Journal of Applied Pharmaceutical Science Vol. 2 (9), pp. 015-019, September, 2012
Available online at http://www.japsonline.com
DOI: 10.7324/JAPS.2012.2903
ISSN 2231-3354

Effects of substitution of pellet of *Moringa oleifera* to commercial feed on rabbit's digestion, growth performance and carcass trait

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ARTICLE INFO

Article history:
Received on: 27/08/2012
Revised on: 15/09/2012
Accepted on: 20/09/2012
Available online: 28/09/2012

Key words:
Moringa oleifera, digestibility, diet efficiency, carcass, sensory quality.

ABSTRACT

A Seventy day feeding trial was carried out to determine the effect of dietary pellets of *Moringa oleifera* leaves (PML) on digestibly, weight gain and carcass trait of growing rabbits. Solar drying of *M. Oleifera* leaves is carried out before its transformation in pellets for the conservation of raw material. The PML were substituted to the commercial feed at level of 0, 10 and 15% to formulate diets of PML0 (control), PML10 and PML15 respectively. Forty five growing rabbits, 35-55 days of age, were allocated to three treatment groups with five replicates in a completely randomized design. Pellets of *M. oleifera* were completely consumed. Digestibility of crude proteins was higher ($p < 0.05$) for diets PML10 (75%) and R15 (70.5%). The best weight gains and feed conversion ratios were obtained in rabbits fed PML10 and PML15 diets respectively for 4.43: 1 and 4.63: 1. The rabbit's carcass yield ranged from 60.6 to 64.5%. Pellets of *M. oleifera* can be substituted at a level of 15% to the commercial feed with a positive effect on weight gains and carcass characteristics of rabbits. The rabbit's meat of this type of feed ingredient present a good sensory quality.

INTRODUCTION

Livestock is one of the main economic activities which constitutes a significant contribution to human livelihood and contributes significantly to food security and cash income of poor households. It is also the main insurance against risks to millions of poor people whose livelihoods depend on rain-fed agriculture. However, this potential in animal production which contains the region is still poorly valued (Kamuanga et al., 2004). Therefore, animal protein sources are becoming inadequate. Thus, rabbit breeding is facing enormous constraints such as diseases but mostly feed. The increasing price of raw materials that is used for concentrate raises the cost of rabbit production. This is why, it is urgent to find endogenous alternatives to produce rabbit in quantity and quality. The nutritional qualities of *Moringa oleifera* are excellent, which constitutes a source of high quality forage for animals. Also, these leaves are browsed by ruminants and poultry because of its high protein and minerals (Foidl et al., 2001), by guinea pigs (Tedonkeng et al., 2005), by rabbits (Nuhu, 2010) and by cricetoms (Dougnon et al., 2011). Studies on *M. oleifera* showed that the leaves are rich in energy and vitamins (Ayssiwede et al., 2011; Mutayoba et al., 2011) and has low anti-nutritional factors. Moreover, Kpodékon et al. (2009) showed that pellets feed provides better performance for rabbits that same meal in flower form. Use of pellets feed reduced fattening period for about 13 to 15 days. However, use of pellets of *M. oleifera* for rabbits fattening is not well documented. This study evaluates the effects of substitution pellets of *M. oleifera* on weight performance and carcass characteristics of rabbits (*Oryctolagus cuniculus*).

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MATERIAL AND METHODS

Diet and fattening rabbits

Moringa oleifera leaves were collected and then dried on fillet net installed under the shade for a week, to lose 80% of moisture. The twigs are collected and disposed after drying. Leaves are then passed directly into the pellets press with 4 mm mesh. Pellets of *M. oleifera* leaves (PML) were substituted to the commercial feed (control) of the Cunicole Association feed - *La Providence (ACP-LP)* at level of 0, 10 and 15% to formulate three diets, PML0 (control), PML10 and PML15 respectively. The commercial feed is composed of 5% maize, 29.0% of palm kernel cake, 16.0% cottonseed meal, 7.0% soybean meal, 20.5% wheat bran, 15.0% rice bran, 2.5% of oyster shell, 0.5% salt, 4.0% sawdust (Kpodékon et al., 2009). The different diets were supplemented with forage of *Panicum maximum C1*.

The experiment was laid out as a completely randomized design with three diets treatments and 5 replicates making a total of 15 experimental units. The three rabbits in each hutch were considered an experimental unit and the pooled data for the three rabbits was used in the analysis. A total of 45 rabbits aged 35-55 days were used for experimentation.

The average body weight of each rabbit in early test ranged from 594.32 to 613.64 g. Each fattening rabbit hutch measure 75 cm long, 46 cm wide and 30 cm high. Rabbits were fed an allowance ranging from 100 to 130 g dry matter (DM) per head, once a day and water was provided *ad libitum*. Commercial diet and pellets of *M. oleifera* were in separate feeder. Any feed left over at the beginning of the next day was weighed and subtracted from that which had been fed the previous day to determine feed intake. Feed intake was recorded daily for each hutch and pooled for 14 days. Feed allowance was adjusted at the end of each 14 days after the rabbits had been weighed. Feed samples were taken every 14 days for determination of DM in an oven at 70 °C until constant weight. This was then used to calculate an average daily feed intake. The rabbits were weighed at the beginning of the trial and every 14 days. Similarly, weights taken at every 14 days were used to calculate an average daily weight gain. The average daily feed intake, divided by the average daily weight gain was calculated as the feed to gain ratio, that is, the weight of feed needed to produce one kilogram of gain.

Evaluation of the digestibility

Fifteen rabbits with average body weight of 2138.33 g at the start of the trial were concerned. The rabbits were divided into three homogeneous groups of five rabbits on the basis of their body weights. Each group was randomly assigned to one of three diets PML0 (control), PML10, and PML15. Each rabbit was placed in a digestibility hutch with a surface of 0.202 m^2 and 0.32 m height, equipped with a system for recovering wasted feed and excreta. Rabbits were fed an allowance of 130 g DM per head, once a day and water was provided ad libitum. Commercial feed and pellets of *M. oleifera* were given in separate feeder. The rabbits received the forage of *P. maximum C1* as supplement. The experiment lasted for 7 days. The diet offered, diet left over and the excreta were weight and recorded daily per animal to determine the feed intake and apparent digestibility of dry matter, of crude protein and of organic matter. The samples of each type of feed offered, type of feed left over and excreta were taken for dry matter determination and chemical analysis.

Laboratory analysis

The samples were used to determine the DM with oven and mineral matter by incineration. The nitrogen determination was done by the Kjeldahl method (AOAC, 1990). The measured nitrogen was multiplied by 6.25 to calculate the crude protein.

Evaluation of carcass characteristics

The evaluation was involved six rabbits randomly selected at two per diet type, slaughtered at the end of the test (78th day) for the study of carcass. The evaluation focused on organ weights, but also the sensory observations that were made through the color, smell and consistency of the carcass and organs such as heart, liver, lung, spleen, kidneys and intestines.

Statistical analyses

The data were subjected to analysis of variance (ANOVA) using the software STATISTICA (1998). An ANOVA with two criteria was used to examine the effects of substitution Pellet of *M. oleifera* proportion in the diet (n = 3: 0%, 10%, 15%). In case of significant difference, the Student-Newman-Keuls test was used to separate homogeneous groups at a significance level of 5%.

RESULTS

Chemical composition of diets

The chemical composition of diets offered is presented in Table 1. The crude protein content of pellets of *M. oleifera* (27.5%) is higher than that of commercial feed (18.2%). But the total ash content is similar for both types of feed.

Table 1: Dry matter content (DM %), total crude protein (CP %), and total ash (%) in the diets offered.

Types of feed	DM	CP	Ash
Commercial feed	88.73	18.2	11.2
Pellets of *M. oleifera*	81.83	27.5	11.5

Fattening rabbits

Diet intake is higher for the control diet (Table 2). PML intake is almost complete for all rabbits. The total intake, about 8% of body weight was higher ($p<0.05$) for PML0 (control) diet. But, the average daily weight gain was lower ($p<0.01$) for the control diet (19.18 g) than that of PML10 and PML15 diets (22.5 to 2296 g). Feed conversion ratio (FCR) were better ($p<0.01$) for PML10 and PML15 diets respectively for 4.43: 1 and 4.63: 1 than that of the control diet (Table 2). Rabbit's growth performance for PML10 and PML15 diets were faster than that of the control diet (figure 1).

Table 2: Diets intake, live weight (LW) and feed efficiency of rabbits fed pellets of *M. Oleifera* as substitute to commercial feed

Parameters	Types of diets			p
	PML0	PML10	PML15	
Commercial feed intake (g DM)	88.37a	77.17b	72.50c	0.0000
Pellets of *M. oleifera* intake (g DM)	0 a	10.00b	14.31c	0.0000
P. maximum intake (g DM)	13.09a	6.92b	6.57b	0.0000
Total feed intake (g DM)	101.46a	94.17b	93.37b	0.0037
Commercial feed intake (%LW)	7.49a	5.73b	5.61b	0.0000
Pellets of *M. oleifera* intake (% LW)	-	0.75b	1.09a	0.0000
P. maximum intake (% LW)	1.06a	0.50b	0.49b	0.0000
Total intake (% LW)	8.54a	6.98b	7.19b	0.0001
Initial LW (g)	613.64a	610.23a	594.32a	0.8856
Final LW (g)	1956.36b	2165.91a	2222.05a	0.0171
Average daily LW gain (g)	19.18b	22.96a	22.5a	0.0008
Feed Conversion Ratio	5.65a	4.43b	4.63b	0.0002

p = Probability of significance. Means followed by different letters on the same line are significantly different at 5% level.
PML0: 0% of PML in the diet; PML10: 10% of PML in the diet; PML15: 15% of PML in the diet.

Table 3: Feed intake, apparent digestibility and excreta of rabbits fed pellets of *M. oleifera* as substitute to commercial feed

Parameters	Types of diets			P
	PML0	PML10	PML15	
Feed intake (g DM/day)	111.42 a	101.56 b	105.44 b	0.0002
Excreta (g DM/day)	53.12 a	44.05 b	45.26b	0.0000
Digestibility of DM (%)	52.3b	56.58a	57.07a	0.0000
Intake of CP (g DM/day)	17.17b	17.52b	18.90a	0.0000
Excreta (g CP/day)	5.81a	4.38b	5.57a	0.0000
Digestibility of CP (%)	66.12c	74.97a	70.54b	0.0000
Intake of OM (g DM/day)	100.49a	91.33b	94.70b	0.0030
Excreta (g OM/day)	45.95a	36.07b	36.68b	0.0000
Digestibility of OM (%)	54.26b	60.46a	61.25a	0.0000

PML0: 0% of PML in the diet; PML10: 10% of PML in the diet; PML15: 15% of PML in the diet.
DM: dry matter; OM: organic matter; CP: crude protein;

Table 4: Carcass traits of rabbits fed pellets of *M. oleifera* as substitute to commercial feed.

Parameters	Types of ration			P
	PML0	PML10	PML15	
Body weight (g)	2144	2233	2197	0.950
Stripped carcass weight (g)	1768	1842	1827	0.957
Eviscerated carcass weight	1277	1413	1387	0.698
Yield %	60.57	64.49	63.19	0.773
Skin weight (g)	360.9	395.4	371.9	0.698
Head weight (g)	129.1	150.5	145.6	0.243
Forelegs weight (g)	32.03	34.44	34.32	0.811
Hind legs weight (g)	100.37	104.26	87.14	0.381
Spleen weight (g)	0.6821	0.9020	0.7618	0.461
Heart weight (g)	7.021	6.285	6.529	0.629
Lung weight (g)	28.42	16.31	14.92	0.139
Liver weight (g)	47.68	56.45	50.03	0.576
Kidney weight (g)	11.70	12.17	12.08	0.961
Intestines empty weight (g)	81.79	86.96	76.66	0.709
Fat weight (g)	174.41	65.50	118.75	0.156

PML0: 0% of PML in the diet; PML10: 10% of PML in the diet; PML15: 15% of PML in the diet.

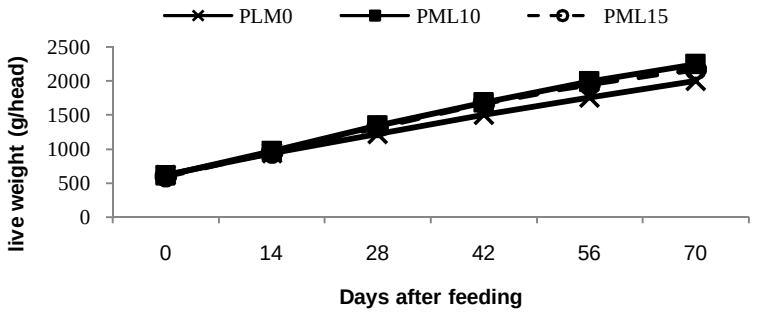

Figure 1: Evolution of growth performance of rabbits fed pellets of *M. oleifera* as substitute to commercial feed
PML0: 0% of PML in the diet; PML10: 10% of PML in the diet; PML15: 15% of PML in the diet.

Apparent digestibility

Dry matter and organic matter intake were higher ($p < 0.01$) for rabbits fed the control diet (Table 3). But, crude protein intake was higher ($p<0.01$) for PMLR15 diet. Digestibility of dry matter, crude protein and organic matter were significantly higher ($p < 0.01$) for PML10 and PML15 diets. Excreta quantity in dry matter and organic matter is higher ($p < 0.05$) for the control diet. But crude protein in excreta were higher for the PML0 and PML15 diets.

Carcass characteristics

The carcass yield was higher (but not significant $p > 0.05$) for PML10 and PML15 diets (Table 4). The substitution of PML to commercial diet has not affected the weight of offal ($p > 0.05$). There was no apparent effect on color, consistency and odor of the carcass and offal.

DISCUSSION

Chemical composition of diets

The transformation of *M. oleifera* leaves in pellets does not affect some nutritional value. Indeed, the crude protein content of PML from this study is similar to that recorded (27.1 to 27.51%) by Booth and Wickens (1988) and Oduro et al. (2008) with flour of *Moringa oleifera* leaf. But, crude protein contents of *M oleifera*, is relatively lower compared to the value (29.25%) recorded by Nuhu (2010). The ash content recorded for this study is somewhat similar to that reported (11.39%) by Ndong et al. (2007). Compared to the commercial concentrate which is constituted of a set of feed ingredients, PML alone constitutes a native feed, exceptionally rich in proteins and minerals, confirming the findings of Fahey et al. (2001).

Growth performance

The PML were palatable to rabbits. A similar observation was made for crycetomes (Dougnon et al., 2011). The partial substitution of commercial feed by PML, accelerate growth performance of rabbits compared to that of the control diet. The PML contains about 33.82% of crude proteins more than commercial feed (control). The partial substitution of the commercial feed by PML brought an extra protein in the diet. This could explain the better weight performance of rabbits fed the diet containing PML. The mechanism that guides the growth responses observed for rabbits does not appear to be related to the amount of DM intake. This mechanism is rather related to the nutritional quality including proteins content and its digestibility as demonstrated by this study. Indeed, the leaves of *M. oleifera* are rich in minerals, vitamins A, B, C and E and especially protein with eight essential amino acids (Odeyinka et al., 2008). A study of rabbit's digestibility, Fanimo et al. (2003) has reported that there was no advantage in feed digestibility compared to the control diet, although the growth rate of rabbits fed diets containing 20 and 30% by-products of cashew apple were better. The mortality rate recorded and failure to observe clinical signs of particular disease could indicate that the partial substitution of commercial feed by PML has no major negative effect on the health of rabbits and their performance.

The rabbits weight gains for PML diets are similar to those obtained (21.5 and 22.6 g / d) by Kpodékon et al. (2008) and Kpodékon et al. (2009). On the other hand, the average daily weight gain for commercial feed (19.18 g/d) is much lower than those reported by these authors. However, the average feed conversion ratio obtained for commercial feed (about 5.65:1) confirms the results of Kpodékon et al. (2009) using the same pellets feed. The partial substitution of commercial feed by PML, improved feed efficiency significantly as demonstrated by the present study. According to Fanimo et al. (2003), this performance is often achieved through an appropriate concentration of energy and protein quality that would be provided in the case by PML. This would explain the faster growth observed in rabbits fed with diets containing PML.

The sensory qualities of meat from rabbits fed PML and the control were similar. This would indicate the existence of any apparent adverse effect of the diet-based PML on the sensory quality of rabbit meat.

CONCLUSION

The dried leaves of *M. oleifera* are adapted to the manufacture of pellets. This format is well appreciated by the growing rabbits. Thus, the PML is a good feed source for growing rabbits. This feed ingredient can be substituted at a rate of 15% to the commercial feed with a positive effect on digestion, feed efficiency and carcass yield of rabbits. The meat from this type of feed ingredient present a good sensory quality.

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How to cite this article:

Dougnon T.J, Aboh B.A., Kpodékon T.M., Honvou S., Youssao I. Effects of substitution of pellet of *Moringa oleifera* to commercial feed on rabbit's digestion, growth performance and carcass trait J App Pharm Sci. 2012; 2(9): 015-019.