# EFFECTS OF DIFFERENT ASCORBIC ACID SUPPLEMENT LEVELS ON GROWTH RATE, NUTRIENTS DIGESTIBILITY AND ECONOMIC RETURN OF CROSSBRED RABBITS IN THE MEKONG DELTA OF VIET NAM

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## ABSTRACT

A study was conducted to evaluate the effects of different ascorbic acid supplement levels in the diets on growth performance, nutrients digestibility and economic return of growing crossbred (New Zealand White x local) rabbits. Sixty rabbits at 42 days of age were arranged in a completely randomized block design with 5 treatments and 3 replications. Four rabbits including 2 males and 2 females were in one experimental unit. Five treatments were 5 ascorbic acid levels adding to drinking water at 0, 250, 500, 750 and 1000 mg per one litter, corresponding to C0, C250, C500, C750 and C1000 treatments, respectively. The apparent nutrient digestibility and nitrogen retention of the rabbits were measured at 12 weeks of age in 7 days. This experimental period was 12 weeks. The results of the study showed that DM, CP and ME intakes were significantly different ($P<0.05$) among the treatments with the higher values for C500 treatments. The daily weight gain was significantly different ($P<0.05$) among treatments and it was 19.4, 20.2, 21.7, 18.2 and 18.0 g/day for C0, C250, C500, C750 and C1000 treatments, respectively. The profit was the highest for C500 treatment. The nutrients digestibility was significantly higher ($P<0.05$) for C500 treatment. It could be concluded that adding ascorbic acid to drinking water at 500 mg per litter should be used to feed growing crossbred rabbits for improving growth, digestible nutrients and economic return.

**Keywords:** *ascorbic acid, income, growth performance, nitrogen, rodents.*

## INTRODUCTION

In recent years, the domestic rabbits have been recommended as a good alternative source of dietary protein for the increasing human population in developing countries where are beginning to utilize the rabbit as a main source of meat. These developing countries as Viet Nam mostly locate in tropical and subtropical regions, so animals is suffered from many problems related to hot climate particularly heat stress. Rising temperatures continues to be a barrier in rabbit's production because of its adverse impacts on feed intake, live weight gain, feed efficiency, meat quality, mortality and health of rabbits (Marai et al., 2008; Hassan et al., 2016). Feed intake of rabbits is reduced through heat stress condition; the growth is reduced consequently due to the decreased digestible energy intake (Ayyat et al., 1996). Vitamin C (ascorbic acid) is one of the most widely studied vitamins used to alleviate heat stress in rabbits and found to be successful.

Ascorbic acid is an essential micronutrient required for normal metabolic functioning of the body (Carr and Frei, 1999). In particular, ascorbic acid could guard against oxidative stress damage through its free-radical scavenging activity (Lee, 2002), but during stress, ascorbic acid produced is rapidly consumed and amount synthesized fall below animal requirements. Improvement of the growth performance result of ascorbic acid supplementation to the drinking water of heat-stressed growing rabbits may be attributed to the animal increased resistance during physiological stress and enhancement of the total antioxidant (Selim et al., 2004). Ascorbic acid helps to control the increase in body temperature and plasma corticosterone concentration. It also protects the immune system and it has an important role

in bone formation through the growth rate (Rama-Rao et al., 2002). Previous studies mainly used commercial feed for rabbit while rabbit producers in the Mekong Delta in Viet Nam combined among locally available feedstuffs for their rabbits. Therefore, the objective of the present study was to investigate the effect of adding drinking water with ascorbic acid with different levels on the growing rabbit's performance under the Mekong delta in Viet Nam conditions.

## MATERIALS AND METHODS

### Location, time, animals and experimental design

The experiment was conducted at the experimental farm in Can Tho city. Sixty crossbred (New Zealand White x local) rabbits at 42 days of age (average live weight of 437±2.11g) were arranged in a Complete Randomized Design with 5 treatments and 3 replications. Four rabbits (balanced for sex) in one cage with dimension of width 0.5 m, length 0.5 m and height 0.4 m was the experimental unit. Five treatments were 5 vitamin C levels adding to drinking water at 0 mg, 250 mg, 500 mg, 750 mg, 1000 mg per one litter corresponding to C0, C250, C500, C750 and C1000 treatments, respectively. Drinking water was supplied for rabbits by automatic drinking water bottle. This experimental period was 12 weeks.

### Digestibility trial

The apparent nutrient digestibility and nitrogen retention of the rabbits were measured at 12 weeks of age in 7 days. The animals had one week for recording quantities and taking samples of offered and refusal feeds, feces and urine.

### Feeds, feeding and management

*Operculina turpethum*, soybean meal, soya waste and ascorbic acid were used in the experiment. *Operculina turpethum* were collected daily in the areas surrounding experimental farm. Soybean meal was bought at a local feed store in one occasion during the experiment while soya waste was taken every day from tofu producer. Vitamin C (Ascorbic acid, assay ≥99%) was imported from Ningxia Yuan Pharmaceutical Company. These feeds were given in fresh form and were offered three times a day at 7:00h, 12:00h and 17:00h. Ascorbic acid was added to drinking water and freely available. Quantities offered and refusals were recorded daily for each forage**.** The rabbits were vaccinated to prevent hemorrhagic and parasite diseases. The experimental diets containing 21.0% crude protein, 37% neutral detergent fiber and 10.5 MJ/kg DM were formulated with 46% *Operculina turpethum*, 38% soybean meal and 16% soya waste (DM basic). The feedstuffs were increased weekly at 10-15% to cover the nutrient requirements of growing rabbits. Ambient temperature ($^0$C) was measured by Thermos recorder TR-73U at 6 am, 8 am, 10 am, 12 pm, 2 pm, 4 pm and 6 pm during the experiment.

### Measurements

Feeds and refusals were taken for analyses of DM, OM, CP, EE, CF following procedure of AOAC (1990). NDF and ADF were analyzed according to method of Van Soest et al. (1991) and Robertson and Van Soest (1981), respectively. Metabolism energy was estimated following a formula proposed by Maertens et al. (2002): ME (MJ/kg) =DE (MJ/kg) x ME/DE

with ME/DE = 0,995-0,0048 x DP (g/kg)/DE (MJ/kg); DP= (%CP x CPD); DE=13,932-0,196*CF with DP : digestible protein; CPD : crude protein digesibility. Feed and water intakes were determined daily by weighing or volume measuring the amount of offered and refusals. Daily weight gain was determined by weighing body weight of individual rabbit weekly from 7:00 h to 7:30 h am before feeding.

Apparent nutrient digestibility and nitrogen retention were determined by collecting and analyzing offered and refusal feeds, feces, and urine daily. The digestive measurement was implemented during 7 consecutive days when rabbits were at 12 weeks of age following the method described by McDonald et al. (2002). Urine was collected in each morning and brought to the laboratory immediately for analyzing total nitrogen by Kjeldhal methods. All offered and refusal feeds, and feces samples were dried at 55°C for 24 hours and to finely ground through 1mm sieve before analyzing.

The measurement taken included daily feed and nutrient intakes, daily weight gain, final weight, nutrient digestibility, digestible nutrients, nitrogen retention and economic returns.

**Statistical analysis**

The data were analyzed by analysis of variance using the ANOVA of general linear model of Minitab Reference Manual Release 16.0. To compare the difference between mean values of treatments, Tukey's test was used (Minitab, 2016).

## RESULTS AND DISCUSSION

**Feed characteristics**

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

Table 1. Chemical composition of feeds (% DM basis except for DM which is on a fresh basis)

| Feed | DM | OM | CP | EE | NDF | ADF | CF | Ash | ME, MJ/kg DM |
|---|---|---|---|---|---|---|---|---|---|
| *OT* | 15.6 | 88.4 | 14.8 | 5.78 | 46.1 | 31.6 | 19.2 | 11.6 | 9.69 |
| Soybean meal | 91.4 | 92.8 | 42.1 | 3.98 | 24.1 | 14.7 | 4.70 | 7.20 | 11.3 |
| Soya waste | 12.4 | 95.4 | 19.5 | 8.76 | 31.3 | 20.4 | 9.80 | 4.60 | 11.1 |

*Note: OT:Operculina turpethum, DM: Dry matter, OM: Organic matter, CP: Crude protein, EE: Ether extraction, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, CF: Crude fiber, ME: Metabolism energy*

Chemical composition of feeds was shown in Table 1. In Table 1, the DM of *Operculina turpethum*, soybean meal and soya waste were 15.6, 91.4 and 12.4%, respectively. The CP content of *Operculina turpethum* was 14.8%, while it was 19.5% in soya waste. Neutral detergent fiber and ADF content of *Operculina turpethum* were higher than soya waste (46.1% vs. 31.3%, 31.6% vs. 20.4%), respectively. Soybean and soya waste had higher levels of crude protein and metabolism energy than the forages.

Table 2. Averages ± SD of air temperature during the experimental period

| Experimental periods | Week | Average± SD, °C | Max value, °C | Min value, °C |
|---|---|---|---|---|
| February 2020 | 1 | 27.3±3.63 | 32.3 | 20.2 |
| | 2 | 28.3±3.06 | 32.7 | 22.0 |
| | 3 | 28.3±3.01 | 32.9 | 20.2 |
| | 4 | 29.1±3.32 | 33.1 | 23.0 |
| March 2020 | 5 | 29.2±2.80 | 32.7 | 23.6 |
| | 6 | 29.5±2.94 | 33.9 | 24.0 |
| | 7 | 30.2±3.13 | 33.8 | 24.2 |
| | 8 | 30.0±3.35 | 34.3 | 24.0 |
| April 2020 | 9 | 31.2±3.32 | 35.0 | 23.6 |
| | 10 | 31.3±2.77 | 35.2 | 26.0 |
| | 11 | 29.9±2.91 | 34.5 | 25.0 |
| | 12 | 31.9±3.27 | 36.5 | 26.4 |

The weekly average ambient temperature value inside the rabbit housing ranged from 27.3 to 31.9°C with the higher values in April, indicated experimental rabbit exposure to severe heat stress during experiment period. A temperature of 21°C is known as the "Comfort Zone" for rabbits. Chronic exposure to extremes of heat leads to decomposition of normal physiological and biological mechanisms with a consequent damage of many organs (Smitha and Kannan, 2014)

Table 3. Feed, nutrient and metabolism energy intakes of experimental rabbits

| Item | Treatments | | | | | ±SE/P |
|---|---|---|---|---|---|---|
| | *C0* | *C250* | *C500* | *C750* | *C1000* | |
| Feed, gDM/rabbit/day | | | | | | |
| *Operculina turpethum* | $29.8^{b}$ | $31.0^{ab}$ | $32.5^{a}$ | $29.2^{bc}$ | $27.2^{c}$ | 0.52/0.001 |
| Soybean meal | 14.6 | 14.6 | 14.6 | 14.6 | 14.6 | - |
| Soya waste | 27.9 | 27.9 | 27.9 | 27.9 | 27.9 | - |
| Water consume, ml/day | 30.0 | 28.1 | 39.0 | 35.1 | 38.8 | 2.52/0.056 |
| Vitamin C, mg/day | $0.00^{e}$ | $7.03^{d}$ | $19.5^{c}$ | $26.3^{b}$ | $38.8^{a}$ | 1.10/0.001 |
| Total intake, g/rabbit/day | | | | | | |
| Dry matter | $72.3^{b}$ | $73.5^{ab}$ | $75.9^{a}$ | $71.7^{bc}$ | $69.7^{c}$ | 0.52/0.001 |
| Organic matter | $66.5^{b}$ | $67.6^{ab}$ | $68.9^{a}$ | $65.9^{bc}$ | $64.2^{c}$ | 0.46/0.001 |
| Crude protein | $16.0^{b}$ | $16.2^{ab}$ | $16.4^{a}$ | $15.9^{bc}$ | $15.6^{c}$ | 0.08/0.001 |
| Ether extract | $4.75^{b}$ | $4.82^{ab}$ | $4.90^{a}$ | $4.71^{bc}$ | $4.59^{c}$ | 0.03/0.001 |
| Neutral detergent fiber | $26.0^{b}$ | $26.5^{ab}$ | $27.2^{a}$ | $25.7^{bc}$ | $24.8^{c}$ | 0.24/0.001 |
| Acid detergent fiber | $17.3^{b}$ | $17.6^{ab}$ | $18.1^{a}$ | $17.1^{bc}$ | $16.4^{c}$ | 0.17/0.001 |
| Crude fiber | $9.19^{b}$ | $9.42^{ab}$ | $9.71^{a}$ | $9.07^{bc}$ | $8.68^{c}$ | 0.10/0.001 |
| Ash | $5.79^{b}$ | $5.93^{ab}$ | $6.11^{a}$ | $5.72^{bc}$ | $5.49^{c}$ | 0.06/0.001 |
| Metabolism energy,MJ | $0.76^{b}$ | $0.78^{ab}$ | $0.79^{a}$ | $0.76^{bc}$ | $0.74^{c}$ | 0.01/0.001 |

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

Feed and nutrient intakes of growing experimental rabbits were presented in Table 3. Due to *Operculina turpethum* intake of C250 and C500 treatment were increased (P<0.05) than that of C0, C750 and C1000 treatments, the nutrient and ME intakes were higher (P<0.05) for the C250 and C500 treatments. The obtained values for nutrient intakes were similar to those of Trung and Dong (2013) who reported that DM, CP and ME intakes of growing Californian rabbits were 71.2-71.8g/head/day; 10.8-16.4g/head/day and 0.825-0.831MJ/head/day, respectively. The DM intake value of rabbits in this study were in accordance with previous trial by Okachi et al. (2017) who reported that daily feed intake of growing rabbits in Nigeria ranged 73.3-76.0 g/day with vitamin C supplement in the diets. However, daily protein intake values in their trial was from 6.7 to 7.9 g/day that was lower than that of this study. Daily weight gain, feed conversion ratio and economic returns of the rabbits were stated in Table 4.

Table 4. Mean values for daily weight gain, feed conversion and economic returns of experimental rabbits

| **Item** | **Treatments** | | | | | **±SE/P** |
|---|---|---|---|---|---|---|
| | ***C0*** | ***C250*** | ***C500*** | ***C750*** | ***C1000*** | |
| Initial live weight, g | 435 | 446 | 442 | 431 | 433 | 4.13/0.133 |
| Final live weight, g | 2061$^{ab}$ | 2141$^{ab}$ | 2267$^{a}$ | 1956$^{b}$ | 1948$^{b}$ | 62.3/0.031 |
| Daily weight gain, g/day | 19.4$^{ab}$ | 20.2$^{ab}$ | 21.7$^{a}$ | 18.2$^{b}$ | 18.0$^{b}$ | 0.73/0.035 |
| Feed conversion ratio | 3.74 | 3.64 | 3.45 | 3.96 | 3.90 | 0.16/0.253 |
| Feed cost (VND/rabbit) | 40,337 | 40,658 | 41,060 | 40,162 | 39,628 | |
| Total cost (VND/rabbit) | 120,337 | 120,658 | 121,060 | 120,162 | 119,628 | |
| Income (VND/rabbit) | 164,911 | 171,264 | 181,438 | 156,502 | 155,853 | |
| Difference (VND/rabbit) | 44,574 | 50,606 | 60,378 | 36,340 | 36,226 | |

*Note: Means with different letters within the same rows are significantly different at the 5%level. Breed cost: 75,000 VND/head, medicine cost: 5,000 VND/head, Operculina turpethum:500VND/kg, soya waste: 1,000 VND/kg, soybean meal: 10,000 VND/kg, rabbit meat: 80,000 VND/kg live weight; 22,000VND=1USD.*

Daily weight gain, feed conversion ratio and economic returns were shown in Table 4. Daily weight gain was significantly different among the treatments (P<0.05) with the highest value of the C500 diet, while the significantly lower value was C1000 diet. The daily weight gain of rabbits in this experiment was similar to results in the New Zealand White rabbits reported by Wang et al. (2012) from 21.5 to 28.1 g/d. Abd El-Moneim et al. (2013) found that daily weight gain of growing rabbits consumed ascorbic acid at 250, 500, 750 mg/L water being 19.6, 22.0 and 20.3 g/day, respectively, while FCR values were 3.62, 3.83 and 3.41, respectively. Islam et al. (2018) stated that growing rabbit fed vitamin C at 0, 0.5, 1.0 and 1.5 g/kg diet gave 23.6, 25.9, 25.8 and 26.4 g/day of daily weight gain and gave 4.95, 4.34, 4.40 and 4.40 of FCR. Also, Al-Shanty (2003) showed that ascorbic acid (1.0 g/L water) significantly improved daily weight gain of growing Flander rabbits as compared to the control group. The positive effects in growth performance of rabbits could be explained that ascorbic acid helped to control the increase in body temperature and plasma corticosterone concentration. It also protected the immune system and it had an important role bone formation through the growth rate (Rama-Rao et al., 2002).

In this study, rabbit fed C500 diet had the best FCR (3.45) (P>0.05), while the worst FCR was observed with those fed C750 diet (3.96). The obtained values for FCR were acceptable levels and consistent with the results being from 3.37 to 3.63 indicated by El-Tahan et al. (2012).

The economic analysis showed that benefits got from the C500 diet was higher than the other diets due to growth rate and feed conversion ratio were better.

Table 5. Nutrient digestibility, digestible nutrients and nitrogen balance of experimental rabbits

| Item | Treatments | | | | | ±SE/P |
|---|---|---|---|---|---|---|
| | ***C0*** | ***C250*** | ***C500*** | ***C750*** | ***C1000*** | |
| *Apparent digestibility, %* | | | | | | |
| Dry matter | 76.2 | 76.9 | 78.2 | 75.8 | 75.6 | 0.94/0.376 |
| Organic matter | 76.6 | 77.0 | 78.3 | 76.0 | 76.0 | 0.91/0.425 |
| Crude protein | $77.8^{ab}$ | $78.4^{ab}$ | $80.1^{a}$ | $76.9^{b}$ | $76.4^{b}$ | 0.55/0.010 |
| Ether extract | 87.8 | 87.6 | 87.5 | 87.0 | 87.5 | 0.53/0.831 |
| Neutral detergent fiber | 59.4 | 61.2 | 64.5 | 60.4 | 59.9 | 1.34/0.155 |
| Acid detergent fiber | 52.8 | 54.3 | 57.5 | 53.3 | 53.1 | 1.45/0.231 |
| *Digestible nutrients, g* | | | | | | |
| Dry matter | 54.7 | 56.7 | 58.3 | 54.2 | 53.1 | 1.50/0.200 |
| Organic matter | 50.5 | 52.2 | 53.7 | 50.0 | 49.2 | 1.33/0.213 |
| Crude protein | $12.4^{ab}$ | $12.7^{ab}$ | $13.1^{a}$ | $12.2^{ab}$ | $12.0^{b}$ | 0.20/0.029 |
| Ether extract | 4.15 | 4.23 | 4.27 | 4.09 | 4.05 | 0.08/0.331 |
| Neutral detergent fiber | 15.3 | 16.3 | 17.4 | 15.5 | 15.0 | 0.62/0.117 |
| Acid detergent fiber | 9.02 | 9.63 | 10.3 | 9.09 | 8.81 | 0.47/0.234 |
| *Nitrogen balance* | | | | | | |
| N intake (NI), g | 2.55 | 2.59 | 2.61 | 2.54 | 2.51 | 0.04/0.328 |
| N in feces, g | 0.57 | 0.56 | 0.52 | 0.58 | 0.59 | 0.02/0.078 |
| N in urine, g | 0.74 | 0.73 | 0.76 | 0.89 | 0.97 | 0.12/0.535 |
| N retention (NR), g | 1.24 | 1.30 | 1.34 | 1.06 | 0.94 | 0.11/0.133 |
| %NR/NI | 48.3 | 50.3 | 50.9 | 41.9 | 37.3 | 4.07/0.173 |
| $NR/W^{0.75}$, g/kg | 0.97 | 1.01 | 0.97 | 0.84 | 0.74 | 0.09/0.261 |

*Note: Means with different letters within the same rows are significantly different at the 5% level.*

In Table 5 also showed that the nutrient digestibility was similar (P>0.05) among treatments, exception for CP digestibility (P<0.05) with the higher values for the C500 treatment. The digestible nutrient value of CP increased with the increase of vitamin C level in drinking water diets and it was significantly different (P<0.05) among treatments with the higher values for the C500 treatment. The nitrogen intake and retention were similar (P>0.05) among the treatments with the higher values for the C500 treatment (2.61 g/day and 1.34 g/day, respectively). Islam et al. (2018) reported that OM digestibility was significantly increased by increasing ascorbic acid supplementation levels in the diets at 0, 0.5, 1.0 and 1.5 g/kg diet (62.5, 64.2, 67.9 and 67.6%, respectively). The economical evaluation in their study showed that the using of 0.5 or 1g ascorbic acid/kg diet was more economical than the other treatments.

## CONCLUSIONS

The conclusion of the study was that using ascorbic acid at a level of 500 mg/L water for growing rabbits gave a better results of growth performance, nutrient digestibility, nitrogen retention and economic returns.

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## REFERENCES

Al-Shanty, H. 2003. Using vitamin C and sodium bicarbonate to alleviate the effect of heat stress on rabbits performance. Egypt. Poult. Sci. J., 23, pp. 129 - 139, 2003

AOAC. 1990. Official Methods of Analysis (15th edition). Association of Official Analytical Chemists. Washington, DC. Volume 1: 69-90, 1990

Ayyat, M.S. and Marai, I.F.M. 1996. Effects of summer heat stress on growth performance, some carcass traits and blood components of New-Zealand white rabbits fed different dietary protein-energy levels, under subtropical Egyptian conditions. 6th World rabbit Congress, Toulouse 9-12 July, 1996, France.

Carr, A. and Frei, B. 1999. Does vitamin C act as a pro-oxidant under physiological conditions? The FASEB J., 13: 1007-1024, 1999.

El-Moneim Abd, Abd El-Moneim, E., Attia1, A.I., Askar1, A.A., Abu-Taleb, A.M. and Mahmoud, M.H. 2013. Response of growing rabbits supplemented with copper sulfate, ascorbic acid or drinking cooled water under Egyptian summer conditions. Zagazig J. Agric. Res., Vol. 40 No. (3) 2013

El-Tahan H.M., Kh. Amber, W.A. Morsy. 2012. Effect of dietary starch levels on performance and digestibility of growing rabbit. In: Proceedings 10th world rabbit congress – September 3-6, 2012 – Aharm El-Seikh-Egypt, pp. 501-505, 2012

Hassan, F.A., Mahrose, K.M. and Basyony, M.M. 2016. Effects of grape seed extract as a natural antioxidant on growth performance, carcass characteristics and antioxidant status of rabbits during heat stress. Archives of Anim. Nut., 70, pp. 141-154, 2016.

Islam E. Sayed-Ahmed, Abd El-Monem, U.M., Al-Sagheer, A.A. and Khalil, B.A. 2018. Effect of ascorbic acid supplementation on performance of growing rabbits under Egyptian conditions. Zagazig J. Agric. Res., Vol. 45 No. (1) 2018

Lee, C. 2002. Explaining just how vitamin C works against cancer. The Lancet, 359: 9301, 2002.

Maertens, L., Perez, J. M., Villamide, M., Cervera, C., Gidenne, T. and Xiccato, G. 2002. Nutritive value of raw materials for rabbits: EGRAN Tables 2002. World Rabbit Sci. 10, pp. 157-166, 2002.

Marai, I.F., Habeeb, A.S.I.A. and Gad, A.E. 2008. Performance of New Zealand White and Californian male weaned rabbits in the subtropical environment of Egypt. Anim. Sci. J., 79, pp. 472-480, 2008.

McDonald, P., Edwards, R. A., Greenhalgh, 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, 2002.

Minitab. 2016. Minitab reference manual release 16.1.0. Minitab Inc, 2016.

Okachi, V. C. W., Ben-Chioma, A. E. and Ani, A. O. 2017. Performance of growing rabbits fed diets containing varying dietary levels of vitamin C and E in a hot humid tropical environment. Journal of Harmonized Research in Applied Sciences 5(1), 2017, pp. 54-62.

Rama-Rao, S. V., Nagalakshmi, S. and Reddy, V. R. 2002. Feeding to minimize heat stress. Poult. Inter., 41: 30 - 33, 2002.

Robertson, J. B. and Van Soest, P. J. 1981. The detergent system of analysis and its application to human foods, Chapter 9. The analysis of dietary fiber in foods (W. P. T. James and O. Theander, editors). Marcel Dekker, NY, USA. 123-158 pp, 1981.

Selim, A. D., Soliman, A. Z. and Abd El-Khalek, A. M. 2004. Effect of drinking water temperatures and some dietary feed Additives on performance of heat stressed rabbits. 8th world Rabbit Congress, Puebla, Mexico, 984: 990, 2004.

Smitha, S. and Kannan, A. 2014. Effect of Probiotic, Lactobacillus casein and Ascorbic Acid Supplementation on Some Physiological Parameters of New Zealand White Rabbits Reared Under Hot Humid Summer. Indian Journal of Natural Sciences, Vol.4 / Issue 25/ August 2014

Trung, T. T. and Dong, N. T. K.. 2013. Effects of dietary crude protein levels on growth performance, nutrient digestibility and nitrogen retention in growing Californian rabbits fed available feedstuffs in Mekong delta of Vietnam. 3rd Conference of Asian Rabbit Production Association - Bali, Indonesia- 2013.

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. Journal of Dairy Science 74, pp. 3583-3597, 1991.

Wang, X., Mingwen, M., Liangzhan, S., Chunyang, W., Yanli, Z. and Fuchang, L. 2012. Effects of different protein, fiber and energy levels on growth performance and the development of digestive organs in growing meat rabbit. In: Proceedings 10th world rabbit congress – September 3-6, 2012 – Aharm El-Seikh-Egypt, pp. 641-645

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