Effect Of Partial Replacement Of Berseem Hay By Ensiled And Dried Sweet Potato Vines On Performance Of Growing Rabbits

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ABSTRACT: Two experiments were done to study the effect of partial replacement of berseem hay by ensiled and dried sweet potato vines on the performance of growing rabbits. In the first one, 8 mature male NZW rabbits with an average body weight of 2.5 kg and 8 months old were used to determine digestibility coefficients and nutritive values of berseem hay (BH), ensiled sweet potato vines (SPVS) and dried sweet potato vines (SPVH). In the second one, 50 NZW growing rabbits of 60 days of age were used in a complete randomized design experiment with five treatments. The first group fed commercial rabbit diet including 40% BH (control diet), while in the other groups 50 or 100% of BH was replaced by SPVS and SPVH throughout the 70 days of experiment. Results of the first experiment showed that the contents of CP and NFE of SPVS were nearly similar to that of BH. While, the contents of EE and ash were higher and CF content was lower in SPVS and SPVH and CP content was lower in SPVH compared to BH. The SPVS had significantly ($P<0.05$) the highest digestibility coefficients of all nutrients and subsequently nutritive values followed by SPVH, while commercial diet had the lowest values. In the second experiment, The contents of OM and CF tended to decrease, but the contents of NFE, EE and ash tended to increase in SPVS and SPVH diets compared with commercial diet. While, CP tend to decrease in SPVH diets than that of commercial diet and SPVS diets. Rabbits fed 100% SPVS diet showed significantly ($P<0.05$) the highest digestibility coefficients of all nutrients and subsequently nutritive values and TVFA's concentration. While, rabbits fed commercial diet recorded the highest pH value and NH_3-N concentration ($P<0.05$). Rabbits fed 100% SPVS diet showed significantly ($P<0.05$) the highest final body weight, total and daily weight gain, total and net revenue and improvement, slaughter weight, carcass weight, dressing percentage, meat weight and percentage. Rabbits fed commercial diet showed the highest average daily and total DM intake and amount of DM/kg gain, feed cost and feed cost/kg gain. Rabbits fed 50% SPVS diet showed significantly ($P<0.05$) the highest DM and ash contents, while those fed 100% SPVS diet had the highest CP and EE contents.

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Key words: NZW rabbits, SPVS, SPVH, digestibility, body weight gain, feed conversion, economic efficiency, carcass traits.

INTRODUCTION

Poor economic conditions in many tropical countries and associated increase in the shortage of available feedstuffs has turned attention to rabbit production as a ready solution to the problem. Use of forage and byproducts of agriculture and food processing to substitute concentrate feed may be an alternative means of reducing the high cost of production associated with all concentrate feeding systems (Iyeghe-Erakpotobor *et al*., 2006).

In Egypt, feed shortage led to increase the prices of concentrates and berseem hay increased the cost of rabbits feeding. The expensive berseem hay contributes about 40% of rabbit diets. Using crops by-products led to some advantages such as participating in solving the problem of feed shortage, decrease the cost of feeding and alleviating the pollution problems (Eweedah et al., 2007).

Rabbits are raised almost in all developing countries, and contribute to improving the nutrition and the economy of smallholder families. They can be fed different kind of grasses, tree leaves, fruits, roots and tubers, and by-products. In particular they find vegetables such as sweet potato vines very palatable (Gang *et al*., 2006).

Sweet potato is traditionally a root crop, the top however is also valuable forage for ruminants and other livestock species **(**Giang *et al*., 2004). Sweet potato vine has a high crude protein content (18-30% in DM), which is comparable to leguminous forages (An *et al*., 2003).

Sweet potato (*Ipomoea batatas*) has been commonly used as feed for pigs, cattle and chicken in Vietnam and many countries in Asia (Duyet *et al*., 2003). Sweet potato vines are a rich source of protein and vitamins and the feeding value of vine is close to that of alfalfa (Dominguez, 1992).

The present study was carried out to investigate the effect of replacing 50 and 100% of berseem hay in rabbit diets by ensiled and dried sweet potato vines on growth performance and carcass traits of growing New Zealand White rabbits

MATERIALS AND METHODS

The current work was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture to investigate the effect of partial replacement of berseem hay by ensiled and dried sweet potato vines on the performance of growing rabbits.

Dried and ensiled sweet potato vines:

After harvesting sweet potato, about of 1000 kg of vines were taken and divided into two parts with 500 kg. The first one was sun dried until the moisture content was reduced to 10-12% and ground for mixing with commercial rabbit diet. At the same time, the second part was chopped and ensiled in plastic bags (about 50 kg capacity) with added 5% molasses (w/w) for two month. Silage quality parameters determined were pH value using Bechman pH meter. The concentration of NH_3-N was determined using a saturated solution of magnesium oxide distillation according to the method of AOAC (1990). The TVFA's concentration was determined by the steam distillation method (Warner, 1964) using markham micro-distillation unit. Lactic acid concentration was determined according to Analytical Chemistry of Foods (1995).

The first experiment:

Three digestibility trials were conducted to determine nutritive values of berseem hay (BH), sweet potato vines silage (SPVS) and sweet potato vines hay (SPVH) using 12 mature male NZW rabbits with an average body weight of 2.5 kg and 8 months old. Rabbits were fed twice daily at 8 a.m. and 3 p.m. and refusals were recorded every day and daily feces was weighed. Representative samples of tested feedstuffs and feces were chemical analysis according to AOAC (1990).

The second experiment:

Experimental rabbits and diets:

Fifty NZW growing rabbits of 60 days of age were used in a complete randomized design experiment with five treatments. The first group fed commercial rabbit diet including 40% BH (control diet), while in the other groups 50 or 100% of BH was replaced by SPVS and SPVH throughout the 70 days of experiment. The composition of commercial rabbit diet is shown in Table (1).

Table 1: Composition of commercial rabbit diets.

Ingredient	%	Ingredient	%
Berseem hay	40	molasses	2
Wheat bran	8	limestone	1
Soybean meal	18	Common salt	0.5
Yellow corn	15	Premix*	0.5
Barley grain	15	Total	100

* Each one kg of premix (minerals and vitamins mixture) contains vit. A, 20000 IU; vit. D3, 15000 IU; vit. E, 8.33 g; vit. K, 0.33 g; vit. B1, 0.33; vit. B2, 1.0 g; vit. B6, 0.33 g; vit. B5, 8.33 g; vit. B12, 1.7 mg; pantothenic acid, 3.33 g; biotine, 33 mg; folic acid, 0.83 g; choline chloride, 200 g; Zn, 11.7 g; Fe, 12.5 g; Cu, 0.5 g; I, 33.33 g; Se, 16.6 mg and Mg, 66.7 mg.

Housing and management:

Rabbits were housed in galvanized wire cages and fresh water was automatically available at all time. All rabbits were kept under the same managerial, hygienic and environmental conditions. Live body weight and feed consumption were recorded at weekly interval throughout the experimental period. Daily weight gain, feed conversion and economic efficiency were calculated.

Digestibility trials:

Digestibility trial was undertaken at the end of the experimental period (16 wk of age) on four animals from each group. Rabbits were housed individually in metabolism cages. The experimental diets were offered daily and fresh water was provided all the time. Feed intake was accurately determined. Feces were collected for 5 days as a collection period, then the feces was dried at 60^{o}C for 12 h. All collected feces for each animal were mixed, then feces were ground for chemical analysis and urine was kept (4-5 ^{o}C) for analysis. Chemical analysis of different foodstuffs and feces was determined according to AOAC (1990).

Carcass traits:

At the end of experiment, 3 rabbits were taken randomly from each group fasted for 18 hours before slaughtering, weighed and slaughtered. Carcass weight (the main body, head, kidneys, liver, heart and other total edible parts) were determined according to Blasco *et al*. (1993). Chemical analysis of meat was done according to AOAC (1990).

Cecum parameters:

Cecum contents of slaughtered rabbits were taken for the determination of pH using Bechman pH meter, NH_3-N concentration according to the method

of AOAC (1990) and TVFA's concentration according to Warner (1964).

Statistical analysis:

The data was statistically analyzed using general linear models procedure adapted by SPSS (2008) for user's guide with one-way ANOVA. Duncan test within program SPSS was done to determine the degree of significance between the means.

RESULTS AND DISCUSSION

The first experiment:

Chemical composition of tested feedstuffs:

Chemical composition of feedstuffs is presented in Table (2). The contents of CP and NFE of SPVS were nearly similar to that of BH. While, the contents of EE and ash were higher and CF content was lower in SPVS and SPVH and CP content was lower in SPVH compared to BH. These results agreed with those obtained by Ali *et al.* (1999) and Kebede *et al*. (2008).

Digestibility coefficients and nutritive values of feedstuffs

As shown in Table (2) SPVS had significantly ($P<0.05$) the highest digestibility coefficients of all nutrients and subsequently nutritive values followed by SPVH, while BH had the lowest values. These results may be attributed to the differences in chemical composition among the different feedstuffs. These results reflect the differences in chemical composition of tested feedstuffs. The obtained results are within the values obtained by Ali *et al.* (1999). The DE value of the different feedstuffs was suitable for growing rabbits as recommended by NRC (1977).

Table 2: Chemical composition, digestibility coefficients and nutritive values of berseem hay (BH), sweet potato vines silage (SPVS) and sweet potato vines hay (SPVH).

Item	BH	SPVS*	SPVH	SEM	P-value
Chemical composition					
DM %	89.45	29.00	90.10		
Composition of DM %					
OM	89.70	87.00	86.15		
CP	14.35	14.30	12.60		
CF	27.64	23.70	24.30		
EE	2.45	3.10	3.00		
NFE	45.15	45.90	46.25		
Ash	10.30	13.00	13.85		
Digestibility coefficients %					
DM	66.20^{b}	69.55^{a}	69.25^{a}	0.61	0.011
OM	67.70^{b}	71.05^{a}	70.30^{a}	0.58	0.015
CP	67.60^{b}	69.65^{a}	68.67^{ab}	0.35	0.022
CF	63.50^{b}	65.36^{a}	65.22^{a}	0.33	0.004
EE	70.75^{b}	74.10^{a}	73.23^{a}	0.58	0.015
NFE	67.40^{b}	70.84^{a}	68.50^{b}	0.58	0.015
Nutritive values					
TDN %	61.58^{b}	63.13^{a}	61.13^{b}	0.34	0.006
DCP %	9.70^{a}	9.96^{a}	8.65^{b}	0.25	0.006
DE (kcal/kg)	2715^{b}	2784^{a}	2695^{b}	16.02	0.040

*Silage SPVS quality was pH 4.05, lactic acid 5.35% of DM, TVFA's 2.15% of DM and NH_3-N 5.20% of total-N.
a, b, c: Values in the same row with different superscripts differ significantly ($P<0.05$).

The second experiment:

Chemical composition of experimental diets

Chemical composition of experimental diets is presented in Table (3). The contents of OM and CF tended to decrease, but the contents of NFE, EE and ash tended to increase in diets contained SPVS and SPVH compared with commercial diet. While, CP tend to decrease in diets contained SPVH than that of commercial diet and diets contained SPVS. The sweet potato vines silage characterized by higher contents of CP and NFE and lower contents of CF and ash (Hamza *et al*., 2009).

Digestibility coefficients and nutritive values of experimental diets

The digestibility coefficients and nutritive values of the different diets are shown in Table (3). The 100% SPVS diet showed significantly (P<0.05) the highest digestibility coefficients of all nutrients and subsequently nutritive values, however, commercial diet had the lowest digestibility coefficients and nutritive values. So, it preferred using SPV in rabbit diets in the form of silage. These results agreed with those obtained by Ali *et al*. (1999) who found that the values of DE, TDN and DCP were significantly affected by feeding rabbits dried sweet potato vines. Iyeghe-Erakpotobor *et al.* (2006) reported that sweet potato vines showed significant increase on nutrients digestibility. Hamza *et al.* (2009) indicated that nutrients digestibility increased with increasing SPVS ratio in the ration.

Cecum parameters

Cecum parameters are shown in Table (4). Rabbits fed commercial diet recorded the highest pH value and NH_3-N concentration and those fed 100% SPVS diet had the highest TVFA's concentration (P<0.05). The cecum fermentation parameters are affected by composition of the diet, feeding type, feeding level, roughage: concentrate ratio and post feeding period of sample. These results are in accordance with those obtained by Ali *et al*. (1999) who reported significant differences in cecum parameters of growing rabbits fed diets containing sweet potato vines. Hamza *et al*. (2009) found significant differences among the different sweet potato ratios in rumen parameters of sheep.

Table 3: Chemical composition, digestibility coefficients and nutritive values of experimental diets by growing rabbits.

Item	Experimental diets					±SEM	P-value
	Control	SPVS		SPVH			
		50%	100%	50%	100%		
Chemical composition:							
DM %	91.23	64.06	49.36	91.36	91.50		
Composition of DM %							
OM	90.27	89.75	89.23	89.56	88.85		
CP	16.78	16.77	16.76	16.43	16.08		
CF	17.81	17.04	16.27	17.14	16.47		
EE	2.69	2.82	2.95	2.80	2.91		
NFE	52.99	53.12	53.25	53.19	53.39		
Ash	9.73	10.25	10.77	10.44	11.15		
Digestibility coefficients %:							
DM	69.47^{b}	73.35^{a}	73.86^{a}	71.89^{ab}	72.38^{a}	0.46	0.011
OM	70.84^{b}	74.48^{a}	75.30^{a}	72.99^{ab}	73.79^{ab}	0.53	0.061
CP	71.35^{b}	72.81^{ab}	74.15^{a}	71.83^{ab}	72.67^{ab}	0.37	0.142
CF	62.23^{b}	66.03^{a}	66.57^{a}	64.71^{ab}	65.57^{a}	0.49	0.027
EE	76.91^{b}	79.52^{ab}	79.69^{a}	77.93^{ab}	78.09^{ab}	0.40	0.138
NFE	71.18^{b}	73.32^{ab}	73.72^{a}	72.15^{ab}	72.45^{ab}	0.35	0.148
Nutritive values:							
TDN %	65.43^{b}	67.45^{ab}	67.80^{a}	66.18^{ab}	66.28^{ab}	0.34	0.159
DCP %	11.97^{bc}	12.21^{ab}	12.43^{a}	11.80^{c}	11.69^{c}	0.08	0.003
DE (kcal/kg)	2885^{b}	2974^{ab}	2989^{a}	2918^{ab}	2922^{ab}	15.16	0.159

a, b, c, d: Values in the same row with different superscripts differ significantly (P<0.05).

Table 4: Cecum microbial activity of growing rabbits fed experimental diets.

Item	Experimental diets					±SEM	P-value
	Control	SPVS		SPVH			
		50%	100%	50%	100%		
pH value	6.12^{a}	5.94^{ab}	5.87^{b}	6.11^{a}	6.04^{ab}	0.03	0.073
TVFA's (mmol/dl)	8.74^{b}	11.19^{a}	11.85^{a}	10.74^{a}	11.37^{a}	0.36	0.036
NH_3-N (mg/dl)	23.87^{a}	22.63^{ab}	21.73^{ab}	21.50^{ab}	20.64^{b}	0.40	0.097

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

Body weight gain

Rabbits fed 100% SPVS diet showed significantly (P<0.05) the highest final body weight, total and daily weight gain, but those fed commercial diet had the lowest values as shown in Table (5). The daily weight gain of rabbits fed 50% SPVS, 100% SPVS, 50% SPVH and 100% SPVH diets increased by 3.80, 10.61, 1.79 and 8.40% compared with 100% BH diet, respectively. Such variations in body weight gain are mainly a reflection of the quality of experimental diets. Ali *et al*. (1999) found that live weight at 12 weeks of age and daily weight gain from 5 to 12 weeks of rabbits were slightly improved by using sweet potato tops up to 30% of the diet. However, Gang *et al.* (2006) stated that body weight gain of rabbit decreased with feeding sweet potato vines. Lam and Ledin (2004) reported that replacement of Sebania with 50% fresh sweet potato vines on a dry matter basis resulted in acceptable live weight gains.

Feed intake

Results in Table (5) showed that rabbits fed commercial diet showed the highest average daily and total DM intake, but those fed 100% SPVS diet had the lowest DM intake (P<0.05). Feed consumption of rabbits depends basically on nutrient contents in accordance with the actual energy need of the animal (Dehalle, 1981) or/and protein and fiber level of its ration (Fekete and Bokori, 1985). Ali *et al*. (1999) found that daily feed intake was slightly increased with increasing sweet potato tops content in the diet up to 30% and decreased afterwards. Gang *et al.* (2006) stated that DM intake by rabbit decreased with feeding sweet potato vines. Lam and Ledin (2004) reported that intake decreased linearly as Sesbania foliage was replaced by sweet potato vines.

Feed conversion

Results in Table (5) showed that rabbits fed commercial diet showed significantly (P<0.05) the highest amounts of DM/kg gain, but those fed 100% SPVS diet had the lowest DM/kg gain. Rabbits fed 100% SPVS diet revealed improvements in the conversion of DM by 18.70% compared with those fed commercial diet. These results reflect the differences in feed intake and body weight gain. Ali *et al*. (1999) reported that rabbits fed diets containing sweet potato vines as silage or hay improved feed conversion.

Economic efficiency

Rabbits fed commercial diet showed significantly (P<0.05) the highest feed cost and feed cost/kg gain, however, those fed 100% SPVS and SPVH diets showed significantly (P<0.05) the highest total and net revenue and improvement (Table 5). The net revenue of rabbits fed 50% SPVS, 100% SPVS, 50% SPVH and 100% SPVH diets increased by 18.12, 37.49, 12.75 and 34.12% compared with commercial diet, respectively. These results may be due to the lower prices of sweet potato veins compared with berseem hay as well as the improvement of weight gain with feeding diets containing SPVS and SPVH. It is well known that grassland conserved products such as silages are normally cheaper per unit of energy than concentrate. If more increasing amounts of such feeds could replace expensive feedstuffs in the diet of rabbits without adverse effect on their performance, the cost of feeding would be reduced. Ali *et al*. (1999) stated that feed cost/kg weight gain decreased and economic efficiency increased by feeding rabbits diets containing sweet potato tops in the form of silage or hay.

Table 5: Body weight gain, feed intake and conversion and economic efficiency of growing rabbits fed experimental diets.

Item	Experimental diets					±SEM	P-value
	Control	SPVS		SPVH			
		50%	100%	50%	100%		
Initial weight (g)	772	773	772	774	774	1.17	0.972
Final weight (g)	2613^{b}	2684^{ab}	2808^{a}	2648^{ab}	2770^{ab}	27.80	0.026
Total weight gain (g)	1841^{b}	1911^{ab}	2036^{a}	1874^{ab}	1996^{ab}	26.84	0.098
Average daily gain (g/day)	26.30^{b}	27.30^{ab}	29.09^{a}	26.77^{ab}	28.51^{ab}	0.38	0.092
Feed intake (g DM/head/day)	105.35^{a}	97.76^{ab}	94.90^{b}	100.57^{ab}	96.48^{ab}	1.14	0.018
Feed consumption (kg DM)	7.37^{a}	6.84^{b}	6.64^{b}	7.04^{ab}	6.75^{b}	0.08	0.014
Feed conversion (kg DM/kg gain)	4.01^{a}	3.58^{bc}	3.27^{c}	3.76^{ab}	3.39^{bc}	0.08	0.005
Total revenue (LE)	29.46^{b}	30.58^{ab}	32.58^{a}	29.98^{ab}	31.94^{ab}	0.42	0.084
Feed cost (LE/head)	14.60^{a}	13.03^{bc}	12.15^{bc}	13.23^{b}	12.01^{c}	0.24	0.001
Feed cost (LE)/kg gain	7.93^{a}	6.82^{ab}	5.97^{b}	7.06^{ab}	6.02^{c}	0.22	0.010
Net revenue (LE/head)	14.86^{c}	17.55^{b}	20.43^{a}	16.75^{b}	19.93^{a}	0.49	0.005
Net revenue improvement %	100.00^{c}	118.12^{b}	137.49^{a}	112.75^{b}	134.12^{a}	4.04	0.007

a, b, c, d: Values in the same row with different superscripts differ significantly (P<0.05).

The price of commercial rabbit diet 1800 LE/ ton, berseem hay 800 LE/ ton, sugar beet tops silage 150 LE/ ton, sugar beet tops hay 350 LE/ to, body weight gain 16 LE/ kg (2009).

Table 6: Carcass traits and chemical composition of meat of growing rabbits fed experimental diets.

Item	Experimental diets					±SEM	P-value
	Control	SPVS		SPVH			
		50%	100%	50%	100%		
Carcass traits							
Slaughter weight (g)	2508^{b}	2583^{ab}	2703^{a}	2531^{b}	2649^{ab}	21.07	0.006
Carcass weight (g)	1512^{b}	1590^{ab}	1711^{a}	1527^{b}	1643^{ab}	20.43	0.003
Dressing %	60.29^{b}	61.56^{ab}	63.30^{a}	60.33^{b}	62.02^{ab}	0.35	0.020
Meat weight (g)	1058^{b}	1113^{ab}	1198^{a}	1069^{b}	1150^{ab}	14.35	0.002
Meat %	42.19^{b}	43.09^{ab}	44.32^{a}	42.24^{b}	43.41^{ab}	0.25	0.018
Chemical composition of meat %							
DM	27.11^{b}	28.48^{a}	27.70^{ab}	28.20^{ab}	27.42^{ab}	0.16	0.023
CP	80.71^{ab}	80.01^{b}	81.63^{a}	79.50^{b}	80.00^{b}	0.19	0.001
EE	11.33^{b}	11.56^{ab}	11.75^{a}	11.45^{ab}	11.63^{ab}	0.04	0.016
Ash	8.15b^{c}	9.30^{a}	8.95^{ab}	9.16^{ab}	8.82^{b}	0.09	0.001

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

Carcass traits

Data in Table (6) showed that rabbits fed 100% SPVS diet showed significantly (P<0.05) the highest slaughter weight, carcass weight, dressing percentage, boneless meat weight and boneless meat percentage, however those fed commercial diet had the lowest values. The differences in carcass traits may be attributed to the differences in slaughter weight. It was obviously that dressing percentage increased with increasing body weight, which was in accordance with those obtained by Szendro *et al*. (1998). Ali *et al.* (1999) found carcass traits improved with using sweet potato vines silage or hay in rabbit feeding.

Meat composition

Rabbits fed 50% SPVS diet showed significantly (P<0.05) the highest DM and ash contents, while those fed 100% SPVS diet had the highest CP and EE contents (Table 6). The chemical composition of meat reflects the protein and energy intake. These results are in agreement with those obtained by Omara *et al*. (2005) and Eweedah *et al*. (2007).

CONCLUSION

From the present study, it could be concluded that in the diets of growing rabbits contained 40% berseem hay, replacing all berseem hay by sweet potato vines silage or hay led to increasing growth performance and economic efficiency, being the highest with the silage.

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