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Serum lipid profile and organoleptic characteristics of meat from rabbits fed diets containing selim pepper *(Xylopia aethiopica)* and African nutmeg *(Monodora myristica)*

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Target Audience: *Livestock farmers, Animal Products Specialists, Meat Scientists*

Abstract

A study was conducted to determine the effect of selim pepper meal (Xylopia aethiopica) and African nutmeg meal (Monodora myristica) on serum lipid profile and sensory quality of rabbit meat. A total of thirty-two weaned rabbits (16 males and 16 females) were used. Four dietary treatments were formulated and the rabbits were randomly allocated to four replicates per treatment groups with each replicate having two rabbits in a completely randomized block design. Diets were formulated to contain 0 % selim pepper meal (SPM) and African nutmeg meal (ANM) (T1). 1% SPM (T_2), 1 % ANM (T_3) and 0.5 % each of SPM and ANM (T_4). After 90 days feeding trial, serum lipid profile and sensory evaluation of meats were carried out. Selim pepper meal, African nutmeg meal and their combination had a significant effect ($P < 0.05$) on the lipid profile of rabbits. Total cholesterol (TC) and low density lipoprotein (LDL) increased in the control group (T_1) ($P<0.05$). Sex effect showed similar ($P>0.05$) result. Sensory properties of rabbit meat showed no adverse effect with the addition of the spices. Nevertheless, rabbit meat from T_3 group had the highest overall acceptability score in both male and female ($P < 0.05$). It is recommended that 1% of ANM be used as additive in rabbit diet to improve lipid profile and sensory quality of rabbit meat.

Key words: *Antioxidants, Cholesterol, Meat sensory quality, Spices, Weaner Rabbits*

Description of Problem

The global population increase has led to an increase in the demand for animal products such as meat (1). The use of fast-growing animals in intensive production systems such as rabbit can meet consumers' meat demand. Rabbits play an important role in human nutrition, employment and income generation. Rabbits are good converters of feed to meat and they can efficiently utilize up to 30 % crude fibre in the diet compared to poultry with 10%. They are also prolific, able to survive solely on forages and require low start-up capital and space (2). Rabbit meat is considered a functional food due to its high nutritional value, making it a desirable source of protein. It contains essential amino acids and has a low allergenic profile (3). Rabbit meat has a healthy lipid profile, with low levels of fat and cholesterol, as well as high levels of unsaturated fatty acids, especially omega-3

and omega-6 (4). Additionally, it has a good ratio of polyunsaturated fatty acids. Rabbit meat is rich in minerals like phosphorus, potassium, calcium, selenium, and cobalt, and iron. It is also an excellent source of vitamins, including B_3, B_6, B_{12} and E. rabbit's meat low sodium content makes it an excellent choice for children, pregnant women, people with cardiovascular diseases, and the elderly (5).

Meat quality attributes are of great importance to meat consumers and require examination. These attributes (colour, flavor, juiciness and tenderness) make cooked meat edible, attractive, appetizing and nutritious. Other known quality attribute and properties of rabbit meat include its high protein, low fat and cholesterol content (6). Recently, consumers have become more concerned about the quality of meat and meat products they consume. Among other reasons, this is because of the health consequences of using synthetic antibiotics for livestock production. Therefore, the use of herbs, spices, extracts and other natural preservatives to improve meat quality and food products is increasing (7). This is because they possess antioxidant properties which could be effectively utilized in the improvement of animal production, without the deposition of residual effect on the products which is detrimental to human health (8, 9). Among the tested natural substances in rabbit nutrition were seed powder of selim pepper (Xylopia aethiopica) and African nutmeg (Monodora myristica). Studies by (10) indicated that the use of these local spices improved the organoleptic qualities of rabbit meat as well as their growth performance.

Selim pepper is an aromatic tree crop which grows up to 15-30m in height and has a diameter of about 60-70cm (10). The plant has a simple, alternate, oblong and elliptic to ovate leaves and bisexual flowers. The fruits of Xylopia aethiopica are like small, twisted bean-pods, aromatic, quite pungent (when fresh), smooth grey bark and slightly bitter (11). The dried fruits, seeds and extracts are used as a spice in preparing soups and as herbal drugs in curing cough, sore throat, kidney disorder, rheumatism and nerve pains. It is a good source of bioactive compounds (β-pipene, α-pinene, myetenol and α-farnesene) (12). The leaf-sap is used to treat epilepsy and it can also be taken to encourage fertility and to ease child birth.

African nutmeg is a perennial tree crop belonging to the family Annonaceae. The tree grows naturally in the evergreen forest of West Africa and can reach a height of 35 cm and 2 m in diameter. It has a clear trunk and branches horizontally. The leaves are alternately arranged and drooping with the leaf blade being elliptical, oblong or broadest towards the apex and tapering to the stalk (13). The essential oil from the seed (myristicin) provides a valuable flavour in meal preparations, soups, sauces and canned foods. The active ingredients make these spices exhibit strong antioxidant, antibacterial, and therapeutic effect when used. They also have been shown to have antioxidant properties which can potentially reduce oxidative stress and inflammation in rabbits, thereby benefiting the lipid profile in the blood and promoting overall cardiovascular health (14). However, there is paucity of information on the effect of selim pepper and African nutmeg on the blood lipid profile and organoleptic quality characteristics of meat from rabbits. By understanding the influence that these spices have on rabbit meat quality parameters, we can determine their potential as functional ingredients in animal feed and their impact on human health, providing insight into developing the nutritional and sensory quality of rabbit meat. This study sets to

investigate the impact of diet containing selim pepper (Xylopia aethiopica) and African nutmeg (Monodora myristica) on the serum lipid profile and taste traits of rabbit meat, providing insight into the benefit or adverse effects of these spices on meat quality.

Materials and Methods

Location of the study

This study was conducted at the Department of Animal Science Teaching and Research Farm, Akwa Ibom State University, Nigeria. The area is situated between latitude 5^{o}17'N and 5^{o}27'N and longitude 7^{o}21'E and 7^{o}58'E with annual rainfall from 3500 – 5000 mm, monthly temperature range of 24 – 26^{o}C and relative humidity between 60 – 90% (15).

Source and processing of test materials

Selim pepper (Xylopia aethiopica) and African nutmeg (Monodora myristica) seeds were purchased from Udua Abak in Abak Local Government Area of Akwa Ibom State. Mature selim pepper seeds were washed and air dried. The dried seeds were thereafter ground into meal form using an industrial grinder before being packaged in cellophane bags for storage. Likewise, the seeds of African nutmeg were washed, air dried and then toasted for 2 minutes at 140^{o}C in an electric oven. The seeds were then crushed into meal form and stored in cellophane bags prior to being incorporated into the experimental diet (16). The two nut meals (1000 g) were then incorporated into the diet of the rabbits according to the method of (17).

Experimental diets

Four experimental diets were compounded for the rabbits such that Treatment 1 (control) contained neither selim pepper nor African nutmeg. Treatment 2 and 3 contained 1 % each of selim pepper and African nutmeg, respectively, while Treatment 4 was the mixture of selim pepper and African nutmeg at 0.5 % each. The two spices were added as an inclusive part of the calculated experimental diets as recommended by (18) as shown in Table 1.

Experimental design and management of rabbits

A total of thirty-two crossbred weaned rabbits (16 males and 16 females) of 7 weeks of age were allotted to four dietary treatment groups in a randomized complete block design (RCBD) with four replicates per treatment having two rabbits in each replicate (a male and a female). Upon arrival, the animals were weighed and kept for 2 weeks for acclimatization in the new environment. The rabbits were housed separately in a 3-tier hutch that was cleaned and disinfected in a well-ventilated building. Clean and fresh feed and water were supplied ad libitum. The rabbits were monitored carefully throughout the experiment, with regular checks for signs of distress or illness. The trial lasted 90 days.

Data collection

Proximate and Phytochemical assay

Samples of selim pepper and African nutmeg meal were subjected to the laboratory for proximate analysis according to methods described by (19). The following components were determined; dry matter content, crude protein, ether extract, and ash. Nitrogen free extract was calculated using the formula: NFE = Dry matter – (Crude Protein + Crude Fibre + Ash + Ether Extract). Phytochemical analysis was also carried out on the two spices according to methods described by (20), (21). Constituents determined include; alkaloids,

tannin, flavonoids, phenolic compounds, glycosides, oxalate, hydrogen cyanide and haemaglutinin.

Serum lipid profile determination

A sample of 5 ml of fresh blood was collected from sixteen rabbits in total, four per treatment, for the evaluation of biochemical properties at the end of the feeding trial. The fresh blood samples were collected through the ear vein from a male and a female rabbit per replicate using hypodermic syringes and needle. The samples were collected into plain vacutainers (without anticoagulants) and centrifuged at 3000 rpm for 15 minutes. The serum was used for lipid determination based on the method described by (22). Parameters assessed included total cholesterol (TC), triglycerides (TG), high density lipoprotein (HDL), low density lipoprotein (LDL) and very low density lipoprotein (VLDL). Commercial kits were utilized to determine TC, TG, and HDL levels. The concentration of LDL was determined by the difference, using the formula described by (23); (LDL) = Total cholesterol - (HDL + VLDL). VLDL was also calculated as triglyceride divided by 5 (TG/5).

Table 1: Ingredient and nutrient composition of the experimental diets for rabbits.

Ingredients (%)	T_1	T_2	T_3	T_4
Maize	26.00	25.00	25.00	25.00
Soya bean meal	10.00	10.00	10.00	10.00
Fish meal	1.00	1.00	1.00	1.00
Wheat offal	60.00	60.00	60.00	60.00
SPM	0.00	1.00	0.00	0.50
ANM	0.00	0.00	1.00	0.50
Bone meal	2.00	2.00	2.00	2.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Vit/min Premix*	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated analysis				
Crude protein (%)	17.09	17.06	17.05	17.06
Crude fibre	6.28	6.43	6.30	6.37
Ether extract	3.59	3.67	3.67	3.67
M.E (kcal/kg)	2681.50	2716.30	2720.60	2718.40

* Vitamin-mineral premix provided per kg the following: Vit. A 1500 IU; Vit.D_3 3000 IU; Vit. E 30 IU; Vit. K 2.5mg; Thiamine B_1 3mg; Riboflavin B_2 6 mg; Pyridoxine B_6 4 mg; Niacin 40 mg; Vit. B_{12} 0.0 mg; Pantothenic acid 10 mg, M.E = Metabolizable energy

Slaughter of rabbits and sensory evaluation

The rabbits were rendered unconscious by mechanical stunning with a 1.2 kg club applied to the forehead. After stunning, the jugular veins and carotid arteries were severed below the jaws to bleed the rabbits. Rabbit carcasses were left to bleed for 30 minutes with their heads down. The rabbits were then skinned, opened up, eviscerated, and washed in a bowl filled with water (24). A chunk of meat samples weighing 300 g were taken from the thigh muscle of each of the 16 rabbits for sensory evaluation.

Samples of meat from each treatment were then collected and chopped into sizeable portions into a well labeled bowl for identification. The meats were taken to the Department of Animal Science Postgraduate laboratory where cooking was conducted. The meats were cooked using a gas cooker at 100 ^{o}C for 15 minutes as described by (25). A 10-man trained panel was used in the meat assessment procedure (26). They were instructed to score based on parameters stated on the scoring sheets: colour, flavor, juiciness, tenderness and overall acceptability after chewing a sample of meat from each treatment. Bottled water and pieces of unsalted biscuit were served to the panelist as neutralizers between samples. This is according to the method of (27). Scoring was based on a nine-point hedonic scale; 1 (extremely dislike) to 9 (like extremely).

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) using SPSS version 20.0 for windows. Significant differences in means were separated using Duncan's Multiple Range test (28).

Table 2: Proximate and phytochemical components of Selim Pepper meal and African nutmeg meal

Proximate (%)	SPM	ANM
Dry matter	91.34	91.40
Crude protein	6.21	4.75
Ether extract	7.62	7.62
Crude fibre	15.31	1.51
Ash	5.24	3.67
Nitrogen free extract	56.96	73.85
Metaboloizable energy (kcal/kg)	3478.00	3909.70
Phytochemicals (mg/kg)		
Alkaloids	1.67	1.24
Tannins	57.95	0.85
Saponins	3.63	2.93
Flavonoids	5.62	4.95
Phenolic compounds	5.62	5.90
Glycoside	1.01	0.13
Oxalate	4.65	-
Haemaglutinin	7.44	-

- = Not detected, SPM = Selim Pepper meal, ANM = African nutmeg meal

Results

Proximate analysis of tested ingredients

The result of proximate composition and phytochemical analysis of selim pepper and African nutmeg seed meal is presented in Table 2. The crude protein, ether extract, crude fibre, ash and nitrogen free extract (carbohydrate) of Xylopia aethiopica seed meal were comparable to values (6.47%, 7.72%, 18.30%, 5.10% and 50.10%), respectively as reported by (29). The metabolizable energy level did not agree with (29). Correspondingly, the ash content and energy of Monodora myristica were close to values (2.41%, 4027.7kcal/kg) reported by (30). Protein content was close to values (6.27%) reported by (12).

Phytochemical analysis of tested ingredients

In selim pepper meal, tannin, hydrogen

cyanide and haemaglutinin were the principal phytochemicals while alkaloids and glycoside were the least abundant. Likewise, flavonoids and phenolic compounds in African nutmeg meal were the principal phytochemicals while Alkaloids, tannin, saponin and glycoside were the least abundant. Oxalate, hydrogen cyanide and haemaglutinin were absent. Results obtained in the current research are close to those reported by (12) and (31) for selim pepper and African nutmeg respectively.

Serum lipid profile of growing rabbits fed diets containing SPM and ANM

Table 3 presents the result for total cholesterol (TC), triglycerides (TG), high density lipoprotein (HDL), low density lipoprotein (LDL) and very low density lipoprotein (VLDL) for rabbits fed selim pepper and African nutmeg seed powder as additive. Result shows significant ($P<0.05$) differences in all parameters assessed except triglycerides (TG) and very low density lipoprotein (VLDL) with the control group (T_1) recording significantly ($P < 0.05$) higher values for TC and LDL with a decreased level of HDL. Sex effect shows no significant ($P > 0.05$) effect in TG and VLDL values for male and female rabbits. However, significant ($P < 0.05$) differences were recorded for TC, HDL and LDL.

Table 3: Serum lipid profile of male and female fattening rabbits fed experimental diets.

Parameters	Sex	T_1 (control)	T_2 (SPM 1%)	T_3 (ANM 1%)	T_4 SPM+ANM (0.5%+ 0.5%)	SEM
Total Cholesterol (mg/dl)	M	96.68^{a}	69.61^{b}	73.47^{b}	69.61^{b}	2.60
	F	112.14^{a}	61.87^{c}	81.21^{b}	65.74^{b}	2.78
	Overall Means	104.41^{a}	65.74^{b}	77.34^{b}	67.68^{b}	5.33
Triglycerides (mg/dl)	M	46.06	30.11	30.11	30.11	4.09
	F	29.23	25.69	26.57	25.69	1.58
	Overall Means	37.65	27.90	28.34	30.56	3.06
High density lipoprotein (mg/dl)	M	27.46	30.16	32.87	34.42	2.50
	F	26.68^{b}	26.30^{b}	34.42^{ab}	36.35^{a}	2.35
	Overall Means	27.07^{c}	28.23^{bc}	33.65^{ab}	34.39^{a}	1.33
Low density lipoprotein (mg/dl)	M	61.87^{a}	30.94^{b}	34.80^{b}	27.07^{b}	2.18
	F	77.34^{a}	54.14^{b}	42.54^{c}	34.80^{c}	2.50
	Overall Means	69.61^{a}	42.54^{b}	38.67^{b}	30.94^{b}	3.70
Very low density lipoprotein (mg/dl)	M	8.89	7.73	5.80	6.96	1.73
	F	5.80	5.03	5.32	5.03	1.00
	Overall Means	7.35	6.38	5.56	6.00	0.58

^{abc}Means in the same treatment by sex block not sharing common superscript are significantly different ($P<0.05$) SEM = Standard error of mean, M = male, F = female, SPM = Selim Pepper Meal, ANM = African Nutmeg Meal

Sensory quality of growing rabbits fed diets containing SPM and ANM

Table 4 shows the organoleptic characteristics of meat from rabbits fed selim pepper and African nutmeg seed meal as dietary additive. Meat tenderness and colour were not affected by the inclusion of the Xylopia aethiopica and Monodora myristica seed powder in the diets. For flavour, T_3 (Monodora myristica) scored the highest (7.90) while T_1 (control) scored the least (5.95). For juiciness, T_1 recorded the highest score (7.35) while T_2 (Xylopia aethiopica) scored the least (5.80). Overall acceptability scores for rabbit meat indicated a significant increase in T_3 and T_4 (7.80). Sex effect showed no significant ($P>0.05$) difference in the tenderness and colour of meat from male and female rabbits. However, significant differences ($P<0.05$) were recorded for flavor, juiciness and overall acceptability.

Table 4: Sensory quality of meat from male and female rabbits fed experimental diets

Parameters	Sex	T_1 (control)	T_2 (SPM 1%)	T_3 (ANM 1%)	T_4 SPM+ANM (0.5%+ 0.5%)	SEM
Flavour	M	5.80^{c}	7.10^{b}	8.00^{a}	7.80^{ab}	0.25
	F	6.10^{c}	$7\ 10^{b}$	7.90^{a}	7.30^{b}	0.20
	Overall Means	5.95^{c}	7.10^{b}	7.90^{a}	7.55^{a}	0.16
Juiciness	M	7.40^{a}	5.90^{b}	6.20^{b}	5.90^{b}	0.32
	F	7.30^{a}	5.70^{b}	6.00^{b}	6.00^{b}	0.24
	Overall Means	7.35^{a}	5.80^{b}	6.10^{b}	5.95^{b}	0.20
Tenderness	M	7.70	7.20	7.50	7.80	0.29
	F	7.20	7.20	7.60	7.50	0.15
	Overall Means	7.45	7.20	7.55	7.65	0.16
Colour	M	6.50	6.70	6.60	6.70	0.16
	F	6.40	6.60	6.60	6.60	0.16
	Overall Means	6.45	6.65	6.60	6.65	0.11
Overall Acceptability	M	7.90^{ab}	7.50^{b}	7.90^{ab}	8.30^{a}	0.13
	F	7.20^{b}	7.10^{b}	7.70^{a}	7.30^{b}	0.68
	Overall Means	7.55^{ab}	7.30^{b}	7.80^{a}	7.80^{a}	0.14

^{abc}Means in the same treatment by sex block not sharing common superscript are significantly different ($P < 0.05$) SEM = Standard error of mean, M = male, F = female, SPM = Selim Pepper Meal, ANM = African Nutmeg Meal

Discussion

No two plants or feedstuff have the same nutrient composition. Also, there are hardly any feed ingredients that are entirely free from bioactive or toxic substances, with these toxins being a determinant factor for the safety or suitability of such feed ingredient. The presence and level of anti-nutrients found in different feed ingredients can vary widely and are subject to several factors, such as the growth conditions of the plant, analytical procedure used, and the age

of the plant during analysis (32). In this study, the disparity in proximate composition may be attributed to the variation in soil characteristics, conditions of growth, genetic makeup, climatic elements at their areas of cultivation and analytical procedures employed (33). The variation in concentrations of these bioactive compounds may be due to varietal differences of the plants, variation in soil characteristics and growth conditions (34).

(35) reported that dietary inclusion of spices decreased both TC and LDL. Low density lipoprotein has been reported to be the main transporter of cholesterol in the blood stream and is considered "bad cholesterol". This is because they carry fats out of the liver to the blood vessels and seem to encourage arterial cholesterol deposition (36). The observed decrease ($P<0.05$) in TC and LDL with spice inclusion in the diet of the rabbits suggests that selim pepper and African nutmeg seed powder are potential hypolipidemic agents. This agrees with the report of (37) who fed fluted pumpkin stem to rabbits. Also, the report of (38) who fed Xylopia aethiopica to male rats agrees with the result obtained in this study. Selim pepper and African nutmeg seeds are rich in antioxidants such as flavonoids and vitamin C (39). This seems to be a contributing factor to the decline in TC and LDL levels with an increased HDL. Previous study by (40) also reported a reduction in LDL, TC, VLDL and TG of rabbits fed ginger and turmeric additives.

Sex effect showed no significant effect ($P<0.05$) in TG and VLDL values for male and female rabbits. However, beneficial effect ($P<0.05$) were recorded for TC, HDL and LDL. Rabbits fed the control diet recorded positive ($P<0.05$) values for TC and LDL in both sexes but lower in HDL compared to other treatments. This suggests that the rabbits efficiently utilized the feed with spice inclusion. The result of this study agrees with (41) in male and female rabbits and (36) who fed pumpkin stem waste as phyto-additive to weaner rabbits.

The values recorded for flavor are comparable with values reported by (42) on rabbit meat. The high flavour score may likely be connected to the presence of various volatile compounds, essential oils and aldehydes in the test material. This is in consonance with (43) who reported an enhanced latent flavour of food with spice inclusion. The current report negates the findings of (44) and (33) who fed aidan (Tetrapleura tetraptera) to rabbits and ginger meal to broiler birds, respectively.

The meat juiciness scores for rabbit fed T_2 did not improve ($P>0.05$) compared to those of T_3 and T_4. Result showed that the values were within the range reported by (45) for broiler chicken meat cured with ginger, garlic and their combination respectively. The reduction in juiciness may be as a result of the antioxidant present in the spices whose impact is in the reduction of fat deposition due to higher energy catabolism. The result is in line with (46) who reported a high juiciness score in broilers fed Ocimum gratissimum.

Overall acceptability scores for rabbit meat indicated a significant increase ($P<0.05$) in T_3 and T_4 (7.80) which implied that meat from rabbit fed T_3 and T_4 were most preferred. Increased overall acceptability recorded could be attributed to the impact of volatile compounds present in the test material. This agrees with (17) who reported a high overall acceptability in fresh pork sausage processed with Xylopia aethiopica and Monodora myristica. The result of this study is also in tandem with (46) who reported that flavour, juiciness and tenderness of meat is responsible for meat

acceptability. The low score of meat from rabbit fed T_2 may be attributed to the bitter taste in selim pepper seed powder. This is in agreement with (47) who applied powdered spices (ginger, turmeric, clove, nutmeg, pepper and cinnamon) at a ratio of 3:1:1:1:1:0.5 to solid brem. However, the result obtained in this study negates the findings of (48) who reported a high overall acceptability in catfish processed with Xylopia aethiopica.

Sex effect showed no improvement ($P > 0.05$) in the tenderness and colour of meat from male and female rabbits. However, positive effects ($P < 0.05$) were recorded for flavour, juiciness and overall acceptability. Rabbits fed T_3-based diet recorded the highest value for meat flavour while T_1 recorded the least. This could be due to the phenolic compounds (myristicin, elemicin, eugenol and flavonoids) contained in African nutmeg. (31) had earlier reported that positive influence among the different treatments in terms of juiciness. This could be due to the fact that, spices have anti-lipidemic properties which led to the reduction in meat fat content. The panelist also found the meat from rabbit fed T_3 and T_4 to be generally acceptable. This could be as a result of the spices' unique properties derived from the essential oil components, which had an impact on the taste and flavour of the meat (47, 49).

Conclusion and Application

Based on results obtained in this study, it is concluded that

1. Supplementing rabbit diets with selim pepper meal (SPM), African nutmeg meal (ANM) and their combination had beneficial effect on the serum lipid profile of male and female rabbits as it increased HDL and reduced the levels of TC and LDL.
2. At 1% level of ANM inclusion compared to other treatments, there was improved organoleptic properties of rabbit meat. .
3. It is therefore recommended that 1% of African nutmeg be used as additive in rabbit diet to improve serum lipid profile and meat organoleptic quality.

Conflict of Interest

The authors declared no conflict of interest.

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