GROWTH AND HAEMATOLOGICAL PARAMETERS OF GROWING MALE RABBITS FED GINGER, GARLIC AND ONION SUPPLEMENTED DIETS

[1*]Ajao, B. H. and [2]Ola, S. I.

[1]Department of Animal Production, University of Ilorin, Ilorin, Nigeria

[2]Department of Animal Sciences, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria

*Corresponding author: ajao.bh@unilorin.edu.ng

ABSRACT

Proximate and phytochemical analysis of ginger, garlic and onion were carried out to determine their moisture (MC), crude protein (CP), crude fibre (CF), ether extract (EE), ash, nitrogen free extract (NFE), flavonoid and alkaloid content. Fifty - five male rabbits were allocated to ten experimental diets including a basal diet with no spices and three each for ginger, garlic and onion at 5g, 10g or 15g/kg feed to determine the effect of the test species on the growth and haematology of the growing male rabbit. Feed intake, weight gain, feed conversion ratio and haematological parameters were monitored. Flavonoid, alkaloid, MC, CP, CF, EE, ash and NFE were significantly different ($p<0.05$) among the three spices. Total feed intake (2867.10g - 3575.80g) similar to average weekly and daily feed intakes were significantly higher ($p<0.05$) in the control and onion supplemented groups compared to the others. Weight gain was significantly higher ($p<0.05$) in group fed garlic at 10 and 15g/kg compared to those fed lower and medium dosages of ginger (5g/kg feed) and onion (5 - 10g/kg feed). FCR was significantly lower ($p<0.05$) between the group fed garlic at 10g/kg compared to other experimental treatments which were statistically similar. Spice supplementation regardless of level of inclusion had no effect on the haematological indices of the rabbit bucks. However, RBC was significantly ($p<0.05$) lower at the end of the experiment while MCV and MCH were higher. The findings of the study revealed that the spice supplemented diets especially that of garlic sustained the weight of the rabbit bucks and were not deleterious to the health of the animals.

Keyword: Spice, Weight Gain, Haematology, Supplemented Diets, Male Rabbit.

INTRODUCTION

Rabbit production has the potential to considerably reduce chronic protein malnutrition especially in Sub-Sahara Africa. This is due to the rabbit short production cycle, large litter size, fast growth and its ability to thrive on poor nutrition. However, poor quality feed have been identified as a major constraint to viable rabbit industry (Oseni, 2010). In addition, high temperature which is prevalent in the tropics depresses feed consumption and ultimately weight gain (Okab *et al*., 2008). Hence, in order to provide adequate nutrition to the rabbit for optimal gain, the twin problem of provision of high-quality feed and its sufficient consumption by the animal have to be resolved. Since the use of antibiotics as growth promoters is being proscribed worldwide, attention had turned to natural feed additives which include spices and other plant materials (Platel and Sirinivasan, 2004). Spices such as ginger, garlic and onion due to their phytochemicals such as flavonoids and alkaloids have inherent capability to improve feed flavour, palatability and consumption (Srinivasan, 2016). Their antimicrobial activities which influence gut microbial populations have been shown to aid efficient feed utilisation in poultry nutrition (Puvaˇca *et al*., 2013). However, information on the effect of these spices on rabbit nutritional performance and haematology, especially in Nigeria, is few and needs further elucidation. Hence, this work studied the effect of ginger, garlic and onion dietary supplementation on growth and haematological parameters of growing rabbits with a view to improve rabbit feed intake, weight gain, feed conversion and its overall welfare.

MATERIALS AND METHODS

The experiment was conducted at the Rabbitary Unit of the Teaching and Research Farm, Obafemi Awolowo University, Ile – Ife, Nigeria. The nutritional trial lasted for 8 weeks in the wet season (May - June). Rabbit bucks averagely aged 6 months with body weight ranging between 0.6kg and 1kg were sourced from reputable farms. Fresh ginger, garlic and onion were purchased from a vegetable market in Ilorin, Kwara State, Nigeria. The sample of garlic, ginger and onion were identified and confirmed with vouchers numbered 17735, 17736 and 17737 respectively at the Herbarium, Department of Botany, Obafemin Awolowo University, Ile - Ife. The spices were washed, peeled, sliced into chips and air-dried for 10 days. The dried chips were ground into powder by the use of a Binatone grinder. The powdered test ingredients and the experimental basal feed which was formulated to meet the nutritional requirements of grower rabbits (Table 1) were analysed for proximate composition using the methods of AOAC (2002). The powdered spices were incorporated into the basal feed to form 10 experimental diets. The basal diet's digestible energy (DE) was calculated using the formula;

DE = 3330 - 46.80CF (Kcal/kg)

(Lebas and Gidenne, 2000); Where CF = Crude Fibre. The quantity of flavonoid and alkaloid in each of the spices were also determined using the procedures of Zhilen *et al.* (1999) (described by Miliauskas *et al.*, 2004) and Shamsa *et al.* (2008). Feed intake was determined daily by subtracting the amount of left over feed from the amount of feed supplied to the animals. The weight of each of the bucks was determined by the use of electronic balance at weekly interval. On the day the weight was taken, it was carried out before feeding the buck in the morning. Feed conversion ratio was calculated as the ratio of feed intake to weight gain. Two millilitres of blood samples were collected from from the marginal vein of the experimental animals' ears into ethylene diamine tetra- acetic acid (EDTA) coated collecting tubes in week 0 and 8 of the study. Haematological parameters which include red blood cell, packed cell volume, haemoglobin concentration, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, mean corpuscular volume were determined as described by Jain (1986). White blood cell count was determined by the method described by Ewuola and Egbunike (2008). Data was analyzed using factorial analysis of variance. Probability value of 5% was considered statistically significant after separation by Duncan Multiple Range Test using SPSS version 17.0 software.

Table 1: Composition of experimental basal diet

Ingredient	Quantity (kg)
Maize	37.00
Brewers' dry grain	21.50
Rice bran	24.50
Groundnut cake	14.00
Bone meal	2.00
Salt	0.20
Vitamin premix	0.30
Lysine	0.30
Methionine	0.20

RESULTS

The results of proximate analysis of the spices are presented in Table 2. Garlic had significantly lower ($p<0.05$) MC compared to ginger and onion that had similar MC. Crude fibre (CF) was significantly higher ($p<0.05$) in ginger than onion and garlic. Crude protein (CP) was significantly different ($p<0.05$) among the spices with ginger having the highest value followed by onion and garlic respectively. Ether extract (EE) was significantly higher ($p<0.05$) in onion than in garlic and ginger both of which has statistically similar values. Ash content ranged from 3.97% (onion) to 7.09% (ginger) and was significantly different ($p<0.05$) among the three spices. The NFE content was significantly different ($p<0.05$) among the spices and ranged from 50.15% in ginger to 74.70% in garlic. Flavonoid and alkaloid contents were significantly different ($p<0.05$) among the three spices and ranged from 189.73 mgQE/g (ginger) to 840.00 mgQE/g (onion) for flavonoid and 16.86 mgAE/g (ginger) to 194.07 mgAE/g (onion) for alkaloid. The proximate composition of basal experimental diet (Table 3) as revealed by proximate analysis was, MC: 9.94%, CP: 17.09%, CF: 11.38, EE: 3.90%, Ash: 13.52 and NFE: 44.17%.

Table 2: Proximate (dry matter) and phytochemical composition of garlic, ginger and onion

Parameter	Garlic	Ginger	Onion
Moisture (%)	9.68 ± 0.05[b]	11.73 ± 0.27[a]	12.31± 0.36[a]
Crude protein (%)	5.02 ± 0.44[c]	26.03 ± 0.01[a]	7.00 ± 0.02[b]
Crude fibre (%)	2.23 ± 0.08[b]	3.27 ± 0.07[a]	1.98 ± 0.01[b]
Ether extract (%)	1.88 ± 0.09[b]	1.75 ± 0.08[b]	4.05 ± 0.27[a]
Ash (%)	6.50 ±0.05[b]	7.09 ± 0. 10[a]	3.97 ± 0.06[c]
NFE (%)	74.70 ± 0.42[a]	50. 15 ± 0.38[c]	70.69 ± 0.68[b]
Flavonoid*	228.04±6.23[b]	189.73±6.23[a]	840.00±6.23[c]
Alkaloid*	118.18±1.16[b]	16.86±1.16[a]	194.07±1.16[c]

[abc] Means with different superscripts within the row are significantly different ($p<0.05$)

Table 3: Proximate analysis of basal experimental diet

Parameter	Composition (%)
Moisture	9.94
Crude protein	17.09
Crude fibre	13.38
Ether extract	3.90
Ash	13.52
Nitrogen free extract	44.17
Digestible energy (kcal/kg) *	2797.42

* = calculated value

There were significant effects of spices, spices' levels and their interaction on feed intake (Table 4). Unlike feed intake, there was no significant ($p>0.05$) effect of the interaction of spices and their level of inclusion on weight gain (Table 4).

The effect of experimental factors and their interactions on the haematological indices of the rabbit bucks is presented in Table 6. Spices and their inclusion level had no significant effect on the haematological parameters of the bucks. Only the period of the experiment had significant effect ($p<0.05$) on red blood cell (RBC), mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH). RBC (5.71 - 4.86 x 10^6/mm^3) was depleted at the end of the experiment while MCV (50.19 - 66.15fl) and MCH (28.36 - 32.89pg) values increased.

Table 4: Effects of spices and spice levels on the feed intake, weight gain and feed conversion ratio of experimental rabbit bucks fed spice – supplemented diets

Factor	Parameter						
Spice (S)	ADFI(g)	AWFI(g)	TFI(g)	ADWG(g)	AWWG(g)	TWG(g)	FCR
Ginger	72.33	607.56	3037.79	8.44	59.06	354.33	11.18
Garlic	77.22	648.61	3243.06	11.40	79.78	478.67	7.81
Onion	81.67	686.00	3430.00	8.02	56.16	336.93	13.17
Spice level (SPL)							
5g/kg	73.84	620.22	3101.09	7.27	50.91	305.47	12.78
10g/kg	77.61	651.94	3259.69	9.77	68.38	410.27	10.96
15g/kg	79.76	670.02	3350.07	10.81	75.70	454.20	8.42
				Probability			
S	0.02	0.01	0.01	0.03	0.03	0.03	0.11
SPL	0.03	0.03	0.03	0.03	0.03	0.03	0.22
SP*SPL	0.02	0.01	0.01	0.86	0.86	0.86	0.50

ADFI= Average daily feed intake; AWFI= Average weekly feed intake; TFI= Total feed intake; ADWG= Average daily weight gain; AWWG= Average weekly weight gain; TWG= Total weight gain; FCR= Feed conversion ratio; *= interaction

Table 5: Effect of spice supplemented diets on feed intake, weight gain and feed conversion ratio of experimental rabbit bucks

TREAT	TREAT LEVEL(g/kg)	TFI(g)	AWFI(g)	ADFI(g)	TWG(g)	AWWG(g)	ADWG (g)	FCR
Zero spice	0	3575.8^{d}	715.16^{d}	85.14^{d}	397.80^{ab}	66.30^{ab}	9.47^{ab}	9.40^{ab}
Ginger	5g	2891.1^{a}	578.23^{a}	68.84^{a}	261.80^{a}	43.63^{a}	6.23^{a}	15.92^{ab}
	10g	3039.9^{ab}	607.99^{ab}	72.38^{ab}	387.00^{ab}	64.50^{ab}	9.21^{ab}	9.79^{ab}
	15g	3182.2^{abc}	636.45^{abc}	75.77^{abc}	414.20^{ab}	69.03^{ab}	9.86^{ab}	7.82^{ab}
Garlic	5g	2867.1^{a}	573.42^{a}	68.26^{a}	361.20^{ab}	60.20^{ab}	8.60^{ab}	9.33^{ab}
	10g	3389.1^{cd}	677.82^{cd}	80.69^{cd}	530.80^{b}	88.47^{b}	12.64^{b}	6.66^{a}
	15g	3472.9^{cd}	694.59^{cd}	82.69^{cd}	544.00^{b}	90.67^{b}	12.95^{b}	7.44^{ab}
Onion	5g	3545.0^{d}	709.00^{d}	84.40^{d}	293.40^{a}	48.90^{a}	6.99^{a}	13.07^{ab}
	10g	3350.0^{bcd}	670.00^{bcd}	79.76^{bcd}	313.00^{a}	52.17^{a}	7.45^{a}	16.41^{b}
	15g	3395.0^{cd}	679.00^{cd}	80.83^{cd}	404.40^{ab}	67.40^{ab}	9.63^{ab}	10.01^{ab}
SEM		46.11	9.22	1.10	22.60	3.77	0.54	0.95

^{abcd}Means with different superscript are significantly different within the column($p<0.05$)

TREAT = Treatment; TFI=Total feed intake; AWFI=Average weekly feed intake; ADFI=Average daily feed intake; TWG=Total weight gain; AWWG=Average weekly weight gain; ADWG=Average daily weight gain

Table 6: Effects of spices, spice levels and stage of experiment on the haematological parameters of experimental rabbit bucks fed spice – supplemented diets

Factor	Parameter						
	RBC	PCV	Hb	MCV	MCH	MCHC	WBC
Period of experiment (PT)	(10^6/mm^3)	(%)	(g/dl)	(fl)	(pg)	(g/dl)	(10^3/mm^3)
Wk 0	5.71	27.54	15.41	50.19	28.36	60.60	6.53
Wk 8	4.86	30.76	15.26	66.15	32.89	49.94	6.32
Spice (SP)							
Ginger	4.76	28.72	15.06	63.63	33.22	54.72	6.18
Garlic	5.57	30.19	15.94	55.62	29.53	53.88	6.18
Onion	5.52	28.53	15.00	55.26	29.12	57.21	6.90
Spice level (SPL)							
5g/kg	5.05	28.47	15.39	59.41	32.23	57.19	6.52
10g/kg	5.41	28.22	15.17	54.54	29.41	59.91	6.41
15g/kg	5.39	30.75	15.44	60.56	30.23	50.72	6.35
				Probability			
PT	0.03	0.07	0.70	0.02	0.04	0.05	0.78
SP	0.09	0.65	0.27	0.36	0.21	0.81	0.36
SPL	0.58	0.38	0.90	0.62	0.51	0.34	0.96
SP*PT	0.49	0.71	0.57	0.42	0.18	0.47	0.29
SPL*PT	0.09	0.21	0.23	0.22	0.23	0.51	0.96
SP*SPL	0.75	0.96	0.90	0.97	0.87	0.97	0.20
SP*SPL*PT	0.78	0.99	0.73	0.94	0.99	0.97	0.76

RBC= Red blood cell; PCV= Packed cell volume; Hbc= Haemoglobin concentration; MCV= Mean corpuscular volume; MCH= Mean corpuscular haemoglobin; MCHC= Mean corpuscular haemoglobin concentration; Wk= Week; *= interaction.

DISCUSSION

Moisture content (MC), crude protein (CP), crude fibre (CF), ether extract (EE), ash and nitrogen free extract (NFE) were significantly different ($p<0.05$) among the three spices which was similar to the report of Otunla *et al.*, 2010. MC in this study ranged from 9.68% (garlic) to 12.31% (onion) which was higher than the reports of Otoikhian *et al.*, 2014, Otunla *et al.*, 2010 and Nwinuka *et al.*, 2005 while it was lower than the findings of Marina *et al.*, 2005, Odebunmi *et al.*,2 010 and Bhattacharjee *et al.*, 2013. Moisture content in the spice determines how well it would keep in storage because it influences several biochemical and physiological process (Onwuka, 2005, Guisseppe and Baratta, 2000). Though CF adds to the bulk of feed and enhances digestion and nutrient utilisation, the amount observed in this study (1.98% - 3.27%) coupled with their level of inclusion in feed may not contribute significantly to fibre level of the feed. However, it is a boost for the spices' utilisation since they are mostly used in animal feed as a source of flavour and phytochemicals (Ameh *et al.,* 2016).

Ginger, in this study had the highest crude protein, 26.03%, which is higher than the value reported by many researchers (Otoikhian *et al.*, 2014; Odebunmi *et al.,* 2010, Otunla *et al.*, 2010 and Nwinuka *et al.,* 2005) while it is similar with the findings of Eze and Agbo, 2011 that reported a value of 26.00%. CP is an important fraction in feed, however in this study the CP present in the spices with the exception of ginger is not high enough to be considered in feed formulation (Karangiya *et al.,* 2016). The EE recorded for garlic and onion in this study was higher than the findings of Otoikhian *et al.*, 2014, Mitra *et al.*, 2012, Odebunmi *et al.*, 2010, Otunla *et al.*, 2010 and Nwinuka *et al.*, 2005. However, oil content was less than 5% in all the spices and thus none of them could serve as a significant source of oil in feeds. The ash content in ginger and garlic is higher than the values reported by previous researchers (Otoikhian *et al*., 2014; Odebunmi *et al.*, 2010, Otunla *et al.*, 2010 and Nwinuka *et al.*, 2005) though Marina *et al*., 2005 reported a higher value for garlic. On the other hand, onion ash content was lower than the value reported by Nwinuka *et al.*, 2005 and higher than the ash content recorded by Bhattacharjee *et al.,* 2013. The ash content is an indication of the overall mineral content of the ingredient. Ginger and garlic could contribute considerable mineral supplementation to the feed since they have over 5% ash content. Nitrogen free extract (NFE) is an estimation of carbohydrate content of a feed. In this study garlic had the highest NFE and it is similar to the values recorded by Otunla *et al.,* 2010 and Nwinuka *et al.,* 2005. NFE content of ginger was the lowest in this study and it was lower than the quantity reported by Otoikhian *et al*., 2014, Otunla *et al.,* 2010 and Nwinuka *et al.,* 2005.

The occurrence of flavonoid and alkaloid in the spices is in agreement with the results of Huzaifa *et al.*, 2014 and Ghasemzadeh *et al.,* 2010. In addition, onion had the highest quantity of both flavonoid and alkaloid while ginger had the least value of the phytochemicals. This result is at variance with the conclusions of Eadlapalli *et al.,* 2016 and Otunla *et al.,* 2010 who reported that ginger had the highest amount of both phytochemicals more than garlic and onion.

However, the high content of flavonoid in onion in this study is consistent with the findings of Muhammad *et al.* (2017) who reported that quercetin; one of the commonest flavonoid is highest in onion, followed by garlic and ginger. Nonetheless, the abundance of a certain phytochemical in a spice is not usually indicative of its potency as it has been shown that spices having less abundant phytochemicals have shown stronger biological activities (Muhammad *et al.*, 2017). The difference in flavonoid and alkaloid constituents of the spices could result from differences in the species of the spices, methods of cultivation and varieties of the phytochemicals present in the spices (Packia-Lekshmi *et al.,* 2015). The proximate constituents of the experimental basal diets (Table 3) were adequate for the nutritional requirements of the experimental rabbits (F.A.O., 1997).

The interaction of spices and their level of inclusion were significant on feed intake but not for weight gain and feed conversion ratio. This implied that higher dosages of spices increased feed intake in agreement with the observation of Horton *et al.,* 1991. Total feed intake parameters were not significantly different ($p<0.05$) among ginger and onion supplemented contrary to the findings of Ortserga *et al.,* 2015. However, this result is comparable to the report of Cullen *et al.,* 2005 who reported non - significant feed intake among ginger and onion fed animals in related studies. Contrary to ginger and onion supplemented groups, feed intake parameters in garlic – supplemented animals increased as the level of inclusion of the spice increased similar to the reports of Ortserga *et al.*, 2015. The report of this study suggests that the increasing levels of the spices (in garlic more than ginger and onion diets) enhanced palatability and encourages consumption of the diets which might be due to the presence of phytochemicals especially flavonoid in the spice (Horton *et al.,* 1991). The weight gain observed among garlic supplemented groups was similar to the findings of Onu and Aja, 2011 and Aji *et al.,* 2011 both of who reported significant weight increment in rabbit and broiler fed ginger and garlic supplemented diets. The non - significant weight gain in ginger and onion supplemented groups was comparable to the reports of Dieumou *et al*., 2009 who reported no significant weight increment in broiler fed ginger and garlic oil extracts. In garlic supplemented groups contrary to both ginger and onion, the increasing levels of the spices enhances consumption and ultimately improves weight gain compatible with the conclusions of Najmul, 2015. Feed conversion ratio (FCR) values recorded in this study were higher than the values reported by Najmul, 2015. Garlic at 10g had the least FCR among the treatments in agreement with the findings of Hossain *et al.,* 2015 who reported that 1% (10g inclusion level) of garlic inclusion had the best performance in rabbits. This might suggest as adduced by Najmul, 2015 that the phytochemicals in garlic and ginger (to a less extent) more than that of the onion influenced the micro flora and fauna of the animals' gut positively to increase feed utilisation.

At the end of the study, RBC was depleted in the treatment groups. The reduction was in similar to the findings of Shinkut, 2015 and may be due to heat stress (NseAbasi *et al*., 2014). RBC was lower at the end of the study though the values were still within the normal range for rabbit (Mitruka and Rawnsley, 1977) implying that spices supplementation was not deleterious to RBC production in agreement with the reports of Najmul, 2015. The non–significant PCV values at the beginning and end of this study was similar to the findings of Ewuola *et al.* (2012) and implied that the spices were not deleterious to the haematopoiesis process of the animals. The effect of spice supplementation was not significant on Hbc among the experimental groups which corroborated the result of Oluwole, 2001 and Najmul, 2015 in garlic and ginger treated rats and rabbits respectively, but differed with the conclusions of Enitan *et al.,* 2012 who reported a significant increment in Hbc due to onion and garlic supplementations. The result of this study implied that ginger, garlic and onion have non-deleterious effects on the oxygen carrying capacity of the RBC. MCV at the beginning of the study was below the range (Research Animal Resources, 2009) for rabbit and was significantly lower ($p<0.05$) than the values obtained at the end of the study. The result suggested that the experimental animals at the beginning of the study had subnormal sized RBC that may be due to impaired bone marrow capacity. At the end of the study, MCV values were within the established values for rabbit (Research Animal Resources, 2009) and were also higher than the initial values. This observation indicates that experimental diets regardless of spice or level of spice supplementation normalised the sizes of the RBC thereby increasing the oxygen carrying capacity of the RBC in the animals (NseAbasi *et al.,* 2014). MCH of the animals at the end of the experiment was higher compared to the beginning implying that the experimental treatments had increased MCH values which are symptomatic of the absence of anaemia (NseAbasi *et al.,* 2014; Enitan *et al.,* 2012). MCHC at week 0 and week 8 was not significantly different similar to the report of Enitan *et al.,* 2012. However, MCHC values were still higher than the normal range reported by Olabanji *et al.* (2007) suggesting that the ingested spices did not exert any harmful effect. White blood cell (WBC) at the beginning and the end of the study were not significantly different among the experimental animals but were within the normal range for the rabbit (Research Animal Resources, 2009). Nonetheless the result of this work corroborated the findings of Ugwu and Omale, 2011 who observed non– significant WBC values in rat fed onion and garlic extracts. The haematological condition observed in the animals could be due to adequate protein provided by the experimental diets and the antioxidant activities of the ingested spices which improved the erythropoietic and haematopoietic functions of the experimental rabbits (NseAbasi *et al.*, 2014).

CONCLUSION

The supplemented diets enhanced feed intake, sustained growth and weight gain in the experimental animals. The least FCR was observed in the group fed garlic at 10g/kg level implying that the diet was the most optimal among the experimental diets. The diets did not adversely affect the haematology of the studied animals revealing that spices' supplementation was not harmful to the animals.

REFERENCE

Ameh, G. I., Ofordile, E. C. and Nnaeme, V.E. (2016). Survey for the composition of some common spices cultivated in Nigeria. *Journal of Agricultural and Crop Research*, 4(5): 66-71

Bhattacharjee, S., Sultana, A., Sazzad, M. H., Islam, M. A., Ahtashom, M.M. and Asaduzzaman. (2013). Analysis of the proximate composition and energy values of two varieties of onion (*Allium cepa* L.) bulbs of different origin: A comparative study. *International Journal of Nutrition and Food Sciences*, 2(5): 246-253.

Cullen S.P., Monahan, F.J., Callan, J.J. and O'doherty, J.V. (2005). The effect of dietary garlic and rosemary on grower-finisher pig performance and sensory characteristics of pork. *Irish Journal of Agricultural and Food Research*: 57-67.

Dieumou, F.E.A., Teguia, J.R., Kuiate, J.D., Tamokou, N.B., Fonge, A. and Dongmo, M.C. (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) 21.

Eadlapalli, S., Vemula, S., Bramhachari, P.V. and R.Vadde. (2016). Activities of commonly used culinary Indian spices. *American Journal of Biochemistry and Molecular Biology*, 6(3): 113 – 120.

Enitan, S. S., Ajeigbe, K. O., Josiah, S. J. and Ehiaghe, F. A. (2012). Haematological and hepatotoxic potential of onion (Allium cepa) and garlic (Allium sativum) extracts in rats. *European Journal of Medicinal Plants* 2(4): 290-307.

Ewuola, E. O. and Egbunike, G. N. (2008). Haematological and serum biochemical response of growing rabbit bucks fed dietary fumonisin B1. *African Journal of Biotechnology*, 7 (23): 4304-4309.

Ewuola, E.O., Jimoh, O.A., Atuma, O.V. and Soipe, O.D. (2012). Haematological and serum biochemical response of growing rabbits fed graded levels of Moringa oleifera leaf meal. Proceedings of the 10th World Rabbit Congress, Sharm El- Sheikh –Egypt: 679 – 683

Eze, J.I. and Agbo, K.E. (2011). Comparative studies of sun and solar drying of peeled and unpeeled ginger. *American Journal of Science and Industrial Research*, 2(2): 136-143.

Ghasemzadeh, A., Jaafar, H. Z. E. and Rahmat, A. (2010). Antioxidant activities, total phenolics and flavonoids contentin two varieties of Malaysia young ginger (*Zingiber officinale* Roscoe). *Molecules*, 15: 4324 - 4333.

Guisseppe, R. and Baratta, T.M. (2000). Antioxidant activity of selected essential oil Components in two lipid model systems. *African Journal of Biotechnology*, 69(2): 167-174.

Horton, G.M.J., Blethen, D.B. and Prasad, B.M. (1991). The effect of garlic (*Allium sativum*) on feed palatability of horses and feed consumption, selected performance and blood parameters in sheep and swine. *Canadian Journal of Animal Science*, 71(2): 607-610.

Hossain, M.J., Kamruzzaman, M., Akbar, M.A. and Haque, M.A. (2015). Feeding garlic powder on growth performance, nutrient digestibility and carcass characteristics of rabbit. *International Journal of Natural and Social Sciences*, 2(5): 74-81.

Huzaifa, U., Labaran, I., Bello, A.B. and Olatunde A. (2014). Phytochemical screening of aqueous extract of garlic (*Allium sativum*) bulbs. *Report and Opinion*, 6(8): 1 – 4.

Jain, N.C. (1986). Scanning electron micrograph of blood cells. In: Schalm's Veterinary Haematology (4th edition). Published by Lea and Febiger. Philadelphia: 4: 63-70.

Marina, S., Masood, S.B., Aamir, S. and Saira, T. (2005). Chemical and mineral analysis of garlic: a golden herb. *Pakistan Journal of Food Sci*ence, 24(2): 108-110.

Miliauskas, G., Venskutonis, P. R. and Van Beek, T. A. (2004). Screening of radical scavenging activity of some medicinal and aromatic plant extract. *Food Chemistry*, 85(2): 231 – 237

Mitruka, B. M. and Rawnsley, H. M. (1977). Clinical, biochemical and haematological reference values in normal experimental animals. Masson Publishing Inc., United State of America: 134-135.

Muhammad, A., Syeda, K. S., Asad, B., Adil, M. and Shabnam, S. (2017). Evaluation of phenolic compounds and antioxidant and antimicrobial activities of some common herbs. *Hindawi International Journal of Analytical Chemistry*, 2017: 1 - 6.

Najmul, K. (2015). Effect of garlic and ginger supplementation on growth performance of broiler rabbit. A MSc. thesis submitted to the Department of Animal Science and Nutrition Faculty of Veterinary Medicine Chittagong Veterinary and Animal Sciences University, Khulshi, Chittagong, Bangladesh.

NseAbasi, N. E., Williams, M. E., Uduak, A., and Edem, E.A.O. (2014). Haematological parameters and factors affecting their values. *Agricultural Science*, 2(1): 37-47.

Nwinuka, N. M., Ibeh, G. O. and Ekeke, G. I. (2005). Proximate composition and levels of some toxicants in four commonly consumed spices. *Journal of Applied Science and Environmental Management*, 9 (1): 150 – 155.

Odebunmi, E.O., Oluwaniyi, O.O. and Bashiru M.O. (2010). Comparative proximate analysis of some food condiments. *Journal of Applied Sciences Research*, 6(3): 272-274.

Okab, A.B., El-Banna, S.G. and Koriem. A.A. (2008). Influence of environmental temperatures on some physiological and biochemical parameters of male New-Zealand rabbits. *Slovak Journal of Animal Science*, 41: 12–19.

Olabanji, R. O., Farinu, G. O., Akinlade, J.A and Ojebiyi, O. O. (2007). Growth performance and haematological characteristics of weaner rabbits fed different levels of wild sunflower (*Tithonia diversifolia* Hems L A. Gray) leaf blood meal mixture. Proceedings of the 32nd Animal Conference of Nigeria Society for Animal Production, 207-209.

Oluwole, F. S. (2001). Effects of garlic on some haematological and biochemical parameters. *African Journal of Biomedical Research*, 4: 39 – 141.

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

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

Onwuka, G.I. (2005). Food Analysis and Instrumentation (Theory and Practice). 1st Edition. Napthal Prints, Lagos, Nigeria: 140- 160

Ortserga, D.D., Andyar, A.C. and Anthony, T.I. (2008). Growth performance of growing rabbits fed graded levels of garlic (*Allium sativum*). Proceedings of the 33rdAnnual Conference of the Nigerian Society for Animal Protein: 189-191.

Oseni, S.O. (2010). Report of an exhibition by the Rabbit Breeders Association of Kenya. Project stories from the field. Rabbit production in developing countries. Available at: http://world-rabbit-science.com/

Otoikhian, C. S.O., Imasuen, J. A. and Igue, U.A., (2014). Growth and haematological performance of rabbits fed varying levels of ginger powder as supplemented diet. *Indo-American Journal of Life Sciences and Biotechnology*: 25 – 31.

Otunola, G. A., Oloyede, O. B., Adenike, T. Oladiji, A. T. and Afolayan A.J. (2010). Comparative analysis of the chemical composition of three spices – *Allium sativum* L. *Zingiber officinale* Rosc and *Capsicum frutescens* L. commonly consumed in Nigeria. *African Journal of Biotechnology*, 9(41): 6927-6931.

Packia- Lekshmi, N. C. J., Viveka, S., Jeeva, S.and Raja- Brindha J. (2015). Phytochemicals in allium species and its analytical methods – a review.

International Journal of Institutional Pharmacy and Life Sciences, 5(1): 38 - 58

Platel, K. and Sirinivasan, K. (2004). Digestive stimulant action of spices: A myth or reality. *Indian J. Med. Res*., 119: 167-172.

Puvaˇca, N., Stana´cev, V., Glamoˇci´c, D., Levi´c, J., Peri´c, L., Stana´cev, V. and Mili´c, D. (2013). Beneficial effects of phytoadditives in broiler nutrition. *Worlds Poult. Sci. J*., 69: 27–34.

Research Animal Resource. (2009). Reference values for laboratory animals: Normal haematological values. University of Minnesota. Available at: http://www.ahc.umn.edu/rar/refvalues.html.

Shamsa, F., Monsef, H., Ghamooshi, R. and Verdian-rizi. M. (2008). Spectrophotometric determination of total alkaloids in some Iranian medicinal plants. Thai Journal of Pharmaceutical Sciences, 32: 17 - 20.

Shinkut Matthew. (2015). Semen characteristics, gonadal sperm reserves and haematological parameters of rabbit bucks fed diets supplemented with *Allium sativum* (garlic). A Master thesis submitted to the School Of Postgraduate Studies, Ahmadu Bello University, Zaria

Srinivasan, K. (2016). Spices and Flavoring Crops: Uses and Health Effects. In: Caballero, B., Finglas, P., and Toldrá, F. (Eds.). *The Encyclopedia of Food and Health*, 5: 98-105. Oxford: Academic Press.

Ugwu, C.E. and Omale, J. (2011). Comparative effects of aqueous garlic (*Allium sativum*) and onion (*Allium cepa*) extracts on some haematological and lipid indices of rats. *Annual Review and Research in Biology*, 1(3): 37–44.

Zhilen, J., Mengeheng, T. and Jianming, W. (1999). The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. *Food Chemistry*, 64:555–559.