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Review article

UTILIZATION OF DIFFERENT FORAGES BY GROWING RABBITS

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ABSTRACT
The acute shortage of meat supply especially in Nigerian diets can be bridged by the production of highly prolific animals with short generation interval such as rabbits. The increase in the world population and high cost of conventional animal feed ingredients and low protein intake in most developing countries has necessitated Animal nutritionist to search for alternative sources of non-conventional feed ingredients that are cheap and readily available. Forages are cheap and can be used in rabbit diet since they utilize grasses and legumes efficiently. Optimum growth performance can be obtained by feeding forages with or without concentrates in their diets. Forages contain appreciable amount of protein, fat, minerals and carbohydrates that can support growth and production. The reviewed revealed that different forages inclusion levels from 30 to 100% enhance rabbit production and can help overcome the protein intake deficiency in the country. Therefore, the use of different forages for feeding rabbit is recommended.

KEYBOARDS: Rabbits, Forage, Utilization, Production

INTRODUCTION

One reason for the acute shortage of animal protein in the diets of most Nigerians is inadequate supply and exorbitant cost of conventional feed ingredient leading to high cost of meat and animal products such as beef, mutton, goat meat, poultry eggs and milk. Rabbit (*Oryctolagus cuniculus*) is increasingly becoming an important meat source and is recommended for production in countries that are experiencing meat shortage (Flecknell, 1985). Rabbits have been recommended as having the best productive advantages to bridge the protein deficiency gap (Taiwo *et al.,* 2005). Similarly, Iyeghe – Erakpotobor *et al.* (2002) reported that increased rabbit production is one sure way of meeting the animal protein requirements of the populace. Akinmutimi and Ezea (2006) stated that conventional feeds account for about 70% of the total cost of rabbit production making them expensive to most farmers.

The enormous potential of rabbits in alleviating animal protein inadequacy in developing economies is hinged on its attributes. These include; ability to thrive well on forages, high reproductive potential with short gestation period, early maturity, highly prolificacy and ability to re–breed shortly after kindling ((Biobaku and Dosumu, 2003; Odimba, 2006). Egbo *et al.* (2000) reported that rabbits are efficient converters of feed to meat and utilize up to 30% fibre as against 10% by most poultry species. Thus, the daily weight gain of rabbit is high in proportion to the body weight which gives them a rapid growth rate before sexual maturity. Thus, they attain a high weight at sexual maturity 30% faster than other animals (Ajayi *et al.,* 2005). Nutritionally, rabbit meat is high in protein but low in fat and cholesterol, and highly digestible with dressed weight of 82 to 85% (Cheeke, 1987; Nyako, 2001; Yusuf *et al.,* 2011a).

The potential of forages as feed for rabbit is of particular significance because of their availability and ability of rabbits to effectively digest leaf protein (Bello, 2003). In addition, the development of high quality forage-based diets with simple supplements is a priority research area in developing countries (Linga *et al.,* 2003). This paper therefore, reviews the utilization of forages by rabbits.

Chemical Composition of Different Grasses and Legumes Forages

The nutrient composition of different grasses and legumes reported by different authors are presented in Table 1. The nutrient content of forage varieties differ greatly among the species, cultivars and stages of growth in the same cultivars (Yono *et al*., 1986). The crude protein (CP) of legumes ranges from 12.80% for *Leucaena* (Oduozo and Adegbola, 1992) to 24.30% for *Centrosema pubescen* (Gohl, 1981). While the crude protein content for grasses ranges from 11.95% for *Penisetum purpureum* (Yono *et al*., 1986; Raharjo *et al*., 1988) to 5.5% for *Panicum maximum* (Yono *et al*., 1986). Leucaena, Gliricida, and *Cajanu caja* also have appreciable amounts of crude protein (Gohl,1981; Yono *et al*., 1986 and Oduozo and Adegbola, 1992) This review indicates that legumes have superior CP content compared to grasses. Higher crude fiber (CF) (48.70%) was reported in *Panicum maximum* and *Chloris gayana* (Yono *et al*., 1986 and Raharjo *et al*.,1988) while it was lower (18.10%) in *Gliricidia sepium* (Gohl, 1981). High crude fibre content of different forages assists the rabbits for normal digestion transit.

According to Yono *et al*. (1986) *Pueraria phasloloid* has a higher fat percentage of 10.70% while the lowest was reported in *Panicum maximum* (Adegbola *et al*., 1985). The higher Ash percentage of 15.5% for *Chloris gayana* was stated by Raharjo *et al*. (1988) while the lower value of 5.80% for *Pueraria phasloloid* was reflected by Raharjo *et al*. (1988*). Cajanus caja* and *Leucaena* contain higher metabolizable energy of 4206 and 4910 ME (Kcal/kg) than other forages (Oduozo and Adegbola, 1992) *Stylosenthes guyanesis* have a low metabolizable energy value of 3107 ME (Kcal/kg) as reported by Raharjo *et al*. (1988). Forages generally contain appreciable amounts of protein, fibre, fat and metabolizable energy that can support growth and production in rabbits.

TABLE 1A: Chemical composition of some forages (grasses and legumes)

Grasses	ME(Kcal/kg)	DM	CP	CF	ADF	NDF	EE	ASH	NF	sources
Panicum maximum	3583	37.0	10.5	30.4	-	-	2.5	7.5	48.7	1
Panicum maximum	-	47.74	5.5	48.7	-	-	-	13.50	-	4
Chloris gayana	3705	21.03	20.8	48.70	28.2	38.9	-	15.50	-	2
Chloris gayana	-	35.60	7.63	44.60	-	-	-	11.40	-	4
Penisetum purpureun	-	17.59	11.95	-	38.70	61.0	-	12.50	-	2
Penisetum purpureun	-	48.0	11.95	39.70	-	-	-	12.50	-	4
Bracharia brisantho		56.8	6.69	36.12	-	-	-	13.10	-	4
Paspalum plicatulum	-	34.62	6.50	44.70	-	-	-	14.60	-	4
Sataria splenda	-	55.8	6.95	39.70	-	-	-	13.20	-	4
Legumes										
Leucaena leucocephela	4206	35.68	12.80	-	21.80	35.0	-	6.70	-	5
Leucaena leucocephela	-	68.20	19.94	20.78	-	-	-	6.80	-	4
Gliricidia sepium	-	-	21.0	18.1	-	-	6.5	6.40	46.0	3
Centrosema pubescens	3885	31.60	21.38	-	35.27	51.40	-	9.9	-	2
Centrosema pubescens	-	20.20	24.30	30.2	-	-	3.5	7.20	32.1	2
Stylosenthes guyanensis	3107	25.44	14.81	-	-	41.50	-	7.20	-	2
Stylosenthes guyanensis	-	-	14.81	41.55	33.08	-	-	14.0	-	4
Desmodium heterophyllum	3750	30.93	13.44	-	-	48.50	-	8.80	-	2
Pueraria phasloloid	3852	90.90	15.63	-	37.10	50.70	-	5.80	-	2
Cajanus cajan	-	24.40	19.19	30.8	39.90	-	6.0	-	36.0	3
Cajanus cajan	4910	92.70	21.40	21.80	-	48.60	-	7.60	42.50	5
Pueraria phasloloid	-	46.10	15.63	39.90	21.20	-	10.7	-	-	4

Sources: 1 Adegbola *et al*. (1985) ; 2 . Raharjo *et al.* (1988) ; 3 . Gohl (1981); 4. Yono *et al*. (1986); 5. Oduozo and Adegbola (1992)

Performance of Rabbits Fed Different Forages

Table 2 summarizes the performance of rabbits fed different levels of forages. El-Gendy (1999a) and Rohilla and Bujarbaruah (2000) reported that up to 30% and 40% of *Acacia saligna* (dried leaves) can replace Clover hay and banana leaves without deleterious effect on growth. In another study, El-Ayouty *et al.* (2000) showed that complete replacement of fresh berseem (*Trifolium alexan drium*) with berseem silage had no negative effect on growth of rabbits and edible body organs. Rohilla and Bujarbaruah (2000) revealed that rabbits can tolerate up to 40% of broom grass (*Thysanolaena mnxima*) in their diets without adverse effect on the growth performance. Scapinello *et al*. (2000a) stated that inclusion of cassava leaves and stem hay up to 20% in rabbit diets does not affect the general performance. Similarly, Fotso *et al.* (2000) reported that up to 42% of cassava leaves meal can be fed to growing rabbit with positive result. Ngodigha *et al.* (1994) observed that up to 50% of groundnut haulms can support weight gain of growing rabbits. Tangenjaja *et al*. (1990) incorporate *Leucaena leucocephala* at 0, 20, 40 and 60% levels as replacement for concentrate and observed that 40% is ideal as it can support growth without adverse effect, this was supported by Scapinello *et al.* (2000b); Nieves *et al*. (1998) and El-Gali *et al*. (2001) who fed similar forages. Lupin (*Lupines albus*) was fed at 0, 10, 20, 30 and 40% levels to growing rabbits and the report indicated the optimum inclusion level as 20% for the best weight gain. (El- Gendy, 1999b). El-Ayouty *et al*. (2000b) stated that up to 100% of maize silage (whole plant) can be fed to growing rabbits without affecting the body weight gain. Similarly, Auxilia and Masoero (1980) fed maize plant (whole plant dried) up to 40% and revealed also that it can support weight gain. Ramchurn *et al*. (2000) reported that rabbits fed with 40% of star grass (*Cynodon plectost)* as a basal diet and shows positive weight gain. Conversely, Payne *et al.*(1983) and Aderibigbe *et al*. (1992) reported that Rye grass as a basal diet can be fed to growing rabbits at levels of up to 20 and 50% without compromising the biological performance of the rabbits. Raju and Screemanna (1995) stated that up to 15% level of sea weed (*Ulva fascilate*) can be incorporated into the diet of growing rabbits.

Bamikole and Ezenwa (1999) reported the incorporation of *Stylosanthes hamata* at different levels (0, 25, 50, 75 and 100%) in diets of growing rabbits and indicated that 50% level is the ideal for maximum weight gain. Harris *et al*. (1981) observe that when sun flower leaves were fed up to 40% to growing rabbits, positive weight gain was observed. Abu *et al*.(1999) reported that inclusion of sweet potato tops up to 40% in the diets of growing rabbits without adverse effect on the body weight gain. Lopez *et al*. (1996) indicated that rabbits can tolerate up to 60% level of *Vicia sativa* with positive weight gain recorded,

the report was supported by Sese *et al*. (1999) who fed a similar forage (60%) to growing rabbits and revealed higher weight gain. Linga and Lukefahr (2000) reported growth rate of 28.9g/day for rabbits fed alfalfa with molasses blocks and growth rates of 10 to 12g/day with fresh lablab with molasses or sugar cane and the report agree with other workers (Linga *et al.,* 2003). Sanni *et al.* (2005) evaluated the economies of producing grower rabbits fed different combinations of concentrates and *stylosanthes* and found that 50:75 combination gave better return on investment, thus cost of feeding grower rabbit could be lowered by supplementing concentrate diets with *stylosanthes*. Ikurior *et al.* (2009) reported that *Tridax procumbens* can be included in cassava based diets for rabbits and nutrient digestibility can be maximized at 10% level of inclusion. Nyako (2001) in his experiment with bitter leaf in weaner rabbit diets reported that 25% of the leaves can be incorporated into rabbit feeds to obtain high yield of meat.

TABLE 2: Performance of Rabbit Fed Different Forages

Ingredients	Highest level studied (%)	Accepted level (%)	Substituted level mainly to	Evaluation on	Sources
Acacia saligna, (Dried leaves)	30	30	Clover hay (berseem)	Growth	El-Gendy (1999a)
Banana leaves (fresh green)	60	40	Basal diet	Growth	Rohilla and Bujarbaruah (2000)
Berseem silage (*Trifolium alexan drium*)	100	100	Fresh berseem	Growth	El-Ayouty *et al.* (2000)
Broom grass (*thysanolaena maxima*	100	40	Concentrate	Growth	Rohilla and Burarbaruah (2000b)
Cassava leaves and stems hay	30	10 – 20	-	Growth	Scapinello *et al.* (2000a)
Cassava leaves meal (dried)	42	42	Poultry offals and wheat bran	Growth	Fotso *et al.* (2000)
Groundnut haulms	100	50	Basal diet	Growth	Ngodigha *et al.* (1994)
Guinea grass (*panium maximum*)			Concentrate	Growth	Bamikole and Ezenwa (1999)
Leucaena leucocephala leaf meal	60	40	-	Growth	Tangendjaja *et al.* (1990)
Leucaena leucocephala hay	23	23	Lucerne	Growth	Scapinello *et al.* (2000b)
Leucaena leuco cephala leaves dried	20	15	-	Growth	El-Gali *et al.* (2001)
Leucaena leucocephala leaves fresh	15	15	-	Growth	Nieves *et al.* (1998)
Lupin (*lupinus albus*) as green forage	40	20	Basal diet	Growth	El-Gendy (1999b)
Maize silage (Whole plant)	100 fresh bersem	100 fresh bersem	Fresh bersem	Growth	El-Ayouty *et al.* (2000).
Whole maize plant (dried)	40	40	Maize plant	Growth	Auxilia and Masoero (1980)
Star grass (*cynodon plectost*) *achyus*	40	40	Basal diet	Growth	Ramchurn *et al.* (2000)
Ryegrass	50	50	Basal diet	Growth	Payne *et a*l. (1983)
Ryegrass (NH3 treated)	20	20	Ryegrass straw	Growth	Aderibigbe *et al.* (1992)
Sea weed (*Ulva fascilata*)	15	15	Concentrate	Growth	Raju and Sreemanna rayana (1995)
Stylosanthes hamata verano hay	100	50	Concentrate	Growth	Banikole and Ezenwa (1999)
Sun-flower leaves	40	40	Lucerne	Growth	Harris *et al.* (1981)
Sweet potato tops	100	80	Sweet potato roots	Growth	Abu *et al.* (1999)
Vicia sativa common vetch sun dried	60	60	Lucerne hay	Breeding	Lopez *et al.* (1996)
Vigna unguiculata cowpea testa	80	60	Poultry mash	Growth	Sese *et al.* (1999)

The importance of forages in rabbit diets cannot be over emphasized. Aduku *et al.* (1986) reported that some forages such as *Tridax procumbens, Desmdium scripiums, Luffa egyptiaca, macroptillium atropur pureum, Leucaena leucocephala, musa spp.* remains green throughout the year and are well accepted by rabbits as feed. However, Raharjor *et al.* (1988) fed some tropical grasses (*Chloris gayana, Panicum maximum,* and *pennisetum purpureum*) and legumes to rabbits and observed that digestibility of the grasses were lower than those of the tropical legumes and this suggested that tropical grasses could only be used as source of indigestible fibre. Oduozo and Adegbola (1992) fed plantain leaves to rabbits and recorded reduced feed intake and 100% mortality. Nwagu *et al.* (2010) in their study stated that groundnut haulms and *Stylosanthes* forages could be fed sole or mixed with concentrate for all classes of rabbits to obtain better growth performance. Abubakar *et al.* (2011) reported that weaned rabbits can utilize varying levels of *Moringa oleifera* leaf meal at up to 45% level in diets without adverse effects on growth

performances, carcass yield, organ and gut characteristics. Similarly, incorporation of *panicum maximum* at 10% inclusion level in rabbit feed regardless of season of harvest, produced best results in terms of weight gain, average daily weight gain and feed conversion ratio (Aderinola *et al.,* 2009). In a study conducted by Ukpe *et al.* (2009) on the performance of weaner rabbits fed three types of forages which include; *Panicum maximum, Calapogonium mucunoides* and *Trindax procumbens* reported that rabbits fed with *Panicum maximum* and *Calapogonium mucunoides* had higher daily feed intake and live weight gain than those fed with *Tridax procumbens* and recommended that rabbits should be fed with *Calapogonium mucunoids* because of its proteineous nature for better performance.

Constraints in the use of forages as rabbit feeds

Although forages are high in nutritional qualities, it is associated with many problems which reduce their effective utilization when fed to rabbits. These include seasonality of production, locality and collection in relation to area of use, processing and transport cost and estimation of their feeding value (Adebowale, 1983). Forages are high in fibre and levels of over 20% may cause caecal impaction and limit energy intake (Champe and Maurice, 1983). Forages are also rich in anti-nutritional factors which have been found to have negative effects on absorption of minerals (Waghorn *et al.,* 1994) and rumen microbial activity (Nunez-Hernandez *et al*., 1991). Some of the anti-nutritional factors act on inhibiting enzymes directly forming complexes with nutrients rendering them indigestible by proteolytic enzymes (Abeke *et al.,* 2003). Furthermore, vicinyl hydroxyl groups of phenolic compounds may chelate metal ions and reduce their bioavailability (Layrisse *et al.,* 2000). The enzymatic oxidation of phenolic compounds considerably enhances their enzyme inhibitory effect, toxicity and also their health promoting properties (Awad *et al.,* 2001).

Anti-nutritional factors such as tannins in forages may precipitate protein in the digestive tract (Hagerman and Butler, 1995). Gualitieri and Rapaccinin (1990) reported that tannins in feedstuffs reduced dry matter and protein digestibility. Tannins are responsible for an astringent taste of feed that induces lower intake due to reduced palatability (Butler *et al.,* 1986). Toxic factors such as cyanide in cassava and mimosine in *Leucaena leucocephala* are often present which could cause growth depression and mortality (Cheeke and Shull, 1985). Anti-nutritional factors in feedstuffs generally hinder the effective utilization of feeds by monogastric animals (Abeke and Otu, 2008).

Methods of detoxifying anti-nutritional factors in forages

Emphasis has always been laid on the toxic and anti-nutritive effects of livestock feeds in the natural state even though many of them are detoxified by several processing methods such as soaking, germination, boiling, autoclaving, fermentation, genetic manipulation and other processing methods (Soetan, 2008). Ahamefule and Odoemelam (2008) reported that 24 hours soaking duration at 40^{o}C of feedstuffs produced better results and would be preferred for tannin and cyanide. The use of enzymes to enhance nutrient digestibility has been investigated and found to be effective by several researchers (Marquardt *et al*., 1996; Choct, 2006). Phytase has merit as a tool for minimizing phosphorus excretion by increasing phosphorus availability and subsequent utilization (Ravindran *et al.,* 1995) thus, addition of enzymes inactivate the activities of anti-nutritional factors in feedstuffs. Similarly, Yusuf *et al.* (2011b) reported that roasted *Afzelia Africana* meal can be used as feed ingredient in the diets of grower rabbits to obtain maximum growth. Trugo *et al.* (1990) reported that cooking for 60 minutes at 100^{o}C was sufficient to inactivate over 90% of the trypsin inhibitor activity in *phaseolus vulgari*. Carlini and Udedibie (1997) also reported that it took 3 hours of boiling at 100^{o}C to completely render the legume lectin-free.

CONCLUSION

It can be concluded from this review that forage grasses and legumes could be used as feed for rabbits at different ages with respect to their inclusion levels. For effective utilization of these forages, it may be necessary to develop processing methods to reduce or completely eliminate anti-nutritional factors that are present in them. Processing methods for rabbit feed production must be simple, economical and inexpensive. Sometimes, single processing method may not effectively remove the anti-nutritional factors in forages; therefore, combination of two or more processing methods may be required.

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