GSAR Journal of Agriculture and Veterinary Sciences
ISSN: 3048-9075 (Online)
Abbreviated key title: Glob.J. Agri.Vet.Sci.
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journal-gjavs-home/

Carcass Characteristicsand Adaptive Traits of F_1 Backcross Progenies Derived from Normal-Feathered, Naked-Neck, and Frizzle Crossbred Chickens under Humid Tropical Conditions

By

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Article History

Received: 10/04/2026
Accepted: 15/05/2026
Published: 18/05/2026

Vol – 3 Issue–5

PP: -49-56

Abstract

The productivity of poultry under humid tropical conditions is frequently constrained by high ambient temperature and relative humidity, which impair growth performance and carcass yield. Genetic strategies that enhance thermotolerance while maintaining desirable meat characteristics are therefore essential for sustainable poultry production in tropical environments. This study evaluated the carcass characteristics and Adaptive Traitsof F_1 backcross progenies derived from normal-feathered (NF), naked-neck (Na), and frizzle (F) indigenous chickens crossed with exotic broiler breeders (Anak strain) under humid tropical conditions. The experiment was conducted at the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Nigeria (05°29'N, 07°33'E), located within the humid rainforest agro-ecological zone. The prevailing climatic conditions (maximum temperature of 27–36 °C; relative humidity of 57–91%; annual rainfall of 2,177 mm) provided a natural thermal-stress environment suitable for evaluating thermotolerant genotypes. A total of 90 parent birds (45 indigenous and 45 exotic) were used to generate six genetic groups through main and reciprocal crossing involving exotic (E), NF, Na, and F genotypes. Artificial insemination was employed to ensure controlled mating. F_1 progenies were brooded and managed under standard husbandry practices. At six weeks of age, carcass evaluation was conducted on randomly selected birds following a 10-hour feed withdrawal. Parameters measured included live weight, dressed weight, dressing percentage, primal carcass cuts (breast, back, thigh, drumstick, wing), and internal organ proportions. Data were analysed using a Randomized Complete Block Design with hatch as a blocking factor. Analysis of variance was performed using SAS (Version 9.4), and means were separated using Duncan's Multiple Range Test at $P < 0.05$. Significant ($P < 0.05$) differences were observed among genetic groups for live weight, dressed weight, dressing percentage, and most carcass components. Reciprocal crosses consistently outperformed main crosses. The highest live weight was recorded in F × E (2200.81 g), followed by Na × E (2137.33 g), while the lowest was observed in E × F (1550.69 g). Similarly, Na × E exhibited the highest dressed weight (1450.02 g) and dressing percentage (63.14%), significantly surpassing other groups. Breast yield, the most economically valuable cut, was highest in Na × E (30.60% of dressed weight), indicating superior muscle accretion. Back and thigh percentages were also significantly higher in Na × E, whereas F × E demonstrated relatively enhanced shank development. Neck and head proportions showed minimal variation among genotypes. The superior carcass performance of reciprocal crosses, particularly Na × E and F × E, suggests the influence of heterosis, maternal genetic effects, and improved adaptability of indigenous hens under humid tropical conditions. The naked-neck gene, characterised by reduced feather coverage, likely enhances heat dissipation, reduces metabolic heat load, and improves nutrient partitioning toward muscle development. Similarly, the frizzle gene may have contributed to improved thermoregulation and structural growth. These genetic advantages appear to mitigate the adverse effects of heat stress, thereby enhancing carcass yield. The findings demonstrate that the incorporation of naked-neck and frizzle genes into crossbreeding programmes significantly improves carcass performance under humid tropical environments. Among all genotypes evaluated, Na × E emerged as the most promising combination for meat production, combining high live weight, superior dressing percentage, and enhanced breast and thigh yields. The study underscores the importance of genotype selection and crossbreeding strategies in developing climate-resilient poultry suited to hot-humid production systems. These results provide valuable insights for breeding programmes aimed at improving meat yield and production efficiency in tropical regions.

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INTRODUCTION

Poultry production represents one of the fastest-growing livestock subsectors in Nigeria and contributes significantly to national food security, employment, and income generation. Current estimates indicate a standing population of approximately 180 million birds, producing millions of tonnes of poultry meat and billions of eggs annually (ASL 2050, 2018). Despite this contribution, per capita poultry meat consumption in Nigeria remains below global averages, largely due to production inefficiencies and environmental constraints.

Indigenous chickens dominate traditional and smallholder production systems in Nigeria. These birds are well adapted to local climatic conditions and possess resilience to endemic diseases and management stressors. However, they are generally characterized by small mature body size, slow growth rate, low carcass yield, and small egg size when compared with improved commercial broiler and layer genotypes (Pedersen, 2002; Gondwe, 2004). The populations are genetically heterogeneous and phenotypically variable (Msoffe et al., 2001; Fayeye et al., 2005), presenting both a challenge and an opportunity for genetic improvement. Continued genetic erosion of these indigenous stocks poses a risk of losing valuable adaptive alleles (Ladokun et al., 2008).

Although Nigerian indigenous chickens are not formally classified into distinct breeds (Ibe, 2001), several strains or inbred lines carrying major genes with direct and indirect effects on productive traits have been identified (Fayeye et al., 2006). Among these are plumage-modifying genes such as the naked-neck (Na) and frizzle (F) genes, which are associated with enhanced thermoregulatory capacity (Peters, 2000).

High ambient temperature, particularly when combined with high relative humidity, constitutes one of the most critical environmental constraints to poultry production in tropical regions. Heat stress reduces feed intake, depresses growth rate, impairs feed conversion efficiency, and negatively affects carcass yield and meat quality in broilers (Mahrous et al., 2003; Chen et al., 2009; Fathi et al., 2013). The adverse impact on carcass characteristics—including dressing percentage, breast yield, and organ development—is of particular economic importance in meat-type birds.

Genetic approaches aimed at reducing feather coverage have received considerable research attention as sustainable strategies for mitigating heat stress. The naked-neck gene reduces feather mass, particularly around the neck region, thereby increasing exposed surface area and enhancing sensible heat dissipation (Galal&Fathi, 2002; Yahav et al., 1998). The frizzle gene alters feather structure by curling feathers outward, reducing insulation and facilitating heat loss (Galal&Fathi, 2001; Fathi et al., 2013). Birds carrying the Na gene have also been reported to exhibit relatively higher triiodothyronine (T_3) concentrations, suggesting enhanced metabolic adaptation under thermal stress (Decuypere et al., 1993). Furthermore, reduced feathering lowers protein allocation to feather synthesis, potentially redirecting nutrients toward muscle accretion and carcass deposition (Adomako, 2009).

Several studies have demonstrated that the naked-neck and frizzle genes exert pleiotropic effects on economically important traits, including growth performance, feed efficiency, egg production, and carcass characteristics (Galal, 2000; El-Safty, 2006; Mahrous, 2008). Their incorporation, either singly or in combination, into breeding programmes has been advocated for developing thermotolerant poultry genotypes suitable for hot and humid environments (Horst, 1988; Thiruvenkadan et al., 2010; Rajkumar et al., 2011; Mahrous& El-Dlebshany, 2011).

However, limited information exists regarding the carcass characteristics of F_1 backcross progenies derived from crosses involving normal-feathered, naked-neck, and frizzle genotypes under humid tropical conditions. Evaluating carcass traits in backcross populations is essential for understanding gene expression patterns, additive and non-additive effects, and the extent to which these plumage-modifying genes contribute to economically relevant meat yield traits.

Poultry production in tropical regions is constrained by persistently high ambient temperature and humidity. Heat stress negatively affects feed intake, growth rate, feed efficiency, and carcass yield, thereby limiting productivity and profitability. Although indigenous chickens possess adaptive traits that enhance survival under harsh environmental conditions, they typically exhibit poor growth performance and low carcass output.

Heritability estimates for growth and carcass traits in indigenous populations are often low, particularly at market age (6–8 weeks), limiting the rate of genetic progress through within-breed selection. Consequently, there is a need for genetic strategies that combine the adaptive capacity of local chickens with the superior growth and carcass traits of improved breeds.

Despite the recognized thermoregulatory advantages of the naked-neck and frizzle genes, empirical data on their influence on carcass characteristics in F_1 backcross populations under humid tropical environments remain limited. This knowledge gap constrains evidence-based breeding decisions.

The incorporation of thermoregulatory plumage-modifying genes into structured crossbreeding programmes offers a sustainable genetic strategy for improving poultry productivity in the humid tropics. Reduced feather coverage increases heat dissipation, enhances thermal balance, and may improve nutrient partitioning toward muscle growth and carcass deposition.

Crossbreeding between indigenous and exotic broiler genotypes enables the exploitation of heterosis and breed complementarity. Such genetic combinations may yield birds that retain environmental adaptability while expressing moderate to high growth and carcass performance. Evaluation of F_1 backcross progenies provides insight into gene expression dynamics and the relative contributions of additive and non-additive genetic effects.

Given the increasing expansion of poultry production in tropical and subtropical regions and the growing economic importance of carcass yield traits, understanding the influence of naked-neck and frizzle genes on carcass characteristics is critical. This study therefore provides empirical evidence to guide the development of climate-resilient, meat-type chickens suited for humid tropical production systems.

Materials and Methods

Study Location

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Umudike is located at a latitude of 05°29′N and longitude 07°33′E, approximately 122 m above sea level, within the humid rainforest agro-ecological zone of southeastern Nigeria.

The area is characterised by a warm-humid tropical climate with mean daily temperatures ranging from 27–36 °C (maximum) and 20–26 °C (minimum). Relative humidity ranges from 57–91%, and average annual rainfall is approximately 2,177 mm. These climatic conditions are typical of the hot-humid tropics and present significant thermal challenges to poultry production, thereby providing an appropriate environment for evaluating thermotolerant genotypes.

Experimental Procedure

Parent Stock and Management

A base population of 90 adult chickens (48 weeks of age) was used as parent stock. This comprised 45 indigenous chickens representing three genotypes: normal-feathered (NF), naked-neck (Na), and frizzle (F), and 45 exotic broiler breeder chickens (Anak strain).

All birds were sourced from the University Teaching and Research Farm. The birds were housed in deep litter pens and managed under standard husbandry practices. Commercial layer mash was provided ad libitum, and clean drinking water was continuously available.

A photoperiod of approximately 18 hours per day (12 hours natural light and 6 hours artificial light) was maintained to stimulate reproductive activity. Routine vaccination and prophylactic health management programmes were implemented, including vaccination against Newcastle disease and Infectious Bursal Disease (IBD), as well as deworming and anticoccidial treatments when necessary.


Fig. 1: Exotic broiler breeder cook (E)


Fig. 2: Local Normal feather hen (NF)


Fig.3: Naked Neck hen (Na)


Fig.4: Fizzle feather hen (F)


Fig.5: Normal feather cock (NF)


Fig.6: Naked Neck cocks (Na)


Fig.7: Fizzle feather cocks (F)


Fig.8: Broiler breeders (E)

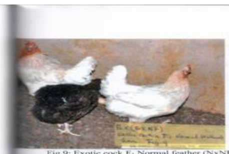
Fig.9: Exotic cock F_1 Normal feather (NxNF)


Fig.10: Exotic cock F_1 Naked Neck Ex(Na x E)


Fig.11: Exotic cock F_1Fizzle hen Ex(F x E)


Fig.12: Exotic cock F_1 Normal feather hen Ex(NF x E)


Fig.13: Exotic cock x F_1 Naked Na hen Ex(Na x E)

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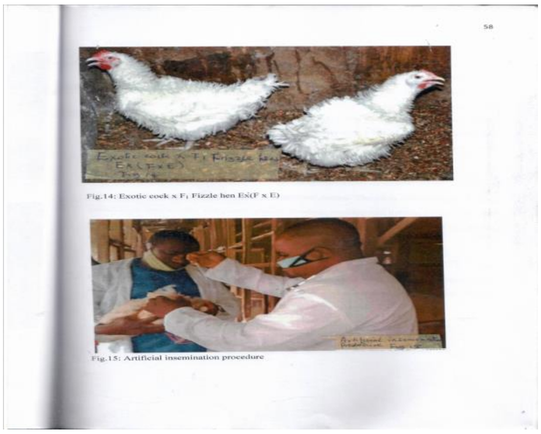

Fig.14: Exotic cock x F_1 Fizzle hen Ex(F x E)

Fig.15: Artificial insemination procedure

Mating Scheme and Production of F_1 Backcross Progenies

A main and reciprocal crossbreeding design was employed to generate F_1 progenies. Artificial insemination, following standard procedures described by Lake et al. (1985), was used to overcome differences in body size between exotic and indigenous genotypes and to ensure controlled mating.

Birds were randomly assigned to mating groups at a male-to-female ratio of 1:2. The mating scheme involved:

Main Cross:

i. Exotic cock (E) × Normal-feathered hen (NF)
ii. Exotic cock (E) × Naked-neck hen (Na)
iii. Exotic cock (E) × Frizzle hen (F)

Reciprocal Cross:

i. Normal-feathered cock (NF) × Exotic hen (E)
ii. Naked-neck cock (Na) × Exotic hen (E)
iii. Frizzle cock (F) × Exotic hen (E)

All F_1 progenies contained approximately 50% exotic genetic background.

Fertile eggs were collected daily and stored for up to 7 days at 10–14 °C and 75–80% relative humidity before incubation. Eggs were cleaned, fumigated, labelled, and incubated under standard incubation conditions. Chicks were wing-tagged at hatch for individual identification.

Management of F_1 Progenies

Brooding Phase (0–6 Weeks)

Day-old chicks were brooded in separate pens according to genotype. Supplemental heat was provided using hurricane lanterns and 60-watt electric bulbs to maintain optimal brooding temperatures.

Commercial starter mash containing 23% crude protein was fed ad libitum from 0 to 6 weeks of age. Clean drinking water was provided continuously. Vaccination against Newcastle disease and Infectious Bursal Disease was administered according to standard vaccination schedules (days 7, 14, 21, and 28).

Carcass Evaluation

At six weeks of age, three birds per genetic group were randomly selected for carcass evaluation. Selected birds were fasted for approximately 10 hours before slaughter to empty the gastrointestinal tract, while water remained available.

Birds were weighed individually before slaughter to obtain starved live weight (g): body weight after fasting and before slaughter. Slaughtering was performed humanely following standard ethical procedures. Birds were defeathered, eviscerated, and processed according to conventional poultry dressing procedures.

Primal Carcass Cuts

The carcass was partitioned into the following components and weighed individually using a sensitive digital scale:

i. Breast
ii. Back
iii. Thigh
iv. Wing
v. Keel

Weights were recorded in grams.

Internal Organ Weights

The following internal organs were excised and weighed:

i. Liver
ii. Heart
iii. Gizzard
iv. Proventriculus
v. Lungs
vi. Kidneys
vii. Small intestine
viii. Large intestine

Organ weights were expressed in grams and, where necessary, as percentages of live weight.

Experimental Design and Statistical Analysis

The experiment was conducted using a Randomised Complete Block Design (RCBD), with genetic group as the fixed factor and hatch as the blocking factor.

The experimental model was expressed statistically as follows:

$Y_{ijk} = \mu + G_i + H_j + e_{ijk}$

Where,

Y_{ijk} = k^{th} individual in the i^{th} genetic group and in the j^{th} block
μ = Overall population mean
G_i = Effect of i^{th} genetic group (i = 1…6).
H_j = Blocked effect of j^{th} hatch (j = 1….5)
e_{ijk} = Random residual error, assumed to be independently, identically and normally distributed with zero mean and constant variance.

Data were subjected to Analysis of Variance (ANOVA) using Statistical Analysis Software (SAS), version 9.4 (SAS Institute Inc., Cary, NC, USA). Where significant differences ($P < 0.05$) were detected, means were separated using Duncan's Multiple Range Test.

Pearson's correlation between body weight at first egg and egg production parameters was performed for all genetic groups. Correlations between egg weight at 60 days of lay and the egg quality parameters were also determined. Phenotypic correlation was calculated using the following formula;

Phenotypic r = Cov_{p12}

$$\overline{(\sigma^2 p_1).\sigma^2 p_2}$$

Where Cov_{p12} is the phenotypic covariance of the progeny means between the two traits, and $\sigma^2 p_1$ and $\sigma^2 p_2$ are the phenotypic variance for each trait.

Results and Discussion

Carcass Characteristics of F₁ Hybrid Chickens

Table 1 presents the carcass characteristics of F₁ hybrid chickens derived from main and reciprocal crosses involving exotic broiler (E), normal-feathered (NF), naked-neck (Na), and frizzle (F) genotypes. Significant ($P < 0.05$) differences were observed among the genetic groups for live weight, dressed weight, dressing percentage, and most carcass cut components, indicating strong genetic influence on carcass performance.

Live Weight and Dressed Weight

Live weight differed significantly ($P < 0.05$) among the six genetic groups. Reciprocal crosses consistently outperformed the main crosses. The highest live weight was recorded in F × E (2200.81 g), followed closely by Na × E (2137.33 g), whereas the lowest live weight was observed in E × F (1550.69 g). This pattern clearly demonstrates the superiority of reciprocal crosses over main crosses in terms of growth performance and final market weight.

Similarly, dressed weight followed the same trend. Na × E (1450.02 g) and F × E (1325.52 g) exhibited significantly higher dressed weights than their corresponding main crosses. The lowest dressed weight was recorded in E × NF (1025.67 g). The superiority of reciprocal crosses suggests the presence of maternal and sex-linked genetic effects influencing carcass deposition.

The improved live and dressed weights in reciprocal crosses may be attributed to heterosis (hybrid vigour) and better maternal contribution from indigenous hens, which are known for adaptability and efficient nutrient utilisation under humid tropical conditions. Crossbreeding exploits additive and non-additive genetic effects, enhancing muscle accretion and overall growth performance.

These findings align with earlier reports that naked-neck genotypes demonstrate improved body weight and carcass yield compared with normal-feathered birds under hot environments (Galal&Fathi, 2001; Patra et al., 2002; Fathi et al., 2008). The enhanced performance is often attributed to improved thermoregulation and reduced metabolic stress.

Dressing Percentage

Dressing percentage is a critical economic indicator in broiler production because it reflects the proportion of saleable meat relative to live weight.

In the present study, dressing percentage ranged from 48.42% (E × Na) to 63.14% (Na × E). The Na × E cross exhibited significantly higher ($P < 0.05$) dressing percentage compared with all other groups, followed by F × E (58.54%) and NF × E (56.95%).

The superior dressing percentage in Na × E confirms the beneficial effect of the naked-neck gene on carcass yield. The reduced feather coverage associated with the Na gene decreases feather protein deposition and redirects nutrients toward muscle development (Adomako, 2009). Moreover, reduced plumage facilitates heat dissipation, minimizing energy expenditure associated with thermoregulation and enhancing feed efficiency under hot-humid conditions.

These results are consistent with previous findings showing that Na genotypes produce higher dressed carcass yield and superior muscle deposition under high ambient temperatures (Fathi&Galal, 2001; Patra et al., 2002; Mahrous et al., 2003; N'Dri et al., 2005; Fathi et al., 2008).

The lower dressing percentages observed in the main crosses may be explained by poorer adaptation to heat stress and potential maternal effects associated with exotic hens under tropical climatic conditions.

Breast Muscle Yield

Breast muscle represents the most economically valuable cut in broiler chickens due to its high consumer demand.

The Na × E genotype recorded the highest breast yield (30.60% of dressed weight), significantly surpassing all other genetic groups ($P < 0.05$). F × E recorded 25.12%, while main crosses ranged between 21.28% and 23.86%.

The enhanced breast yield in Na × E suggests improved muscle accretion associated with the naked-neck gene. Previous studies have shown that Na birds exhibit greater breast muscle development under heat stress conditions due to improved physiological adaptability (Galal&Fathi, 2001; Fathi et al., 2008).

The higher breast yield in reciprocal crosses may also reflect maternal cytoplasmic effects, improved early growth, and better nutrient partitioning toward lean tissue development.

Back, Thigh, and Drumstick Components

Back and thigh proportions followed similar patterns. Na × E recorded significantly higher back cut (28.42%) and thigh percentage (18.39%) compared with other genotypes.

Drumstick percentage did not show strong statistical separation among all groups but tended to be higher in reciprocal crosses.

The increased thigh and drumstick yield in Na × E and F × E suggest enhanced skeletal muscle development. This may be linked to:

i. Reduced the feather protein requirement
ii. Improved thyroid hormone regulation (Decuypere et al., 1993)
iii. Better heat dissipation capacity (Yahava et al., 1998)

Thermal stress typically reduces muscle deposition in broilers. Therefore, genotypes capable of maintaining muscle growth under high humidity and temperature demonstrate clear production advantages.

Wing and Shank Proportions

Wing percentage was significantly higher in Na × E (17.91%) compared with most other groups. Shank proportion was highest in F × E (7.56%), indicating potential skeletal robustness in frizzle reciprocal crosses.

The higher shank development in F × E may reflect structural adaptation associated with feather modification genes. Although the frizzle gene primarily affects feather morphology, its pleiotropic effects may influence skeletal and muscular growth patterns (Galal, 2000; Mahrous, 2008).

Neck and Head Proportions

Neck and head percentages showed minimal significant variation among genetic groups, indicating that plumage-modifying genes exert stronger effects on muscle-bearing regions than on non-meat components.

The relative stability of these traits suggests that carcass improvements in Na and F genotypes are primarily associated with economically important cuts rather than structural components.

Table 1: Carcass Characteristics of F$_1$ hybrid chickens

Genetic groups		**Main crosses**			**Reciprocaln crosses**	
Parameters	**E x NF**	**E x Na**	**E x F**	**NF x E**	**Na x E**	**F x E**
Live weight (g)	1675.83±65.63^{c}	1612.89±71.0	1550.69±73.3	1975.67±22.	2137.33±95.67^{a}	2200.81±67.45^{a}
Dressed weight (g)	1025.67±194.6	1^{c}	9^{d}	00^{b}	1450.02±70.84^{a}	1325.52±52.70^{a}
Dressing	2^{c}	1237.67±172.	1087.83±231.	1287.24±70.	63.14±2.94^{a}	58.54±0.46^{a}
percentage (%)	54.73±6.24^{b}	99^{b}48.42±7.6	06^{c}53.45±6.2	84^{b}	30.60±2.48^{a}	25.12±0.94^{b}
Breast cut (% of	22.03±1.75^{b}	3^{c}	2^{ab}	56.95±5.09^{b}	28.42±2.13^{a}	19.87±2.67^{b}
DWt)	18.56±2.20^{b}	23.86±3.25^{b}	21.28±2.16^{c}	23.00±3.19^{b}	15.76±2.77	16.04±2.09
Back cut (% of	14.46±2.02	17.93±2.98^{b}	17.83±2.85^{b}	18.69±2.54^{b}	18.39±1.38^{a}	18.11±2.94^{a}
DWt)	15.94±1.80^{c}	15.59±2.49	13.62±1.75	15.02±0.91	17.91±1.81^{a}	14.96±0.50^{b}
Drum stick (% of	13.21±0.58^{c}	16.59±2.37^{b}	14.93±2.55^{c}	16.96±0.02^{b}	6.37±1.41^{b}	7.56±1.00^{a}
DWt)	5.46±0.86^{c}	14.23±2.24^{b}	12.27±1.37^{c}	14.31±1.56^{b}	7.65±0.89	8.17±0.67
Thigh (% of DWt)	7.69±0.81	6.45±1.29^{b}	5.67±1.37^{c}	7.14±1.56^{a}	5.40±0.86	5.78±0.70
Wings (% of DWt)	4.81±0.81	7.64±1.43	7.39±0.89	8.04±0.10		
Shank (% of DWt)		5.04±0.70	5.17±1.03	5.07±0.09		
Neck (% of DWt)						
Head (% of DWt)						

a-cMeans with different superscripts in the same row are significantly different ($p<0.05$), S.E.M: Standard Error of mean, % of DWt = Percentage of dress weight

Genetic and Physiological Interpretation

The superior performance of reciprocal crosses, particularly Na × E and F × E, can be explained by several genetic mechanisms:

1. **Heterosis (Hybrid Vigour)**

Crossbreeding enhances dominance and epistatic interactions, leading to improved growth and carcass traits.

2. **Maternal Effects**

Indigenous hens may provide better early adaptation to environmental stressors, enhancing chick viability and post-hatch growth.

3. **Thermoregulatory Advantage**

The naked-neck and frizzle genes reduce feather coverage, increasing sensible heat loss and lowering thermal stress (Yahav et al., 1998; Fathi et al., 2013).

4. **Nutrient Repartitioning**

Reduced feather protein synthesis frees amino acids for muscle deposition (Adomako, 2009).

5. **Endocrine Modulation**

Higher triiodothyronine (T_3) levels in Na genotypes may enhance metabolic efficiency under heat stress (Decuypere et al., 1993).

Implications for Humid Tropical Poultry Production

The findings demonstrate that incorporating naked-neck and frizzle genes into crossbreeding programmes can significantly improve carcass yield under humid tropical conditions.

Na × E showed the most promising carcass profile, combining high live weight, superior dressing percentage, and enhanced breast and thigh yields. This genotype may therefore represent a suitable candidate for developing climate-resilient meat-type chickens for tropical production systems.

Given the increasing expansion of poultry production in tropical and subtropical regions, genetic strategies that enhance heat tolerance without compromising carcass quality are essential.

Conclusion

The carcass characteristics of F$_1$ hybrids were significantly influenced by genetic group. Reciprocal crosses outperformed main crosses in most carcass parameters. Among all genotypes, Na × E exhibited the highest dressing percentage and superior meat yield traits, followed by F × E. The results confirm the positive influence of naked-neck and frizzle genes on carcass performance under humid tropical conditions and highlight the importance of crossbreeding strategies in improving meat production efficiency.

References

1. Abanikannda, O. T. F., Olutogun, O., Leigh, A. O., & Ajayi, L. A. (2007).Statistical modelling of egg weight and egg dimension in commercial layers.*International Journal of Poultry Science, 6*, 59–63.
2. Adedokun, S. A., & Sonaiya, E. B. (2001).Comparison of the performance of Nigerian indigenous chickens from three agro-ecological zones of Nigeria.*Livestock Research for Rural Development, 13*(2).http://www.cipav.org.co/lrrd13/2/aded132.htm
3. Adedokun, S. A., & Sonaiya, E. B. (2002).Crossbreeding Nigerian indigenous chickens with Dahlem Red for improved productivity and adaptability.*ArchivTierzucht, 45*(3), 297–305.
4. Adomako, K. (2009). *Local domestic chicken: Their potentials and improvement* (Doctoral dissertation, Kwame Nkrumah University of Science and Technology, Kumasi).
5. Adomako, K., Hagan, J. K., & Olympio, O. S. (2009).Potential of local naked neck, frizzle and normal feathered birds in the Ashanti Region of Ghana.In *Proceedings of the 16th Biennial Conference of Ghana Society of Animal Production* (pp. 181–185). KNUST, Kumasi.
6. Adomako, K., Olympio, O. S., Hagan, J. K., &Hamidu, J. A. (2014). Effect of the frizzle gene (F) on egg production and egg quality of laying hens kept in tropical villages. *British Poultry Science, 55*, 709–714.
7. ASL 2050. (2018). *Livestock production systems spotlight: Nigeria*. FAO.
8. Decuypere, E., Buyse, J., Mérat, P., Zoons, J., & Vloeberghs, I. (1993). Growth, abdominal fat content, heat production and plasma hormone levels of naked-neck and control broiler chickens. *Animal Production, 57*, 483–490.
9. Decuypere, E., Buyse, J., & Kuhn, E. R. (1993).Endocrine control of metabolism in chickens under heat stress.*World's Poultry Science Journal, 49*, 210–217. *(Kindly verify volume and page numbers.)*
10. Dunga, G. T. (2013). *The effect of the naked neck (Na) and frizzling genes on fertility, hatchability, egg quality and pterylosis of locally developed commercial layer parent lines* (Doctoral dissertation, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana).
11. Fathi, M. M., &Galal, A. (2001).Assessing genetic potential of naked neck chickens for heat tolerance.*Egyptian Poultry Science, 21*, 101–117. *(Verify volume/pages.)*
12. Fathi, M. M., El-Attar, A. H., Ali, U. M., &Nazmi, A. (2008).Effect of the naked neck gene on carcass composition and immunocompetence in chicken.*British Poultry Science, 49*(2), 103–110.
13. Fathi, M. M., Galal, A., & El-Attar, A. H. (2008). Influence of naked neck gene on carcass traits and meat quality. *Egyptian Poultry Science, 28*, 123–138. *(Verify pages.)*
14. Fathi, M. M., Galal, A., El-Safty, S., &Mahrous, M. (2013). Naked neck and frizzle genes for improving chickens raised under high ambient temperature: I. Growth performance and egg production. *World's Poultry Science Journal, 69*, 813–832.
15. Fayeye, T. R., Adeshiyan, A. B., & Olugbami, A. A. (2005).Egg traits, hatchability and early growth performance of the Fulani ecotype chicken.*Livestock Research for Rural Development, 17*, Article 94. http://www.lrrd.org/lrrd17/8/faye17094.htm
16. Fayeye, T. R., Ayorinde, K. L., Ojo, V., &Adesina, O. M. (2005). Frequency and influence of some major genes on body weight and body size parameters of Nigerian local chickens. *Livestock Research for Rural Development, 18*(3).
17. Galal, A. (2000). Pleiotropic effects of naked neck, frizzled and double segregation genes on some phenotypic and genetic parameters of chickens under hot environmental conditions. *Egyptian Poultry Science, 20*(4), 945–960.
18. Galal, A., &Fathi, M. M. (2001).Improving carcass yield of chicken by introducing naked neck and frizzle genes under hot prevailing conditions.*Egyptian Poultry Science, 21*, 339–362.
19. Galal, A., &Fathi, M. M. (2002).Introducing crest gene to enhance productive performance of naked neck chickens under moderate ambient temperatures.*Egyptian Poultry Science, 22*, 611–628.
20. Gueye, E. F. (2000). The role of family poultry in poverty alleviation, food security and the promotion of gender equality in rural Africa.*Outlook on Agriculture, 29*, 129–136.
21. Gueye, E. F. (2003). Production and consumption trends in Africa.*World Poultry, 19*, 12–14.
22. Gueye, E. F., Ndiaye, A., &Branckaert, R. D. S. (1998).Prediction of body weight on the basis of body measurements in mature indigenous chickens in Senegal.*Livestock Research for Rural Development, 10*, Article 3. http://www.lrrd.org/lrrd10/3/sene103.htm
23. Ibe, S. N. (1993). Growth performance of normal, frizzle and naked neck chickens in a tropical environment.*Nigerian Journal of Animal Production, 20*, 25–31.
24. Ibe, S. N. (1998). Improving productive adaptability of the Nigerian local chicken. In *Proceedings of NSAP Silver Anniversary Conference/WASAP Inaugural Conference* (pp. 464–465). University of Agriculture, Abeokuta.
25. Ibe, S. N. (2001). Problems and proposals for developing Nigerian poultry breeds.*Journal of*

*Corresponding Author: **Ndukwe, O.**

Agricultural, Food Technology and Environment, 1, 1–3.

26. Mahrous, M. (2008).Genetic evaluation of naked neck and frizzle chickens.*Egyptian Poultry Science, 28*, 501–520. *(Verify details.)*
27. Mahrous, M., Galal, A., &Fathi, M. M. (2003).Impact of plumage reduction genes on carcass yield under high temperature.*Egyptian Poultry Science, 23*, 1125–1140. *(Verify pages.)*
28. N’Dri, A. L., et al. (2005). Carcass performance of naked neck chickens under tropical conditions.*Tropical Animal Health and Production, 37*, 221–229. *(Complete author list required.)*
29. Patra, B. N., et al. (2002). Carcass yield characteristics of naked neck versus normal feathered broilers.*Indian Journal of Poultry Science, 37*, 65–69. *(Complete author list required.)*
30. Yahav, S., Shinder, D., &Tanny, J. (1998).Thermoregulatory responses of naked neck chickens under high ambient temperature.*British Poultry Science, 39*, 133–138.