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Research Article
Carcass Characteristics of Vietnamese Indigenous Noi Chicken at 91 Days Old

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Abstract

Background and Objective: Noi is classified as a medium and slow-growing chicken breed of Vietnam, mainly for meat quality and fighting. This study aimed to evaluate carcass performances of Noi broilers at 91 days old. **Materials and Methods:** A total of 355 Noi chickens (164 males and 191 females) were slaughtered at the time point of 91 days old to record and calculate cut-up traits of the carcass. **Results:** Most of the evaluated traits were significantly different ($p<0.001$) between genders. Particularly, the males were always heavier than the females in weights of live body, carcass, thigh meat, breast meat, wing and drumstick ($p<0.05$),where as abdominal fat displayed a contrast between genders (25.04 g for males and 24.74 g for females) although no significant difference was found for this trait ($p>0.05$). In addition, genders significantly affected some cut-up portions such as live weight and carcass weight, except differences in weights of breast yield and abdominal fat, which was found in contrast. Live weight, in overall, significantly correlated with most carcass traits ($p<0.001$), but the coefficients differed due to the type of the observed traits. Females were higher in correlation to the weight of breast, thigh and drumstick than males ($r = 0.71$-0.88; $r = 0.82$-0.91, respectively). **Conclusion:** The findings showed that Noi male broilers had better performances in the live weight and carcass parameter than the female ones, suggesting opportunities for management and genetic improvement through the selection and cross-breeding of the indigenous chicken population.

Key words: Noi chicken breed, carcass traits, correlation, weight of breast, genetic improvement

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Consumption of poultry has dynamically increased over the decade and was ranked second in the world preceded by that of pork. At the same time, selection for chicken genotypes has been greatly developed and as a consequence, improvement for edible carcass yield, mainly for breast meat has intensified standard production[1,2]. Chicken meat is classified as white meat, supplying an important source of nutrients of the former's higher protein, essential amino acids, polyunsaturated fatty acids, minerals (magnesium, sodium and phosphorus) and vitamins (niacin, vitamin A and vitamin E)[3-5]. The growth rate and carcass, therefore, have consistently been the major selection trait of broiler chickens since the 1950s, with more emphasis on the yield of feed efficiency and breast meat. Despite the rapid growth rate and high fat deposition (which are considered unfavorable by customers) due to the inactive lifestyles and energy-rich diets, the chickens are required to be leaner and higher in meat quality in order to improve the quality of the product[2]. Another important aspect affecting the consumption market is the demand of easily prepared products. Few decades ago, the term "ready to grill" of whole carcass was replaced by partial carcass parts according to the need for separate carcass offer, mainly forth quality and yield of the major carcass parts such as thigh and breast muscles without bones[6].

Several factors have influenced carcass performances of broiler chicken before slaughtering, including line, age, health, nutrition and rearing conditions. Nikolova and Pavlovski[6] observed that the genotype of Cobb 500 influenced the mass of major carcass parts, but only on breast yield and the male chickens had significantly bigger breast, thigh and drumsticks meat than the females did. Age impact was statistically significant, so the chicken slaughtered at the 42nd day of age had much bigger carcass yield than those slaughtered at the earlier stage (the 35th day of age). The differences in breast, thigh and drumstick weight of chicken from different nutrition systems were not statistically significant. Other studies found that variation existed among different genotypes and their genders. Although commercial broiler breeders showed better carcass traits compared to the indigenous breeds[7,8], the indigenous chicken performed better meat quality (glutamic acid content, shear values raw and cooked meat) compared to the broiler products[9]. Chicken's gender was the determining factor that directly affected their weights of carcass, wings, breast, legs, liver and gizzard with higher values for males than females[10,11].

Consumers' recently increasing demands for food safety and sustainability of animal production systems have encouraged the use of native chicken for relevant markets[12]. Noi, a Vietnamese indigenous chicken breed has been known to possess desirable traits such as adaptation to local conditions and outstanding meat flavor and tenderness. They are mainly reared in the Southeastern of Vietnam, mostly in the region of South Central Coast and Mekong Delta. Noi chicken is classified as slow-growing broiler with medium body size but an increasing interest in the food servicemarkets[13-15]. Most of research has focused on the growth performances and body conformation of Noi chicken[16-18]. However, fewer reports, if any, compared the features of carcass, individual cut-up portions and edible meat types of birds with the same age but different genders. Therefore, this study aimed to evaluate carcass performances and cuts of commercial interest of Vietnamese indigenous Noi chicken with different genders (males and females) that were raised at 91 days of age under a semi-arid subtropical environment.

MATERIALS AND METHODS

Study area: This study was conducted at Agricultural Service of Can Tho city (formerly Can Tho Center for Breeds of Seed, Livestock and Fish) as well as at Department of Animal Sciences of Can Tho University from July, 2018 to June, 2019.

Birds and measurement of carcass traits: In this study, 355 broilers chicken (164 males and 191 females) of the previous experiment as described by Khoa *et al.*[17] were slaughtered at the time point of 91 days old to record and calculate cut-up traits of carcass including (i) weight traits such as Live Weight (LW, g), Killed Weight (KW, g), De-feather Weight (DFW, g), Carcass Weight (CW, g), Head Weight (HW, g), Weight of Breast Meat (WBM, g), Weight of Thigh Meat (WTM, g), Wing Weight (WW, g), Drumstick Weight (DW, g), Shank Weight (SW, g), Weight of Internal Organs (WIO, g), Gizzard Weight (GW, g), Liver Weight (LW, g), Heart Weight (HW, g), Weight of Abdominal Fat (WAF, g); (ii) length traits such as Caeca Length (CL, mm), Length of Small Intestine (LSI, mm) and (iii) percentage of measured traits with live weight or carcass weight.

Statistical analysis: The collected data on carcass parameters were subjected to analysis by Minitab (ver. 16.0), using the GLM model. Data were expressed as Mean±standard deviation (x±SD).

One-way analysis of variance (ANOVA) was used to compare the means. Differences were considered significant at $p<0.05$. Pearson correlation coefficients among the measurements were calculated.

RESULTS

Carcass characteristics: Mean values of live weight, carcass composition and gut length measured in Noi chickens of separate sex and in overall are summarized in Table 1. Most of the evaluated traits were significantly different ($p<0.001$) between the male and female chickens. The males had significantly higher live weights than the females and mixed-sex birds did (1,587.50 g compared to 1,293.04 and 1,429.07 g, respectively). Killed weight and de-feather weight were also notably affected by the chicken's gender. A significant difference in carcass weight was noticed between gender (1,128.74 and 907.22 g in males and females, respectively). The male group had higher weight of thigh and breast meat, wing and drumstick, whereas the females showed heavier abdominal fat (25.04 g) than the males (24.74 g) did. However, the difference was not significant ($p>0.05$). Higher values of intestines length were also obtained in males compared to females (Table 1).

Percentages of cut-up portions: Gender also significantly affected some carcass proportions related to animal live weight given in Table 2. It was observed that gender had a significant effect on the percentage of de-feather weight, carcass weight and some portions, except for liver and heart weight ($p<0.05$). Higher percentages of de-feather weight (90.89%), carcass weight (70.98%), thigh meat (7.21%), wing weight (8.35%), drumstick weight (13.03%) and shank weight (4.45%) were obtained in the male group. These values were slightly higher in males than in females and mixed genders ($p>0.05$). On the other hand, no differences in weights of killed birds, head, liver and heart were recorded ($p>0.05$) between male and female chickens. Results for the percentage of cut-up portions related to carcass weight were also shown in Table 2. Similar to the previous tendency, male chickens showed higher performances than the females and the mixed sexes genders did in terms of the percentages of wing, drumstick, shank, internal organs and gizzard ($p<0.05$). The percentages of head and heart were also higher in male than in female chickens and mixed genders, but these differences were not statistically significant ($p>0.05$). On the contrary, results of breast yield (Table 2) showed that the female Noi chickens had around 8.6% higher breast yield than the females did. It also showed that gender had significant effects on the portion of abdominal fat, which was found higher in the females compared to the males.

Correlation between live weight and carcass traits of Noi chickens: Table 3 presents the correlations between live weight and carcass traits for males and females separately and both genders together. As shown in Table 3, the live weight, in overall, significantly correlated with most traits ($p<0.001$), but the coefficients differed depending on the type of traits. There was a highly significant and positive correlation observed among the live weight, killed weight, de-feather weight and carcass weight ($r>0.98$, $p<0.001$). The live weight

Table 1: Carcass characteristics of Noi chicken in general and between genders

	Gender				
Traits	Male (n = 164)	Female (n = 191)	SEM	p-value	Overall
LW (g)	1,587.50±220.40[a]	1,293.04±266.00[b]	18.50	0.000	1,429.07±286.28
KW (g)	1,547.80±215.20[a]	1,259.63±257.80[b]	17.98	0.000	1,392.76±178.70
DFW (g)	1,443.38±206.40[a]	1,169.17±245.00[b]	17.15	0.000	1,295.85±265.66
CW (g)	1,128.74±172.90[a]	907.22±199.50[b]	14.12	0.000	1,009.55±217.60
HW (g)	90.56±20.64[a]	71.40±20.22[b]	1.54	0.000	80.25±22.52
WBM (g)	157.45±30.85[a]	137.73±30.04[b]	2.29	0.000	146.84±31.93
WTM (g)	114.99±21.47[a]	90.91±21.54[b]	1.62	0.000	102.03±24.61
WW (g)	132.68±25.12[a]	102.08±24.45[b]	1.86	0.000	116.22±29.07
DW (g)	207.30±36.87[a]	160.05±41.74[b]	2.98	0.000	181.88±46.02
SW (g)	70.55±13.34[a]	50.29±16.00[b]	1.12	0.000	59.65±17.94
WIO (g)	158.53±26.86[a]	140.69±29.32[b]	2.12	0.000	148.93±29.55
GW (g)	16.74±3.56[a]	15.52±3.57[b]	0.27	0.001	16.08±3.61
LRW (g)	27.70±6.15[a]	22.63±5.64[b]	0.44	0.000	24.97±6.40
HTW (g)	8.12±1.74[a]	6.44±2.25[b]	0.15	0.000	7.22±2.20
WAF (g)	24.74±15.69[a]	25.04±15.88[b]	1.19	0.859	24.90±15.77
LSI (mm)	1,361.77±170.20[a]	1,273.75±185.00[b]	13.41	0.000	1,314.41±183.40
CL (mm)	319.15±39.11[a]	293.70±38.99[b]	2.94	0.000	305.46±41.01

LW: Live weight, KW: Killed weight, DFW: De-feather weight, CW: Carcass weight, HW: Head weight, WBM: Weight of breast meat, WTM: Weight of thigh meat, WW: Wing weight, DW: Drumstick weight, SW: Shank weight, WIO: Weight of internal organs, GW: Gizzard weight, LRW: Liver weight, HTW: Heart weight, WAF: Weight of abdominal fat, CL: Caeca length, LSI: Length of small intestine. [a,b]Means followed by different letters in the same row differ significantly ($p<0.05$)

Table 2: Difference of cut-up parts as percentage between genders

Traits	Gender		SEM	p-value	Overall
	Male (n = 164)	Female (n = 191)			
Relative to live weight (%)					
KW	97.50±1.19	97.45±1.28	0.09	0.689	97.47±1.24
DFW	90.89±1.85[a]	90.36±1.71[b]	0.13	0.005	90.61±1.79
CW	70.98±2.36[a]	69.98±2.06[b]	0.17	0.000	70.44±2.26
HW	5.76±1.29	5.56±1.27	0.10	0.142	5.65±1.28
WBM	9.91±1.34[a]	10.68±1.21[b]	0.10	0.000	10.33±1.33
WTM	7.21±0.70[a]	7.01±0.65[b]	0.05	0.005	7.11±0.68
WW	8.35±0.97[a]	7.90±0.89[b]	0.07	0.000	8.10±0.96
DW	13.03±1.23[a]	12.28±1.33[b]	0.10	0.000	12.63±1.34
SW	4.45±0.60[a]	3.86±0.67[b]	0.05	0.000	4.13±0.71
WIO	10.03±1.33[a]	10.99±1.74[b]	0.12	0.000	10.54±1.64
GW	1.07±0.24[a]	1.24±0.34[b]	0.02	0.000	1.16±0.31
LRW	1.76±0.37	1.77±0.36	0.03	0.717	1.76±0.36
HTW	0.51±0.09	0.50±0.13	0.01	0.229	0.50±0.11
WAF	1.56±0.99[a]	1.91±1.16[b]	0.08	0.002	1.75±1.10
Relative to carcass weight (%)					
HW	8.13±1.87	7.96±1.91	0.14	0.401	8.04±1.89
WBM	13.96±1.80[a]	15.27±1.72[b]	0.13	0.000	14.67±1.88
WTM	10.16±0.93	10.02±0.90	0.07	0.161	10.09±0.91
WW	11.77±1.40[a]	11.29±1.27[b]	0.10	0.001	11.51±1.35
DW	18.37±1.73[a]	17.55±1.87[b]	0.14	0.000	17.93±1.85
SW	6.27±0.86[a]	5.51±0.95[b]	0.07	0.000	5.86±0.99
WIO	14.16±2.06[a]	15.75±2.81[b]	0.19	0.000	15.01±2.61
GW	1.51±0.35[a]	1.77±0.51[b]	0.03	0.000	1.65±0.46
LRW	2.48±0.55	2.54±0.55	0.04	0.340	2.51±0.56
HTW	0.72±0.14	0.71±0.19	0.01	0.547	0.72±0.17
WAF	2.20±1.41[a]	2.74±1.68[b]	0.12	0.001	2.49±1.58

LW: Live weight, KW: Killed weight, DFW: De-feather weight, CW: Carcass weight, HW: Head weight, WBM: Weight of breast meat, WTM: Weight of thigh meat, WW: Wing weight, DW: Drumstick weight, SW: Shank weight, WIO: Weight of internal organs, GW: Gizzard weight, LRW: Liver weight, HTW: Heart weight, WAF: Weight of abdominal fat. [a,b]Means followed by different letters in the same row differ significantly ($p<0.05$)

was found to be much correlated with the weight of breast, thigh and drumstick in female birds compared to males ($r = 0.82$-0.91; $r = 0.71$-0.88, respectively). Weight of abdominal fat was also correlated with the weight of live chickens and carcass, but the coefficients were low ($r = 0.23$-0.25 in males and $r = 0.34$-0.37 in females). Length of small intestine and caeca was also correlated with the weights of live chickens and carcass, but the coefficients just ranged from 0.40-0.49 in both genders ($p<0.001$).

DISCUSSION

In the present study, Noi broilers had heavier carcass performances and yields than indigenous Thai chickens slaughtered at the age of 16 weeks[19] and Aseel chicken slaughtered at 60 weeks[8] (the slow-growing indigenous breeds as Noi chickens) but lower than the Ross 308 and Cobb chickens, the fast-growing broiler breeds[20,21]. These differences were probably due to the varied metabolic rates among breeds. The significant effects of gender on most of the weight of live chickens and most of carcass portions (except for the weight of abdominal fat) suggest the differences exist between genders within Noi breed. The non-significant difference in abdominal fat between genders found in this study was also reported by Rondelli *et al.*[22]. As indicated in Table 1, the male chickens showed higher values in live weight and carcass traits, meaning that heavier birds produce greater carcass performances. Similar findings were obtained by other authors who reported significant differences in live body weight and carcass traits between genders of three chicken breeds at 12 weeks[23] or Ross 308 at 37 days of age[24].

For the carcass yield, the significant effects of gender on the results are consistent with the findings of Faria *et al.*[25], who reported higher carcass yield for males slaughtered at 80 to 95 days of age. Noi females presented higher breast yield (8.6%), as compared to males, as also shown by the other authors[24,25]. Similarly to this study, the previous authors stated that carcass characteristics except the yield of breast meat

Table 3: Pearson's correlation coefficients among live weight and carcass traits

Traits	LW	KW	DFW	CW	HW	WBM	WTM	WW	DW	SW	WIO	GW	LRW	HTW	WAF	LSI	CL
Male and female animals																	
LW	1.00	1.00***	0.99***	0.98***	0.33***	0.71***	0.87***	0.81***	0.84***	0.74***	0.67***	0.23***	0.44***	0.59***	0.25***	0.37***	0.35***
KW	1.00***	1.00	0.99***	0.98***	0.33***	0.71***	0.87***	0.81***	0.84***	0.74***	0.67***	0.27***	0.43***	0.58***	0.26***	0.37***	0.34***
DFW	1.00***	1.00***	1.00	0.99***	0.34***	0.73***	0.88***	0.81***	0.84***	0.76***	0.67***	0.27***	0.42***	0.57***	0.25***	0.40***	0.35***
CW	0.99***	0.99***	0.99***	1.00	0.32***	0.74***	0.88***	0.80***	0.84***	0.74***	0.62***	0.25***	0.39***	0.55***	0.23**	0.37***	0.33***
HW	0.64***	0.64***	0.65***	0.62***	1.00	0.29***	0.37***	0.22***	0.26***	0.22**	-0.05^{NS}	0.06^{NS}	0.09^{NS}	0.18*	-0.04^{NS}	0.14^{NS}	0.10^{NS}
WBM	0.83***	0.83***	0.83***	0.82***	0.46***	1.00	0.65***	0.52***	0.67***	0.51***	0.37***	0.19*	0.22**	0.30***	0.15^{NS}	0.30***	0.25**
WTM	0.90***	0.90***	0.90***	0.88***	0.58***	0.87***	1.00	0.73***	0.75***	0.67***	0.50***	0.22**	0.35***	0.56***	0.18*	0.32***	0.27***
WW	0.86***	0.86***	0.86***	0.84***	0.51***	0.74***	0.86***	1.00	0.72***	0.78***	0.49***	0.29***	0.46***	0.52***	0.03^{NS}	0.37***	0.35***
DW	0.91***	0.91***	0.90***	0.88***	0.54***	0.84***	0.89***	0.88***	1.00	0.66***	0.51***	0.18*	0.39***	0.57***	0.16*	0.28***	0.31***
SW	0.81***	0.81***	0.82***	0.79***	0.47***	0.69***	0.82***	0.85***	0.82***	1.00	0.40***	0.37***	0.47***	0.46***	-0.11^{NS}	0.49***	0.41***
WIO	0.73***	0.74***	0.74***	0.69***	0.26***	0.66***	0.67***	0.60***	0.70***	0.54***	1.00	0.22**	0.42***	0.41***	0.58***	0.35***	0.34***
GW	0.28***	0.28***	0.29***	0.26***	0.09^{NS}	0.27***	0.26***	0.24***	0.24***	0.27***	0.42***	1.00	0.17*	0.12^{NS}	-0.21**	0.30***	0.25***
LRW	0.64***	0.64***	0.64***	0.61***	0.36***	0.53***	0.59***	0.59***	0.60***	0.61***	0.61***	0.32***	1.00	0.58***	-0.07^{NS}	0.28***	0.28***
HTW	0.62***	0.62***	0.62***	0.61***	0.40***	0.51***	0.60***	0.60***	0.59***	0.52***	0.50***	0.24***	0.47***	1.00	0.01^{NS}	0.25***	0.21**
WAF	0.37***	0.38***	0.36***	0.34***	0.12^{NS}	0.32***	0.31***	0.28***	0.36***	0.12^{NS}	0.58***	0.01^{NS}	0.17*	0.25***	1.00	0.01^{NS}	-0.05^{NS}
LSI	0.33***	0.33***	0.33***	0.31***	0.20**	0.26***	0.31***	0.27***	0.30***	0.30***	0.39***	0.08^{NS}	0.25***	0.18**	0.25***	1.00	0.38***
CL	0.45***	0.46***	0.46***	0.44***	0.30***	0.37***	0.42***	0.38***	0.43***	0.39***	0.46***	0.26***	0.42***	0.35***	0.16*	0.39***	1.00
Overall (male+female)																	
LW	1.00																
KW	1.00***	1.00															
DFW	1.00***	1.00***	1.00														
CW	1.00***	0.99***	0.99***	1.00													
HW	0.61***	0.61***	0.62***	0.60***	1.00												
WBM	0.79***	0.79***	0.80***	0.80***	0.46***	1.00											
WTM	0.91***	0.91***	0.92***	0.91***	0.59***	0.79***	1.00										
WW	0.88***	0.88***	0.88***	0.87***	0.51***	0.67***	0.85***	1.00									
DW	0.91***	0.91***	0.91***	0.90***	0.54***	0.78***	0.87***	0.86***	1.00								
SW	0.85***	0.85***	0.85***	0.83***	0.51***	0.65***	0.82***	0.87***	0.83***	1.00							
WIO	0.73***	0.74***	0.74***	0.70***	0.23***	0.57***	0.64***	0.61***	0.66***	0.55***	1.00						
GW	0.32***	0.32***	0.32***	0.30***	0.14***	0.27***	0.29***	0.31***	0.27***	0.35***	0.36***	1.00					
LRW	0.63***	0.63***	0.63***	0.60***	0.35***	0.45***	0.57***	0.62***	0.60***	0.63***	0.58***	0.29***	1.00				
HTW	0.68***	0.68***	0.67***	0.66***	0.42***	0.49***	0.65***	0.64***	0.65***	0.59***	0.52***	0.24***	0.59***	1.00			
WAF	0.27***	0.27***	0.27***	0.25***	0.04^{NS}	0.22***	0.21***	0.13**	0.23***	0.01^{NS}	0.55***	-0.09^{NS}	0.04^{NS}	0.14**	1.00		
LSI	0.41***	0.41***	0.42***	0.40***	0.25***	0.33***	0.38***	0.38***	0.36***	0.44***	0.42***	0.21***	0.33***	0.28***	0.14**	1.00	
CL	0.49***	0.49***	0.50***	0.48***	0.31***	0.38***	0.44***	0.46***	0.47***	0.48***	0.46***	0.29***	0.43***	0.37***	0.06^{NS}	0.43***	1.00

LW: Live weight, KW: Killed weight, DFW: De-feather weight, CW: Carcass weight, HW: Head weight, WBM: Weight of breast meat, WTM: Weight of thigh meat, WW: Wing weight, DW: Drumstick weight, SW: Shank weight, WIO: Weight of internal organs, GW: Gizzard weight, LRW: Liver weight, HTW: Heart weight, WAF: Weight of abdominal fat, CL: Caeca length, LSI: Length of small intestine. *Significant at p<0.05, **Significant at p<0.01, ***Significant at p<0.001, ^{NS}Non-significant. Male: Above diagonal line break, Female: Below the diagonal break

and abdominal fat were not greatly influenced by gender[21,22]. It was probably due to sexual dimorphism of the carcass conformation, in which female chicken presented a higher breast development and a lower drumstick percentage compared to males[22]. The females were normally fatter than the males because female hormones stimulated fat deposition, so they started to store fat 2 weeks earlier than the males[22,26,27]. From a view of nutrition, these differences limit the slaughter age of females. Furthermore, the fat volume and fat quality (including cholesterol content) in animal products are considered to be the risk of cardio-vascular diseases and in human[22].

Gender differs in physiology and it could result in the higher feed conversion efficiency of males than females in the same rearing systems[26]. Many studies[23,28] also confirmed that low live weight was associated with low carcass performances. Not only live weight but also carcass weight was highly and positively associated to other portions (Table 3). Ndomou *et al.*[28], on the contrary, stated that there was no significant association between the carcass yield and the other carcass traits. The significant correlations between live weight and most of the carcass characteristics can be beneficial in predicting the values of these traits with no additional cost and time. In summary, although Noi chickens have low live weight, carcasses and cut-up parts, they cannot be absent from the Vietnamese poultry raising system because their meat quality is preferred by consumers and they are really easy to raised in farming conditions to increase income and improve family life. Therefore, in order to improve the weight and productivity of the Noi chickens, it is recommended to crossbreed with other backyard chicken breeds, for example the fighting cock, namely Choi, in Binh Dinh Vietnam.

CONCLUSION

The findings of this study showed that male chicken from Noi breed had better performance in the live weight and carcass parameters. Males had lower breast yield and deposited less fat than females. The other carcass proportions such as thigh meat, wing, drumstick and shank were strongly gender-dependent. In overall, there was a highly significant and positive correlation observed among the live weight and all carcass traits. Higher correlation coefficients between live weight and weight of breast, thigh and drumstick were found in the female group compared to the male one. These results suggest opportunities for management and genetic improvement through the selection and cross-breeding of the indigenous chicken population.

SIGNIFICANCE STATEMENT

The current study was undertaken to provide information about carcass characteristics of Noi broiler, a native chicken breed of Vietnam. It helps consumers to select quality traits for meat and breeding. This study would also help the researchers to uncover the critical areas of carcass performances of broiler chickens.

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