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National Animal Production Research Institute
Ahmadu Bello University
P.M.B 1096, Shika-Zaria,
Kaduna State, Nigeria.
Email: japr@napri.gov.ng
Website: http://journals.napri.gov.ng

NUTRIENTS UTILIZATION AND CARCASS CHARACTERISTICS OF WEANER RABBITS AS INFLUENCED BY DIFFERENTLY PROCESSED RATTLE BOX (*Crotolaria retusa*) LEAF MEAL

***[1]Yashim, S. M., [2]Gadzama, I. U. and [1]Anene, D. O.**
[1]Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria.
[2]National Animal Production Research Institute, Ahmadu Bello University, Shika-Zaria.
**Corresponding Author's email and phone number: yashimms@gmail.com; smyashim@abu.edu.ng +2348023633456*

ABSTRACT

In an experiment to evaluate the effect of feeding differently processed rattle box (*Crotalaria retusa*) leaf meal on nutrient retention, digestibility and carcass characteristics of weaner rabbits in Northern Guinea Savannah zone of Nigeria, twenty four (24) weaner rabbits of mixed breeds with an average weight of 658±0.12 g were randomly allotted to four (4) dietary treatments with six (6) rabbits per treatment in a Completely Randomized Design. The leaves of *Crotalaria retusa* were harvested fresh and divided into three portions of 4kg each. The first portion was ensiled in a polyethene bag for 14 days, the second portion was oven dried at 60^{o}C for six (6) hours while the third portion was shade-dried for three (3) days. After proper drying, all the samples were ground using hammer mill and taken to the laboratory for proximate analysis. The results of the nutrient intake and digestibility revealed that dry matter (DM), crude protein (CP), crude fibre (CF), ether extract, minerals (ash) and nitrogen free extract (NFE) were significantly higher ($P<0.05$) in the diet containing ensiled *Crotalaria retusa* leaf meal as compared to other treatment diets. Nutrients intake and digestibility were significantly similar ($P>0.05$) in oven-dried *C. retusa* and air-dried *C. retusa* diets. Dietary treatments have no significant ($P>0.05$) effect on chest, loin, stomach, length of large intestine, empty weight of the small intestine and large intestines. But significant ($P<0.05$) difference were observed across the treatments for pre-slaughter weight, dressing percentage, heart, lungs, head, liver, kidney, thigh, tail, fat, spleen, weight of small intestine and empty weight of the small intestine. It was concluded that processed leaves of *Crotalaria retusa* could be efficiently utilized by weaner rabbits without any deleterious effect. However, further studies into the long term effect on internal organs and reproductive performance is suggested.

Key words: Rattle box, *Crotalaria retusa*, Nutrient Utilization, Carcass, Rabbits.

INTRODUCTION

Rabbits play an important role in the supply of animal protein to the Nigerian populace. They are efficient converters of feed to meat and can utilize up to 30% crude fibre as against 10% by most poultry species (Egbo *et al*., 2001). Rabbits can utilize unconventional feedstuffs and diverse forage legumes such as *Crotalaria retusa* (Yashim *et al*., 2016). To make rabbit rearing more viable as a small-scale business, Olabanji *et al*. (2007) have advocated the development of alternative feeding materials that would be relatively cheaper when compared with commercial feeds or conventional feedstuffs. For decades, researches have been conducted to identify alternative substances used for animal production. But the search for alternative feed resources for farm animals as a way of reducing production costs, and making livestock products more readily

available to the populace in the tropics is far from over (Amata, 2010; Phuoc and Jamikorn, 2017).

Rapid increase in meat consumption are not attainable with large animal in view of their long gestation period but may however be met by short breeding-circle animals like the rabbit (Shaahu *et al*., 2014). In view of this, attention is now being shifted to rabbit production in order to solve the problem of shortage of animal protein in human diets (Cavani *et al*., 2000). Increased rabbit production is one sure way of meeting the animal protein requirements of the humans. Rabbits are monogastric herbivores, fast growing, and have short gestation interval, with the ability to rebreed shortly after parturition. They are highly prolific and have the ability to efficiently convert non-competitive feed sources to meat, and do not require a hatchery for continuous production (Shaahu *et al*., 2014).

Rabbit meat is considered as a delicacy and a healthy food product (Baiomy and Hassanien, 2011). This basic understanding is largely attributed to the fact that rabbit has a lean meat which is rich in proteins of high biological value (Dalle Zotte, 2014), with highly unsaturated lipids, low cholesterol content (Palazzo *et al*., 2015), and noticeable quantities of linolenic fatty acid. Also, it displays a low sodium content and high phosphorus content and can be a good source of B vitamins (Hernández and Gondret, 2006). Therefore, rabbit meat is characterized by a high digestibility (Palazzo *et al*., 2015).

Rabbit meat products can be evaluated according to carcass quality and meat quality as for other livestock. Carcass quality has to satisfy economic objectives, such as saleable meat yield and attractiveness to consumers (Dalle Zotte, 2002). The dressing percentage is a very important economic variable in the rabbit market. Information on carcass characteristics is therefore helpful for the effective utilization of rabbit meat (Dalle Zotte, 2014). Some combinations of measurements such as retail cut weights or length measurements are necessary to predict lean percentage in the carcass. Moreover, commercial cutting techniques are easier to carry out than the determination of total lean content in the carcass (Yalçın *et al*., 2006).

The carcass of the domestic rabbit has long shown its importance in the supply of meat for human consumption in densely populated countries (Nwagu *et al*., 2009). Carcass and meat quality changes markedly with the animal's age or slaughter weight (Dalle Zotte, 2002). The production of commercial carcasses in a short time and the improvement of feed efficiency and dressing percentage are the most important criteria to optimize rabbit meat production costs, under the producer and processor perspectives (Bianospino *et al*., 2006). However, information on the evaluation of carcass characteristics of mixed breed of rabbits fed *Crotalaria retusa* leaf meal in Northern Guinea Savammah zone of Nigeria is still scanty. Therefore, the current study was conducted to evaluate the effect of feeding differently processed leaves of rattle box (*Crotalaria retusa*) on nutrient intake, digestibility as well as various carcass traits of weaner rabbits.

MATERIALS AND METHODS

Location of the Experiment

The experiment was carried out at the Rabbitary unit of the Teaching and Research Farm of Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria, Nigeria. The study area is located in the Northern Guinea Savannah zone of Nigeria and is situated on

Latitude 11^{o} 12'N and Longitude 7^{o} 37' E at an altitude of about 610m above sea level (Ovimaps, 2016).

Preparation of Experimental Diets

The leaves of *Crotolaria retusa* used were harvested from the Institute for Agricultural Research (IAR) research farm, Ahmadu Bello University, Zaria. The leaves were separated from the stalks and divided into three (3) portions of equal proportion (4 kg each). The fresh leaves collected were subjected to three (3) processing methods, which were: shade drying, oven drying and ensiling. The rattle box leaves in the first category were air-dried under the shade for three (3) days to preserve its nutritive value as much as possible. While those in the second category were oven dried at 60^{o} C for six (6) hour as over exposure to heat can denature the nutrient content. However, the leaf sample in the third category were ensiled by putting them in a polyethene bag which was properly tied to exclude air and was then transferred into an air-tight container with cover and was buried in the ground for 14 days (2 weeks). After completing each of the processing method, the dried leaves were ground using hammer mill and stored in an air tight container for further use as reported by Yashim *et al.* (2012). The test ingredients were incorporated into four (4) diets at 5% level each except diet one which served as the control.

Table 1: Ingredient composition of the experimental diets fed to weaner rabbits.

	Dietary Treatments			
Ingredients (%)	**Control**	**Ensiled *C. retusa***	**Oven-dried *C. retusa***	**Air-dried *C. retusa***
Maize	36.10	36.40	36.20	36.10
Maize Offal	10.00	10.00	10.00	10.00
Rice Offal	20.00	20.00	20.00	20.00
Groundnut cake	15.30	10.00	10.20	10.30
Blood Meal	5.00	5.00	5.00	5.00
BDG	8.00	8.00	8.00	8.00
C.retusa leaf meal	0.00	5.00	5.00	5.00
Bone Meal	5.00	5.00	5.00	5.00
Salt (Na Cl)	0.30	0.30	0.30	0.30
Lysine	0.10	0.10	0.10	0.10
Methionine	0.20	0.20	0.20	0.20
Total	**100.00**	**100.00**	**100.00**	**100.00**
Cost/kg (~~₦~~)	**59.10**	**51.65**	**51.65**	**51.65**
***Calculated Analysis* (%)**				
Crude Protein	17.09	17.57	17.39	17.35
Crude Fibre	12.08	13.09	12.73	12.36
Ether Extract	4.06	4.32	4.19	4.12
ME (kcal/kg)	2,527	2,516	2,522	2,517
Ca:P	1:7	1:7	1:7	1:7
Lysine	0.88	0.87	0.83	0.83
Methionine	0.70	0.67	0.60	0.60

Key: BDG = Brewer's Dried Grain; ME = Metabolizable Energy; Ca:P = Calcium-Phosphorus ratio

Animals and their Management

Twenty-four mixed-breeds 6 – 7 weeks old weaner rabbits aged between 6 to 7 weeks old with an average weight of 658±0.12g were randomly allocated to four (4) dietary treatment groups in a

completely randomized design. There were 6 rabbits per treatment and each rabbit constituted a replicate. The rabbits were housed individually in all-wire metabolic cages, which were designed for easy collection of faeces and urine. The rabbits were provided with clean drinking water *ad libitum* while weighed amount of feed was offered at 8:00 and 15:30 hr daily. Feed offered and the left over (ort) were weighed to determine feed intake of the animals. The experiment lasted for 63 days.

Digestibility Trial

At the end of the 8 weeks feeding trial, three (3) rabbits were randomly selected from each treatment making a total of 16 rabbits. Faecal samples were collected daily for one week and oven-dried at 60^{o}C for 24 hours until a constant weight was attained. The dried faecal samples were analyzed for the proximate constituents and the results were used to determine digestibility of the feed nutrients by the rabbits.

Carcass Evaluation and Organ Weights

At the end of the digestibility study, two (2) rabbits were randomly selected from each of the 4 treatments (making a total of 8 rabbits) and were used for carcass and organ evaluation. Prior to slaughter, the rabbits were properly tagged, fasted for 12 hours and weighed to determine the final live weight. The rabbits were stunned before bleeding. Bleeding was done by severing the jugular vein with the aid of a sharp knife followed by flaying which was done by hanging the animals by the neck on a hook. Evisceration was carried out immediately by removing the viscera and intestines. The weight of the dressed carcass, head and internal organs were taken. The dressed carcass was cut into chest, loin and thigh and were expressed as a percentage of the live weight. The other organs were expressed as percentage of the empty carcass weight. The intestinal length was determined with the aid of a measuring tape.

Chemical Analysis

The proximate components of the faecal samples were determined using the methods described by AOAC (2005).

Statistical Analysis

The data generated from this study were subjected to Analysis of Variance (ANOVA) procedure of SAS (2002). Significant differences ($P<0.05$) among treatment means were compared using Duncan's Multiple Range Test (Duncan, 1955). The following linear model was used:

$Y_{ij} = \mu + T_i + e_{ij}$

Where:

Y_{ij} = the response variable;

μ = Overall mean;

T_i = effect of the i^{th} treatment (i = 1, 2, 3 and 4);

e_{ij} = random error.

RESULTS AND DISCUSSION

Table 2 and 3 shows the nutrient intake and digestibility of rabbits fed differently processed *Crotalaria retusa* leaf meal. Dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract intake were significantly higher ($P<0.05$) in rabbits fed ensiled *Crotalaria retusa* leaf

meal as compared to other treatments. There was no significant (P>0.05) difference between rabbits fed oven-dried *C. retusa* leaf meal and rabbits fed air-dried *C. retusa* leaf meal. This higher nutrients intake observed with rabbits fed ensiled *C. retusa* leaf meal could be possibly attributed to the aroma and palatability of the ensiled *C. retusa* leaf meal and this agrees with the report of Makinde (2016) for rabbit fed *Leucaena leucocephala* or *Macroptilium atropurpureum* leaves and Yashim *et al*. (2016) for rabbits fed *C. retusa* leaf meal.

Table 2: Nutrient intake of rabbits fed the experimental diets

	Processing methods of *C. retusa*				
Parameter (g/day)	Control	Ensiled	Oven-dried	Air-dried	SEM
Dry Matter	41.99[b]	63.80[a]	29.17[c]	29.43[c]	1.04
Crude Protein	7.31[b]	11.23[a]	4.98[c]	5.54[c]	0.18
Crude Fibre	6.04[b]	8.91[a]	4.34[c]	4.38[c]	0.15
Ether Extract	1.56[b]	2.47[a]	1.03[c]	1.19[c]	0.03
Ash	5.20[b]	7.18[a]	3.85[c]	3.88[c]	0.12
NFE	24.88[b]	37.89[a]	16.36[c]	17.23[c]	0.61

[abc] means with different superscripts within the same row differed significantly (P <0.05).
Key: NFE = Nitrogen Free Extract; SEM = Standard Error of Mean

The digestibility coefficient recorded in this study for dry matter, crude protein, ash and nitrogen free extract were significantly higher (P<0.05) in the control diet than the other processing methods. These were comparable to the results obtained by Adegbola and Okonkwo (2002) who fed cassava leaves to rabbits. There was no significant difference (P>0.05) in the digestibility of ether extract across the dietary treatments. The low digestibility of dry matter observed in air-dried *Crotalaria retusa* leaf meal might have been as a result of the method of processing employed. Apparent crude protein digestibility was similar for all the animals except those on the control diet. Studies have shown that as dietary fibre or cell wall material levels increased, apparent digestibility of dry matter declined (Uko *et al*., 2001). This result also corroborates with the reports of Abegunde *et al*. (2014) when *Garcinia kola* leaf meal was fed to rabbits and Fayemi *et al*. (2011) when rabbits were fed *Leucaena leucocephela* leaves, who both observed reduced apparent dry matter digestibility. The initial increase in digestibility observed in rabbits fed the control diet might be attributed to better utilization of the feed by the animal (possibly as a result of non-inclusion of *Crotalaria retusa* leaf meal) which triggered better movement in the tract and improved digestion.

The carcass characteristics and organ weights of weaner rabbits fed differently processed *crotalaria retusa* leaf meal is as shown in Table 4. All parameters investigated were significantly affected by the diets except the chest, loin, stomach, length of large intestine, weight of small and large intestines (empty) and weght of large intestine (full). The pre-slaughter and carcass weight of rabbits fed control,ensiled and oven-dried *C. retusa* leaf meal were statistically higher than the air-dried *C. retusa* leaf meal diet. The significant difference (P<0.05) observed in pre-slaughter weight and carcass weight is a reflection of feed intake which was lower for rabbits fed air-dried *C. retusa* leaf meal. The values observed for the lungs ranged between 1.14 and 2.98% and those for thigh were 35.12 and 40.40%. The differences observed in the thigh weights may not have

been as a result of the treatment effects but due to individual differences or human error during cutting.

Table 3: Nutrient digestibility of rabbits fed the experimental diets.

	Processing methods of *C. retusa*				
	Control	Ensiled	Oven-dried	Air-dried	SEM
Dry Matter	57.01^{a}	43.67^{ab}	34.45^{b}	29.40^{b}	2.39
Crude Protein	67.69^{a}	54.83^{ab}	43.57^{b}	47.32^{ab}	3.10
Crude Fibre	63.48	54.55	42.34	42.08	3.46
Ether Extract	75.21	74.30	71.02	70.39	2.72
Ash	61.45^{a}	50.42^{ab}	33.87^{b}	37.36^{b}	2.72
NFE	47.98^{a}	34.65^{ab}	33.96^{ab}	24.69^{b}	2.37

^{abc} means with different superscripts within the same row differed significantly (P <0.05).
Key: NFE = Nitrogen Free Extract; SEM = Standard Error of Mean

Table 4: Carcass characteristics of rabbits fed the experimental diets.

	Dietary Treatments					
Parameters	**Control**	**Ensiled *C. retusa***	**Oven-dried *C. retusa***	**Air-dried *C. retusa***	**SEM**	**LOS**
Pre-slaughter	1224.00^{a}	1257.00^{a}	1062.00^{a}	674.00^{b}	35.95	*
Carcass weight	616.00^{a}	636.00^{a}	507.00^{a}	318.00^{b}	19.74	*
Dressing %	49.38^{a}	49.37^{a}	44.34^{b}	43.07^{b}	0.34	*
Head*	18.22^{c}	18.05^{c}	21.80^{b}	25.47^{a}	0.40	*
Heart*	0.40^{b}	0.32^{b}	0.50^{a}	0.63^{a}	0.01	*
Lungs*	1.14^{b}	1.24^{b}	1.67^{a}	2.98^{a}	0.33	*
Liver*	4.96^{b}	4.92^{b}	5.74^{ab}	6.91^{a}	0.15	*
Kidney*	1.38^{b}	1.42^{b}	2.36^{a}	2.67^{a}	0.04	*
Thigh*	36.66^{b}	35.12^{ab}	35.51^{ab}	40.40^{a}	0.66	*
Chest*	37.57	38.94	38.45	38.04	0.41	NS
Loin*	24.73	23.24	24.85	19.34	1.00	NS
Tail*	1.13^{ab}	0.79^{b}	0.98^{ab}	1.25^{a}	0.17	*
Stomach*	12.16	12.51	11.04	11.32	0.43	NS
Abdominal Fat*	2.65^{ab}	4.46^{a}	0.39^{b}	0.00^{b}	0.40	*
Spleen*	0.16^{b}	0.23^{ab}	0.19^{ab}	0.31^{a}	0.01	*
Length of small intestine [1]	100.50^{a}	93.00^{ab}	100.00^{a}	81.00^{b}	4.32	*
Length of large intestine[1]	45.70	55.50	58.50	46.25	3.09	NS
Small intestine (full)	6.92^{ab}	5.79^{b}	6.99^{ab}	8.95^{a}	0.35	*
Small intestine (empty)	4.99	4.45	5.31	5.81	0.41	NS
Large intestine (full)	16.52	17.14	19.52	19.02	0.60	NS
Large intestine (empty)	7.50	9.13	10.82	9.12	0.77	NS

^{abc} means with different superscripts within the same row differed significantly (P <0.05).
* Organs expressed as percentage of empty carcass
[1] = measured in centimeters (cm), SEM = Standard Error of Mean

The dressing percentage ranged from 43.07 to 49.38% with the highest values (49.38) observed in the control and lowest (43.07%) in air-dried. The higher dressing percentage may be related to the higher fat content recorded with the carcass. This is similar to the report of Fielding (1991), who opined that the dressing percentage of rabbits normally tends to be greater if the rabbits are fully grown and have some abdominal fat. Fielding (1991) further stated that the dressing percentage would be 50% or less if the rabbit is young, thin and with a full digestive tract at slaughter. Uko *et al*. (2001) obtained dressing percentage ranging from 67.60 to 68.40% in rabbits in which the fur was removed by roasting and the head left intact. The study revealed that there was a relationship between dressing percentage and abdominal fat of carcass.

Fat deposition expressed as percentage of carcass is significantly higher in rabbits fed control and ensiled leaves diets when compared with other diets. Values obtained for heart, lungs, liver and kidneys for animals fed the ensiled *C. retusa* in this study were statistically similar with rabbits on the control diet. This implies that the inclusion of the ensiled *C. retusa* leaf meal in the diets of rabbits did not have deleterious effect on major internal organs rabbits like heart, lungs, liver and kidneys that could be used to assess the toxicity of the feed. This finding support the report of Abegunde *et al*. (2014) who replaced maize with *Garcinia kola* leaf meal. It is a common practice in feeding trials to use weights of some internal organs like liver and kidneys as indicators of toxicity. Bone (1979) reported that if there is any toxic element in the feed, abnormalities in weights of liver and kidney would be observed. The abnormalities arise because of increased metabolic rate of the organ in attempt to reduce these toxic elements or anti-nutritional factors to non-toxic metabolites. Values obtained by Ekpo *et al.* (2009) did not show any significant difference ($P>0.05$) among treatments for heart, lungs, kidney and liver of rabbits fed cassava tuber meals.

CONCLUSION

Results showed that inclusion of ensiled *Crotalaria retusa* leaf meal in the diets of weaner rabbits did not have deleterious effect on major internal organs like heart, lungs, liver and kidneys. It is recommended that ensiled leaves of *C. retusa* could be incorporated into the diets of weaner rabbits at 5% inclusion levels. However, further studies into other processing methods should be explored and the long term effect on internal organs and reproductive performance is suggested.

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