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(RESEARCH ARTICLE)

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# Different basal source of energy as alternative to Maize (*Zea mays*) in Turkey diet

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## Abstract

Maize is a major source of energy in the diet of turkey. Increase in the cost of maize has been a major challenge to poultry farmers. Therefore, there is need to explore available and cheaper alternatives. A twenty-four weeks trial was conducted to investigate the effect of using different source of energy in turkey's diets as alternative for maize on the growth performance and lipid profile.

Four diets for both starter and finisher phase were used, control diet (maize as the energy source), sweet potato (SP), guinea corn (GC) and cassava (CA). 30-day-old-poults were randomly allocated into 4pens with at least 7poults per pen. Lipid profile, weekly body weight, daily feed intake, final weight gain and feed conversion ratio were recorded.

The result revealed no significant difference in the final body weight of turkey when SP was used as alternative to maize at starter phase.

At the finisher phase, there was a numerical increase in the final weight of turkeys fed SP diet when compared to GC and CA diet. No significant difference in the FCR was observed when SP and CA were used as alternative to maize.

The total cholesterol (TC) value was not significant when SP was used as alternative to maize but there was a significant increase in TC value when CA and GC were used as alternative to maize.

It can be concluded that sweet potato can be used as an alternative to maize without adverse effects on performance of turkey and its lipid profile.

**Keywords:** Turkey; Maize; Guinea corn; Cassava; Growth performance; Lipid profile

## 1. Introduction

Turkey (*Meleagris gallopavo*) production is a significant and extremely profitable agricultural business and its product demand is growing globally [1,2]. The production of turkey meat is growing at an average annual growth rate of 3% worldwide [3]. People are raising turkey for its higher meat production and as an alternative to chicken with a change of taste and also as food for festivals. Also, the trend of consuming turkey as white meat is increasing [4].

Feed cost for any poultry enterprise in developing countries is on the increase [5]. According to Ogbonna and Ige [6] acute shortage and price of feed ingredients are responsible for the present rise in poultry feed. This situation has led to high cost of production and reduced return on investment. The cost of feed is up to 80% of the running cost in

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commercial poultry enterprise [7] with energy source ingredients covering about 50% of the total cost of compounded ration.

Maize is a major source of energy in the diet of turkey. Increase in the cost of maize has been a major challenge to poultry practitioners in developing countries. Therefore, there is a need to explore available and cheaper alternatives. Sweet Potato, Cassava and Sorghum have potential to be used as alternative to Maize.

Sweet potato is the second most important root tuber and the seventh most important food crop of the world [8]. It can be grown year-round in tropical and subtropical countries. As far as nutritious value is concerned, it contains substantially greater amount of all essential amino acids, especially lysine [9]. Sweet potato is rich in β-carotene and contains significant amounts of protein, fat, carbohydrate, dietary fibre, zinc, potassium, sodium, manganese, calcium, magnesium, iron and vitamin C and some phytonutrients [10,11]. Very low concentration (<1%) of the fat was reported in sweet potato [12,13,14]. The protein in the range of 1.91%–5.83% was reported for sweet potato [13]. The metabolizable energy of sweet potato is the within the range of 344.52–375.05 kcal/100g [15,16]. The metabolizable energy of sweet potato is comparable with the cereals such as maize (365.2 kcal/100 g) and rice (365 kcal/100 g); in comparison with the other roots and tubers, the energy composition of the sweet potato was reported better.

Cassava (*Manihot esculenta*), is a major carbohydrate rich staple cultivated in the tropics. FAO [17] reported world production at about 157 million tons with Nigeria accounting for about 16% of the world total production. Iyayi et al [18] and Saroeun [19] noted conclusively that cassava may replace maize and cereals without any negative effects. In Nigeria, in spite of cassava availability its use as sole or component of energy source in livestock feed has not been given due recognition. Cassavas root products are rich in carbohydrates and thus are used mainly as sources of energy [20]. Though cassava is produced in abundance in most parts of Nigeria, it enjoys limited use relative to cereals, even when its energy content is higher than that in cereals [21]. The root is composed almost exclusively of carbohydrate, as well as approximately 1% to 3% crude protein [22]. The metabolizable energy (ME) levels of cassava root have been presented by various authors, with values ranging from 3,200 kcal/kg [23], 3145 kcal/kg [24] and 3,279 kcal/kg [25].

Sorghum (Guinea corn) is widely grown in the semi-arid and savannah regions of Nigeria. Maunder [26] reported that sorghum is a traditional crop of much of Africa and Asia and an introduced and hybridized crop in the western hemisphere. It benefits from an ability to tolerate drought, soil toxicities and temperature extremes more effectively than other cereals. Nigeria was currently ranked the third largest producer of sorghum in the world with about 6 million tonnes of grains produced from 5.7 million hectares of land [27]. A report by Abubakar et al [28] indicated that sorghum is cheaper than maize in the northern part of Nigeria. Sorghum grains contain about 92.50 % dry matter, 3270 kcal/kg metabolizable energy for poultry, 9.5 % crude protein, 2.55 % ether extract, 2.70 % crude fibre, 1.25 % ash and 76.6 % nitrogen free extract (NFE). Its protein is slightly higher than maize but as with most cereals deficient in lysine and tryptophan [29].

The objective of the current study was to evaluate sweet potato, guinea corn and cassava as a potential alternative source of energy to completely replace maize in turkey diets and effect on the growth performance and lipid profile of turkey.

## 2. Material and methods

### 2.1. Experimental Site

All procedures used in the experiments were approved by the Institutional Animal Care and Use of Peace House Agricultural Training Institute, Isarun, Ondo State. The experiments were conducted in the poultry pen constructed.

### 2.2. Animals and Experimental Design

A total of thirty (30) one-day-old, poults were obtained from a reputable hatchery in Ibadan, south-west, Nigeria. The turkeys were brooded for a period twenty-eight days, temperature of the experimental unit was maintained at 35±1 °C during the first week and gradually decreased to 21 °C till 3 weeks of age.

The poults were weighed, then randomly divided into four dietary treatment groups (Control, SP, GC and CA) with an average of seven poults per treatment group. Four (4) experimental diets were used; SP diet (Sweet potato as energy source), GC diet (Guinea corn as energy source) and CA diet (Cassava as the energy source) and the control diet (Maize as its energy source).

The crude protein (%) and metabolizable energy (Kcal/kg) contents of the diets were balanced according to NRC [30]. The gross composition of experimental diets is presented in Table 1 and Table 2. The study had the starter (days 0–56) and finisher (days 57–140) phases.

**Table 1** Feed composition of turkey experimental diet for starter feed

| **INGREDIENTS** | **GC** | **CA** | **SP** |
|---|---|---|---|
| Guinea corn (%) | 49.7 | - | - |
| Sweet potato (%) | - | - | 39.6 |
| Cassava (%) | - | 39.7 | - |
| Full fat soya (%) | 39.1 | 47.15 | 50 |
| Palm kernel cake (%) | 4.8 | 7 | 6 |
| Bone meal (%) | 2.7 | 3.4 | 3.4 |
| Wheat offal (%) | 2.9 | 1.9 | 0.15 |
| Premix (%) | 0.25 | 0.25 | 0.25 |
| Lysine (%) | 0.15 | 0.15 | 0.15 |
| Methionine (%) | 0.2 | 0.2 | 0.2 |
| Salt (%) | 0.25 | 0.25 | 0.25 |
| Total | 100 | 100 | 100 |
| Cal. Crude protein (%) | 28 | 28 | 28 |
| Cal. ME (kcal/kg) | 3100 | 3100 | 3100 |

**Table 2** Feed composition of turkey experimental diet for finisher feed

| **INGREDIENTS** | **GC** | **CA** | **SP** |
|---|---|---|---|
| Guinea corn (%) | 53.1 | - | - |
| Sweet potato (%) | - | - | 39.95 |
| Cassava (%) | - | 39.7 | - |
| Full fat soya (%) | 27.3 | 37.1 | 37.3 |
| Palm kernel cake (%) | 8.4 | 10.5 | 12.4 |
| Bone meal (%) | 3 | 2.7 | 2.7 |
| Wheat offal (%) | 7.4 | 2.9 | 6.8 |
| Premix (%) | 0.25 | 0.25 | 0.25 |
| Lysine (%) | 0.1 | 0.1 | 0.1 |
| Methionine (%) | 0.2 | 0.2 | 0.2 |
| Salt (%) | 0.25 | 0.25 | 0.25 |
| Total | 100 | 100 | 100 |
| Cal. Crude protein (%) | 22 | 22 | 22 |
| Cal. ME (kcal/kg) | 3000 | 3000 | 3000 |

### 2.3. Data collection

Initial body weights (kg/bird) were obtained before the administration of experimental treatments. Weekly live body weight was measured. Weight gain per turkey was calculated as Mean final body weight – Mean initial body. Daily feed intake (g) was obtained as the difference between the quantity of feed given the previous day and the left over, and divided by the number of turkeys in a diet group. Feed conversion ratio (FCR) was calculated as the ratio of total feed intake per bird and mean weight gain.

### 2.4. Proximate analysis

This was determined according to the procedure outline by AOAC [31].

### 2.5. Lipid profile

At the end of the experiment, 3 ml blood samples were collected from three turkeys per group through brachial vein puncture into plain bottles without anti-coagulant which were centrifuged for 15 minutes to collect the serum for lipid profile. Total cholesterol, triglyceride, high density lipoprotein and low-density lipoprotein are determined and measured according to standard procedures.

### 2.6. Research policy

All procedures used in the experiments were approved by the Institutional Animal Care and Use of Peace House Agricultural Training Institute Isarun, Ondo State. The experiments were conducted in the poultry unit of the Institute.

### 2.7. Statistical analysis

The means and standard error of mean (SEM) of the data were calculated. The results were analysed by one-way analysis of variance (ANOVA) with Tukey-Kramer Multiple Comparisons Test using Graph pad prism 5.0 Software (www.graphpad.com) to determine significant differences between means and where applicable, least significant difference (LSD) was used to determine significant results. The differences between groups were considered significant at $P < 0.05$.

## 3. Results

### 3.1. Proximate analysis

Proximate analysis result is presented in Table 3 below. There is a numerical increase in crude protein value of SP and CA feed when compared with the control feed and a numerical decrease in the crude protein value of GC when compared with the control, SP and CA feed. The CHO level in SP and CA is lower when compared with the control feed and GC feed. The crude fat content in SP and CA is numerically lower than that of the control and GC feed.

**Table 3** Proximate analysis of Stater Feed

| **PROXIMATE %** | | | | | | |
|---|---|---|---|---|---|---|
| | **MC** | **CF** | **CP** | **ASH** | **C.FAT** | **CHO** |
| Control | 11.329 | 20.417 | 5.52 | 9.5 | 2.912 | 50.322 |
| SP | 9.163 | 28.921 | 7.32 | 10.67 | 2.414 | 41.512 |
| GC | 10.805 | 24.707 | 4.41 | 6.74 | 2.975 | 50.363 |
| CA | 9.629 | 27.453 | 6.39 | 9.6 | 1.064 | 45.864 |

**MC**: Moisture content; **CF**: Crude fibre; **CP**: Crude protein; **C.FAT**: crude fat; **CHO**: Carbohydrate

### 3.2. Growth Performance

Growth performance results are presented in Tables 4 and 5. There is no significant difference ($P>0.05$) in the weight gain of turkeys fed with SP starter diet when compared with the control diet but there is a significant difference ($P<0.05$) in the weight gain of turkeys fed with GC and CA starter diet when compared with the SP starter diet and control starter diet. There is no significance in the feed conversion ratio across all diet groups (SP, GC and CA) but when compared with control starter diet, there is a significant increase ($P<0.05$).

There is a significant difference in the weight gain of turkeys fed with the SP, GC and CA finisher diet when compared with the control diet. There is a significant increase in weight gain of turkeys fed with SP finisher diet when compared with GC finisher diet but there is no significant difference in the weight gain of turkeys fed with GC and CA finisher diet. There is no significant difference in the feed conversion ratio of turkeys fed with the SP and CA finisher diet when compared with the control diet but there is a significant difference in the feed conversion ratio of turkeys fed with GC finisher diet when compared with control diet.

**Table 4** Growth performance of different diet groups (0-8weeks)

| | **Control** | **SP** | **GC** | **CA** |
|---|---|---|---|---|
| Initial weight/bird (Kg) | 0.058±0.001 | 0.059±0.001 | 0.058±0.001 | 0.059±0.001 |
| Final weight/bird (Kg) | $1.19\pm0.02^{a}$ | $1.10\pm0.06^{a}$ | $0.916\pm0.02^{b}$ | $0.879\pm0.06^{b}$ |
| Change in weight/bird (Kg) | $1.13^{a}$ | $1.04^{a}$ | $0.86^{b}$ | $0.82^{b}$ |
| Total feed consumed/bird (Kg) | 2.32 | 3.2 | 2.43 | 2.59 |
| Feed conversion rate (FCR) | $2.05^{a}$ | $3.08^{b}$ | $2.83^{b}$ | $3.16^{b}$ |

Values are expressed in Mean±SEM. Mean value with the same superscript across the same row are not significant (P>0.05) while Mean value with different superscript across the same row are significant (P<0.05).

**Table 5** Growth performance of different diet groups (9-24weeks)

| | **Control** | **SP** | **GC** | **CA** |
|---|---|---|---|---|
| Initial weight/bird (Kg) | 1.19±0.02 | 1.10±0.06 | 0.916±0.02 | 0.879±0.06 |
| Final weight/bird (Kg) | $11.80\pm0.15^{a}$ | $9.90\pm0.00^{b}$ | $8.50\pm0.00^{c}$ | $9.00\pm0.60^{bc}$ |
| Change in weight/bird (Kg) | $10.61^{a}$ | $8.8^{b}$ | $7.58^{c}$ | $8.12^{bc}$ |
| Total feed consumed/bird (Kg) | 34.49 | 36.03 | 36.95 | 33.91 |
| Feed conversion rate (FCR) | $3.25^{a}$ | $4.09^{ac}$ | $4.88^{bc}$ | $4.18^{ac}$ |

Values are expressed in Mean±SEM. Mean value with the same superscript across the same row are not significant (P>0.05) while Mean value with different superscript across the same row are significant (P<0.05).

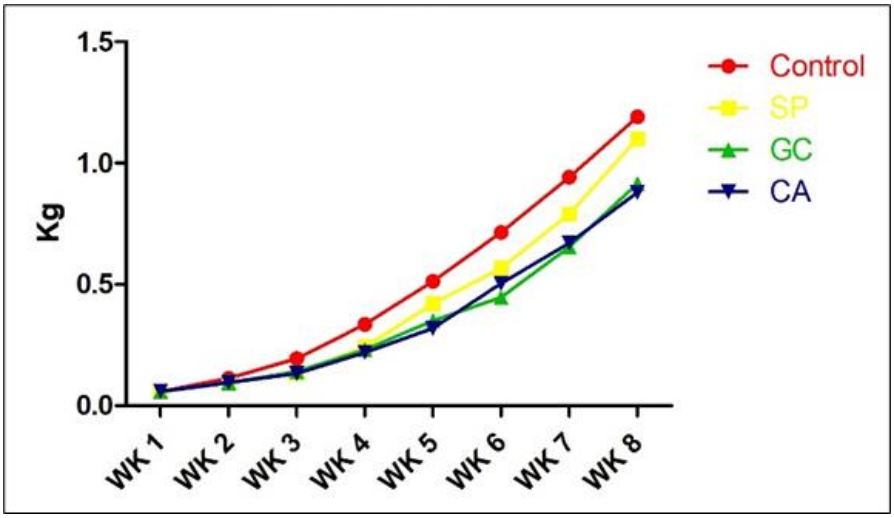


**Figure 1** Growth performance of turkeys fed with starter diet

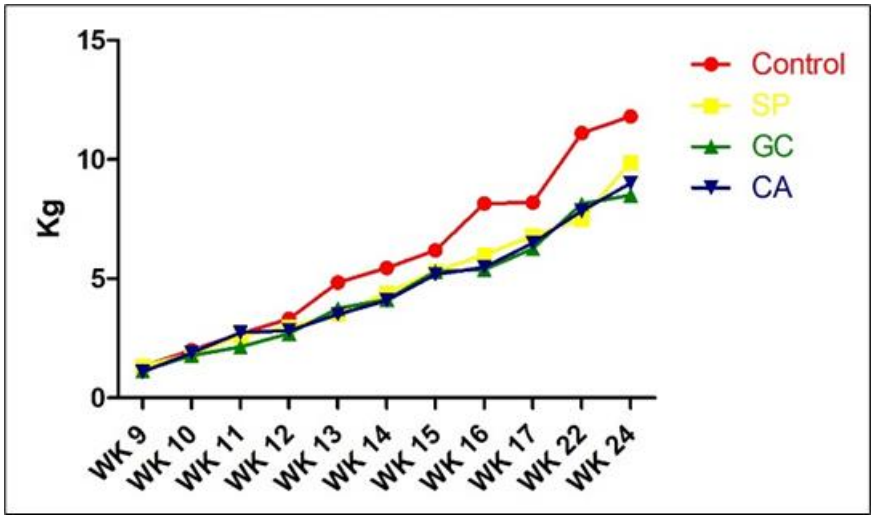


**Figure 2** Growth performance of turkeys fed with finisher diet

### 3.3. Lipid Profile

Lipid profile results are presented in table 6. There is no significant difference (P>0.05) in the triglyceride (TG), high density lipoprotein (HDL) and low-density lipoprotein (LDL) values of turkeys fed with SP, GC and CA diets when compared with control. There is a significant difference in the total cholesterol (TC) values of turkeys fed with GC and CA diet when compared with turkeys fed with the control diet but there is no significant difference in the TC value of turkeys fed with SP diet when compared with those fed with the control diet.

**Table 6: Lipid profile of turkeys in different diet groups**

| Group | TG (mmol/L) | TC (mmol/L) | HDL (mmol/L) | LDL (mmol/L) |
|---|---|---|---|---|
| Control | 0.33±0.02$^{a}$ | 4.27±0.56$^{a}$ | 2.87±0.41$^{a}$ | 1.23±0.12$^{a}$ |
| SP | 0.33±0.05$^{a}$ | 5.30±0.15$^{ac}$ | 3.93±0.52$^{a}$ | 1.30±0.06$^{a}$ |
| GC | 0.34±0.04$^{a}$ | 5.97±0.18$^{bc}$ | 4.23±0.24$^{a}$ | 1.60±0.38$^{a}$ |
| CA | 0.63±0.16$^{a}$ | 6.07±0.33$^{b}$ | 3.50±0.25$^{a}$ | 2.27±0.27$^{a}$ |

Values are expressed in Mean±SEM. Mean value with the same superscript across the same column are not significant (P>0.05) while Mean value with different superscript across the same column are significant (P<0.05).

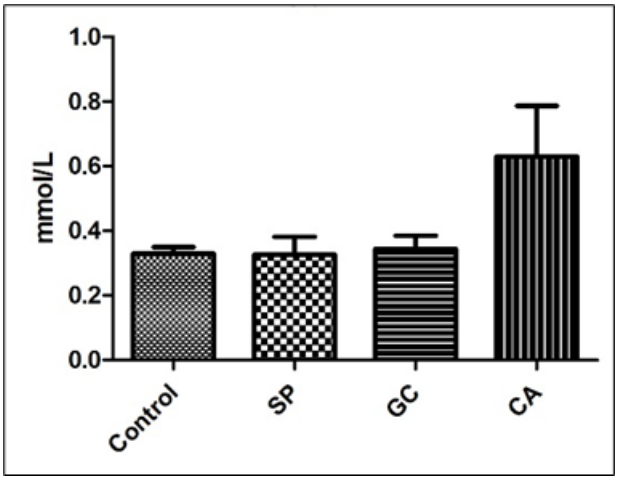


**Figure 3** Triglyceride values of different diet groups

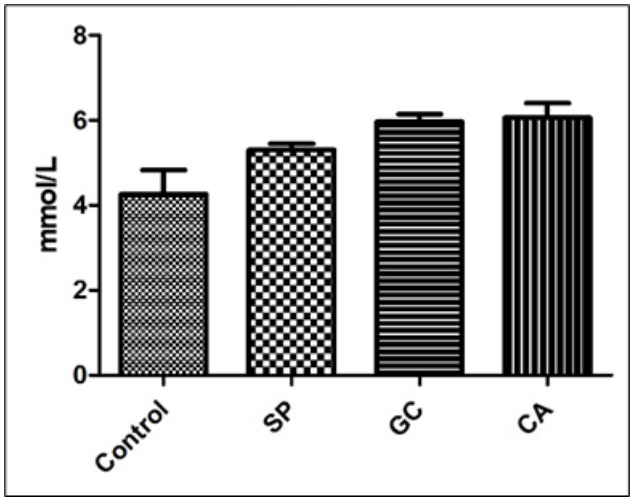


**Figure 4** Total cholesterol values of different diet groups

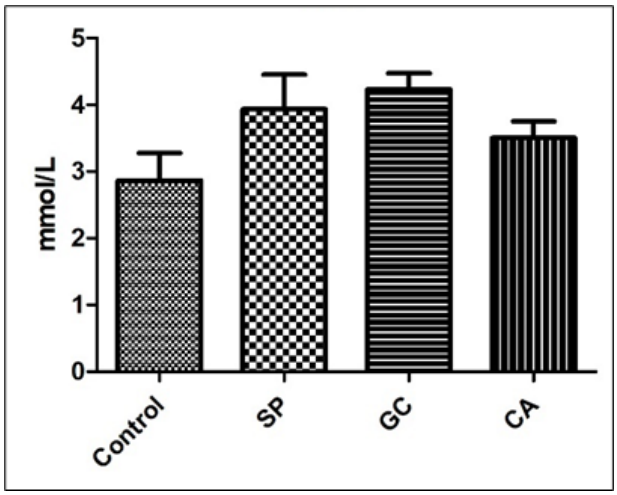


**Figure 5** High density lipoprotein values of different diet groups

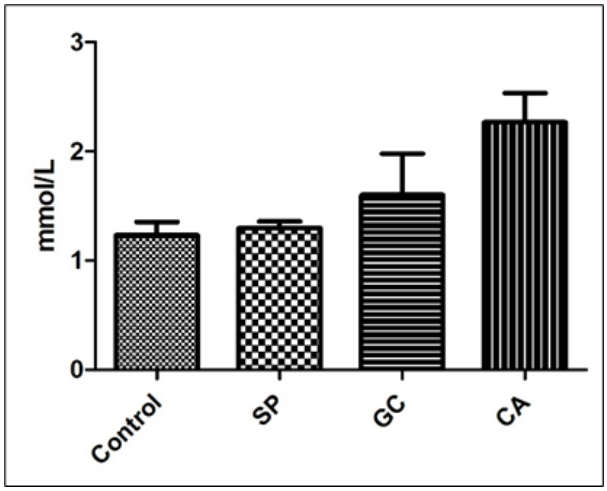


**Figure 6** Low density lipoprotein values of different diet groups

## 4. Discussion

The significant decrease in the final weight gain and significant increase in FCR of turkeys fed with CA starter and finisher diet may be attributed to poor diets utilization caused by high fibre content as shown by the proximate analysis and possibly high load of hydrogen cyanide in cassava root meal (CRM). This agreed with earlier report of Hassan et al [32], Ukachukwu [33] and Akinfala [34], who recommended inclusion level of up to 25% CRM in poultry rations. Other workers [35,36] reported growth depression when CRM was added to poultry rations. The current results agreed with Gowdh et al [37] and Elnour et al [38] who reported that cassava roots depressed the broiler growth when included in the diets at rate (48.6%).

The significant decrease in the final weight gain and significant increase in FCR of turkeys fed with GC starter and finisher diet could be attributed to presence of kafirin (the dominant protein fraction), phytate and non-tannins phenolic compounds in sorghum which could compromise the quality of protein and starch. This was also supported by Haladu et al [39] who reported birds on the sorghum diet recorded the poorest feed conversion ratio and Farahat et al [40] also reported that 100% substitution of sorghum results in a significant decrease of the final average BW by 5.25% compared to broilers fed on corn diet and the FCR was significantly increased by levels up to 8% at 100% inclusion of sorghum.

This finding agrees with Torres et al [41] who reported that using sorghum at 100% as alternative to maize resulted in the poor weight gain and feed conversion ratio compared to 100% maize diet or using sorghum at 50% as alternative to maize. Similarly, Ahmed et al [42] reported poor FCR at 100% sorghum inclusion and the best results were achieved at 100% corn inclusion. Likewise, Mohamed et al [43] did not observe a negative impact on the broiler chicken performance by using sorghum at levels up to 45% as alternative to corn.

Final weight gain of turkeys fed with SP starter diet was not significantly different to the turkeys fed with control diet, this weight gain could be due to the good utilization of nutrients in the sweet potato-based diet. This finding is in agreement with Mozafari et al [44], Ayuk and Essien [45], Agwunobi [46] and Turner et al., [47] who reported that feeding 25% potato to starter birds, 50% sweet potato to broiler starter, 36 and 45% sweet potato to starter and finisher birds, or feeding either potato or sweet potato in diets did not affect the body weight gain, food conversion ratio, or mortality percentages.

There was a significant difference in the final weight gain of turkeys fed with SP finisher diet when compared to the turkeys fed with control diet with no significant difference in the FCR could be due to high fibre content in the sweet potato-based diet. This finding was also reported by Sultan et al [48] that abdominal fat percentage decreases with the increasing potato meal and the lower weight of dressing is likely due to the low content of fat.

The lipid profile in this experiment reflects low total cholesterol (TC) in the turkey fed with SP diet when compared with turkeys fed with GC and CA and no significant difference in the TC of SP diet and control diet which reveals that there was a reduced fat in turkeys fed with SP diet and control diet. This will definitely make the meat produced to be of more worth in terms of fetching higher market prices since high animal fat causes elevated blood cholesterol leading to atherosclerosis or heart failure [49]. This finding was also observed by Sultan et al [48].

## 5. Conclusion

The SP diet has higher crude protein content, low crude fat, equal low level of LDL and about equal basal energy when compared to control diet. Sweet potato is cheaper, easily accessible and grown round the year and even their leaves control weeds unlike maize which is expensive and seasonal in production. Based on this finding, it can be concluded that sweet potato can be used as an alternative to maize without adverse effect on growth performance and lipid profile of turkey.

The findings of this study also showed that the use of cassava roots and guinea corn as a source of energy up to 100% in starter and finisher diets of turkey reduced growth performance and deleterious effect on lipid profile of turkey by increasing the cholesterol deposit in meat.

### *Recommendation*

Further studies should be carried to determine the best inclusion percentage of sweet potato in turkey feed that will increase growth performance.

## Compliance with ethical standards

### *Acknowledgments*

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### *Disclosure of conflict of interest*

The authors declare no conflict of interest.

### *Statement of ethical approval*

Ethical approval with reference number - AEC/23/01/002 was obtained from the Institutional Animal Care and Use of Peace House Agricultural Training Institute, Isarun, Ondo State.

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