Bulgarian Journal of Agricultural Science, 26 (No 3) 2020, 652–658

Effect of the sex separate and straight-run type of rearing on the performance, carcass and meat chemical composition in fast growing broilers

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Abstract

Petkov, E., Ignatova, M. & Popova, T. (2020). Effect of the sex separate and straight-run type of rearing on the performance, carcass and meat chemical composition in fast growing broilers. *Bulg. J. Agric. Sci., 26 (3)*, 652–658

The aim of the study was to assess the effect of the type of rearing (sex separate *vs*. straight-run) in broiler chicks on their performance, carcass and meat quality. The trial was carried out in the experimental poultry farm of the Institute of Animal Science – Kostinbrod with the fast growing hybrid Cobb-500. The one day old chickens were sexed, marked and separated into three groups (n = 100): two sex separate groups containing male and female chickens respectively and one straight-run reared into deep litter. The chickens were fed *ad libitum* starter, grower and finisher diet and the major zootechnical parameters were controlled. The carcass quality and meat chemical composition were analyzed at 35 d of age.

The effect of the rearing system was slight in the male birds and was mainly related to the weight gain and the feed intake per kg weight gain at 35 days of age showing certain advantage for the straight-run chickens. The female straight-run birds,on the other hand, showed lower weight gain at 35 and 49 days of age ($P < 0.05$) as well as higher feed intake per kg body weight and weight gain ($P < 0.001$) at 49 days. Significant difference between the sex separate reared groups and the straight-run one were observed in regard to the content of the abdominal fat (lowest in the male sexed chicks) and leg (highest in the male sexed and straight run chicks). Except for the ash content, the type of rearing did not exert any significant differences in the major chemical components of the breast and leg meat between the groups.

Keywords: broilers; sex separated rearing; straight-run rearing; performance; meat

Introduction

Which is the best way to grow broilers (sex separate or straight-run) has been one of the cornerstones in the broiler production during the years and still the problem is not solved. Most of the studies in the area have been carried out about 50 years ago, however the topic remains timely even nowadays when the minimal age for slaughter of the broilers is 35 days. The advantage of solving the problem is the improvement of the efficiency of the reared chickens, namely changes and optimization of the growth rates, increased efficiency of the feeds (due to the more precise diets according to the needs of each sex), as well as the uniformity of the batches facilitating the processing of the chickens.

It has been shown that the sexual dimorphism of the broilers starts at embryonic phase regardless of the weight (Burke and Sharp, 1989) or muscle development (Henry and Burke, 1998). During the life cycle of the poultry differences in the growth rates, feed intake and feed conversion have been observed (Gous et al., 1999; May & Lott, 2001). Despite the possibilities for investigation of different birds according to their growth rate and nutritional needs, very little has been done to study the effects of the sex separation as well as the potential ways to specify the nutrition and management of each sex. Most of the experiments on the effect of the sex separate rearing on the growth rate of the birds from the same genotype have been carried out according to models not taking the age of the birds into account.

The reports, available in the literature, concerning the efficiency of the sex separate rearing are contradictory. Some authors (Smith et al., 1954; Hess et al., 1960; Lang et al., 1960; Lamoreux & Proudfoot, 1969) conclude that there is no benefit from the separation of the chickens. On the other hand, other scientists report that the sex separate rearing has significant benefit especially in regard to the performance and the uniformity of the chicken batches when separated (Becker & Berg, 1959; Deaton et al., 1973; Gehle et al., 1974; Laseinde & Oluyemi, 1994; Albuquerque et al., 2006; Api, 2014). Regardless of the results, the effect on the variation coefficient in the live weight of the groups is consistent and the parameters are higher in the straight-run flocks in comparison to the sex separate reared ones (Becker & Berg, 1959; Hess et al., 1960; Lamoreux & Proudfoot, 1969; Deaton et al., 1973). According to Da Costa et al. (2017), the contradictory opinions of the authors are result of the methods of data evaluation in the groups. They found that the most indicative is the difference in the variation coefficient between the sex separate and the straight-run groups.

In view of the contradictory data and the lack of timely information in the literature about the effects of the sex separate rearing of broilers from the modern fast growing hybrids, we aimed to assess the effect of the type of rearing (sex separate *vs.* straight-run) on the performance, carcass quality and meat chemical composition in Cobb-500 broilers.

Material and Methods

The trial was carried out in the experimental poultry farm of the Institute of Animal Science – Kostinbrod, Bulgaria with Cobb 500 fast growing chickens. The one day old chickens were marked individually on the wings and separated after sexing into two groups of 100 males and 100 females. The third group (straight-run) was formed by 50 male and 50 female chicks. The chickens were reared in deep litter with density of 7 birds/m² with control of microclimate parameters according to the Regulation of the veterinary requirements for the animal farms in the EU.

The chickens from the three groups were fed *ad libitum* with compound feed during the starter (0–14 d, ME 3160 kcal/kg, protein, 23.00%), grower (15–28 d, ME 3050 kcal/kg, protein 21.50%) and finisher periods (28+d; ME 3200 kcal/kg, protein 20.50%). The performance parameters for each group were controlled until 49 days of age that is recommended from the manufacturer. The live weight was recorded at hatching, weekly and before slaughter using an electronic balance. The feed intake was recorder daily. Based on these two parameters we calculated the weight gain individually and for the whole period; feed intake per kg live weight and per kg weight gain (weekly and for the whole trial period). At the age of 35 days, 6 birds of each group were slaughtered based on the average live weight. After stunning, decapitation and bleeding, the carcasses were plucked, eviscerated and their feet removed. The edible by-products (neck, liver, gizzard, heart and spleen) were weighed and their content was calculated as percentage of the body weight. The carcasses were then stored at 4°C for 24 h and weighed again to calculate the dressing percentage. Further, the internal fat was removed from the carcasses and they were separated into breast, leg, back and wings. The weight of the internal fat and the parts was recorded. The content of the separated parts and internal fat was calculated as percentage of the live body weight as well as of the cold eviscerated carcass. The analysis of the chemical composition was done on breast and leg meat. The determined traits included protein, fat and ash content, as well as moisture, according to AOAC, 2004.

The data were subjected to statistical analysis through one way ANOVA to determine the differences between the sex separate groups and the straight-run one. In case of effect of the type of rearing, post-hoc comparisons were carried out through Tukey test ($P < 0.05$). In order to assess the effect of the type of rearing in the same sex when reared straight-run or sex separate we applied t-test.

Results and Discussion

Performance of the birds according to the type of rearing

The live weight of the chickens did not differ among the types of rearing, except in the periods where the diets were changed in the first 4 weeks (Table 1). We suggest this response might be due to the specific reaction of the chickens' organism in each of the sexes. This was confirmed by the lack of significant difference between the sex separate and straight-run types of rearing in the next two periods for weigh measurements when there was no change of the diet.

Discrepancies were, however, observed between the male and female chickens in the separate sex groups ($P < 0.05$), showing advantage for the male birds. Significant differences were found also between the male and female birds in regard to the weight gain which was lower in the female chickens at the age of 14 days ($P < 0.05$). The rearing system showed effect on the feed intake/ kg body weight and feed intake/ kg weight gain, and this effect was also observed at the end of the trial period. The differences were significant between the female group and the straight-run group, as the latter showed higher values of these traits. These differences could be due to physiological changes in the period after 28 days of age (Onegbesan et al., 2006), leading inevitably

Table 1. Effect of the type of rearing on the performance traits of Cobb 500 chickens

Age/d	Sex separated		Straight-run	Sig.
	Male	Female		
Live body weight, g				
Day-old	45.24±0.36	44.22±0.43	45.20±0.34	ns
14	287.18±4.01a	270.07±3.09b	277.17±3.63ab	**
28	899.58±11.51a	865.53±8.46b	875.71±10.12ab	*
35	1393.47±17.59	1373.09±13.46	1373.30±15.74	ns
49	2097.73±24.51	2051.91±19.07	2030.99±26.49	ns
Weight gain, g				
14	242.94±3.86a	225.05±3.06b	231.47±3.46ab	**
28	612.40±9.62	595.46±7.42	598.54±7.60	ns
35	493.89±10.35	507.55±8.88	497.63±8.81	ns
49	1197.25±19.15	1186.38±16.00	1152.75±24.73	ns
Feed intake per kg live body weight, g/kg				
14	1.69±0.02a	1.79±0.02b	1.65±0.02a	***
28	1.82±0.02ab	1.89±0.02a	1.80±0.02b	**
35	1.84±0.02	1.87±0.02	1.82±0.02	ns
49	2.51±0.03a	2.40±0.02b	2.54±0.03a	**
Feed intake per kg weight gain, g/kg				
14	2.02±0.03a	2.16±0.03b	1.99±0.04a	**
28	1.89±0.03	1.94±0.03	1.85±0.02	ns
35	1.95±0.04	1.91±0.06	1.86±0.03	ns
49	2.13± 0.03ab	2.01±0.03a	2.21±0.05b	**

*P < 0.05; ** P < 0.01; *** P < 0.001, ns – non significant. Values presented as Mean ±SEM. Values connected with different letters are significantly different (P < 0.05)

to competition between the sexes (Popova-Ralcheva et al., 2008). According to Mench (1988) the birds in the straight-run type of system display lower feed intake, due to changes in the poultry physiology (Gonzales et al., 2003).

In order to explain the effect of the type of the rearing on the major performance parameters for the sex itself, it is necessary to compare the development of male and female birds in the sex separate and straight-run type of rearing.

After comparing the male chickens reared in straight-run and sex separate type of system, we did not find any significant differences in the weight throughout the trial period (Table 2).

The live weight of the female birds did not show any significant changes due to the type of rearing, however after 35 days of age until the end of the trial, the female chickens reared straight-run displayed lower weight (P < 0.05). We consider this due to the superiority of the male chicks in regard to their performance traits right from hatching (Burke & Sharp, 1989; Henry & Burke, 1998). We suggest that the presence of male chickens in the straight-run group commences to accumulate negative effect from 28 days of age after the hormonal changes (Onegbesan et al., 2006), sex competition (Popova-Ralcheva et al., 2008) and sexual dimorphism (Sredkova & Bakalivanova, 2005), which however becomes visible at the age of 35 days.

The weight gain of the of the male birds was higher in the chickens reared straight-run when compared to the sex separate at the age of 35 days (P < 0.05), while on the other hand the females reared straight-run showed lower values of this parameter at the age of 35 and 49 days. The observed differences in the live weight and weight gain in the female chickens corresponded to the higher feed intake/kg live weight as well as the feed intake/kg weight gain in the female chickens reared in the straight-run type of system.

Carcass and meat chemical composition

Carcass traits are presented in Table 3. The dressing percentage was not affected by the type of the rearing, while the content of abdominal fat showed significant difference between the male birds reared in the sex separate type of system and the straight-run group, showing higher content in the latter.

The males reared in the sex separate system also showed lower abdominal fat when compared to the female group. This could be explained with the reported lower fat deposition in the males due to higher activity and the competition after the sex-

Table 2. Comparisons between the types of rearing for the male and female chickens concerning the performance traits

Age/d	Male chickens in the different groups		Sig.	Female chickens in the different groups		Sig.
	Sex separated	Straight-run		Sex separated	Straight-run	
Live body weight, g						
Day-old	45.24±0.36	45.63±0.45	ns	44.22±0.43	44.70 ±0.52	ns
14	282.13±4.01	277.02±4.7	ns	270.07±3.09	276.60±5.60	ns
28	899.58±11.52	870.20±13.70	ns	865.53±8.42	881.70±15.10	ns
35	1393.42±17.59	1398.80±22.65	ns	1373.09±13.42	1346.17±21.35	ns
49	2092.75±24.52	2028.33±38.27	ns	2051.91±19.07	1928.14±35.03	*
Weight gain, g						
14	242.09±3.87	231.36±4.63	0.08	225.05±3.32	231.56±4.58	ns
28	612.40±9.62	592.49±7.82	ns	595.45±7.46	605.11±10.56	ns
35	493.89±10.35	528.80±12.72	*	507.55±8.89	464.47±10.25	**
49	1192.12±19.15	1210.00±90.18	ns	1186.38±17.30	1088.84±25.58	**
Feed intake per kg live body weight, g/kg						
14	1.69±0.02	1.63±0.03	ns	1.79±0.02	1.66±0.04	**
28	1.81±0.02	1.81±0.02	ns	1.89±0.02	1.79±0.03	**
35	1.84±0.02	1.79±0.03	ns	1.87±0.02	1.86±0.02	ns
49	2.52±0.03	2.48±0.04	ns	2.40±0.03	2.60±0.04	***
Feed intake per kg weight gain, g/kg						
14	2.02±0.04	1.97±0.04	ns	2.16±0.04	2.00±0.05	*
28	1.88±0.03	1.87±0.03	ns	1.97±0.03	1.830±0.03	*
35	1.95±0.05	1.75±0.04	**	1.91±0.05	1.99±0.07	ns
49	2.12±0.04	2.10±0.07	ns	2.00±0.04	2.32±0.05	***

*P < 0.05; ** P < 0.01; ***P < 0.001, ns – non significant

Table 3. Effect of the type of rearing on the carcass composition of Cobb 500 chickens

Trait	Sex separate		Straight-run	Significance
	Male	Female		
Dressing precentage	69.39±0.37	68.95±0.80	68.94±1.24	ns
Abdominal fat, % LBW	1.42±0.05a	1.68±0.07b	1.65±0.04b	*
Breast, % LBW	22.26±0.30	23.11±0.20	22.39±0.70	ns
Leg, % LBW	11.25±0.08a	10.29±0.08b	10.99±0.23a	**
Liver, % LBW	2.37±0.04	2.58±0.18	2.54±0.14	ns
Gizzard, % LBW	2.11± 0.09a	1.81±0.05b	1.98±0.04ab	*
Heart, % LBW	0.65±0.02a	0.55±0.02b	0.64±0.02a	**
Spleen, % LBW	0.195±0.01	0.193±0.02	0.211±0.02	ns
Breast, % CEC	32.08±0.30	33.54±0.40	32.45±0.70	ns
Leg, %CEC	16.22±0.12a	14.94±0.19b	15.96±0.27a	**

% LBW –percentage of the live body weight; % CEC- percentage of the cold eviscerated carcass; * – P < 0.05; ** – P < 0.01; ns- non significant. Values presented as Mean ±SEM. Values connected with different letters are significantly different (P < 0.05)

ual maturation and dimorphism (Popova-Ralcheva et al., 2008; McLean et al., 2002), leading to increased collisions between the individuals (McLean et al., 2002), decreased feed intake and high activity to evade conflicts. This could clarify the significant difference in the percentage of the leg that was higher in the male group and the straight run group in comparison to the female chickens. The heart and gizzard showed higher percentage in the sex separate male chickens and the straight-run group, when compared to the females, and this shows effect of the type of rearing system but only in regard to the females.

The effect of the type of the rearing in the individual sexes was limited to the higher percentage of the breast from the eviscerated carcass weight in the male sexed chickens ($P < 0.05$) and the higher percentage of the gizzard in the female straight-run chickens (Table 4).

A tendency toward lower content of the breast as percentage of the live body weight was found in the males from the straight run group compared to the sexed males. Another very slight increase was detected in the content of the leg as percentage from the live body weight in the straight run females compared to the sexed females. The same was observed in regard to the heart. In their studies, Burke & Sharp (1989) and Henry & Burke (1998) reported higher development of the muscles in the male compared to female chickens.

The trends toward higher percentage of the leg and heart in the straight-run female birds might be explained again with the hormonal changes described by Onagbesan et al. (2006), that occur in the male chickens and the subordination of the female chickens in the straight-run group, as well as the increased activity when compared to the sexed groups where no such effect was observed (Lei & van Beek, 1997).

No effect of the type of rearing has been observed in the major chemical components of the meat from breast and leg (Table 5).

Significant difference was found only in regard to the ash content that showed lower values in the breast and legs of the straight-run chickens. In the leg of the males however we observed considerably higher ash content when compared to the females (Table 6).

Similarly, when comparing the sexed male or female chickens with the same sexes from the straight run group, we found no difference in either of the meat chemical components except in the ash. It showed lower content in the breast of the female straight-run chickens and also lower content in the legs of both male and female chickens from the straight-run group when compared to the sexed.

Table 4. Comparisons between the types of rearing for the male and female chickens concerning the carcass composition

Traits	Male chickens in the different groups		Sig.	Female chickens in the different groups		Sig.
	Sex separate	Straight-run		Sex separate	Straight -run	
Dressing percentage	69.39±0.86	68.18±1.21	ns	68.95±0.80	69.68±1.66	ns
Abdominal fat, % LBW	1.45±0.05	1.58±0.04	ns	1.68±0.08	1.72±0.06	ns
Breast, % LBW	22.27±0.30	21.04±0.61	0.08	23.11±0.19	23.73±0.54	ns
Leg, % LBW	11.25±0.09	11.27±0.35	ns	10.29±0.08	10.72±0.25	0.08
Liver, % LBW	2.37±0.05	2.54±0.17	ns	2.56±0.19	2.54±0.22	ns
Gizzard, % LBW	2.11±0.09	1.93±0.04	ns	1.81±0.05	2.04±0.08	*
Heart, % LBW	0.65±0.02	0.65±0.02	ns	0.54±0.02	0.63±0.05	0.10
Spleen, % LBW	0.20±0.02	0.19±0.02	ns	0.19±0.02	0.23±0.02	ns
Breast, % CEC	32.08±0.29	30.87±0.11	*	33.54±0.46	34.05±0.24	ns
Leg, % CEC	16.21±0.13	16.54±0.23	ns	14.94±0.20	15.37±0.03	ns

% LBW – percentage of the from live body weight; % CEC – percentage of the cold eviscerated carcass; * – $P < 0.05$, ns- non significant. Values are presented as Mean ± SEM

Table 5. Effect of the type of rearing on the meat chemical composition of Cobb 500 chickens

Traits	Groups separated by sex		Straight-run	Sig.
	Male	Female		
Breast meat				
Moisture, %	73.66±0.30	72.19±0.20	73.09±0.20	ns
Protein, %	23.16±0.35	23.17±0.25	23.21±0.31	ns
Fat, %	2.05±0.24	1.84±0.19	2.46±0.12	ns
Ash, %	1.17±0.04a	1.13±0.01a	0.82±0.06b	***
Leg meat				
Moisture, %	75.06±0.35	74.22±0.45	74.18±0.40	ns
Protein, %	19.00±0.17	19.06±0.14	19.25±0.14	ns
Fat, %	5.07±0.29	5.95±0.27	5.86±0.24	ns
Ash, %	1.04±0.03a	0.86±0.03b	0.60±0.06c	***

*** $P < 0.001$, ns – non significant. Values presented as Mean ±SEM. Values connected with different letters are significantly different ($P < 0.05$)

Table 6. Comparisons between the types of rearing for the male and female chickens concerning the meat chemical composition

Trait	Male chickens in the different groups		Sig.	Female chickens in the different groups		Sig.
	Sex separate	Straight-run		Sex separate	Straight run	
Breast meat						
Moisture, %	73.66±0.42	73.18±0.08	ns	72.91±0.24	73.02±0.23	ns
Protein, %	23.16±0.39	23.35±0.29	ns	23.18±0.28	23.08±0.78	ns
Fat, %	2.05±0.26	2.48±0.23	ns	1.84±0.21	2.44±0.25	ns
Ash, %	1.17±0.05	0.89±0.14	ns	1.13±0.02	0.77±0.07	*
Leg meat						
Moisture, %	75.06±0.39	74.76±0.37	ns	74.22±0.50	73.61±0.26	ns
Protein, %	19.00±0.19	19.11±0.30	ns	19.06±0.15	19.42±0.16	ns
Fat, %	5.07±0.32	5.45±0.04	ns	5.95±0.30	6.28±0.44	ns
Ash, %	1.04±0.04	0.66±0.04	***	0.86±0.04	0.54±0.07	**

*P < 0.05; ** P < 0.05;*** P < 0.001, ns – non significant. Values presented as Mean ± SEM. Values connected with different letters are significantly different (P < 0.05)

Conclusions

The effect of the type of rearing (sex separate *vs.* straight run) was slightly pronounced in the male birds, mainly in regard to the weight gain and the feed intake per kg weight gain at 35 days of age, showing advantage for the straight run chickens. The female straight run chicks had lower weight gain at 35 and 49 days of age and higher feed intake per kg body weight and weight gain. Significant difference between the sex separate reared groups and the straight run one were observed in regard to the content of the abdominal fat (lowest in the male sexed chicks) and leg (highest in the male sexed and straight run chicks). Except for the ash content that appeared to be affected by the type of rearing, it did not induce any significant differences in the major chemical components (moisture, fats and protein) of the breast and leg meat between the groups.

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Received: July, 26, 2019; *Accepted:* August, 13, 2019; *Published:* June, 30, 2020