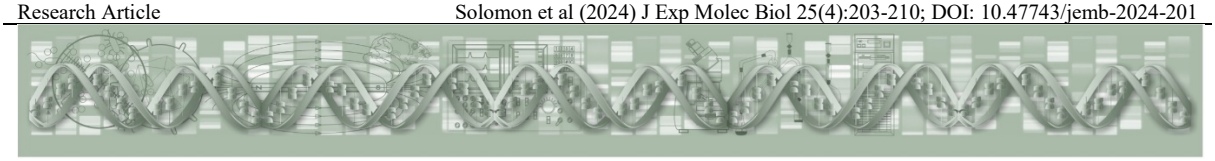

GROWTH PERFORMANCE AND SEMEN CHARACTERISTICS OF MONGREL RABBIT BUCKS FED DIETARY LEVELS OF GARLIC (*ALLIUM SATIVUM*) MEAL

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Abstract

This study was designed to evaluate the effect of garlic meal supplementation on growth performance and semen characteristics in rabbit bucks. Twenty-four (24) mixed breed rabbit bucks were used for this study. The bucks were allowed to acclimatize for two weeks before the commencement of the study, during this period, they were fed formulated diet and Calopogonium ad-libitum. Feed and clean drinking water were offered ad libitum to the experimental animals. Four different experimental diets were formulated with varying levels of 0.00, 0.50, 1.00 and 1.50% garlic meal as supplement and were coded as T1, T2, T3 and T4 respectively, with as control. The 24 bucks were weighed and randomly allotted into the four experimental treatments and replicated thrice with two rabbit bucks per replicate in a complete randomized design (CRD) for a period of 8 weeks. At the end of the feeding period, semen collection was done using a specially designed artificial vagina for rabbits. The data obtained were subjected to one-way analysis of variance (ANOVA) procedure using IBM Statistical Package for Social Science (SPSS) version 21. The result showed that garlic meal had significant effect ($P<0.05$) on final weight, total and daily feed intake. Garlic significantly influenced ($p<0.05$) sperm volume, motility, concentration and total cells per ejaculate however, did not affect sperm morphology. In conclusion, garlic meal supplementation at 1.0% (10g/kg) can improve some growth and seminal parameters in male rabbits.

Keywords: garlic, supplements, spices, sperm profile, semen, growth, performance

Introduction

The use of antibiotics as growth promoters over the years by farmers to improve the growth performance in livestock and also for the treatment and prevention of certain livestock diseases and infections have been banned in many Countries due to a reduced social acceptance by consumers of animal products for the fear of residual deposits. However, there has been a search for alternative replacements of antibiotics with natural feed additives (Onunkwor et al. 2022).
According to Lee et al. (2013), it has been known from ancient times that garlic possess biological, antibacterial, antifungal and antioxidants properties. Garlic as natural plant products are excellent growth promoter (Khan et al. 2012a) having no resistance and residues (Jin 2010) are used to increase feed efficiency. Garlic are readily available, less hazardous and affordable for financially disadvantaged farmers and this have attracted increasing interest as an alternative feeding strategy to replace antibiotics growth promoters.
Garlic as natural feed additives are commonly incorporated into the diets of livestock particularly rabbits and poultry, for the prevention of diseases, improve weight gain, feed

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efficiency, flavor, palatability and above all to exert a positive effect on rabbit buck's fertility (Abou-Elkhair et al. 2014). This is done by stimulating secretion of digestive enzymes, leading to aid digestion and absorption (Rehman and Munir 2015). According to Salah et al. 2014, garlic increased sperm concentration and improved male reproductive functions.
The aim of this study was to investigate the effects of dietary supplementation of garlic meal on growth performance and semen characteristics in mongrel rabbit bucks.

Materials and Methods

Experimental Site

The study was conducted at the Rabbitry unit of the Teaching and Research Farm, Department of Animal Science, University of Uyo, Uyo, Akwa-Ibom State. The study site as described by Solomon et al. (2023) is located at 50 1′N; 70 35′E with a mean annual temperature of between 26°C and 28°C, with mean annual rainfall ranging from 2000 mm – 3000 mm.

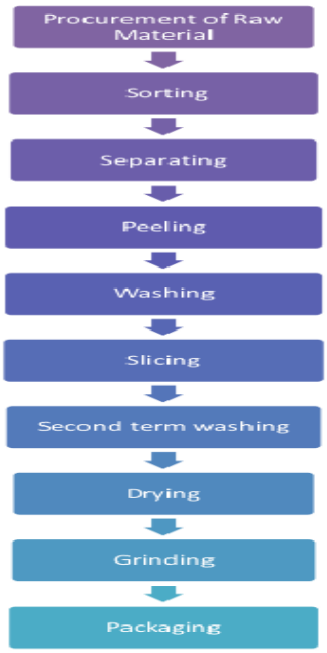
Experimental animals and management

Twenty-four (24) mixed-breed rabbit bucks were purchased and used for this study. The rabbit bucks were allowed to acclimate for a period of two weeks before the study commenced. During this period, the bucks were fed formulated diet and Calopogonium ad-libitum. Oxytetracycline 20% and ivermectine injection were administered intramuscularly and subcutaneously respectively against bacteria, internal and external parasites according to manufacturer's recommendation before the commencement of the study, which lasted for 8 weeks (56 days). The animals were housed in a wire-meshed rabbit hutch in the course the study. Fresh feed and clean drinking water were made available ad libitum to the bucks.

Sample Preparation

The fresh garlic cloves were purchased from Itam market, in Uyo Local Government Area of Akwa Ibom State, Nigeria. They were thoroughly washed under running water, peeled, cut into small sizes and air- dried for 6 days. The dried Garlic was ground into powder, stored in a bottle jar under room temperature and used as garlic meal in the study.

Sample preparation (Garlic Powder Meal)



Experimental Diets

Four different experimental diets were formulated with varying levels of 0.00, 0.50, 1.00 and 1.50% garlic meal as supplement and were coded as T1, T2, T3 and T4 respectively and represent in Table 1, with T1 as control diet.

Table 1. Experimental Diets

Ingredients	**T1 (0.00% DGM)**	**T2 (0.50% DGM)**	**T3 (1.00% DGM)**	**T4 (1.50% DGM)**
Maize	41.20	41.20	41.20	41.20
Soybean mean	12.80	12.80	12.80	12.80
Wheat offals	42.00	42.00	42.00	42.00
Bone meal	3.00	3.00	3.00	3.00
Common salt	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated Composition				
Metabolizable Energy (Kcal/kg)	2675.50	2675.50	2675.50	2675.50
Crude protein (%)	16.68	16.68	16.68	16.68
Crude fibre (%)	6.23	6.23	6.23	6.23
Ether extract (%)	3.54	3.54	3.54	3.54

Data Collection

The bucks were weighed using an electronic kitchen scale with 1g sensitivity at the commencement of the study, to obtain their initial weights. They were subsequently weighed weekly to monitor weight changes and recorded. The individual feed intake was obtained as the as the difference between the feed offered and left over after a 24-hour feeding.

Weight gain per rabbit was calculated as the difference between final weight and initial weight. The feed conversion ratio was computed by dividing the total weight gain by the total feed intake as follows:

Feed conversion ratio = feed intake/weight taken

Semen Collection

A specially designed artificial vagina (AV) for rabbits was used to collect semen collection from the bucks, by introducing a rabbit doe as a teaser into the buck's cage. The buck was careful observed, and the AV placed gently at the vulva of the doe as the buck and mounted the doe, so as to direct the penis into the AV for penetration and ejaculation.

Semen evaluation

The semen samples obtained were examined using a compound microscope as described by Shinkut (2015), and adopted by Solomon et al. (2023). This method entails the visual or gross examination of the semen sample immediately after collection to assess the volume and colour. microscopic examination for motility, concentration, percentage live spermatozoa and morphological abnormalities was carried out thereafter.

Experimental Design

The bucks were weighed and randomly assigned into four experimental groups and replicated thrice to have two rabbit bucks per replicate, in a completely randomized design (CRD) for a period of 8 weeks.

Statistical Analysis

The data obtained from the study were subjected to one-way analysis of variance (ANOVA) procedure using IBM Statistical Package for Social Science (SPSS) version 20. Were significant differences were observed, the means were separated using Duncan of the software.

Results

Growth Performance of rabbit buck fed diets supplemented with garlic meal

The results on growth performance of mongrel rabbit bucks fed varied levels of dietary supplementation of garlic meal are presented in Table 2. The result showed that garlic meal had a significant effect ($P<0.05$) on final weight, total and daily feed intake. Total and daily weight gains and feed conversion ration were also influenced ($p<0.05$) by garlic meal supplementation in the bucks' diets. Higher final weights were observed in rabbit groups whose diets were supplemented with garlic meal except those of rabbit bucks in T4 that had similar statistical value ($p>0.05$) with bucks in the control group. Final weights observed in the study were 1593.50, 1658.50, 1789.50 and 1653.33 g for T1, T2, T3 and T4 respectively. Rabbit bucks with 1.00% (T3) and 1.50% (T4) garlic in their diets recorded significantly higher ($p<0.05$) total and daily feed intake compared to those with 0.00% (T1) and 0.50% (T2) garlic supplementation in their diets respectively. The total feed intake was 4154.00 and 4154.83g for bucks in T3 and T4 respectively, while bucks in T1 and T2 recorded total feed intake of 3976.00 and 4086.00 g respectively. Garlic meal supplementation did also affect the feed conversion ratio, as values observed in the study varied statistically ($p<0.05$) in all treatment groups.

Table 2. Growth Performance of Mongrel Rabbit Bucks Fed varied levels of Garlic powder Meal

Parameters	T1 (Control)	T2 (0.5% GMP)	T3 (1.0% GMP)	T4 (1.5% GMP)	SEM
Initial weight (g)	1147.67	1146.33	1147.83	1143.50	13.83
Final weight (g)	1593.50^{b}	1658.50^{ab}	1789.50^{a}	1653.33^{ab}	32.05
Total weight gain (g)	445.83^{b}	517.17^{ab}	641.67^{a}	509.83^{ab}	33.47
Daily weight gain (g)	7.96^{b}	9.15^{ab}	11.46^{a}	9.11^{ab}	0.60
Total Feed intake (g)	3976.00^{c}	4086.00^{b}	4154.00^{a}	4154.83^{a}	22.72
Daily feed intake (g)	71.00^{c}	72.97^{b}	74.18^{a}	74.20^{a}	0.41
Feed Conversion Ratio	9.18^{a}	8.13^{ab}	6.53^{b}	8.79^{b}	0.59

a, b, c - Means on the same row but with different superscripts are significant at $P< 0.05$; GMP-Garlic Powder Meal

Semen Characteristics of rabbit bucks fed diets supplemented with garlic meal.

The results on semen profile of rabbit bucks administered supplemental levels of garlic meal are presented in Table 3. The results revealed that garlic significantly influenced ($p<0.05$) sperm volume, motility, concentration and total cells per ejaculate. However, garlic meal did not affect sperm morphology as percentage normal and abnormal sperm cells were statistically similar ($p>0.05$) in all treatment levels.

Table 3. Semen characteristics of Rabbit bucks fed diets supplemented with garlic meal

Parameters	T1 (Control)	T2 (0.5% GMP)	T3 (1.0% GMP)	T4 (1.5% GMP)	SEM
Volume (ml)	0.59^{b}	0.58^{b}	0.71^{a}	0.68^{a}	0.02
Colour	Milky	Milky	Milky	Milky	
Motility (%)	66.00^{c}	70.67^{b}	71.00^{b}	75.33^{a}	1.06

Concentration (x 10^6/ml)	75.67^b	81.00^b	96.33^a	94.33^a	2.75
Normal cells (%)	71.00	73.33	80.33	77.67	2.19
Abnormal cells (%)	29.00	26.67	19.67	22.33	2.19
Live cells (%)	81.67	84.67	85.33	84.33	1.30
Dead cells (%)	18.33	15.33	14.67	15.67	1.30
Total cells/ejaculate) (X 10^6/ml)	44.65^c	46.96^c	68.36^a	64.11^b	3.16

a, b, c - Means on the same row but with different superscripts are significant at (P< 0.05); GMP-Garlic Powder Meal, SEM – Standard error of mean

Semen volume was higher in treatments 3 (0.71ml) and 4 (0.68ml) respectively compared to those of bucks in T1 (0.59 ml) and T2 (0.58 ml). Garlic meal supplementation in the bucks' diets did not affect (p>0.05) the semen colour as all treatments recorded milky colour. This study observed a significant increase (p<0.05) in sperm motility with garlic meal supplementation in bucks' diets. Values observed were 66.00, 70.67, 71.00 and 75.33% for T1, T2, T3 and T4 respectively. Garlic meal supplementation also increased semen concentration in T3 and T4 when compared to T1 and T2. Bucks in T3 recorded sperm concentration of 96.33 X 10^6/ml while bucks in treatment group 1, 2 and 4 recorded values of 75.67, 81.00 and 94.33 X 10^6/ml respectively. Live and dead sperm cells were not influenced by garlic meal supplementation in the bucks' diets. Live cells percentage observed were 81.67, 84.67. 85.33 and 84.33% for T1, T2, T3 and T4 respectively. Garlic meal supplementation significantly increased (p<0.05) total sperm cells per ejaculate with higher values recorded in T3 (68.36 X 10^6/ml) followed closely by T4 (64.11 X 10^6/ml) while T1 and T2 had similar (p>0.05) values of 44.65 and 46.96 X 10^6/ml respectively.

Discussions

The significant result observed in final weights in this study agrees with the statement of Abdelnour et al. (2018), who highlighted the use of plant-based supplements in livestock production to improve growth performance. This therefore implies that incorporating such plant-based supplements into rabbit feeds may enhance nutrient absorption and utilization as documented by Földešiová et al. (2015). Reports by Olaleye et al. (2006), and Panggabean et al. (2019), described garlic as a herb which acts as growth promoter with ability to reduce the degradation of amino acids, thereby causing improved weight gain due to the availability of more amino acids. The increased daily and total feed intake of mongrel rabbit buck fed diets containing 0.50, 1.00 and 1.50% GPM respectively resulted in the increase in bucks' weight when compared to the control. This improvement could be as a result of the bioactive constituents of the garlic powder meal on the digestibility process as reported by Mandey et al. (2019) and Suliman et al. (2021). There was a significant improvement in feed intake of bucks in this study, particularly in rabbit bucks fed diets containing 1.00% garlic meal which could be due to enhanced appetite, increased pancreatic and digestive enzymes secretion, and improved intestinal digestibility as noted by Arif et al. (2022). Earlier reports (Dhama et al. 2015, Sapsuha et al. 2021), again, noted that the presence of garlic meal could deactivate the growth of pathogenic bacteria, enhance the multiplication of beneficial bacteria, and accelerate nutrient metabolism and absorption in the digestive tract which may result in the overall improved body weight of rabbit bucks

Better feed conversion ratio (FCR), was observed in bucks fed diets containing 1.00% garlic supplementation in their diets, implying that the feeds were better utilized due to the enhanced

production of endogenous enzymes, pancreatic juices, and bile salt triggered by the synergetic effects of the bioactive components of the garlic when compared to the control according to Adu et al. (2020) and Sapsuha et al. (2021).

Effect of garlic meal supplementation on semen characteristics of rabbit bucks

The results on semen profile of rabbit bucks in this study showed significant increase in semen volume at 10 and 15 g/kg (T3 and T4 respectively) supplementation in the diets. This however, differs from the result of Shinkut et al. (2016), who recorded reduced semen volume with garlic meal at 2.5 and 5.0% supplementation in their study. This variation may be due to higher doses used in comparison with this study. The authors also attributed the observed increase in mean ejaculate volume of the control when compared to the treated groups to possibility of contamination of the semen by urine as reported by Jordi et al. (2005), who noted a 13% chance of contamination of rabbits' semen by urine during collection when using artificial vagina. Earlier report (Campos et al. 2014), put the normal ranges of semen volume between 0.3-0.6 ml, which is below the values observed in T3 and T4. This observation is however similar to those of Ekuma et al. (2017), who observed that the supplementation of garlic alone, combination of garlic and vitamin E significantly increases the sperm motility and spermatozoa proportion in their study. Higher motility was observed in bucks fed diets with garlic supplementation than in those without garlic supplementation. This observation however, disagrees with the report of Shinkut et al. (2016), and Omotoso et al. (2012), who in their respective studies, observed no significant difference in sperm motility in rabbit bucks, and a decrease in sperm motility in Wister rats administered dietary levels of garlic.

The higher sperm concentration observed in the study is similar to earlier reports (Salah et al. 2014, Shinkut et al. 2016, Ekuma et al. 2017). Ajao and Ola (2022), stated that the general positive impact of spice supplementation on sperm parameters can be attributed to the spices' antioxidant properties and androgenic effects as supported by Ramandeep et al. (2013) and Morakinyo et al. (2010), which they noted have the ability to enhance sertoli cells activities in maintaining sperm production. Normal and abnormal sperm cells as well as live and dead sperm cells were not affected by garlic supplementation in this study. These results, however, vary from the report of Ajao and Ola (2022) and Ekuma et al. (2017), who observed significant differences in these parameters in their respective studies but, similar to the report of Shinkut et al. (2016), who also observed no significant effect of garlic supplementation on these parameters. Garlic meal supplementation significantly increased the total sperm cells per ejaculate in bucks fed T3 diet, followed by bucks fed T4 diet. However, bucks fed the control diet T1 and T2 had similar values.

Conclusions

The findings of this study showed that garlic meal had a significant effect on final weight, total and daily feed intake. Garlic meal supplementation can also increase semen volume, motility, concentration and total sperm cells per ejaculate. Hence, supplementation of garlic meal in rabbit bucks' diets at 1.0% (10 g/kg), can improve final weight, feed intake and semen parameters.

References

Abdelnour S, Alagawany M, Abd El-Hack ME, Sheiha AM, Saadeldin IM, Swelum AA. 2018. Growth, Carcass Traits, Blood Hematology, Serum Metabolites, Immunity, and Oxidative Indices of Growing Rabbits Fed Diets Supplemented with Red or Black Pepper Oils. Animals (Basel). 8(10): 168.

Adu CA, Gbore FA, Oloruntola OD, Falowo AB, Olarotimi OJ. 2020. The effects of Myristica fragrans seed meal and syzyguim aromaticum leaf meal dietary supplementation on growth performance and oxidative status of broiler chicken. Bulletin of National Research Centre. 44: 149.
Ajao BH, Ola SI. 2022. Effects of Dietary Supplementation of Ginger, Garlic and Onion on Semen Profile, Haematological and Serum Antioxidant Status of Rabbit Bucks Raised in the Dry Season of the Humid Tropic. The Journal of Agricultural Sciences - Sri Lanka. 17(1): 228–240.
Alejandra CC, Ana CS, Marta, CM, Mar V. 2010. A comprehensive survey of garlic functionality. In: Pacurar M., Krejei G., editors. Garlic consumption and health. p. 1-60.
Arif M, Rehman A, Naseer K, Abdel-Hafez SH, Mohamed FM, ElSaadony T, Abd El-Hack ME, Taha, Salem AE, Alagawany M. 2020. Effect of Aloe vera and clove powder supplementation on growth performance, carcass and blood chemistry of Japanese quails. Poultry Science. 101 (4): 101702.
Campos ACN, Gadelha CRF, Guerreiro MEF, Pereira ES, Lima ICS, Linard MAB, Meneses HM, Castelo-Branco KF, Estevam FNL. 2014. Male rabbit reproductive physiology. Standard Research Journal of Agricultural Science. 2: 120–128.
Chang KJ, Cheong SH. 2008. Volatile organosulphur and nutrient compounds from garlic by cultivating areas and processing methods. Fed. Am. Soc. Exp. Bio. J. 22: 1108–1112.
Dhama K, Latheef SK, Mani S, Samad HA, Karthik K, Tiwari R, Khan RU, Alagawany M, Faraq MR, Alam GM, Laudadio V, Tufarelli V. 2015. Multiple beneficial applications and modes of action of herbs in poultry health and production—a review. International Journal of Pharmacology. 11: 152–176.
Ekuma BO, Amaduruonye W, Onunkwo DN, Herbert U. 2017. Influence of garlic (*Allium sativum*) and vitamin E on semen characteristics, reproductive performance and histopathology of rabbit bucks. Nigerian Journal of Animal Production. 44(3): 117–128.
Földešiová M, Baláži A, Chrastinová I, Chrenek P. 2015. The effect of Curcuma longa dried powder in the diet on weight gain of rabbit does. Slovak Journal of Animal Science. 48(1): 43–48.
Hanieh H, Narabara K, Piao M, Gerile C, Abe A, Kondo Y. 2010. Modulatory effects of two levels of dietary Alliums on immune responses. *Animal Science Journal* 81:673-680
Istifanus SB. 2023. Effect of dietary supplementation of garlic (*Allium sativum*) and ginger (*Zingiber officinale*) blend on growth response, blood profile, and carcass characteristics of broiler chickens. MSc Dissertation, Taraba State University, Jalingo.
Jordi R, Silvia M, Juan O, Inma P, Juan M, Emilio AM. 2005. Influence of Constant Long Days on Ejaculate Parameters of Rabbits Reared Under Natural Environmental conditions of Mediterranean Area. Livestock Production Science. 94: 169–177.
Khan RU, Naz M, Javdani Z, Nikousefat M, Selvaggi V, Tufarelli V, Laudadio 2012a. The use of turmeric *(Curcuma longa)* in poultry feed. World's Poultry Science Journal. 68: 401–408.
Khan SH, Sardar R, Anjum MA. 2007. Effect of dietary garlic on performance and serum and egg yolk cholesterol concentration in broiler. Asian - Australian Journal of Animal Science. 2(1l): 22–27.
Mandey JS, Wolayan FR., Pontoh CJ, Sondakh B. 2019. Phytochemical characterization of cucumber (*Cucumis sativus* L.) seeds as candidate of water additive for organic broiler chickens. Journal of Advance Agricultural Technology. 6: 61–64.
Morakinyo OA, Achema P, Adegoke O. 2010. Effect of Zingiber officinale (ginger) on sodium arseniteae; induced reproductive toxicity in male rats. African Journal of Biomedical Research. 13(1): 39–45.
Olaleye MT, Akinmoladun AC, Akindahunsi AA. 2006. Antioxidant (Houtt) and its effect on selected organs of albino rats. African Journal of Biotechnology. 5(13): 1274–1278.

Omotoso GO, Oyewopo A, Onanuga IO, Enaibe BU. 2012. Garlic consumption alters testicular histology and antioxidant status in wista rats. The Tropical Journal of Health Sciences. 19(2): 31–33.
Panggabean KA, Rusmarilin H, Suryanto D. 2019. The utilization of nutmeg seed (*Myristica fragrans* Houtt) extract as an antimicrobial on tempeh sausage. Earth Environmental Science. 260: 012087.
Qiu Z, Zheng Z, Zhang B, Sun-Waterhouse D, Qiao, X. 2020. Formation, nutritional value, and enhancement of characteristic components in black garlic: A review for maximizing the goodness to humans. Comprehensive reviews in food science and food safety. 19: 801–834.
Ramandeep S, Ashraf A, Jeyabalan G, Semwal A, Jaikishan. 2013. An overview of the current methodologies used for evaluation of aphrodisiac agents. Journal of Acute Disease: 85–91.https://doi.org/10.1016/S2221-6189 (13)60105-5.
Rehman Z, Munir MT. 2015. Effect of garlic on the health and performance of broilers. Veterinaria. 3(1): 32-39.
Salah MMA, Rashaa FA, Dalia AS. 2014. Physiological and histological effect of aqueous and alcoholic extract of garlic (Allium sativum) on testicular function of albino male mice treated with lead acetate. Journal of Biotechnology Research Centre (Special edition). 8(2): 41–48.
Sapsuha Y, Suprijatna E, Kismiati S, Sugiharto S. 2021. The effect of nutmeg flesh (Myristica fragrans Houtt) extract on growth performance, internal organ and carcass of broiler chickens raised at high stocking density. Livest. Res. Rural. Dev. 33, Article #75.
Shinkut M, Rekwot PI, Nwannenna IA, Bugau JS. 2016. Spermiogram of Rabbit Bucks Fed Diets Supplemented with *Allium sativum* (garlic). IOSR Journal of Agriculture and Veterinary Science. 9(2): 20–26.
Solomon IP, Istifanus EF, Idang EJ (2023). Effects of frequency of ejaculation and graded levels of Roselle (*Hibiscus sabdariffa*) calyx meal supplementation on sperm profile of mongrel rabbit bucks. Nigerian Journal of Animal Production. 49(3): 167–173.
SPSS, 2012. Statistical package for social science scientists. Version 21.0 for windows. IBM Corp., Armonk, NY.
Suliman GM, Alowaimer AN, Al-Mufarrej SI, Hussein EOS, Fazea EH, Naiel MAE, Alhotan, RA, Swelum AA. 2021. The effects of clove seed (*Syzygium aromaticum*) dietary administration on carcass characteristics, meat quality, and sensory attributes of broiler chickens. Poultry Science. 100(3): 100904.
United States Department of Agriculture (USDA). 2018. Agricultural research service. Food Data Central ("Garlic, raw"). Washington, DC: USDA. https:/fdc.nal.usda.go/fdc-app.html#lfood-details/169230nutrients