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Effect of turmeric, garlic, ginger powder and their blends on growth performance and carcass yield of rabbits

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Abstract
Phytogenic additives are natural growth promoters that can be used as potential alternatives for common artificial growth promoters like antibiotics. Thus, this study was conducted to evaluate the effect of turmeric, garlic, ginger powder and their blends on growth performance and carcass yield of rabbits. Forty-eight (48) weaner rabbits (8 weeks old) were randomly allotted into eight dietary groups designated in a completely randomized design. The T1 contained 0g, T2- 3g of turmeric, T3- 3g of garlic, T4-3g of ginger, T5- 3g turmeric and 3g garlic, T6- 3g turmeric and 3g ginger, T7- 3g of garlic and 3g of ginger and T8- 2g turmeric, 2g garlic, 2g ginger. Data were collected for all the growth parameters and carcass yield. Result showed significant (p< 0.05) higher final body weight of the rabbits were recorded with rabbit fed diets containing 3g of Garlic and Ginger (2057.0g) while rabbit fed diets containing 6g Ginger (1339.5g) had lowest total weight gain. Rabbits fed 6g garlic had significant (p< 0.05) higher quantity of feed consumed per day (65.42g) while rabbit fed diet containing 3g turmeric and 3g garlic had the least value (55.05g). Rabbit group fed diet containing 3g turmeric and 3g garlic had significantly (p<0.05) lower value (0.10) of feed efficiency ratio while rabbits fed 3g garlic and 3g ginger utilized feed more efficiently (0.21). Rabbit fed diet with 6g garlic had highest (p<0.05) eviscerated and dressed weight of (1438.40g), (1204.7g) while lowest were recorded in rabbit fed 6g ginger (885.70g) and (733.3g) respectively. It was concluded that rabbits fed 3g of garlic and ginger blend had higher growth indices and carcass yield hence could be recommended for use by rabbit farmers.

Key words: *Rabbit, growth performance, Carcass, Turmeric, Garlic, and Ginger*

Introduction

The animal protein intake in Nigeria has been reported to be abysmally low due to high cost of livestock products resulting from rapid increase in the cost of most feedstuff (Sobayo et al., 2013). Larger proportion of Nigerian population depends mainly on red meat sources for animal protein supply (FAO, 2018) but this has proven to be grossly unhealthy. Substantial evidence from randomized trials and observational studies suggests that high consumption of red meat, especially processed red meat, is associated with an increased risk of mortality (Alshahrani et al., 2019) and major chronic diseases (Lo et al., 2020) including coronary heart disease (Micha et al., 2012). Rabbit, (Oryctolagus cunniculus) is one of the animals that can be reared successfully at family level. Rabbit is used as laboratory animal in the field of medicine research and biotechnological application (Chantry-Darmon, 2003) and can therefore be categorized as multi-purpose

animal for research and human uses. Rabbit meat is particularly advantageous in Western countries where people's diets are frequently high in fat and salt, posing health risks. The functional proteins in rabbit meat has been recognized as some of the best quality proteins that offer a well-balanced amino acid profile (Cardinali et al., 2015). The advantages of rabbit meat have made it one of the most promising nutritious meals, and as a result, the rabbit business has attracted a lot of attention recently (El-Adawy et al., 2020). In addition, meat from rabbits has lower levels of salt, fat, cholesterol (59 mg/100 g of muscle), and calories (789 kJ/100 g meat) than meat from other animals. It also has no uric acid and a low purine level while most of the energy comes from proteins (Dalle Zotte and Szendrõ, 2011).

Phytobiotics are plant derived products added to the livestock feeds to improve performance. Leaves, roots, flowers, and the whole plants are used for production of phytobiotic products. Phytobiotics are natural growth promoters (NGPs) identified as effective alternative to antibiotics and synthetic preservatives (Panda *et al.*, 2009) and used in nutritionally insignificant quantities as a food additive for flavor and sometimes as preservative to kill or prevent the growth of harmful bacteria (Adamson, 2004).

Turmeric (*Curcuma longa*) is an important herb and spice in Indian Ayurvedic medicine. Curcumin, the main active compound in turmeric could inhibit lipid peroxidation and scavenge the superoxide anion and hydroxyl radicals (Amadi, 2010) and possess anti-carcinogenic, antibacterial (De *et al.*, 2009), anti-inflammatory and cholesterol lowering properties (Jurenka, 2009). Garlic (*Allium sativum*) contains significant quantity of insulins and fructo-oligosaccharides while its functional and biological responses are reported to include reduction of risk factors of cardiovascular diseases, stimulation of immune function, detoxification, cholesterol-lowering, anti-stress factor (Amagase *et al.*, 2001).

Garlic ethanolic extract was found to be most effective in inhibiting the microbial growth (Baljeet *et al*., 2015) and in the same vein, Brzoska *et al.* (2015) reported reduction in bird mortality, increased feed intake, improved dressing percentage and carcass parameters, higher crude protein and ash content of breast meat as well as improved immune system in broiler groups fed garlic extract.

Similarly, ginger (*Zingiber officinale*), a spice used globally especially in most of the Asian countries and has been reported to contain gingerol and other phenolic compounds noteworthy of improving meat quality (Olatidoye *et al*., 2015). The antioxidant capacity of ginger was however highlighted to increase meat shelf-life due to its ability to delay lipid oxidation of meat samples during storage at 4^0C (Mancini *et al*., 2018). These exemplary phytobiotics (garlic, ginger and turmeric) have substantial evidence of beneficial effects on livestock by decreasing certain diseases caused by immune dysfunction, controls oxidation of low density lipoproteins (LDL), inhibits formation of arterial plaque, platelet aggregation and immunomodulation and improves feed consumption, growth performance and FCR (Shewita and Taha, 2018), induces marked reduction in serum glucose concentration, total cholesterol and abdominal fat (Karim *et al*., 2017), increases total white blood cells (Fadlalla *et al*., 2010), inhibits total bacteria growth, improve meat colour indices (Mancini *et al*., 2018), decreases meat redness but increases muscle pH and yellowness in stored fresh meat products (Olatidoye, 2015). Turmeric, garlic and ginger have been studied for their

antioxidant and antimicrobial properties in dietary supplementation and in food preservation (Mancini, *et al*. 2017), however, there is dearth of information on the cumulative effects of these phytobiotics on finished meat products when fed to meat animals and owing to variation in the composition of their constituents, there is need for combination to enhance stability, establish complementary action for optimal growth performance and carcass yield of rabbit therefore necessitates the present study.

Materials and methods

The experiment was conducted at Cuniculture facility of Federal College of Agriculture Livestock Farm, Institute of Agricultural Research and Training, Ibadan, Oyo State, Nigeria. Turmeric rhizome, garlic and ginger was cut to increase the surface area and make grinding easy and enhance its colour and flavour. Thereafter, the boiled turmeric was air dried for 10 days and milled into fine powder according to the method described by Jayaprakasha *et al.* (2005) and stored in airtight container until use. A total of 48 eight weeks old weaner rabbits were used for the study and were randomly allotted into eight dietary groups designated T1 to T8 in a completely randomized design (CRD) with each treatment having three replicates of two rabbits each. T1 (control) is 0g, T2- 6 unsexed rabbit fed diet containing of 6g of turmeric (Tr) in the diet, T3- 6 unsexed rabbit fed diet containing of 6g of garlic (Ga) in the diet, T4- 6 unsexed rabbit fed diet containing of 6g of ginger in the diet (Gn), T5- 6 unsexed rabbit fed diet containing of 3g of turmeric and 3g of garlic (TrGa) in the diet, T6- 6 unsexed rabbit fed diet containing of 3g of turmeric and 3g of ginger (TrGn) in the diet, T7- 6 unsexed rabbit fed diet containing of 3g of garlic and 3g of ginger (GaGn)in the diet, and T8- 6 unsexed rabbit fed diet containing of 2g of turmeric, 2g of garlic and ginger (TrGaGn) in the diet. Data were collected on growth performance parameters and carcass yield.

For growth performance, rabbits were weighed individually at the beginning of the experiment and subsequently on weekly basis using a digital weighing scale. Weight gain was determined by calculating the difference between the final body weight and the initial body weight. Weekly records of average feed consumed were taken for each treatment and per replicate. Leftover feed was subtracted from the total feed given to the rabbits to determine feed intake. Feed Efficiency (FE) was calculated as weight gain (g) per feed intake. At the end of the (12^{th}) week of the experiment, three (3) rabbits per treatment whose weights were close to the average weight of each treatment were used for carcass studies. They were fasted for twelve (12) hours to empty their gastrointestinal tract (GIT) and reduce contamination of carcass. The carcass was cut into retail parts (forelimb, hind limb, chest, neck, loin, back, head and tail) and then weighed with a sensitive electronic weighing scale. The weight of the liver, kidney, heart, lung, and spleen were also taken. The primal cut up parts and organs were expressed as percentage of live weight. Dressing percentage was determined as dresses weight over live weight multiplied by 100.

Data collected on performance and carcass yield were analysed using ANOVA as contained in SAS (2002). Significant means were separated using Duncan Multiple Range Test as contained in SAS (2002).

Table 1: Effect of Dietary Phytobiotics on Growth Performance of Rabbits

	Experimental Diets									
Parameters	Control	6gTr	6gGa	6gGn	3gTrGa	3gTrGn	3gGaGn	2gTrGaGn	SEM	P-value
Initial weight (g)	863.30	980.20	990.00	855.70	874.20	894.50	947.70	990.00	97.32	0.820
Final weight (g)	1380.83^{cd}	1658.33^{bcd}	1841.33^{ab}	1339.50^{d}	1318.67^{d}	1704.00^{abc}	2057.00^{a}	1690.83^{ab}	104.15	0.001**
Total weight gain (g)	517.53^{d}	678.13^{bc}	851.33^{b}	483.80^{cd}	444.47^{cd}	809.50^{ab}	1109.30^{a}	700.83^{c}	91.99	0.007**
Daily weight gain (g)	7.26^{bcd}	8.07^{bcd}	10.91^{ab}	5.76^{cd}	5.29^{d}	9.64^{abc}	13.21^{a}	8.70^{abcd}	1.00	0.006**
Daily feed intake (g)	57.31^{c}	54.04^{d}	65.42^{a}	50.82^{e}	55.05^{d}	65.18^{a}	64.29^{a}	62.81^{b}	0.60	0.000**
Feed efficiency ratio	0.13^{bc}	0.15^{bc}	0.17^{b}	0.13^{bc}	0.10^{c}	0.15^{bc}	0.21^{a}	0.14^{bc}	0.96	0.002**

^{a,b,c,d,e} Mean in the same row with different superscripts differ significantly ($P<0.05$); **: Significant difference at 1% ($P<0.01$)

KEYS: Control: Basal diet, 6gTr- Basal diet + 6g/kg of turmeric powder, 6gGa- Basal diet + 6g per kg garlic powder, 6gGn- Basal diet + 6g per kg ginger powder, 3gTrGa- Basal diet + 3g each per kg of turmeric and garlic powder, 3gTrGn- Basal diet + 3g each per kg of turmeric and ginger powder, 3gGaGn- Basal diet + 3g each per kg of ginger and garlic powder, 2gTrGaGn- Basal diet + 2g per kg each of turmeric, ginger and garlic powder.

Table 2: Effect of Dietary Phytobiotics on Carcass Yield of Experimental Rabbits

	Experimental Diets									
Parameters (g)	Control	6gTr	6gGa	6gGn	3gTrGa	3gTrGn	3gGaGn	2gTrGaGn	SEM	P-Value
Live weight	1567.00	1988.67	1971.67	1294.00	1491.67	1686.67	1857.70	1863.33	134.24	0.254
Bled weight	1530.00^{bc}	1897.70^{ab}	1912.70^{a}	1263.00^{c}	1455.70^{bc}	1633.30^{abc}	1801.70^{ab}	1820.00^{ab}	128.79	0.025*
Singed weight	1448.00^{bc}	1832.00^{ab}	1897.30^{a}	1107.00^{c}	1396.00^{bc}	1569.70^{ab}	1732.00^{ab}	1723.30^{ab}	112.35	0.008**
Carcass yield										
Eviscerated weight (g)	1098.00^{abc}	1370.30^{ab}	1438.30^{a}	885.70^{c}	1017.70^{bc}	1147.30^{abc}	1315.70^{ab}	1310.00^{ab}	101.56	0.032*
Dressed weight (g)	869.01^{ab}	1150.70^{a}	1204.70^{a}	733.30^{b}	840.00^{ab}	931.00^{ab}	869.70^{ab}	1089.00^{ab}	97.55	0.084
Dressing percentage (%)	55.59	57.79	58.34	58.12	57.25	55.10	47.73	58.26	3.56	0.382
Cut-up parts (% Dressed weight)										
Head	8.45	7.66	7.79	8.54	8.47	7.99	8.27	8.18	0.42	0.863
Fore limb	10.12	11.11	10.93	11.41	10.64	10.13	10.38	8.89	0.84	0.765
Hind limb	17.01^{ab}	20.12^{a}	16.65^{ab}	16.79^{ab}	16.09^{ab}	14.87^{b}	14.53^{b}	14.28^{b}	1.17	0.141
Chest	9.46	9.77	8.68	10.78	9.36	9.24	10.95	10.90	1.55	0.711
Neck	1.57	1.98	1.75	1.82	1.73	2.25	2.27	2.17	0.22	0.539
Loin	4.92	5.19	5.99	6.07	5.88	5.16	6.27	6.95	0.85	0.858
Back	11.95^{ab}	11.51^{ab}	13.49^{ab}	10.62^{b}	11.97^{ab}	12.52^{ab}	13.82^{a}	13.58^{ab}	0.85	0.245
Tail	0.34	0.50	0.50	0.45	0.43	0.48	0.44	0.48	0.09	0.812

^{a,b,c,d} Means in the same row with different superscripts differ significantly (0<0.05)

KEYS: Control: Basal diet, 6gTr- Basal diet + 6g/kg of turmeric powder, 6gGa- Basal diet + 6g per kg garlic powder, 6gGn- Basal diet + 6g per kg ginger powder, 3gTrGa - Basal diet + 3g each per kg of turmeric and garlic powder, 3gTrGn- Basal diet + 3g each per kg of turmeric and ginger powder, 3gGaGn- Basal diet + 3g each per kg of ginger and garlic powder, 2gTrGaGn - Basal diet + 2g per kg of turmeric, ginger and garlic powder.

Results and Discussion

The effect of phytobiotic additive on the growth performance of the experimental rabbits is presented in Table 1 and the results obtained show significant ($p<0.05$) differences on the growth parameters measured across the treatment groups. Phytobiotics significantly ($p< 0.05$) affected the final body weight of the rabbits. Rabbit group fed experimental diet 3gGaGn utilizes the diet better and had a complementary better final weight of (2057.00g) when compared to rabbit group fed 3gTrGa with the highest total weight gain of 1109.30g. Similarly, rabbit group fed experimental diet 3gGaGn significantly ($p<0.05$) gained more weight both in the total and average daily weight (1109.30g and 13.21g respectively) than all other treatment groups while 3gTrGa had the lowest total weight gain and average daily weight gain of 444.47g and 5.29g respectively. Rabbit group fed 6gGa and 3gTrGn consumed significantly ($p<0.05$) larger quantity of feed per day (65.42g and 65.18g) respectively, however, a comparable average daily feed intake was recorded in rabbits from the other four dietary groups. Nevertheless, rabbit group fed 6gGn consumed a significantly ($p<0.05$) lower quantity (50.82) of feed daily while rabbits maintained on 3gGaGn was able to utilize feed consumed efficiently when compared with animals in other treatment groups and it has a feed efficiency of 0.21 which was significantly ($p<0.05$) higher than other rabbit groups. Rabbits maintained on 3gTrGa had the least (0.10) feed efficiency ratio. The enhanced body weight observed in this study strengthens the findings of Ademola *et al*. (2009) who reported significant increase in body weight gain of rats and broilers fed a mixture of garlic and ginger respectively. This result also corroborates the report of Rahimi, *et al.* (2011) and Issa and Omar (2012) that garlic when fed alone had no significant effect on body weight however, a resultant improved weight gain was produced when garlic was combined with ginger in 3gGaGn. The results of this trial also buttress the report of Gheisar *et al*. (2015) that supplementing broiler diet with combination of phytobiotic feed additives led to a 3.9 and 3.4% improvement in body weight gain and FCR, respectively. The relative and synergetic growth-promoting effects of garlic/ginger blend reported in this present study was consistent with earlier assertion of Pullaiah (2011) that majority of the plant materials are stable, but their various constituents are photo or thermo labile and are limited in action due to plant species, soil type, location, weather condition, harvesting procedure, storage conditions among others which may affect their composition and potency of active ingredients (Vispute, 2019) and this suggests the use of more than one combination as being more efficient than just a single plant species (Jamroz, 2001). Similarly, this result overrides the conclusion of Ahmed *et al*. (2002) that 1% garlic powder is sufficient to significantly improve total body weight, daily weight gain and feed conversion ratio in rabbit rations. The enhanced average daily feed intake (ADFI) observed in rabbits maintained on 6gGa with the comparable value recorded in 3gTrGn diets could be because of garlic and ginger additives that can control the microbiota which therefore improve digestive efficiency or immune status, and thus digestive health, resultantly improving the appetite of the rabbits and stimulate water and feed intake. According to Gregacevic *et al*. (2014), adding phytobiotics to monogastric feed reduces immune stress through anti-inflammatory and antioxidant activity, antimicrobial, antiviral, and anticoccidial effects. It also increases intestinal availability for absorption of essential nutrients by

improving feed intake and flavor, stimulating the secretion of digestive enzymes, and promoting motility of the stomach and intestine. The highest feed intake in 6gGa may be attributed to the fructans of short-chain length called the fructo-oligosaccharides present in garlic, which consequently stimulates an increase in feed intake due to their mild sweet taste hence desirable enough to even replace sugars (Venkatesh, 2018). Additionally, garlic also contains a compound called ally methyl sulfide which gives garlic a distinctive characteristic aroma which happens to be the rabbit's favorite. It is therefore evident that rabbits found the feed even more palatable as the dietetic inclusion levels of garlic increases to 6g per kg thereby increasing feed intake as well. The present findings agreed with that of Chimbaka and Walubita (2020) who supplemented rabbit diets with 0.3%, 0.6%, and 0.9% garlic powder and recorded improved feed intake and feed conversion ratio as the inclusion rate increases and then postulated that higher inclusion levels of garlic powder in rabbit feed can further enhance feed consumption and growth parameters of the rabbits. Similarly, turmeric, and ginger blend synergetic effect on feed consumption recorded in 3gTrGn could be due to presence of two noteworthy chemicals, curcumin and curcuminoids in turmeric as well as the antioxidant composition which are beneficial on duodenum and intestinal morphology by maintaining a healthy gut microbial environment that promotes better feed consumption and utilisation as evidenced by an enhanced feed conversion ratio by preventing and restricting the development and colonization of various pathogenic and non-pathogenic species of bacteria (Durrani *et al*., 2006).

The effect of dietary phytobiotics on carcass yield of rabbits is shown in Table 2. Rabbits fed 6gGa had the highest significant ($p<0.05$) carcass yield with its bled and singed weight of 1912.7g and 1897.3g respectively while 6gGn was observed to have the least bled and singed weight of 1263.0g and 1107.0g respectively. Carcass yield relating to eviscerated weight and dressed weight values were also determined and the rabbits fed 6gGa had the highest eviscerated and dressed weight of 1438.4g and 1204.7g respectively ($p<0.05$) while lowest eviscerated weight and dressed weight of 885.7g and 733.3g were recorded in rabbits fed 6gGn. However, the hindlimb of rabbits fed 6g turmeric had an increase ($p>0.05$) in weight (20.12g) while comparable hindlimbs weight was recorded from 3gTrGn, 3gGaGn and 2gTrGaGn with weights of 14.87g, 14.53g, 14.28g respectively ($p>0.05$). The back cut of 3gGaGn had the heaviest weight of 13.82g followed by 13.58g obtained at 2gTrGaGn while rabbit with the lowest back cut weight of 10.62g was found in 6gGn. The present study affirmed that garlic powder at 6g/kg inclusion level significantly influenced the edible carcass parts of the rabbits and this improvement in the carcass yield of the rabbits could be attributed to the antibacterial and antifungal properties of garlic which might have improved the microflora and gut environment of the rabbits resulting in improved feed utilization and meat yield value. This result agrees with that of Raeesi *et al*. (2010) who observed a substantial influence on the carcass parts of broilers given garlic, The result also buttress the findings of Mancini *et al*. (2018), using 4 g and 8 g of ginger in the diet, who reported no effects of ginger treatment on carcass quality. Although several other plants have been used in rabbit feed in previous studies, in general, no effects on carcass quality have been found. Highest dressed weight was recorded in both rabbit groups fed 6gTr and

6gGa. This result agrees with the study of Elagib *et al*. (2013) who reported that 3% garlic supplement had positive effects on hot weight, breast weight, dressed weight, fleshed breast weight, and fleshed breast percentage of broiler chicken. Issa and Omer, (2012) also affirmed that garlic powder and humic acid had positive effect on carcass weight compared to the control group. The result is also in line with Saiyed *et al*. (2015) who reported that 0.5% and 3% garlic supplement had effects on some body parts of broilers and recommended higher inclusion levels. Significant dietary influence was observed on percentage weight of the hindlimb and the back cuts of dressed rabbits. Group fed 6gTr had the heaviest hindlimb percentage and this increase in hindlimb weight may be due to optimum antioxidant activity of turmeric (*Curcuma longa*) that stimulate protein synthesis by rabbit enzymatic system. This result agreed with the findings of Salih (2013) who reported highest percent of breast and thigh in 7 g turmeric powder / kg diet on broiler chicken. Similarly, rabbit groups maintained on 3gGaGn diet had the heaviest back cut percentage. This result partially agreed with the report of Raeesi *et al*. (2010) that feeding garlic for whole of the experiment resulted in higher thigh yield of broiler chicken but was at variance with the findings of Emmanuel and Ochefu (2020) that ginger root powder showed no variation in the mean values of the body weight and carcass parameters measured.

Conclusion

The study showed that rabbits fed a combination of 3g of each garlic and ginger had higher growth indices as well as carcass yield, to reap better beneficial effects the inclusion of 3g garlic and 3g ginger blend in the diets of rabbits is therefore recommended for farmers.

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