 the mean body weight as well as the daily weight gain in group 25 kg/m^2 was relatively higher compare to group 58 kg/m^2 due to the high mortality rate in this group as well as the birds of the group 25 kg/m^2 were slaughtered 3 days later (Table 5). However, no statistically significant differences could be determined between the different stocking densities.

Tab. 3: Medicament applied and duration of the treatment

Farm I					Farm I			
Treatments	Age in weeks	Duration (days) groups kg/m²			Treatment	Duration (days) Age in weeks	Groups kg/m²	
		58	48	25			58	25
Amoxicillin Trihydrat 100	5	7	7	7	Sulfaclocin	5	7	7
Aviapen	6	6	0	0	Aviapen	5	7	7
Colistinsulfat	6	0	0	7	Toltrazuril	6	3	3
Ascorbinsäure	9	3	3	3	Amoxicillin	6	2	2
Oxytetracyclin	15-16	5	5	5	Amoxicillin	9-10	5	0
					Difloxacin	16 -17	5	5
Total		21	15	22			29	24

Table 4: No. of dead birds per group and the mortality rates

	Farm I								Farm 2				
	House 1				House 2					58 kg		25 kg	
Age in	58 kg		25 kg		58 kg		48 kg		Age in				
week	No.	%	No.	%	No.	%	No.	%	week	No.	%	No.	%
5	2	0.07	13	1.01	2	0.07	4	0.17	1	59	1.66	5	0.29
6	5	0.17	11	0.85	12	0.40	8	0.33	2	2	0.06	1	0.06
7	22	0.74	40	3.11	17	0.57	21	0.88	3	3	0.08	1	0.06
8	13	0.44	31	2.41	12	0.40	15	0.63	4	4	0.11	1	0.06
9	8	0.27	6	0.47	9	0.30	8	0.33	5	17	0.48	1	0.06
10	7	0.24	0	0.00	5	0.17	2	0.08	6	297	8.34	57	3.35
11	7	0.24	6	0.47	4	0.13	10	0.42	7	30	0.84	14	0.82
12	14	0.47	7	0.54	14	0.47	9	0.38	8	13	0.36	5	0.29
13	7	0.24	6	0.47	16	0.54	13	0.54	9	5	0.14	4	0.24
14	26	0.88	8	0.62	43	1.45	36	1.50	10	11	0.31	2	0.12
15	30	1.01	6	0.47	15	0.51	15	0.63	11	3	0.08	2	0.12
16	28	0.94	14	1.09	34	1.15	18	0.75	12	8	0.22	5	0.29
17	9	0.30	7	0.54	13	0.44	16	0.67	13	8	0.22	1	0.06
18	19	0.64	19	1.48	16	0.54	16	0.67	14	10	0.28	4	0.24
19	24	0.81	16	1.24	39	1.31	27	1.13	15	24	0.67	7	0.41
20	23	0.77	12	0.93	37	1.25	21	0.88	16	9	0.25	6	0.35
21	49	1.65	4	0.31	15	0.51	44	1.84	17	14	0.39	2	0.12
									18	30	0.84	13	0.76
									19	16	0.45	1	0.06
									20	23	0.65	5	0.29
									21	15	0.42	0	0.00
Total	293	9.87	206	15.99	303	10.21	283	11.82	Total	601	16.87	136	8.09
Mean	10.04		15.99				11.82						

Table 5: Technical and economic parameters in two farms

Parameter	Farm I Groups			Farm 2 Groups	
	58 kg/m²	48 kg/m²	25 kg/m²	58 kg/m²	25 kg/m²
No. of birds	5936	2394	1288	3563	1700
No. of dead birds	596	283	206	601	136
Mortality %	10.04	11.82	15.99	16.87	8.09
Age at slaughter (day)	147	147	147	145	148
No. of birds slaughtered	5340	2111	1082	2962	1564
Mean body weight (kg)	18.03	18.22	18.94	19.17	21.59
Daily weight gain	122.65	123.94	128.84	132.20	145.87

Haematological examinations: The results of haematological examinations revealed that there was no stocking density significant influence on the erythrogram including hematocrit, red blood cells count, hemoglobin, MCV, MCH, MCHC and the thrombocytes as well as leukogram including total leukocytes count or differential leukocytic count. Also no significant difference could be determined by the calculation of Heterophils/ Lymphocytes ratio, which is used as stress indicator (Tables 6 and 7).

Immune response: The immune response to applied vaccines such as Newcastle disease, avian metapneumovirus and/or to field infections with Ornithobacterium rhinotracheale were measured at different ages. The obtained results showed that there were no significant differences between the groups (Tables 8, 9 and 10).

DISCUSSION

According to Beaumont *et al.* (2010), animal welfare measures should guarantee that animals are free from hunger, thirst, discomfort, pain, injuries, diseases, fear and distress and that animals are able to express a normal behaviour. By judgment on animal welfare aspects a balance between ethical and economical concerns and scientific opinion should be considered, however not on the cost of birds. Current methods of assessing welfare in the turkey industry have concentrated on assessing the impacts of housing and husbandry on production, behaviour and physiology (Glatz, 2013). The influence of density on the behaviour and health of turkey poults was investigated by (Martrenchar *et al.*, 1999), who reduced space allowance from 24 to 15 dm 2 and from 16 to 10 dm2 for males and females, respectively until wk 12, and from 40 to 25 dm2 afterward in case of males. The

Table 6: Erythrogram and Thrombocytes in experimental birds

Blood parameters	kg/m²	Farm 1			Farm 2			
		Age in weeks			Age in weeks			
		7	12	16	7	12	16	20
RBCs (million/µl)	58	2.49±0.21	2.27±0.15	2.37±0.21	2.49±0.17	2.30±0.12	2.24±0.15	2.40±0.18
	48	2.46±0.17	2.30±0.17	2.37±0.16	----------	----------	----------	----------
	25	2.42±0.13	2.39±0.25	2.23±0.15	2.29±0.15	2.22±0.09	2.25±0.12	2.38±0.18
Hb (g/dl)	58	13.85±1.01	13.29±0.71	14.72±1.02	13.56±0.80	13.41±0.63	13.59±0.72	15.17±1.05
	48	13.90±0.68	13.38±0.76	14.64±0.68	----------	----------	----------	----------
	25	13.62±0.74	13.99±1.15	14.00±0.70	12.98±0.65	13.04±0.50	13.79±0.74	14.74±1.14
Htc (%)	58	38.84±3.53	36.21±2.34	42.5±3.17	39.98±3.31	38.20±1.85	38.25±2.66	38.62±2.86
	48	39.79±2.46	36.74±2.46	41.61±2.11	----------	----------	----------	----------
	25	38.37±2.31	37.71±3.77	39.16±2.48	37.67±2.60	36.17±1.62	39.37±2.22	37.85±3.15
MCV (fl)	58	156.00±8.11	159.53±3.81	179.4±5.43	160.78±9.18	165.85±5.10	162.14±9.16	160.95±4.85
	48	162.00±8.65	159.74±4.68	175.47±5.47	----------	----------	----------	----------
	25	158.91±5.19	157.65±4.21	175.80±4.92	164.5±5.47	162.95±3.06	175.21±4.53	159.40±8.22
MCH (pg)	58	55.69±1.47	58.62±1.36	62.23±1.77	54.48±1.28	58.22±1.94	60.71±1.60	63.24±2.21
	48	56.56±1.69	58.28±3.18	60.08±6.30	----------	----------	----------	----------
	25	56.24±0.80	58.64±1.70	62.93±1.88	56.73±2.55	58.82±1.28	61.46±1.73	61.89±3.24
MCHC (%)	58	35.79±1.97	36.72±0.85	34.64±0.65	33.93±1.39	35.10±1.94	35.58±0.90	39.31±0.73
	48	34.98±1.72	36.47±1.93	35.15±0.70	----------	----------	----------	----------
	25	35.44±0.99	37.19±0.88	35.74±0.61	34.50±0.81	36.07±0.63	35.08±0.88	38.81±1.01
Thrombocytes (1000/µl)	58	8.51±4.38	2.08±1.30	3.10±2.79	7.28±3.86	2.85±1.11	4.08±2.10	2.97±1.15
	48	6.85±3.11	1.42±0.68	1.78±1.00	----------	----------	----------	----------
	25	11.24±5.75	2.33±1.56	1.87±1.21	8.15±3.41	2.31±1.46	4.84±1.74	1.97±0.82

mean±SD RBCS: red blood cells; Hb: haemoglobin; Hct: hematocrite; MCHC: mean corpuscular haemoglobin concentration; MCV: mean corpuscular volume MCH: mean corpuscular haemoglobin amount; Erythrogram and thrombocytes not detected in farm 1 at 20 weeks of age

Table 7: Leukogram and H/L ratio

Blood parameters	kg/m²	Farm 1			Farm 2			
		Age in weeks			Age in weeks			
		7	12	16	7	12	16	20
Leukocytes (1000/µl)	58	11.17±3.52	17.46±5.47	17.13±5.33	16.58±6.88	22.99±6.11	21.94±9.68	25.34±8.41
	48	9.49±3.53	17.92±3.06	17.49±3.38	----------	----------	----------	----------
	25	14.04±5.66	16.54±4.37	15.05±2.33	15.15±2.69	25.71±6.61	19.48±6.35	31.52±8.26
Lymphocytes (%)	58	6.36±8.88	14.64±6.61	13.38±9.21	28.84±12.16	38.08±10.32	24.69±12.82	38.92±16.57
	48	5.55±3.44	14.31±9.60	10.99±4.00	----------	----------	----------	----------
	25	7.66±2.48	17.85±12.02	17.41±7.60	17.86±12.93	55.90±13.49	27.34±15.36	34.22±15.97
Heterophils (%)	58	79.80±10.21	71.24±6.26	72.69±8.23	61.63±12.98	50.52±9.10	64.26±11.81	53.45±14.45
	48	77.17±6.41	72.82±9.39	74.89±4.53	----------	----------	----------	----------
	25	76.81±6.25	69.66±11.24	70.18±7.89	69.30±14.01	35.35±11.33	62.41±13.88	58.64±14.40
Monocytes (%)	58	13.29±4.38	13.45±2.91	13.32±2.77	8.53±4.07	9.66±1.83	10.42±3.52	6.85±2.79
	48	16.23±5.50	12.53±3.69	13.6±3.00	----------	----------	----------	----------
	25	15.01±5.16	11.83±2.30	11.83±2.15	11.63±5.84	6.84±2.96	9.25±3.40	6.37±2.57
Eosinophils (%)	58	0.38±0.48	0.34±0.29	0.32±0.23	0.25±0.24	0.21±0.21	0.29±0.24	0.09±0.12
	48	0.72±1.33	0.21±0.15	0.33±0.20	----------	----------	----------	----------
	25	0.33±0.48	0.21±0.18	0.28±0.26	0.51±0.63	0.15±0.25	0.32±0.28	0.10±0.08
Basophiles (%)	58	0.22±0.27	0.35±0.35	0.26±0.26	0.74±0.52	1.02±0.73	0.35±0.36	0.70±0.48
	48	0.25±0.33	0.13±0.10	0.20±0.19	----------	----------	----------	----------
	25	0.19±0.29	0,43±0.40	0.29±0.28	0.73±0.66	1.76±0.61	0.67±0.59	0.69±0.51
H/L Ratio	58	29.69±33.76	6.15±3.82	10.44±11.50	2.82±1.99	0.70±0.39	4.06±1.99	1.86±0.33
	48	10.89±26.89	8.33±8.71	7.59±2.62	----------	----------	----------	----------
	25	11.60±5.55	5.38±2.72	4.60±1.58	6.28±4.24	1.63±0.93	4.37±1.24	3.78±1.63

mean±SD H/L ratio: heterophils/ lymphocytes ratio; Leukogram and H/L ratio not detected in farm 1 at 20 weeks of age

authors observed gait deterioration at higher density, suggesting stocking density as one of the potential causal factors. They also showed that stocking density had less influence on behaviours such as standing, walking, feeding, drinking, preening, and pecking at the environment, or at another bird. However, similar to the findings for other density studies conducted in broilers (Ventura *et al.,* 2012). Many investigations about high stocking densities and economic parameters were published, however there is only sparse knowledge about the effect of high stocking density on health condition (Ellerbrock, 2000), immune response and the use of drugs. The Farm Animal Welfare Council (Anon, 1995) recommendation states that maximum stocking density in kg/m^2 should be calculated from the live weight of the birds using the formula weight / (0.0459 x weight). However, no explanation is given for the way in which this formula was determined. Ellerbrock and Knierim (2002) used overhead photographs of turkeys to determine the floor-area covered by a male British United Turkey's (BUT-Big 6) body, i.e. they determined the physical space that a turkey takes up. Every two weeks from week 11 to week 21 of age they took measurements from 24 randomly selected turkeys. This data enabled them to reject. The Farm Animal Welfare Council recommendation as unsuitable for turkeys larger than 5kg. However, the formula provided by this paper can be used to determine the area taken up by a single turkey but cannot be used on its own to estimate appropriate stocking density. Pattison *et al.* (2008) stated that commercial turkeys reared for meat, the recommendation is that stocking density should not exceed 34 kg/m^2. The obtained results in the present investigation indicate that the stocking density has neither influence on haematological parameters, the response of the immune system nor on the use of medicaments.

Table 8: HI- Titre in log 2 in farm 1 and 2

Groups		Farm 1				Farm 2			
		Age in weeks				Age in weeks			
		7	12	16	20	7	12	16	20
58kg	X	5.70	2.65	5.00	2.85	0	2.05	3.11	1.38
	SD	2.45	2.0	2.15	2.41	0	2.79	2.24	1.29
48kg	X	6.80	3.05	4.95	1.85	-------	-------	-------	-------
	SD	0.92	1.43	2.46	2.23				
25kg	X	3.55	2.45	3.60	1.50	0	0.4	5.83	2.94
	SD	3.05	2.19	2.50	1.79	0	1.27	1.54	1.95

X =Mean; SD = Standard Divination

Table 9: Antibodies against Avian metapneumovirusin ELISA in Farm 1and 2

Groups		Farm 1				Farm 2			
		S/P				S/P			
		Age in weeks				Age in weeks			
		7	12	16	20	7	12	16	20
58kg	X	0.579	1.035	1.104	2.094	0.124	0.083	0.977	0.658
	SD	0.391	0.395	0.431	0.971	0.160	0.100	0.641	0.540
48kg	X	0.578	0.974	0.933	1.881	-------	-------	-------	-------
	SD	0.161	0.452	0.493	0.561				
25kg	X	0.518	0.938	0.800	1.354	0.120	0.044	0.289	0.860
	SD	0.283	0.272	0.368	0.619	0.098	0.095	0.263	0.494

S/P = Optic density sample/ Optic density of positive control; X =Mean; SD = Standard Divination

Table 10: Antibodies against ORT in ELISA in Farm 1and 2

Groups		Farm 1				Farm 2			
		S/P				S/P			
		Age in weeks				Age in weeks			
		7	12	16	20	7	12	16	20
58kg	X	0.070	0.074	0.072	0.096	0.071	0.079	0.139	0.137
	SD	0.014	0.012	0.022	0.036	0.027	0.035	0.121	0.124
48kg	X	0.087	0.064	0.069	0.134	-------	-------	-------	-------
	SD	0.013	0.012	0.010	0.071				
25kg	X	0.060	0.092	0.068	0.107	0.079	0.108	0.107	0.155
	SD	0.014	0.027	0.010	0.095	0.037	0.047	0.065	0.106

S/P = Optic density sample/ Optic density of positive control; X =Mean; SD = Standard Divination

Regarding the results of haematological investigation, Tayeb *et al*. (2011) found that there were no significant differences among different stocking density groups of broilers for PCV, RBC, total protein, albumin, globulin and low density lipoprotein (LDL). H-L ratio considered as indicators of stress (Zulkifli *et al.*, 2003) but in this study showed no significant difference between different stocking density supported with Thaxton *et al.* (2006) who reported that stocking density did not cause physiological adaptive changes indicative of stress.

Here we refer to humoral immunity, or the ability to produce on antibody response, is commonly used method of assessing stress and immunosuppression. The response to a foreign antigen in an individual depends on several factors such as genetic background, dosage of antigen, route of administration. In this study the antibody titres against NDV, AmPV and ORT were not affected by stocking density. This means that the stocking density not negatively affect the immune response, however, Erişir and Erişir (2002) observed a significant decrease in immune response with an increase in stocking density in Japanese quails.

Concerning the mortality, increased mortality can be explained by decreased animal welfare, such as bad air and litter quality and poor feed intake. Feather pecking and cannibalism different results were achieved on the two farms. At farm 1 a higher mortality rate caused by feather picking and cannibalism occurred in the low density group, whereas at farm 2 there was a higher mortality rate caused by coccidiosis and necrotic enteritis in the high density group. Feather pecking and cannibalism occur in various forms in all poultry species and between birds and in all rearing forms. Cannibalism in turkeys is mostly accompanied with feather losses, temperature losses, injuries, pain and suffering, stress as well as mortality and increase of the susceptibility to other disease conditions. Many causes have been suggested, but problem of cannibalism occur in one pen whereas apparently similar environmental conditions or feeding practices in another pen on the same farm do not cause any problem. Although the exact cause of feather pecking and cannibalism is unknown, however, many endogenic and exogenic factors predispose to cannibalism (Hafez, 1996 & 1999).

The daily weight gain on both farms was slightly higher in the 25 kg/m^2 groups compared to other groups. However, no statistically significant differences could be determined between the different stocking densities. Previous investigations showed that extreme high stocking densities about 3.5 male turkeys/m^2 negatively influences the daily weight gain. However Jankowski *et al.* (2014) found that the body weight during the first four weeks of life in the heat-stressed group reared at increased stocking density, 34 birds per pen, 10 m^2 each pen, 3.4 birds/m^2 was significantly higher compared with thermo-neutral temperature group, 28 birds per pen, 10 m^2 each pen, 2.8 birds/m^2, however, during the remaining period of the experiment, increased stocking density and ambient temperature reduced body weight gain. Dozier *et al.* (2006) reported that increased stocking density in broiler chickens was also a negative factor that inhibited systemic development. In conclusion the obtained results

demonstrate that the three compared stocking densities (25, 48 and 58 kg/m^2) did not specifically influence the health conditions, haematology, immune response and application of medicaments of male meat turkeys under field conditions. However, according to statements of the producers, considerable problems appeared with the marketing of the extensively held turkeys (25 kg/m^2) due to high production costs.

Finally, international agreements on health and welfare regulations for turkeys must be regarded as a potential improvement of turkey keeping and not only as a commercial disadvantage.

REFERENCES

Anon, 1995. Report on the Welfare of turkeys. FAWC. Block D. Government Buildings. Hook Rise South, Tolworth Surbiton, Surrey KT6 7Nl, pp: 1-42.

Beaumont C, Lebihan-Duval E, Mignon-Grasteau S and Leterrier C, 2010. The European experience in poultry welfare-A decade ahead. Poult Sci, 89: 825-83.

Campbell TW, 2004. Hematology of birds. In: Veterinary Hematology and Clinical chemistry. Chapter 17. Thrall MA, DC Baker DC, TW Campbell, D De Nicola, MJ Fettman, ED Lassen, A Rebar and G Weiser. Lippincott Williams Wikins. Philadelphia, PA. pp: 225-258.

Charuta A, Dzierzecka M and Biesiada-Drzazga B, 2012. Evaluation of densitometric and geometric parameters of tibiotarsal bones in turkeys. Bull Vet Inst Pulawy, 56: 379-384.

Dozier WA III, Thaxton JP, Purswell L, Olanrewaju HA, Branton SL *et al*., 2006. Stocking density effects on male broilers grown to 1.8 kilograms of body weight. Poult Sci, 85: 344-351.

Ellerbrock S, 2000. Beurteilung verschiedener Besatzdichten in der intensiven Putenmast unter Berücksichtigung ethologischer und gesundheitlicher Aspekte. Dissertationsarbeit TiHo Hannover.

Ellerbrock S and Knierim U, 2002. Static space requirements of male meat turkeys. Vet Record, 151: 54-57.

Erişir M and Erişir Z, 2002. Yerleşimsıklığıarttırılanbıldırcınların (*Coturnixcoturnix japonica*) bazıbiyokimyasalkanparametrelerindeki-değişiklikler. Turk J Vet Anim Sci, 26: 491-496.

Glatz P and Rodda B, 2013. Turkey farming: Welfare and husbandry issues. Afr J Agric Res, 8: 6149-6163.

Hafez HM, 1996. Übersichtüber Probleme der haltungs- und zuchtbedingten Erkrankungenbei Mastputen. Archiv für Geflügelkunde, 60: 249-256.

Hafez HM, 1999. Gesundheitsstörungen bei Putenim Hinblick auf die tierschutzrelevanten und wirtschaftlichen Gesichtspunkte. Archiv für Geflügelkunde, 63: 73-76.

Hafez HM and Löhren U, 1990. Swollen Head Syndrome: Clinical observations and serology in West Germany. Deutsche Tierärztliche Wochenschrift, 97: 322-324.

Hafez HM and Sting R, 1999. Investigations on different Ornithobacterium rhinotracheale "ORT" isolates. Avian Dis, 43: 1-7.

Jankowski J, Mikulski D, Tatara MR and Krupski W, 2014. Effects of increased stocking density and heat stress on growth, performance, carcase characteristics and skeletal properties in turkeys. Vet Record, 176: 21.

Martrenchar A, Huonnic D, Cotte JP, Boilletot E and Morisse JP, 1999. Influence of stocking density on behavioural, health and productivity traits of turkeys in large flocks. Br Poult Sci, 40: 323-331.

OIE Terrestrial manual, 2008. The World Organisation for Animal Health. OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals. Chapter, 2.3.4. http://www.oie.int/eng/normes/manual/A_00037.htm.

Pattison M, Mcmullin PF, Bradbury JM and Alexander DJ, 2008. Poultry Diseases. 6th edn Edinburgh, UK: Elsevier Ltd.

Sarwar G, Akhter S, Khan SH *et al*., 2015. Effect of different dietary protein and energy levels on the growth performance, meat and body fat composition in broiler chicks. Pak J Agric Sci, 52: 1125-1129.

Tayeb IT, Hassan SN, Mustafa MM, Sadeq SAM, Ameen GI *et al*., 2011. Effects of various stocking density on productive performance and some physiological traits of broiler chicks. Res Opin Anim Vet Sci, 1: 89-93.

Thaxton JP, Dozier WA, Branton SL, Morgan GW, Miles DW *et al*., 2006. Stocking density and physiological adaptive responses of broilers. Poult Sci, 85: 819-824.

Ventura BA, Siewerdt F and Estevez I, 2012. Access to barrier perches improves behaviour repertoire in broilers. PLoS ONE 7: e29826.

Zulkifli I, Liew PK, Israf DA, Omar AR, Hair-Bejo M, 2003. Effect of early age feed restriction and heat conditioning on heterophil/lymphocyte ratios, heat shock protein 70 expression and body temperature of heat-stressed broiler chickens. J Therm Biol, 28: 217-222.