Nutrient digestibility, growth, carcass, and bio-marker traits of weaner rabbits fed diets containing graded levels of cowpea (*Vigna unguiculata*) hull meal

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**ABSTRACT**

This study aimed to determine the dietary effects of cowpea hull (CPH) meal on nutrient digestibility, growth, carcass, and biomarker traits of weaner rabbits. Sixteen 6-wk-old hybrids (Chinchilla × New Zealand white) rabbits with an average weight of 760 g were randomly allocated to four dietary treatments in four replications of one rabbit each. The dietary treatments consisted of basal diets supplemented with cowpea hull at 0, 10, 20, and 30% levels, represented as CPH0, CPH10, CPH20, and CPH30. Rabbits fed CPH0 and CPH10 had higher (P < 0.05) lambing percentage and post weaning growth rate compared to CPH20 and CPH30. It was concluded that up to 10% cowpea hull inclusion did not impair the nutrient digestibility and growth performance of rabbits, but improved their health status and reduced the cost of production.

1. Introduction

To attain food security and curb the incidence of dietary protein deficiency, countries in Sub-Saharan Africa need to pay particular attention to intensive livestock production (Schonfeldt and Hall 2012). There is need to advocate and encourage the rearing of micro-livestock species such as rabbits, considering the comparative advantage of these animals over large animals such as cattle, sheep, and goats. These advantages range from minimal space requirement, low initial capital involvement, low labour demand, and quick high turn-over on investment (Oseni and Lukefahr 2014). Rabbits are herbivores with early maturity, short generation interval, high prolificacy, and ability to utilize forages that abound in rural communities (Ojebiyi et al. 2010; Dalle Zotte 2014). Rabbit meat is healthy and has high nutritional value due to its low content of fat, cholesterol, calories, and sodium, as opposed to beef, chicken, and pork (Dalle Zotte and Szendro 2011). Conventional feedstuffs like cereal grains and legumes are expensive and highly demanded by humans. This increases production cost and makes it uneconomical to feed conventional feedstuffs to rabbits in developing countries (Coles et al. 2016). Hence, to ensure unimpeded all-year-round rabbit production at a minimal cost, alternative, cheap, and less competitive feed ingredients such as cowpea hulls can be used to formulate balanced rations for rabbits.

Cowpea (*Vigna unguiculata* [L] Warp), also referred to as ‘beans’, is an essential leguminous cover crop, that is indigenous to Sub-Saharan African countries like Nigeria (Igwebuike et al. 2016; Baptista et al. 2017). Due to its high economic value, cowpea is regarded as one of the essential legumes widely grown and consumed not only in Africa but in many parts of the world (Murdock and Barua 2014). Interestingly, many rural dwellers depend directly or indirectly on cowpea production for their livelihood (Irtwange 2009). Cowpea hull (CPH) is a by-product that emanates from the processing of cowpea or bean cake, which ordinarily should be discarded as waste, but has found relevance as an essential feed for livestock and poultry (Alabi et al. 2011). Since many rural dwellers in Africa keep animals for consumption and economic value, cowpea hull can be utilized as a feed for these animals, rather than being discarded as waste, to avoid constituting environmental pollution. As a legume, cowpea is an essential part of a healthy diet for millions of people living in developing countries (Timko and Singh 2008). This may be due to the potential of cowpea to control and prevent metabolic disorders like obesity, which is associated with a myriad of other conditions like cardiovascular diseases, diabetes, and cancer (Clifton 2010).

Cowpeas have high amino acid and protein quality, with a protein content of 18–25% (Frota et al. 2017), and are rich sources of water-soluble vitamins like riboflavin, thiamine, niacin, whose concentrations are as good as the levels found in fish and lean meat (Asare et al. 2013; Goncalves et al. 2016). Cowpeas contain fat of about 1.4–2.7% (Antova et al. 2014), the crude fiber of 6% (Sreerama et al. 2012), and calcium content that is richer than that found in meat, and iron that equals that of milk (Carvalho et al. 2012). Cowpeas possess anti-inflammatory properties attributed to their rich content of phenols and other antioxidant compounds (Ojebiyi et al. 2010).

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contribute significantly to food security and maintenance of the environment for small-scale agrarian and rural dwellers in low and middle-income countries (Davis et al. 2013). However, Ahamefule et al. (2008) noted that cowpea seeds contain trypsin inhibitors, hemagglutinins, and condensed tannins that have growth depressing effects when fed to livestock and poultry in their raw state. Subjecting cowpea seeds to different post-harvest processing can considerably reduce their antinutrient components. These processing techniques include sun-drying (Asante et al. 2017), boiling (Torres et al. 2019), toasting (Oyeagu et al. 2015), soaking (Chipurura et al. 2018), fermentation (Madode et al. 2013), amongst others. According to Igwebuike et al. (2016), dietary inclusion of cowpea testa meal improved the average final body weight of rabbits. Igwebuike et al. (2016) also reported a considerable reduction in feed cost per kg weight gain in rabbits when cowpea testa meal replaced wheat offal in their diets up to 75%. The hypothesis of the present study is on the premise that cowpea hull (CPH) meal does not affect rabbits. However, based on the aforementined benefits of CPH meal, we envisaged that dietary supplementation of cowpea hull in this present study has the capacity to enhance the overall growth and immune status of the experimental rabbits. Besides, the use of cowpea seed meal and its associated by-products (cowpea hull meal) has the capacity to reduce the production cost in any rabbit enterprise. Nonetheless, there is still minimal literature on the use of cowpea hull meal in the diets of weaner rabbits. Therefore, the present study was designed to determine the dietary effects of cowpea hull (CPH) meal on the nutrient digestibility, growth, carcass, and blood bio-marker traits of weaner rabbits.

2. Materials and methods

2.1. Study location and experimental ingredient

The study was carried out at the Rabbit Unit of the Department of Animal Science, Teaching and Research Farm, University of Nigeria, Nsukka. The cowpea hulls (CPH) used for the experiment were collected from local cowpea seed sellers located in Okpuno-Egbu, and Umudim, both in Nnewi North Local Government Area of Anambra State, Nigeria. The cowpea seeds were blanched and decorticated to yield the hulls, which were then sun-dried for 48hrs, and passed through a pental attrition mill for particle size reduction.

2.2. Management of experimental animals

A total of sixteen 6-wk-old hybrids (Chinchilla × New Zealand white) rabbits with an average weight of 760 g were used for this eight weeks feeding trial. The rabbits were randomly allocated to four dietary treatments with four replicates of one rabbit, each in a completely randomized design (CRD). The dietary treatments consisted of basal diets supplemented with cowpea hull at levels of 0 (control), 10, 20, and 30%, and were represented as CPH0, CPH10, CPH20, and CPH30. The rabbits were housed in a four-tier rabbit cage, measuring 0.6 m × 0.5 m × 0.4 m, with 16 huches per tier. Each hutch represented a replicate pen and had properly installed vents and windows to allow the exchange of air. The huches were further partitioned with metallic sheets and wire meshes. Each hutch had stainless feeders and drinkers, and well fitted metallic trays for an accessible collection of fecal matter during the digestibility trial. The rabbits had ad libitum access to fresh feed and clean water. At the onset of the study, the rabbits were weighed, thoroughly mixed with hand, and stored at −20°C. Representative samples of daily fecal material collected were dried for 48 h at 60–70°C and ground through a 1 mm mill screen openings. The diets and fecal samples were analyzed to ascertain their proximate contents using the methods of AOAC (2006), and then digestibility coefficients were determined.

2.3. Digestibility study

In the 7th week of the study, two rabbits per treatment were randomly selected and used for a 5-day digestibility trial. The quantity of feed offered and the amount remaining were recorded for each day and used to determine daily intake. After that, fecal materials collected for the five consecutive days were weighed, thoroughly mixed with hand, and stored at −20°C. Representative samples of daily fecal matter collected were dried for 48 h at 60–70°C and ground through a 1 mm mill screen openings. The diets and fecal samples were analyzed to determine weight gain. The weigh back technique was used for the average daily feed intake (ADFI) which was determined by subtracting the quantity of feed rejected from the quantity that was initially supplied. The values obtained from the weight gain, feed consumption, and protein intake was used to determine weight gain. The weigh back technique was used for the average daily feed intake (ADFI) which was determined by subtracting the quantity of feed rejected from the quantity that was initially supplied. The values obtained from the weight gain, feed conversion ratio and protein efficiency ratio. The study was carried out based on ethical guidelines recommended for the use of animals in biomedical research as prescribed by the ethical research committee of the University of Nigeria, Nsukka. Table 1 shows the ingredients and nutrient composition of the experimental diets.

2.4. Haematological evaluation

The hematological evaluation was done on the 56th day of the feeding trial. Blood collection was done aseptically from the ear

![Table 1. Percentage composition of diets containing graded levels of cowpea hull.](image-url)
vene of two randomly selected rabbits per treatment using sterile syringes. Blood samples were transferred into sterile bottles containing ethyl diamine tetraacetic acid (EDTA). The blood sample was used to determine the hematological traits such as, packed cell volume (PCV), red blood cell count (RBC), hemoglobin concentration (Hb), white blood cell count (WBC), mean cell volume (MCV), mean cell hemoglobin (MCH) and mean cell hemoglobin concentration (MCHC). PCV was determined using the microhaematocrit method, while total WBC was determined with a hemocytometer (Thrall and Weiser 2002). Cynamethaemoglobin method was used to determine Hb concentration as outlined by Higgins et al. (2008), whereas; MCV, MCH, and MCHC were calculated using the standard formulae of Feldman et al. (2000).

2.5. Carcass and organ evaluation

On the 56th day of the trial, two rabbits per treatment were randomly selected and used for carcass and organ evaluation. The rabbits were taken off feed for 12hrs, weighed, and slaughtered humanely. Upon slaughter, the liver, kidney, heart, lungs, and other visceral organs were excised from the carcasses and weighed individually. After manual evisceration, the carcasses were roasted to remove the fur. Each carcass was weighed to determine the yield. The weights of the small and large intestines were also recorded.

2.6. Proximate and statistical analyses

Representative samples of the test ingredient (cowpea hull) and the four experimental diets were analyzed to determine their proximate contents according to the methods of AOAC (2006), as shown in Tables 2 and 3. The gross energy of the experimental diets was determined using the adiabatic oxygen bomb calorimeter. Data were subjected to statistical analysis using a Stat Graphic Computer Package (SPSS 2007), based on analysis of variance (ANOVA) as prescribed for a completely randomized design (CRD). Mean separation was done using Duncan’s New multiple range tests, and differences were declared significant at P < 0.05.

Table 2. Proximate composition of cowpea hull.

| Components          | Percentage composition (%) |
|---------------------|----------------------------|
| Dry matter          | 91.00                      |
| Crude protein       | 13.56                      |
| Crude fibre         | 28.50                      |
| Ether extract       | 2.5                        |
| Ash                 | 3.05                       |
| Nitrogen-free extract | 43.39                     |

Table 3. Proximate composition of cowpea hull meal based diets (%).

| Components          | CPH0 | CPH10 | CPH20 | CPH30 |
|---------------------|------|-------|-------|-------|
| Dry matter          | 88.35| 88.35 | 87.55 | 87.5  |
| Crude protein       | 16.08| 16.06 | 16.04 | 16.06 |
| Crude fibre         | 8.5  | 9.15  | 9.90  | 11.00 |
| Ether extract       | 2.65 | 1.45  | 1.65  | 2.55  |
| Ash                 | 6.90 | 6.05  | 6.72  | 7.60  |
| NFE                 | 65.87| 67.29 | 65.69 | 62.79 |
| ME (Kcal/kg)        | 2693 | 2654  | 2482  | 2556  |

Table 4. Digestibility coefficients of cowpea hull meal fed to rabbits.

| Parameters          | CPH0 | CPH10 | CPH20 | CPH30 |
|---------------------|------|-------|-------|-------|
| Dry matter %        | 72.50| 72.20 | 67.53 | 60.00 |
| Crude protein %     | 84.07| 75.52 | 70.73 | 57.77 |
| Crude fibre %       | 80.70| 80.50 | 79.53 | 59.27 |
| Ether extract %     | 78.33| 73.93 | 69.00 | 61.00 |
| Nitrogen-free extract % | 72.77| 53.83 | 49.67 | 39.67 |

3. Results

3.1. Growth performance of rabbits

Table 4 shows the growth traits of weaner rabbits fed cowpea hull meal (CPH) at different dietary levels. The average final body weight and average daily weight gain of the rabbits was significantly influenced (P < 0.05) by dietary treatments. Rabbits that were fed CPH at levels of 0 (control) and 10% (CPH10) had higher (P < 0.05) average final body weight (AFBW) and average daily weight gain (ADWG) than those that received CPH at 20 (CPH20) and 30% (CPH30) inclusion rates. Similar (P > 0.05) AFBW and ADWG were observed among rabbits that received CPH20 and CPH30 diets. Based on these observations, rabbits fed CPH20 could be said to have competed favourably with those that received the CPH0 (control) diets, with regards to AFBW and ADWG. Nevertheless, dietary treatments had no significant (P > 0.05) effect on average daily feed intake, daily protein intake, feed conversion ratio, and protein efficiency ratio.

3.2. Apparent nutrient digestibility of rabbits

Apparent nutrient digestibility of dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), and nitrogen-free extract are shown in Table 5. At increasing levels of inclusion, cowpea hull meal (CPH) was found to have depressing (P < 0.05) effects on the digestibility of DM, CP, CF, EE, and NFE. Rabbits fed CPH30 had lower DM and NFE digestibility than the CPH0 and CPH10, and lower CP and CF digestibility than those on other treatment diets. Rabbits that received CPH20 and CPH30 diets had lower (P < 0.05) values for EE digestibility compared with the CPH0 group.

3.3. Cost parameters of rabbits fed cowpea hull based diets

Table 6 shows the results on the cost implication of feeding cowpea hull meal (CPH) to rabbits at varying dietary levels.
Dietary treatments had significant ($P < 0.05$) influence on total feed intake, total weight gain, cost of total feed consumed, and feed cost/kg gain. Rabbits fed CPH0, CPH10, and CPH30 consumed more ($P < 0.05$) feed, compared with the CPH20 treated groups. Total weight gain was highest ($P < 0.05$) in rabbits fed the CPH0 and CPH10 diets, whereas it was lowest ($P < 0.05$) in those that received CPH20 and CPH30 diets. While the cost of total feed consumed was least ($P < 0.05$) among rabbits fed CPH30, the highest ($P < 0.05$) value was recorded in rabbits that received the control (CPH0) diet. The cost of feed needed to produce a kilogram weight (N165.52) was highest ($P < 0.05$) in rabbits fed the CPH20 diet, whereas it was lowest ($P < 0.05$) in those fed CPH30 with a value of N127.38. The live body weight and daily weight gain of the rabbits were significantly ($P < 0.05$) affected by the cowpea hull meal (CPH) supplementation. Although, dietary treatments had significant influence ($P < 0.05$) on the weights of liver, heart, and lung, the relative (percentage) organ weights did not differ ($P > 0.05$). Live body weight and dressed carcass weight was higher ($P < 0.05$) in rabbits fed CPH0 and CPH10 diets, but lower in those that received CPH20 and CPH30 diets. Dressing percentage was improved at 0 (control), 10 (CPH10), and 20% (CPH20) supplementation of CPH than at 30% inclusion. Rabbits fed CPH0 diet had heavier heart and lungs compared with those fed CPH20 and CPH30 diets. Heavier livers were also recorded for rabbits fed CPH0 diet compared with those fed CPH20 and CPH30 diet. Rabbits fed CPH10 diet had comparable ($P > 0.05$) heart, liver and lung weights with rabbits fed CPH0 diet.

### 3.4. Haematological parameters of rabbits

Table 7 shows the bio-marker traits of rabbits fed cowpea hull meal (CPH) at varying inclusion levels. Dietary supplementation of CPH significantly ($P < 0.05$) affected hemoglobin concentration (Hb), packed cell volume (PCV), and white blood cell counts (WBC). Rabbits that received CPH at 0 (control) had higher Hb value compared with the CPH20 and CPH30 groups, whereas, PCV was higher in the CPH0 compared with those fed other diets. RBC values were similar ($P > 0.05$) across treatment groups. WBC was highest ($P < 0.05$) among the CPH0 and CPH10 rabbits and lowest in those fed CH20 and CPH30 diets.

### 3.5. Carcass and organ traits of rabbits

The carcass and organ traits are shown in Table 8. The live body weight, dressed carcass weight and dressing percentage of the rabbits were significantly ($P < 0.05$) affected by the cowpea hull meal (CPH) supplementation. Although, dietary treatments had significant influence ($P < 0.05$) on the weights of liver, heart and lung, the relative (percentage) organ weights did not differ ($P > 0.05$). Live body weight and dressed carcass weight was higher ($P < 0.05$) in rabbits fed CPH0 and CPH10 diets, but lower in those that received CPH20 and CPH30 diets. Dressing percentage was improved at 0 (control), 10 (CPH10), and 20% (CPH20) supplementation of CPH than at 30% inclusion. Rabbits fed CPH0 diet had heavier heart and lungs compared with those fed CPH20 and CPH30 diets. Heavier livers were also recorded for rabbits fed CPH0 diet compared with those fed CPH20 and CPH30 diet. Rabbits fed CPH10 diet had comparable ($P > 0.05$) heart, liver and lung weights with rabbits fed CPH0 diet.

### 4. Discussion

#### 4.1. Growth performance

The average final body weight and daily weight gain of the rabbits showed a linear decrease as the inclusion levels of cowpea hull meal (CPH) increased. The reduced body weight gain of rabbits observed with an increase in dietary levels of CPH in this study may be due to increased fibre content. However, according to Bawa et al. (2008) and Oyeagu et al. (2016), this slight reduction might be attributed to increased levels of cowpea shells in the diets, which resulted in poor feed utilization efficiency. Nonetheless, feed conversion ratio was not different among the different dietary groups even when the body weight gain decreased as the level of CPH inclusion increased. Conventional feedstuffs contain anti-nutritional factors, which at high concentrations impact negatively on growth. However, when they are subjected to processing methods like sun-drying, their anti-nutrient content becomes reduced to tolerable levels for animal use (Tisdale 2015; Akanji et al. 2016). The daily weight gain (8.75–7.4 g/day) reported in this study was somewhat lower than the 17.4–20.11 g/day recorded by Bawa et al. (2008), who fed rabbits with diets containing varying levels of cowpea shell and groundnut haulm. Nevertheless, it was within the range of 7.4–12.03 g reported by Oloruntola et al. (2015), who...
supplemented rabbit diets with different forages. This indicates that dietary cowpea hull meal encouraged significant growth in the rabbits, as noted in this study. It could also be said that the test ingredient compared favourably with other non-conventional feed ingredients in these previous reports. Although daily feed intake was not affected, the numerical value of 58.56–60.70 g obtained in this study was considerably higher than the 46.68–49.50 g recorded by Bawa et al. (2008). They supplemented rabbit diets with cowpea shells and groundnut haulms. The fibre content of different non-conventional feedstuffs varies, and this might be responsible for some variations in daily feed intake values generated in this study, compared with that of other studies like Bawa et al. (2008). Earlier reports showed that an increase in dietary fibre led to a corresponding increase in feed intake and feed cost/kg weight gain of pigs (Ani et al. 2012; Oyeagu et al. 2015). Bawa et al. (2008) reported that rabbits fed high fibre-containing groundnut haulms and cowpea shell diets had increased feed consumption in an attempt to satisfy their metabolizable energy requirements.

4.2. Apparent nutrient digestibility

The decrease in apparent nutrient digestibility at increasing levels of CPH may be due to the processing method (sun-drying only) used in this study. The processing method used may not have been sufficient to reduce the antinutrient factors present in the cowpea to a tolerable level. Although the fibre content of the experimental diets was in the range of 8.5–11.0%, the fibre content of cowpea hull used was 28.50%. Rabbits require 10–12% dietary fibre and digest only 14% of ingested fibre (Gidienne et al. 2010b; Trocino et al. 2012). Akanji et al. (2016) observed that cooking, dehulling, and roasting of raw cowpea seeds were able to reduce their fibre content to 2.17, 2.34, and 2.54%, respectively. It suggests that further processing was needed to reduce the fibre content of the cowpea hulls that were used in our study. Other researchers reported that heat treatment (toasting) is one effective method of improving the nutritional value and protein digestibility of feedstuffs (Oyeagu et al. 2015, 2016). In the study of Bawa et al. (2008), it was observed that the digestibility of dry matter (DM), crude protein (CP), and crude fibre (CF) in rabbits were reduced due to high inclusion levels of cowpea shells and groundnut haulms, with fibre levels of 33.40 and 23.60. Hence, this probably may have been responsible for the reduced feed utilization noted among the experimental rabbits in their study. The result on apparent nutrient digestibility in the present study supports the findings of Zhang et al. (2013). They reported that increased dietary fibre levels resulted in decreased digestibility in pigs. Our results also agree with the findings of Andrade et al. (2019) who reported that higher inclusion levels of cowpea stover significantly reduced the apparent nutrient digestibility (CP, neutral detergent fibre, and organic matter) in growing rabbits. The DM, CP, and ether extract (EE) digestibility values recorded in this study were also within the range reported by Igwuebuike et al. (2013) for rabbits fed sorghum as a replacement for maize. Dietary fibre (cellulose, pectin, and lignin), feed type, and feeding system have a significant effect on the structure and morphology of the intestinal mucosa of animals (Lingberg 2014; Jha and Berrocoso 2015). High fibre diets move down quickly through the alimentary canal and limits the activities of digestive enzymes, thereby, leading to an overall decrease in nutrient digestibility (Grundy et al. 2016). It is noteworthy that the control diet was better digested than the 30% inclusion rate of cowpea. The higher nutrient digestibility observed at the CPH0 inclusion level could suggest its superiority over the CPH30, whereas the CPH10 and CPH20 cowpea hull treated groups competed favourably with the CPH0 (control) diet.

4.3. Cost parameters

An increase in dietary levels of cowpea hull (CPH) meal resulted in a reduction in feed cost (Table 6). At increasing dietary levels, CPH significantly influenced the cost of feed per kg of weight gain (N). The highest cost of feed that produced a kg weight gain (N165.52) was recorded in rabbits fed CPH0 (control), while the least value of N127.28 was obtained for rabbits that were fed CPH at 30% inclusion (CPH30). With an increase in dietary CPH, the cost of feed required for the animal to produce a kg body weight decreased. Ani et al. (2012) and Oyeagu et al. (2016) also had similar observations and attributed such reduction in feed cost to improved average daily weight gain and efficiency of feed utilization. Based on this report, it does seem that it is more cost-effective to include CPH at 10% for an improved weight gain and cost of feed per kg gain.

4.4. Haematology

The values of haemoglobin concentration (Hb) was decreased at 20 and 30% levels inclusion levels of cowpea hull (CPH) meal (i.e. CPH20 and CPH30), whereas, packed cell volume (PCV) decreased considerably at all inclusion levels of CPH meal compared with the CPH0 (control) (i.e. CPH20 and CPH30). The observed decrease in Hb and PCV, with increased inclusion levels of CPH in our study may be attributed to the harmful effects that anti-nutrient factors (ANFs) exert on red blood cells. Raw cowpea seeds contain haemagglutinin, and other ANFs (Ahamefule et al. 2008). There may be some inherent biotoxins that remained in the processed cowpea hull used in the present study. Ani and Omeje (2011) made similar observations. Oyeagu et al. (2016) reported a similar reduction in PCV and Hb for broiler chicks fed high dietary levels of toasted Bambara-nut offal. They attributed such reduction in blood traits to the high content of ANFs, which destroys the red blood cells. Decreased red blood cell concentration may cause anaemia. In such a condition, Souma et al. (2015) noted that there could be the destruction of cellular respiration leading to tissue necrosis, particularly of the brain, liver, and heart. According to Suzuki (2015), erythropoietin is produced in the liver, kidney, and bone marrow. The author opined that organ damage might affect the rate of erythropoietin production and utilization. However, the values obtained in our study were within the values reported by Amata (2010) and Njidda and Isidahomen (2010) as normal haematology parameters for rabbits. At low levels of CPH inclusion, i.e. CPH0
and CPH10, there was a significant increase in white blood cell (WBC) concentration. Rabbits that were fed these levels of CPH recorded an increased concentration of WBC, which may have resulted in increased immunity among the rabbits. White blood cells are immune cells that protect the body against infections. The result of our hematology study aligns with that of Sugiarto et al. (2016), whose work revealed higher monocyte, lymphocyte, eosinophil, and WBC counts in broiler chickens. They attributed it to the increased ability of the broiler birds to respond to infections.

4.5. Carcass and organ parameters

Average live weight of 1190–1340 g recorded in our study is similar to the 1075–1460 g reported by Henry et al. (2013) for weaned rabbits when they were fed orange waste meal as an alternative dietary fibre source. The average carcass weight (700.50–850.50 g), which we recorded in this study, is similar to the 775.98–983.10 g reported by Bawa et al. (2008) for rabbits fed dietary cowpea shell meal. The dressing percentage (52.20–67.21 g) values recorded in our study were lower than the 82.66–87.39 g reported by Henry et al. (2013). Nevertheless, Odeyinka et al. (2007) reported a dressing percentage of 51.30–53.30 g, upon feeding weaner rabbits with varying levels of cowpea testa, soybean milk residue, and corn starch diets. As the inclusion levels of CPH increased, the heart, liver and lung weights decreased. Interestingly, rabbits fed CPH10 diet competed favourably with those fed control (CPH0) diet with regards to heart, liver and lung weights. An earlier report showed that increased heart weight may lead to sufficient oxygen and nutrient supply and this may perhaps improve the growth performance of animals (Pittman, 2010). Liver plays an important role in the detoxification of toxins. Rabbits fed CPH0 and CPH10 diets had increased liver weights which may explain their better performance. Nourmohammadi et al. (2011) reported that increase in lymphoid organ weights (e.g. liver) indicates an improvement in the immune response which suggests higher immunity in the animals. Our results showed that cowpea hull inclusion up to 10% significantly improved the carcass yield and had no harmful effects on the organs of rabbits evaluated. Our result does not agree with the findings of Amaefule et al. (2011). They reported that dietary supplementation of raw Bambara groundnut offal did not influence either the warm dressed weight or organ weights of heart and liver of rabbits. Henry et al. (2013) also reported non-treatment effects on internal organs of rabbits fed diets supplemented with orange waste meal.

5. Conclusion

The results of the present research indicate that rabbits can tolerate up to 10% cowpea hull in their diets, without any harmful impact on overall growth and health status. The use of cowpea hulls when formulating diets for rabbits could also reduce the cost of production, thus encouraging all-year-round availability of rabbit products at affordable prices.

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