A RESPONSE OF NUTRIENT INTAKES, FEED CONVERSION RATIO AND DIGESTION OF MEAT RABBITS ON DIETARY FIBER LEVELS

Nguyen Thi Kim Dong[1] and Nguyen Van Thu[2]

[1]College of Applied Biology, Tay Do University, Vietnam;
[2]College of Agriculture, Can Tho University, Vietnam

Corresponding author: Nguyen Thi Kim Dong; Email: ntkdong@tdu.edu.vn

ABSTRACT

It was a complete randomized design with six treatments and three replicates, which was implemented with different levels of neutral detergent fiber (NDF) at 37, 41, 45, 49, 53 and 57% corresponding to the treatments of NDF37, NDF41, NDF45, NDF49, NDF53 and NDF57, respectively to evaluate growth performance and nutrient digestibility of growing crossbred rabbits for applications. Two female and two male rabbits at 54 days of age were allocated in one experimental unit. The results showed that in Exp 1 the dry matter (DM) and organic matter (OM) intakes were significantly increased ($P<0.001$) when increasing levels of NDF in the diets. The crude protein (CP) intake was the lowest value in the NDF57 diet ($P<0.001$). The NDF and ADF intakes were significantly increased ($P<0.001$) when increasing levels of NDF in the diets. The daily weight gain was significantly decreased ($P<0.001$), the daily weight gain in the NDF41 treatment (20.3g/rabbit/day) was higher than this in theNDF45, NDF49, NDF53 and NDF57ones, however, the lower feed conversion ratio was found ($P<0.05$) in the NDF37 treatment (3.45). In Exp 2 the coefficient of total tract apparent digestibility of DM, OM, NDF and acid detergent fiber (ADF) decreased when levels of NDF increased in the diets ($P<0.05$). The nitrogen intake of NDF37 treatment was higher than that of the NDF57 one ($P<0.05$), while the retained nitrogen ($g/kgW^{0.75}$) of rabbits hada linear relationship with the NDF levels (%) with $y=-0.008x + 1.21$ ($R^2= 0.928$, $P=0.002$ and $SE=0.020$). It was concluded that increasing levels of NDF in the diets of the meat rabbits reduced daily weight gain and nutrient digestibility andat a level of 41 % NDF in diet gave better growth performance and dietary nutrient utilization.

Keywords: *daily weight gain, digestibility, growing rabbit and neutral detergent fiber.*

INTRODUCTION

In recent years, the diseases in animals have seriously occurred as African swine fever (ASF), avian influenza outbreaks and foot and mouth disease, which were reported in China, Vietnam, Korea, Nepal, Cambodia, etc. (Nguyen Van Thu, 2019). While COVID-9 pandemic has led to a dramatic loss of human life worldwide and presented an unprecedented challenge to public health and food systems (WHO, 2020). So to find alivestock raising model to prevent these diseases is interested, in which rabbit is anherbivore, has special digestive system that let them digest all kinds of plants including grasses, and is a promised animal species for our production. Mekong Delta has a lot of the river and branches, hot and humid climate with two seasons (rainy and sunny season), so feed sources for feeding rabbits are very plentiful and abundant (Truong Thanh Trung and Nguyen Thi Kim Dong, 2020), not only in rural areas but alsoperi-urban areas. There are many kinds of forages such as Para grass (*Brachiaria mutica)*, Mom grass (*Hymenachne acutigluma)*, Sa grass (*Panicum maximum)* and vegetables such as sweet potato vine *(Ipomoea batatas)* and water spinach leaf. The main nutrient of forages is fiber, particularly neutral detergent fiber (NDF). Quantitatively the largest cellulose and hemicellulose are potentially digestible, but due to their complex chemical structures (Nguyen Binh Truong and Nguyen Van Thu, 2021). The other main components of NDF arelignin and cutin, which are virtually indigestible in both the rumen and lower intestines. In addition, both inhibit digestion of the underlying and/or associated cellulose or hemicellulose either by physical or chemical shielding. Therefore, the objectives of study are to evaluate effect of levels of neutral detergent fiber on growth rate and

digestibility of meat rabbits. The results of the study will be disseminated to producers for practice.

MATERIALS AND METHODS

Experiment 1: Feeding trial

The experiment aimed to measure the effect of different levels of NDF in the diets on feed utilization, growth rate and digestivenutrient of crossbred rabbits. Thirty six rabbits (New Zealand × local breed) at 54 days of age (average live weight of 701 g) were allocated in a complete randomized design with 6 treatments and 3 replications (1 females and 1 males in an experimental unit). The treatments were the dietary NDF at levels of 37, 41, 45, 49, 53 and 57% (DM basis), while the concentrate supplementation was the same for all treatments of 20 g/rabbit/day. Chemical composition of feeds used in the experiment was showed in Table 1.

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

Feed	DM	OM	CP	NDF	ADF	Ash
Para grass	18.9	88.8	9.11	69.8	34.6	11.2
Sweet potatovine	9.74	89.0	17.2	40.8	26.9	11.1
Concentrate	87.0	91.1	20.0	23.6	8.06	8.90

DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ADF: acid detergent fiber

Table 2. Tentative daily diets (g/head) at the beginging of the Experiment 1

Item	Treament					
	NDF37	***NDF41***	***NDF45***	***NDF49***	***NDF53***	***NDF57***
Feeds (in fresh)						
Sweet potato vine	500	400	300	200	100	0
Paragrass	0	50	100	150	200	250
Concentrate	20	20	20	20	20	20
Feeds (in DM)						
Sweet potato vine	20.4	16.3	12.2	8.14	4.07	0.00
Paragrass	0.00	6.60	13.2	19.8	26.4	33.0
Concentrate	4.11	4.11	4.11	4.11	4.11	4.11
Total DM, g	66.1	65.8	65.5	65.2	64.9	64.7
Total NDF, g	24.5	27.0	29.5	32.0	34.6	37.1

The feeds and refusals were taken for analyses of DM, OM, CP, NDF, ADF, and Ash following procedure of AOAC (1990) and Van Soest et al. (1991). At the beginning of the experiment two rabbits per experimental unit were weighed. The tentative diets for feeding rabbits were presented in Table 2 which were built up based on 3 days – feeding practice for getting the average DM intake of rabbits in the treatments. During the experiment, the feed intakes were daily measured and adjusted following the tentative diets by computerization. They were weighed weekly during experimental period and the diets of rabbits in treatments were increased 5.0% (DM) of the previous week. Daily feed intakes, growth rate, and feed

conversion ratio were measured and calculated.

Experiment 2: Digestibility trial

The second experimental design was similar to that of the feeding trial; however, the 14-week old rabbits were used. The animals had one week for adaptation and another week for getting samples according to by fecal collection for 6 days. Feeds and refusals were daily measured. Urine was also collected for nitrogen analysis to calculate the nitrogen retention. DM, CP, NDF and ADF digestibility were employed according Mc Donald et al. (2002).

Statistical analysis

The data were calculated by using the Excel software and then analyzed variance by using the ANOVA of General Linear Model (GLM) of Minitab Reference Manual Release 16.1 (Minitab, 2010). When the paired comparison of two treatments evaluated the Tukey test of the Minitab was used.

RESULTS AND DISCUSSION

Experiment 1: Feeding trial

Daily feed and nutrient intake (g/rabbit/day)of rabbits in the experiment 1 were presented in Table 3.

Table 3. Daily feed and nutrient intake (g/rabbit/day) of rabbits in the experiment 1

Intake (g/rabbit/day)	Treatment						±SE/P
	NDF37	***NDF41***	***NDF45***	***NDF49***	***NDF53***	***NDF57***	
Para grass	-	33.7^{a}	65.0^{b}	91.3^{c}	103^{c}	132^{d}	2.83 / 0.001
Sweet potato	100^{a}	74.7^{b}	59.7^{c}	42.0^{d}	20.3^{e}	-	1.30 / 0.001
DM	65.7^{a}	70.0^{ab}	78.3^{b}	82.7^{b}	77.3^{b}	81.7^{b}	1.77 / 0.001
OM	58.7^{a}	62.7^{ab}	69.7^{b}	73.7^{b}	69.7^{b}	73.0^{b}	1.56 / 0.001
CP	11.7^{a}	11.0^{ab}	11.7^{a}	11.3^{a}	10.0^{bc}	9.67^{c}	0.27 / 0.001
NDF	24.0^{a}	30.7^{b}	38.7^{c}	44.3^{d}	44.0^{cd}	50.0^{e}	1.13 / 0.001
ADF	14.7^{a}	17.3^{b}	20.3^{c}	22.0^{cd}	21.3^{cd}	23.3^{d}	0.56 / 0.001
Ash	7.00^{a}	7.33^{ac}	8.00^{abc}	8.67^{b}	8.33^{bc}	8.67^{b}	0.27 / 0.004

NDF37: 37% NDF, NDF41: 41%NDF, NDF45: 45%NDF, NDF49: 49% NDF, NDF53: 53%NDF, NDF57: 57% NDF. Means with different letters within the same rows are significantly different at the 5% level

Sweet potato vine and Para grass intakes were significantly different ($P<0.05$) among treatments. The sweet potato vine intake decreased when increasing levels of NDF in the diets, being the highest in the NDF37 diet (100 gDM/day) and the lowest one in the NDF57 diet. The Para grass intake increased with increasing levels of NDF in the diets, reaching the highest in the NDF57 diet (132 gDM/day) and the lowest in the NDF37 diet.

The daily DM and OM intakes were significantly different ($P<0.001$) among treatments, the DM and OM intakes in the NDF37 group was lower than those in the NDF45, 49, 53 and 57 groups, possibly due to the higher DM content in Para grass and the lower DM in sweet potato vine, so the total DM intake in rabbits fed Para grass only (NDF57) was significantly higher. The DM intake (65.7 to 81.7 g/d) of the experiment was higher than data indicated by Ho Xuan Nghiep (2020) being from 53.4 to 79.8 g/rabbit/day of crossbred rabbits. The CP intake significantly ($P<0.001$) decreased when increasing levels of NDF in the diets, the highest was 11.7 g/rabbit/day (NDF37) and higher than in the NDF57 group ($P<0.001$), while the NDF

and ADF intakes were at least in the NDF37 group (24.0 g/rabbit/day and 14.7 g/rabbit/day, respectively). Similarly, Ho Xuan Nghiep (2020) reported that the daily CP intake of the growing crossbred rabbit was from 10.3 to 11.2 g.

Daily weight gain and feed conversion ratio of the rabbits were presented in Table 4.

Table 4. Daily weight gain and feed conversion ratio of the rabbits fed different dietary treatments in experiment 1

Item	Treatment						±SE/P
	NDF37	*NDF41*	*NDF45*	*NDF49*	*NDF53*	*NDF57*	
LW initial (g)	693	707	695	695	697	720	86.9/0.89
LW final (g)	2,168^{ab}	2,268^{a}	2,104^{ab}	2,005^{b}	1,982^{b}	2,030^{ab}	54.0/0.021
Daily weight gain (g/rabbit)	19.2^{a}	20.3^{a}	18.3^{b}	17.0^{b}	16.7^{b}	16.8^{b}	0.49/0.001
Feed conversion ratio	3.45^{a}	3.62^{ab}	4.30^{ab}	4.86^{b}	4.71^{ab}	4.86^{b}	0.31/0.018

LW: live weigh; Means with different letters within the same rows are significantly different at the 5% level

Table 4 showed that final live weights and daily weight gains had tendency to decrease when increasing NDF level in the diets with a linear relationship by y=-0.13x + 23.2 (R^2=0.752) in Fig 1. The daily weight gain (WG) was significantly higher (P<0.01) for rabbits fed 37 and 41% NDF diets than those fed higher levels of NDF in the diet. The difference was probably due to higher CP intakes from sweet potato vine and better nutrient digestion. This result was similar to that of the crossbred rabbits stated by Truong Thanh Trung and Nguyen Thi Kim Dong (2020) being from 18.0 to 21.7 g/day and Ho Xuan Nghiep (2020) being from 16.2 to 21.5 g/d.

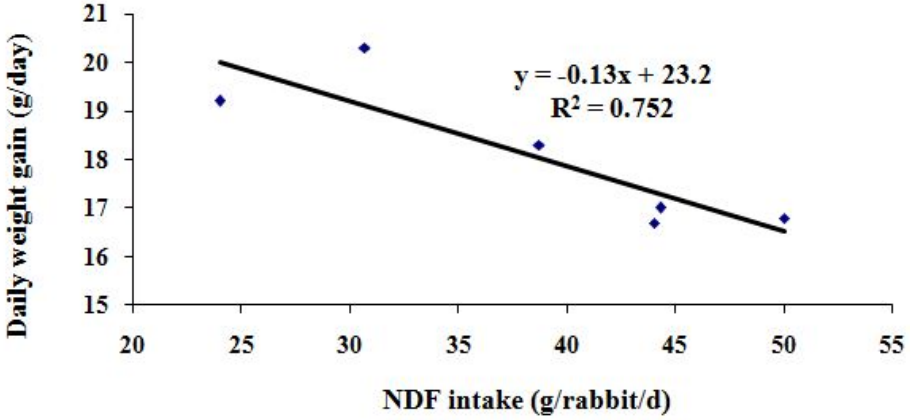

Fig 1. The effect of the NDF intake on daily weight gain of crossbred rabbits

The feed conversion ratio increased when increase levels of NDF in the diets,the feed conversion ratio was poorer for animals fed the diets included 49, 53 and NDF57, and improved (P<0.05) with inclusion level of sweet potato vine, as a result of better daily weight gain. The values of NDF37 and 41 were similar to the results found by Truong Thanh Trung and Nguyen Thi Kim Dong(2020) being from 3.45 to 3.96, and Ho Xuan Nghiep (2020) being from 3.13 to 3.35.

Experiment 2: Digestibility trial

Table 5. Chemical composition of diet ingredients (% in DM except for DM which is on fresh basic) for the experiment 2

Feed	DM	OM	CP	NDF	ADF	Ash
Sweet potato vine	9.26	90.7	17.7	39.1	26.9	9.30
Para grass	18.6	89.8	9.38	70.9	34.6	10.2
Concentrate	87.0	91.1	20.0	23.6	8.06	8.90

DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ADF: acid detergent fiber

The chemical composition of the feedstuffs used (Table 5) was similar to those in experiment 1.

Table 6. Feed and nutrient intakes (g DM) of the rabbits in the experiment 2

Item	Treatment						±SE / P
	NDF37	*NDF41*	*NDF45*	*NDF49*	*NDF53*	*NDF57*	
DM	62.5^{a}	68.8^{ab}	76.1^{ab}	79.4^{b}	76.9^{b}	71.7^{ab}	2.92 / 0.015
OM	56.7^{a}	63.5^{ab}	69.2^{b}	72.1^{b}	69.6^{b}	64.9^{ab}	2.54 / 0.012
CP	12.2^{a}	11.1^{ab}	11.4^{ab}	11.0^{ab}	10.1^{bc}	8.87^{c}	0.37 / 0.001
NDF	22.6^{a}	30.1^{ab}	36.6^{bc}	41.4^{c}	42.4^{c}	41.5^{c}	1.81 / 0.001
ADF	13.5^{a}	16.4^{ab}	19.3^{b}	21.0^{c}	20.8^{c}	19.7^{c}	0.94 / 0.001

Means with different letters within the same rows are significantly different at the 5% level

The feed and nutrient intakeswere significantly different (P<0.05) among diets. The DM and OM intakes in the NDF49 treatment (79.4 gDM/day and 72.1 gDM/day, respectively) were higher than those in the NDF37 treatment (P<0.05). The CP intake decreased when increasing levels of NDF in the diets (P<0.001), while the NDF and ADF intakes were increased when increasing levels of NDF in the diets (P<0.001), according with experimental design.

Nutrient digestibility and nitrogen retention of rabbits were stated in Table 7.

Table 7. Nutrient digestibility (%) and nitrogen retention (g/kgW$^{0.75}$) of rabbits

Digestibility (%)	Treatment						±SE/P
	NDF37	*NDF41*	*NDF45*	*NDF49*	*NDF53*	*NDF57*	
DMD	69.1^{a}	68.3^{a}	63.4^{ab}	60.6^{ab}	58.0^{b}	54.6^{b}	2.03 / 0.002
OMD	69.8^{a}	69.2^{a}	63.5^{ab}	60.7^{ab}	58.2^{b}	54.8^{b}	2.15 / 0.002
CPD	79.5	79.0	79.5	79.6	76.5	75.2	1.44 / 0.205
NDFD	50.9^{ab}	54.1^{a}	48.5^{ab}	47.1^{ab}	46.5^{ab}	42.3^{b}	2.41 / 0.050
ADFD	47.9^{a}	47.8^{a}	40.4^{ab}	35.8^{ab}	31.9^{b}	26.7^{b}	3.04 / 0.002
Nitrogen balance (g/kg W^{0,75})							
N intake	1.62^{a}	1.49^{ab}	1.50^{ab}	1.50^{ab}	1.45^{ab}	1.25^{b}	0.07 / 0.040
N retention	0.88	0.85	0.82	0.82	0.74	0.70	0.09 / 0.701

DMD, OMD, CPD, NDFD, ADFD: dry matter, organic matter, crude protein, neutral detergent fiber, acid detergent fiber digestibility, respectively. Means with different letters within the same rows are significantly different at the 5% level.

The digestibility of DM and OM were significantly (P<0.01) decreased when increasing levels of NDF in the diets. The DMD washigher value in the NDF37 and NDF41 treatments (69.1% and 68.3%) and lower results in the NDF53 and NDF57 ones (58.0 and 54.6%). The explanation was that high fiber content in PG leading high intake of fiber for rabbits consumed large amount of PG. An increase of fiber leads to decrease of retention time and an increase of caecotrophe production because of increasing bacterial fibrolytic activity, which in turn results in a reduction of digestibility of diets. The results in our study were lower than the reports of Nguyen Thi Kim Dong (2020) when studying growing crossbred rabbit fed broccoli leaves and Para grass, being from 55.6 to 75.2%. The CP digestibility was not significantly different among diets (P>0.05) from 75.2-79.5%. The digestibility of NDF reduced when increasing levels of NDF in the diets (P<0.05), the significantly lower value was found in the NDF57 treatment. This result was lower than values reported by Nguyen Thi Kim Dong (2020) being 46.2 - 59.1%.

There was an decrease in both the nitrogen intake and nitrogen retention corresponding with increasing levels of NDF in the diets, but being significantly different only for the nitrogen intake (P<0.05). The nitrogen intake in the present study was in the similar range as those and considerably reported by Nguyen Thi Kim Dong (2020) from 1.31-1.42 g/kgW$^{0.75}$.

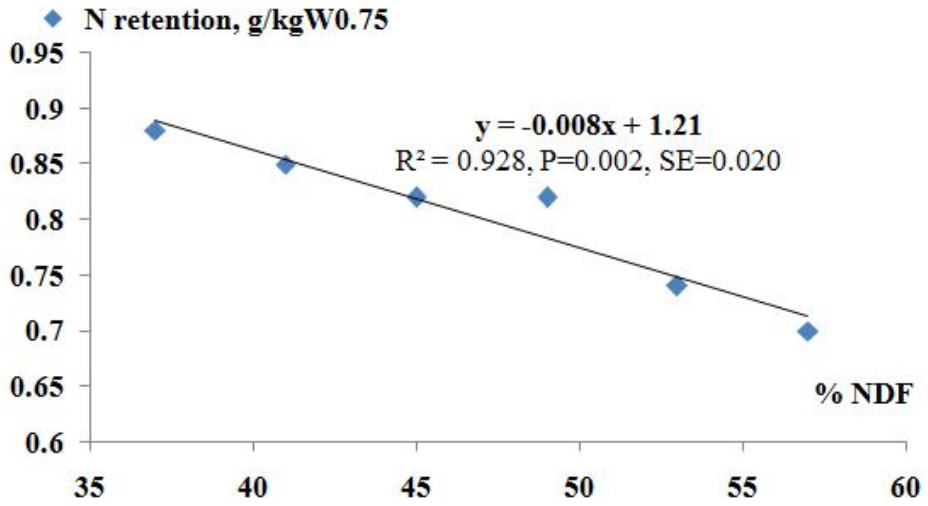

Fig 2. Linear relationship between N retetion (g/kgW$^{0.75}$) and dietary NDF levels (%)

The nitrogen retention of rabbits (g/kgW$^{0.75}$) was not significantly different among the treatments being from 0.70 to 0.88; however there was a trend ofgradual reduction from the NDF37 to NDF57 (Fig. 2) in the present study with y=-0.008x + 1.21 (R^2= 0.928, P=0.002 and SE=0.020). The results were similar those reported by Truong Thanh Trung and Nguyen Thi Kim Dong (2020) being from 0.74 to 1.01 and being from 0.70 to 0.78 (Nguyen Thi Kim Dong (2020).

CONCLUSION

The conclusion of the study was that increasing levels of NDF in the diets of growing crossbred rabbits reduced daily weight gain and nutrient digestibility. At a level of 41% NDF in diet gave better growth rate and dietary nutrient utilization.

REFERENCES

AOAC. 1990. Official methods of analysis (15th edition), Washington, DC, Volume 1: 69-90.

Dominguez, P. L. 1990. Feeding of sweet potato to monogastrics. http://www.fao.org/AG/aga/agap/frg/AHPP95/95-217.pdf.

Ho Xuan Nghiep. 2020. Astudy on nutrient intake, growth performance and economic return of crossbred rabbit (New Zealand x local) supplemented cassava tube as a dietary energy source. J. Anim. Sci. and Technol. Vol. 116, pp. 57-61

Mc Donald, P., Edwards, R. A., Greehalgh, J. F. D. and Morgan, C. A. 2002 Digestibility evaluation of foods, In Animal Nutrition. 6th Edition, Longman Scientific and Technical, New York, pp. 245-255.

Minitab. 2000. Minitab reference manual release 13.21, Minitab Inc.

Nguyen Binh Truong and Nguyen Van Thu. 2021. Effect of neutral detergent fiber on *in vitro* CH_4 and CO_2 production. Journal of Animal Husbandry and Technics. No. 262, pp. 27-36.

Nguyen Thi Kim Dong. 2020. A response of feed utilization, nutrient digestibility and growth rate to broccoli leaf (*Brassica oleracea)* replacement for Para grass (*Brachiaria mutica*) as a basal diet of crossbred rabbits. J. Anim. Sci. and Technol. Vol. 116, pp. 86-92.

Nguyen Van Thu. 2019. Recent production status, research results and development conditions of rabbit production in Vietnam - a review. Can Tho University Journal of Science. Vol. 11, No. 1, pp. 30-35.

Truong Thanh Trung and Nguyen Thi Kim Dong. 2020**.** Effects of different ascorbic acid supplement levels on growth rate, nutrients digestibility and economic return of crossbred rabbits in the Mekong delta of Vietnam. J. Anim. Sci. and Technol. Vol. 116, pp. 16-25.

Van Soest, P. J., Robertson, J. B. and Lewis, B. A. 1991 Symposium: Carbohydrate methodology, metabolism and nutritional implications in dairy cattle: methods for dietary fiber, and non-starch polysaccharides in relation to animal nutrition. J. Dairy Sci. 74, pp. 3585-3597.

World Health Organization (WHO). 2020. Impact of COVID-19 on people's livelihoods, their health and our food systems. https://www.who.int/news/item/13-10-2020-impact-of-covid-19-on-people's-livelihoods-their-health-and-our-food-systems.

Received date: 08/01/2021

Submitted date: 15/01/2021

Acceptance date: 26/02/2021

Opponent: Assoc. Prof. Bui Quang Tuan