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Original article

Carcass and Meat Composition in F1 Crosses of Two Lines of Slow-Growing Chickens Reared in Conventional or Alternative System with Access to Pasture[1]

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Abstract

The study was carried out to compare the carcass quality, meat chemical composition and its fatty acid profile in two slow-growing crosses obtained from La Belle (LB) and Bresse Gauloise (BB) parents, reared in conventional or alternative system with pasture access. At the age 12 weeks, male chickens (n=6) of each cross were slaughtered. Two-way ANOVA was used to assess the effect of the rearing strategies as well as the crossbreed on the carcass quality and meat chemical and fatty acid composition. The live and carcass weight of both crosses, as well as the dressing percentage were influenced mostly by the rearing system, showing advantage of the indoors grown birds. Despite the reduced values of these parameters, no deposition of abdominal fat was detected in the pastured birds from both crosses, which is a positive influence of the outdoors system observed in the particular crosses. In regard to the chemical composition of the meat, the pasture access decreased the protein content in both breast and thigh meat ($P<0.001$) but increased the moisture ($P<0.001$). The cross and the rearing system had different effect on the fatty acid composition of the meat and the related lipid indices, associated with its dietetic quality. While the thigh meat was mostly affected by the cross of the chickens, showing higher content of monounsaturated fatty acids (MUFA) ($P<0.01$) but lower in polyunsaturated fatty acids (PUFA) ($P<0.05$) in the ♂BBx♀LB birds, the fatty acid of the breast meat, showed different response according to the crossbreed and the rearing system. The differences were more pronounced in the ♂LBx♀BB, indicating certain advantage of the pastured chickens from this cross with lower content of saturated fatty acids (SFA) but higher of PUFA and improved values of the polyunsaturated/saturated fatty acids (P/S) and n-6/n-3 PUFA ratios.

Keywords: Crossbred slow-growing lines, Pasture access, Carcass quality, Meat chemical composition, Fatty acid profile.

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INTRODUCTION

Autochthonous chicken lines have been recently gaining popularity for production of high quality meat with improved dietetic and nutritional value (Anh et al., 2015; Sokolowicz et al., 2016). Such lines are usually slow-growing and are slaughtered at later age. Contrary to the commercial broilers, the slow-growing lines are better adapted to alternative systems similar to the natural environment and usually providing access to pasture (Fanatico et al., 2005). In attempt to study the possibilities of some indigenous lines for production of slow-growing chickens with high quality meat we described in details the La Belle line (LB) which is representative for the national gene pool of Bulgaria. We compared it with White Plymouth Rock (Popova et al., 2016) and the recently imported Bresse Gauloise (BB) (Popova et al., 2017; Popova et al., 2018). Since the latter has been recognised for the high quality of its meat and meat products, we were interested to what extent the LB and BB lines could affect the performance and meat quality of their crossbred lines. Hence their crosses ♂LBx♀BB and ♂BBx♀LB have been described in our studies so far (Popova et al., 2017) when they have been compared with the pure lines LB and BB and reared only in conventional conditions. In the present work, we aimed to examine the differences in the carcass quality, chemical composition and fatty acid profile of the meat between the two F1 crossbred lines when they are reared in conventional and pastured system.

Material and Methods

The experiment was designed as two trials carried out simultaneously in the experimental poultry farm of the Institute of Animal Science- Kostinbrod, Bulgaria (conventional system) and the symbiotic Livadi farm, situated in Damyanitsa village, Sandanski region, Bulgaria (pasture system).

Experimental birds and rearing systems

For the first trial (conventional system), a total of 26 ♂LBx♀BB and 27 ♂BBx♀LB 1-day old male chickens were obtained after crossing of the parent lines La Belle (LB) and Bresse Gauloise (BB) from the stock in the Institute. After hatching, they were placed into a deep litter facility with a stocking density of 14 birds/m^2 in separate pens in the same poultry house in the Institute. All the birds were fed *ad libitum* starter (ME-13.18MJ/kg; protein content-19.41%) and finisher (ME -13.00 MJ/kg, protein content-17.77%) diets, respectively for 4 and 8 weeks. Water was provided *ad libitum* with a nipple drinker. The lighting regime was 15 h of light and 9 h of darkness, and the temperature ranged between 20 and 24 (started from 32-36°C in the first 3 days after hatching, followed by a programmed decrease).

In the second trial, the total number of chickens hatched and reared in Livadi farm was 43, divided into two groups, each containing 23 and 20 chickens according to the crossbreed – ♂LBx♀BB and ♂BBx♀LB. For a period of 3 weeks after hatching, the chickens were kept in controlled microclimate conditions (as described by Salatin, 1998). From 4 to 12 weeks of age, the birds were reared outdoors in wooden cages covered inside with aluminium plates to prevent the overheating of the chickens. The cages were equipped with nipple drinkers and feeders while being open so that the birds could access pasture. Additionally, the chickens were fed *ad libitum* the same diet as the ones reared conventionally in the first trial. The fatty acid composition of the diets and grass is presented in Table 1.

Table 1. Fatty acid composition (% FAME) of the diet and grass

Fatty acid	Starter (1-28d)	Finisher (29 d +)	Grass (29 d +)
C14:0	0.19	0.09	3.97
C16:0	16.38	14.30	36.61
C16:1	0.26	0.22	2.80
C18:0	2.75	2.63	7.15
C18:1	25.97	28.76	12.98
C18:2n-6	53.43	52.34	22.59
C18:3n-3	1.01	1.65	13.90

Slaughtering and carcass analysis

At 12 weeks of age, 6 birds of each cross from both trials (rearing systems) were selected for slaughter 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 live weight. Hot carcass weight was recorded and dressing percentage was calculated. The carcasses were then stored at 4ºC for 24 h and weighed again. Further the internal fat was removed from the carcasses and they were separated into breast, thigh, back and wings. The weight of the internal fat and the parts was recorded. The skin and bones from the breast and thighs were removed to obtain the muscles and they were also weighed. The content of the separated parts, muscles and internal fat was calculated as percentage of the cold eviscerated carcass weight. Then the breast and thigh muscles were minced and frozen at -20 ºC until further analysis of the chemical composition of the meat.

Analysis of the chemical and fatty acid composition of the meat

The breast and thigh meat was analysed for lipid, protein, moisture and ash content following the AOAC (2004) Official method of analysis. For the analysis of the fatty acid profile, total lipids from the breast meat were extracted according to the method of Bligh and Dyer (1959). Methyl esters of the total lipids, isolated by preparative thin layer chromatography, were obtained using 0.01 % solution of sulfuric acid in dry methanol for 14 h, as described by Christie (1973). The fatty acid composition of total lipids was determined by gas–liquid chromatography (GLC) analysis using a chromatograph CSi 200 equipped with a capillary column (DM-2330:30 m×0.25 mm×0.20 μm) and hydrogen as a carrier gas. The oven temperature was first set to 160ºC for 0.2 min, then raised until 220◦C at a rate of 5◦C/min and then held for 5 min. The temperatures of the detector and injector were 230◦C. Methyl esters were identified through comparison to the retention times of the standards. Fatty acids are presented as percentages of the total amount of the methyl esters (FAME) identified (Christie, 1973).

Statistical evaluation

Data were statistically evaluated by two-way ANOVA as the rearing system, the cross of the birds and their interaction were included in the model. The Fit model procedure of JMP v.7 software package was used to perform the statistical analysis (JMP Version 7, SAS Institute Inc. Cary, NC). The effects were considered to be significant at P<0.05; P<0.01 and P<0.001. Significant differences among the means were determined using Tukey post hoc test (P<0.05). All data were expressed as mean values with pooled standard errors.

Results and discussion

Carcass analysis

The carcass traits of the crossbred lines reared in the two systems are presented in Table 2. Both crosses reared on pasture had significantly lower live weight when compared to the indoors reared ones, however this trait depended on the line (P<0.001). As a whole, the chickens from the ♂BBx♀LB crossbred line displayed higher live weight that ♂LBx♀BB when grown conventionally, but this trait had significantly lower value in this cross when reared in pasture system. The same was observed in regard to the carcass weight and dressing percentage. The differences could be explained with the performance abilities of both crosses and could indicate also necessary modifications in the pasture system to compensate the lower weight and yield in the ♂BBx♀LB cross, since clear difference between the lines regardless of the rearing system was not observed. Lower live, carcass weight and dressing percentage of the birds on pasture has been observed in a previous study on the pure LB and BB lines (Popova et al., 2018 in press).

Table 2. Effect of the rearing system, cross and their interaction on the carcass characteristics of the chickens

Treatment	Live weight, g	Carcass weight, g	Dressing, %	Inedible, %	Edible, %	Abdominal fat, %	Breast (skin+bone), %	Thigh (skin + bone), %	Breast (muscle), %	Thigh (muscle), %	Back, %	Wings, %
♂LBx♀BB c	2025.83b	1290.19	63.68a	11.67	6.12	3.03	25.81	36.68	18.09	24.97	20.55	13.18
♂LBx♀BB p	1883.50a	1114.33	59.10b	10.47	7.07	0.00	24.71	37.78	14.69	25.54	21.53	13.39
♂BBx♀LB c	2137.50d	1322.16	61.84ab	12.41	6.49	3.61	25.08	35.51	18.01	23.88	21.38	13.90
♂BBx♀LB p	1741.67c	1062.33	61.02ab	10.87	7.45	0.00	25.09	36.99	15.18	24.38	21.04	13.57
Rearing system (R)												
Conventional	2081.67	1306.17	62.76	12.04	6.31	3.32	25.44	36.09	18.06	24.42	20.97	13.54
Pasture	1812.58	1088.33	60.06	10.67	7.26	0.00	24.90	37.39	14.93	24.96	21.28	13.48
Cross (C)												
♂LBx♀BB	1954.67	1202.25	61.39	11.07	6.60	1.51	25.26	37.23	16.39	25.26	21.04	13.28
♂BBx♀LB	1939.58	1192.25	64.44	11.64	6.98	1.81	25.08	36.25	16.60	24.13	21.21	13.73
Sig.												
R x C	***	0.09	*	ns	ns	ns	ns	ns	ns	ns	ns	ns
R	***	***	**	***	***	***	ns	0.07	***	ns	ns	ns
C	ns	ns	ns	0.08	0.05	ns	ns	ns	ns	0.06	ns	ns
Pooled SEM	32.96	25.64	0.51	0.21	0.14	0.37	0.52	0.36	0.39	0.29	0.27	0.15

*P<0.05;**P<0.01;*** P<0.001.Values connected with different letters differ at P<0.0

Similarly, Ipek and Sozcu (2017) found consderably lower live weight in slow-growing lines reared with pasture access, however they did not observe any effect of the rearing system on the dressing percentage. Fanatico et al. (2005) found no differences in the carcass yield of indoor and outdoor reared birds, and Ponte et al. (2008) observed increases in carcass yields in pastured broilers. The rearing system affected significantly the inedible parts of the carcass (P<0.001) showing lower percentage in the birds reared on pasture. This corresponded to the higher part of the edible by-products in the pastured crosses (P<0.001). On the other hand, these two parameters tended to differ between the crossbred lines, showing higher content in the ♂BBx ♀LB birds. These results partly contradict to the previously observed in the LB and BB lines where the pastured birds showed higher percentage of both inedible parts and edible internal organs. The higher percent of the edible gastrointestinal organs in the pastured lines is mainly due to the considerably higher content of the gizzard, as seen from Figure 1, and shows adaptation of the birds to the higher content of fiber in the diet.

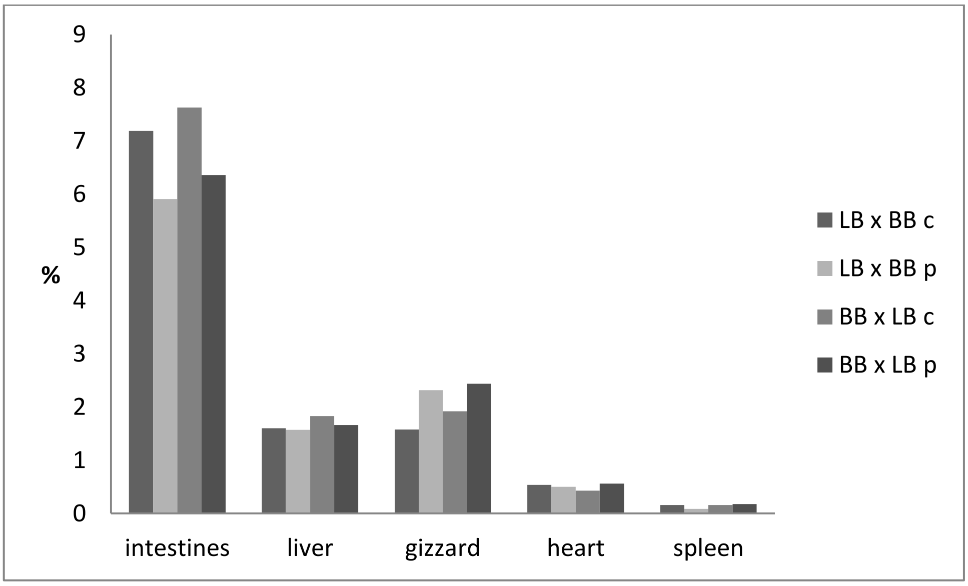

Figure 1. Content of the intestines and giblets in the crosses

It is known that the dietary fiber content in the diet could affect considerably the development and the size of the digestive tract organs in the chickens (Mourão et al., 2007) which has also a significant impact on the carcass yield. The deposition of the abdominal fat content has been positively affected by the rearing system in this study (P<0.001), showing lack of abdominal fat in the crossbred lines reared on pasture. In regards to this trait, the crossbred lines reared on pasture show clear advantage over the pure parent lines, which were not affected by the pasture access (Popova et al., 2018, in press). The abdominal fat deposition causes economical losses, hence its decrease is desirable in the poultry breeding. So far, the results of the studies about the effect of the pasture access on the abdominal fat has been inconclusive. In line with our observations, Wang et al. (2009) and Li et al. (2017) registered significant decline in the deposition of abdominal fat in free-range reared chickens with access to grass. There was no significant influence of the rearing conditions on the main carcass parts, except the breast muscle which was considerably diminished in the crossess on pasture (P<0.001), corresponding to the lower dressing percentage. Contrary to our findings, Castellini et al. (2002) observed significant increase in the breast and thigh parts in outdoors raised chickens in organic production system, because of the better muscle development due to higher motor activity.

Meat chemical composition and fatty acid profile

The chemical composition of the breast and thigh meat has been affected to a different extent by both factors- rearing system and cross, as well as their interaction (Table 3). Despite the lack of significant difference, the lipid content of the breast meat in the pastured birds was decreased by 36%. Similarly, in the thigh meat, rearing system did not affect the lipids, however, their content differed significantly between the crosses (P<0.05) showing higher contents in the ♂BB x ♀LB chicks. Both rearing system and cross interacted significantly (P<0.05) showing the different response of the crosses to the pastured and conventional rearing in regard to the lipid content of the thigh meat. As expected, the lipids were higher in the crosses reared conventionally but only in the ♂BB x ♀LB birds, while surprisingly, the chicken from the ♂LB x ♀BB crossbred line displayed higher content of the lipids in thigh when reared on pasture. So far the results reported in the literature concerning the effect of the outdoor system on the lipids of poultry meat vary considerably. Fanatico et al. (2007) observed decreased intramuscular lipids in breast of chickens reared outdoors, while Küçükyalmaz (2012), Mikulski et al. (2011) and Li et al. (2017) did not observe any change of the lipid content in meat in pastured birds in comparison to the indoors reared. The different effect of the rearing system on the intramuscular lipids in the breast and thigh meat suggests different response of these muscles due to their metabolic type. Poultry meat is known for being low in fat, especially the breast, since the lipids are mainly deposited subcutaneously or in the abdomen rather than in the meat. The higher deposition of fat in the thigh meat of ♂LB x ♀BB cross reared on pasture could be considered positive, since the LB line initially has very low intramuscular fat content due to the selection process and its increase in the cross could improve the organoleptic qualities of meat.

Breast meat of both lines reared on pasture, exhibited lower protein (P<0.001) but higher moisture content (P<0.001) in the pastured birds. Although the significant interaction (P<0.05) between the cross and rearing system found, both factors affected the protein content of the thigh. In line with the results for the breast meat, indoors reared birds had higher protein content (P<0.001). Furthermore, ♂LB x ♀BB cross had more protein in thighs when compared to the ♂BB x ♀LB (P<0.05). Moisture was higher in the thigh meat of the pastured crosses as well (P<0.001). The lower protein content in the meat, particularly the breast of the pastured birds found in our study corresponds to the lower percentage of the breast muscle separated from the carcass of these chickens. Contrary to us, Fanatico et al. (2007) found higher protein content in slow-growing chickens reared outdoors, while Wang et al. (2009) did not observe any effect of the outdoors rearing on the protein in meat. These authors also did not find any significant difference in regard to the moisture in the meat between the indoors and outdoors reared chicks, while Castellini et al. (2002) determined higher moisture in the organically raised chickens.

Table 3. Effect of the rearing system, cross and their interaction on the chemical composition of the breast and thigh meat in the chickens

Treatment	Breast				Thigh			
	Lipids, %	Protein,%	Moisture,%	Ash, %	Lipids, %	Protein,%	Moisture,%	Ash, %
♂LBx♀BB c	1.15	24.85	70.89	1.13a	4.29a	20.47a	72.29	1.04a
♂LBx♀BB p	1.02	22.13	73.75	1.12a	5.81ab	17.28ab	74.11	0.91c
♂BBx♀LB c	1.61	24.74	70.57	1.11a	6.82b	18.07b	72.27	0.97b
♂BBx♀LB p	0.75	22.60	73.62	1.03b	5.88ab	16.99b	74.30	0.94bc
Rearing system (R)								
Conventional	1.38	24.80	70.73	1.12	5.56	19.27	72.28	1.004
Pasture	0.88	22.37	73.68	1.07	5.84	17.13	74.20	0.93
Cross (C)								
♂LBx♀BB	1.08	23.49	72.32	1.13	5.05	18.87	73.20	0.98
♂BBx♀LB	1.18	23.67	72.10	1.07	6.35	17.53	73.28	0.96
Sig.								
R x C	ns	ns	ns	***	*	*	ns	***
R	ns	***	***	***	ns	***	***	***
C	ns	ns	ns	***	*	*	ns	0.08
Pooled SEM	0.16	0.30	0.32	0.009	0.30	0.36	0.31	0.01

*P<0.05;*** P<0.001.Values connected with different letters differ at P<0.05

This finding was confirmed in our previous study where the pure LB and BB lines reared on pasture exhibited higher moisture (Popova et al., 2018 in press).

The ash content in the breast and thigh meat showed differences between the two crosses. The ♂BB x ♀LB birds had considerably lower ash content in breast, but significant interaction between the crossbreed and the rearing system was also detected. It was determined by the stronger influence of the rearing system (P<0.001).

The fatty acid profile of the breast meat (Table 4) was affected by the significant interaction of the rearing system and the cross of the birds. The content of C14:0 and C16:0 showed different response in both crosses according to the rearing system, showing lower levels in the ♂LB x ♀BB birds reared outdoors, and at the same time increased in the pastured ♂BB x ♀LB birds. Rather different were the results for the PUFA contents showing the opposite trends. Generally, the amounts of C20:2n-6, C20:3n-6, C20:4n-6, C 22:5n-3 and C22:6n-3 showed dramatic increase in the ♂LB x ♀BB chickens reared on pasture, while the differences in the ♂BB x ♀LB chickens reared in different systems were not strongly pronounced. Both the cross and the rearing system affected the contents of the essential C18:2n-6 and C18:3n-3. These fatty acids showed higher content in the pastured chickens, but their levels were significantly lower in the ♂BB x ♀LB cross. The increase of the levels of C18:2n-6 and C18:3n-3 in the breast meat of the pastured birds was expected and could be explained by the higher content of the latter in the grass (Table 1) and the additional intake of feed in this group of chickens. This was also observed by Popova et al. 2018 (in press). However, Cömmert et al. (2016) observed decrease in the content of C18:2n-6 in organically reared poultry, when compared to conventional.

The fatty acid composition of the thigh meat (Table 5) was affected mostly by the cross, showing significantly higher C16:1n-7 (P<0.05) in the meat of the ♂BB x ♀LB birds. This crossbreed also tended to have higher levels of C16:0 (P=0.08), and C18:1n-9 (P=0.06), while in regard of the individual PUFA, certain advantage was observed in the other cross. The chickens of the ♂LB x ♀BB displayed higher content of C18:2n-6, C 18:3n-3, C20:2n-6, C20:4n-6 and C22:5n-3. The effect of the rearing system was limited to only one of the fatty acids – C16:0 which tended to decrease in the pastured birds.

The total amounts of the fatty acids and related nutritional indices (P/S and n-6/n-3) are presented in Table 6. The results are to a great extent determined by the effects of both factors or their interaction on the individual fatty acids. The content of the SFA in the breast meat was decreased in the pastured ♂LB x ♀BB line, while their content was higher in the outdoors reared ♂BB x ♀LB. As for the content of PUFA, n-3 and n-6, their amounts were mostly increased in the ♂LB x ♀BB birds reared in the pastured system. This cross also exhibited positively augmented P/S ratio as well as lower n-6/n-3 ratio. The content of MUFA was significantly affected only by the kind of the rearing system, showing considerable decrease in the pastured birds (P<0.001).

The total amount of the fatty acids in the thigh meat were determined by the crossbreed, presenting significantly higher content of MUFA in the ♂BB x ♀LB ($P<0.01$), while at the same time, this cross was characterized by lower ($P<0.05$) content of PUFA (including n-3 and n-6), when compared to the ♂LB x ♀BB birds. These differences in the content of PUFA led to lower values of the ratio P/S and higher n-6/n-3 in the thigh meat of the ♂BB x ♀LBs. Fatty acid composition is an important trait which can be affected by many factors. One of the most important is the rearing conditions of the animals. The studies on the fatty acid profile, affected by the rearing systems, especially outdoors with pasture access appear to be very different. In line with our results, Cömmert et al. (2016) reported higher content of SFA but lower in MUFA in slow growing genotype, reared organically with pasture access. This also has been observed by Husak et al. (2008) comparing meat from free range and conventionally grown chicks. On the other hand, Molee et al. (2012) did not find any difference in SFA and MUFA in conventional and free range reared birds. However, these authors found significantly augmented levels of n-3 in the breast but not in thigh meat. Besides the rearing systems, line can be significant source of variation in the fatty acid profile (Dal Bosco et al., 2012). In our study we also found difference between the lines in regard to the individual and total amounts of fatty acids, especially in the thigh meat which affected the P/S and n-6/n-3 ratio showing more favourable values in the ♂LB x ♀BB birds. P/S ratio varied in the range of 0.66 – 0.67 respectively for the ♂LB x ♀BB and the reciprocal cross. These values are due exclusively to the higher levels of C18:2n-6, which is the major polyunsaturated fatty acid in the poultry meat. The recommended values of P/S should not be less than 0.4. On the other hand, the results of the present study show that besides the pasture rearing and the effect of the line, n-6/n-3 ratio is much above the recommended values of 4, and differ substantially from the reported by Dal Bosco et al. (2012) and Cömmert et al. (2016). However, Küçükyalmaz et al. (2012) determined this ratio in thighs to be 50.9 and 46.7, while in breast 39.2 vs. 50.7 respectively for the conventional and organically reared birds with pasture access. This suggests that the pasture alone is not enough to meet the nutritional recommendation in regards to this trait.

Conclusions

The results of the study indicated that the live and carcass weight, as well as dressing percentage of the crosses were mostly affected by the rearing system, with advantage of the indoors grown birds. On the other hand, the crossbred birds reared on pasture did not deposit abdominal fat, which is a positive influence of the outdoors system observed in these particular crossbred lines. In regard to the nutritional composition of the breast and thigh meat, the pasture rearing decreased the protein content in both kinds of meat and increased the moisture. The cross and the rearing system had different effect on the fatty acid composition of the meat and the related indices, characterizing the dietetic quality. The thigh meat was mostly affected by the line of the chickens, showing higher content of MUFA but lower in PUFA in the ♂BB x ♀LB birds. The fatty acid of the breast meat, however showed different response according to the cross and the rearing system. The differences were more pronounced in the ♂LB x ♀BB, and it showed certain advantage with lower content of SFA but higher of PUFA and improved values of P/S and n-6/n-3 ratios in the pastured chickens of this crossbreed.

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Table 4. Effect of the rearing system, cross and their interaction on the fatty acid composition (%FAME) in the breast meat of the chickens

Treatment	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2n-6	C18:3n-3	C20:2n-6	C20:3n-6	C20:4n-6	C20:5n-3	C22:5n-3	C22:6n-3
♂LBx♀BB c	0.71a	28.73b	5.89	8.39	35.77a	18.75	0.40	0.21a	0.20a	0.88a	0.00	0.06a	0.01a
♂LBx♀BB p	0.63a	25.26c	5.46	8.16	33.81ab	21.79	0.53	0.34b	0.39b	3.17b	0.02	0.33b	0.11b
♂BBx♀LB c	0.73a	29.15b	7.48	7.30	37.33a	16.85	0.39	0.14a	0.14a	0.46a	0.00	0.04a	0.00a
♂BBx♀LB p	1.22b	34.55a	8.13	7.85	30.04b	16.98	0.42	0.13a	0.09a	0.59a	0.00	0.00a	0.00a
Rearing system (R)													
Conventional	0.72	28.94	6.69	7.84	36.55	17.80	0.39	0.18	0.17	0.66	0.00	0.05	0.01
Pasture	0.92	29.90	6.80	8.01	31.92	19.38	0.47	0.24	0.24	1.88	0.01	0.17	0.06
Cross (C)													
♂LBx♀BB	0.67	26.99	5.67	8.28	34.79	20.27	0.47	0.27	0.29	2.03	0.01	0.20	0.06
♂BBx♀LB	0.97	31.85	7.81	7.59	33.68	16.91	0.40	0.14	0.11	0.52	0.00	0.02	0.00
Sig.													
R x C	***	***	ns	ns	*	0.06	ns	*	***	***	0.13	***	**
R	***	ns	ns	ns	***	*	***	0.06	*	***	0.13	***	**
C	***	***	***	ns	ns	***	*	***	***	***	0.13	***	***
Pooled SEM	0.05	0.76	0.28	0.22	0.76	0.54	0.02	0.02	0.03	0.25	0.002	0.03	0.001

*P<0.05;**P<0.01;*** P<0.001.Values connected with different letters differ at P<0.05

Table 5. Effect of the rearing system, cross and their interaction on the fatty acid composition (%FAME) in the thigh meat of the chickens

Treatment	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2n-6	C18:3n-3	C20:2n-6	C20:3n-6	C20:4n-6	C20:5n-3	C22:5n-3	C22:6n-3
♂LBx♀BB c	0.98	27.07	8.66	7.08	34.31	19.58	0.49	0.19	0.15	1.34	0.02	0.11	0.02
♂LBx♀BB p	0.91	25.04	7.74	6.93	37.02	20.47	0.50	0.23	0.14	0.90	0.01	0.11	0.00
♂BBx♀LB c	1.09	29.97	10.64	5.94	38.18	13.48	0.28	0.12	0.12	0.18	0.00	0.00	0.00
♂BBx♀LB p	0.99	27.09	9.39	6.37	37.84	16.98	0.40	0.16	0.10	0.61	0.01	0.05	0.01
Rearing system (R)													
Conventional	1.02	28.55	9.64	6.51	36.24	16.53	0.39	0.16	0.13	0.76	0.01	0.05	0.01
Pasture	0.95	26.07	8.56	6.65	37.42	18.73	0.45	0.20	0.12	0.75	0.01	0.08	0.005
Cross (C)													
♂LBx♀BB	0.94	26.06	8.20	7.00	35.66	20.03	0.50	0.22	0.14	1.11	0.02	0.11	0.01
♂BBx♀LB	1.04	28.53	10.02	6.16	38.01	15.23	0.34	0.14	0.11	0.39	0.004	0.03	0.005
Sig.													
R x C	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.08
R	ns	0.07	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
C	ns	0.08	*	ns	0.06	*	*	*	ns	**	ns	*	ns
Pooled SEM	0.04	0.72	0.38	0.21	0.63	0.98	0.03	0.02	0.02	0.14	0.006	0.02	0.004

*P<0.05.Values connected with different letters differ at P<0.05

Table 6. Effect of the rearing system, cross and their interaction on the total amounts of fatty acids and lipid nutritional indices in the breast and thigh meat of the chicken

Treatment	Breast							Thigh						
	SFA	MUFA	PUFA	n-3	n-6	P/S	n-6/n-3	SFA	MUFA	PUFA	n-3	n-6	P/S	n-6/n-3
♂LBx♀BB c	37.83a	41.66	20.50a	0.46a	20.04a	0.54a	43.56a	35.13	42.97	21.90	0.64	21.26	0.62	33.21
♂LBx♀BB p	34.05b	39.27	26.68b	0.99b	25.69b	0.78b	25.95b	32.28	44.76	22.36	0.62	21.74	0.68	35.06
♂BBx♀LB c	37.18a	44.81	18.01a	0.43a	17.58a	0.48c	40.88a	37.00	48.82	14.18	0.28	13.90	0.38	49.64
♂BBx♀LB p	43.62c	38.17	18.21a	0.42a	17.79a	0.42ac	42.36a	34.45	47.23	18.32	0.47	17.85	0.53	37.98
Rearing system (R)														
Conventional	37.50	43.24	19.26	0.45	18.81	0.51	41.80	36.08	45.88	18.04	0.46	17.58	0.50	38.21
Pasture	38.83	38.72	22.45	0.71	21.74	0.68	30.63	33.67	45.98	20.35	0.54	19.80	0.60	36.33
Cross (C)														
♂LBx♀BB	35.94	40.46	23.60	0.74	22.86	0.66	30.89	34.00	43.87	22.14	0.64	21.50	0.65	33.59
♂BBx♀LB	40.41	41.49	18.10	0.42	17.68	0.45	42.09	35.73	48.03	16.25	0.38	15.87	0.45	41.87
Sig.														
R x C	***	0.09	**	***	**	***	***	ns	ns	ns	ns	ns	ns	ns
R	ns	**	**	***	**	**	**	ns	ns	ns	ns	ns	ns	ns
C	***	ns	***	***	***	***	**	ns	**	*	*	**	*	*
Pooled SEM	0.84	0.78	0.84	0.05	0.79	0.03	1.86	0.75	0.81	1.18	0.05	1.13	0.04	2.40

*P<0.05;**P<0.01;*** P<0.001.Values connected with different letters differ at P<0.05