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Estimation of Carcass Trait Characteristics, Proportions, and Their Correlation with Preslaughter Body Weight in Indigenous Chickens in Southeastern Ethiopia

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Abstract: This study aimed to estimate carcass trait characteristics, proportions, and their correlation with the preslaughter body weight of indigenous chickens in Southeastern Ethiopia. Data from 42 healthy male chickens were collected and analyzed using SAS 2012 ver. 9.4, R software ver.4.3.1, and MetaboAnalyst 5.0. The results indicated significant fixed effect of districts on dressed carcass weight, drumsticks, thighs, wings, and gizzard between Goba and Agarfa chickens ($p < 0.05$). The fixed effect of age and the district–age interaction effect were not significant. Principal component analysis revealed that PC1, accounting for 96.8% of the total variation between Goba and Agarfa chickens, was contributed by preslaughter and dressed carcass weight. Among the carcass components, the key contributors to differentiation between the Goba and Agarfa indigenous chicken carcass yields were the drumstick, thigh, breast (with/without keel bone), and back with thoracic weight (VIP > 1); there was a higher yield in Goba chickens. Preslaughter weight exhibited stronger correlations with most other traits, while dressing percentages displayed a negative correlation with various carcass components and edible giblet yields across the study districts. This study provides useful insights into carcass component characteristics and yields of indigenous Ethiopian chickens, which can increase our understanding of carcass components and their relationships with other qualities for improvement and further studies on poultry production.

Keywords: body weight; carcass component; correlation; dressing percentage; edible giblet; Ethiopia; indigenous chicken; multivariate analysis

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1. Introduction

Ethiopia is characterized by diverse agroclimatic conditions and possesses abundant plant and animal genetic resources, making it one of the world's endowed countries in terms of biodiversity [1]. The term "poultry" in Ethiopia broadly refers to domestic chickens (*Gallus gallus domesticus*), as other poultry sources of eggs and meat are relatively unpopular [2]. Indigenous chickens are widely reared in Ethiopia for numerous societal and economic purposes, including cash income, hatching to replace stock, home consumption, and participation in sociocultural and religious ceremonies [3,4]. Indigenous chickens are commonly found throughout rural Ethiopia and are an important source of protein and income for numerous families [4]. Smallholder farmers primarily raise indigenous chickens in scavenging environments, accounting for 78.0% of the country's total chicken population, which is estimated to be over 41.35 million [5]. However, the economic contribution of indigenous chicken farming remains limited due to poor feeding, inadequate housing, and limited access to veterinary services, which are related to challenges in production, reproduction, and infrastructure [6].

Local chicken breeds are potential sources of valuable genetic resources for future breeding strategies and research [7]. The conservation of these breeds has emerged as a crucial concern for the global scientific community [8]. In addition, modern consumer preferences have shifted towards traditional products that are more environmentally friendly and prioritize animal welfare. Consequently, rural poultry production has attracted increasing interest [9,10]. In contemporary poultry production, carcass tissue composition is of significant economic importance because of the rising consumer preference for specific meat cuts [11]. Traits such as retail product weight and meat proportion indicate carcass quality based on marketable quantities [12]. Thus, broiler production strongly focuses on ensuring high standards and optimal output of primary carcass components [11].

Native chicken ecotypes in Ethiopia are preferred over commercial poultry strains because of their natural coloration, sensory appeal, distinctive flavor, and lean meat [13]. Different poultry species dominate smallholder production systems across various regions worldwide and are influenced by ecological and sociocultural preferences [8]. Despite their popularity and adaptability to the local environment, indigenous chickens generally perform worse than exotic or hybrid poultry breeds. Kenyan studies on native poultry have consistently shown that indigenous chickens produce smaller eggs and chicks [14]. They also display relatively lower meat and egg yield than industrial poultry strains, which could be partly attributed to genetic limitations and extensive poultry husbandry practices prevalent among farmers.

Despite the preference and popularity of indigenous chickens' meat among farmers and consumers, more comprehensive studies must be conducted on their carcass and edible giblet component traits, proportions, and their correlation with preslaughter weight and dressing percentages. Understanding these characteristics and their potential correlation with preslaughter weight will contribute to broader knowledge of indigenous chicken breeding and management strategies, ultimately benefiting local poultry production and the livelihoods of rural farmers. Therefore, this study aimed to investigate the carcass components and edible giblet characteristics and proportions, and their correlation with the preslaughter body weight and dressing percentage of indigenous chickens managed by farmers in two different extensive raising systems in southeastern Ethiopia.

2. Materials and Methods

2.1. Description of the Study Areas

The research was conducted in the Agarfa and Goba districts of the Bale Administrative Zone of southeastern Ethiopia, Oromia Regional State, which is located 430 km southeast of Addis Ababa (the country's capital city) and has 11 districts and two urban administrative towns. The West Arsi Zone borders it in the north, the Guji Zone in the south, the Somali Regional State and West Bale Zone in the east, and the West Arsi Zone in the West, according to information obtained from the Agricultural and Natural Resource Bureau of the Bale Zone (ANRBBZ, 2021). The Bale Zone has an altitude of 300–4377 m above sea level with longitudes 38°40′–46°3′ E and latitudes 4°11′–8°11′ N. Rainfall per annum ranges between 1100 and 1300 mm, while the mean day and night temperatures range between 3.5 and 30 °C.

2.2. Animals and Data Collection

Carcass data were collected from 42 healthy local male chickens, aged between 40 and 60 weeks, purchased randomly from farmers' houses from the two districts. They were transported to the Agarfa Agricultural Technical, Vocational, and Educational Training College (ATVET), where they were slaughtered and the carcass parameters were measured. The animals were permitted to reacquaint themselves with their surroundings before slaughter. They were fasted overnight before slaughter, and their preslaughter weight (in gram) was measured immediately prior to killing using a spring balance (SALTER Model 235, Salter Brecknell, West Midland, UK) with a weighing capacity of 10 kg and an accuracy of 50 g. Then, the chickens were humanely slaughtered by cutting their jugular vein to ensure proper bleeding, and they were immersed in hot water at temperatures ranging from 50 °C to 60 °C for 2 to 4 min to loosen the feathers. Scalded chickens were manually abraded to remove feathers, and the carcass was manually apportioned by cutting, followed by evisceration, which involved removing the head, feet, and viscera. Once separated from the offal, carcass components were weighed (in grams) using a digital scale with an accuracy of one gram. Commercial carcass cuts, including breasts with and without bone, drumstick, thigh, back with thorax, neck, skin, and wing weights, and edible giblets, such as the heart, liver, and gizzard recovered from sorted viscera, were manually separated and individually weighed. The following formulas were used to calculate the dressed carcass weight, dressing percentage, proportions of carcass components, and edible giblet proportions:

$$\text{DCW} = \text{PSW} - \text{OW (head, feet and feather inclusive)} \tag{1}$$

$$\text{DP (\%)} = \text{Weight of the carcass/PSW} \times 100 \tag{2}$$

$$\text{CCP} = \text{Carcass component weight/DCW} \times 100 \tag{3}$$

$$\text{EGP} = \text{Recovered edible giblet weight/PSW} \times 100 \tag{4}$$

where variables represent the following characteristics: DCW, dressed carcass weight; PSW, preslaughter weight; OW, offal weight; DP, dressing percentage; CCP, carcass component proportions; and EGP, edible giblet proportion.

The following model was employed to demonstrate the effect of district (location of native chicken habitats) and age category on the various cuts of different carcass yields and the preslaughter weight of the indigenous Ethiopian chickens:

$$Y_{ijk} = \mu + \beta_i + D_j + (\beta D)_{ij} + \varepsilon_{ijk} \tag{5}$$

where Y_{ijk} is the observed value of dependent variables, μ is the mean value, β_i is the effect of the ith age group category on carcass yield (i = AG1: 40–46, AG2:47–53, and AG3: 54–60 weeks) D_j is the effect of the jth district (j = Goba and Agarfa), $(\beta D)_{ij}$ is the effect of the district–age interaction, and ε_{ijk} is the residual error of the kth observation recorded for the ith age and jth district.

2.3. Statistical Analysis

All data on the carcass component characteristics and proportions of indigenous chicken ecotypes were encoded and documented in a Microsoft Excel spreadsheet 2019 ver.1808 for window and saved as a "CSV" file. Two-way ANOVA was used to analyze the data in SAS 2012 ver. 9.4, and expressed as the least squares means (LSM) ± SE. The R software ver.4.3.1 [15] was used for correlation analysis and graphical presentation. Least squares mean comparisons of preslaughter weight, dressed carcass, dressing percentage, carcass component characteristics, and carcass proportions of the indigenous chickens of different extensive raising systems and ages were made using Tukey's range test, and the values were considered significant at $p < 0.05$.

A multivariate statistical analysis procedure, principal component analysis (PCA), was performed employing MetaboAnalyst5 (https://www.metaboanalyst.ca, accessed on 15 August 2023) to classify the most important variables contributing to variability in the Goba and Agarfa indigenous chicken carcass yield characteristics. The pair plot Pearson correlation of preslaughter and dressed carcass weight, carcass components, and edible giblets between the Goba and Agarfa were visualized using R software ver.4.3.1 [15]. The results are presented as graphical plots.

3. Results

3.1. Preslaughter Body Weight, Dressed Carcass Weight, and Dressing Percentages

The data on preslaughter weight (g), dressed carcass weight (g), and dressing percentage (%) of indigenous chicken ecotypes from the Goba and Agarfa districts in southeastern Ethiopia are presented in Table 1. Dressed carcass weight was significantly different between the two districts ($p < 0.05$). The results depicted in Table 1 demonstrate that there was no significant difference in the preslaughter body weight, dressed carcass weight, and dressing percentages of Ethiopian indigenous chickens in the three age categories ($p > 0.05$).

Table 1. LSM ± SE values for preslaughter weight and carcass component yield (g) characteristics in indigenous chickens across the three age groups and two districts (N = 42).

Traits	Ages (A)			*p*-Values	District (D)		*p*-Values
	AG-1	AG-2	AG-3		Goba	Agarfa	
PSW	1300 ± 57.74	1270.59 ± 25.4	1338.89 ± 32.5	0.341	1338.1 ± 27.15 [a]	1271.4 ± 27.73 [a]	0.094
DCW	923.69 ± 39.09	901.36 ± 19.34	939.57 ± 23.15	0.542	949.39 ± 18.18 [a]	893.52 ± 20.19 [b]	0.046
DP	79.38 ± 3.69	80.71 ± 1.55	76.95 ± 2.01	0.434	76.83 ± 1.65 [a]	80.92 ± 1.74 [a]	0.096
DS	142.33 ± 9.25	138.51 ± 4.79	146.79 ± 4.99	0.597	149.49 ± 4.16 [a]	135.9 ± 4.59 [b]	0.034
Th	184.91 ± 5.04	182.39 ± 3.48	184.67 ± 4.09	0.907	188.47 ± 2.94 [a]	179.11 ± 3.45 [b]	0.045
BWB	165.27 ± 8.3	158.92 ± 5.09	169.27 ± 5.78	0.459	168.76 ± 4.77 [a]	160.07 ± 5.06 [a]	0.219
BWKB	107.3 ± 6.52	102.98 ± 3.17	110.59 ± 3.57	0.381	111.28 ± 3.22 [a]	102.65 ± 2.99 [a]	0.057
BkWT	114.59 ± 6.74	114.98 ± 2.81	115.3 ± 3.93	0.999	118.51 ± 2.9 [a]	111.6 ± 3.37 [a]	0.128
SSF	79.97 ± 2.67	77.18 ± 1.79	82.4 ± 1.8	0.159	81.72 ± 1.77 [a]	78.04 ± 1.5 [a]	0.121
Wg	78.86 ± 1.61	77.11 ± 0.87	79.41 ± 1.05	0.282	79.74 ± 0.78 [a]	77.03 ± 0.93 [b]	0.031
Nk	50.46 ± 1.82	49.29 ± 1.05	51.13 ± 1.1	0.547	51.41 ± 0.81 [a]	49.14 ± 1.1 [a]	0.104
Gd	21.63 ± 1.51	20.36 ± 0.81	22.86 ± 0.87	0.161	22.74 ± 0.79 [a]	20.55 ± 0.76 [b]	0.053
Ht	8.54 ± 0.39	8.66 ± 0.27	8.51 ± 0.29	0.921	8.58 ± 0.26 [a]	8.58 ± 0.24 [a]	0.989
Lr	20.51 ± 1.55	21.82 ± 0.72	22.04 ± 0.74	0.639	22.62 ± 0.65 [a]	20.77 ± 0.71 [a]	0.060

[a,b] Means between districts with different superscript letters are significantly different ($p < 0.05$). LSM: Least squares means, SE: standard errors, and N: number of indigenous chickens slaughtered. Age groups (AG-1: 40–46, AG-2: 47–53, and AG-3: 54–60 weeks). PSW: preslaughter weight, DCW: dressed carcass weight, DP: dressing percentage, DS: drumstick, Th: thigh, BWB: breast without keel bone, BWKB: breast with keel bone, BkWT: back with thorax, SSF: skin with subcutaneous fat, Wg: wing, Nk: neck, Gd: gizzard, Ht: heart, and Lr: liver.

3.2. Characteristics of Carcass Components and Edible Giblet Yields

Table 1 displays the least square mean values of carcass components and edible giblets for the three age categories and two districts. No significant differences were observed among the three age categories for any of the carcass components or edible giblet yield. However, significant differences were prominent in the drumstick, thigh, wing, and gizzard in indigenous chickens from the Goba and Agarfa districts with higher yields from Goba compared to Agarfa ($p < 0.05$).

3.3. Effect of District, Age, and the District–Age Interaction on Carcass Components Characteristics

The effects of district, age, and the district–age interaction on preslaughter weight, dressed carcass weight, dressing percentage, and carcass component yields are presented in Tables 1 and 2. The results indicated that district had a significant effect on dressed carcass weight, drumstick, thigh, wing, and gizzard ($p < 0.05$). Age and the district–age interaction effects did not show any significant differences in PSW, DCW, DP, and carcass components ($p > 0.05$).

3.4. Carcass Component and Edible Giblet Proportions

The least squares mean (LSM) of carcass components and edible giblet proportions of indigenous chickens from the Goba and Agarfa districts are presented in Table 3. The results indicated no significant differences in the proportions of all carcass and edible giblet component yields among indigenous chickens from the Goba and Agarfa districts in southeastern Ethiopia.

Table 2. District–age (D×A) interaction effect on preslaughter weight, dressed carcass weight, dressing percentage, and carcass component characteristics (LSM ± SE) in Ethiopian indigenous chickens (N = 42).

Traits	Goba			Agarfa			*p*-Values
	AG-1	AG-2	AG-3	AG-1	AG-2	AG-3	
PSW	1266.67 ± 88.19	1300 ± 46.29	1390 ± 31.45	1325.00 ± 85.39	1244.44 ± 24.22	1275 ± 55.9	0.312
DCW	922.9 ± 63.87	933.86 ± 30.42	969.76 ± 24.56	924.28 ± 57.51	872.47 ± 21.71	901.84 ± 39.93	0.680
DP (%)	81.28 ± 5.91	79.11 ± 2.85	73.68 ± 1.74	77.95 ± 5.34	82.13 ± 1.50	81.04 ± 3.60	0.309
DS	147.03 ± 15.68	148.13 ± 7.18	151.32 ± 5.61	138.8 ± 12.91	129.96 ± 5.22	141.13 ± 8.80	0.806
Th	187.13 ± 5.04	187.64 ± 4.71	189.54 ± 4.94	183.25 ± 8.60	177.73 ± 4.75	178.59 ± 6.54	0.874
BWB	159.83 ± 10.98	164.24 ± 8.27	175.06 ± 6.84	169.35 ± 12.97	154.19 ± 6.22	162.04 ± 9.69	0.540
BWKB	110.43 ± 12.93	107.55 ± 5.36	114.52 ± 4.12	104.95 ± 7.80	98.92 ± 3.34	105.69 ± 5.99	0.965
BkWT	110.50 ± 13.30	117.64 ± 4.46	121.61 ± 3.43	117.65 ± 7.96	112.62 ± 3.60	107.41 ± 7.04	0.265
SSF	78.83 ± 3.15	78.64 ± 3.00	85.06 ± 2.45	80.83 ± 4.42	75.89 ± 2.16	79.08 ± 2.30	0.483
Wg	79.00 ± 3.33	78.69 ± 1.42	80.81 ± 0.79	78.75 ± 1.86	75.70 ± 0.86	77.66 ± 2.06	0.699
Nk	50.13 ± 0.87	51.35 ± 1.58	51.84 ± 1.19	50.70 ± 3.34	47.46 ± 1.15	50.25 ± 2.03	0.522
Gd	21.03 ± 1.88	21.81 ± 1.45	24.00 ± 1.00	22.08 ± 2.46	19.08 ± 0.62	21.44 ± 1.40	0.458
Ht	8.10 ± 0.40	8.43 ± 0.35	8.84 ± 0.46	8.88 ± 0.59	8.88 ± 0.42	8.10 ± 0.25	0.208
Lr	20.70 ± 2.27	23.31 ± 1.03	22.65 ± 0.89	20.38 ± 2.42	20.49 ± 0.83	21.28 ± 1.25	0.649

LSM: Least squares means, SE: standard errors, and N: number of indigenous chickens slaughtered. Age groups (AG-1: 40–46, AG-2: 47–53, and AG-3: 54–60 weeks). PSW: preslaughter weight, DCW: dressed carcass weight, DP: dressing percentage, DS: drumstick, Th: thigh, BWB: breast without keel bone, BWKB: breast with keel bone, BkWT: back with thorax, SSF: skin with subcutaneous fat, Wg: wing, Nk: neck, Gd: gizzard, Ht: heart, and Lr: liver.

Table 3. Least squares mean (LSM ± SE) of carcass component and edible giblet proportions of indigenous chickens' carcasses in southeastern Ethiopia (N = 42).

Classification	Trait Components	Goba (*n* = 21)	Agarfa (*n* = 21)	*p*-Values
Major carcass component proportion	Drumstick	15.71 ± 0.23	15.15 ± 0.24	0.1045
	Thigh	19.90 ± 0.20	20.09 ± 0.19	0.4838
	Breast without keel bone	17.73 ± 0.21	17.86 ± 0.21	0.6548
	Breast with keel bone	11.71 ± 0.22	11.48 ± 0.18	0.4296
	Back with Thorax	12.47 ± 0.17	12.48 ± 0.25	0.9760
Minor carcass component proportion	Skin with subcutaneous fat	8.62 ± 0.13	8.76 ± 0.12	0.4087
	Wing	8.44 ± 0.12	8.67 ± 0.12	0.1910
	Neck	5.43 ± 0.07	5.51 ± 0.07	0.4200
Edible giblet proportion	Gizzard	1.70 ± 0.04	1.61 ± 0.04	0.1283
	Heart	0.64 ± 0.02	0.68 ± 0.02	0.1540
	Liver	1.69 ± 0.04	1.63 ± 0.04	0.2782

LSM: Least squares means, SE: standard errors, and N: total number of indigenous chickens slaughtered. *n* = number indigenous chicken slaughtered from each district.

3.5. Multivariate Analysis of Carcass Component and Edible Giblets

Principal component analysis (PCA) and variable importance on projection (VIP) scores for preslaughter weight, dressed carcass, carcass components, and edible giblets of indigenous chickens in the Goba and Agarfa districts of southeastern Ethiopia are shown in Figure 1a–d. The analysis revealed that the PC 1 accounted for 96.8% of the total variation between the Goba and Agarfa districts (Figure 1c). However, when excluding the preslaughter weight and dressed carcass yields as indicated in Figure 1a, the analysis revealed that the PC1 accounted for 79% of the total variation between Goba and Agarfa districts.

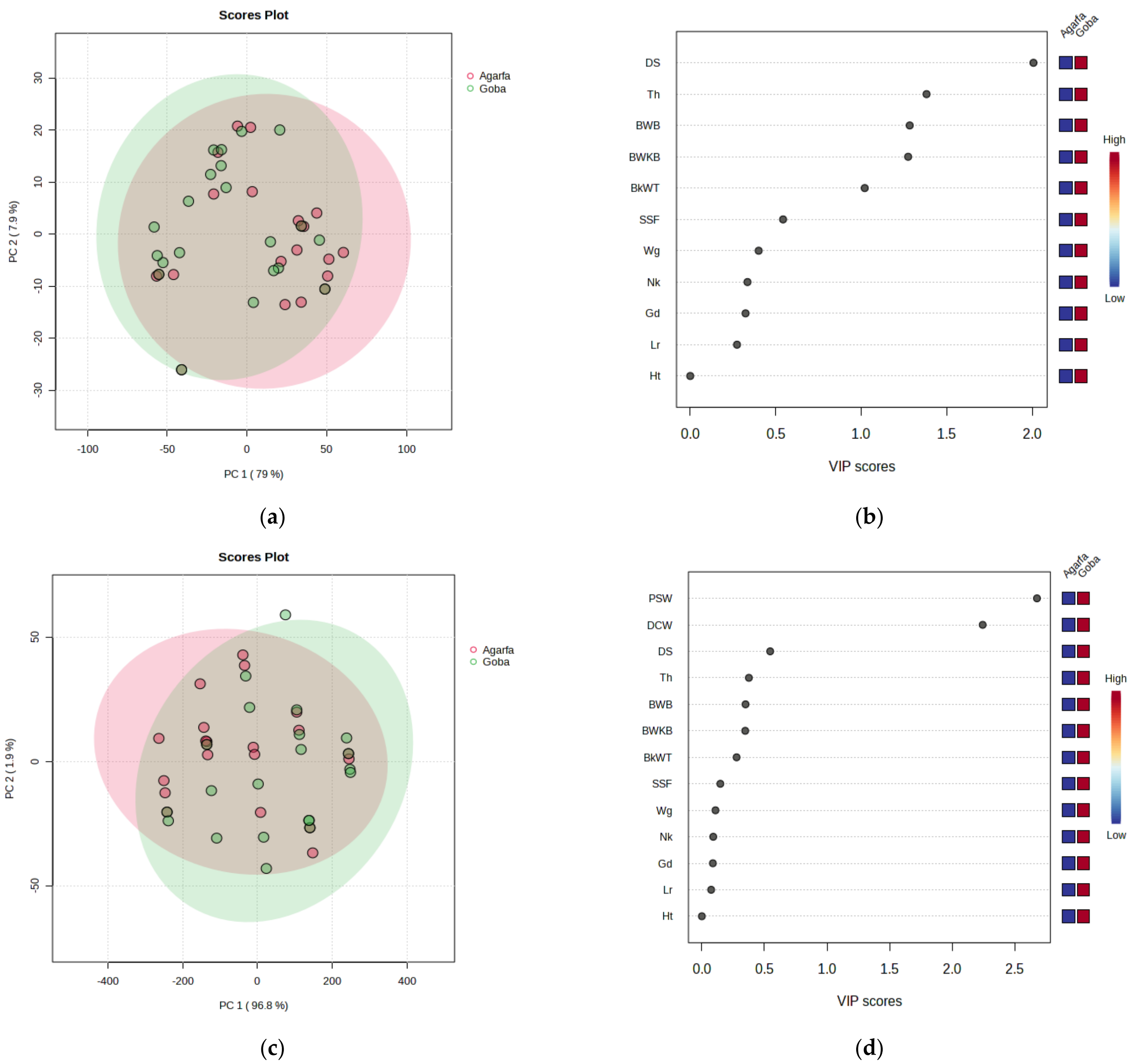

Figure 1. Principal component analysis (PCA) results (**a**,**c**) and variable importance in projection (VIP) scores (**b**,**d**) display the relationships among preslaughter weight, dressed carcass weight, carcass component characteristics, and edible giblet yields of indigenous chicken meat cuts in two districts. Preslaughter and dressed carcass weight are excluded (**a**,**b**) and included (**c**,**d**). Acronyms: PSW: preslaughter weight, DCW: dressed carcass weight, DS: drumstick, Th: thigh, BWB: breast without keel bone, BWKB: breast with keel bone, BkWT: back with thorax, SSF: skin with subcutaneous fat, Wg: wing, Nk: neck, Gd: gizzard, Ht: heart, and Lr: liver.

3.6. Carcass Component and Preslaughter Body Weight Correlations

The result indicated in Figure 2 presents a pair plot showing the spearman correlations of preslaughter weight and carcass components yields from indigenous chickens from the Agarfa and Goba districts for each pair of variables. The correlation results revealed that heart yield exhibited a relatively low correlation with other traits, particularly gizzard and liver yields, followed by back, thorax, and drumstick yields. Preslaughter weight indicated higher correlation with the majority of the other traits across the study area, except that it negatively correlated with dressing percentages. On the other hand, dressing percentages showed a negative correlation with other carcass components and edible giblet yields across the study districts.

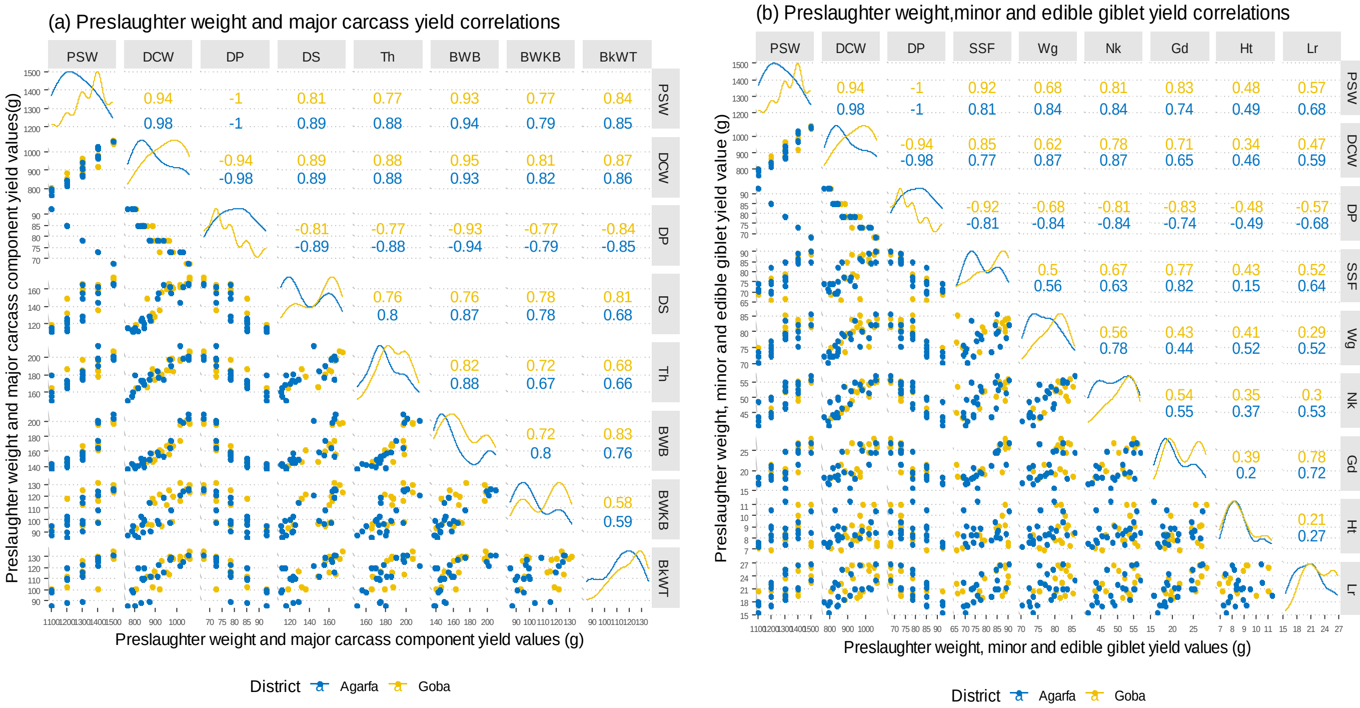

Figure 2. A pair plot showing the spearman correlations between preslaughter weight and carcass components of indigenous chickens from the Agarfa and Goba districts for each pair of variables in the form of scatterplots in the lower diagonal, densities on the diagonal, and correlations written in the upper diagonal. (**a**) between preslaughter weight, dressed carcass weight, dressing percentage and major carcass components yields; (**b**) between preslaughter weight, dressed carcass weight, dressing percentage, minor carcass components, and edible giblet. Abbreviation: PSW: preslaughter weight, DCW: dressed carcass weight, DP: dressing percentage, DS: drumstick, Th: thigh, BWB: breast without keel bone, BWKB: breast with keel bone, BkWT: back with thorax, SSF: skin with subcutaneous fat, Wg: wing, Nk: neck, Gd: gizzard, Ht: heart, and Lr: liver.

4. Discussion

The least squares mean values pertaining to the preslaughter weight and carcass component yield characteristics of the indigenous chickens in the present investigation did not display any statistically significant discrepancies with respect to the traits observed in indigenous chickens across the three age groups. The preslaughter weight presented in the present study showed no difference in yield between Goba (1381.1 g) and Agarfa (1271.4 g) ($p > 0.05$). However, the dressed carcass weight yield results showed a significant difference between Goba (949.39 g) and Agarfa (893.52 g) indigenous chickens ($p < 0.05$). According to Mogesse [16], indigenous chickens have a slaughter weight ranging from 1045 to 1517 g, aligned with the current study. However, the preslaughter weight indicated in the current study was lower than that described by Alemneh et al., Iqbal et al., and Motsepe et al. [17–19], who documented higher slaughter weights for local and F1-crosses of indigenous chicken breeds in southwestern Ethiopia and indigenous chickens raised in Kashmir and South Africa, respectively. According to Yousif et al. [20], dissimilarities in the body weights of local foraging chickens raised in different regions may be attributed to genetic differences, management systems, and ecological conditions. However, dressed carcass weight yields of the South African Ovambo (1303 g) and Potchefstroom Koekoek (1282 g) indigenous chickens kept under intensive management, as reported by Motsepe et al. [19], were higher than the yield from southeastern Ethiopia. This may be attributed to management systems, breed types, and geographical differences. Moreover, the results of

Alemneh et al. [17] showed higher dressed carcass weight yield for local and F1-crosses of indigenous chicken breeds in Sheka, southwestern Ethiopia, compared to our study. However, the value revealed in the present study was higher than that reported by Youssao et al. [21] for forest chickens and lower than that reported for Label Rouge and Savanna indigenous chickens. This might be attributed to various factors, including genetic constituents, husbandry systems, and ecological situations other than the district and age of the indigenous chickens measured in this study.

The dressing percentage value for Goba (76.8%) and Agarfa (80.9%) indigenous chickens observed in our results showed a higher dressing percentage compared to that of Mogesse [16], who reported that the percentage value for local chicken ecotypes reared in Northwestern Ethiopia was 65.7%. However, Alemneh et al. [17] reported lower values than the present results for local and F1-crosses in indigenous chicken breeds in southwestern Ethiopia. Moreover, the dressing percentage of an indigenous chicken in the present study was higher than that described by Magala et al. [22] for free-range, run, and deep litter in local Ugandan chickens and Melesse et al. [23] for commercial Koekoek chickens reared in Ethiopia under intensive management. However, the dressing percentage of Goba indigenous chickens aligned with the values reported by Yousif et al. [20] and Azahan and Zahari [24] for the Hubbard breed of Sudan and native chickens from Malaysia, respectively. The current results deviate from the findings reported by Jaturasitha et al. [25] and Melesse et al. and Yitbarek [26,27] for Thai native chickens and their crosses with Barred Plymouth Rock and RIR commercial chickens in Ethiopia under an intensive management system. The difference in dressing percentage in Goba and Agarfa indigenous chicken could be ascribed to the presence of a higher number of nonedible organs in the carcasses of crossbred and exotic chickens than in those of indigenous chickens. This suggestion is in line with research conducted by Alemu and Tadelle [28], who proposed that indigenous chicken breeds have a higher dressing percentage. Wang et al. [29] also reported that chickens under free-range production systems have a higher dressing percentage than those under confined management, which aligns with the current findings. This suggests that the indigenous chicken ecotypes may be advantageous for chicken meat production efficiency.

Among the carcass components and edible giblets, a significant difference was observed in the yield of drumstick, thigh, wing, and gizzard, with Goba indigenous chickens exhibiting heavier yields (weight) than their counterparts from Agarfa ($p < 0.05$) (Table 1). The drumstick, thigh, and breast, with and without the keel bone, recorded in our results showed higher yields (weights) than the broiler strains such as Hybro and Hubbard, as well as indigenous chicken ecotypes such as bare-neck, large beladi, and betwil in Sudan, as reported in the study conducted by Yousif et al. [20]. In contrast, the present study's findings indicate that the weight of the breast, both with and without the keel bone, is lower than that reported by Youssao et al. [21] for Savanna indigenous chickens and Label Rouge chickens. However, a higher wing (weight) yield was reported for Savanna and forest indigenous chickens and Label Rouge chickens [21]. The findings of the study conducted by Alemneh et al. [17] indicated higher yield (weight) for the thigh, drumstick, wing, neck, skin, and backbone of indigenous chicken breeds from southwestern Ethiopia, whereas a lower yield (weight) was observed for the breast, compared to the current study. Nevertheless, Motsepe et al. [19] reported that the weight (yield) for the thigh and breast of Ovambo and Potchefstroom Koekoek indigenous chickens in South Africa exceeded those observed in the current study. The values observed in the present study were similar to those reported by Alemneh et al. [17] regarding the weights of the heart and liver in indigenous chicken breeds in southwestern Ethiopia. Abdullah and Buchtova [30] reported higher yields for the heart, gizzard, and liver in organic commercial broiler chickens and conventional commercial broiler chicken carcasses. In contrast, Youssao et al. [21] reported lower liver and heart yields (weights) in forest and indigenous savannah chickens. However, they observed higher gizzard, heart, and liver weights in Label Rouge chickens.

The results pertaining to dressed carcass weight, dressing percentage, carcass components, and edible giblet yield indicated no significant differences among the slaughter ages of indigenous chickens in Goba and Agarfa, suggesting that age had no discernible impact on these traits. However, Coban et al. [31] found a significant decrease in neck yield and a significant increase in leg yield with increasing slaughter age. Additionally, according to Kim and Kang [32], chicken size and stocking density increase correspondingly, potentially leading to antagonistic effects on chicken meat quality and consumer rejection. The effects of district on dressed carcass weight, drumstick, thigh, wing, and gizzard were significant. However, the district–age interaction effect was not significant for any of the traits studied.

In the present study, there were no statistically significant differences in the proportion or percentage yield of carcass components and edible giblets between the Goba and Agarfa chickens. The edible giblet proportions (liver and gizzard) in Goba and Agarfa indigenous chickens were consistent with the findings of Abdullah and Buchtova [30] for commercial and conventional broiler chickens. However, a lower proportion of hearts in conventional commercial broiler chickens than that in the present study was described by the same author.

Principal component analysis (PCA) and variable importance on projection (VIP) scores for preslaughter weight, dressed carcass, carcass components, and edible giblets of indigenous chickens were used to compare carcass component yields in the two districts to identify the traits that caused the most significant differences. The analysis revealed that the PC 1 accounted for 96.8% of the total variation between the Goba and Agarfa districts (Figure 1c). In the variable importance projection score plot, the major components that contributed to the separation between indigenous chickens in the Goba and Agarfa areas were preslaughter and dressed carcass weight yields, which had a VIP > 1 (Figure 1b), indicating a higher value in the Goba indigenous chicken. However, when excluding the preslaughter weight and dressed carcass yields as indicated in Figure 1a, the analysis revealed that PC1 (79%) accounted for the total variation among the carcass components and edible giblet yields. However, in the variable importance projection score plot, the major components that contributed to the separation between the indigenous chickens in the Goba and Agarfa districts were the drumstick, thigh, breast with and without keel bone, and back with thoracic weight, which had a VIP > 1 (Figure 1b), indicating a higher value in the Goba indigenous chicken. As we separated preslaughter and dressed carcass weight from carcass components and edible giblet weight when performing the PCA and VIP score analysis, the central part contributed to the separation between or discrimination of the variance between the indigenous chickens in the two studied areas also varies.

A Spearman correlation of preslaughter weight and carcass components yields of indigenous chickens from the Agarfa and Goba districts for each pair of variables are presented in Figure 2. According to Havenstein et al. [33], the association between weight gain and organ weight results in a relative reduction in heart size, which is consistent with the current results. However, the higher correlations observed between preslaughter body weight and heart weight (0.95) in broiler breeds reported by Thiruvenkadan et al. [34] contradict the current results. The authors emphasized that selection for greater body weight may lead to a disproportionate increase in the size of the edible giblet organs.

Dressed carcass weight in the present study was shown to have multicollinearity and exhibited the highest positive correlation with the majority of the traits other than heart weight, with a relatively low positive correlation. The highest correlation was observed between preslaughter weight and dressed carcass weight, indicating that preslaughter weight can strongly predict dressed carcass weight, an essential indicator of indigenous chickens in southeastern Ethiopia. The current findings align with the estimated correlation (0.97) between body weight and dressed carcass weight in broiler chickens reported by Venturini et al. [35]. Moderate to high correlation estimates (greater than 0.6) exist between body weight and dressed carcass weight as well as the weights of other carcass parts [35]. These findings indicated that environmental factors and nonadditive genetic effects influence these traits in a similar manner. Most of the correlations observed between preslaughter weight, dressed carcass weight, carcass components, and edible giblets were positive, indicating that they tended to increase or decrease together. The strongest positive correlation was found between dressed carcass weight and preslaughter weight, suggesting that indigenous chickens in Goba and Agarfa with higher preslaughter weight also tended to have higher dressed carcass weight. Certain carcass traits also exhibited moderate correlations, indicating moderate associations between these variables. However, edible giblet weights, such as liver and heart weights, liver weight, and skin with subcutaneous fat, exhibited relatively weak correlations, suggesting a weak association between the two carcass component yields (weights). Predominantly, the correlations observed between preslaughter weight, dressed carcass weight, carcass components, and edible giblets characterized in Goba and Agarfa indigenous chickens in southeastern Ethiopia all showed positive correlations. The findings of this study illustrate that selecting a higher preslaughter weight may lead to a favorable correlation between dressed carcass weight and the weights of various carcass components. However, when selecting edible giblet weights, especially heart weight, the application of preslaughter weight indicates limited effectiveness.

Native chicken ecotypes in Ethiopia are preferred over commercial poultry strains owing to their natural coloration, sensory appeal, distinctive flavor, and lean meat [13]. In our investigation of the estimation of carcass trait characteristics and their correlation with preslaughter body weight in indigenous chickens of Southeastern Ethiopia under an extensive raising system, we aimed to reveal the characteristics of the carcass covered in our study for conservation and improvement intervention strategies, ultimately benefiting local poultry production and the livelihoods of rural farmers. The research was conducted based on indigenous chickens collected and purchased from farmers' households and then slaughtered for carcass parameter estimation; however, certain limitations were observed. The farming community lacked basic records of their livestock, particularly chickens, which may have caused variation among chicken's records, such as age. Hence, it was challenging to obtain chickens of the same age under the farmer management system in our study because each owner hatched the chickens at different times and weeks. In addition, we did not carry out feeding trials, so the impact of diet on local chicken's carcass performance was not considered in our study; hence, the model design employed was based on the extensive farmers' management system. Furthermore, only male chickens were used in our experiment, as females are typically used for hatchery purposes rather than meat production until they reach culling age in the farmers' community context. It is advisable to consider other factors to address the limitations of our study using an experimental design based on an intensive management system to confirm the validity of the data obtained from the farming community.

5. Conclusions

This study aimed to estimate carcass trait characteristics, proportions, and their correlation with preslaughter body weight in indigenous chickens in Southeastern Ethiopia. The results indicated significant differences in dressed carcass weights, drumsticks, thighs, wings, and gizzards between the districts. The fixed effect of district affected dressed carcass weight, drumstick, wing, and gizzard, whereas age and the district–age interaction did not show any significant effects. Principal component analysis indicated that preslaughter and dressed carcass weights are crucial for discriminating between Goba and Agarfa indigenous chickens. Preslaughter and dressed carcass weights showed a strong positive correlation, suggesting that selecting a higher preslaughter weight could lead to improved carcass component yield in these indigenous chickens. Positive correlations (medium to strong) were observed between preslaughter weight, dressed carcass weight, and various carcass components yields, indicating their interdependency. However, edible giblets displayed relatively weak correlations with preslaughter weight, dressed carcass (yields) weight, and other carcass component yields, suggesting a limited role for preslaughter weight in predicting the weight of edible giblets. Analysis of carcass component traits indicated better carcass component yields; however, further study on physiochemical and serum metabolites of indigenous chickens' meat will be helpful to gain a deeper understanding of the carcass quality and composition in their native ecotypes and production environments.

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Institutional Review Board Statement: All chickens used in this study were approved by the Arsi University College of Agriculture and Environmental Science (AU-CoAES) Institutional Animal Care and Use Committee (AU-CoAES IACUC; approval number: AU-CoAES IACUC 2022-12). The chickens were all approved for their health before slaughter and underwent humane slaughter procedures. Throughout the process, every possible effort was made to minimize animal pain during slaughter.

Data Availability Statement: The corresponding author can provide the data upon request.

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