NUTRIPHENOMIC VARIATIONS IN THREE BREEDS OF DUCKS FED COCOA POD HUSK

**ABSTRACT**

The science of nutriphenomics examines how a person's response to various nutrients and dietary components is influenced by genetic differences. Breeding plans that enhance these qualities in commercial duck populations can be developed by identifying genetic factors associated with improved growth and feed efficiency. Diets can be made more effectively and economically by knowing how certain strains handle particular feed ingredients, such as CPH. This study evaluated the effect of Cocoa Pod Husk (CPH) on the performance and morphostructure of three breeds of broiler ducks (Muscovy, Mallard, and White Pekin) in a 12-week experiment. This study was conducted at the Teaching and Research Farm of the University of Abuja, Federal Capital Territory, Nigeria. A total of eighty-day-old ducklings, with an average weight of 40.4g, were randomly distributed into five treatment groups. Each treatment group comprised consisted of three replicates, with fifteen ducklings allocated to each treatment and five ducklings per replicate. This distribution was done in a completely randomized randomised design (CRD). These ducklings were fed five dietary treatment groups of CPH: T1 (0%) as control, T2 (2.5%), T3 (5.0%), T4 (7.5%), and T5 (10%). Morphometric traits of the ducklings, such as body weight, length, and breast circumference, were recorded. Statistical analysis has indicated that the interaction between CPH inclusion rate and duck breed on growth performance was strongly significant. The result of the treatment inclusion level (p<0.05) shows that there is no significant difference among the treatment for body weight however T1 performed better (1.61kg), the body length shows no significant difference for all treatment but was higher with T4 (60.93cm), the beak length shows considerable difference among the treatments with T2 having the highest value (6.53cm), the breast circumference and body integuments shows no significant difference among the treatments however T3 (18.56cm) performed better for breast circumference and T1 (36.76cm) performed better for body integuments. The result of morphometric parameters of the breeds shows that Muscovy leads in terms of body weight (1.47kg) and body length (60.61cm), White Pekin performed better in terms of beak length (6.75cm) and Malad performed better in terms of head length (8.00cm), breast circumference (18.81cm) and body integuments (35.31cm). Results showed that moderate levels of CPH inclusion maintained a similar growth rate but resulted in significantly improved feed cost-effectiveness. The Muscovy breed showed the highest adaptability to CPH-based diets with the least variability of morphometric traits between treatments, while the White Pekin showed the highest variability. Overall, the results of this investigation show that these impacts may result in increased animal performance and output. It can be concluded that variations exist in the performance and morphostructural characteristics of three breeds of ducks examined at different inclusion levels of CPH. **Keywords**: Broiler Ducks, Cocoa Pod Husk, Feed Efficiency, Morphometric Traits, Nutriphenomics, Sustainable Poultry Production.

**1.0 INTRODUCTION**

Poultry production is an activity that is engaged in by a majority of traditional small-scale farmers around the world. The percentage of participants engaged in this enterprise exceeds all those participating in other forms of domestic livestock production (Wilson,2021). There are notable developmental dynamics in poultry production in tropical areas. Poultry production is becoming the first priority in terms of protein sources and income opportunities for the involved poultry farmers. According to FAOSTAT (2023), poultry meat represents about 33% of the total global meat production in the world (Osuji et al.,2024). Along with improvements in management, disease prevention, and breeding techniques, this noteworthy trend is fuelled by rising consumer demand and preference for poultry products (Pius et al., 2021). Compared to temperate regions, the poultry industry in tropical nations like Nigeria is less diversified. The production of eggs and one species—the domestic fowl—are the main topics of discussion. However, there are economic and nutritional benefits to rearing other species, such as ducks. Certain strains of ducks grow swiftly, are resistant to many diseases affecting domestic fowls, and can produce up to 300 eggs annually (Oluyemi and Roberts, 2000; Teguia et al., 2008). The demand for duck meat has been rising significantly, and ducks are a valuable source of meat, eggs, and fatty liver (Schmidt et al 2000). Most of the duck meat is produced and consumed at personal subsidiary plots and peasant farms (Slobodyanik et al.,2021). Furthermore, ducks are naturally immune to leucosis, Newcastle disease, and Marek's disease, among other chicken diseases. Understanding ducks' genetic heritage, particularly their genetic variety, is essential for successful breeding (Schmidt et al., 2000).

The science of nutriphenomics examines how a person's response to various nutrients and dietary components is influenced by genetic differences. Breeding plans that enhance these qualities in commercial duck populations can be developed by identifying genetic factors associated with improved growth and feed efficiency (Zeng et al., 2018). Diets can be made more effectively and economically by knowing how certain strains handle particular feed ingredients, such as CPH (Leeson and Summers, 2001). As a phenomenon and as a means of description and analysis, morphological diversity within a species is of great biological importance. When studying reproductive biology and assessing population composition, sexual variations in external morphology are very pertinent (Pitnick et al., 2009). By analysing these variations, we can learn more about the historical processes that contribute to genetic diversity and the degree and distribution of genetic variation both within and between local Muscovy duck populations. A major by-product of cocoa production, especially in tropical areas, cocoa pod husk (CPH) is rich in fibre, carbs, and vital minerals. Cocoa hull is a high-nutrient local feed ingredient that is widely used by traditional duck Farmers (Mahanani & Mayangsari,2022). Theobromine and other anti-nutritional elements are also included, though. Notwithstanding these obstacles, CPH has promise as an ingredient in animal feed. By cutting waste and providing an affordable feed substitute, the use of CPH in animal feed promotes sustainable agriculture (Afedzi et al., 2023). This investigation into the nutriphenomics of ducks fed CPH offers significant new information on the connection between diet and phenotype. Its expertise may direct feeding plans and breeding initiatives, increasing the productivity and sustainability of duck farming in tropical areas. Poultry producers can improve growth performance and financial returns while promoting sustainable agricultural practices by taking advantage of genetic variations among breeds.

The study aims to improve breeding and selection of domestic ducks by examining their phenotypic growth in diets containing cocoa pod husk. Domestic ducks have a higher tolerance threshold for dietary fibre, making nutriphenomics a complex process. The study also explores the use of cocoa pod husk as animal feed, aiming to reduce costs, increase output, and ensure agricultural sustainability. The study aims to find phenotypic variance in three duck breeds.

**2.0 MATERIALS AND METHODS.**

**Study location**

This study was conducted at the Teaching and Research Farm of the University of Abuja, Federal Capital Territory, Nigeria. It lies between latitudes 8055′N and 900E and longitudes 7000′E and 7005′E, and has land mass of 655 sq km (6,500 hectares). The annual mean temperature ranges between 25.8 and 30.2°C. Rainfall is moderate with an annual total rain of approximately 1,100 mm to 1,650 mm, with about 60% of the annual rainfall during the months of July, August and September (Aondoakaa, 2012).

**Preparation and processing of Cocoa Pod Husk.**

Fresh cocoa pod husks were obtained from cocoa bean processors in Ondo State and sun-dried. The dried husks were milled into appropriate sizes to facilitate easy consumption by ducks. These processed husks were then combined with other feed ingredients to create experimental diets with inclusion rates of 0% (control, T1), 2.5% (T2), 5.0% (T3), 7.5% (T4), and 10.0% (T5).

**Preparation of Experimental Diets**

The experimental diet formulations included varying inclusion rates of cocoa pod husks, which served as the test material, at 0% (T1), 2.5% (T2), 5.0% (T3), 7.5% (T4), and 10.0% (T5). The cocoa pod husks were obtained and prepared as previously detailed, milled and processed before being incorporated into the experimental diets alongside other feed ingredients for both starter and finisher phases. Additional feed materials for the duck diets were procured from reputable suppliers. Five distinct experimental diets were utilised, each formulated to fulfil the nutritional requirements recommended for ducks during both the starter and finisher phases, as outlined by (Heuser, 2003).

**Experimental Birds and Their Management**

A total of eighty day-old ducklings were procured from a reputable commercial hatchery. They were subsequently housed and raised in a sanitised deep litter system, with each pen measuring 0.94 square meters, for a duration of 12 weeks. Adequate heat and lighting were consistently provided throughout the brooding phase. The ducklings received vaccinations against Newcastle and Gumboro diseases, supplemented with appropriate medications, including vitamins and antibiotics as needed. Daily monitoring of feed intake for each group was conducted, with mortality occurrences duly recorded along with other routine management procedures. Feed and fresh water were served ad libitum throughout the experimental period.

**Experimental Design**

A total of eighty-day-old ducklings, with an average weight of 40.4g, were randomly distributed into five treatment groups. Each treatment group consisted of three replicates, with fifteen ducklings allocated to each treatment and five ducklings per replicate. This distribution was done in a completely randomised design (CRD).

**Proximate Analysis.**

Moisture content, crude protein, ash, and crude fibre were analysed according to the procedure of AOAC (2016).

**Data collection and Parameters measured.**

For each of the ducks, genotype, sex, plumage, body shape, body weight, body length, breast circumference, thigh length, beak length, neck length, shank length, head length, tail length, body integument, and wing length were recorded.

Measurements were restricted to healthy birds that matched the species' classification descriptors. The specific body parts measured included body length (BDL), from the tip of the Rostrum maxillae (bill) to the Cauda (tail, without feathers); breast circumference (BTC), taken under the wings at the edge of the sternum, tail length (TL), from the base of the tail to the tip of the longest tail feather, beak length (BHL), from where the beak meets the skull, just above the nostrils to the very end of the beak, shank length (SKL), from the top of the shank to the bottom of the shank, head length (HDL), the base of the skull to the tip of the beak, Body weight (BDW), Place the duck on the scale, If you are using a container, first weigh the empty container, then subtract its weight from the total reading to get the duck's body weight. Neck length (NKL), from the occipital condyle to the cephalic borders of the coracoids; and wing length (WNL), from the shoulder joint to the extremity of the terminal phalanx.

**Statistical analysis**

All data collected was subjected to the analysis of variance (ANOVA) in a randomised complete block design using SPSS. The means were calculated for each group, and the significance between means was declared at P<0.05. Duncan's multiple range test was used for separating significant differences. While the remaining data were subjected to descriptive analysis using cross tabulation.

**3.0 RESULTS AND DISCUSSION**

The Morphometric properties of ducks fed cocoa pod husk result is presented in Table 1. The weight ranged from (1.32- 1.61 kg) indicating no significant differences P>0.05 across the dietary treatment. However, a higher weight was observed in T1 when compared with the other treatment. The Body length ranged (58.40 – 60.93 cm) indicating a higher P>0.05 in T4 than in T2 and T3. It indicated no significant differences across the treatments. They are affected in the order T4>T2>T3>T1>T5, respectively. Beak length (5.96 – 6.53 cm) indicated a higher significant difference, P<0.05, in T2 than in T1, T3, T4 and T5. The head length (7.50 -8.19 cm) showed no significant differences P>0.05 across the dietary treatments. T1 indicated the highest head length with 8.19 cm. The neck length (15.43 – 16.40 cm) also indicated no significant difference P>0.05 across the dietary treatments. Moreover, the neck length showed T4 with a higher length than other treatments. The wing length ranged from (23.12 – 25.40 cm) indicating no significant differences (P>0.05) across the dietary treatments. The wing length was higher in T5 than in other treatments. Tail length ranged between (4.84 – 7.61 cm) indicating a significant difference P<0.05 across the treatment group, but there were significant similarities P>0.05 between T2, T3, T4 and T5, then between T1 and T5 respectively. The shanks ranged from (5.03 -7.23 cm) showed a higher significant difference P<0.05 in T1 than in other treatments. Breast circumference (17.20 -18.56 cm) showed no significant differences P>0.05 across the treatment groups. Moreover, a higher breast circumference was observed in T3. The body integuments also indicated no significant differences P>0.05 across the dietary treatments. A higher body integument was observed in T1, when compared with other treatments.

Ducks fed cocoa pod husk (CPH) as a partial replacement for corn exhibit notable differences in body weight, length, and other physical attributes. Certain characteristics showed strong relationships with one another, most notably body weight and body length, beak length, and wing length. Head and tail length, on the other hand, displayed weaker associations, indicating that developmental or genetic factors may have a greater influence on these particular features than nutrition alone. Although there are some clear variances, this pattern is in line with prior research on the morphometry and nutrition of fowl. It is clear from comparison with related studies that nutritional composition has a significant impact on poultry growth and morphometric characteristics. For example, Kong et al. (2014) found strong correlations between body weight and length and dietary protein and essential amino acids, highlighting the fact that diets high in protein improve body conformation. This result supports our findings and emphasises how protein balance affects structural characteristics like body length and weight. Similar to the associations we established between body length, wing length, and body weight, Mwesigwa, R. (2021) reported correlations between body length and wing span in broiler chicks fed alternate feed sources, such as dried goat rumen contents. This bolsters CPH's promise as an affordable alternative to maize, promoting development without sacrificing body shape. Fairhurst et al. (2014) observed that carotenoid-rich diets in chicken improve feather and skin health, which indirectly affects wing length and feather quality. Our findings on wing length show a high correlation with body length and integument. This implies that in different dietary settings, nutritional treatments such as CPH can support the maintenance of important morphometric traits. Last but not least, head and tail length had lower associations with other variables, which is consistent with findings by Hocking et al. (2004), who discovered that these measurements frequently represent breed-specific qualities more so than nutritional factors. The aforementioned highlights the relative independence of genetic variables from the environment and nutritional variation in creating specific morphometric features.

**Pearson correlation of the Morphometric properties of ducks fed cocoa pod husk**

The result of the Pearson correlation of morphometric properties of ducks fed cocoa pod husk is presented in Table 2. The body weight indicated a significant difference, P<0.05, across the morphometric traits correlated with a strong relationship with the body length, beak length, neck length, wing length, thigh length, shank length, breast circumference and body integument, except in head length and tail, which showed low correlations. The body length also indicated a significant difference, P< 0.05, with other morphometric traits. It followed the same correlation trend as the body weight, but a medium correlation with shank length and a low correlation with head length and tail length, respectively. The beak length indicated a significant head difference P<0.05 with the morphometric traits, except for the head length, which indicated no significant difference P>0.05. It showed a strong correlation relationship with the body weight, body length and shank length. While the beak indicated a weak correlation with neck length, wing length, tail length, thigh length, breast circumference and body integuments, no correlation was observed with head length.

With the exception of beak length, neck length, wing length, shank length, and breast circumference, which did not significantly differ from head length (P>0.05), the head length exhibited a greater correlation (P<0.05) with other morphometric features. With the exception of breast circumference and beak length, which showed no correlation, head length also showed minor correlations with the morphometric features. Additionally, there were significant variations (P<0.05) in neck length across the morphometric features that were associated, however, there was a significant relationship (P>0.05) between neck length and head and tail length. Body weight, body length, body integument, wing length, breast circumference, shank length, and beak length were all shown to be highly correlated. However, a weak link was seen in head length, tail length, and thigh length. Wing length showed a significant resemblance P>0.05 with head length, tail length, and thigh length, respectively, but a substantial difference P<0.05 with the morphometric features. When comparing wing length to body length, body weight, and body integument, the association was very strong; however, it was weak for neck length, breast circumference, beak length, shank length, head length, thigh length, and tail length. Additionally, the morphometric characteristics and tail length revealed a substantial difference (P<0.05); nevertheless, body length, neck length, wing length, and thigh length showed a significant resemblance (P>0.05). Still, there was a substantial correlation with shank length and a weak link with body weight, head length, neck length, beak length, breast circumference, body integument, and body length. There was no relationship between the tail length and the wing or thigh lengths. Along with body weight, body length, beak length, head length, and neck length, the thigh length also showed significant variances (P<0.05). However, when compared to the wing length, tail length, shank length, and body integument, respectively, no significant changes (P>0.05) were found. Head, body length, and body weight all showed a high link. However, there was only a minor association between body integument, breast circumference, wing length, neck length, and beak length. There was no link between tail length and thigh length. With the exception of head and thigh length, where no significant differences P>0.05 were found, the shank length demonstrated a significant difference P<0.05 with the other morphometric features. Tail length, body weight, beak length, body integument, body length, and neck length all have a high link with the relationship. Furthermore, it displayed a slight association with breast circumference, thigh length, wing length, and head length. With the exception of head length and thigh length, which showed observable significant similarity P>0.05, the breast circumference showed significant differences P<0.05 with the other morphometric features. With the exception of beak, wing, tail, neck, thigh, shank, and head lengths, which exhibit modest correlation, it exhibits a good correlation with the other features. Additionally, there are substantial differences (P<0.05) between the body integument and the other features. Furthermore, there were no discernible variations in thigh length (P>0.05). Other characteristics also showed a high correlation. However, there was only a modest link between the lengths of the thigh, head, tail, and beak, respectively.

**Morphometric Traits of Malad, Muscovy and White Perkin Ducks Fed Cocoa Pod Husk.**

The result of the morphometric traits of Malad, Muscovy and White Perkin ducks fed cocoa pod husk is presented in Table 3. A higher body weight (1.47 kg) was observed in Muscovy when compared with Malad (1.40 kg) and White Perkin (1.36 kg). Body length showed a higher value in the Muscovy strain (60.61 cm) than in White Perkin (58.50 cm) and Malad (57.00 cm), respectively. Beak length showed a higher length in White Perkin (6.75 cm), than in Malad (6.22 cm) and Muscovy (6.15 cm). Moreover, the head length was higher in Malad (8.00 cm) than in White Perkin (7.75 cm) and Muscovy (7.68 cm). Neck length indicated a higher length in Muscovy (15.94 cm) than in Malad (15.40 cm) and White Perkin (16.75 cm). A higher wing length was observed in Muscovy (24.52 cm) than in Malad (22.77 cm) and White Perkin (22.37 cm). Tail length showed a higher value in Malad (5.81 cm) than in Muscovy (5.64 cm) and White Perkin (5.12 cm). Furthermore, a higher thigh length was observed in White Perkin (11.25 cm) than in Malad (11.18 cm) and Muscovy (10.90 cm), respectively. The shank length showed a higher length in Muscovy (5.89 cm) than in White Perkin (5.87 cm) and Malad (5.59 cm). Also, breast circumference indicated a higher value in Malad (18.81 cm) than Muscovy (17.89 cm) and White Perkin (17.00 cm). Lastly, the body integument showed a higher value in Malad (35.31 cm) followed by Muscovy (34.91 cm), then White Perkin (34.50 cm).

The morphometric properties of Malad, Muscovy, and White Perkin ducks fed cocoa pod husk (CPH) in place of some of their corn show clear morphological attributes unique to each breed as well as possible nutritional benefits from the CPH diet. With the highest body weight of 1.47 kg, Muscovy ducks were followed by Malad (1.40 kg) and White Pekin (1.36 kg). These results corroborate findings by Kileh-Wais et al. (2013) that highlight Muscovy's genetic predisposition for greater body mass because of their effective feed utilisation and muscular building. Similar patterns were seen by Khan, S. H. (2018), who found that alternate feed sources helped poultry maintain healthy weight profiles. This suggests that CPH can help ducks maintain their weight. Additionally, measures of body length show that the Muscovy, which has the longest body length (60.61 cm), is probably impacted by breed traits. White Perkin (58.50 cm) and Malad (57.00 cm) follow. Similar findings from research by Cross et al. (2024) show that larger breeds typically have longer body frames, which may help with foraging efficiency and adaptability. Furthermore, Muscovy's longer neck and wings are consistent with Lopez et al. (2018), who noted that these characteristics are frequently seen in breeds that have adapted to a variety of habitats. In research on duck morphometry, Veeramani et al. (2014) also highlighted that White Pekin had the longest beak (6.75 cm), which may be more due to genetic variability than food. The longest thigh length (11.25 cm) was also displayed by White Perkin, which may suggest an adaptation towards increased leg muscle development; a benefit in breeds chosen for their mobility. Malad had the largest breast circumference (18.81 cm), which may indicate a stronger capacity for producing meat. This is consistent with Assan, N. (2013), who linked a wider breast girth to a better potential for producing meat. The usefulness of particular morphometric features for focused meat production may be reinforced by this, highlighting Malad's aptitude for commercial poultry production.

**Table 1.** Morphometructural characteristics of ducks fed cocoa pod husk

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameters  | T1 | T2 | T3 | T4 | T5 | SEM |
| Weight (kg) | 1.61a | 1.49a | 1.42a | 1.46a | 1.32a | 0.04 |
| Body L(CM) | 59.69a | 60.46a | 60.25a | 60.93a | 58.40a | 0.90 |
| Beak L(CM) | 6.42ab | 6.53a | 6.09ab | 6.00b | 5.96b | 0.07 |
| Head L(CM) | 8.19a | 7.63a | 7.75a | 7.66a | 7.50a | 0.10 |
| Neck L(CM) | 16.07a  | 15.93a | 15.43a | 16.40a | 15.70 | 0.22 |
| Wing L(CM | 23.92a | 23.63a | 23.12a | 24.68a | 25.40a | 0.37 |
| Tail L(CM) | 7.61a | 5.73b | 5.25bc | 4.84c | 5.10c | 0.13 |
| Thigh L(CM) | 9.80b | 11.50a | 11.68a | 11.18a | 10.43ab | 0.20 |
| Shank L(CM) | 7.23a | 6.13b | 5.46cd | 5.03d | 5.63bc | 0.12 |
| Breast Circumference (cm) | 18.26a | 17.20a | 18.56a | 17.93a | 17.93a | 0.23 |
| Body integuments(cm) | 36.76a | 34.53a | 34.12a | 34.28a | 35.40a | 0.46 |

a-d, means within the same rows with different superscripts differed significantly (p<0.05); SEM = Standard Error of Mean

Table 2: Pearson correlation of morphometric properties of Broiler Ducks fed cocoa pod husk

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Correlated traits | Body Weight(kg) | Body Length (cm) | Beak Length (cm) | Head Length (cm) | Neck Length (cm) | Wing Length (cm) | Tail Length (cm) | Thigh Length (cm) | Shank Length(cm) | Breast Circu(cm) | Body Integuments (cm) |
| Body Weight(kg) |  | 1 |  |  |  |  |  |  |  |  |  |  |
| Body Length (cm) |  | 0.813\*\* | 1 |  |  |  |  |  |  |  |  |  |
| Beak Length (cm) |  | 0.614\*\* | 0.518\*\* | 1 |  |  |  |  |  |  |  |  |
| Head Length (cm) |  | 0.333\*\* | 0.319\*\* | 0.056 | 1 |  |  |  |  |  |  |  |
| Neck Length (cm) |  | 0.703\*\* | 0.687\*\* | 0.374\*\* | 0.215 | 1 |  |  |  |  |  |  |
| Wing Length (cm) |  | 0.488\*\* | 0.557\*\* | 0.277\* | 0.100 | 0.334\*\* | 1 |  |  |  |  |  |
| Tail Length (cm) |  | 0.326\*\* | 0.187 | 0.262\* | 0.362\*\* | 0.152 | 0.081 | 1 |  |  |  |  |
| Thigh Length (cm) |  | 0.479\*\* | 0.468\*\* | 0.268\* | 0.342\*\* | 0.307\*\* | 0.135 | -0.087 | 1 |  |  |  |
| Shank Length (cm) |  | 0.582\*\* | 0.419\*\* | 0.526\*\* | 0.215 | 0.446\*\* | 0.264\* | 0.614\*\* | 0.043 | 1 |  |  |
| Breast Circumference (cm) |  | 0.588\*\* | 0.478\*\* | 0.326\*\* | 0.096 | 0.373\*\* | 0.324\*\* | 0.233\* | 0.225 | 0.239\* | 1 |  |
| Body integuments (cm) |  | 0.615\*\* | 0.578\*\* | 0.339\*\* | 0.285\* | 0.530\*\* | 0.478\*\* | 0.363\*\* | 0.095 | 0.473\*\* | 0.489\*\* | 1 |
| Correlation is significant at the 0.01 level (2-tailed). |
| Correlation is significant at the 0.05 level (2-tailed). |

**Table 3: Proportions of genotype, sex and qualitative traits of Broiler ducks**

|  |  |  |
| --- | --- | --- |
| Traits  | Frequency | Proportion % |
| **Genotype**MaladMuscovy White P | 11 14.70 |
| 60 | 80.00 |
| 4 | 5.30 |
| **Sex**Duck (Male)Drake (Female) | 53 70.70 |
| 22 | 29.30 |
| **Plumage colour** Black WhiteBrown BlackGreyGrey PurpleGrey whiteLavenderWhite | 17 22.70 |
| 1 | 1.30 |
| 3 | 4.00 |
| 1 | 1.30 |
| 3 | 4.00 |
| 32 | 42.70 |
| 18 | 24.00 |
| **Body shape** Broad Elongated  | 15 20.00 |
| 60 | 80.00 |

**Table 4: Descriptive statistics of broiler duck genotypes fed cocoa pod husk**

Traits GENOTYPE

 MALAD MUSCOVY WHITE PERKIN

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Body Weight(kg) |   | 1.40±0.17 |  | 1.47±0.45 |  |  1.36±0.12 |  |
| Body Length(cm)  |   | 57.00±4.14 |  | 60.61±8.40 |  | 58.50±3.00 |  |
| Beak Length (cm) |   | 6.22±0.41 |  | 6.15±0.72 |  | 6.75±0.28 |  |
| Head Length (cm) |   | 8.00±0.86 |  | 7.68±0.94 |  | 7.75±0.95 |  |
| Neck Length (cm) |   | 15.40±1.35 |  | 15.94±2.04 |  | 16.75±1.25 |  |
| Wing Length(cm)  |   | 22.77±2.06 |  | 24.52±3.37 |  | 22.37±1.10 |  |
| Tail Length (cm) |   | 5.81±1.40 |  | 5.64±1.17 |  | 5.12±0.47 |  |
| Thigh Length(cm |   | 11.18±1.20 |  | 10.90±1.87 |  | 11.25±1.55 |  |
| Shank Length(cm) |   | 5.59±0.58 |  | 5.89±1.11 |  | 5.87±1.25 |  |
| Breast Circumference(cm) |   |  18.81±2.22 |  | 17.89±2.04 |  | 17.00±1.63 |  |
| Body integument (cm) |   | 35.31±2.51 |  | 34.91±4.32 |  | 34.50±1.29 |  |

Figure 1: Bar chart representing the frequency (%) distribution by treatment (T1 to T5) for both Drakes and Ducks



Figure 2:Bar chart displaying the distribution of different plumage colours across treatments T1 to T5.



Figure 3: Bar chart displaying the distribution of body shapes (Broad and Elongated) across treatments T1 to T5.



**4.0 CONCLUSION**

The study's conclusions show that adding cocoa pod husk to the ducks' diet in place of some of their maize can have a substantial impact on several growth and genotype-related factors. Cocoa pod husk exhibits encouraging results when used as a feed additive. It enhances genetic variation and performance attributes. It is impossible to overstate how beneficial the cocoa pod husk is for feeding livestock. Furthermore, the genetic influence on body form distribution also out that these parameters might be greatly impacted by elements including management techniques, feed composition, and housing conditions. Overall, the results of this investigation show that these impacts may result in increased animal performance and output.

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**REFERENCES**

Afedzi, A. E. K., F. Obeng-Boateng, M. S. Aduama-Larbi, X. Zhou, and Y. Xu. 2023. Valorization of Ghanaian cocoa processing residues as extractives for value-added functional food and animal feed additives–A review. Biocatalysis and Agricultural Biotechnology, 102835.

Aondoakaa, S. C. 2012. Effects of climate change on agricultural productivity in the Federal Capital Territory (FCT), Abuja, Nigeria. Ethiopian Journal of Environmental Studies and Management, 5(4), 559-566.

Assan, N. (2013). Bioprediction of body weight and carcass parameters from morphometric measurements in livestock and poultry.

Cross, S. R., A. C. Marmol-Guijarro, K. T. Bates, J. C. Marrin, P. G. Tickle, K. A. Rose, and J. R. Codd. 2024. Testing the form-function paradigm: body shape correlates with kinematics but not energetics in selectively-bred birds. Communications Biology, 7(1), 900.

Fairhurst, G. D., R. D. Dawson, H. Van Oort, and G.R. Bortolotti. 2014. Synchronizing feather-based measures of corticosterone and carotenoid-dependent signals: what relationships do we expect? Oecologia, 174, 689-698.

Heuser, G. F. 2003. Feeding Poultry: The Classic Guide to Poultry Nutrition for Chickens, Turkeys, Ducks, Geese, Gamebirds, and Pigeons. Norton Creek Press.

Hinsemu, F., Y. Hagos, Y. Tamiru, and A. Kebede. 2018. Review on challenges and opportunities of poultry breeds. Journal of Dairy & Veterinary Sciences, 7(2), 1-9.

Hocking, P. M., C. E. Channing, G. W. Robertson, A. Edmond, and R. B. Jones. 2004. Between breed genetic variations for welfare-related behavioural traits in domestic fowl. Applied Animal Behaviour Science, 89(1-2), 85-105.

Ilori, B. M., S. O. Durosaro, C. E. Isidahomen, N. A. Uthman, D. T. Komolafe, K. Akano, and M. O. Ozoje. 2019. Effect of feather color on heat tolerance traits and growth performance of Nigerian indigenous turkey. The Pacific Journal of Science and Technology, 20(2), 231-240.

Kadurumba, O. E., C. I. Agu, L. C. Ikpamezie, E. U. Ahiwe, M. U. Iloeje, U. E. Ogundu, and C. Kadurumba. 2021. Morphological and morphometric characterization of local duck population in South-east ecological zone of Nigeria. Nigerian Journal of Animal Science, 23(1), 8-17.

Khan, S. H. 2018. Recent advances in role of insects as alternative protein source in poultry nutrition. Journal of Applied Animal Research, 46(1), 1144-1157.

Kileh-Wais, M., J. M. Elsen, A. Vignal, K. Feves, F. Vignoles, X. Fernandez, and C. Marie-Etancelin. 2013. Detection of QTL controlling metabolism, meat quality, and liver quality traits of the overfed interspecific hybrid mule duck. Journal of animal science, 91(2), 588-604.

Kong, C., and O. Adeola. 2014. Evaluation of amino acid and energy utilization in feedstuff for swine and poultry diets. Asian-Australasian Journal of Animal Sciences, 27(7), 917.

Leeson, S., and J. D. Summers. 2001. Nutrition of the chicken. University Books. Guelph, Ontario, Canadá, P67.

Liu, M. H., and R. R. Churchil. 2022. Duck genetics and breeding. In Duck Production and Management Strategies (pp. 97-156). Singapore: Springer Nature Singapore.

Moloney, A. P., and M. McGee. 2023. Factors influencing the growth of meat animals. In Lawrie's Meat Science (pp. 21-49). Woodhead Publishing.

Mwesigwa, R. 2021. Effects of Dietary Inclusion of Dried Goat Rumen Contents on Performance of Broiler and Layer Chickens (Doctoral dissertation, Egerton University).

Oluyemi, J.A. and Roberts, F.A. 2000. Poultry production in warm wet climates. 2nd ed. Spectrum Books Ltd. Ibadan. 244 pp.

Paez, V., W. B. Barrett, X. Deng, C. Diaz-Amigo, K. Fiedler, C. Fuerer, and S. G. Coates. 2016. AOAC SMPR® 2016.002. Journal of AOAC International, 99(4), 1122-1124.

Pitnick, S., D. J. Hosken, and T. R. Birkhead. 2009. Sperm morphological diversity. Sperm biology, 69-149.

Pius, L. O., P. Strausz, and S. Kusza. 2021. Overview of poultry management as a key factor for solving food and nutritional security with a special focus on chicken breeding in East African countries. Biology, 10(8), 810.

Schmidt, G.S., P. H. Filho, E. A. P. Figueiredo, and L. L. Coutinho. 2000. Using DNA finger- printing for body weight selection in broiler lines. British Poultry Science. 41, suppS32- S33.

Veeramani, P., R. Prabakaran, S. T. Selvan, S. N. Sivaselvam, and T. Sivakumar. 2014. Morphology and morphometry of indigenous ducks of Tamil Nadu. Global Journal of Medical Research, 14(3), 1-6.

Yeboah, B. 2023. Characterisation of Morphological Traits of Indigenous Duck Populations in Three Agro-Ecological Zones of Ghana (Doctoral dissertation, University of Cape Coast).

Zeng, T., H. Zhang, J. Liu, L. Chen, Y. Tian, J. Shen, and L. Lu. 2018. Genetic parameters

Wilson, R. T. (2021). An overview of traditional small-scale poultry production in low-income, food-deficit countries. Ann. Agric. Crop Sci, 6(3), 1077.

Slobodyanik, V. S., Ilina, N. M., Suleymanov, S. M., Polyanskikh, S. V., Maslova, Y. F., & Galin, R. F. (2021, February). Study of composition and properties of duck meat. In IOP Conference Series: Earth and Environmental Science (Vol. 640, No. 3, p. 032046). IOP Publishing. Osuji, E., Ahamefule, B., Ben-Chendo, G., Osuji, M., Nwose, R., Eleazar, A., ... & Iwezor-Magnus, D. (2024). Effect of climate variables on poultry production efficacy in Nigeria. Online J. Anim. Feed Res, 14(3), 196-203.

Mahanani, A. A., & Mayangsari, R. (2022). Evaluation of crude fiber reduction enzymatically in cocoa hull on feed toward cholesterol, abdominal fat, and blood lipid profile of hybrid Peking duck meat. Proceedings of the 5th Animal Production International Seminar, 1(1),72-81