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Interactive Effect of Sex and Genotype on the Carcass Characteristics of Nigerian Purebred and F₂ Upgrades

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Abstract

The study evaluated interactive effect of sex by genotype on carcass traits in Nigerian purebred, F₁ crosses and F₂ upgrade genotypes of Nigerian Chicken raised at T&R Farm in FUNAAB. The genotypes were: Nigerian Indigenous Normal feathered (N), Frizzle-feathered (Fz) and Naked neck (Nk) chickens were crossed with Marshall (M) Exotic breed to obtain F₁ (MN, MNk and MFz) and F₂ upgrades (MMN, MMFz, MMNk). A population of 500 chicks of 50 per genotype of equal sexes was reared intensively in a randomized completed block design (RCBD) study. The genotypes represented treatments. 200 birds of 20 per genotype of equal sexes at 8 weeks were randomly selected for carcass evaluation. The parameters were: carcass traits and organ measurements. Data collected for carcass were analyzed using GLM of SAS statistical software package. The results showed that sex significantly ($p < 0.001$) influenced all the carcass traits and the internal organs at 8 weeks studied. Males had mean values in all the carcass and organs traits measured significantly higher than the female counterparts. The results showed that genotype significantly ($p < 0.001$) influenced all the carcass traits measured. M genotype had higher mean values in all the carcass traits measured. F₂ upgrades comparatively had means significantly similar to M genotype (control). MMFz upgrade had the highest mean live-weight among the F₂ upgrades while MMNk upgrade had higher means in eviscerated weight and all the important carcass cuts and the internal organ measurement than MMFz upgrade and MMN though not significantly different among the upgrades. The MNk cross had higher means but relatively similar to the MFz and MNFz counterparts. The Nk genotype emerged the best carcass produced purebred chickens compared to MFz and MNFz. Conclusively, the F₂ upgrades carcass performance were similar to the exotic breed in terms of meat ratio. Hence, farmers should use exotic breed to improve chickens for optimal production.

Key words: Carcass traits, F₁ crosses, F₂ upgrades, Genotypes, Purebred, Interactions, Sex

1.0 Introduction

The livestock sector contributes significantly to the global food and nutrition security providing invaluable animal proteins (FAO, 2025; Sam *et al.*, 2025). Consumers' recent demand for food safety and sustainability of animal production systems to encourage the use of native chicken for relevant markets has increased (Padhi, 2016). Nigerian Indigenous Chicken breeds have been known to possess desirable traits which make them thrive well in the harsh environmental conditions of this tropical zone and outstanding meat flavor and tenderness. They are mainly reared in all the local zones of Nigeria (Sam *et al.*, 2026). These breeds of chickens are classified as slow-growing of both dual purpose chickens with medium body size but an increasing interest in the food service markets (Van Duc and Long 2008; Cuc *et al.*, 2010; Lan Phuong, *et al.* 2015). Most of the research has focused on the growth performances and body conformation of these chickens (NGU, *et al.* 2016 ; Anh *et al.* 2019a; Anh *et al.* 2019b). Several factors have influenced carcass performances of broiler chicken before slaughtering, which include genotype, sex, age, health status, feed and management conditions. Nikolova and Pavlovsk, (2009) observed that the genotype significantly affected the major carcass parts, but sex significantly influenced breast yield, thigh and drumstick meat in favour of males. Other studies also showed similar observations in respect to different genotypes and their genders. Although commercial broiler breeders showed better carcass traits compared to the indigenous breeds; (Ganabadi *et al.* 2009; Khan *et al.*, 2019; Udo *et al.*, 2025), the indigenous chicken performed better meat quality (glutamic acid content, shear values raw and cooked meat) compared to the broiler products (Wattanachant *et al.*, 2004). 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 (Sam *et al.*, 2019; Tareke *et al.*, 2018; Fernandes *et al.*, 2013). However, fewer reports 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 Nigerian indigenous chickens with different genotypes and genders (males and females) reared 12 weeks of age under a tropical environment.

2.0. Materials and Methods

2.1 Experimental Site

The research was carried out at the Poultry Breeding Unit of the University Teaching and Research Farm of Federal University of Agriculture, Abeokuta, Alabata, Ogun state. Alabata is at latitude 7°10`N and longitude 3°2`E in Odeda Local Government Area of Ogun State, Nigeria. The area is characterized by a tropical climate with a mean annual rainfall of about 1037mm. The mean monthly ambient temperature ranged from 28- 36°C and 34°C on average. Relative humidity ranged from 60-94%, 82% on the average. The vegetation represents an inter-phase between the tropical rainforest and the derived savannah (FUNAAB Meterological station, 2022).

2.2 Experimental Stock

2.2.1. Parents

Pure indigenous chicken genotypes reared in the breeding unit of the University's Research Farm were used to generate the offspring for this research. The parent stock were basically Normal-feathered (N) of Cocks and hens, Frizzled-Feathered (Fz) of Cock and hens and naked neck chicken (NK) of Cocks and hens and Marshall (M) of three Cocks and hens and dihybrid cross hens which were cross through artificial insemination method. The combination of these four genotypes at different bloodlines resulted in ten genotypes used in this study: 100% pure breeds, 50:50% M: Ind (di-hybrid), 75:25% M: Ind (F₂ upgrade) fifty chickens per genotype (sample size) making five hundred chickens altogether. The genotypes are presented below:

2.2.2 Mating Design

	Sires	Dams	100% bloodline (purebreds)	
1.	M	X	M	= M
2.	N	X	N	= N
3.	Fz	X	Fz	= Fz
4.	Nk	X	Nk	= Nk
50%:50% (M: Ind) bloodline (F ₁ crosses)				
5.	M	X	N	= MN (F ₁)
6.	M	X	Fz	= MFz (F ₁)
7.	M	X	Nk	= MNk (F ₁)
75%:25% (M: Ind) bloodline (F ₂ upgrades)				
8.	M	X	MN	= MMN (F ₂)
9.	M	X	MF	= MMFz (F ₂)
10.	M	X	MNk	= MMNk (F ₂)

M- Marshall Exotic breed, N-Normal-Feathered, Fz-Frizzle-Feathered, Nk-Naked Neck chicken genotype, M: Ind = Marshall: indigenous.

2.3 Inseminations, Egg Collection and Hatching

Artificial insemination was carried out on the chickens three times a week. It was done by introducing semen collected from Exotic Marshall cocks (sires) into the reproductive tracts of both exotic and indigenous hens (dams), also, indigenous cock to Indigenous hens following the above mating design to produce the 10 different genotypes of birds studied in this research. The parent stock was housed in the battery cage system singly and fed *ad libitum* with constant water supplied. The pure Marshall genotype served as control. Then the same exotic cocks (Marshall) were crossed to all the genotypes to obtain F₁ birds with 50%: 50% M: Ind bloodline (dihybrid crosses) and F₂ birds with 75%:25% M: Ind bloodline (F₂ upgrades).

2.3.1 Egg Collection, Incubation and Hatching

Eggs from each mating group were collected daily and labelled according to sire-line. The eggs were then transferred to the University's Teaching and Research farm hatchery unit for incubation and hatching. Assortment of eggs for incubation was done by selecting cracked, discolored or odd-shaped eggs before setting. The eggs were fumigated so as to destroy microbes using fumes from a mixture of 35g potassium permanganate in 53cc formalin per cubic meters. Circular air movement in the cabinet and speedy gas removal after 20 minutes fumigation was ascertained. Three day egg collections were set along sire-lines at a temperature of 38-39°C and humidity of 55-66% for the first eighteen days. On the 18th day of incubation, candling was conducted and the number of fertile eggs was recorded. The eggs were transferred into the hatcher; the temperature was set to 39-40°C and humidity to 70-75%. The eggs were turned automatically hourly through 90°C in the incubator. On the 21st day chicks were collected and the number of hatched chicks was recorded.

2.3.2 Housing, Feeding and Management of Birds

Chicks obtained were identified by wing-tagged immediately after hatching in respect to their sire line. From the hatchery, the chicks were transferred to the already disinfected brooding pens according to the genetic groups. The chicks were brooded for 3 weeks. Adequate management and health care. The chicks were fed with commercial starter ration that contain 23% crude protein and 2850 kcal/kg Metabolizable energy (ME) for up to three weeks of age. At four weeks of age, chicks were transferred to already compartmentalized rearing pens of 48.5 x 37 x 41.5 cm deep litter system to accommodate 50 birds per genotype and fed with grower mash (20 CP and 3000Kcal/Kg (ME)) till six weeks. Placement into each compartment was randomly done. Water was constantly supplied to the chicks and fed *ad libitum* with commercial broiler feed then switched to finisher ration that supplied 19.5% CP and 3080kcal/kg (ME) from six weeks to eight weeks of age when the project terminated. Vaccine/medication was administered to the birds to avoid disease outbreak. At day old Newcastle NDV-Komorov 9th day, 17th day Gumboro day 16, 26 Fowl Pox 6th week Coccidiostat 2 weeks interval.

2.4 Data Collection

2.4.1 Carcass Traits

Twenty chickens were randomly selected and slaughtered, 10 males and 10 females per genotype at 8 weeks of age. They were dissected for carcass measurement. Feed was withdrawn for 24 hours from the chickens prior to slaughter, to ensure empty crop and thus reduce the variability in body weight due to intestinal content. The chickens were weighed before slaughtered and were defeathered before dissecting the carcass. The method of Hahn and Spindler (2002) was adopted during slaughtering. The following weights were taken: Live weight (LW): This was weight of birds fasted overnight and taken just before slaughtered. Eviscerated weight (EW): weight taken after intestines were removed (gizzard and other organs of the body) and was expressed as percentage of the fasted live weight.

Weights of body parts were also taken: wings, back, breast, thighs, drumstick, gizzard and liver. Carcass yield (%) was calculated as the percentage by weight of the carcass of the living bird before slaughter.

2.6. Statistical Analysis

All data collected from the carcass were subjected to Analysis of variance through General Linear Model of SAS Package ver. 9.2 (2010). Means were separated using DUNCANS Multiple Range Test.

Experimental model: Model 1

$$Y_{ijk} = \mu + G_i + S_j + (GS)_{ij} + \epsilon_{ijk}$$

Where:

Y_{ijk} = Observation of the i^{th} genotype and j^{th} sex on the k^{th} bird

μ = Overall mean

G_i = Effect of the i^{th} chick genotype ($i = 1, 2 \dots 10$)

S_j = Effect of the j^{th} sex ($j = \text{male, female}$)

$(GS)_{ij}$ = Interaction effect of the i^{th} genotype and j^{th} sex

ϵ_{ijk} = Random, residual error

The yields of some carcass parts were also expressed as the percentage of the fasted liveweight for comparison.

3.0 Result and Discussion

3.1 Effect of Genotype on Carcass Parameter

The results showed that genotype significantly ($p < 0.0001$) influenced carcass parameters measured in this study as presented in Table 3.1. The mean values obtained (Table 3.1) on carcass measurement revealed that although Marshall genotype had higher mean values in all the carcass parameters measured at 8 weeks, F_2 upgrades comparatively had mean values statistically ($p > 0.0001$) similar to the Marshall genotype as the control.

Comparison with the F_2 upgrades showed that Frizzle-feathered upgrade had the highest values among the F_2 upgrades for live weight while Naked Neck upgrade had higher values in eviscerated weight and all the important cut: thigh, drumstick, wing, shank, back, breast, neck, head and internal organs: full-gizzard, empty gizzard, liver and heart weights than Frizzle-Feathered F_2 upgrade although there was no significant $P > 0.0001$ different among them Table 3.1.

For the F_1 crosses, Marshall x naked neck had higher mean values relatively similar to Marshall x Normal-Feathered, Marshall x Frizzle-Feathered cross as seen in Table 3.1. Naked Neck indigenous had the highest mean values in all the carcass parameters measured in this study amongst the purebred indigenous.

In addition, F_2 upgrades had the highest mean carcass weights relatively similar to the Marshall exotic while the indigenous purebreds were the least, Table 3.1. This indicates that at F_2 upgrade level Nigerian Indigenous chicken are similar to Marshall Exotic in terms of Productive performance.

Table 3.1a: Effects of genotype on carcass parameters (LSM±SE)

Genotype	N	Live weight(g)	Eviscerated weight(g)	Thigh (g)	Drumstick (g)	Wing (g)	Shank (g)	Back (g)
M x M	20	1409.70±91.55 ^a	894.10±69.45 ^a	142.90±13.16 ^a	132.60±15.70 ^a	122.85±9.86 ^a	64.25±5.03 ^a	164.60±14.85 ^a
N x N	20	953.00±55.34 ^c	524.35±32.34 ^b	68.30±3.86 ^d	57.70±2.58 ^e	72.10±3.60 ^b	34.95±2.46 ^d	83.70±5.22 ^d
Fz x Fz	20	997.00±59.44 ^c	567.75±51.42 ^b	74.30±4.58 ^d	70.15±3.53 ^{de}	78.20±5.38 ^b	35.00±1.77 ^d	96.75±6.68 ^{c d}
Nk x Nk	20	1017.95±50.10 ^c	621.80±31.52 ^b	86.70±12.78 ^{cd}	82.85±4.65 ^{cd}	83.35±4.77 ^b	35.45±1.65 ^d	107.50±13.90 ^{cd}
M x N	20	1079.15±72.44 ^{bc}	658.60±46.69 ^b	103.05±7.75 ^{bc}	91.50±7.75 ^{cd}	84.90±5.05 ^b	42.45±5.16 ^{cd}	124.30±8.24 ^{bc}
MxFz	20	1050.25±45.64 ^c	623.60±89.96 ^b	89.20±4.94 ^{cd}	82.00±8.44 ^{cd}	87.96±7.01 ^b	38.35±2.49 ^d	124.20±7.57 ^{bc}
MxNk	20	1122.75±82.05 ^{bc}	795.25±68.02 ^a	122.75±11.74 ^a	104.20±8.53 ^{bc}	107.10±8.34 ^a	51.15±2.54 ^{bc}	147.00±13.18 ^{ab}
MxMxN	20	1122.85±106.17 ^{bc}	850.25±74.35 ^a	129.30±10.86 ^a	116.00±9.41 ^{ab}	108.00±7.15 ^a	51.70±3.77 ^{bc}	151.25±12.01 ^{ab}
MxMxFz	20	1389.40±79.48 ^a	880.30±68.09 ^a	133.25±0.76 ^a	126.95±10.85 ^a	111.60±8.22 ^a	57.00±4.01 ^{ab}	157.20±16.25 ^a
MxMxNk	20	1233.45±100.99 ^b	889.65±69.30 ^a	139.95±15.50 ^a	131.00±12.56 ^a	112.40±10.7 ^a	57.35±6.44 ^{ab}	159.50±13.20 ^a

^{a, b, c, d, e} Means within the same column with same superscripts are not significantly different; M-Marshall, N-Normal Feathered, F- Frizzle-Feathered, NK- Naked Neck. MxM-Pure Marshall, NxN- Pure Normal-Feathered, Fx F-Pure Frizzle-Feathered, NKxNK-Pure Naked Neck, MxN-Dihybrid Normal-Feathered, MxF-dihybrid Frizzle-Fathered, MxNK-dihybrid Naked Neck, MxMxN-Normal-Feathered upgrade, MxMxF-Frizzle-Feathered upgrade, MxMxNK-Naked Neck upgrade.

Table 3.1b: Effects of genotype on carcass parameters (LSM±SE)

Genotype	N	Breast (g)	Neck (g)	Head (g)	Full-gizzard (g)	Empty-gizzard (g)	Liver (g)	Heart (g)
MxM	20	202.65±20.09 ^a	66.50±7.24 ^a	43.85±2.38 ^a	65.20±3.73 ^a	41.85±2.62 ^a	36.10±8.20 ^a	6.75±0.49 ^a
NxN	20	69.45±4.01 ^e	32.75±2.59 ^e	27.20±0.91 ^c	37.05±1.89 ^e	24.95±1.25 ^e	16.90±0.68 ^d	3.55±0.20 ^d
FzxFz	20	103.85±7.44 ^d	38.15±1.95 ^{de}	29.80±1.21 ^c	43.15±4.21 ^{de}	26.50±1.69 ^{de}	17.50±1.65 ^d	4.55±0.43 ^c
NkxNk	20	113.90±19.63 ^{cd}	40.00±6.31 ^{de}	33.25±2.30 ^{bc}	46.50±2.21 ^d	26.80±2.83 ^{de}	17.85±2.49 ^d	4.95±0.33 ^{bc}
MxN	20	127.10±12.12 ^{cd}	45.40±2.71 ^{bcd} _e	38.70±7.14 ^{ab}	48.10±3.98 ^{cd}	30.85±1.48 ^{cd}	24.25±1.71 ^{bcd}	5.10±0.50 ^{bc}
MxFz	20	140.60±12.12 ^{bc}	40.60±5.93 ^{cde}	34.05±1.23 ^{bc}	46.65±3.13 ^d	30.80±3.01 ^{cd}	19.90±1.11 ^{cd}	5.05±0.25 ^{bc}
MxNk	20	169.25±16.30 ^{ab}	49.55±3.04 ^{bcd}	39.45±2.11 ^{ab}	48.55±2.29 ^{cd}	32.40±1.53 ^{bc}	28.35±1.88 ^{abc}	5.15±0.37 ^{bc}
MxMxN	20	179.05±16.27 ^a	51.85±3.82 ^{bcd}	42.85±2.71 ^a	54.85±4.17 ^{bc}	36.15±2.67 ^{bc}	30.65±2.98 ^{ab}	5.55±0.43 ^{bc}
MxMxFz	20	182.00±13.85 ^a	53.90±7.17 ^{abc}	43.40±30.54 ^a	56.85±4.16 ^b	36.85±3.21 ^{ab}	33.60±2.90 ^{ab}	5.75±0.40 ^b
MxMxNk	20	195.05±21.21 ^a	54.90±4.87 ^{ab}	43.55±2.54 ^a	62.25±3.74 ^{ab}	37.25±2.71 ^{ab}	34.25±2.81 ^a	5.80±0.35 ^b

^{a, b, c, d, e} Means within the same column with same superscripts are not significantly different ; M-Marshall, N-Normal-Feathered, F- Frizzle-Feathered, NK-Naked Neck. MxM-Pure Marshall, NxN- Pure Normal-Feathered, Fx F-Pure Frizzle-Feathered, NKxNK-Pure NakedNneck, MxN-Dihybrid Normal-Feathered, MxF-dihybridFrizzle-Feathered, MxNK-dihybrid Naked Neck, MxMxN-Normal-Feathered upgrade, MxMxF-Frizzle-Feathered upgrade, MxMxNk-Naked Neck upgrade.

Table 3.2a: Effects of sex on carcass parameters (LSM±SE)

Sex	N	Live weight (g)	Eviscerated weight (g)	Thigh (g)	Drumstick(g)	Wing (g)	Shank (g)	Back (g)
Male	100	1365.81±34.14 ^a	902.27±30.72 ^a	134.78±5.73 ^a	123.27±5.52 ^a	114.66±4.02 ^a	54.43±2.08 ^a	159.76±6.27 ^a
Female	100	909.29±22.73 ^b	558.86±18.89 ^b	83.16±3.01 ^b	75.74±2.57 ^b	77.84±2.27 ^b	39.10±1.53 ^b	103.44±3.46 ^b

Table 3.2b: Effects of sex on carcass parameters (LSM±SE)

Sex	N	Breast (g)	Neck (g)	Head (g)	Full-gizzard (g)	Empty-gizzard (g)	Liver (g)	Heart (g)
Male	100	185.36±8.65 ^a	57.00±2.59 ^a	43.48±1.74 ^a	59.47±1.77 ^a	38.68±1.17 ^a	30.16±1.23 ^a	5.96±0.20 ^a
Female	100	111.22±4.34 ^b	37.72±1.62 ^b	31.74±0.81 ^b	42.36±1.18 ^b	26.20±0.78 ^b	21.71±1.84 ^b	4.48±0.14 ^b

^{a, b} Means within the same column with same superscripts are not significantly different, M- Male, F- Female

Table 3.3a: Effects of genotype x sex interaction on carcass parameters (LSM±SE) (g)

Genotype	Sex	N	Live Weight	Eviscerated Weight	Thigh	Drumstick	Wings	SHank	Back
MxM	Male	10	1695.80±93.44 ^a	1094.40±74.06 ^a	166.70±11.56 ^a	158.50±12.50 ^a	137.10±8.58 ^a	71.70± 6.70 ^a	197.70± 16.11 ^a
	Female	10	1123.60±92.20 ^b	693.80±77.22 ^b	99.80±10.34 ^b	95.40±10.57 ^b	86.10±8.17 ^b	56.80±75.1 ^b	121.30±12.34 ^b
NxN	Male	10	1044.70±90.98 ^a	728.8±81.17 ^a	113.70±13.36 ^a	101.10±10.79 ^a	89.50±9.31 ^a	44.20±4.06 ^a	136.80±12.72 ^a
	Female	10	861.30±52.80 ^b	588.40±39.00 ^b	92.40±7.04 ^b	81.90±5.22 ^b	80.30±4.03 ^b	32.50±1.45 ^b	111.60±6.67 ^b
Fz x Fz	Male	10	1212.00±49.58 ^a	721.50±73.42 ^a	73.70±5.73 ^a	60.90±4.29 ^a	75.9±5.67 ^a	39.10±3.90 ^a	85.20±8.72 ^a
	Female	10	782.20±46.78 ^b	414.00±22.86 ^b	62.90±4.86 ^b	54.50±2.70 ^b	68.3±4.39 ^b	30.80±2.54 ^b	82.20±6.21 ^b
Nk x Nk	Male	10	1170.89±50.72 ^a	699.30±42.82 ^a	100.06±6.90 ^a	94.20±5.72 ^a	89.70±6.66 ^a	38.40±1.48 ^a	146.4±11.29 ^a
	Female	10	865.10±53.22 ^b	544.3±32.07 ^b	77.80±5.13 ^b	71.50±5.49 ^b	72.80±6.14 ^b	32.50±2.71 ^b	109.50± 8.04 ^b
M x N	Male	10	1342.40±75.34 ^a	1116.00±75.40 ^a	190.30±19.78 ^a	179.50±18.69 ^a	142.10±16.33 ^a	73.10±41.91 ^a	125.40±17.25 ^a
	Female	10	815.90±32.87 ^b	584.50±44.34 ^b	89.60±7.75 ^b	85.70±9.95 ^b	82.70±4.71 ^b	51.76±8.95 ^b	113.80±7.77 ^b
MxFz	Male	10	1210.50±31.70 ^a	632.10±22.78 ^a	89.20±3.93 ^a	82.10±3.18 ^a	95.30±4.62 ^a	40.80±159 ^a	117.50±7.93 ^a
	Female	10	890.00±45.83 ^b	416.60±36.32 ^b	59.40±4.90 ^b	58.20±3.284 ^b	61.10±5.99 ^b	29.20±1.77 ^b	76.90±5.48 ^b
Mx Nk	Male	10	1397.50±80.50 ^a	1120.30±60.97 ^a	162.50±12.38 ^a	146.80±10.22 ^a	126.30±9.33 ^a	59.10±4.84 ^a	184.30±18.94 ^a
	Female	10	848.00±71.93 ^b	640.30±55.30 ^b	96.10±10.00 ^b	85.20±9.65 ^b	89.70±7.38 ^b	44.30±4.92 ^b	109.70± 8.08 ^b
MxMxN	Male	10	1441.00±135.67 ^a	888.90±126.97 ^a	123.10±50.30 ^a	119.90±18.54 ^a	111.4±12.42 ^a	54.70±6.61 ^a	142.10±19.34 ^a
	Female	10	840.70±81.79 ^b	358.30±49.08 ^b	50.3±6.66 ^b	44.30±5.77 ^b	52.60±6.47 ^b	30.20±5.62 ^b	72.90±13.25 ^b
MxMxFz	Male	10	1502.90±144.52 ^a	106.50±104.03 ^a	173.10±20.77 ^a	163.30±19.48 ^a	145.40±15.88 ^a	68.70±5.62 ^a	193.60±25.17 ^a
	Female	10	964.00±77.70 ^b	732.80±63.14 ^b	112.70±9.87 ^b	98.70±7.40 ^b	100.30±5.93 ^b	45.30±2.42 ^b	120.80±13.67 ^b
MxMxNk	Male	10	1640.50±96.92 ^a	974.90±103.06 ^a	154.90±17.02 ^a	126.40±13.44 ^a	129.70±12.57 ^a	54.50±4.64 ^a	178.60± 17.56 ^a
	Female	10	1138.30±57.16 ^b	615.60±41.71 ^b	90.60±7.90 ^b	82.00±13.44 ^b	84.50±4.65 ^b	47.80±1.81 ^b	123.90±11.56 ^b

^{a,b} Means within the same column with same superscripts are not significantly different ; MxM-Pure Marshall, NxN- Pure Normal-Feathered, Fz F-Pure Frizzle-Feathered, NKxNK-PureNnakedNneck, MxN-Dihybrid Normal-Feathered, MxF-dihybrid Frizzle-Feathered, MxNK-dihybrid Naked Neck, MxMxN-Normal-Feathered upgrade, MxMxF-Frizzle-Feathered upgrade, MxMxNK-Naked Neck upgrade

Table 3.3b: Effects of genotype x sex interaction on carcass parameters (LSM±SE) (g)

Genotype	Sex	N	Breast	Neck	Head	Full-Gizzard	Empty-gizzard	Liver	Heart
MxM	Male	10	234.20±16.97 ^a	69.20± 6.94 ^a	49.60±2.79 ^a	76.60± 2.47	47.40±2.46 ^a	40.80±4.38 ^a	7.00±0.33 ^a
	Female	10	123.90±12.05 ^b	40.60± 5.30 ^b	38.10±2.94 ^b	47.90 ±2.90 ^b	27.10±144	26.4±2.17 ^b	4.60±0.27 ^b
NxN	Male	10	154.4 ±20.06 ^a	49.70± 2.71 ^a	36.70±3.12 ^a	54.80± 2.90 ^a	35.70±2.50 ^a	27.10±2.02 ^a	6.30±0.40 ^b
	Female	10	126.8± 13.22 ^b	41.10± 2.66 ^b	29.80±3.14 ^b	42.30±2.24 ^b	29.10±1.12	21.40±2.53 ^b	5.20±0.30 ^a
Fz x Fz	Male	10	69.50±6.33 ^a	35.50± 4.20 ^a	27.5 ±1.55 ^a	34.20±2.96 ^a	23.70±1.89	16.8±1.04 ^b	4.00±0.21 ^a
	Female	10	69.40±5.29 ^a	30.00± 2.99 ^b	26.90±1.00 ^b	39.90±2.10 ^b	26.20±1.62 ^a	17.00±0.94 ^a	3.10±0.27 ^b
Nk x Nk	Male	10	144.5±11.89 ^a	42.20± 2.68 ^a	37.60±1.47 ^a	50.5±3.35 ^a	34.10±2.13 ^a	21.90±1.44 ^a	5.40± 0.50 ^a
	Female	10	109.70±7.32 ^b	34.10±2.30 ^b	30.50±1.21 ^b	42.50±2.40 ^b	27.60±1.53 ^b	17.90±.48 ^b	4.50±0.37 ^b
M x N	Male	10	263.90±26.82 ^a	72.40± 11.46 ^a	53.80± 5.19 ^a	68.30±5.07 ^a	46.40±2.05 ^a	36.30±3.11 ^b	7.10± 0.43 ^a
	Female	10	126.20±11.26 ^b	35.40±3.07 ^b	33.00± 1.40 ^b	41.40±2.80 ^b	25.90±1.58	35.90±16.59 ^a	4.00±0.25 ^b
MxFz	Male	10	127.80±5.77 ^a	50.40±10.80 ^a	33.80±1.16 ^a	52.50±3.76 ^a	30.90±2.25 ^a	22.70±12.30 ^a	5.80±0.85 ^a
	Female	10	79.00±8.55 ^b	30.80± 3.21 ^b	25.80±1.12 ^b	40.80±4.44 ^b	22.10±2.80 ^b	12.30±1.36 ^b	4.40±0.70 ^a
Mx Nk	Male	10	227.6±12.45 ^a	57.80± 3.30 ^a	50.10±3.11 ^a	70.30±3.11 ^a	46.90±3.76 ^a	38.50±4.20 ^a	5.50±0.64 ^a
	Female	10	136.4±13.90 ^b	41.30±3.58 ^b	35.60±3.08 ^b	43.40±4.16 ^b	26.80±2.63 ^b	22.80±2.49 ^b	4.80± 0.36 ^b
MxMxN	Male	10	162.10±31.43 ^a	55.50±10.18 ^a	52.60±12.99 ^a	54.80±5.69 ^a	35.30±3.66 ^a	24.70±3.75 ^a	5.70±0.65 ^a
	Female	10	65.70±11.07 ^b	24.50±3.30 ^b	31.50± 3.48 ^b	31.50± 3.47 ^b	18.30±2.08 ^b	11.00±1.32 ^b	3..44.00±0.27 ^b
MxMx Fz	Male	10	219.70±22.39 ^a	63.50± 4.65 ^a	43.80± 2.96 ^a	59.6±5.46 ^a	39.50±3.96 ^v	32.20±.85 ^a	5.10± 0.34 ^a
	Female	10	118.80±7.38 ^b	40.20± 3.16 ^b	35.10±2.39 ^b	36.6± 2.77 ^b	22.10±2.39	24.50±1.87 ^b	5.00±0.36 ^a
MxMxNk	Male	10	249.90± 31.79 ^a	73.80±10.69 ^a	49.30± 3.78 ^a	73.10±5.09 ^a	46.90±3.39 ^a	40.60±3.56 ^a	7.70±0.76 ^a
	Female	10	155.40±14.08 ^b	59.20±9.76 ^b	37.75±3.01 ^b	557.3±4.33 ^b	36.80±3.39	27.90±3.40 ^b	5.80± 0.49 ^b

^{a, b} Means within the same column with same superscripts are not significantly different ; MxM-Pure Marshall, NxN- Pure Normal-Feathered, Fx F- Pure Frizzle-Feathered, NKxNK-PureNaked Neck, MxN-Dihybrid Normal-Feathered, MxF-dihybridFrizzle-Feathered, MxNK-dihybrid NakedNeck, MxMxN-Normal-Feathered upgrade, MxMxF-Frizzle-Feathered upgrade, MxMxNK-Naked Neck upgrade.

3.2 Effects of Sex on Carcass Parameters

The result in Table 3.2 showed that sex highly ($p < 0.0001$) influenced the carcass parameters measured in this study. The least means of carcass parameters presented in Table 3.2 showed that generally males had mean values significantly higher than the female counterparts when compared.

3.3 Effects of Genotype by Sex Interaction on Carcass Parameters

Analysis of variance showed that genotype by sex interactively influenced ($P < 0.1$ to $P < 0.0001$) all the carcass parameters except in the shank, neck, liver and heart (Table 3.3b).

The least square means of genotype by sex interaction presented in Table 3.3 showed that males consistently had higher mean values than their female counterparts in all the genotypes. Comparison between the Marshall exotic and the F₂ upgrades showed that although, both Marshall male and female had higher mean values there was no significant ($P < 0.1$ to $P < 0.0001$) difference between the F₂ upgrades both in males and females.

However, the Frizzle-Feathered upgrade had the highest mean values in all the carcass parameters measured in this work, though not significantly ($P < 0.1$ to $P < 0.0001$) different from the other two upgrades. Similarly, Marshall x Naked Neck cross males and females had higher values than all the F₁ crosses counterparts. Males and females of Purebred Naked Neck genotype had values higher than the other indigenous purebreds. Males of F₂ upgrades performed better than the females while purebred indigenous males and females were the least in weight as shown in Table 3.2

4.0 Discussion

However, the Frizzle-Feathered upgrade had the highest mean values in all the carcass parameters measured in this work, though not significantly ($P < 0.1$ to $P < 0.0001$) different from the other two upgrades. Similarly, Marshall x Naked Neck cross males and female had higher values in eviscerated weight, thigh, drumstick, wing, shank, back, breast, neck, head, full-gizzard, empty gizzard, liver and heart weights than the Marshall x Frizzled feathers and Normal feathered crosses. Males and females of Purebred Naked Neck genotype had higher mean values than the other indigenous purebreds. Males of F₂ upgrades performed better than the females while purebred indigenous males and females were the least in weight as shown in Table 3.3. Genotype and sex interaction significantly affected carcass parameters measured.

However the result of these studies agree with Hussein *et al.*, (2018) who reported a significant ($P < 0.01$) effect of line x sex interaction on live weight and slaughter weight. These studies are in line with the report by Hack *et al.* (2019) who reported a similar observation as males of broiler strains could be raised for maximum profit and increase animal proteins consumption since more meat was obtained in males than females and increase animal proteins consumption. These studies agree with the observation by Lopez *et al.* (2011) which reported on Sex effects that broiler males had higher ($P < 0.05$) carcass weights, live BW and breast weights than females birds, but lower ($P < 0.05$) breast meat yield and dressing percentage. The result of this study is in consonance with Karima and Fathy (2005), and Musa *et al.* (2006) who reported significant breed differences in live body weight and other carcass parameters. In the Nigerian improved indigenous genotype naked neck upgrade performance was the best in all carcass traits

measured except live weight; that Frizzle-Feathered upgrade was the best although not different ($p > 0.0001$) statistically from each other. Both upgrades (Naked Neck and Frizzle-feathered upgrade) competed comparatively similar to Marshall breed which is expected to perform best because of its long time development.

Within the Nigerian improved chickens, naked neck upgrade emerged the best in performance in carcass trait measurement while Frizzle-feathered performed next but Normal-feathered was the least among the F_2 upgrades. F_1 crosses then followed while the pure indigenous were the least in carcass trait. The trend of this work showed that F_2 upgrades performance was quite similar to the values obtained from pure Marshall. The di-hybrid crosses were equally high in carcass traits compared to pure indigenous genotypes. The reason for the cross's good performance was due to the high level of Marshall genotype to indigenous genotype. The reason for the naked neck upgrade performing better than the other Frizzle upgrade could be due to the naked neck gene present in the genotype which is a major gene. This observation was in consonance with Gunn (2008) and Peters *et al.* (2008) who observed that major genes have positive effects on carcass and organ weight at 20 weeks as such necked necks performed better than the Frizzle and Normal-Feathered chickens. This better carcass quality in exotic genotypes was also observed by Adebambo *et al.* (2010) with exotic (Anak Titan, Giriraja, Alpha) breeds of chicken.

Sex significantly ($p < 0.0001$) affected all the carcass trait, live weight, eviscerated weight, thigh weight, head weight, drumstick, wing weight, shank weight, back weight, breast weight, neck, head weight, full gizzard weight, empty-gizzard weight, liver weight and heart weight. This result was in agreement with the report of Adebambo *et al.* (2010) and Worku *et al.* (2026) who observed that sex influenced carcass quality. However, the results of this study corroborates with the observation of Adenaike *et al.* (2015) which reported that Males of indigenous chickens had higher significant carcass parameters (live weight, carcass weight and yield, breast weight, leg weight and yield, wing weight and yield and back and shoulder weight) compared with females, except for back percentages. This also agreed with the findings of Adedeji *et al.* (2008), Siegel & Hononaker, 2024; Scanes (2025) and worku *et al.* (2026) who observed that males had higher values than the females in carcass traits. The reason could be attributed to the sexual dimorphism caused by faster growth and muscle-laying activity due to the male hormones.

5.0 Conclusion

Genotype and sex interaction significantly affected carcass parameters measured. In the Nigerian improved indigenous genotype naked neck upgrade performance was the best in all carcass traits measured while Frizzle-Feathered upgrade was the heaviest in terms of liveweight although not different ($p > 0.0001$) statistically from each other.

Both upgrades (Naked Neck and Frizzle-feathered upgrade) competed comparatively similar to Marshall Exotic breed (control) which is expected to perform best because of its long time development. Within the Nigerian improved chickens, naked neck upgrade emerged the best in performance in carcass trait measurement while Frizzle-feathered performed next but Normal-feathered was the least among the F_2 upgrades. F_1 crosses then followed while the pure indigenous were the least in carcass trait. The trend of this work showed that F_2 upgrades

performance was quite similar to the values obtained from pure Marshall. The di-hybrid crosses were equally high in carcass traits compared to pure indigenous genotypes. The reason for the cross's good performance was due to the high level of Marshall Genotype to indigenous genotype. The reason for the naked neck upgrade performing better than the other Frizzle upgrade could be due to the naked neck gene present in the genotype which is a major gene.

Sex significantly ($p < 0.0001$) affected all the carcass trait, live weight, eviscerated weight, thigh weight, head weight, drumstick, wing weight, shank weight, back weight, breast weight, neck, head weight and organs traits: full gizzard weight, empty-gizzard weight, liver weight and heart weight measured.

This study revealed that sex significantly influenced the entire carcass measurements of improved Nigerian indigenous chicken measured at week 8 studied. Males of improved Nigerian indigenous chickens had significantly higher means in LW, DW, EVW, Thigh, drumstick wings, breast cut, back cut, Neck, shank, and all the internal organs than the Females counterpart exception of liver that females had larger liver size than males while kidney in both sexes were similar as measured in this study.

Recommendation

It is recommended that males of improved Nigerian indigenous chickens should be raised for meat production purpose since it had higher means for live weight and carcass quality traits measured in this study. Farmers and breeders should practice crossbreeding due to high improvement found in carcass production outcome in F₁ Crosses and F₂ Upgrades of NICs.

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