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PHENOTYPIC CHARACTERIZATION OF INDIGENOUS BREEDS OF CHICKENS IN SIERRA LEONE

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Abstract

This study phenotypically characterized indigenous breeds of chickens in regional Sierra Leone and analyzed the prevalence of E. coli isolate in fecal swabs of both indigenous and other exotic breeds of chicken. Five distinct ecotypes were identified with no significant differences (P>0.05) in morphological appearance. Qualitatively, orange and yellow eye colors were commonly found; brown and yellow beak colors predominate in the Normal and Frizzle, with single comb type observed in all breeds. The Kebu showed 100% grey shanks. Body parameters were also not significant (P>0.05). However, the Kebu showed better character than others did. An average resistance to antibiotics was shown for Sulphathiazole (97%), Ampicillin (30.4%), and Chloramphenicol (3.0%). E. coli isolates from the Kebu exhibited resistance to all the antibiotics used, while, E. coli isolates from all breeds showed resistance to Sulphathiazole and Ampicillin. All isolates were 100% susceptible to cefepime, and 92.3% susceptible to cephalosporin.

Keywords*: Chicken breeds, Characterization, Antibiotics, Susceptibility, Resistance*

INTRODUCTION

Poultry is widely known as the livestock of the poor, and its production is believed to have been practiced by most smallholder farmers in Sub-Saharan Africa being the most efficient and economical converter of vegetable food into animal protein with quick returns when compared to the production of other proteins of animal origin (Patrick et al; 2003). Poultry production in Sierra Leone is made of two distinct types. There is the multimillion commercial poultry that supplies high-quality reasonable priced protein, and the resource-poor popular backyard poultry found in both rural and urban areas where a small number of indigenous chickens are kept for income generation, food security and supplies, social, cultural, and environmental values (Akinola & Essien, 2011; Wong et al., 2017). It also plays a significant role in poverty alleviation strategies, especially for resource-poor and traditionally neglected groups (Islam & Jabbar, 2005; Assa, 2012). Smallholder chicken production accounts for about 80% of the poultry flock in Sub-Saharan Africa (Akinola & Essien, 2011; FAO, 2020). However, low input-output production systems characterize the sector. In addition, limitations in access to improved breeds, input and output markets, institutional support, and technical and financial capacity constrain the sector. Thus, improving the production and productivity of the sector requires an integrated intervention that includes improving management practices and enhancing the productivity of genotypes (Riise et al., 2005; Pym, 2013; FAO, 2014; Padhi, 2016; Wong et al., 2017). Historically, the introduction of exotic genetics into smallholder, intensive chicken production has not been competitive in SubSaharan Africa, especially Sierra Leone, due to management issues and high feed, veterinary, and energy costs (Sonaiya & Swan, 2004). While many Sub-Saharan African countries have access to exotic germplasm, the birds developed for high-input production systems in temperate regions are generally poorly adapted to low-input chicken management systems in these countries. (Dana et al., 2010) reported that smallholder farmers in sub-Saharan Africa need tropically adapted, improved breeds that are dual-purpose, using modest management conditions (Alam et al., 2025)**.**

Indigenous chickens produced through backyard poultry rearing are characterized by scavenging for feed which is highly likely to be contaminated with microbes during harvest or through fecal contamination and contaminated eggs. According to (Adyanju G. T. & Ishola O, 2014) contaminated poultry feed has been associated with Escherichia coli and Salmonella species (Mohd Pauzi & Shahadat Hossen, 2025).

Escherichia coli is a Gram-negative, rod-shaped, anaerobic bacterium in the family of Enterobacteriaceae that is found in the gastrointestinal tract of domesticated livestock and humans (M. Levine 1987). There are concerns about the devastating effects on the health of humans caused by many strains of E. coli that are zoonotic in nature and can cause diseases like enteritis, endocarditis, urinary tract infection, septicemia, meningitis, epidemic diarrhea, and others (M. Rhaman et al; 2020). In poultry, it causes yolk-sac infection, omphalitis, swollen head syndrome, coligranuloma and colibacillosis (Islam et al; 2021).

This project therefore aimed to avail high-producing, farmer-preferred chicken genotypes to improve the country's smallholder chicken production and productivity systems and characterized E. coli isolates obtained from different breeds of locally adapted chickens raised by backyard poultry farmers across Sierra Leone (Rashed et al., 2025)**.**

METHODOLOGY

The indigenous chicken germplasm collection and phenotypic characterization were conducted in all four regions of the country. Sierra Leone is located on the west coast of Africa, between the 7th and 10th parallels north of the equator. It is bordered by Guinea to the north and northeast, Liberia to the south and southeast, and the Atlantic Ocean to the west. The country has a total area of 71,740 km^2 (27,699 sq. mi), divided into a land area of 71,620 km^2 (27,653 sq. mi) and water of 120 km^2 (46 sq. mi). *(LeVert, 2007).* The country has four distinct geographical regions: coastal Guinean Mangroves, the wooded hill country, an upland plateau, and the eastern mountains. The climate is tropical with two seasons, dry season (November – May) and rainy season (June – October). December to January are the coolest months of the year, although temperatures can still exceed 40 °C or 104 °F, lower to moderate humidity makes the heat around this time of the year more tolerable. Unlike March and April, the months that it gets hot and humid with temperatures around 33 to 36 °C or 91 to 97 °F and a solid 50% humidity, making the heat index higher than the actual temperature. The average sea temperature is 30 °C or 86 °F.

Chicken origin

The indigenous chickens used in this study were sourced from backyard poultry farmers in all four regions of the country. This was done to examine the breed type and antibiotic resistance in different breeds in all regions. One hundred and fifty (150) locally adapted chickens of various sizes (ranging from growers to adult male and female birds) were randomly selected, phenotypically characterized, and swabbed for bacteria *E.coli*. These local chickens were raised in a free-to-range system of production where they scavenged for various feed sources ranging from plant materials, insects, and some kitchen scraps with little or no supplementation. However, the chickens are partly sheltered at night to protect them from predators.

Data collection

Data were collected on body parameters (body weight, body length, shank length, spur length, toe length, wing length, tail length and neck length) and head parameters (head length, beak length, comb height, comb length, wattle height and length) for indigenous chickens only. Data were collected using a dial spring weighing scale for live body weight, simple rule tape and ruler for body linear parameters and a GPS device for coordinates. Qualitative traits like comb type, beak color, shank color and eye color were vividly observed, the live body weight was measured in a dial spring weighing scale, and body length was taken from the tip of the beak through the body trunk to the tail end. Head and body parameters were measured in centimeters using a ruler and measuring tape.

Morphological Characterization of Bacteria

All bacteriological analyses were performed at the Central Veterinary Laboratory, in Teko, Makeni. The cloacal swab samples were placed in Peptone Water and incubated at 37°C for 18-24 hrs. The isolates were cultured as previously described (Mudenda *et al.*, 2023). Briefly, 10µl of overnight cultures were inoculated onto MacConkey Agar (ROTH®, Germany) and Eosin Methylene Blue (EMB) Agar (ROTH®, Germany). Discrete single bacterial colonies that fermented lactose, which grew as pinkish mucoid colonies on MacConkey Agar, and colonies exhibiting a green metallic sheen color were presumptively taken as *E. coli* colonies and subcultured on Nutrient Agar (ROTH®, Germany) to obtain pure colonies.

Identification of Bacteria using Analytical Profile Index (API) 20E.

The identification of all *E. coli* isolates was confirmed using the bioMérieux API 20E Kit. Briefly, cultures of presumptive *E. coli*, less than 24 hours old were used. Using a discrete colony, a 5ml suspension was prepared using sterile distilled water and adjusted to 0.5 McFarland standard.
Using manufacturer's instructions and aseptic techniques, the bacterial suspension was transferred to the API 20E strips and incubated at 36°C ± 2°C for 18-24 hrs. After incubation, required reagents were added and the 7- digit code generated for each isolate was read against the online bioMérieux *Enterobacteriaceae* identification database.

Antibiotic Susceptibility Test (AST)

Using the Clinical and Laboratory Standards Institute (CLSI) guidelines, 32nd edition (CLSI; 2022) AST was performed on identified *E. coli* isolates against a panel of 12 antibiotics. The antibiotics included amoxicillin-clavulanate acid, ampicillin, cefepime, cefotaxime, ceftazidime, ceftriaxone, ciprofloxacin, chloramphenicol, doxycycline, gentamicin, meropenem and Sulphamethoxazole.
All antibiotic discs were purchased from Oxoid (Oxoid, UK).

RESULTS AND DISCUSSION

Table 1 shows the results for body parameters of local breeds of chickens in Sierra Leone. The results showed no significant ($p>0.05$) differences for all parameters. However, the Kebu showed better character in terms of body weight (922.30 g), body length (19.75 cm), shank length (5.15 cm) and neck length (5.1 cm). The Kebu breed of chicken is bigger when compared to other breeds and is mostly raised by the Fulani people in rural settings that practice nomadic herding. Mature males and females can have live weights of 3.2 and 2.5 kg respectively. The body weight obtained in this study showed that the indigenous breed of chickens used are of a combined age group and sex (growers and adult males and females), and are lower compared to the values obtained by Deneke *et al*. (2014). This is probably because indigenous breeds sampled for this study have not undergone appreciable gene mixing with the exotic breeds, otherwise, their body weight could have been high.

The results for head parameters displayed in (Table 2) depict no significant (p>0.05) differences for breeds. The head length varies from 1.2 - 3.0 cm with Kebu and Normal breeds with high values (3.4 cm), (3.0 cm) respectively, while the straw breed had the lowest value (1.2 cm). The beak length, comb height and length and wattle height are in close range for all the breeds except the straw type that recorded 0.6 cm for beak length, 0.4 cm for comb height, 0.9 cm for comb length and 0.5 cm for wattle height. The straw type is smaller in size compared to other breeds. This could be a reason for its lower values in all the parameters observed.

Table 01: Body parameters of different breeds of local chickens in Sierra Leone

	Body parameters							
Indigenous breed types	Body weight (g)	Body length (cm)	Shank length(cm)	Spur length(cm)	Toe length(cm)	Wing length(cm)	Tail length(cm)	Neck length(cm)
Frizzle	877.80±172.82	16.95±1.06	4.25±0.07	0.00±0.00	4.60±0.14	6.30±0.28	9.40±0.85	4.40±0.42
Kebu	922.30±190.64	19.75±1.48	5.15±0.92	0.25±0.35	5.15±0.49	6.85±0.78	9.75±2.19	5.10±0.99
Naked neck	883.35±117.874	16.85±0.92	4.50±0.57	0.25±0.35	5.00±0.14	7.10±0.85	8.85±1.34	4.95±1.20
Normal	843.25±90.30	18.55±0.49	4.70±0.28	0.15±0.21	4.75±0.21	6.55±0.21	10.45±2.33	4.45±0.92
Straw	340.85±206.83	7.90±4.81	1.95±1.20	0.00±0.00	2.03±1.24	2.80±1.70	3.85±2.33	1.65±1.06

Table 02: Head parameters of different breeds of local chickens in Sierra Leone

Head parameters						
Indigenous breed types	Head length(cm)	Beak length(cm)	Comb height(cm)	Comb length(cm)	Wattle length(cm)	Wattle height(cm)
Frizzle	2.40±0.57	1.50±0.14	1.30±0.85	3.05±1.20	1.20±0.57	1.05±0,78
Kebu	3.45±0.49	1.60±0.14	1.40±1.41	3.20±2.26	0.95±0.92	1.30±0.42
Naked neck	2.85±0.35	1.55±0.07	1.60±1.41	3.75±2.76	1.55±1.06	1.75±1.06
Normal	3.00±0.57	1.45±0.07	1.55±1.06	3.50±2.12	1.50±0.99	1.55±0.64
Straw	1.20±0.71	0.60±0.42	0.35±0.21	0.85±0.49	0.35±0.21	0.50±0.28

Figure 1 depicts the results for four qualitative traits (eye, beak and shank color, and comb type) of five indigenous breeds of chickens sampled in all five regions of Sierra Leone. The results showed that orange (53%) and yellow (27%) eye colors are the most common types found. This corroborates the findings of Ekeocha *et al*. (2021), Ssewayana *et al*. (2008) for Nigeria and Uganda indigenous chickens respectively. The brown and yellow beak colors are the predominant types in the Normal (57%) and Frizzle (27%) breeds of locally adapted chickens. The four comb- types (single, pea, rose and double) were observe for all breeds in all regions of the country. The most common comb type was the single for all breeds. This study agrees with the findings of Ikeobi *et al*. (2001) who also reported that among all the comb types sampled for their study, the single comb is the most commonly observed in indigenous chickens in Nigeria. The results showed that 100% of the Kebu breed of local chickens have gray shank color. The gray shank color is dominant for local breeds of chicken followed by black shank color. This study is in contrast with the findings of Ekeocha *et al*. (2021); Dana *et al*. (2010); who observed predominantly yellow shanks among indigenous chickens. This could be a result of indiscriminate and uncontrolled mating between the improved and their indigenous breeds of chickens arising from the extensive or freeto-range system of chicken management.

Figure 2 presents the antibiogram of *E. coli* isolated from the poultry cloacal swabs. Of the 12 antibiotics tested against the 28 *E. coli* isolates, resistance was shown against only three (3) antibiotics, Sulphamethoxazole, Chloramphenicol and Ampicillin, with the highest resistance being shown to Sulphamethoxazole (96.2%). The resistance pattern of the *E. coli* isolates showed that 18 (64.29%) were resistant to only Sulphamethoxazole, 8 (28.57%) were resistant to Ampicillin and Sulphamethoxazole and 1 (3.57%) was resistant to Chloramphenicol, Ampicillin and Sulphamethoxazole. Of the 28 *E. coli* isolates, only 1 (3.57%) isolate did not show resistance to any of the 12 antibiotics. The *E. coli* isolated from the 7 breeds were at least resistant to Sulphamethoxazole. *E. coli* resistance to Ampicillin was seen in the FRIZZLE, HYBRID, IMPROVE BREED, KEBU and NAKED-NECK breeds. The only chloramphenicol resistance was seen in an *E. coli* isolated from the KEBU breed. Further, of the 28 *E. coli* isolates, the only isolate that was not resistant to any antibiotic was from the KEBU breed. For the three antibiotics to which there was resistance, there was no significant difference in the mean zones of inhibition for Ampicillin ($p = 0.093$), Sulphamethoxazole ($p = 0.210$) and Chloramphenicol ($p = 0.358$). Based on the MAR index displayed by the isolates, a high number (96.4%) of the *E. coli* isolates had a MAR index of less than 0.2. Multi-drug resistance was not observed among the *E. coli* isolates (Rahman, Hossain, et al., 2025).

Figure 3 revealed that there was a 100% susceptibility against five of the antibiotics which included; Meropenem, Gentamicin, Ceftriaxone, Ceftazidime and Cefepime. This isolate however showed intermediate susceptibility to Doxycycline and Sulphamethoxazole, based on the breeds used for this study. It was observed that there was an average of 92.3% susceptibility to 3rd Generation Cephalosporin while there was a 100% susceptibility to Cefepime, a 4th Generation cephalosporin. This is in line with (De Cesare *et al*., 2022) who reported that there is a reduced resistance to antibiotics in poultry when antibiotics are not used in their production. This finding supports the principle of recent EU regulations to limit the unnecessary use of antibiotics in animal production (Schmerold *et al*., 2023). The *E. coli* isolates showed very low Multiple Antibiotic Resistance Indices with only one isolate having an MAR Index of 0.25 and all others below 0.2. Furthermore, multi-drug resistance was not observed in any of the isolates. This is attributed to the fact that the chickens from which the *E. coli* were isolated had consumed no antibiotics before (Hossen et al., 2023)**.**

However, even though the chickens in this study were not exposed to antibiotic therapy, resistance to antibiotics was shown against Sulphamethoxazole (96.2%). This high resistance to Sulphamethoxazole could be attributed to the naturally occurring resistance of *E. coli* to sulfonamide due to spontaneous gene mutations Huovinen., (2001) or the acquisition of any of the three sulfonamide-resistance genes which can lead to sulfonamide resistance Poirel *et al*., (2018).

Similar to the present study and being that *E. coli* and other Enterobacteriaceae can confer resistance to each other through plasmids De Angelis *et al*., (2020), a high resistance against Sulpha-based drugs was seen in a study by Tigabie *et al*., (2023) was also seen in Enterobacteriaceae (65.7%) and specifically *E. coli* (63.2%) isolated from poultry farms in Ethiopia. In the present study, resistance was also shown against Ampicillin (34.2%). A study from Los Angeles, California, also recorded *E. coli* resistance against Ampicillin (60.7%) at a poultry farm that was antibiotic-free Sanchez *et al*., (2020). The study, however, went on further to state that there was no significant difference (p > 0.05) in Ampicillin resistance between the antibiotic-free farm and the conventional poultry production farm that used antibiotics sub-therapeutically and recorded an Ampicillin resistance of 56.2%. Ibrahim *et al*., (2023) reported in their study that there was a 93% prevalence of resistance against Ampicillin shown by *E. coli* in almost all poultry farms that use antibiotics. This may infer that the environment may harbor naturally antibiotic-resistant bacteria (Alam et al., 2025).

The current study recorded resistance to Chloramphenicol in only one (3.8%) of the 28 *E. coli* isolates. In their study, Mudenda *et al*., (2023) only used laying hens that were not on antibiotic treatment; similar to the current study, they recorded a low *E. coli* resistance of 8.8% against Chloramphenicol. This low resistance to chloramphenicol reported is encouraging being that Phenol-based drugs, due to their toxicity, were banned in 1994 from use in food-producing animals Poirel *et al*., (2018).

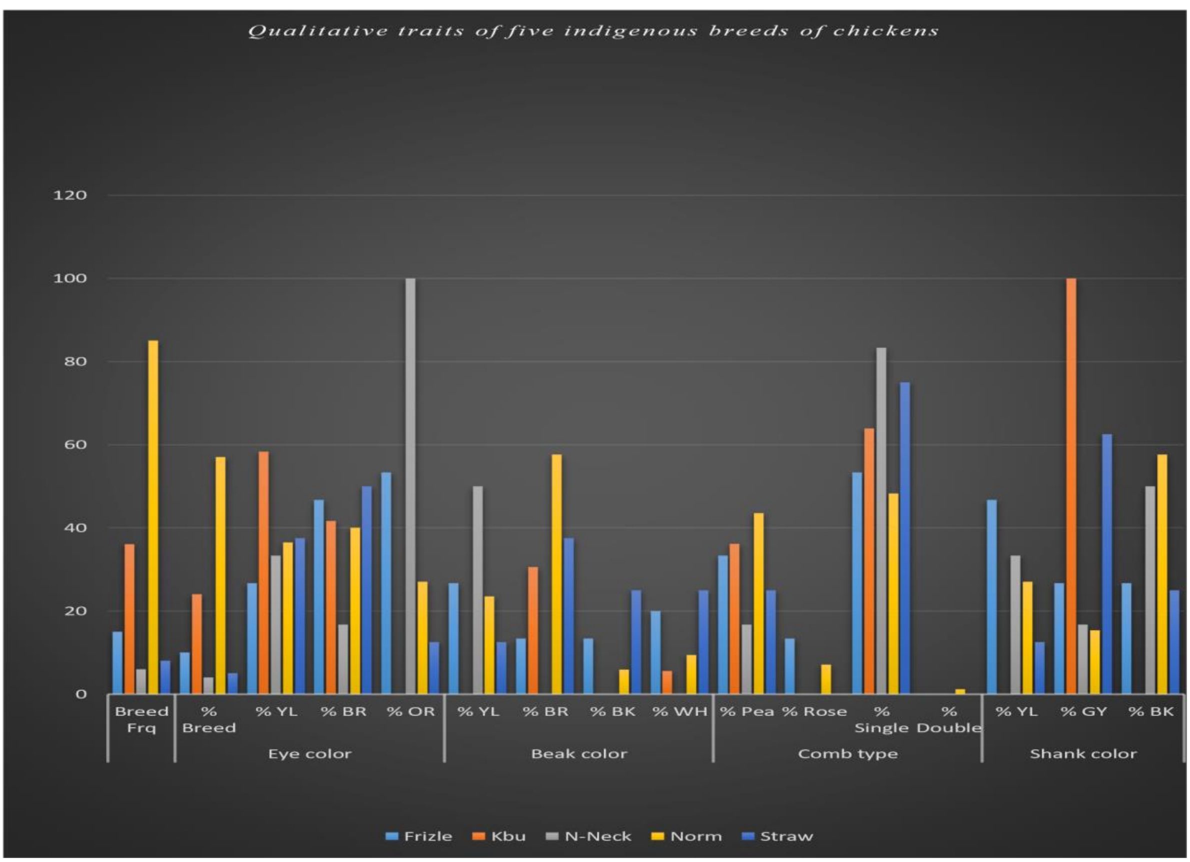

Figure 1: *Qualitative traits of five indigenous breeds of chickens*

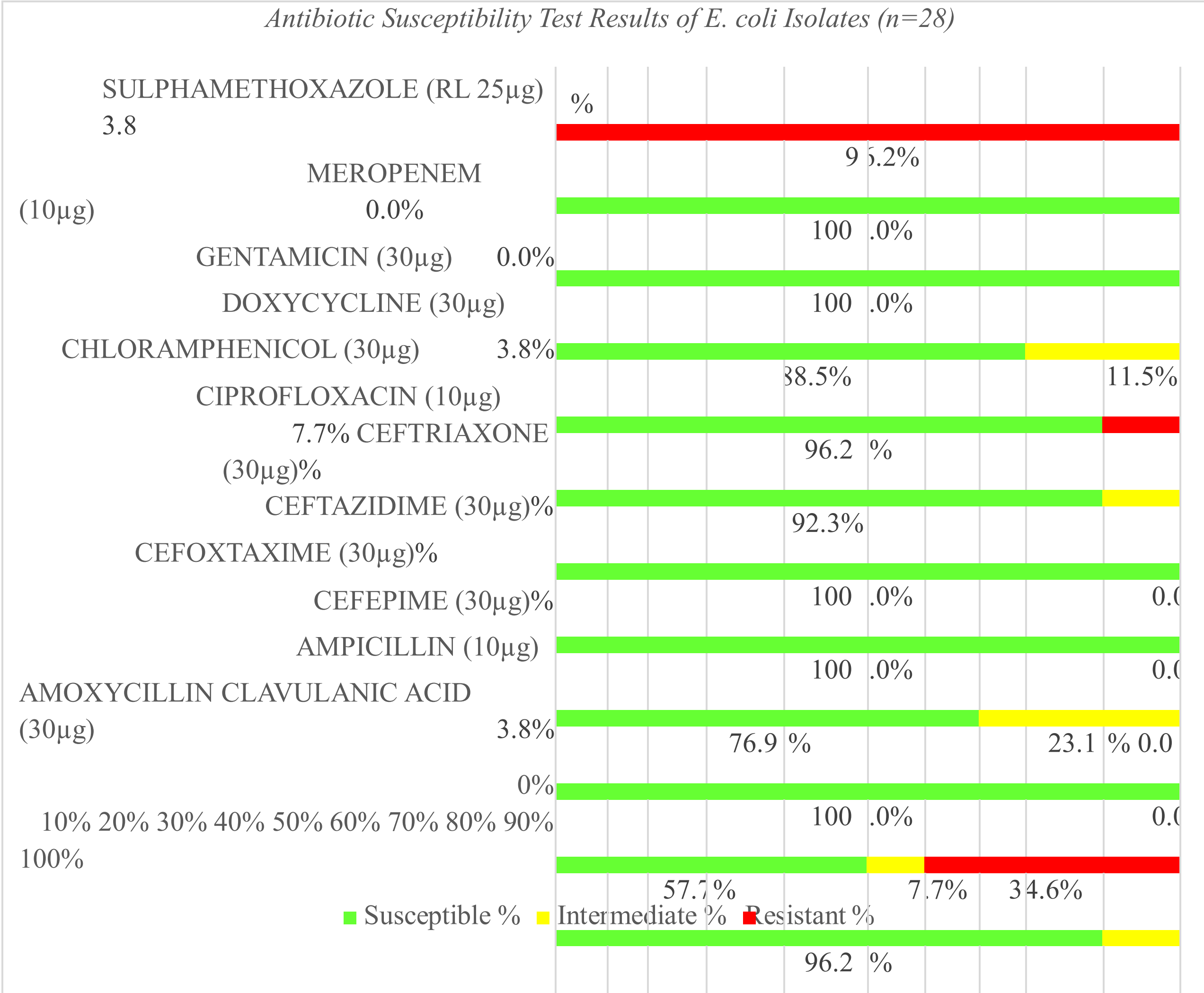

***Figure 2**: Antibiotic Susceptibility Test Results of E. coli isolate*

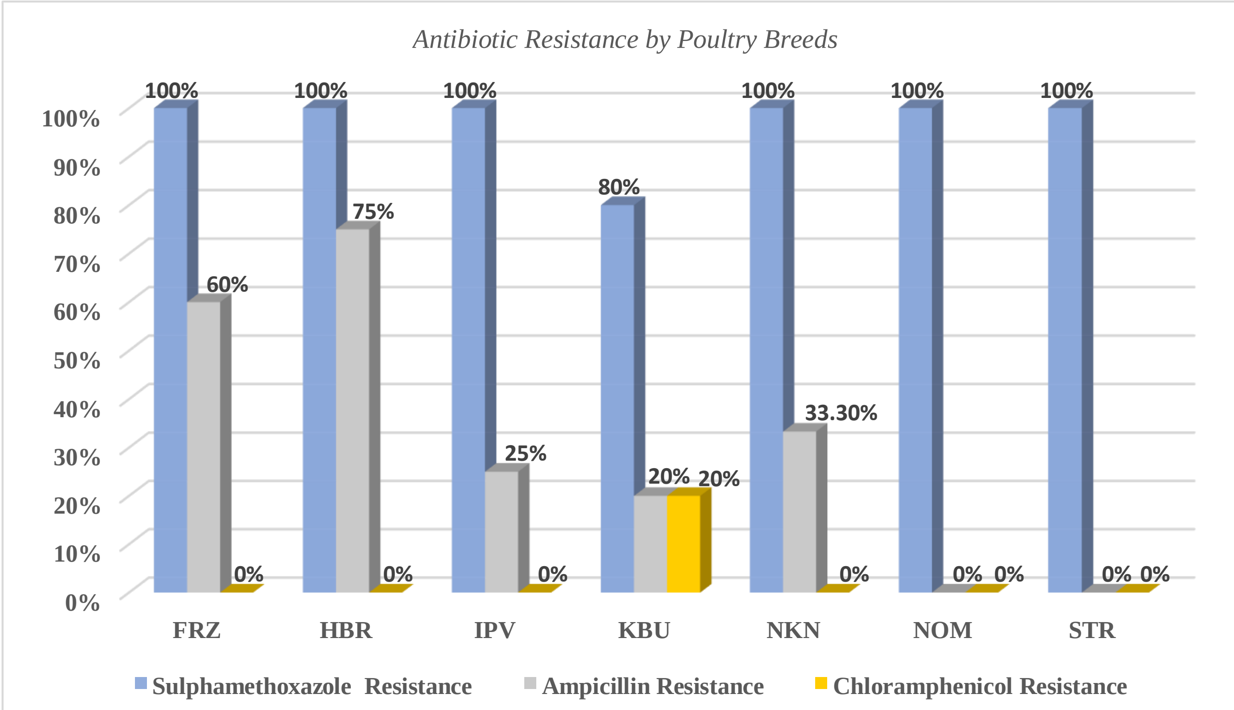

Figure 3: Antibiotic Resistance by Poultry Breed

CONCLUSION

The indigenous breeds sampled, can be found and thrive well in all regions of the country but with very low genetic performance potentials. Also, there is a slight phenotypic variability among breeds that are affected by both genetic and environmental factors. A high frequency of resistance was observed for Sulphamethoxazole and Ampicillin in all breeds, while, only the Kebu breed showed resistance to Chloramphenicol.

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Data Availability: The author holds all the data employed in this study and is open to sharing it upon reasonable request.

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