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Influence of Breed, Sex, and Age on Body Composition of Turkeys Reared in Southern Benin

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ABSTRACT

Exotic turkey breeds generally exhibit superior growth performance compared to indigenous breeds in Benin. While local turkeys are recognized for their hardiness, they tend to demonstrate comparatively lower growth rates and have less well-documented carcass characteristics. The present study aimed to evaluate the body composition of the local turkey population reared in Southern Benin. Data were collected from 40 turkeys per breed (Exotic and local), totaling 80 turkeys. Each breed included 20 males and 20 females. The turkeys were divided into two age groups, including 7-month-old turkeys (Age-Group 1) and 9-month-old turkeys (Age-Group 2). Following a 24-hour hydrous diet, the turkeys were slaughtered by jugular vein, bled, scalded in water at 75°C, manually plucked, and the hot carcasses were weighed. Each carcass was cut to measure the weight of the wishbone, thigh and shank, wings, head, neck, gizzard, heart, liver, and legs. The current results indicated that the slaughter, hot carcass, and cold carcass weights of the exotic turkey were significantly higher than those of the local turkey. Additionally, male turkeys had notably higher slaughter, hot carcass, and cold carcass weights than females, regardless of breed. Furthermore, the live weight of turkeys at 7 months (3637 g) was significantly lower than at 9 months (4160.98 g). The weights of the breast, thigh, and tail cuts increased significantly as the turkeys aged. However, exceptions were observed in abdominal fat and specific parameters such as cold carcass yield, slaughter weight, and fifth-quarter components, including the heart, gizzard, head, and legs, which showed a positive correlation, especially in the exotic-type breeds. In contrast, no statistically significant correlation was observed between carcass yields at slaughter and abdominal fat in the exotic breed compared to the local breed. It might be beneficial to consider selecting or crossbreeding the local turkey population with more efficient exotic breeds to improve their overall body composition.

Keywords: Body composition, Carcass yield, Exotic turkey, Local turkey, Southern Benin

INTRODUCTION

Livestock production is a significant industry in West Africa, employing over 80% of the working population as either a primary or secondary activity (FAOSTAT, 2023). The livestock sub-sector has been thriving for nearly ten years, with a variety of animal species being raised, especially poultry. In Benin, poultry farming is resurging, particularly in the Southern region, where breeders raise different species, including local chickens, guinea fowl, ducks, pigeons, quails, and turkeys (Dotché et al., 2021). Numerous studies have been conducted on the zootechnical characteristics, carcass traits, and meat quality of these species. Studies on local chickens have concentrated on chicken feed, growth performance, carcass quality, and meat quality (Youssao et al., 2009; Tougan et al., 2013; Gangbédji et al., 2023). Additionally, zootechnical performance and meat quality of duck meat have been studied in Benin (Aboh et al., 2011; Houéssionon et al., 2020). In guinea fowl raised in Benin, studies have primarily focused on the technical and sanitary challenges of traditional guinea fowl production (Boko et al., 2012) as well as their zootechnical characteristics (Dahouda et al., 2008, 2009; Boko et al., 2012; Houndonougbo, 2017). Although the zootechnical performance and slaughter characteristics of many species have been documented in recent years, there is limited information on turkeys, which are currently classified as

neglected breeds (Dotché et al., 2021). The current body of literature on turkey farming in Benin is mainly limited to the findings of Dèdéhou et al. (2019) in Northwestern Benin and Dotché et al. (2021) in Southern Benin, which primarily focused on the classification of turkey farming practices. The existing studies do not consider the influence of zootechnical factors, including genetic variation and age, on animal performance, body composition, and carcass quality. Similarly, there are no published scientific data on the potential relationships between body components and carcass quality in turkeys in Benin. These different characteristics vary according to the turkey breed or strain, and for the same strain, they vary according to sex and age at the time of slaughter. To enhance the contribution of turkeys to food security, the present study aimed to investigate the impact of breed, sex, and age at slaughter on the body composition of turkeys raised in Southern Benin.

MATERIAL AND METHODS

Ethical approval

The study protocol has been approved by the ethics committee of the Laboratory of Animal Biotechnology and Meat Technology of Benin (N°210 DPSA/LBATV/D).

Study area

The study was conducted at the Agricultural College of Sékou in Allada and the Laboratory of Animal Biotechnology and Meat Technology at the University of Abomey-Calavi, Benin. Animals were reared and slaughtered at the Agricultural College of Sékou, while their body composition was analyzed at the Abomey-Calavi laboratory.

Both townships are situated on the Atlantic coast. The department has a sub-equatorial climate, characterized by two distinct rainy seasons. The main rainy season occurs from April to July, while a secondary, shorter rainy period happens between September and November. The region receives approximately 1,200 millimeters of rainfall annually. The average monthly temperatures range from 27°C to 31°C, while the relative humidity varies from 65% and 97% throughout the year. Allada township spans 381 km², representing 11.78% of the Atlantic department's total area. It is located between 6°32' and 6°48' N latitude and 2°0' and 2°16' E longitude and bordered by the townships of Toffo to the north, Tori-Bossito to the south, Zè to the east, and Bopa to the west (Nangbe, 2006). Abomey-Calavi covers 539 km² and shares borders with Zè to the north, the Atlantic Ocean to the south, So-Ava and Cotonou to the east, and Tori-Bossito and Ouidah to the west.

Study design

Eighty turkeys were used in the present study, including 40 exotic (Figure 1) and 40 local turkeys (Figure 2), with an equal number of males and females (20 males and 20 females). The turkeys were divided into two age groups, including 7-month-old turkeys (Age-Group 1) and 9-month-old turkeys (Age-Group 2). The local turkeys were produced from a selected breeding group of two males and four females, and the exotic one-day-old turkeys were imported from Ghana. Each turkey was marked with a number on a cloth strip around the leg. The local turkeys' reproducers were purchased from local poultry breeders in Southern Benin. The turkeys were reared within a traditional breeding system characterized by a well-ventilated henhouse spanning 300 m², constructed from locally sourced materials, which was located at the Agricultural College of Sékou, Benin. The feeding regimen consisted of commercial feeds, including a starter feed, a growing feed, and a finishing feed, which were systematically designed to meet the nutritional needs of the turkeys at different stages of growth (Table 1). The starter feed was administered during the first 8 weeks, followed by grower feed from 8 to 20 weeks, and finishing feed from 20 weeks until the end of the experiment at 28 or 36 weeks. Additionally, the animals had *ad libitum* access to water and a forage-based feed supplement, which included *Panicum C1*, *Moringa oleifera* leaves, *Amaranthus* species leaves, or *Allium* species leaves. The turkeys were exposed to natural light and benefited from the ambient temperature, which ranged from 24°C to 29°C.

To reduce turkey mortality and ensure their health during the experiment, they were vaccinated against Newcastle disease at 26 days old (AVI ND LASOTA®, France), against infectious bronchitis at 3 days old (AVI IB H120®, in France), and fowl pox (Diftosec®, France) at 35 days of age, with a booster administered at 105 days age. In addition to vaccination efforts, several preventive measures were implemented, including ALFACERYL®, a water-soluble formulation comprising a mixture of antibiotics and vitamins, which was administered at one day of age for five days. This intervention aimed to mitigate and address a range of potential bacterial infections. Furthermore, at 21 days of age, Alfamisol® (Alfasan, Netherlands) was utilized as a deworming agent for the turkeys, thereby contributing to their overall health management strategy.

Figure 1. A 9-month-old exotic turkey reared in Allada, Benin.

Figure 2. A 9-month-old local turkey reared in Allada, Benin

Table 1. Chemical composition of the commercial diets given to turkeys at different physiological stages

Nutrient constituents	**Starter** (0 to 8 weeks)	**Grower** (8 to 20 weeks)	**Laying** (20 to 28/36 weeks)
Energy (kcal/kg feed)	2900	2800	2500
Crude protein (%)	21	19	18.5
Lysine (%)	1.1	1	0.9
Methionine (%)	1	0.44	0.44
Calcium (%)	1.08	1.01	3.5
Total phosphorus (%)	0.55	0.5	0.5
Crude ash (%)	7.37	7.12	13
Crude cellulose (%)	2.5	3.32	-
Sodium (%)	0.2	-	-
Crude fat (%)	5.54	5	4.5
Flavomycin (%)	0.007	0.007	0.005
Chloride (%)	0.19	-	-

Body composition and carcass quality

Before slaughter, turkeys were fasted for 24 hours. Two groups of turkeys, each with 40 turkeys, were slaughtered and bled sequentially by cutting the jugular vein. Following the bleeding process, the turkeys were subjected to a scalding procedure in water at a temperature of 75°C, after which they were manually plucked. The legs were severed at the tarsometatarsal joint, and the head was separated from the neck at the skull-atlas junction. The abdominal and thoracic cavity organs were then removed. The hot carcasses were weighed using a scale with a 5000 g capacity. The cold carcass weight was taken 24 hours later after refrigeration. The weight of each carcass cut was determined, including the breast, thigh-drumstick, wings, head, neck, gizzard, heart, liver, and legs.

Statistical analysis

The data on slaughter, hot carcass, cold carcass, and cut weights were recorded in Microsoft Excel and analyzed using SAS software (SAS Institute Inc., Cary, NC, USA, 2013). Carcass yields were calculated based on turkey live weights, cut weights (breast, thigh-drumstick, and wing), and cold carcass weights. The analysis of variance was performed using the GLM procedure of SAS. The significant effects of the breed, sex, and age on each carcass variable were determined using an F-test. Means were calculated using the Proc Means procedure and compared using a T-test. Correlations between variables were determined using the Proc CORR procedure. Principal component analysis of carcass characteristics was performed with the Proc PRINCOMP procedure. A significance level of $p < 0.05$ was used for all comparisons in both tests.

RESULTS

Body composition

Breed

The body composition and the yields of carcasses and cuts are presented in Table 2. Breed-specific variations in turkey body composition were notable. The weights of exotic turkeys at slaughter, hot carcass, and cold carcass were all greater than those of native turkeys ($p < 0.05$), and the same significant difference ($p < 0.05$) was

observed for hot carcass yield, cold carcass yield, chilling loss, and abdominal fat weight. Exotic turkeys were notably heavier than local turkeys in terms of breast, thigh-drumstick, wings, head, neck, legs, heart, liver, abdominal fat, and carcass rest ($p < 0.05$). However, there was no significant difference between the breeds in gizzard weights ($p > 0.05$).

Sex

The body composition of turkeys varied significantly by sex (Table 2). The male animals exhibited significantly higher slaughter, hot carcass, and cold carcass weights than the females ($p < 0.05$). Additionally, this trend was observed for carcass cuts, including breast, thigh-drumstick, wings, head, legs, liver, gizzard, and abdominal fat. Furthermore, the hot carcass yield of males was found to be significantly higher than that of females, while cold carcass yield and chilling loss were similar for both sexes ($p < 0.05$). Additionally, carcass rest and heart weights exhibited comparable patterns in both breeds.

Age

The age of the animal significantly affected the carcass characteristics (Tables 2). The live, hot carcass, cold carcass, and breast weight of 7-month-old exotic turkeys (Age-Group 1) were found to be significantly ($p < 0.05$) higher than those of local turkeys at 7 months, and the same trend was observed in turkeys aged 9 months (Age-Group 2). Conversely, the weight of the fifth-quarter components, namely thigh-drumstick, wings, head, neck, legs, abdominal fat, rest, heart, and gizzard, did not differ significantly with age, regardless of breed. A comparison of the two age groups indicated that the older turkeys (9 months) had better carcass composition, except for the fifth-quarter components.

Interaction between sex and breed

Carcass traits for each breed by sex are shown in Table 3. In male exotic turkeys, apart from hot carcass and cold carcass yields, body composition was significantly higher than in females ($p < 0.05$). In the local breed, chilling loss, thigh-drumstick, and head measurements were significantly higher in males than in females ($p < 0.05$). Conversely, females of the local breed had a greater hot carcass weight than males ($p < 0.05$).

Interaction between breed and slaughter age

The carcass characteristics of breeds by age are presented in Table 4. Apart from the fifth quarter, carcass characteristic components of exotic turkeys were significantly lower ($p < 0.05$) at 7 months compared to those slaughtered at 9 months of age. The components of body composition in local turkeys did not vary significantly by slaughter age.

Table 2. Turkey body composition by breed, sex, and age at slaughter time

	Breed		Sex		Age		RSD	Significant level		
Variables	**Exotic**	**Local**	**Female**	**Male**	**7 months**	**9 months**		**Breed**	**Sex**	**Age**
Live weight (g)	4865.48	2932.5	3328.73	4469.25	3637	4160.98	477.37	***	***	***
Hot carcass (g)	3671.70	1980.2	2282.39	3075.41	2376.88	2980.93	544.27	***	***	***
Cold carcass (g)	3427.06	1930.75	2250.53	3035.25	2335.7	2962.85	421.60	***	***	*
Hot carcass yield (%)	70.16	65.83	68.2	67.17	65.49	69.88	6.56	*	*	*
Cold carcass yield (%)	69.54	64.11	67.94	66.80	64.10	68.37	6.12	*	NS	*
Chilling loss (%)	3.97	2.87	2.56	2.46	3.35	2.80	5.17	*	NS	*
Breast (g)	1084.14	480.25	600.5	963.89	676.5	887.89	218.89	***	***	***
Thigh (g)	808.71	501.67	555.6	754.78	545.45	764.93	177.53	***	***	***
Wings (g)	533.12	343	384.25	491.86	413.35	462.77	100.36	***	***	NS
Head (g)	106.91	80.33	71.75	115.5	90.58	96.66	6.82	***	***	**
Neck (g)	415.8	187.83	198.8	404.83	270.17	333.47	84.29	***	***	*
Legs (g)	116.15	88.25	74.07	130.33	98.67	105.74	9.08	***	***	*
Abdominal fat (g)	39.25	25.5	62.75	2	34.67	30.08	19.98	*	***	NS
Rest (g)	585.39	341.92	439.39	487.92	459.42	467.89	64.92	***	NS	NS
Heart (g)	18.74	13.67	13.2	19.21	15.83	16.58	2.68	***	NS	NS
Liver (g)	65.36	50.08	52.53	62.92	58.83	56.61	4.51	***	***	NS
Gizzard (g)	98.12	97.92	74.41	121.63	101.58	94.45	14.45	NS	***	NS

RSD: Residual standard deviation, NS: Not significant. */ **/ ***: Indicates a statistically significant difference at $p < 0.05$.

Table 3. Variation in turkey body composition by breed and sex

Variables	Exotic		Local		RSD	Significant level
	Female	Male	Female	Male		
Live weight (g)	3774.96^{b}	5955.99^{a}	2882.50^{c}	2982.50^{c}	477.37	***
Hot carcass (g)	2616.79^{b}	4880.00^{a}	2037.67^{b}	1913.50^{c}	544.27	***
Cold carcass (g)	2463.40^{b}	4237.33^{a}	1948.00^{c}	1850.30^{c}	421.6	**
Hot carcass yield (%)	68.81^{a}	70.28^{a}	67.59^{a}	64.06^{b}	6.56	NS
Cold carcass yield (%)	68.23^{a}	72.09^{a}	67.65^{a}	63.8	6.12	NS
Chilling loss (%)	0.67^{b}	7.28^{a}	0.46^{b}	7.01^{a}	5.17	*
Breast (g)	706.25^{b}	1462.04^{a}	494.75^{c}	465.75^{c}	218.89	***
Thigh-drumstick (g)	628.04^{b}	989.39^{a}	483.17^{c}	520.17^{b}	177.53	**
Wings (g)	418.51^{b}	647.73^{a}	350.00^{c}	336.00^{c}	100.36	***
Head (g)	72.66^{c}	141.17^{a}	70.83^{c}	89.83^{b}	6.82	***
Neck (g)	228.77^{b}	602.83^{a}	168.83^{b}	206.83^{b}	84.29	***
Legs (g)	79.39^{c}	152.92^{a}	68.75^{d}	107.75^{b}	9.08	***
Abdominal fat (g)	78.49^{a}	0.00^{c}	47.00^{b}	4.00^{c}	19.98	*
Rest (g)	491.37^{b}	679.42^{a}	387.42^{c}	296.42^{c}	64.92	***
Heart (g)	13.73^{b}	23.75^{a}	12.67^{b}	14.67^{b}	2.68	***
Liver (g)	57.97^{b}	72.75^{a}	47.08^{c}	53.08^{b}	4.51	*
Gizzard (g)	72.90^{c}	123.33^{a}	75.92^{b}	119.92^{a}	14.45	NS

RSD: Residual standard deviation. ^{a,b,c} Means of the same row followed by different superscript letters differ significantly at $p < 0.05$, NS: Not significant. */ **/ ***: $p < 0.05$.

Table 4. Variation in turkey body compositions by breed and slaughter at ages seven months and nine months

Variables	Exotic		Local		RSD	Significant level
	Age 1	Age 2	Age 1	Age 2		
Live weight (g)	4474.00^{b}	5256.95^{a}	2800.00^{c}	3065.00^{c}	477.37	*
Hot carcass (g)	2921.50^{b}	3932.61^{a}	1832.25^{c}	2029.25^{c}	544.27	**
Cold carcass (g)	2750.20^{b}	3671.70^{a}	1745^{c}	1925^{c}	421.6	**
Hot carcass yield (%)	65.53^{b}	73.56^{a}	65.45^{b}	66.20^{b}	6.56	*
Cold carcass yield (%)	62.47	70.16	62.47	70.16	6.12	*
Chilling loss (%)	3.3	3.97	3	3.57	5.17	*
Breast (g)	908.00^{b}	1260.28^{a}	445.00^{c}	515.50^{c}	218.89	*
Thigh-drumstick (g)	681.40^{b}	936.03^{a}	409.50^{c}	593.83^{b}	177.53	NS
Wings (g)	499.20^{b}	567.04^{a}	327.50^{c}	358.50^{c}	100.36	NS
Head (g)	105.67	108.16	75.5	85.17	6.82	NS
Neck (g)	359.33	472.27	181	194.67	84.29	NS
Legs (g)	114.83	117.48	82.5	94	9.08	NS
Abdominal fat (g)	47.83	30.66	21.5	29.5	19.98	NS
Rest (g)	574.33	596.45	344.5	339.33	64.92	NS
Heart (g)	17.67	19.82	14	13.33	2.68	NS
Liver (g)	63.67	67.06	54	46.17	4.51	***
Gizzard (g)	101.17	95.07	102	93.83	14.45	NS

Age 1: 7 Months, Age 2: 9 Months, RSD: Residual standard deviation, NS: Not significant. */ **/ *** ^{a,b,c} Means of the same row followed by different superscript letters differ significantly at $p < 0.05$.

Correlations among carcass parameters of exotic and local turkeys

Table 5 displays the correlation coefficients between the turkey's body components and slaughter weight. Except for abdominal fat and cold carcass yield, the slaughter weight of the exotic breeds was favorably associated with the carcass and fifth-quarter components. Carcass and fifth-quarter components indicated a negative correlation with abdominal fat ($p < 0.05$) in the exotic turkeys. Moreover, correlations between carcass yields at slaughter time and abdominal fat were non-significant in the exotic breed ($p > 0.05$). Similarly, to the exotic breed, live weight at slaughter showed a significant correlation with the weights of the hot carcass, cold carcass, cuts, and fifth-quarter components, such as the neck and the remaining parts of the carcass in the local breed. Conversely, live weight at slaughter time exhibited a negative correlation with both cold carcass yield and hot carcass yield ($p < 0.05$).

Table 5. Correlations among the proportions of carcass cuts from exotic (above the diagonal) and local (below the diagonal) turkeys

Variable	W Breast	W ThDru	W Wing	W head	W neck	W leg	W Rest	W Heart	W Liver	W Gizzard	W Fat
Breast	1	-0.13^{NS}	-0.53**	0.35^{NS}	0.81***	0.55**	-0.54**	0.17^{NS}	0.65***	-0.14^{NS}	0.54**
Thigh-Dru	0.19^{NS}	1	0.77***	0.53**	-0.1^{NS}	0.54**	0.59***	0.56**	0.44*	0.41^{NS}	0.22^{NS}
Wing	-0.86***	-0.01^{NS}	1	0.09^{NS}	-0.58***	0.19^{NS}	0.69***	0.45*	0.72***	0.29^{NS}	0.32^{NS}
Head	-0.96***	-0.05^{NS}	0.78***	1	0.31^{NS}	0.66***	-0.06^{NS}	0.47*	0.05^{NS}	-0.04^{NS}	-0.23^{NS}
Neck	-0.72**	-0.41^{NS}	0.3^{NS}	0.78***	1	0.47*	-0.6***	0.3^{NS}	-0.78***	-0.04^{NS}	-0.71***
Leg	-0.86***	-0.14^{NS}	0.64*	0.95***	0.87***	1	0.16^{NS}	0.6***	-0.03^{NS}	0.29^{NS}	-0.33^{NS}
WRest	-0.67*	-0.75***	0.55^{NS}	0.47^{NS}	0.45^{NS}	0.38^{NS}	1	-0.01^{NS}	0.76***	0.51*	0.71***
WHeart	-0.53^{NS}	0.17^{NS}	0.83***	0.37^{NS}	-0.20^{NS}	0.12^{NS}	0.42^{NS}	1	0.19^{NS}	0.15^{NS}	-0.44*
WLiver	-0.94***	-0.43^{NS}	0.71**	0.85***	0.75**	0.74**	0.83***	0.44^{NS}	1	0.23^{NS}	0.56**
WGizzard	-0.92***	-0.10^{NS}	0.9***	0.89***	0.59*	0.78***	0.55^{NS}	0.63*	0.83***	1	0.4^{NS}
WFat	-0.36^{NS}	-0.43^{NS}	0.63*	0.13^{NS}	-0.18^{NS}	-0.01^{NS}	0.73**	0.74**	0.41^{NS}	0.37^{NS}	1

LW: Live weight, CarH: Hot carcass, CarcC: Cold carcass, Yield1: Hot carcass yield, Yield24: Cold carcass yield, Thigh-drum/ThDru: Thigh-drumstick, W: Weight, NS: Not significant. * / **/ ***: $p < 0.05$: Indicates a statistically significant difference at $p < 0.05$.

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Table 6. Correlations between proportions of carcass cuts and body components in local turkeys

Variable	W Breast	W ThDru	W Wing	W head	W neck	W leg	W Rest	W Heart	W Liver	W Gizzard	W Fat
LW	0.83***	-0.18^{NS}	-0.82***	-0.82***	-0.46^{NS}	-0.65*	-0.34^{NS}	-0.67*	-0.72*	-0.94***	-0.21^{NS}
CarcH	0.86***	-0.04^{NS}	-0.88***	-0.82***	-0.46^{NS}	-0.67*	-0.45^{NS}	-0.71*	-0.76***	-0.98***	-0.36^{NS}
CarcC	0.86***	-0.03^{NS}	-0.88***	-0.82***	-0.46^{NS}	-0.67*	-0.46^{NS}	-0.71*	-0.76***	-0.98***	-0.36^{NS}
Yield1	0.02^{NS}	0.65*	-0.26^{NS}	0.1^{NS}	0.11^{NS}	0.04^{NS}	-0.47^{NS}	-0.20^{NS}	-0.06^{NS}	-0.13^{NS}	-0.70*
Yield24	0.05^{NS}	0.67*	-0.28^{NS}	0.09Ns	0.1^{NS}	0.04^{NS}	-0.50^{NS}	-0.23^{NS}	-0.10^{NS}	-0.16^{NS}	-0.72*
Breast	0.93***	0.04^{NS}	-0.91***	-0.88***	-0.54^{NS}	-0.74*	-0.55^{NS}	-0.69*	-0.85***	-0.99***	-0.39^{NS}
Thigh-Dru	0.88***	0.2^{NS}	-0.87***	-0.82***	-0.55^{NS}	-0.69*	-0.62*	-0.66*	-0.84***	-0.98***	-0.45^{NS}
Wing	0.82***	-0.03^{NS}	-0.81***	-0.79***	-0.49^{NS}	-0.65*	-0.41^{NS}	-0.64*	-0.74**	-0.96***	-0.26^{NS}
Head	-0.50^{NS}	-0.12^{NS}	0.16^{NS}	0.6*	0.69**	0.7**	0.22^{NS}	-0.27^{NS}	0.45^{NS}	0.19^{NS}	-0.21^{NS}
Neck	0.43^{NS}	-0.39^{NS}	-0.77***	-0.36^{NS}	0.22^{NS}	-0.14^{NS}	-0.13^{NS}	-0.92***	-0.27^{NS}	-0.65*	-0.49^{NS}
Leg	0.05^{NS}	-0.25^{NS}	-0.34^{NS}	0.1^{NS}	0.44^{NS}	0.34^{NS}	-0.09^{NS}	-0.73**	-0.06^{NS}	-0.30^{NS}	-0.42^{NS}
Fat	0.34^{NS}	-0.46^{NS}	-0.15^{NS}	-0.52^{NS}	-0.49^{NS}	-0.51^{NS}	0.32^{NS}	0.05^{NS}	-0.22^{NS}	-0.46^{NS}	0.61*
Rest	0.61*	-0.44^{NS}	-0.71**	-0.68*	-0.28^{NS}	-0.55^{NS}	0.02^{NS}	-0.58^{NS}	-0.42^{NS}	-0.81***	-0.02^{NS}
Heart	0.61*	0.19^{NS}	-0.36^{NS}	-0.71**	-0.82***	-0.76***	-0.21^{NS}	0.04^{NS}	-0.58*	-0.72**	0.23^{NS}
Liver	-0.22^{NS}	-0.69**	-0.14^{NS}	0.1^{NS}	0.43^{NS}	0.12^{NS}	0.65*	-0.25^{NS}	0.47^{NS}	-0.09^{NS}	0.17^{NS}
Gizzard	-0.99***	-0.26^{NS}	0.87***	0.94***	0.7**	0.85***	0.72**	0.54^{NS}	0.94***	0.92***	0.44^{NS}
Chilling	-0.37NS	-0.39NS	0.4NS	0.17NS	0.09NS	-0.02NS	0.62*	0.57*	0.53NS	0.52NS	0.55NS

LW: Live weight, CarH: Hot carcass, CarcC: Cold carcass, Yield1: Hot carcass yield, Yield24: Cold carcass yield, Thigh-drum/ThDru: Thigh-drumstick, W: Weight, NS: Not significant. * / **/ ***: $p < 0.05$: Indicates a statistically significant difference at $p < 0.05$

Table 7. Correlations between proportions of carcass cuts and body components in exotic turkeys

Variable	W Breast	W ThDru	W Wing	W head	W neck	W leg	W Rest	W Heart	W Liver	W Gizzard	W Fat
LW	0.82***	-0.33^{NS}	-0.62**	0.15^{NS}	0.92***	0.37^{NS}	-0.77***	0.22^{NS}	-0.86***	-0.23^{NS}	-0.82***
CarcH	0.83***	-0.36^{NS}	-0.69***	0.11^{NS}	0.92***	0.28^{NS}	-0.79***	0.1^{NS}	-0.91***	-0.22^{NS}	-0.74***
CarcC	0.7***	-0.56**	-0.77***	-0.04^{NS}	0.82***	0.07^{NS}	-0.87***	-0.03^{NS}	-0.92***	-0.3^{NS}	-0.72***
Yield1	0.58***	-0.34^{NS}	-0.69***	-0.04^{NS}	0.59***	-0.1^{NS}	-0.57**	-0.42*	-0.8***	-0.03^{NS}	-0.17***
Yield24	-0.04^{NS}	-0.68***	-0.63***	-0.45*	0.02NS	-0.69***	-0.47*	-0.76***	-0.49*	-0.16^{NS}	0.11^{NS}
Breast	0.89***	-0.42*	-0.72***	0.1^{NS}	0.87***	0.27^{NS}	-0.8***	0.05*	-0.88***	-0.27^{NS}	-0.71***
Thigh-Dru	0.78***	-0.27^{NS}	-0.62***	0.18^{NS}	0.92***	0.3^{NS}	-0.79***	0.17^{NS}	-0.9***	-0.2^{NS}	-0.75***
Wing	0.7***	-0.25^{NS}	-0.46*	0.09^{NS}	0.81***	0.29^{NS}	-0.77***	0.24^{NS}	-0.84***	-0.21^{NS}	-0.77***
Head	0.78***	-0.33^{NS}	-0.69***	0.32^{NS}	0.88***	0.29^{NS}	-0.84***	0.12^{NS}	-0.88***	-0.29^{NS}	-0.76***
Neck	0.77***	-0.36^{NS}	-0.72***	0.09^{NS}	0.95***	0.25^{NS}	-0.75***	0.12^{NS}	-0.88***	-0.17^{NS}	-0.73***
Leg	0.84***	-0.28^{NS}	-0.61***	0.22^{NS}	0.92***	0.45*	-0.71***	0.19^{NS}	-0.84***	-0.14^{NS}	-0.76***
Fat	-0.54**	0.22^{NS}	0.32^{NS}	0.25^{NS}	-0.7***	-0.33^{NS}	0.7***	-0.46*	0.52**	0.4^{NS}	1***
Rest	0.68***	-0.19^{NS}	-0.51*	-0.01^{NS}	0.84***	0.48*	-0.36^{NS}	0.08^{NS}	-0.75***	0.15^{NS}	-0.52**
Heart	0.73***	-0.12^{NS}	-0.42*	0.25^{NS}	0.9***	0.43*	-0.72***	0.47*	-0.73***	-0.12^{NS}	-0.81***
Liver	0.64***	-0.39^{NS}	-0.48*	0.16^{NS}	0.67***	0.35^{NS}	-0.73***	0.31^{NS}	-0.58***	-0.2^{NS}	-0.78***
Gizzard	0.69***	-0.41^{NS}	-0.69***	-0.03^{NS}	0.87***	0.23^{NS}	0.7***	0.07^{NS}	-0.87***	0.03^{NS}	-0.65***
Chilling	0.79***	0.48*	-0.03^{NS}	0.55**	0.7***	0.81***	-0.08^{NS}	0.48*	-0.34^{NS}	0.18^{NS}	-0.36^{NS}

LW: Live weight, CarH: Hot carcass, CarcC: Cold carcass, Yield1: Hot carcass yield, Yield24: Cold carcass yield, Thigh-drum/ThDru: Thigh-drumstick, W: Weight, NS: Not significant. * / **/ ***: $p < 0.05$.: Indicates a statistically significant difference at $p < 0.05$.

The correlations between hot and cold carcass weight and the weights of the breast, thigh-drumstick, neck, and carcass rest were statistically significant ($p < 0.05$) for the local breed. Conversely, cold carcass weight was inversely correlated with gizzard weight and had no significant effects on the yields of leg, fat, and liver weights ($p < 0.05$). Unlike the current observations in exotic breeds, the correlation between abdominal fat and cold carcass yield, as well as gizzard weight, was found to be negative ($p < 0.05$) in local turkeys. However, abdominal fat was positively correlated with breast weight ($p < 0.05$). The correlation coefficients between carcass cut proportions in exotic and local turkeys are presented in Table 6. In exotic turkeys, the breast proportion was positively associated with abdominal fat, liver, neck, and leg proportions ($p < 0.05$). Conversely, the breast proportion was negatively associated with wing size ($p < 0.05$). In local turkeys, the abdominal fat proportion was positively correlated with that of the heart ($p < 0.05$). Breast proportion was negatively correlated with the fifth-quarter components of the animal and cuts, except for the thigh-drumstick ($p < 0.05$).

The correlations between the proportions of carcass cuts and body components of local turkeys are presented in Table 6. A statistically significant correlation was observed between live weight and breast proportions, while there was a negative correlation between live weight and the other carcass cuts and fifth-quarter components ($p < 0.05$). The correlation between breast proportion and body components was notably positive ($p < 0.05$), in comparison to the correlations observed between these proportions and those of other carcass cuts and fifth-quarter components.

The correlations between the proportions of carcass cuts and body components of exotic turkey are presented in Table 7. Live weight had positive correlation coefficients with breast proportions and negative correlation with those of other carcass cuts and fifth-quarter components ($p < 0.05$). The proportions of breast, neck, and heart indicated a significantly positive correlation with body components compared to the other cuts and fifth-quarter components, which exhibited more negative correlations with the different body components ($p < 0.05$). Additionally, the fat percentage was negatively correlated with all body components ($p < 0.05$).

Principal component analysis of turkey carcass characteristics

Figure 3 shows the principal component analysis of turkey carcass characteristics. The current results were interpreted using two axes. The initial two axes together account for 16.65% of the total inertia, with 13.14% attributed to the first axis and 3.32% to the second (Figure 3). Regardless of the axis considered, the two local and exotic breeds are in opposition to each other. Most quantitative variables, including live weight, hot carcass weight, cold carcass weight, and weight of certain cuts, were linked to the exotic breed through axis 1. The fat weight, in addition to the chilling loss and gizzard, served to differentiate the local breed from exotic breeds.

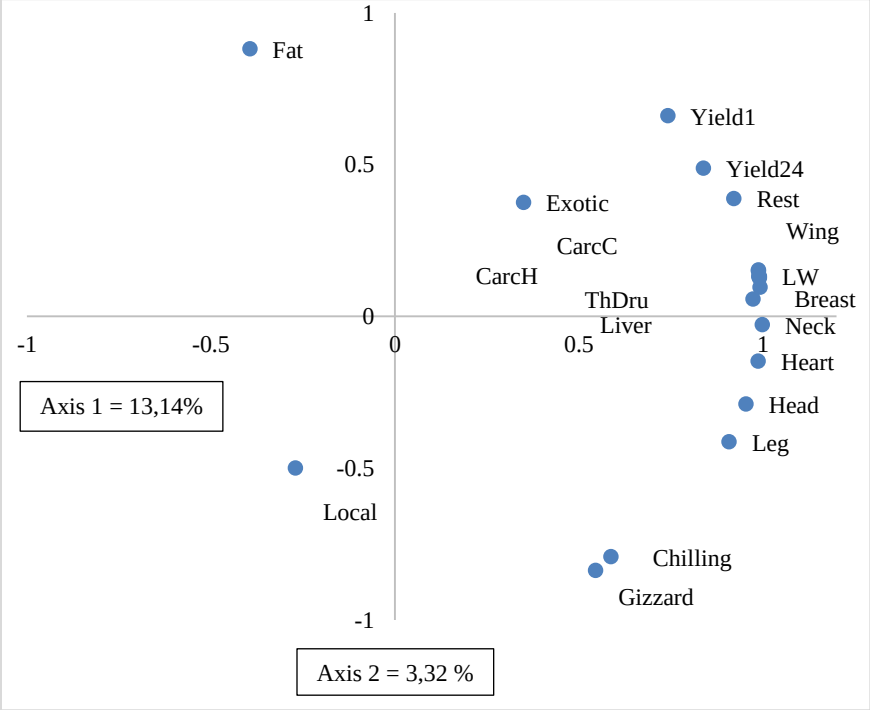

Figure 3. Principal component analysis of exotic and local turkey carcass characteristics. LW: Live weight, CarcH: Hot carcass, CarcC: Cold carcass, Yield1: Hot carcass yield, Yield24: Cold carcass yield, ThDru: Thigh-drumstick.

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DISCUSSION

Effects of breed on body composition

The present study indicated that exotic turkey breeds had higher slaughter weights and better carcass characteristics compared to local turkeys when reared under the same conditions and slaughtered at the same age. This difference in body composition is due to genetic factors. The exotic turkey is a genetic type with eumetrical and mediolinear features (Dotché et al., 2021), while the local turkey is relatively brevilinear with an ellipometric shape (Dédèhou et al., 2019). The impact of genetic variation on slaughter weight and body composition has been observed in different stablished and reproductive turkey lines (Chartrin et al., 2018), as well as in Isa Brown, Harco, and Lohman chickens reared in Benin (Tossou et al., 2019), lean or force-fed Barbary and Mulard ducks (Houessionon et al., 2019), Djallonké and Sahelian sheep within traditional farming systems (Djenontin et al., 2017), and Borgou, Lagunaire, and Zebu Peulh cattle grazing on natural pastures (Salifou et al., 2013). Due to the genetic diversity among local and exotic turkey breeds, it is essential to establish specific age parameters for slaughter to optimize both their genetic characteristics and economic viability. Each breed possesses unique attributes that can be better leveraged through tailored management practices in terms of their harvesting age. This age is defined by the growth curve of each breed and usually occurs at the inflection point. Therefore, studying the growth curves of these two genetic types is essential.

The correlation between slaughter weight and carcass and fifth-quarter components was found to be positive in exotic and local breeds. A similar finding was reported by Laudadio et al. (2009) for turkeys in Italy. Therefore, slaughter weight acts as an indicator of turkey carcass conformation. It is reasonable to infer that those higher weights lead to better carcass conformation. The principal component analysis demonstrated that exotic turkeys have a more favorable spatial distribution of carcass components, indicating better carcass conformation than local turkeys.

Abdominal fat was negatively correlated with carcass and fifth-quarter components in exotic breeds. The relationship between abdominal fat and carcass composition revealed significant differences between exotic and local turkey breeds. It has been observed that an increase in abdominal fat correlates with a decrease in the proportion of lean meat within the carcass, ultimately leading to a reduction in carcass quality for exotic breeds. Conversely, no such correlation was identified in local turkey breeds, suggesting a distinct metabolic or genetic profile. It may be hypothesized that the notable absence of abdominal fat in local turkeys was linked to their relatively lower slaughter weights, indicating potential implications for breeding and management strategies in poultry production.

Effects of sex on body composition

The present study demonstrated that the primary characteristics of turkey carcasses, including live weight, hot carcass weight, and body component weight, were significantly higher in males compared to females. This discrepancy in performance between males and females can be attributed to the pronounced sexual dimorphism observed in this species, with females exhibiting a lower average body weight than males. This dimorphism was observed in a multitude of species and breeds of the same species (Damaziak et al., 2013; Portillo-Salgado et al., 2022). In breeding turkeys, males have higher slaughter weight, breast, and thigh-drumstick yields compared to females, which is consistent with the pattern observed in standard animals (Chartrin et al., 2018). In Muscovy ducks, the mean live weight at slaughter, hot carcass weight, cold carcass weight, hot carcass yield, and cold carcass yield were found to be greater in males than in females (Houessionon et al., 2019). Additionally, the weight of specific body components differed between the sexes. The same trends were obtained in ecotypes of the local *Gallus gallus* poultry population in Benin (Tougan et al., 2013; Edénakpo et al., 2020). Similarly, the male turkeys in the present study exhibited higher weights and carcass characteristics than the females (Damaziak et al., 2013; Portillo-Salgado et al., 2022).

Since the growth curves of males and females vary in most species, the age at slaughter for local and crossbred turkeys should be determined based on sex, which was not done in the current study. The slaughter age can be chosen according to the male or female's tendency to deposit carcass or abdominal fat. In standard turkeys from typical breeding farms, males are slaughtered at 16 weeks of age, weighing 14-15 kg, while females are slaughtered at 12 weeks, weighing 6-7 kg (Chartrin et al., 2018).

Effects of age on body composition

The current study revealed that 9-month-old turkeys exhibit more advanced development of body components compared to their 7-month-old counterparts. A comprehensive analysis indicated that there was a positive correlation between age and different metrics, including live weight, hot carcass weight, cold carcass weight, and the weights of individual cuts, indicating that physiological growth and development continue to progress significantly during this period. The chosen slaughter ages in the present study correspond to the ages at which turkeys are typically processed in Benin. The 7- to 9-month period marks the end of the accelerated growth phase or the start of the slow growth phase. During the accelerated growth phase, cells multiply and grow larger. In the slow-growth phase, animals' weight increases due to an increase in cell size (Pérez-Lara et al., 2013). This increase in animal weight is accompanied by a change in

meat texture, with an impact on meat sensory quality (Salgado Pardo et al., 2024). The growth in live weight at slaughter, hot carcass weight, cold carcass weight, and the weight of distinct carcass components with age has been documented by Chartrin et al. (2018) in turkeys and Houessionon et al. (2019) in Barbary ducks in Benin.

CONCLUSION

The present findings demonstrated that exotic turkey breeds exhibit greater slaughter weights and carcass characteristics compared to local turkey breeds, when both are raised and processed under identical environmental conditions and at the same age. Both exotic and local breeds exhibited a positive correlation among slaughter weight, carcass weight, and fifth-quarter components. Notably, the exotic breed revealed a negative correlation between abdominal fat and both carcass and fifth-quarter components. In contrast, the local breed did not display a significant correlation between abdominal fat and carcass components. Regardless of breed, male turkeys consistently demonstrated higher live weights, hot carcass weights, and body component weights compared to their female counterparts. Additionally, 9-month-old turkeys presented more developed body components than those at 7 months old, suggesting a developmental advantage with age. Overall, exotic turkeys have better carcass characteristics than the local breed. It is recommended that future studies evaluate the technological and organoleptic characteristics of meat from these two genetic types of turkey. Focusing on attributes such as tenderness, juiciness, and flavor could deepen the understanding of the meat quality associated with these genetic variants, benefiting breeding practices and consumer choices.

DECLARATIONS

Finding

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Competing interests

The authors declared no conflicts of interest.

Authors' contributions

Baba Issimouha Loukyatou, Dotche Ignace, and Youssao Aboudou Karim Issaka contributed to the study design and planning. Baba Issimouha Loukyatou and Bonou Assouan Gabriel were responsible for data collection and drafting the first version of the manuscript. Data analysis and interpretation were carried out by BABA Issimouha Loukyatou, Adzona Pitchou Prudence, Dotche Ignace, and Youssao Aboudou Karim Issaka. Salifou Chakirath and Youssao Aboudou Karim Issaka contributed to the critical revision and editing of the manuscript. All authors read and approved the final version of the manuscript.

Ethical considerations

The authors hereby affirm this manuscript has been prepared and submitted in accordance with the highest standards of scientific integrity. All authors have been checked the text of the manuscript for plagiarism, dual publication and/or submission, falsification and/or fabrication, and redundancy.

Availability of data and materials

The data will be available upon a reasonable request from the corresponding author.

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