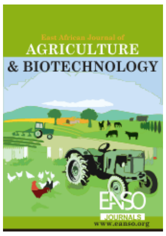

East African Journal of Agriculture and Biotechnology
eajab.eanso.org
Volume 7, Issue 1, 2024
p-ISSN: 2707-4293 | e-ISSN: 2707-4307
Title DOI: https://doi.org/10.37284/2707-4307

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Effect of Dietary Ginger (Zingiber officinalis) Powder on Growth Performance, Carcass Characteristics, And Gut Microbiota in Weaned Rabbits (Oryctolagus cuniculus)

Tansho Lufong Anslem[1], Nounamo Arthenice Jemima Guiekep[1] & Aziwo Tatanja Niba[1]*

[1] The University of Bamenda, P. O. Box 277 Bamenda, Cameroon.
* Author for Correspondence Email: lufongany@gmail.com

Article DOI : https://doi.org/10.37284/eajab.7.1.1881

Date Published:

22 April 2024

Keywords:

Carcass, Feeding, Growth, Gut microbiota, Rabbit.

ABSTRACT

This study was conducted to evaluate the effects of dietary ginger powder as a natural feed additive on the growth performance, carcass traits and gut microbiota of growing rabbits. For this purpose, a total of 36 equal-sexed New Zealand white rabbits aged 6 weeks ± 5 days old were randomly assigned into 4 treatments with 3 replicates each. The control animals (T0) received the basal diet without feed additive, while the 3 other groups T1, T2, and T3 respectively received diets 5, 10, and 15 g of ginger/kg of feed. Data was collected on feed intake, body weight gain, carcass indices and gut microbial load. Results revealed that the inclusion of ginger significantly ($p<0.05$) increased daily feed intake approximately by 16.02 g in T1 (5g ginger) compared to the control. The total feed intake followed the same trend. Daily weight gain increased approximately by 3.46g T3 (15g ginger). The feed conversion ratio was not significantly affected by dietary ginger inclusion. The addition of ginger did not significantly ($p>0.05$) affect the carcass characteristics of rabbits; However, a reduction was observed in abdominal fat content with approximately 0.81% in T3. Ginger powder in rabbits' diets caused a decrease in the population of pathogenic microorganisms (gram-positive bacteria) but did not have any effects on total coliforms (gram-negative bacteria). It can therefore be concluded that ginger could be added to growing rabbits' feed to improve live weight and reduce levels of gram-positive bacteria.

APA CITATION

Anslem, T. L., Guiekep, N. A. J. & Niba, A. T. (2024). Effect of Dietary Ginger (Zingiber officinalis) Powder on Growth Performance, Carcass Characteristics, And Gut Microbiota in Weaned Rabbits (Oryctolagus cuniculus). *East African Journal of Agriculture and Biotechnology*, *7*(1), 194-203. https://doi.org/10.37284/eajab.7.1.1881

CHICAGO CITATION

Anslem, Tansho Lufong, Nounamo Arthenice Jemima Guiekep and Aziwo Tatanja Niba. 2024. "Effect of Dietary Ginger (Zingiber officinalis) Powder on Growth Performance, Carcass Characteristics, And Gut Microbiota in Weaned Rabbits (Oryctolagus cuniculus).". *East African Journal of Agriculture and Biotechnology* 7 (1), 194-203. https://doi.org/10.37284/eajab.7.1.1881

HARVARD CITATION

Anslem, T. L., Guiekep, N. A. J. & Niba, A. T. (2024) "Effect of Dietary Ginger (Zingiber officinalis) Powder on Growth Performance, Carcass Characteristics, And Gut Microbiota in Weaned Rabbits (Oryctolagus cuniculus).", *East African Journal of Agriculture and Biotechnology*, 7(1), pp. 194-203. doi: 10.37284/eajab.7.1.1881.

Article DOI : https://doi.org/10.37284/eajab.7.1.1881

IEEE CITATION

T. L. Anslem, N. A. J. Guiekep & A. T. Niba "Effect of Dietary Ginger (Zingiber officinalis) Powder on Growth Performance, Carcass Characteristics, And Gut Microbiota in Weaned Rabbits (Oryctolagus cuniculus)", *EAJAB*, vol. 7, no. 1, pp. 194-203, Apr. 2024.

MLA CITATION

Anslem, Tansho Lufong, Nounamo Arthenice Jemima Guiekep & Aziwo Tatanja Niba. "Effect of Dietary Ginger (Zingiber officinalis) Powder on Growth Performance, Carcass Characteristics, And Gut Microbiota in Weaned Rabbits (Oryctolagus cuniculus)". *East African Journal of Agriculture and Biotechnology*, Vol. 7, no. 1, Apr. 2024, pp. 194-203, doi:10.37284/eajab.6.1.1881.

INTRODUCTION

Antibiotics have been incorporated to animal feeds into prevent, and treatment of infections, reduce morbidity and mortality as well as improvement in growth and production performance (Nasab *et al.,* 2015). Nevertheless, it has been proven these antibiotics have potential side effects such as residuals in tissues, development of resistance in microorganisms and allergies which have become a real public health concern in monogastric animals (Nweze *et al*., 2011). So, the increased concern regarding the transmission of the resistance bacteria and it proliferation through the food chain (Zeng *et al*., 2015) this resulted in the banning of sub-therapeutic usage of Antibiotic Growth Promoters (Nweze *et al*., 2011). Some feed additive such as vitamin E and selenium have been added in monogastric feeds, but rather have proven to be very expensive. Consequently, researchers are looking for alternatives that can replace antibiotics as growth promoters, from natural substances such as herbs and spices, seen as potential solution that can address the public health concerns without compromising the productivity of livestock production (Toghyani *et al.*, 2011).

Herbs and spices recently have caught scientific attention due to their potential role as alternative to in feed antibiotic growth enhancer in monogastric animals (Khan and Naz, 2013) Their usefulness lies in their availability, low cost compared with synthetic chemical drugs, safety to the animal and final consumer, and some have proven to reduce serum lipids and have resulted to improve immune response in humans and animals (Yadgar and Yavuz, 2015). Some of them include garlic, thyme, black pepper, moringa, African nutmeg and ginger. Owing to their aromatic properties, several phytogenic feed additives are reported to have improved feed quality, palatably, based on the dosage or concentration of the additive in the animal diet (Odoemelam *et al*., 2013).

Ginger (zingiber officinele) a perennial herb belonging to the family zingiberacease has been widely used around the world as food spie and as herbal remedy for some infections **(Botsoglou *et al*., 2002)**. Ginger contains vas active ingredients which enable them to act as a nutrient. Ginger has proven to have a lot of potential in human and animal health such as anti-bloating, anti-vomiting, anti-dyspesia and diarrhoea, speeds digestion, in addition it enhances by-pass protein digesting enzyme (zingibaine). *Zingiber* has antiflammatory and antibacterial actions and it has also proven to lowers blood cholesterol levels (Jubril, 2019). Studies conducted on ginger powder or extracts in poultry and growing rabbits have shown to improve appetite, facilitates gastric enzymes flow, nutrient absorption, feed palatability thereby increasing growth and reducing feed efficiency ratio (Windisch *et al*., 2008; Karangiya *et al*., 2016; Jubril, 2019; Duwa *et al*., 2020). The desirable active compounds fund in ginger are gingerdione, gingerdiol and gingerol with potential to stimulate the gastric enzymes and alter microbial activities and anti-oxidative activities. Therefore, the present study was conducted to evaluate the effect of dietary ginger as alternative to in feed antibiotic growth promoters in weaned rabbit nutrition.

MATERIALS AND METHODS

Study site

This research was conducted at Nazareth agro-pastoral training and production centre (NAPTPC) in Menteh Nkwen in the Bamenda III

Article DOI : https://doi.org/10.37284/eajab.7.1.1881

subdivision. The centre is located approximately 3 km from the mile 4 main junction. It has a rainfall of 1000-3000 m with the highest record in the month of August; annual average temperature from 19.09-28.28° C, with the lower rang during January and the up during April. Its humidity ranges from 70-85%.

Preparation of experimental ingredients (*Zingiber officinalis*)

Ginger was obtained from the Nkwen main market Bamenda (North West region of Cameroon), peeled, chopped into bits and shade-dried. The ground ginger was stored until usage as described by Hossian *et al.* (2015).

Animal housing and Equipment

Rabbits were reared individually in metal cage with dimension of 45 × 40 cm as floor space and height of 30 cm corresponding to a calculated space requirement of 1800 cm^2 per animal inside a closed rabbit unit with proper ventilation and dissipation of heat. Cages were equipped with feeders and watery troughs.

Experimental Diet and Design

A standard diet (*Table 1*) was formulated using ingredients obtained from the local market, these ingredients especially Maize were milled at a diameter range of 1-3 mm as recommended by Hy-Line International (2015). Ginger powder was added in the diet at graded inclusions which corresponded to the treatment groups. The basal diet was formulated to meet the nutritional requirements of weaned rabbits. Feed and water were provided *ad libitium* throughout the trial period.

A total of 36 weaned rabbits (18 males and 18 females) aged 6 weeks old and average weighing 522 ± 79.36 g were used. They were obtained from a commercial rabbit farm in Banjoun's west region of Cameroon. The rabbits were randomly allocated in to 4 dietary treatments denoted asT0, T1, T2 and T3 with 9 rabbits each corresponding to 0g, 5g, 10g, and 15 g ginger powder per kg of feed. They were allowed for one week to adapt to their new environment and feed.

Table 1: Formula and Calculated chemical composition of rations

Ingredients	Quantity in kg
Maize	24
Palm oil	1
Soybean	6
Fishmeal	2
Groundnut meal	4
Bone meal	2.5
Wheat bran	40
Rice bran	10
PKC	10
Premix	0.5
Total	100
Calculated chemical composition of rations	
M. E. (Kcal/kg)	2553.69
Crude protein (%)	16.53
Crude fibre (%)	11.11
Calcium (%)	0.84
Phosphorus	1.47
ASH (%)	5.5505
Lysine (%)	0.8748
Methionine (%)	0.41

Data Collection

Feed Intake

Formulated diets were measured and served to the rabbits on a daily basis and the leftovers were collected and weighed every morning before

East African Journal of Agriculture and Biotechnology, Volume 7, Issue 1, 2024
Article DOI : https://doi.org/10.37284/eajab.7.1.1881

serving feed to the rabbits. Weekly feed intake was calculated by subtracting the leftovers from the quantity served to each rabbit in each treatment.

Live Weight and body weight gain

At the beginning of the feeding trial, all the rabbits in each treatment were weighed. Subsequently, they were weighed individually before feeding every seventh day, using an electronic balance with a sensitivity of 1 g. The weight gain (WG) was calculated as follows:

$$WG\ (g) = Wn-(Wn-1)$$

Where WG: weight gain; Wn: final weight at the end of the current week; Wn-1: initial weight

Feed Conversion Ratio (FCR)

Feed conversion was computed by divided the total feed consumed during the period of evaluation by the total weight gained during the same period.

$$FCR = \frac{\text{Total feed consumed (g)}}{\text{Total Weight gain (g)}}$$

Carcass Characteristics

At the end of the feeding trial 3 rabbits from each group) were weighed and faster for 12hours with access to only water after the animals were stunned and slaughtered. The animals after bleeding were dissected following the procedures of Fathi *et al.* (2017). Offal's were removed and the carcass, head, liver, kidney and spleen were weighed and recorded accordingly. The carcass was divided into cuts; fore legs mid part and hind legs. All weights were expressed as percentage of the live body weight. Carcass yield was expressed as the live weight(after fasting) and multiplied by a hundred.

$$\text{Carcass Yield (CY \%)} = \frac{\text{Carcass weight}}{\text{Live body weight}} \times 100$$

Relative organs weight

Relative weight of organ (kidney, liver, spleen, and heart) was computed as the ratio the weight of the organ to the live body weight and computed as a percentage (Fadlalla *et al*., 2010).

$$Organ\ weight(\%) = \frac{\text{weight of organ}}{\text{live weight of the animal}} \times 100$$

Mortality rate

$$\text{Mortality}(\%) = \frac{\text{Number of dead during the trial period}}{\text{Number at the beginning of the trial}} \times 100$$

Intestinal Microbial Populations

Twelve (n=3 animals for each group) animals were slaughtered and dissected in a clean environment, faecal samples were obtained from three parts (entry, middle and end) of the caecum into sterile and put on ice and transported into the laboratory for enumeration and identification bacterial population. A 10- fold serial dilution of the fecal samples 10-1-10-7 was made in sterile physiological saline (9g/l) then 1 ml of the dilutions was duplicated and inoculated onto the agar plates by the spread plate method for plate count determination. Samples from each rabbit were evaluated for Clostridium spp. and Coliform at the Laboratory of Animal Health and Physiology, Department ff Animal Production, Faculty of Agronomy and Agricultural Science, University of Dschang.

Data Analyses

Data collected on live-daily weight gain, live weight, weight gain feed conversion ratio and feed intake were imputed in Microsoft Excel and then subjected into one way analysis of variance (ANOVA). The statistical model utilized was summarized as follows:

Yij: =µ+Ti+éij where:

Yij = Observation of the rabbits j receiving diets i, µ = mean of the treatment, T_i = effect of dietary treatment, éij = Residual as a result of rabbit j receiving diet i.

The Duncan multiple range test was use to separate significant means at 5% significant (Steel and Torrie, 1980). Prior to statistical analysis,

Article DOI : https://doi.org/10.37284/eajab.7.1.1881

microbial colonies farming units (CUFs) was expressed as logarithmic (log_{10}) transformation per gram of fecal sample. All analyses were conducted using statistical package for social sciences (SPSS) version 23.0for windows program and presented on tables as mean ± SD

RESULTH AND DISCUSSION

Effect of Dietary ginger (*Zingiber officinale*) on growth Parameters in Weaned Rabbits (*Oryctolagus cuniculus)*

Total and daily feed intake significantly ($p<0.05$) increased in in rabbits receiving 5g ginger powder in their feed (T1) among all the other treatments. Live body weight, daily weight and total weight gain increased significantly ($p<0.05$) in rabbits receiving *Zingiber* powder in their diet compared to the control treatment (*Table 2*). The FCR was Lowest in treatment T2 (10g) compared to the control and other dietary treatments. However a steady and linear decreased in feed conversion ratio, obtained with increasing ginger inclusions as an additive in the diet. Yet, they was no significant differences observed ($p>0.05$).

Effect of Dietary Ginger Powder (*Zingiber officinale*) on the Carcass Characteristics of Rabbits (*Oryctolagus cuniculus*)

Carcass yield and relative cut yield of weaned rabbits as affected by dietary ginger are presented on *Table 3*. The results show no significant ($p<0.05$) effect on yield, relative percentage head, fore legs, and main body for all treatments. Only the hind legs were statistically influenced ($p<0.05$) by ginger among all dietary group. Nevertheless, an increased trend in the carcass characteristics in groups fed *Z. officinale* was generally observed (*Table 3*).

Effects of Dietary ginger Levels on the Relative Organ Weights of Rabbits

The results *(Table 4)* revealed no differences ($p>0.05$) on the relative weights different organs studied (liver, kidney, heart, and spleen). Nonetheless, rabbits receiving ginger in their diet generally showed some increases in the weights of these organs in comparison with the control animals.

Effect of Dietary Ginger on Faecal Microbial Populations of Rabbits

The result on the microbial count in faecal samples of rabbits fed varying addition of ginger powder in feed revealed no statistical ($p>0.05$) effects on Enterobacteria Spp. However, the highest count was observed in T2 (6.11±0.84) and a low count in T1 (4.59±0.36). The effect of dietary ginger on clostridium Spp count revealed a positive effect (*Table 5*)

Article DOI : https://doi.org/10.37284/eajab.7.1.1881

Table 2: Effects of Dietary ginger (*Zingiber officinale*) on growth Parameters in Weaned Rabbits (*Oryctolagus cuniculus)*

Growth parameters	The inclusion level of ginger				
	T0 (0)	**T1 (5 g)**	**T2 (10 g)**	**T3 (15 g)**	**P value**
Daily feed intake(g)	66.03±0.70^{c}	82.64±1.02^{a}	66.09±1.54^{c}	73.06±5.82^{b}	0.00
Total feed intake(g)	5546.17±59.08^{c}	6941.86±85.67^{a}	5252.17±129.11^{c}	6136.88±487.61^{b}	0.00
Final live weight(g)	1864.00±277.17^{b}	2086.20±214.49^{ab}	2067.80±246.92^{ab}	2214.25±243.84^{a}	0.17
Daily weight gain(g)	14.26±1.74^{b}	16.89±1.65^{a}	16.44±1.82^{ab}	17.72±1.93^{a}	0.02
Final weight gain(g)	1198.17±146.41^{b}	1419.00±138.74^{a}	1381.20±152.68^{ab}	1488.50±162.42^{a}	0.03
Feed conversion ratio	4.71±0.76	4.93±0.44	4.08±0.41	4.19±0.86	0.12
Mortality rate (%)	1.85	1.85	1.85	1.85	*

$^{a.b.c:}$ *means with in arrow with different superscripts differ significantly (p<0.05).*

Table 3: Carcass characteristics of rabbits as affected by variable inclusion levels of ginger powder in the diet

Carcass parameters	The inclusion level of ginger				
	T0 (0)	**T1 (5 g)**	**T2 (10 g)**	**T3 (15 g)**	**P value**
Carcass Yield (%)	61.43±2.46	63.36±3.45	64.24±3.63	63.32±1.73	0.70
Head (%)	8.08±1.14	8.51±0.24	8.97±1.21	8.84±1.16	0.72
Hind Leg (%)	13.18±0.84^{a}	13.87±1.02^{a}	13.00±0.22^{a}	8.84±1.16^{b}	0.00
Fore Leg (%)	7.46±0.58	7.45±0.20	7.61±0.61	7.18±0.52	0.78
Main Body (%)	29.07±1.61	28.93±1.93	30.83±5.13	29.87±2.60	0.87
Abdominal Fat (%)	1.29±0.11	0.93±0.09	1.02±0.29	0.70±0.30	0.12

$^{a.b.c:}$ *means with in arrow with different superscripts differ significantly (p<0.05).*

Table 4: Influence of variable levels of ginger powder on the relative weight of internal organs

Internal organs	Inclusion level of ginger				
	T0 (0)	**T0 (0)**	**T1 (5 g)**	**T2 (10 g)**	**T3 (15 g)**
Liver (%)	2.66±0.32	3.30±0.36	2.81±0.16	2.86±0.26	0.21
Heart (%)	0.20±0.03	0.21±0.04	0.23±0.06	0.25±0.02	0.66
Kidney (%)	0.69±0.01	0.78±0.10	0.70±0.14	0.75±0.10	0.84
Spleen (%)	0.05±0.00	0.05±0.00	0.06±0.01	0.05±0.02	0.81

$^{a.b.c:}$ *means with in arrow with different superscripts differ significantly (p<0.05).*

Table 5: Effect of dietary Zingiber officinale on faecal microbial populations of rabbits

Bacteria types	Inclusion level of ginger				
	T0 (0)	**T1 (5 g)**	**T2 (10 g)**	**T3 (15 g)**	**P value**
Total coliform	5.11±0.57	4.59±0.36	6.11±0.84	5.18±1.48	0.31
Clostridium spp	5.92±0.99	4.59±0.26	5.09±0.12	4.53±0.50	0.06

$^{a.b.c:}$ *means with in arrow with different superscripts differ significantly (p<0.05).*

Article DOI : https://doi.org/10.37284/eajab.7.1.1881

DISCUSSION

The results of this study indicate that dietary ginger powder hard positive effects on the growth characteristics of weaned rabbits. The result revealed a marked increase in the daily feed intake of rabbits fed ginger. This increase could be attributed to the potential of ginger powder proven to enhance feed palatability and also stimulate appetite (Choudhury, 2015). The higher feed intake in rabbits fed ginger powder maybe due to the enhanced palatability, flavour and test of the feed which might have improve the appetite of the rabbits hence stimulating better feed consumption. The improvement in intake from this study is accordance with the works of Adeniyi and Balogun (2002); Okoye *et al.* (2006*)* and Omage *et al.* (2007).

From the present study, the final live body weight of rabbits increased in the feed additive treatments compared to the treatment without ginger. These results agrees with those of Onu and Aja (2011) who recorded higher final live body weight with the addition of garlic and ginger and mixture of both spices compared to the control groups. Body weight gain also improved in groups given ginger in their diets compared to the control. This observation was also in close agreement with the reports of Okoye *et al.* (2006) and Zhang *et al.* *(*2009) who reported increased daily weight gain by supplementing ginger powder with broilers. However, these observations contradicts Omege *et al*, (2007); Ademola *et al* 2006) and those of Horton et al, (1991) who reported that addition of garlic and ginger did not improved the weight gain in broiler, sheep, and swine.

The increased weight gain observed from the ginger inclusion group suggests the positive beneficial growth promoting the synergistic effect of ginger powder. It could be suggested that ginger might have the effect of controlling and limiting the growth and colonization of pathogenic bacteria in the gut resulting to improve conversion of feed to flesh Reeds *et al*., 1993). The enhanced body weight gain of the rabbit showed a positive nutritive of the natural feed additive. Moreover, ginger powder has been shown to have beneficial effects in animal nutrition such as increasing and improving endogenous enzymes secretion, activation of immune response and antibacterial, antiviral, antioxidant and anthelminthic action. All these actions might have led to the improvement in health growth and performance of rabbits in this study (Rahimi *et al.*, 2011). Also, the active compounds present in ginger such as ginerol, gingerdiol and gingerdione with the ability to stimulate digestive enzymes and affect the pathogenic microbial flora in the small intestine which competes with the host for nutrients (Dieumou *et al.*, 2009)

Though FCR was slightly high in ginger groups, no significant effect was observed among treatments. This study closely agrees with Onu and Aja (2011) who found a higher feed efficiency compared with the control treatment. The better feed utilization in rabbits feed ginger in their diet could be attributed to the potential antifungal and antibacterial properties of this species which might have improve greatly the microbial flora and gut environment of the rabbits hence causing improvement in feed utilization

The findings of this present study on carcass characteristics of rabbits indicate no significant difference on carcass yield. These results are in agreement the findings of EL-Deek *et al*., (2002) who stated that the carcass yield in broilers were not affected significantly when fed diets with ginger inclusion compared with the control at 6 week. Onu (2010) demonstrated that inclusion of ginger powder did not significantly improved carcass traist in broilers. Also, findings of Erener *et al*., (2005) and those of Cabuk *et al*.,(2006) revealed that ginger powder and extract feed to broilers at different levels did not significantly affect their carcass characteristics at six weeks of age. According to the findings of this study, ginger inclusion did not affect significantly the relative weight of organs in rabbits

The number of Enterobacteria Spp in faecal samples of rabbits fed ginger at varying inclusion levels was not significantly affected, though numerical increases were observed in treatment with inclusions of ginger. These results contradict Bakht *et al*. (2013) who reported that herbs possess strong antimicrobial activities especially against gram (-) bacterial. The negative effect of ginger on gram-negative bacteria in this study could be attributed to the processing and perseveration method which may have led to a loss of some chemical and antimicrobial properties of this spice.

Regarding Clostridium spp, a Gram-positive bacterium, dietary ginger affected the faecal count as revealed by the low number of bacterial colonies formed in treatment with ginger inclusion when compared to the control treatment. This could be because of the active compounds present in ginger such as ginerol, gingerdiol and gingerdione with the ability to stimulate digestive enzymes and affect the pathogenic microbial flora in the small intestine which competes with the host for nutrients (Dieumou *et al*.,2009) This is in line with Reeds *et al*. (1993) who attributed the susceptibility of pathogenic gram-positive bacteria to the antibacterial components of ginger which is higher than the physiologically desirable intestinal bacteria.

CONCLUSION

The present study was carried out to evaluate the effect of dietary ginger powder on the growth performance and carcass characteristics and gut microbial population in weaned rabbits. The following conclusions were drawn with respect to the objectives of this study. The growth performance (feed consumption, live body weight, body weight gain and feed conversion ratio) of weaned rabbits were significantly enhanced by dietary. The best inclusions in this study were observed to be 0.5% ginger. The carcass yield and relative organs weights rabbits were not affected significantly even at the maximum concentration 1.5% for this study ginger showed no significant effect on gram-negative bacteria of rabbits but a reduction was observed on gram-negative bacteria clostridium spp. Therefore, ginger can be used and any concentration between 0.5 and 1.5% in the diet of rabbits to improve live weight and the growth of pathogenic gram (+) bacteria

REFERENCES

Ademola SG, Farinu GO, Obe AA and Babatunde GM. (2006). Growth, haematological and biochemical studies on garlic-and ginger-fed broiler chickens. *Moor Journal of Agricultural Research. 5(2): 122-128.*

Adeniyi AA and Balogun OO. (2002). Utilization of flavour-treated blood-rumen content mixture in the diets of laying hens. *Nigerian Journal of Animal Production*. 29(1): 34-39.

Bakht J., Khan S., Shafi M. (2013). Antimicrobial potentials of fresh Allium cepa against gram-positive and gram-negative bacteria and fungi. *Pakintain Journal of Botany* 45(S1): 1–6.

Botsoglou NA, Florou-Paneri E, Christaki E, Fletouris DJ and Spais BA. (2002). Effect of dietary oregano essential oil on performance of chickens and on iron-induced lipid oxidation of breast, thigh, and abdominal fat tissues. *British Poultry Science*. 43: 223-230.

Cabuk M, Bozkurt M, Alcicek A, Akbas Y, Kucukylmaz K (2006). Effect of an herbal essential oil mixture on growth and internal organ weight of broilers from young and old breeder flocks. *South African Journal of Animal Sciences*. 36:135-141.

Choudhury, J. E. (2015). Effects of addition of ginger root powder as a natural feed additive. *American Journal of Animal Science*, 14:45-49.

Dieumou FE, Teguia A, Kuiate JR, Tamokou JD, Fonge NB and Dongmo MC. 2009. Effects of ginger (*Zingiber officinale*) and garlic (*Allium sativum*) essential oils on growth performance and gut microbial population of broiler chickens. *Livestock research for rural development*. 21(8): 23-32.

Duwa H, Amaza IB, Dikko MI, Raymond JB, Paullyne UO (2020). Effect of ginger (*Zingiber officinale)* on the growth

Article DOI : https://doi.org/10.37284/eajab.7.1.1881

performance and nutrient digestibility of finisher broiler chickens in the semi-arid zone of Nigeria. Nigerian Journal of Animal Science, 22(3): 279-286.

El-Deek AA, Attia YA, Maysa M, Hannfy M (2002). Effect of anise (Pimpinella anisum), ginger (*Zingiber officinale Roscoe*) and fennel (*Foeniculum vulgare*) and their mixture on the performance of broilers. *Archieves of Geflugelkd* 67(2):92-96.

Erener G, Ocak N, Ak FB, Ve-Altop A (2005). Performance of broiler fed peppermint (Menthol) or organ (Carvacrol) essential oil supplemented diet. *Proceedings of 3rd National Congress of Animal Nutrition*. pp. 58-62.

Fathi M., Abdelsalam M., Al-homidan I., Ebeid T., El-zarei M., Abou-Eme- ra O. (2017). Effect of probiotic supplementation and genotype on growth performance, carcass traits, haematological parameters and immunity of growing rabbits under hot environmental conditions. *Animal Science journal* 88: 1644–1650; doi:10.1111/asj.12811

Horton GMJ, Fennell MJ and Prasad BM. (1991). Effect of dietary garlic (Allium sativum) on performance, carcass composition and blood chemistry changes in broiler chickens. *Canadian Journal of Animal Science*. 71(3): 939-942.

Hossian J, Kamruzzaman M, Akbar A, Haque A (2015) Feeding garlic powder on growth performance, nutrient digestibility and carcass characteristics of rabbit. 2:74–81.

Hy-Line. (2015). Hy-Line International Hy-Line W-36 commercial layers management guide.

Jubril TO. (2019). Growth performance and Digestibility in growing rabbits fed diet supplemented with powdered ginger. Asian Journal of Research in Animal and Veterinary Sciences, 4(4): 1-5.

Karangiya VK, Savsani HH, Patil SS, Garg DD, Murthy KS, Ribadiya NK, Vekariya SJ. (2016) Effect of dietary supplementation of garlic, ginger and their combination on feed intake, growth performance and economics in commercial broilers. *Veterinary World*, 9(3):245–250.

Khan RU and Naz S. (2013). The applications of probiotics in poultry production. World's Poultry Science Journal, 69 http://doi.org/10.1017/S0043933913000627.

Nasab M.E., Moslem B., Hamed A.P., Mahnaz A.H. and Jaafar E.N. (2015). Role of antibiotic in ruminant: Review. *World Journal of Clinical Pharmacology, Microbiology and Toxicology*, 1(1): 37-40.

Nweze B.O., Nwankwegu A.E. and Ekwe O.O. (2011). The performance of broiler chickens on African porridge fruit (*Tetrapleura tetraptera*) pod under different feeding regimes. *Asian Journal of Poultry Sciences*, 5(4): 144-149.

Odoemelam, V.U., Nwaogu, K.O., Ukachukwu, S.N., Esonu, B.O., Okoli, I.C., Etuk, E.B., Ndelekwute, E.K., Etuk, I.F., Aladi, N.O. and I.P. Ogbuewu (2013), Carcass and Organoleptic assessment of Broiler fed Ocimum gratissimum Supplemented diets. Proc. 38th Conf. Nig. Soc. Anim. Prod. 17-20th March, 2013, Rivers state Univ. of Sci. and Tech., Port Harcourt, 767-770.

Okoye F.C., Ugwuene M.C. and Mbarah J.U. (2006). Effects of local spices on the utilization of cassava peel meal-based diets by weaner rabbits. *Pakistan Journal of Nutrition* 5(3):203-20

Omage JJ, Onimisi PA, Adegbite EK and Agunbiade MO. 2007. The Effect of Ginger (ZingiberOfficinale Roscoe) Waste Meal on Growth Performance, Carcass characteristics, serum lipid and serum cholesterol profiles of rabbit. *Pakistan Journal of Nutrition*. 6(4): 359-362.

Article DOI : https://doi.org/10.37284/eajab.7.1.1881

Onu PN and Aja PM. 2011. Growth performance and haematological indices of weaned rabbits fed garlic (*Allium sativum*) and ginger (*Zingiber officinale*) supplemented diets. *International Journal of Food*, *Agriculture and Veterinary Science*. 1: 51-59.

Onu P. N. (2010) Evaluation of two herbal spices as feed additives for finisher broilers. *Biotechnology in Animal Husbandry*, 26: 383-392.

Rahimi S, TeymoriZadeh Z, Torshizi K, Omidbaigi R and Rokni H. 2011. Effect of the three herbal extracts on growth performance, immune system, blood factors and intestinal selected bacterial population in broiler chickens. *Journal of Agricultural Science and Technology*. 13: 527-539.

Reeds PJ, Burrin DG, Davis TA and Fiorotto ML. 1993. Postnatal growth of gut and muscle: competitors or collaborators. Proceedings of the Nutrition Society. 52(01): 57-67.

Steel R. G., and Torrie J. H. (1980).Principles and procedures of statistics. *McGraw Hill Book* C, New York 633 pp. Stevens, C.E. and Hume, I.D. (1995). Comparative physiology of the vertebrate digestive system, 2nd ed. Cambridge University Press, Cambridge, United Kingdom.

Windisch W., Schedle K., Plitzer C. and Kroismayr A. (2008). Use of phytogenic products as feed additives for swine and poultry. *Journal of Animal Science*, 86: 140-148.

Yadgar and Yavuz G. (2015). Sumac (*Rhus coriaria* L) and ginger (*Zingiber officinale)* as feed additives in poultry nutrition. KSU Journal of Natural Science, 18(3): 44-48.

Zeng Z., Zhang S., Wang H. and Piao X. (2015). Essential oil and aromatic plants as feed additives in non-ruminant nutrition: Review. *Journal of Animal Science And Biotechnology*, 6: 7.

Zhang GF, Yang ZB, Wang Y, Yang WR, Jiang SZ and Gai GS. (2009). Effects of ginger root (*Zingiber officinale*) processed to different particle sizes on growth performance, antioxidant status and serum metabolites of broiler chickens. *Poultry science*. 88(10): 2159-2166.

