# Effects of Different Supplement of Cassava Chip in Para Grass and Water Spinach Basal Diets on Reproductive Performance of Californian Rabbits

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## ABSTRACT

An experiment was done at the Experimental farm Long Hoa in Binhthuy district of Cantho city to evaluate the effects of different supplement levels of cassava chip (CAC) in para grass and water spinach basal diet on the reproductive performance of Californian rabbits in two litters. The experiment was a completely randomized design, with 5 treatments as 5 diets and 6 replicates. One male rabbit at 5-6 months of age per experimental unit and 8 California female rabbits were used for mating service for the study. Five treatments were the supplement levels of cassava chip of 10 g (CAC10), 20 g (CAC20), 30 g (CAC30), 40 g (CAC40), and 50 g (CAC50) per doe per day, respectively. In two litters the results indicated that DM and ME intakes significantly increased ($P<0.05$) when CAC supplement levels was increased in the diets. Significantly higher litter weight at birth and litter weight at weaning ($P<0.05$) were found for rabbits offered 40 g CAC/day for litter one. Litter sizes at birth, milk yield and daily weight gain of does were significantly higher ($P<0.05$) in the CAC40 and CAC50 dietary treatments for both litters. A comparison of results between the two litters showed that litter weight at weaning, milk yield and daily gain of kitten were significantly higher for the litter two, however being higher daily gain of does for litter one ($P<0.05$). It was concluded that at supplement level of 40g cassava chip had better reproductive performance and gave higher economic returns for Californian does.

**Key Words**: Doe, Cassava Tuber, Milk Production, Litter Size at Birth and Weaning

## INTRODUCTION

Rabbit meat production has increased considerably in Vietnam in recent years in order to meet the increasing demand for human food from animal products. It is also increasingly popular due to the fact that it is very nutritious, lean and low in fat and cholesterol. However, pure breeding rabbit stocks are still limited, so it is impossible for producer to buy Californian weaned rabbits for their production. Almost recent studies have focused on feeds and feeding of growing rabbits rather than on reproductive does. Improving the nutrition of breeding rabbits is important for increasing their productivity. In particular determining the optimal level of energy-supplied for pure breeding rabbits makes the better rabbit production and gives the high income for the rabbit keepers (Ren et al. 2003). In the Mekong delta, besides abundant green forages, there is a lot of carbohydrate feeds such as cassava tuber, sweet potato tuber, molasses *etc*., that are valuable energy feed sources for livestock. Especially, para grass and water spinach leaf were used as basal feed diet with local energy and protein feed supplementation from dried cassava chips and soya waste to make balanced nutrient diets that can increase feed utilization and reproductive performance of Californian rabbits. Therefore this study aimed to evaluate the efficiency of dried cassava chip supplement in diets on reproductive performance of Californian does.

## MATERIALS AND METHODS

### Animals and experimental design

The trial was carried out at the Experimental farm Long Hoa in Binhthuy district, Cantho city. Thirty 6 months old Californian rabbits with live weight average of 2860 g were arranged in a complete randomized design with 5 treatments and 6 replications. The dietary treatments were different supplementation levels of 10, 20, 30, 40 and 50 g dried cassava chips to para grass and water

spinach leaf basal diet, corresponding to the CAC10, CAC20, CAC30, CAC40 and CAC50 treatments. Soya waste with amount of 200 g and 30 g concentrate and 20 g oil-extracted soybean were offered per rabbit per day. Does were housed individually in separate per wire mesh and woody cage, and each doe was considered as an experimental unit. The eight female Californian rabbits were used for mating services and the trial was monitored for 2 litters.

**Feeds, feeding and management**

Para grass (PG), water spinach leaves (WSL) and soya waste (SW) were collected and bought daily, except for dried cassava chips bought from farmers in one occasion to be used during experiment. The animals were fed three times a day at 8:00, 14:00 and 18:00 h. The WSL and SW were adjusted weekly by increasing allowances by 5, 10 and 15% in the second, third and fourth week of pregnancy, respectively. During lactation period allowances were increased by 10% in the first week, 30% for the second and third week, and 40% in the fourth week. All animals had access to fresh water at all times. The breeding service was done at two weeks after birth. The new-born animals were weaned at the 30th day. Before the experiment started, all does were vaccinated to prevent rabbit hemorrhagic and parasite diseases.

**Measurements**

Reproduction criteria were recorded in 2 litters. Feeds given and refusals were taken for analyses of DM, OM, CP, EE, Ash and NDF following procedure of AOAC (1990) and van Soest et al. (1991) and ME (Maertens et al. 2002). The measurement taken included: daily feed and nutrient intakes for each litter, litter size at birth and weaning, daily milk yield recorded by weighing the kids before and after suckling.

**Statistical analysis**

The data were analyzed by analysis of variance using the ANOVA of General linear model of Minitab Reference Manual Release 16.1.0 (Minitab 2010). For the comparison of the reproduction criteria between the litters the paired T test of Minitab Reference Manual was used.

## RESULTS AND DISCUSSION

**Feed characteristics**

The para grass (PG) contained higher DM, but lower CP concentrations as compared to water spinach leaves (WSL). Supplementation of SW and ESB to para grass and WSL diets provided protein, while CAC supplemented energy for does in the diets. The CP content of WSL and SW used in our experiment are similar to values (27.0 and 21.2%, respectively) reported by Thoai (2012). The CP and ME concentrations of CAC in a current study are consistent with the results of 2.70% CP and 13.4 MJ ME stated by Nguyen & Nguyen (2012).

Characteristics of feeds used in the trial are presented in Table 1.

**Table 1.** Chemical composition of feeds (% DM) used in the trial

| Feed (%) | DM | OM | CP | EE | Ash | NDF | ME, MJ/kg DM |
|---|---|---|---|---|---|---|---|
| Cassava chip (CAC) | 90.00 | 97.30 | 2.85 | 1.38 | 2.67 | 15.00 | 13.30 |
| Para grass (PG) | 15.50 | 89.20 | 12.60 | 4.50 | 10.80 | 65.50 | 8.23 |
| Water spinach leaves (WSL) | 11.50 | 90.60 | 29.60 | 8.00 | 9.40 | 41.00 | 12.00 |
| Soya waste (SW) | 12.40 | 96.20 | 21.00 | 15.50 | 3.80 | 36.50 | 11.20 |
| Oil-extracted soybean (ESB) | 87.60 | 89.80 | 41.80 | 3.40 | 10.20 | 27.50 | 11.40 |
| Concentrate (CON) | 89.50 | 92.20 | 19.90 | 7.35 | 7.80 | 25.20 | 11.90 |

DM: dry matter; OM: organic matter; CP: crude protein; EE: ether extraction; NDF: neutral detergent fiber and ME: metabolisable energy (Maertens et al. 2002)

**Feed and nutrient utilization**

The daily intakes of feed, nutrient and ME of the does were shown in Table 2

The results of pregnant and lactation periods of the Californian does indicate that daily DM and OM intakes were significantly higher (P<0.05) for the CAC40 and CAC50 treatments. Especially, The ME intake considerably increased with increasing CAC levels in the diets (P<0.05), reaching the highest results for the CAC40 and CAC50 treatments (Table 2). The DM intakes are in a range of 111 to 145 g, but being higher ME intakes than those (1.06-1.53 MJ/rabbit) of a study on Californian does reported by Trang (2012).

**Effect of cassava chip supplement on reproductive performance of does, litter 1**

For litter 1, litter size at birth and at weaning had tendency to increase for the does supplemented CAC (P>0.05), while the weight of litter at birth and at weaning were the highest (P<0.05) for the does supplemented CAC in the CAC40 and CAC50 treatments (Table 3). The litter size at birth is consistent with the findings stated by Mai (2005) (3-8 kids/litter) and Thoai (2012) (5.67-7.33 kids/litter), but being lower than report of Lebas et al. (1986) (7-9 kids/litter). The relationship between ME intake and litter size at birth was presented in Figure 1 with $R^2 = 0.99$.

**Table 2.** Daily intakes of feed, nutrients and ME of Californian rabbits in litter 1

| Item | Treatment | | | | | SE/P |
|---|---|---|---|---|---|---|
| | CAC10 | CAC20 | CAC30 | CAC40 | CAC50 | |
| Daily intake of nutrients and ME in pregnant period (g/doe) | | | | | | |
| DM | 113.00 | 112.00 | 114.00 | 120.00 | 120.00 | 2.520/0.130 |
| OM | 104.00 | 105.00 | 106.00 | 113.00 | 111.00 | 2.410/0.080 |
| CP | 23.00 | 22.80 | 22.50 | 23.00 | 23.10 | 0.320/0.830 |
| EE | 6.47 | 6.54 | 6.09 | 6.33 | 6.28 | 0.280/0.820 |
| NDF | 38.30 | 37.00 | 39.00 | 39.00 | 39.00 | 1.440/0.830 |
| ME (MJ/doe) | 1.24[a] | 1.27[a] | 1.31[ab] | 1.41[b] | 1.39[b] | 0.030/0.002 |
| Daily intake of nutrients and ME in lactation period (g/doe) | | | | | | |
| DM | 123.00[a] | 127.00[a] | 139.00[b] | 152.00[c] | 151.00[c] | 2.430/0.001 |
| OM | 113.00[a] | 117.00[a] | 128.00[b] | 141.00[c] | 140.00[c] | 2.200/0.001 |
| CP | 26.00 | 26.80 | 26.60 | 27.10 | 26.40 | 0.370/0.410 |
| EE | 7.15 | 7.06 | 7.14 | 7.42 | 7.27 | 0.120/0.310 |
| NDF | 46.60 | 44.40 | 48.90 | 46.40 | 47.10 | 1.240/0.210 |
| ME (MJ/doe) | 1.27[a] | 1.31[a] | 1.46[b] | 1.62 | 1.63[c] | 0.020/0.001 |
| Daily intake of nutrients and ME in pregnant and lactation period (g/doe) | | | | | | |
| DM | 118.00[a] | 119.00[a] | 126.00[ab] | 136.00[b] | 135.00[b] | 2.170/0.001 |
| OM | 109.00[a] | 111.00[a] | 117.00[ab] | 127.00[bc] | 126.00[c] | 2.020/0.001 |
| CP | 24.40 | 24.80 | 24.60 | 25.00 | 24.70 | 0.260/0.660 |
| EE | 6.80 | 6.80 | 6.60 | 6.90 | 6.78 | 0.170/0.860 |
| NDF | 42.50 | 40.70 | 43.90 | 42.70 | 43.00 | 0.180/0.260 |
| ME (MJ/doe) | 1.26[a] | 1.29[a] | 1.39[b] | 1.51[c] | 1.52[c] | 0.020/0.001 |

[a. b, c] Mean values with different superscripts within the same row are different at P<0.05

**Table 3.** Effect of cassava chip supplement on reproductive performance of does, litter 1

| Item | Treatment | | | | | SE/P |
|---|---|---|---|---|---|---|
| | CAC10 | CAC20 | CAC30 | CAC40 | CAC50 | |
| Pregnancy duration (day) | 30.00 | 29.50 | 30.30 | 30.30 | 30.00 | 0.380/0.630 |
| Litter size at birth (rabbit) | 6.50 | 7.00 | 7.50 | 8.00 | 7.75 | 0.420/0.140 |
| No of alive rabbit at birth | 6.50 | 6.75 | 7.25 | 7.50 | 7.50 | 0.380/0.270 |
| Weight at birth (g/kitten) | 61.60 | 56.10 | 57.20 | 54.70 | 56.10 | 2.700/0.470 |
| Weight of litter at birth | 381.00$^{a}$ | 390.00$^{ab}$ | 427.00$^{ab}$ | 435.00$^{c}$ | 430.00$^{c}$ | 14.500/0.050 |
| Litter size at weaning (rabbit) | 6.25 | 6.75 | 7.00 | 7.50 | 7.25 | 0.390/0.250 |
| Weight at weaning (g/rabbit) | 415.00 | 413.00 | 420.00 | 446.00 | 437.00 | 15.200/0.460 |
| Weight of litter at weaning (g) | 2593.00$^{a}$ | 2778.00$^{ab}$ | 2919.00$^{abc}$ | 3333.00$^{c}$ | 3161.00$^{bc}$ | 128.000/0.007 |
| Milk yield (g/day) | 96.80$^{a}$ | 108.00$^{ab}$ | 118.00$^{abc}$ | 133.00$^{c}$ | 127.00$^{bc}$ | 4.760/0.001 |
| Milk amount (g/kitten/day) | 15.70 | 16.13 | 16.90 | 17.90 | 17.60 | 0.990/0.490 |
| Daily gain of litter (g/litter) | 2212.00$^{a}$ | 2401.00$^{ab}$ | 2521.00$^{abc}$ | 2923.00$^{c}$ | 2755.00$^{bc}$ | 116.000/0.005 |
| Daily gain (g/kitten) | 11.80 | 11.90 | 12.10 | 13.10 | 12.70 | 0.470/0.260 |
| Daily gain of doe in pregnant time | 16.00 | 16.40 | 17.60 | 17.80 | 17.70 | 0.480/0.050 |

$^{a, b, c}$ Mean values with different superscripts within the same row are different at P<0 05

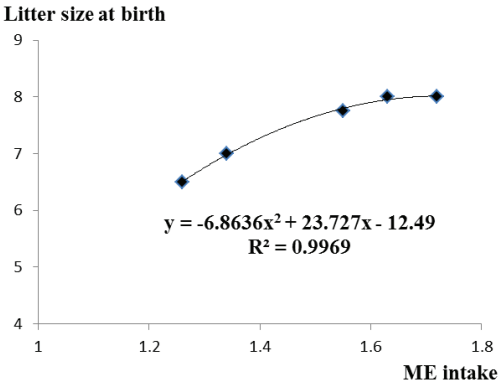


**Figure 1.** Effect of ME intake on litter size at birth

Milk yield was affected by CAC supplement in the diets corresponding with increase of ME intakes. The results were significantly higher (P<0.05) for the animals fed from 40 g to 50 g CAC in the CAC40 and CAC50 treatments. The data recorded in our study is considerably higher than those (67.3-83 g/day) of a study on Californian does cited by Khoi (2012).

## Daily intakes of feed, nutrients and ME of Californian does supplemented different levels of cassava chips, litter 2

Table 4 shows that the DM and ME intakes obtained in litter 2 were higher than those in litter 1. The daily intake average of DM, OM and ME increased following with increasing the CAC supplement levels in diets (P<0.05) getting the highest in the CAC40 and CAC50 treatments. The ME intakes are consisted with those (1,42-1,50 MJ/rabbit), while DM intakes were lower than the values of 148 g to 150 g of a trial on does supplemented oil- extracted soybean in diets (Trinh 2012).

## Effect of cassava chip supplement on reproductive performance of does, litter2

For litter 2, litter size at birth was significantly higher (P<0.05) in the CAC40 and CAC50 treatments. Also, the litter size at birth and at weaning are in agreement with data cited by Linh (2008) (5.76-7.33 kids/litter) and Thao (2012) (5.33-7.0 kids/litter), respectively. The CAC supplementation clearly improved milk yield of does, and getting the highest value (P<0.05) for the animals given 40 g CAC in the CAC40 diet. The results obtained in a present study are better than the values (72.2-92.8 g/day) of crossbred does supplied dried sweet potato tuber (Loan 2010). Effect of ME intake on milk production and litter size at weaning of Californian does is shown in Figure 2 with $R^2$= 0.95 and $R^2$= 0.85

**Table 4.** Daily intakes of nutrients and ME of Californian does supplemented different levels of cassava chips, litter 2

| Item | Treatment | | | | | SE/P |
|---|---|---|---|---|---|---|
| | CAC10 | CAC20 | CAC30 | CAC40 | CAC50 | |
| Daily intake of nutrients and ME in pregnant period (g/doe) | | | | | | |
| DM | 110.000[a] | 115.000[a] | 134.000[b] | 141.000[bc] | 145.000[c] | 1.910/0.001 |
| OM | 102.000[a] | 107.000[a] | 124.000[b] | 131.000[bc] | 136.000[c] | 1.850/0.001 |
| CP | 21.600 | 21.700 | 21.300 | 22.100 | 22.200 | 0.370/0.460 |
| EE | 8.600 | 9.050 | 9.480 | 8.750 | 8.450 | 0.260/0.100 |
| NDF | 47.200 | 47.400 | 47.600 | 48.800 | 48.600 | 0.750/0.470 |
| ME (MJ/doe) | 1.170[a] | 1.250[a] | 1.480[b] | 1.550[bc] | 1.630[c] | 0.020/0.001 |
| Daily intake of nutrients and ME in lactation period (g/doe) | | | | | | |
| DM | 125.000[a] | 129.000[a] | 143.000[b] | 153.000[c] | 160.000[d] | 1.480/0.001 |
| OM | 115.000[a] | 120.000[a] | 133.000[b] | 142.000[c] | 150.000[d] | 1.320/0.001 |
| CP | 25.600 | 25.800 | 25.900 | 25.700 | 25.800 | 0.170/0.720 |
| EE | 9.600 | 9.700 | 9.700 | 10.100 | 10.300 | 0.210/0.130 |
| NDF | 51.200 | 50.900 | 51.600 | 49.800 | 51.600 | 0.600/0.250 |
| ME (MJ/doe) | 1.350[a] | 1.420[b] | 1.610[c] | 1.700[d] | 1.820[e] | 0.010/0.001 |
| Daily intake average of nutrients and ME in pregnant and lactation period (g/doe) | | | | | | |
| DM | 118.000[a] | 122.000[a] | 138.000[b] | 147.000[c] | 153.000[c] | 1.510/0.001 |
| OM | 109.000[a] | 113.000[a] | 129.000[b] | 137.000[c] | 143.000[c] | 1.410/0.001 |
| CP | 23.600 | 23.700 | 23.600 | 23.900 | 24.000 | 0.170/0.430 |
| EE | 9.100 | 9.350 | 9.600 | 9.450 | 9.380 | 0.120/0.100 |
| NDF | 28.300 | 28.400 | 28.800 | 29.800 | 29.600 | 0.430/0.090 |
| ME (MJ/doe) | 1.260[a] | 1.340[b] | 1.550[c] | 1.630[d] | 1.720[e] | 0.010/0.001 |

[a, b, c, d, e] Mean values with different superscripts within the same row are different at P<0 05

**Table 5.** Effect of cassava chip supplement on reproductive performance of does, litter 2

| Item | Treatment | | | | | SE/P |
|---|---|---|---|---|---|---|
| | CAC10 | CAC20 | CAC30 | CAC40 | CAC50 | |
| Pregnancy duration (day) | 30.000 | 30.000 | 29.800 | 30.000 | 30.300 | 0.440/0.950 |
| Litter size at birth (rabbit) | 6.500[a] | 7.000[a] | 7.750[b] | 8.000[b] | 8.000[b] | 0.360/0.030 |
| No of alive rabbit at birth | 6.500 | 7.000 | 7.500 | 7.800 | 7.500 | 0.310/0.080 |
| Weight at birth (g/kitten) | 62.800 | 59.700 | 56.400 | 57.100 | 55.600 | 2.570/0.310 |
| Weight of litter at birth | 406.000 | 419.000 | 435.000 | 453.000 | 442.000 | 14.100/0.190 |
| Litter size at weaning (rabbit) | 6.500 | 7.000 | 7.300 | 7.500 | 7.500 | 0.310/0.180 |
| Weight at weaning (g/rabbit) | 440.000 | 437.000 | 443.000 | 471.000 | 460.000 | 16.000/0.530 |
| Weight of litter at weaning (g) | 2860.000 | 3065.000 | 3206.000 | 3530.000 | 3448.000 | 178.000/0.100 |
| Milk yield (g/day) | 106.000[a] | 119.000[ab] | 128.000[ab] | 141.000[c] | 134.000[bc] | 5.100/0.002 |
| Milk amount (g/kitten/day) | 16.400 | 17.200 | 17.100 | 18.300 | 18.100 | 1.040/0.700 |
| Daily gain of litter (g/litter) | 2454.000 | 2646.000 | 2771.000 | 3077.000 | 3006.000 | 173.000/0.120 |
| Daily gain (g/kitten) | 12.600 | 12.600 | 12.800 | 13.700 | 13.370 | 0.530/0.500 |
| Daily gain of doe in pregnancy | 10.700 [a] | 10.900[a] | 11.800[b] | 12.000[b] | 11.900[b] | 0.330/0.050 |

[a, b, c] Mean values with different superscripts within the same row are different at P<0 05

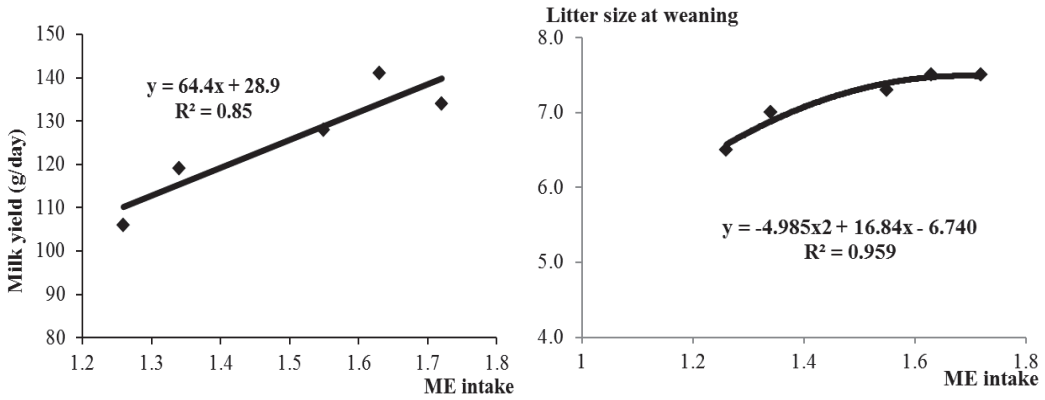


**Figure 2.** Effect of ME intake on milk production and litter size at weaning of does in litter 2

## Comparison the reproductive performance between two litters

A comparison of reproductive criteria of the does between two litters is presented in Table 6. There was no significant difference in litter size at birth and at weaning, weight at birth (P>0.05) between two litters, while litter weight at weaning, milk yield and daily weight gain of kitten were significantly higher (P<0.05) for litter 2. Also, daily weight gain of does in pregnant period was higher for litter 1 (P>0.05).

## Analysis of economic returns of Californian does supplemented cassava chips of two litters

In Table 7 analysis of economic returns of Californian does were supplemented cassava chips in the diets of two litters indicate that the lower total expense, but higher income were found in the CAC40 treatment, resulting in giving more benefits for Californian does fed 40 g cassava chips per day.

**Table 6.** Comparison the reproductive performance among two litters

| Item | Litter 1 | Litter 2 | SE/P |
|---|---|---|---|
| Pregnancy duration (day) | 30.00 | 30.00 | 0.260/1.000 |
| Litter size at birth (rabbit) | 7.40 | 7.50 | 0.230/0.670 |
| No of alive rabbit at birth | 7.10 | 7.30 | 2.200/0.450 |
| Litter size at weaning | 7.00 | 7.20 | 0.190/0.300 |
| Weight at birth (g/rabbit) | 57.10 | 58.30 | 1.500/0.430 |
| Litter weight at weaning (g) | 2,957.00[a] | 3,222.00[b] | 82.400/0.005 |
| Milk yield (g/day) | 116.00[a] | 126.00[b] | 0.330/0.001 |
| Milk amount (g/kitten/day) | 16.80 | 17.40 | 0.480/0.250 |
| Daily gain of litter (g/litter) | 2,562.00 | 2,791.00 | 77.400/0.008 |
| Daily gain (g/kitten) | 12.30[a] | 13.00[b] | 0.050/0.001 |
| Daily gain of doe in pregnant time | 17.10[a] | 11.50[b] | 0.090/0.001 |

**Table 7.** Analysis of economic returns of does supplemented cassava chips of two litters (VND)

| Item | Treatment | | | | |
|---|---|---|---|---|---|
| | CAC10 | CAC20 | CAC30 | CAC40 | CAC50 |
| Litter size at weaning rabbit | 6.4 | 6.9 | 7.3 | 7.5 | 7.4 |
| Income from selling rabbits | 448,000.0 | 483,000.0 | 511,000.0 | 525,000.0 | 518,000.0 |
| Feed cost | 39,140.0 | 40,017.0 | 38,206.0 | 39,607.0 | 39,885.0 |
| Housing | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Medicine cost | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Total expense | 39,170.0 | 40,047.0 | 38,236.0 | 39,637.0 | 39,915.0 |
| Profit | 408,830.0 | 442,953.0 | 472,764.0 | 485,363.0 | 478,085.0 |

Cost were 70,000 VND/weaned rabbit, 8000 VND/kg dry cassava chips

## CONCLUSION

Dried cassava chip is a valuable energy source, could be used for feeding rabbit does. The Californian does supplemented cassava chips at level of 40g per day improved DM and ME intakes and gave better reproductive performance and profits.

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