Performance of growing rabbits fed soybean cheese waste meal diet and lablab hay

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Abstract

Growing crossbred rabbits were used to study the performance of rabbits fed different levels of soybean cheese waste (SCW) diet and lablab hay. The treatments comprised of levels of soybean cheese waste diet and lablab hay on a gram to gram basis of: (1) 100:60 (100:60S), (2) 75:85 (75:85S), (3) 50:110 (50:110S) and (4) 25:135 (25:135S) to give a total feed supply of 160g/rabbit/day. The control was 100:60 (100:60R) of rabbit diet and lablab hay respectively. The concentrates and forage were offered in separate feeders at 08.00 hours. Rabbits on 100:60S had significantly higher weight gain than the control on rabbit diet (100:60R). Weight gain decreased linearly with decrease in level of SCW. Total daily feed intake was significantly higher for the control than the SCW treatments. Among the SCW treatments, total daily feed intake was significantly higher for rabbits on 25:135S than 50:110S. The control had the highest feed cost. Cost/kg gain was significantly higher for the control and 25:135S treatments than the other treatment groups with savings of 58-73% on SCW. Nutrient intake was significantly higher for the control than SCW treatments. Dry matter and ether extract digestibility was similar for the treatments. Crude fibre digestibility was lowest while nitrogen free extract digestibility was highest for the control than the SCW treatments. Crude protein digestibility was similar for the control and other treatments but higher for 75:85S. It is concluded from this study that based on the lower cost of production and high nutrient digestibility of rabbits on soybean cheese waste diet and lablab hay, soybean cheese waste shows good prospect as an alternative cheap feed stuff for rabbit production.

Keywords: Digestibility, forage, lablab, performance, rabbits, soybean cheese waste.

Introduction

Present economic condition in most tropical countries, which is characterized by great shortage of animal protein, has turned attention to rabbit production as a ready solution to the provision of animal protein. This is in view of its fast growth, short generation interval and large litter size. The problem for most producers however, is the high cost of concentrate feed for rabbits. This has necessitated the need to seek for alternative feed sources in forages, especially so, because of the availability of forages and ability of rabbits to convert forage protein into meat. This has resulted in the search for cheaper ways of producing rabbits. A combination of concentrate diet and forage to achieve this goal is especially being sought after, to reduce cost of feeding, as well as the total cost of production for the small scale rabbit producers.

Studies by several researchers have shown the potentials of using high levels of forages in profitable rabbit raising especially for growth. Studies in Cambodia using fresh water spinach gave weight gains as high as 23-43g/day (Khuc Thi and Preston, 2006). Weight gains of 7.8-13.9g/day with water lettuce and water hyacinth diets (Biobaku and Ekpennyong, 1991), and 10.14-11.95g/day with concentrate supplemented with *Syndrella nodiflora* (Animashahun *et al.*, 2005) have been reported in Nigeria. Rabbits fed fresh lablab or lablab hay had similar final weights and average daily gains (Linga *et al.*, 2003). Feeding rabbits solely on some forage species in the tropics has resulted in negative effect of weight loss (Adegbola *et al.*, 1985; Bamikole and Ezenwa, 1999) while giving positive gains as high as 18g/day with water

spinach in Cambodia (Khuc Thi and Preston, 2006). The use of compounded concentrates alone has also not given optimum results (Adegbola *et al.*, 1985; Bamikole and Ezenwa, 1999).

Soybean cheese waste, a by-product of soybean cheese production, is very readily available and cheap in towns and villages of Nigeria where soybean cheese is widely eaten. It is widely used by farmers for fattening sheep and cattle. This product has the potential of reducing the cost of concentrate intake by rabbits especially when supplemented with a legume. The objective of this study was to investigate the performance of growing rabbits fed different levels of soybean cheese waste meal and lablab hay.

Materials and Methods

Study site

The study was conducted in the Rabbitry of the National Animal Production Research Institute, Shika, Nigeria (10°11 'N and 7°8 'E, 650m above sea level).

Animals and housing

Growing crossbred rabbits were used for this study. The rabbits were progenies obtained from mating between New Zealand White X California and California X Chinchilla breeds. The rabbits were individually housed in metal cages of dimensions 120 x 60 x 50 cm located in a well-ventilated house. The house is completely walled with wide, open windows covered with wire mesh and mosquito netting. The experimental animals were kept, maintained and treated in adherence

to accepted standards for the humane treatment of animals.

Experimental procedure

Thirty growing crossbred rabbits were randomly allocated to five treatment combinations of soybean cheese waste meal (SCW) and lablab hay in a completely randomized design. The treatments comprised the following levels of soybean cheese waste meal and lablab hay on a gram:gram basis respectively:

- 1). 100g rabbit diet and 60g lablab hay (100:60R) served as control
- 2). 100g soybean cheese waste diet and 60g lablab hay (100:60S)
- 3). 75g soybean cheese waste diet and 85g lablab hay (75:85S)
- 4). 50g soybean cheese waste diet and 110g lablab hay (50:110S)
- 5). 25g soybean cheese waste diet and 135g lablab hay (25:135S).

The control concentrate (rabbit diet) was a formulated rabbit diet routinely fed to rabbits in the Unit. Percentage proportions of concentrate to lablab hay were: 1) 63:37, 2) 47:53, 3) 31:69 and 4) 16:84 respectively. Soybean cheese waste meal is a by-product of soybean cheese production. Soybean cheese waste meal was obtained from households. The composition of concentrates fed is shown in Table 1. The concentrates and forage were offered to give a total feed supply of 160g/rabbit/day. Lablab forage was obtained after harvesting and seed removal, dried at room temperature and chopped before feeding. Nutrient composition of concentrates and lablab hay fed to rabbits is

shown in Table 2. The concentrate and lablab were fed in separate feeders at 08.00 hours daily. Water was supplied *ad libitum* daily 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. Parameters monitored were concentrate and forage intake, weight change, feed conversion efficiency, feed cost, and feed cost/kg gain. The study lasted seven weeks.

Digestibility study

Digestibility study was conducted in the fifth week of study for four days to determine the effect of concentrate:lablab ratio on digestibility of rabbits. Faecal samples were collected daily for four days and stored at -20°C in a deep freezer immediately after collection. At the end of each collection period, the faecal samples were bulked for each animal for proximate analysis according to Association of Official Analytical Chemists (AOAC, 1980) procedures. Compositions of the concentrate and lablab were determined according to AOAC (1980). Feed and nutrient intake and digestibility coefficients were determined.

Apparent digestibility coefficients of nutrients (aDC) was calculated as:

$$\text{aDC (\%)} = \frac{\text{nutrient intake} - \text{nutrient in faeces}}{\text{nutrient intake}} \times 100.$$

Statistical analysis

Cost of concentrate was computed at ₦30/kg for the rabbit diet, ₦11.59/kg for soybean cheese waste and ₦20/kg for lablab forage. Data

Table 1: Composition of concentrate diets fed to rabbits

Ingredient	Proportion in diet (%)	
	Rabbit diet (Control)	Soybean cheese waste meal diet
Maize	39.24	-
Maize offal	15.00	48.50
Groundnut cake	42.26	-
Soybean cheese waste meal	-	48.00
Bone meal	3.00	3.00
Salt	0.25	0.25
Vitamin/mineral premix*	0.25	0.25
Energy (Kcal ME/kg)	2600	2300
Feed cost/kg (Rs)	30.00	11.59

*Content/kg ration: Vit. A 1251 IU, Vit. D3 2750 IU, Vit. E 151 IU, Vit. K 0.002g, Vit. B₂ 0.006g, Nicotinic acid 0.035, Calcium D-Pantothenate 0.01mg, Vit. B₆ 0.0035g, Vit. B₁₂ 0.02g, Folic acid 0.001g, Biotin 0.0005g, Vit. C 0.025g, Cholin chloride 0.39g, Zinc bacitracine 0.02g, Methionine 0.2g, Avatec (Lasoloid) 0.09g, Manganese 0.1g, Iron 0.05g, Zinc 0.04g, Copper 0.002g, Iodine 0.0015g, Cobalt 0.000225g, Selenium 0.0001g.

Table 2: Nutrient composition of concentrates and forage fed (%DM)

	Dry Matter	Ash	Ether Extract	Crude Fibre	Crude Protein	Nitrogen Free Extract
Rabbit diet (control)	95.71	24.64	12.48	11.19	17.88	33.81
Soybean cheese waste meal diet	97.89	16.51	15.22	19.11	15.18	33.98
Lablab hay	96.43	19.26	3.56	28.40	13.43	35.35

collected were subjected to analysis of variance using the General Linear Model procedure in a completely randomized design. Pair-wise difference method was used to separate significant means (SAS, 2000).

Results

Final weight of rabbits was affected by treatment (Table 3). Rabbits offered the control (100:60R) and 100:60S treatments had similar final weight which was significantly higher ($P<0.05$) than for 50:110S and 25:135S treatments. Rabbits on 100:60S had significantly ($P<0.05$) higher total and daily weight gain than the control diet. Weight gain decreased with decrease in the level

of soybean meal. Pattern of daily weight gain (Fig. 1) showed a quadratic trend with increase and subsequent reductions. Total daily feed intake (Table 3) was significantly higher for the control than the soybean cheese waste diet treatments and showed a quadratic trend. Among the soybean cheese waste diet treatments, total daily feed intake was significantly higher for rabbits on 25:135S than 50:110S. Concentrate (Fig. 2a) and lablab hay (Fig. 2b) intake increased as level of offer increased however, total feed intake (Fig. 2c) was only higher for the control and similar for the soybean cheese waste diet treatments. Feed conversion (Table 3) was similar for all the treatments except for 25:135S which

Table 3: Performance of growing rabbits fed soybean cheese waste meal and lablab hay

Concentrate type	Rabbit diet		Soybean cheese waste meal diet			SE	Contrast**		
Concentrate level (g)	100	100	75	50	25		a	b	c
Forage level (g)	60	60	85	110	135				
Initial weight (kg)	1.29	1.21	1.21	1.19	1.33	0.11			
Final weight (kg)	1.69 ^a	1.78 ^a	1.63 ^{ab}	1.47 ^b	1.56 ^b	0.08	*		*
Total weight gain (g)	400 ^b	575 ^a	425 ^{ab}	275 ^{bc}	225 ^c	59.22	*		*
Av. daily gain (g)	9.52 ^b	13.69 ^a	10.12 ^b	6.55 ^{bc}	5.36 ^c	1.42	*		*
Concentrate intake (g)	82.0	62.58	52.67	30.87	20.11	2.66	*		
Lablab intake (g)	36.23	27.48	44.28	56.13	78.91	2.53	*	*	
Total daily feed intake (g)	118.23 ^a	90.06 ^{bc}	96.95 ^{bc}	87.0 ^c	99.02 ^b	3.80	*	*	
Feed conversion ratio	12.96 ^{ab}	6.91 ^a	10.09 ^a	6.34 ^a	20.01 ^b	2.74		*	
Feed cost (N/day)	3.84 ^a	1.49 ^c	1.68 ^b	1.59 ^b	1.88 ^b	0.11	*	*	*
Cost/kg gain (N)	419.80 ^a	114.20 ^b	174.67 ^b	115.92 ^b	380.08 ^a	52.12		*	
Savings (N/kg gain)	-	305.60	245.13	303.88	39.72				
Percent savings	-	72.80	58.39	72.39	9.46				

^{ab} Means with different superscript along rows are significantly different ($P < 0.05$). SE – Standard error. N – Naira (Nigerian currency). a-Linear, b- Quadratic, c-Cubic

Table 4: Nutrient intake and digestibility coefficients of rabbits fed soybean cheese waste meal diet and lablab hay

Concentrate type	Rabbit diet		Soybean cheese waste meal diet			SE	Contrast**		
Concentrate level	100	100	75	50	25		a	b	c
Forage level	60	60	85	110	135				
Nutrient intake (gDM/d)									
Dry matter	113.78 ^{ab}	79.83 ^c	107.69 ^b	104.17 ^b	121.65 ^a	4.02			
Ash	25.97 ^a	13.98 ^b	19.25 ^c	18.98 ^c	22.87 ^d	0.78			
Ether extract	10.76 ^a	8.77 ^b	10.16 ^c	8.31 ^b	6.77 ^c	0.45			
Crude fibre	19.37 ^c	17.99 ^c	25.59 ^b	25.95 ^b	32.63 ^a	0.99			
Crude protein	18.63 ^a	11.61 ^b	15.41 ^c	14.68 ^c	16.70 ^b	0.59			
Nitrogen free extractives	39.07 ^{ab}	27.53 ^c	37.32 ^b	36.28 ^b	42.72 ^c	1.40			
Digestible energy (kcal/day DM)**	391.94 ^b	298.29 ^c	420.67 ^{ab}	396.59 ^b	458.11 ^a	21.17			
Digestibility coefficient									
Dry matter	0.83	0.82	0.86	0.83	0.83	0.017			
Ether extract	0.71 ^a	0.72 ^a	0.78 ^a	0.69 ^a	0.53 ^b	0.035	*	*	
Crude fibre	0.59 ^c	0.75 ^b	0.84 ^a	0.76 ^{ab}	0.73 ^b	0.032	*	*	
Crude protein	0.87 ^{bc}	0.83 ^c	0.92 ^a	0.89 ^{ab}	0.87 ^{bc}	0.014	*		*
Nitrogen free extractives	0.93 ^a	0.88 ^b	0.87 ^b	0.88 ^b	0.90 ^{ab}	0.012		*	

^{abc} Means with different superscript along rows are significantly different ($P < 0.05$, ** $P < 0.001$). SE – Standard error. a-Linear, b- Quadratic, c-Cubic

was significantly higher. Feed cost was significantly ($P<0.05$) lowest for the 100:60S than the other treatments. The control group however, had the highest feed cost. Cost/kg gain was significantly higher for the control and 25:135S treatments than the other SCW treatment groups. Savings in cost/kg gain of 58-73% was obtained with 100:60S, 75:85S and 50:110S, while only a saving of 9% was obtained with 25:135S treatment.

Faecal output and dry matter (Fig. 3) were similar for all the treatments except 100:60S which was lower though feed intake was higher for the control than the other treatments. Nutrient intake and digestibility of rabbits is shown in Table 4. Nutrient intake was significantly higher for the control and lower for rabbits on 100:60S treatment than the other treatments. Dry matter digestibility was similar for all treatments. Ether extract, crude fibre and crude protein digestibility were significantly higher for 75:85S than 100:60S and the control and had a quadratic trend. Crude fibre digestibility was lower for the control while crude protein digestibility was lower for 100:60S treatment than the other treatments. Nitrogen free extractives digestibility was significantly higher with a quadratic trend for the control than all the soybean cheese waste diet treatments. Digestible energy intake was similar for 25:135S and 75:85S but higher than the other treatments. Rabbits on 100:60S treatment had the lowest digestible energy intake.

Discussion

Rabbits consume legumes well when fed as sole or in combination with other forages or concentrates (Iyeghe-Erakpotobor and

Muhammad, 2008). Feed intakes obtained in this study are comparable with earlier studies (Iyeghe-Erakpotobor *et al.*, 2005, Iyeghe-Erakpotobor *et al.*, 2006ab, Iyeghe-Erakpotobor 2006). When offered concentrate and forages, rabbits would consume enough dry matter to meet their requirement for nutrients. The type of forage appears to determine the total feed intake by affecting the intake of both the concentrate and forage. Feed intake of both soybean cheese waste diet and forage was lower for coarse forage hays such as *Brachiaria decumbens* grass, (Iyeghe-Erakpotobor *et al.*, 2006) compared with intakes obtained with soybean cheese waste diet and lablab in this study.

Daily weight gains obtained in this study (5.4 - 13.7g) are similar with daily gains of 12.5g and 8.4 for fresh lablab and molasses block, 8.4 for fresh lablab and sugar cane, 10.3 for lablab hay and molasses block 6.3 for lablab hay and sugar cane reported by Linga *et al.* (2003). The reason for higher gain by the 100:60S group over the control could likely be because of more balanced amino acid composition in soybean compared with that in groundnut cake which was the protein source in the control diet. Recent observations have indicated that soybean contains a certain intrinsic value which encourages growth in animals. Groundnut cake is commonly used in animal diets as the sole protein source or in combination with other protein sources such as soy bean, blood meal and palm kernel meal.

Higher balance of amino acid in soybean could also be the reason for the high feed conversion efficiency observed for the 100:60S treatment group, despite their lower feed and

Figure 1: Daily weight gain of rabbits fed varying levels of soybean cheese waste meal diet and lablab and control rabbit diet. 100:60R= 100:60 rabbit diet and lablab forage, 100:60S= 100:60 soybean cheese waste meal diet and lablab forage, 75:85S= 75:85 soybean cheese waste meal diet and lablab forage, 50:110S= soybean cheese waste meal diet and lablab forage and 25:135S= soybean cheese waste meal diet and lablab forage.

Figure 2a: Concentrate intake of growing rabbits fed varying levels of soybean cheese waste diet, control rabbit diet and lablab hay. 100:60R= 100:60 rabbit diet and lablab forage, 100:60S= 100:60 soybean cheese waste meal diet and lablab forage, 75:85S= 75:85 soybean cheese waste meal diet and lablab forage, 50:110S= soybean cheese waste meal diet and lablab forage and 25:135S= soybean cheese waste meal diet and lablab forage.

Figure 2b: Lablab hay intake of growing rabbits fed varying levels of soybean cheese waste diet, control rabbit diet and lablab hay. 100:60R= 100:60 rabbit diet and lablab forage, 100:60S= 100:60 soybean cheese waste meal diet and lablab forage, 75:85S= 75:85 soybean cheese waste meal diet and lablab forage, 50:110S= soybean cheese waste meal diet and lablab forage and 25:135S= soybean cheese waste meal diet and lablab forage.

Figure 2c: Total feed intake (concentrate plus lablab forage) of growing rabbits fed varying levels of soybean cheese waste diet, control rabbit diet and lablab hay. 100:60R= 100:60 rabbit diet and lablab forage, 100:60S= 100:60 soybean cheese waste meal diet and lablab forage, 75:85S= 75:85 soybean cheese waste meal diet and lablab forage, 50:110S= soybean cheese waste meal diet and lablab forage and 25:135S= soybean cheese waste meal diet and lablab forage.

Figure 3: Effect of varying levels of soybean cheese waste meal diet, control rabbit diet and lablab hay on feed intake, faecal output and faecal dry matter of growing rabbits. 100:60R= 100:60 rabbit diet and lablab forage, 100:60S= 100:60 soybean cheese waste meal diet and lablab forage, 75:85S= 75:85 soybean cheese waste meal diet and lablab forage, 50:110S= soybean cheese waste meal diet and lablab forage and 25:135S= soybean cheese waste meal diet and lablab forage.

digestible energy intake compared with the other treatments. Rabbits on this combination (100:60S) were able to convert feed into tissue more efficiently than the other combination groups, even the control which had higher nutrient intake compared with the other groups. Rabbits in an earlier study were also able to utilize low protein intakes of 9.6-9.8 g/day from soybean cheese waste treatments for growth (Iyeghe-Erakpotobor *et al.*, 2006a). Weight gains obtained using lablab forage hay in this study was higher than -2.1-6.7g/d obtained with

brachiaria grass (Iyeghe-Erakpotobor *et al.*, 2006b). An increasing level of concentrate (i.e. 25, 50 and 75%) in diets with moderate to high quality forage increased average daily gain by young Alpine doe lings though it did not influence feed intake (Goetsch *et al.*, 2003). Studies have shown that rabbits can utilize 50g of concentrate with forage grass or legume without adverse effect on growth (Bamikole and Ezenwa, 1999; Iyeghe-Erakpotobor *et al.*, 2002, 2006b, Iyeghe-Erakpotobor, 2006).

The effect of ambient temperature on rabbit performance can not be overlooked. Lower performance of rabbits in most tropical regions compared with temperate regions could be attributed to the effect of high ambient temperature which can be as high as 35 to 41°C. When ambient temperature rises above 25°C, feed intake and in consequence, daily weight gain of rabbits are reduced (Owen, 1981, Adegbola *et al.*, 1985) because of considerable rise in maintenance energy requirements causing additional protein losses from blood plasma due to sweat gland activity, reduction in production efficiency through both direct and indirect effects on metabolism and physiological function of animals (Tizikara *et al.*, 1985). This could be the reason for low weight gains obtained in this study compared with gains of 27.5-25.2 g/day reported by Mudunuru *et al.* (2008) for rabbits fed 75, 50, 25% pellets plus lablab with or without molasses mini-blocks. It is worthy to note also, that while Mudunuru *et al.* (2008) used highly nutritious lablab leaves cut before seed production in their study, lablab used in this study were obtained after harvesting the seeds and were therefore of lower quality.

Savings per kg gain obtained using soybean cheese waste and lablab hay compared with the more conventional rabbit diet control, could likely result in a general reduction in cost of production of rabbits and make it possible for farmers to break even and likely make profit. Considering rabbits are sold at an average of price ₦600 to ₦900, it would cost between ₦300 to ₦436.68 to produce rabbits on 100:60S, 75:85S and 50:110S. Soybean cheese waste meal is cheap and readily available in most areas of the country because of the widespread production and consumption of soy milk and soy cheese. It is widely used by farmers in Northern towns and villages of Nigeria for fattening sheep and cattle. Nutrient intake and digestibility have an effect on performance. Though nutrient intake was higher in the control group because of higher feed intake, crude protein, ether extract, crude fibre and nitrogen free extract digestibility were higher for 75:85S than 100:60S and the control. Protein digestibility obtained in this study agrees with Villamide and Fraga (1998) who reported that, the crude protein content of dry forages and protein concentrates is a good predictor of crude protein digestibility. The nutritive value of a protein is determined not only by its amino acid composition, but also by its digestibility or proportion of ingested protein that is digested in the gut and absorbed as free amino acids (Fraga, 1998). Weight gain therefore, does not depend only on nutrient intake and digestibility alone but also on the balance of amino acids in the protein and efficiency of utilization of protein for tissue lay down. While digestibility of protein, fibre and energy of tropical grasses is very low in rabbits, many of the tropical legumes are as digestible as

temperate forages (Cheeke *et al.*, 1986). Nutrient intake and digestibility coefficients obtained for all nutrients in this study were higher than those obtained when rabbits were offered soybean cheese waste diet and *Brachiaria decumbens* grass hay (Iyeghe-Erakpotobor *et al.*, 2006a) and concentrate and *Stylosanthes hamata* (Iyeghe-Erakpotobor, 2006)). It would therefore appear that lablab and soybean cheese waste might have a high nutritive value going by the nutrient intake and digestibility coefficients obtained in this study.

Conclusion

Based on good performance and lower cost of production of rabbits on soybean cheese waste meal diet supplemented with lablab hay, compared with the conventional rabbit diet control, it is concluded that soybean cheese waste and lablab forage hay shows good prospect as alternative cheap feeding regime for rabbit production, especially where soybean is used for making cheese, milk and yoghurt, the residue could be used as feed resource for feeding rabbits.

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References

- Adegbola, T. A., TiBi, E. U., Asogwa, D. C.
1985. Feed intake and digestibility of rabbits on all-forage, forage plus

- concentrate and all-concentrate diets. *Journal Animal Production Research*. 5(2): 185-191.
- Animashahun, R. A., Bamgbose, A. M., Omoikhoje, S. O., and Aruna, M. B.** 2005. Performance of weaner rabbits fed concentrate supplemented with graded levels of *Syndrella nodiflora*. Proc. 10th Ann. Conf., ASAN, Univ. of Ado-Ekiti, Nigeria. Sept. 12-15, 2005: 264-266.
- AOAC, 1980.** Official Method of Analysis, thirteenth edition. Association of Official Analytical Chemists, Washington, D.C.
- Bamikole M. A., Ezenwa I., 1999.** Performance of rabbits on guinea grass and verano stylo hays in the dry season and effect of concentrate supplementation. *Animal Feed Science and Technology*. 80(1): 67-74.
- Biobaku, W. O. and Ekpenyong, T.E.** 1991. Effect of feeding graded levels of water lettuce and water hyacinth on the growth of rabbits. *J. Appl. Rabbit Res.* 14:98-100.
- Cheeke, P. R., Grobner, M. A. and Patton, N. M.** 1986. Fibre digestion and utilization in rabbits. *Journal of Applied Rabbit Research*. 9(1): 25-30.
- Fraga, M. J.** 1998. Protein requirements. IN: *The nutrition of the rabbit*. Eds C. de Blas and J. Wiseman. CABI Publishing. Pg 137-143.
- Goetch, A. L., Detweiler, G., Sahl, T., Hayes, J., Puchala, R.** 2003. Effects of separate offering of forage and concentrate on feed intake and growth of Alpine doelings. *Small Ruminant Research*. 48(3):209-216.
- Iyeghe-Erakpotobor, G. T.** 2006. Performance of grower rabbits fed concentrate and *Stylosanthes* (verano) combinations under tropical conditions. *Animal Science Journal*. 77 (1):71-78.
- Iyeghe-Erakpotobor, G. T.; Abdulmalik, M. E., Uguru, J. O. and Abeke, F. O.** 2002. Determination of optimum concentrate and forage combination for small holder feeding of rabbits. *Trop. J. Anim. Sci.* 5(1): 181-187.
- Iyeghe-Erakpotobor, G. T., Aliyu, R., Uguru, J.** 2006a. Evaluation of concentrate, grass and legume combinations on performance and nutrient digestibility of grower rabbits under tropical conditions. *African Journal of Biotechnology*. 4(20):2004-2008.
- Iyeghe-Erakpotobor, G. T., Osuhor, C.U. and Olugbemi, T. S.** 2006b. Performance and digestibility of weaner rabbits fed

- graded levels of soybean cheese waste/maize offal diet and brachiaria grass hay. *African Journal of Biotechnology*. 5(17):1579-1583.
- Iyeghe-Erakpotobor, G. T., and Muhammad, I. R.** 2008. Intake of tropical grass, legume and grass-legume mixtures by rabbits. *Tropical Grasslands*. Vol 42(2): 112-119.
- Khuc Thi Hue and Preston, T. R.** 2006. Effect of different sources of supplementary fibre on growth of rabbits fed a basal diet of fresh water spinach (*Ipomoea aquatica*). *Livestock Research for Rural Development* 18/hue180.htm.
- Linga, S. S., Lukefahr, S. D. and Lukefahr, M. J.** 2003. Feeding of *Lablab purpureus* forage with molasses blocks or sugar cane stalks to rabbit fryers in subtropical south Texas. *Livestock Production Science*. 80(3):201-209. viewed by Scopus.
- Mudunuru, U., Lukefahr, S.D., Nelson, S. D., Flores, D.O.** 2008. Performance of growing rabbits fed *Lablab purpureus*. <http://world-rabbit-science.com/WRSA-Proceedings/congress-2008-Verona/papers/N-Mudunuru.pdf>.
- Owen, J. E.** 1981. Rabbit meat for the developing countries. *World Animal Review*. 39:2-11.
- SAS.** 2000. *Statistical Analysis System*. User's guide: Statistics. 6th edition. SAS INSTITUTE Inc. North Carolina, USA.
- Tizikara, C., Akinokun, O. and Chiboka, O.** 1985. A review of factors limiting productivity and evolutionary adaptation of tropical livestock. *World Review of Animal Production*. 21(4):41-46.
- Villamide, M. J. and Fraga, M. J.** 1998. Prediction of the digestible crude protein and protein digestibility of feed ingredients for rabbits from chemical analysis. *Animal Feed Science Technology*. 70: 211-224.

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