

RESPONSE OF GROWING RABBITS (*ORYCTOLAGUS CUNICULUS*) FED
DIETS CONTAINING RAW TALLOW (*DETARIUM MICROCARPUM*)
SEED MEAL

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Abstract: A 12-week study was conducted to determine the effect of graded levels of raw tallow seed meal (RTSM) on growth performance, haematological and biochemical parameters and organoleptic qualities of growing rabbits. Five experimental diets were compounded to contain 0, 25, 50, 75 and 100% RTSM replacing the palm kernel cake weight for the weight designated as T1, T2, T3, T4 and T5, respectively. Forty-five (45) weaned rabbits between 5 and 6 weeks with an average body weight ranging from 500 to 600 g of mixed breeds and sexes (females and males) were randomly allocated to the five (5) dietary treatments in the randomized complete block design with nine (9) rabbits per treatment replicated three (3) times with three (3) rabbits each. Data were collected on feed intake, weight gain, feed conversion ratio, nutrient digestibility, some haematological and biochemical parameters and organoleptic qualities of the rabbits. The feed intake, weight gain and feed conversion ratio were significantly ($P<0.05$) affected by the dietary treatments. The rabbits fed diets T1, T2 and T3 recorded similar feed intake (62, 66.95, and 66.50 g), total weight gain (1328.73, 1320.44, and 1323.49 g) and feed conversion ratio (3.92, 4.26, and 4.22) which were significantly better than those observed for the rabbits fed diets T4 and T5. The nutrient digestibilities of the rabbits fed the experimental diets were also significantly ($P<0.05$) affected. The rabbits fed diet T2 had better fiber digestibility (47.05%) compared to other treatment groups. Ether extract digestibility was observed to be better in the group of rabbits fed diets T1, T2 and T3, respectively. Some of the other nutrients in the group of rabbits fed diets T3, T4 and T5 were similarly digested. The haematological parameters were observed to be depressed as the level of RTSM increased in the diets. Packed cell volume, red blood cells and white blood cells were observed to reduce from 37.69 to 21.22%, 4.14 to 2.18

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g/dl and 4.98 to 3.02 g/dl. The biochemical parameters indicated a similar trend as that of the haematological parameters. Total protein, glucose and urea reduced from 6.15 to 4.63 g/dl, 5.15 to 3.80 g/dl and 7.76 to 4.00 mmol/l. The result of the organoleptic qualities indicated a non-significant ($P>0.05$) difference except for the juiciness which was significantly ($P<0.05$) high in the rabbits fed diets T1 (5.90), T3 (5.65), and T4 (5.90), respectively. In conclusion, up to 50% of RTSM can be included in the diets of rabbits without adverse effects on productive performance, nutrient utilization, blood parameters and organoleptic qualities.

Key words: rabbits, raw, tallow, seed meal, performance, nutrient digestibility.

Introduction

In Nigeria, there is an insufficient supply of cereals, cereal by-products and other agro-industrial wastes to sustain small- and medium-scale rabbit production (Makinde et al., 2017). To make rabbit rearing more viable as a small-scale business, Makinde and Inuwa (2015) advocated the utilization of cheap and locally available feedstuffs with a high nutritive value and digestibility.

One of such cheap and locally available ingredient is tallow (*Detarium microcarpum*) seeds. Tallow seed was reported by Uchegbu et al. (2009) to contain a sufficient amount of protein (17–36%), carbohydrate (39–66%) and fats (10–17%) with relatively adequate proportions of lysine and methionine as a percentage of the protein (2.14 and 1.0% respectively). In the feeding trial conducted by Obun et al. (2011), the authors reported that when tallow seed meal was boiled for 80 minutes, about 20% was incorporated in the diet of starter chicks without any adverse effects on growth performance. Furthermore, Obun (2013) reported that raw tallow seed meal can be included in the broiler diet up to the 5% level without influencing the acceptability of the feed and haematological and biochemical indices of broilers. However, there is a dearth of information on the potential of *D. microcarpum* seed meal as an alternative feed source for rabbits. It was in view of the above that this study was conducted to investigate productive performance, blood constituents, nutrient digestibility and organoleptic properties of rabbits fed raw tallow seed meal based diets.

Materials and Methods

Experimental site

The study was carried out at the Rabbitry Unit of the Ministry of Livestock Services and Development, State Veterinary Centre, Bosso, Minna, Niger State. Minna is located on the latitude 9⁰N, longitude 7⁰E. Minna experiences distinct dry

and wet seasons with its mean annual rainfall of 1100 and 1600 mm (with the highest main monthly rainfall in September) and a mean temperature ranges between 21⁰C and 36.5⁰C (Climatemp, 2011).

Source of feed ingredients and experimental diets

Tallow seeds were sourced from Bida and its surrounding villages, while the fixed ingredients such as premix, bone meal, oyster shell, maize, PKC and maize offal were obtained from Sammy Agro-ventures Milling Center, Minna, Niger State while the common salt was obtained from Kure Ultra-modern Market, Minna. Raw tallow seed (50 kg) was crushed using a crushing machine before taken to Sammy Agro-venture milling center to formulate the rabbit diets. Five dietary treatments were formulated. Diet T1 (control diet) contained 0% raw tallow seed meal, while T2, T3, T4 and T5 contained 25, 50, 75 and 100% raw tallow seed meal respectively with the tallow seed being quantitatively substituted for palm kernel cake (PKC). The proximate composition of raw tallow seed is shown in Table 1 while the gross composition of experimental diets is shown in Table 2.

Table 1. Proximate composition of raw tallow seed.

Parameters	Composition (%)
Dry matter	92.00
Crude fiber	14.95
Crude protein	19.25
Ether extract	8.38
Ash	3.50
Nitrogen-free extract	46.62
Energy (kcal/kg ME)	3300.60

NFE = 100 – (% moisture + % crude protein + % ether extract + % crude fiber + % ash).

Experimental rabbits and their management

The experiment was conducted using forty-five (45) weaned rabbits of different breeds and mixed sexes. The rabbits were purchased from the Rabbitry Unit of the Ministry of Livestock Service and Development, State Veterinary Center Bosso, Minna, Niger State, Nigeria. The rabbits were between 5 and 6 weeks of age with an average initial weight ranging between 500 and 600 g. Before arrival of the rabbits, hutches were washed, cleaned and disinfected using detol and detergent. Also, both the feeders and drinkers were washed and cleaned. The hutches, feeders and drinkers were cleaned and dried on a daily basis before water and feeds were supplied as prescribed by Aduku and Olukosi (1990).

There was an adaptation period of 4–5 days for the animals to become accustomed to the environment and new feed. The rabbits were randomly allocated

to five treatments in a completely randomized design. There were nine rabbits in each treatment with three rabbits per replicate. The routine veterinary care was given throughout the period of the experiment. All the rabbits were dewormed against ecto and endo parasites using Ivermectin injection.

Table 2. The gross composition of the experimental diets.

Ingredient (%)	T ₁ (0%)	T ₂ (25%)	T ₃ (50%)	T ₄ (75%)	T ₅ (100%)
Maize	17.05	17.05	17.05	17.05	17.05
PKC	58.10	43.57	29.05	14.53	0.00
RTSM	0.00	14.53	29.05	43.57	58.10
Maize offal	20.00	20.00	20.00	20.00	20.00
Salt	0.50	0.50	0.50	0.50	0.50
*Vitamin premix	0.25	0.25	0.25	0.25	0.25
Bone meal	3.00	3.00	3.00	3.00	3.00
Oyster shell	1.10	1.10	1.10	1.10	1.10
Total	100.00	100.00	100.00	100.00	100.00
Determined nutrients (%)					
Crude protein	16.85	17.00	17.25	16.45	17.00
Crude fiber	15.62	16.28	15.11	14.23	14.68
Ash	8.50	10.00	12.50	13.50	10.50
Ether extract	9.00	8.50	10.50	9.50	9.50
Energy,Kcal/kg ME	2523.00	2620.00	2632.00	2721.00	2641.00

T₁(0% RTSM), T₂(25% RTSM), T₃(50% RTSM), T₄(75% RTSM), T₅(100% RTSM) *premix supplied contains: retinol acetate (1000000 iu), Vit D3, (20000000 iu), Vit E (1500 iu), Vit B (3000 mg), Niacin (1500 mg), Calcium pantoethenate (800 mg), Vit B6 (300 mg), Vit B12 (10 mg), Vit K3 (2000 mg), Biotin (20 gm), Folic acid (500 mg), Choline chloride (250000 mg), Manganese (75000 mg), Iron (2500 mg), Copper (5000 mg), Zinc (7000 mg), Selenium (150 mg), Iodine (1300 mg), Magnesium (100 mg), 500g ethoxyquin and BHT (700 g).

Data collection

Feed consumption was calculated on a daily basis using the formula:

Feed consumption = amount of feed given (g) – amount of left-over feed (g).

The animals were weighed individually on a weekly basis to determine the weight changes, and the weight gained was determined by the formula shown below:

$$\text{Daily weight gained/rabbits/day} = \frac{\text{final weight(g)} - \text{initial weight(g)}}{\text{number of rabbits} \times \text{number of days}}$$

Feed conversion ratio (FCR) was also calculated as the quantity of feed that would produce 1 kg of weight gain using the formula:

$$\text{Feed conversion ratio (FCR)} = \frac{\text{total feed intake}}{\text{total weight gain}}$$

Digestibility trial

The digestibility test was carried out using the complete collection method at the eleventh (11) week of the study. The rabbits were placed in their respective metabolic cages according to their treatment and were adapted for three (3) days. Faecal samples were collected for five days, air-dried, bulked together and maintained with boric acid independently in a dark plastic bag and then saved in the fridge in the laboratory with the number label on each nylon, for easy identification. The faecal samples were oven-dried and the differences were taken between the wet and dried faecal samples and the sub-samples were analyzed for proximate composition. The percentage of nutrient retention was calculated using the equation below:

Nutrient retention = [(nutrient intake - nutrient in excreta) / (nutrient intake)] × 100,

where:

Nutrient intake (g) = dry feed intake × nutrient in diet,

Nutrient in excreta (g) = dry faecal output × nutrient in faeces.

Haematological and blood serum analysis

At the end of the trial, two rabbits per replicate were randomly selected for blood analysis at the 12th week. They were bled from the ear vein. About 5 ml of blood for haematological analysis was collected from each rabbit into bottles containing ethylene diamine tetra acetic acid (EDTA). Blood samples meant for determining biochemical indices (total protein, albumin, globulin, urea, cholesterol and triglyceride) were collected into the bottles without EDTA. Haematological and biochemical parameters were determined using the standard clinical chemistry procedure (Olorede et al., 1996).

Sensory evaluation

The meat from the hind limbs was boiled and used for the sensory evaluation. Various cuts of the meat were made into bite sizes and then served in coded plates to twenty (20) qualified panel members to evaluate the meat for color, bitterness, juiciness, taste and overall acceptability using the 9-point hedonic scale (1 – hate incredibly, 9 – like extremely). The order of demonstration of samples was randomized to the panelists. Each of these palatability characteristics was ranked independently of others. Cool water was provided to the judges to rinse their mouths after scoring each sample.

Statistical analysis

All data collected were subjected to one-way analysis of variance (ANOVA). Differences between means were separated using Duncan's multiple range test (Duncan, 1955). All computations were made by statistical software (SPSS, 2006).

Results and Discussion

The results of growth performance of rabbits fed raw tallow seed meal (RTSM) are presented in Table 3. The feed intake, weight gain and feed conversion ratio (FCR) were significantly ($P < 0.05$) affected. Similar weight gains and feed conversion ratio were observed in the groups of rabbits fed diets T1, T2 and T3, respectively. The lowest feed intake, weight gain and poor feed conversion ratio were recorded in the groups of rabbits fed diets T4 and T5. However, the low feed intake was similarly recorded in the group of rabbits fed diet T1. The decrease in the final live weight, feed intake, weight gain and poor FCR observed among rabbits fed diets T4 and T5 is in line with a similar observation made by Obun et al. (2011), for broiler chickens fed raw tallow diets. This could be attributed to the inherent anti-nutritional factors present in the raw tallow seed meal (RTSM) such as oxalates, phytates, saponins and tannins. Oxalates form complexes with the mineral such as calcium and thus make them unavailable to the body, resulting in low feed intake and causing irritation of the gut, inhibiting energy and protein utilization in broilers (Agwunobi et al., 2002; Okereke, 2012). Phytates affect protein and mineral utilization, which results in the poor performance while tannins impair digestive enzymes and cause gut irritation. Also, oxalates impair the absorption of calcium in the digestive tract and limit nitrogen retention (Hang and Binh, 2013). Olomu (1995) has reported that saponin impairs the performance through its irritating effect on the linings of the mouth and guts and through its bitter taste. Tannin in diets imposes an astringent taste that affects palatability, reduces feed consumption and consequently growth performance. It also binds to both endogenous and exogenous proteins including enzymes of the digestive tract, thereby affecting the protein utilization (Sotelo et al., 1995). The improved performance observed among rabbits fed 25 and 50% RTSM diets in terms of body weight gain, feed intake and feed conversion ratio suggests that there was an enhanced availability, digestion, absorption and utilization of the nutrients by the rabbits.

Table 3. Growth performance of rabbits fed graded levels of raw tallow seed meal.

Parameters	T ₁ (0%)	T ₂ (25%)	T ₃ (50%)	T ₄ (75%)	T ₅ (100%)	SEM	LS
Average initial weight, g/r	505.44	504.45	506.40	506.11	506.11	0.98	NS
Average final weight, g/r	1834.17 ^a	1824.89 ^a	1829.89 ^a	1637.00 ^b	1626.00 ^b	28.00	*
Total weight gain, g/r	1328.73 ^a	1320.44 ^a	1323.49 ^a	1130.89 ^b	1119.89 ^b	26.15	*
Average daily weight gain, g/r	15.82 ^a	15.72 ^a	15.76 ^a	13.46 ^b	13.33 ^b	0.28	*
Total feed intake, g/r	5208.00 ^b	5623.80 ^a	5586.00 ^a	5812.80 ^a	5376.00 ^{ab}	134.40	*
Average feed intake, g/r	62.00 ^b	66.95 ^a	66.50 ^a	69.20 ^a	64.00 ^{ab}	1.60	*
FCR	3.92 ^a	4.26 ^a	4.22 ^a	5.14 ^b	4.80 ^b	0.15	*
Mortality, %	0.00	0.00	0.00	0.00	0.00		

^{abc} means with different superscripts in the same row are significantly ($p < 0.05$) different. SEM = standard error of the mean, LS = level of significance, g/r = grams per rabbit, FCR = feed conversion ratio.

The results of nutrient digestibility of rabbits fed RTSM based diet are shown in Table 4. The results show that digestibilities for crude protein, crude fiber, ether extract and nitrogen-free extract were significantly ($p < 0.05$) different while dry matter showed no significant ($p > 0.05$) difference in all treatments. Crude protein digestibility of the rabbits fed T1 diet was significantly ($p < 0.05$) higher than those of the rabbits fed other diets. The crude fiber digestibility showed that rabbits fed diets T1 and T2 had significantly ($p < 0.05$) higher values than those fed diet T5 which had the lowest value (39.49%). Ether extract digestibility was similar ($p > 0.05$) for rabbits fed diets T1, T2 and T3. The lowest values were recorded among rabbits fed T4 and T5 diets ($p > 0.05$). Nitrogen-free extract digestibility was significantly ($p < 0.05$) higher among rabbits fed diets T1, T2 and T3 than among those fed other diets. The results of the digestibility studies show that there was a significant ($P < 0.05$) reduction in the digestibility of nutrients with increasing levels of RTSM in the diets. Rabbits fed diets T1, T2 and T3 had similar ether extract and nitrogen-free extract digestibilities which could be an indication that the rabbits could tolerate RTSM up to the 50% inclusion level in the diets. The reduction in crude protein digestibility and other nutrients with increased RTSM may be ascribed to the presence of the anti-nutritional substances contained in the raw tallow seed meal. The anti-nutritional factors (ANFs) interfere with metabolic processes such as growth and bioavailability of nutrients that are negatively influenced (Binita and Khetarpaul, 1997). Like other ANFs, the intake of a sufficient quantity of dietary tannin resulted in decreased daily gain and impaired the efficiency of feed utilization due to reduced protein digestibility in chickens (Obun et al., 2011) and pigs (Jansman et al., 1993). Tannins have been reported to contain a high protein binding capacity, that is, tannin-protein complexes, which are extremely hydrophobic (Mitaru et al., 1984) and have been reported to be responsible for low digestibility of protein and low availability of amino acids due to increased faecal excretion of nitrogen in pigs (Hlodversson, 1987) and chickens (Ortiz et al., 1993).

Table 4. Nutrient digestibility of rabbits fed graded levels of raw tallow seed meal.

Parameters (%)	T ₁ (0%)	T ₂ (25%)	T ₃ (50%)	T ₄ (75%)	T ₅ (100%)	SEM	LS
Dry matter	85.05	81.13	81.12	82.10	81.70	0.49	NS
Crude protein	84.19 ^a	79.83 ^b	80.85 ^b	80.64 ^b	79.97 ^b	0.62	*
Crude fiber	47.57 ^a	47.05 ^a	43.61 ^b	45.70 ^b	39.49 ^c	0.63	*
Ether extract	92.93 ^a	93.86 ^a	93.72 ^a	81.88 ^b	82.88 ^b	1.16	*
NFE	87.69 ^a	85.12 ^a	84.04 ^a	81.49 ^c	78.89 ^d	1.74	*

^{abc} means with the same superscript in the same row are significantly different ($p < 0.05$). LS = level of significance, SEM = standard error of the mean, NFE = nitrogen-free extract.

The results of haematological parameters of rabbits fed RTSM based diets are shown in Table 5. The results reveal that packed cell volume (PCV), haemoglobin (Hb), white blood cell (WBC), mean corpuscular volume (MCV), neutrophils, lymphocyte, and basophil were significantly ($p < 0.05$) affected by the dietary treatments. The lower values for white blood cell, lymphocytes, neutrophils and basophil counts as observed among rabbits fed diets T3, T4 and T5 could be attributed to the accumulative toxic effect of high RTSM levels in the diets. This is similar to the report of Obun (2013), who observed a decrease in the white blood cell as raw tallow seed meal increased in the diet of broiler chickens. The non-significant effect of the diet on red blood cells was an indication that the diet had no influence on the red blood cells. Fanimo et al. (2003) had earlier reported that the inclusion of cashew apple waste in the diet of growing rabbits did not affect the red blood cell. The values of haemoglobin of rabbits fed diets T4 and T5 (9.25 and 8.10 g/dl) fell below the normal range of 10–15 g/dl and the PCV values of rabbits fed diets T2, T3, T4 and T5 (27.18, 28.55, 13.94 and 21.22%) also fell below the normal range of 30–50% reported by RAR (2009). Lloyd and Gibson (2006) observed that normal haemoglobin and PCV values are good indicators of the nutritional status of the feed. Mean corpuscular volume was significantly higher among rabbits fed diet T3 compared with those fed other diets.

Table 5. Haematological values of rabbits fed graded levels of raw tallow seed meal.

Parameters	T ₁ (0%)	T ₂ (25%)	T ₃ (50%)	T ₄ (75%)	T ₅ (100%)	SEM	LS
PCV (%)	37.69 ^a	27.18 ^b	28.55 ^b	13.94 ^c	21.22 ^b	2.77	*
Hb (g/dl)	11.35 ^a	11.50 ^a	11.60 ^a	9.25 ^b	8.10 ^b	0.94	*
RBC ($\times 10^6/\text{mm}^3$)	4.98	4.05	3.00	3.38	3.02	0.37	NS
WBC ($\times 10^3/\text{mm}^3$)	6.29 ^a	6.14 ^a	4.15 ^{ab}	3.30 ^{bc}	2.18 ^c	0.70	*
MCH (pg)	19.90	19.70	19.85	17.00	18.70	0.63	NS
MCV (fl)	67.50 ^b	76.50 ^b	91.50 ^a	77.00 ^b	76.00 ^b	2.84	*
MCHC (g/dl)	21.25	28.65	28.15	23.85	28.35	1.26	NS
Neutrophils (%)	69.38 ^a	60.27 ^b	58.25 ^b	58.85 ^b	49.95 ^c	2.59	*
Lymphocyte (%)	28.30 ^a	30.10 ^a	23.65 ^{ab}	17.20 ^b	13.15 ^b	2.56	*
Monocyte (%)	5.58	5.00	13.45	11.40	17.40	1.83	NS
Basophil (%)	3.53 ^a	2.95 ^a	0.20 ^b	0.20 ^b	0.20 ^b	0.53	*

^{abc} means with different superscripts in the same column are significantly ($p < 0.05$) different. SEM = standard error of the mean, NS = not significant, *significant, PCV = packed cell volume, Hb = haemoglobin, RBC = red blood cell, WBC = white blood cell, MCH = mean corpuscular haemoglobin, MCHC = mean corpuscular haemoglobin concentration, MCV = mean corpuscular volume.

The results of serum biochemical indices of rabbits fed RTSM based diets are shown in Table 6. The results show that total protein, albumin, cholesterol, triglyceride and urea were significantly ($p < 0.05$) affected by the dietary treatments. The observed decrease in total protein, albumin and urea concentrations among rabbits fed diets T4 and T5 suggests alteration of normal protein metabolism due to

interference of protein utilization. This result is in line with similar observation made by Obun (2013), for broiler chickens fed raw tallow diets. The decrease in serum cholesterol among rabbits fed diet T4 may be attributed to the metabolites present in RTSM. Price et al. (1987) had earlier reported that saponin in diets of animals is known to reduce the uptake of certain nutrients such as cholesterol and glucose, and may help in reducing the metabolic burden that would have been placed on the liver. Similarly, Awe and Sodipo (2001) observed that saponin reduces body cholesterol by preventing the bile reabsorption and suppresses rumen protozoan thereby causing it to lyse. Triglyceride was significantly higher among rabbits fed diets T2 and T3, but differed ($p < 0.05$) significantly from all other treatment means which were similar ($p > 0.05$).

Table 6. Serum biochemical indices of rabbits fed graded levels of raw tallow seed meal.

Parameters	T ₁ (0%)	T ₂ (25%)	T ₃ (50%)	T ₄ (75%)	T ₅ (100%)	SEM	LS
Total protein (g/dl)	6.15 ^a	5.70 ^{ab}	5.90 ^a	4.95 ^b	4.63 ^b	0.23	*
Albumin (g/dl)	4.10 ^a	3.65 ^{ab}	3.80 ^a	2.80 ^b	2.45 ^b	0.31	*
Globulin (g/dl)	2.05	2.05	2.10	2.15	2.18	0.18	NS
Cholesterol (g/dl)	1.25 ^{ab}	1.85 ^a	1.85 ^a	0.60 ^b	1.25 ^{ab}	0.17	*
Triglyceride (g/dl)	0.30 ^b	1.75 ^a	1.55 ^a	0.60 ^b	0.70 ^b	0.19	*
Glucose (g/dl)	5.15	3.85	4.35	4.75	3.80	0.23	NS
Urea (mmol/L)	7.76 ^a	6.66 ^{ab}	7.75 ^a	4.26 ^b	4.00 ^b	0.61	*

^{a,b,c} means with different superscripts in the same row are significantly ($p < 0.05$) different. SEM = standard error of the mean, LS = level of significance.

The results of the sensory evaluation of meat from rabbits fed RTSM based diet are shown in Table 7. The results reveal that tenderness, flavor, color and overall acceptability were not significantly ($p > 0.05$) different except for the juiciness. The non-significant difference ($p > 0.05$) observed in this study on the organoleptic qualities of boiled meat from rabbits fed graded levels of RTSM is in line with the report of Vasanthakumar et al. (1999) that sensory attributes of pressure-cooked meat from weaned rabbits fed graded levels of neem seed kernel cake were found to be similar.

Table 7. Sensory evaluation of meat from rabbits fed graded levels of raw tallow seed meal.

Parameters	T ₁ (0%)	T ₂ (25%)	T ₃ (50%)	T ₄ (75%)	T ₅ (100%)	SEM	LS
Tenderness	5.25	5.10	5.05	4.55	5.00	0.13	NS
Flavor	5.85	6.80	6.20	6.10	6.05	0.20	NS
Juiciness	5.90 ^a	5.00 ^b	5.65 ^{ab}	5.90 ^a	4.60 ^b	0.19	*
Color	5.90	5.75	5.50	5.60	5.90	0.20	NS
Overall acceptability	6.70	7.15	6.75	5.95	6.20	0.41	NS

^{abc} means with the same superscript in the same column are significantly ($p < 0.05$) different. LS = level of significance, SEM = standard error of the mean.

Conclusion

This study shows that up to 50% of RTSM can be included in the diets of rabbits without adverse effect on productive performance, nutrient utilization, blood parameters and organoleptic qualities.

References

- Aduku, A.O., & Olukosi, J.O. (1990). Rabbit management in the tropics, production, processing, utilization, marketing, economics, practical training, research and future prospects G.U Publications, Abuja, Nigeria, 33-44.
- Agwunobi, L.N., Angwukan, P.O., Cora, O.O., & Isika, M.A. (2002). Studies of the use of *Colocasia esculenta* (Taro Cocoyam) in the diets of weaned pigs. *Tropical Animal Health and Production*, 34(3), 241-247.
- Awe, I.S., & Sodipo, O.A. (2001). Purification of saponins of root of *Blighia sapida*. *Nigerian Journal of Biochemistry and Molecular Biology*, 16(3), 201-204.
- Binita, R., & Khetarpaul, N. (1997). Probiotic fermentation: Effect on anti-nutrients and digestibility of starch and protein of indigenous developed food mixture. *Journal of Nutrition and Health*, 4, 139-147.
- Climatetemp. (2011). Minna climate information. <http://www.climatetemp.info/nigeria/minna.html>.
- Duncan, D.B. (1955). Multiple range F-test. *Biometric* 11, 1-42.
- Fanimo, A.O., Oduguwa, O.O., Alade, A.A., Ogunnaike, T.O., & Adesehinwa, A.K. (2003). Growth performance, nutrient digestibility and carcass characteristic of growing rabbits fed cashew apple waste. *Livestock Research for Rural Development*, 15(8), 1-8.
- Hang, D.T., & Binh, L.V. (2013). Oxalate concentration in taro leaves and petioles and effect of added calcium on nitrogen and calcium retention in pigs given diets containing 50% ensiled taro leaves and petioles. *Livestock research for Rural Development*, Volume 25, Article #65. Retrieved April 17, 2013, from <http://www.lrrd.org/lrrd25/4/hang25065.htm>
- Hlodversson, R. (1987). The nutritive value of white- and dark-flowered cultivars of pea for growing pigs. *Animal Feed Science and Technology*, 17, 245-255.
- Jansman, A.J.M., Huisman, J., & Van der Poel, A.F.B. (1993). Ileal and faecal digestibility in piglets of field beans (*Vicia faba*L.) varying in tannin content. *Animal Feed Science and Technology*, 42, 83-96.
- Lloyd, S., & Gibson, J.S. (2006). Haematology and biochemistry in healthy young pheasants and red-legged partridges and effects of spironucleosis on these parameters. *Avian Patol*, 35 (4), 335-340.
- Makinde, O.J., Aremu, A. Alabi, O.J., Jiya, E.Z., & Ibe, E.A. (2017). Roasted African star apple (*Chrysophyllum albidum*) kernel meal improves growth performance of growing rabbits. *Tropical and Subtropical Agroecosystems*, 20, 457-464.
- Makinde, O.J., & Inuwa, M. (2015). The use of agro industrial by-products in the diet of grower turkeys. *Tropical and Subtropical Agro Ecosystem*, 18, 371-378.
- Mitaru, B.N., Reichert, R.D., & Blair, R. (1984). The binding of dietary protein by sorghum tannins in the digestive tract of pigs. *Journal of Nutrition*, 114, 1787-1796.
- Obun, C.O., Yahaya, M.S., & Kibon, A.A. (2011). Responses of broilers to dietary levels of processed *Detarium microcarpum* (Guill and sperr) seed meal. *Livestock Research for Rural Development*. Volume 23, Article #4. Retrieved April 20, 2011, from <http://www.lrrd.org/lrrd23/04/hang21164.htm>

- Obun, C.O. (2013). Impact of Raw Tallow (*Detarium microcarpum*) (Guill and Sperr) Seed Meal on Performance and Blood Parameters in Broilers. *Iranian Journal of Applied Animal Science*, 3 (2), 289-294.
- Olorede, B.S.R., Onifade, A.A., Okpara, O.A., & Babatunde, G.M. (1996). Growth, nutrient retention, haematology and serum biochemistry of broiler chickens fed shea butter cake and palm kernel cake in humid tropics. *Journal of Applied Animal Research*, 4, 173-180.
- Okereke, C.O. (2012). Utilization of Cassava, sweet potato and Cocoyam meals as dietary sources for poultry. *World Journal of Engineering and Pure and Applied Sciences*, 2 (3), 63-68.
- Olomu, J.M. (1995). *Monogastric Animal Nutrition: Principles and practice*. 1stedn. A Jachem publication, Benin City, Nigeria, 157 pp.
- Ortiz, L.T., Centeno, C. & Trevino, J. (1993). Tannins in faba beans seeds, effects on the digestibility of protein and amino acids in growing chicks. *Animal Feed Science and Technology*, 41, 271-278.
- Price, K.R., Johnson, I.T., & Fenwick, G.R. (1987). The chemistry and biological significance of saponins in food and feeding stuffs. CRC critical reviews. *Food Science and Nutrition*, 26, 127-135.
- Research Animal Resource [RAR] (2009). *Reference values for laboratory animals: Normal haematological values*. RAR Websites, RAR, University of Minnesota. Retrieved from <http://www.ahc.umn.edu/rar/refvalues.html>
- Sotelo, A.E.C., & Flores, S. (1995). Nutritional values and content of anti-malnutrition compounds and toxics in ten wild legumes of Yucatan peninsula. *Plant Foods for Human Nutrition*, 47, 115-123.
- SPSS, (2006). *Statistical Package for Social Sciences*, Version 16 for windows.
- Uchegbu, F.O., Chioma, C., Owuchekwa, C., Iweala, E.J., & Ijeoma, K. (2009). Effect of Processing Methods on Nutritive and Antinutritive Properties of Seeds of *Brachystegia eurycoma* and *Detarium microcarpum* from Nigeria. *Pakistan Journal of Nutrition*, 8 (4), 316-320.
- Vasanthakumar, P., Sharma, K., Sastry, V.R.B., & Kumar, S. (1999). Effect of graded levels of neem (*Azadirachta indica*) seed kernel cake on carcass characteristics of broiler rabbits. Experimental report. *Animal nutrition division, IVRI Izantanga, India*.

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ODGOVOR UZGAJANIH KUNIĆA (*ORYCTOLAGUS CUNICULUS*)
HRANJENIH SAČMOM SIROVOG SEMENA BILJKE
DETARIUM MICROCARPUM

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R e z i m e

Dvanaestonedeljno istraživanje sprovedeno je kako bi se utvrdio uticaj unosa različito graduisane sačme sirovog semena biljke *Detarium microcarpum* (engl. *raw tallow seed meal* – RTSM) na učinak rasta, hematološke i biohemijske parametre i organoleptičke osobine uzgajanih kunića. Pet eksperimentalnih obroka sastavljeni su tako da sadrže 0, 25, 50, 75 i 100% RTSM zamenjujući težinu pogače palminog zrna za težinu označenu kao T1, T2, T3, T4 odnosno T5. Četrdeset pet (45) odbijenih kunića mešovitih rasa i polova (muškog i ženskog) starosti između 5 i 6 meseci sa prosečnom telesnom težinom od 500 do 600 g nasumično su podeljeni u pet (5) dijetetskih tretmana po metodu slučajnog potpunog blok dizajna sa devet (9) kunića po tretmanu koji je ponovljen tri (3) puta sa tri (3) kunića po ponavljanju. Prikupljeni su podaci o uzimanju hrane, prirastu težine, odnosu utroška hraniva prema jedinici prirasta, svarljivosti hranljivih materija, nekim hematološkim i biohemijskim parametrima i organoleptičkim osobinama kunića. Uzimanje hrane, prirast težine i odnos utroška hraniva prema jedinici prirasta bili su značajno ($P < 0,005$) uslovljeni dijetetskim tretmanima. Kod kunića koji su hranjeni obrocima T1, T2 i T3 zabeleženo je slično unošenje hrane (62, 66,95, i 66,50 g), ukupan prirast težine (1328,73, 1320,44, i 1323,49 g) i odnos utroška hraniva prema jedinici prirasta (3,92, 4,26, i 4,22) koji su bili značajno bolji nego vrednosti zabeležene kod kunića hranjenih obrocima T4 i T5. Svarljivost hranljivih materija kunića hranjenih ekperimentalnim obrocima takođe je bilo značajno ($P < 0,05$) uslovljeno. Kunići hranjeni obrokom T2 imali su bolju svarljivost vlakana (47,05%) u poređenju sa drugim grupama. Zabeleženo je da je svarljivost ekstrakta etra bolja u grupi kunića hranjenih obrocima T1, T2 odnosno T3. Neke druge hranljive materije u grupi kunića hranjenih obrocima T3, T4 i T5 bile su slično svarene. Uočeno je da su se hematološki parametri smanjivali kako se nivo RTSM povećavao u obrocima. Primećeno je da se hematokrit, crvena krvna zrnca i bela krvna zrnca smanjuju sa 37,69 na 21,22%, sa 4,14 na 2,18 g/dl i sa 4,98 na 3,02 g/dl. Biohemijski parametri ukazuju na sličan trend koji postoji i kod

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hematoloških parametara. Ukupni proteini, glukoza i urea se smanjuju sa 6,15 na 4,63 g/dl, sa 5,15 na 3,80 g/dl i sa 7,76 na 4,00 mmol/l. Rezultat organopetičkih osobina pokazuje manje značajnu ($P>0,05$) razliku osim za sočnost koja je značajno ($P<0,05$) visoka kod kunića hranjenih obrocima T1 (5,90), T3 (5,65), odnosno T4 (5,90). Da zaključimo, do 50% RTSM može se uključiti u obroke kunića bez štetnih uticaja na produktivni učinak, iskorišćenost hranljivih materija, hematološke parametre i organoleptičke osobine.

Ključne reči: kunići, sirov, *Detarium microcarpum*, sačma, učinak, svarljivost hranljivih materija.

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