Protein and energy partitioning for growth by rabbits fed soybean cheese waste diet and lablab hay

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Abstract

Thirty crossbred rabbits were randomly allocated to five treatment combinations of soybean waste meal and lablab forage hay in a completely randomized design. The treatments comprised graded levels of soybean cheese waste meal diet (SCW) and lablab hay (LH) on a gram: gram basis: 1) 100g SCW: 60g LH (100:60S), 2) 75g SCW: 85g LH (75:85S), 3) 50g SCW: 110g LH (50:110S), 4) 25g SCW: 135g LH (25:135S), 5) 100g rabbit diet: 60g LH (100:60R, control). This gives a total feed supply of 160g/rabbit/day. Metabolic weight gain, empty body gain and composition of gain were significantly ($p < 0.001$) higher for rabbits on 100:60S than 100:60R (control) and decreased with decrease in level of soybean cheese waste diet. Digestible crude protein (DCP) intake was higher ($p < 0.05$) for the control (100:60R) than the SCW levels. DCP maintenance (DCP_m) was significantly ($p < 0.05$) lower for rabbits on 50:110S than 100:60S but similar for all other treatments. DCP content of gain, total DCP required for protein synthesis decreased significantly ($p < 0.001$) as level of SCW decreased and LH increased and was higher for 100:60S than the control and other levels. Efficiency of DCP utilization for growth decreased as SCW level decreased and ranged between 0.41-0.85. Digestible energy (DE) intake of rabbits was significantly higher ($p < 0.001$) on 25:135S and lower for 100:60S. More DE was retained as protein, fat and for growth by rabbits on 100:60S than the control and other SCW levels. DE_m, DE requirement for protein, fat, growth and total energy required for growth also decreased with decrease in level of SCW. The control and 75:85S rabbits significantly had higher DE requirement than 25:135S. Efficiency of DE utilization for growth was similar for the control, 100:60S and 75:85S than 25:135S. Efficiency of DE utilization ranged between 0.21-0.24 and was lowest on 25:135S.

Keywords: soybean cheese waste, energy, protein, partitioning, growth, lablab, forage

Introduction

Rabbits perform well with mixed regime of forages and concentrates without adverse effect (Bamgbose *et al.*, 2003). The use of concentrates alone has not given optimum results and the feeding of high concentrate and low forage levels as practiced by rabbit producers has in recent times resulted in very expensive rabbits (Iyeghe-Erakpotobor, 2007). Nworgu *et al.* (1998) noted that rabbits tend to perform better when fed with mixed forage and concentrate and the cost of feeding also reduced in his study with a ratio of 50:50 of *Centrocema pubescens* and concentrate.

According to Onwudike (1995) rabbits produce better when fed mixture of forage and concentrate. Feeding rabbits on sole forage in the tropics resulted in negative effect of weight loss (Adegbola *et al.*, 1985; Bamikole and Ezenwa., 1999) and low feed intake (Ezenwa *et al.*, 1998), inferior body weight gain as compared to those whose forage diets were supplemented with concentrate feed (Shoremi *et al.*, 2001). Omole *et al.* (2007) reported that sole feeding of *Stylosanthes guianensis* and *Lablab purpureus* compared favourably in terms of feed intake, weight gain, feed conversion ratio, nutrient digestibility and

carcass analysis to the widely used common rabbit feed or sunflower. Rabbits utilized 50g of concentrate with forage grass (*Chloris* hay) and legumes (groundnut haulms, sweet potato vines and soyabean forage) without adverse effect on growth (Iyeghe-Erakpotobor, 2006) though their growth rate was not optimum. Ekpenyong (1986), accorded that rabbits can be raised largely on forages with supplementation of concentrates with no adverse effect on body weight.

Soybean cheese waste is a by-product of soybean cheese production in towns and villages especially in northern Nigeria, where soybean cheese is widely eaten. Soybean cheese waste meal is widely used by farmers for fattening sheep and cattle (Iyeghe-Erakpotobor, 2006). It has the potential of reducing the cost of concentrate feeds used for rabbits and in areas where soyabean cheese waste meal, lablab forage, groundnut haulms, sweet potato vines and soybean forage are available, these could be utilized for feeding growing rabbits. This study was conducted to investigate partitioning of protein and energy by rabbits fed varying levels of soyabean cheese waste diet and lablab forage hay.

Materials and Methods

Study site

The study was conducted in the Rabbitry of the National Animal Production Research Institute, Shika-Zaria, Nigeria. Shika is located in the Northern Guinea Savanna, on latitude 11° 12'N of the equator and longitude 7° 33' with altitude of about 610 m while temperature ranges between 14.50°C during the early dry season (November-January) and 39.30°C to 40°C which are usually expected during the late dry season (February to May) (Osinowo et al., 1991).

Experimental procedure

Thirty crossbred rabbits aged 11 to 12 weeks old were randomly allocated to five treatment combinations of soybean waste meal and lablab forage hay in a completely randomized design. The rabbits were progenies obtained from mating between New Zealand White X California and California X Chinchilla breeds. The treatments comprised graded levels of soybean cheese waste meal diet and lablab hay on a gram: gram basis: 1) 100g soybean cheese waste diet: 60g lablab hay (100:60S), 2) 75g soybean cheese waste diet: 85g lablab hay (75:85S), 3) 50g soybean cheese waste diet: 110g lablab hay (50:110S), 4) 25g soybean cheese waste diet: 135g lablab hay (25:135S), 5) 100g rabbit diet: 60g lablab hay (100:60R, control).

Lablab forage was obtained after harvesting the seed, dried at room temperature and chopped before feeding. Composition of concentrates and lablab forage fed to rabbits is shown in Table 1. Concentrates and the forage were offered to give a total feed supply of 160g/rabbit/day in separate feeders at 08.00 hours daily. Water was supplied *ad libitum* in earthen drinkers. Concentrate and forage leftovers and wastage were measured daily before feeding. Flat bottom earthen feeders with rims were used for feeding the rabbits to reduce wastage to a minimum. The study lasted seven weeks.

Digestibility study was conducted using 20 rabbits (n=4 rabbits/treatment), during the 6th week of the feeding trial. Faecal samples were collected for four days per period and stored in a deep freezer at -20°C during collection. At the end of the collection period, faecal samples were bulked for each rabbit for analysis. Proximate composition of feed and faecal samples was analyzed according to the procedure of AOAC

Table 1: Nutrient composition (%) of concentrates and forages fed to rabbits

	Dry Matter	ASH	Ether Extract	Crude Fibre	Nitrogen Free Extract	Crude Protein
Rabbit diet	96.57	6.68	12.61	10.13	48.64	21
Lablab leaf meal	96.42	19.26	3.56	28.40	35.35	13
Soyabean cheese waste meal diet	96.10	6.14	20.28	10.26	50.79	13

(1980).

Data computation and Statistical analysis

Data on live weight, weight gain, feed intake, digestible crude protein (DCP) intake obtained from the experiment were used to compute the composition of body gain, protein content of gain, retained energy as protein and fat, protein and digestible crude protein intake, requirement for maintenance and growth, protein synthesis and fat synthesis. Reference data from works by other authors given as; DCP requirement for maintenance of growing rabbits of $2.9\text{g DCP kg LW}^{-0.75}\text{ day}^{-1}$, protein content in live weight gain of 180g CP kg^{-1} and efficiency of utilization of dietary DCP for body protein synthesis of 0.56, empty body gain (EBG) of 0.87 LW gain, EBG composition: water, 0.61; protein, 0.21; fat, 0.15; ash, 0.03, caloric value of body protein of 23.2 KJ g^{-1} , caloric value of body fat of 35.6 KJ g^{-1} , efficiency of DE utilization for RE as protein of 0.04, and efficiency of DE utilization for RE as fat of 0.65 (Garcia *et al.*, 1996, Motta Ferrira *et al.*, 1996, Fernandez and Fraga, 1996, Fraga, 1998) was used in computation of the parameters as indicated below.

- Metabolic Live Weight gain

$$= \text{Final Weight} - \text{Initial Weight} \left(\text{LW}^{0.75} \right)$$
- Metabolic Live Weight (MLWT)

$$= \text{LWT}^{-0.75}$$

- DCP requirement for main

$$(\text{DCP}_m) = 2.9\text{g} \times \text{LW}^{0.75}$$
- Total DCP content of gain

$$\times \text{Metabolic Live Weight gain}^{0.75}$$
- Total DCP requirement for
 synthesis (DCP_g, g)

$$= (\text{DCP Content of gain}) / (\text{Efficiency of utilization of DCP for Protein Synthesis})$$
- DCP requirement for Protein
 Synthesis $(\text{DCP}_p, \text{g/d}) =$

$$\text{rqt} / (\text{No of days of gain study})$$
- Daily DCP content of gain

$$= (\text{DCP Content of gain} / \text{days of gain})$$
- Efficiency of DCP Utilization

$$= (\text{Total DCP reqd for growth}) / (\text{DCP intake for growth})$$
- Total DCP requirement

$$\text{DCP}_m + \text{DCP}_g$$
- Empty Body Gain (EBG)

$$\text{Live Weight gain} \times \text{Efficiency of utilization of DCP}$$
- Protein gain = Empty Body Gain

$$\times \text{Protein Content of gain}$$
- Fat Gain = Empty Body Gain

$$\times \text{Fat Content of gain}$$

content of gain

- Retained Energy as Protein (RE_p) = Protein Gain x Caloric value of body protein
- Retained Energy as fat (RE_f) = Fat gain x Caloric value of body fat
- Total Retained Energy (RE_t) = $RE_p + RE_f$
- Digestible Energy requirement for maintenance (DE_m) = $430 \text{ KJ day}^{-1} \text{ kg}^{-0.75}$
- DE requirement for RE_p (DE_{RE_p}) = $RE_p / (\text{Efficiency of DE utilization for RE as Protein})$
- DE requirement for RE_f (DE_{RE_f}) = $RE_f / (\text{Efficiency of DE utilization for RE as fat})$
- Total Digestible Energy requirement for growth (DE_g) = $DE_{RE_p} + DE_{RE_f}$
- Efficiency of DE utilization for growth = $(\text{Total } RE_g) / DE_g$
- Total DE requirement = $DE_m + DE_g$

DCP required for growth based on intake were also calculated. Data collated were subjected to analysis of variance using GLM procedure for a completely randomized design while pair-wise difference method was used to separate significant means (SAS, 1987)

Results

Initial weight of rabbits was similar while final weight was significantly ($p < 0.05$) affected by soybean cheese waste diet level (Table 2). Weight gain, metabolic weight gain, empty body gain and composition of gain were significantly ($p < 0.001$) higher for rabbits on 100:60S than the control (100:60R) and decreased with decrease in level of soybean cheese waste diet.

DCP retention and requirement for growing rabbits fed graded levels of soybean cheese waste diet and lablab hay is shown in table 3. Metabolic weight and DCP requirement for maintenance of rabbits were significantly ($p < 0.05$) lower on 50:110S than 100:60S. DCP content of gain, total DCP required for protein synthesis decreased significantly ($p < 0.001$) as level

Table 2: Weight gain and body composition of gain of growing rabbits fed graded levels of soybean cheese waste diet and lablab hay

	Treatments					SEM	P Level
	100R	100S	75S	50S	25S		
Concentrate (g/d)	60	60	85	110	135		
Lablab hay (g/d)	60	60	85	110	135		
Initial weight (kg)*	1.29	1.21	1.21	1.10	1.33	0.10	0.74
Final weight (kg)*	1.69 ^{ab}	1.78 ^a	1.63 ^{ab}	1.46 ^b	1.56 ^b	0.09	0.05
Weight gain (kg)*	0.40 ^b	0.58 ^a	0.43 ^b	0.36 ^{bc}	0.23 ^c	0.07	0.001
Metabolic weight gain (WG ^{0.75})	0.50 ^b	0.66 ^a	0.52 ^b	0.46 ^b	0.32 ^c	0.07	0.001
Ave. daily gain (g)*	9.52 ^b	13.69 ^a	10.11 ^b	8.57 ^{bc}	5.36 ^c	0.33	0.001
Empty body gain (g/d)	8.29 ^b	11.91 ^a	8.80 ^b	7.46 ^{bc}	4.66 ^c	0.31	0.001
Water (g/d)	4.88 ^b	7.02 ^a	5.19 ^b	4.39 ^{bc}	2.74 ^c	0.24	0.001
Protein (g/d)	1.74 ^b	2.50 ^a	1.85 ^b	1.57 ^{bc}	0.98 ^c	0.14	0.001
Fat (g/d)	1.41 ^b	2.03 ^a	1.50 ^b	1.27 ^{bc}	0.79 ^c	0.13	0.001
Ash (g/d)	0.23 ^b	0.33 ^a	0.25 ^b	0.21 ^{bc}	0.13 ^c	0.05	0.001

^{abc}Means with the same superscript along rows are significantly different ($p < 0.05, 0.001$)

*Source: Iyeghe-Erakpotobor 2010

Table 3: Protein retention and requirement of growing rabbits fed graded levels of soybean cheese waste diet and lablab hay

	Treatments						
Concentrate (g/d)	100R	100S	75S	50S	25S		
Lablab hay (g/d)	60	60	85	110	135	SEM	P level
Metabolic weight (LW ^{0.75})	1.48 ^{ab}	1.54 ^a	1.44 ^{ab}	1.33 ^b	1.39 ^{ab}	0.07	0.05
DCP requirement for maintenance (g/d)	4.30 ^{ab}	4.47 ^a	4.18 ^{ab}	3.85 ^b	4.04 ^{ab}	0.12	0.05
Based on weight gain:							
DCP content of gain (g/d)	1.61 ^b	2.11 ^a	1.68 ^b	1.48 ^b	1.04 ^c	0.12	0.001
DCP requirement for protein synthesis (g/d)	2.87 ^b	3.77 ^a	3.01 ^b	2.65 ^b	1.86 ^c	0.56	0.001
Total DCP requirement (g/d)	7.17 ^b	8.24 ^a	7.19 ^b	6.50 ^{bc}	5.90 ^c	0.16	0.001
Based on intake:							
DCP intake (g/d)	16.21 ^a	9.64 ^c	14.18 ^b	13.07 ^b	14.53 ^b	0.34	0.05
DCP intake requirement for growth (g/d)	9.01	5.40	7.94	7.32	8.14	0.29	0.05
Efficiency of DCP utilization for growth (DCP _g)	0.44 ^c	0.85 ^a	0.51 ^b	0.50 ^{bc}	0.41 ^c	0.05	<0.0001

^{abc}Means with the same superscript along rows are significantly different ($p < 0.05$, 0.001). DCP- digestible crude protein

of soybean cheese waste diet decreased and lablab forage increased and was higher for 100:60S than the control and all other treatments and was lowest on 25:135S. Based on DCP intake of the rabbits, intake was higher ($p < 0.05$) for the control rabbits (100:60R) than the soybean cheese waste diet levels. Among the soybean cheese waste diet treatments, 100:60S had lower DCP intake than the other levels. DCP requirement for growth based on intake was also lower for 100:60S than the other treatments. Total DCP requirement based on weight gain was higher for 100:60S than DCP requirement for growth based on intake, while for the control, 50:110S and 25:135S, it was lower. Efficiency of DCP utilization for growth decreased as soybean cheese waste diet level decreased and ranged between 0.41-0.85.

DE intake of rabbits was significantly

higher ($p < 0.001$) on 25:135S and lower for 100:60S (Table 4). More energy was retained as protein, fat and for growth by rabbits on 100:60S than the control and other soybean cheese waste diet levels while 25:135S retained the lowest energy compared with all other treatments. Maintenance DE requirement, DE requirement for protein, fat, growth and total DE required for growth also decreased with decrease in level of soybean cheese waste diet and increase in lablab hay level. These parameters were significantly ($p < 0.05$) higher for 100:60S than all other treatments. The control and 75:85S rabbits also significantly had higher total DE requirement than 25:135S. Efficiency of DE utilization for growth of rabbits was similar for the control, 100:60S and 75:85S which was significantly higher ($p < 0.0001$) than 25:135S. Efficiency of DE utilization

Table 4: Digestible energy retention, requirement and efficiency of retention of growing rabbits fed graded levels of soybean cheese waste diet and lablab hay

Concentrate Lablab	Treatments					SEM	P level
	100R 60	100S 60	75S 85	50S 110	25S 135		
DE intake (kcalDM/d)	391.94 ^b	298.29 ^c	420.67 ^{ab}	396.59 ^b	458.11 ^a	21.17	0.001
DE intake (kJDM/d)*	1640	1248	1760	1659	1917	-	-
Retained DE as protein (RE _p kJ/d)	40.37 ^b	58.03 ^a	42.89 ^b	36.33 ^b	22.71 ^c	1.16	0.001
Retained DE as fat (RE _f kJ/d)	50.15 ^b	72.09 ^a	53.28 ^b	45.13 ^b	28.21 ^c	1.29	0.001
Retained DE for growth (RE _g kJ/d)	90.51 ^b	130.11 ^a	96.17 ^b	81.46 ^{bc}	50.91 ^c	1.79	0.001
Maintenance DE requirement (DE _m kJ/d)	215.14 ^b	282.37 ^a	225.32 ^b	198.13 ^b	139.27 ^c	3.13	0.001
DE requirement for protein synthesis (DE RE _p kJ/d)	100.92 ^b	145.08 ^a	107.23 ^b	90.83 ^{bc}	56.77 ^c	1.84	0.001
DE requirement for fat synthesis (DE RE _f kJ/d)	77.15 ^b	110.90 ^a	81.97 ^b	69.43 ^{bc}	43.40 ^c	1.59	0.001
DE requirement for growth (DE _g kJ/d)	178.07 ^b	255.97 ^a	189.19 ^b	160.26 ^{bc}	100.16 ^c	2.43	0.001
Total DE requirement (kJ/d)	393.21 ^b	538.34 ^a	414.51 ^b	358.39 ^{bc}	239.43 ^c	3.96	0.001
Eff. DE utilization for growth	0.23 ^{ab}	0.24 ^a	0.23 ^{ab}	0.22 ^b	0.21 ^c	0.04	0.001

^{abc}Means with the same superscript along rows are significantly different ($p < 0.001$). *DE- calculated.
Eff.-efficiency

ranged between 0.21-0.24.

Discussion

Significantly higher metabolic weight gain, empty body gain and composition of gain for rabbits on 100:60S indicates faster growth of rabbit on this treatment. Higher growth rate on the high soyabean cheese waste diet especially above the conventional control could indicate the fact that soyabean might have a growth stimulating factor. Reduction in weight gain at lower levels of soyabean cheese waste diet and high levels of lablab forage hay (50:110S and 25:135S) agrees with Partridge *et al.* (1989) who reported similar

depression of growth rates of rabbits fed diets with high levels of grassmeal. Decrease in water, protein, fat and ash composition of body gain as soybean waste meal diet decreased indicates a reduction in growth enhancing effect of soyabean cheese waste as a result of increase in forage level fed on body composition of rabbits. Higher fat content of gain in 100:60S agrees with Fraga (1998) who reported that a higher content of body fat and energy, and lower water content was observed in fast growing rabbits however in this study water content of gain was also high for the faster growing rabbits. Close (1980) reported that

rate of change in protein and fat depend on level of feeding however, protein retention was less seriously affected by environmental temperature than fat deposition. An increase in the level of dietary energy intake could affect the composition of the body gain and the partition of energy retained as protein and fat (Partridge *et al.*, 1989).

DCP_m of 4.04-4.47g/d observed for the control and soyabean groups is higher than 3.8g/d reported by de Blas *et al.* (1985) however similar 3.85g/d was observed for 50:110S treatment group. Reduction in DCP content of gain and requirement for protein synthesis despite increase in DCP intake, with decrease in level of soyabean cheese waste diet, could be as a result of reduction in concentrate supply as lablab forage increased. This might have resulted in a likely low availability of nutrients for growth. Rate of protein retention was attributed to body weight, level of feeding and concentration, digestibility and availability of protein in food (Close, 1980).

The rabbits were laying down 1.04-2.11 g DCP/d as protein even the low concentrate:high forage groups especially rabbits on 25g concentrate and 135g lablab forage (25:135S) which laid down 1.04 DCP g/d. Higher DCP intake on the control (100:60S) than the soybean cheese waste diet levels was as a result of higher feed intake which was highest on the control and lowest on the 100:60S group. The result also showed that level of DCP intake of rabbits on all the treatments was adequate for growth and appeared better utilized by rabbits on 100:60S than the other treatments. High efficiency of DCP utilization for growth obtained also indicates better protein retention with higher soybean cheese waste diet level.

DE_m of 100 to 183 kJ DE kg^{0.75} day⁻¹ obtained

in this study are lower than values of 351 to 434 kJ DE kg^{0.75} day⁻¹ reported by Partridge *et al.* (1989) for growing New Zealand White rabbits offered increasing proportions of fibre as grassmeal or 552 kJ DE kg^{0.75} day⁻¹ reported for Giant Spanish growing rabbits by de Blas *et al.* (1985). This large difference in DE for maintenance could be due to the fact that their rabbits were kept under temperate conditions where more energy is used for maintenance of body temperature while rabbits in this study, were kept under tropical conditions, where less energy is required for maintenance of body temperature but rather energy is used for dissipation of excess body heat.

Though DE intake of rabbits was significantly higher for rabbits on 25:135S and lower for 100:60S, however, more DE was retained as protein, fat and for growth by rabbits on 100:60S than the control and other soybean cheese waste diet levels. This might indicate that energy utilization does not only depend on supply but might also depend on availability of the energy for utilization for growth. It appears that energy supply by forages might not be as available for utilization for growth as that supplied by concentrate. Total DE requirement, requirement for maintenance and growth of rabbits was highest on 100:60S and lowest on 25:135S. This indicates that soybean cheese waste diet and lablab combination at the level of 100:60S was adequate in energy and available protein for growth of rabbits.

Efficiency of DE utilization of 0.21 – 0.24 is low and indicates inefficient energy utilization by the rabbits probably as heat dissipation for body maintenance and for protein and fat synthesis. This might be because the rabbits were kept under tropical conditions with its associated high ambient temperatures of 34°C -40°C that cause heat stress resulting in loss of energy as heat to

protect the animal from heat overload and keep the animal more comfortable. Exposure to high ambient temperature induces rabbits to try to balance excessive heat load by dissipating latent heat.

Heat stress results in drastic changes in the biological functions of rabbits by depressing feed intake, feed efficiency and utilization, disturbances in metabolism of water, protein, energy and mineral balances, enzymatic reactions, hormonal secretions (Marai *et al.*, 2002). Habeeb *et al.* (1993) also reported the adverse effect of high ambient temperature to be due to decrease in feed consumption, dehydration of animals, tissue catabolism and low metabolizable energy left for growth since more energy is consumed by the increase in respiratory frequency that occurs in hot ambient temperature.

Conclusion

DCP requirement for growth was higher for the high concentrate-low forage (100:60S) treatment than the high forage-low concentrate (25:135S) treatment. Efficiency of DCP utilization for growth ranged between 0.41-0.85 even surpassing the reference efficiency level of 0.56 reported in literature. DE requirement and utilization in growth increased as the concentrate level increased and was lowest in the high forage-low concentrate treatment though DE intake was higher on the high 25:135S treatment. Efficiency of DE utilization of 0.21-0.24 was low indicating substantial losses in energy of rabbits probably as heat. The study however showed that DCP intake of rabbits on all the treatments was adequate for growth and appeared especially better utilised by rabbits on 100:60S than the other treatments.

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