# REPRODUCTIVE PERFORMANCE OF CROSSBRED RABBIT DOES (*ORYCTOLAGUS CUNICULUS*) FED DIETARY ASCORBIC ACID SUPPLEMENTATION

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**ABSTRACT**
*Effect of dietary ascorbic acid supplementation was investigated on reproductive performance of crossbred rabbit does (Oryctolagus cuniculus) in a 13-week feeding trial. A total of 30 mature rabbit does of 18 to 20 weeks old with average weight of 2.75 kg were used. Ascorbic acid was included in the diets of the rabbits at levels of 0 (control), 100, 200, 300 and 400 mg/kg feed. The rabbits were randomly allotted to the diets (n=6 rabbits/treatments and housed individually. All data were subjected to general linear model while the significant differences in means were separated using pairwise-difference. The Results showed that rabbit does fed dietary ascorbic acid supplementation (200, 300 and 400 mg/kg diet) had significantly (P<0.05) higher litter size (6.25-8.29 vs. 4.48-6.00) and litter weight (400.00-5850.33 g vs. 300.00-3870.50 g) than their counterparts fed the control diet. However, does fed dietary ascorbic acid supplementation had significantly (P<0.05) lower total kit mortality (14.58, 20.53, 13.77 vs. 27.28%) compared to their counterparts fed the control diet. The Results of this study suggest that feed grade ascorbic acid supplementation at 200, 300 and 400 mg ascorbic acid/kg diet could improve litter performance of rabbit does.*
**Key words: Ascorbic acid, rabbit does, litter performance**

## INTRODUCTION

Hyperthermia or elevated temperature induced by heat stress could result to uterine environmental changes, reduced embryo development, damaged mammary epithelium and reproductive failures due to embryonic death in farm animals (Elvinger *et al.,* 1992; Makarevich *et al.* 2006). Ascorbic acid is synthesized *de novo* in the liver of rabbits and thus it is not required in the diet. However, under adverse conditions, such as hot weather, stress, weaning and sub-clinical diseases, ascorbic acid biosynthesis is reduced and its supplementation is physiologically beneficial during these times so as to meet their metabolic demands (Amy, 2010; Munj *et al.,* 2010).
The objective of the present study was to explore the effect of dietary ascorbic acid supplementation to rabbit does' rations on their reproductive performance.

## MATERIALS AND METHODS

### Location of Experimental Site

The study was conducted in the Rabbit Unit of the National Animal Production Research Institute (NAPRI), Shika, Zaria, situated on latitude 11° and 12°N and between longitude 7° and 8°E with an altitude of 691m above sea level (Ovimaps, 2012). The mean maximum temperature varies from 19ºC to 38ºC depending on season, while the mean relative humidity during dry and wet season is 21% and 72% respectively. Morning temperature range between 19ºC and 32ºC while afternoon temperature ranged between 20ºC and 40ºC (Iyeghe-Erakpotobor *et al.,* 2013).

### Animals and Experimental Design

A total of 20 sexually-mature crossbred rabbit does aged 18 to 20 weeks old with an average weight 2.75 kg were used. The rabbits were weighed and randomly allotted to five dietary groups in a completely randomized design. Each group constituted a treatment and each rabbit within a group was a replicate (four rabbits per treatment). The rabbits were equally assigned to one of the following levels of ascorbic acid (0, 100, 200, 300, 400 mg ascorbic acid/kg diet). The does were bred and examined using a real-time ultrasound 9 days post-coitus.

**Statistical Analysis**
All data obtained from this study were subjected to General Linear Model of SAS (2002) package and the significant differences in means were separated using pairwise-difference (P-DIFF SAS, 2002) of the same software.

**RESULTS AND DISCUSSION**
Table 1presents the effect of ascorbic acid levels on doe performance, litter size and litter weight of rabbit does. Litter size at birth and litter size from the second week all through to weaning significantly (P<0.05) increased as the levels of ascorbic acid supplementation increased in the diet. Improved litter size at birth observed in rabbit does fed dietary ascorbic acid supplementation (200, 300 and 400 mg/kg diet) compared to does fed the control diet in this study suggests that ascorbic acid scavenge reactive oxygen species (which attack and cause damages to embryo resulting in birth defects and lower litter size at birth). It is also believed that ascorbic acid possibly improved follicle development and fetal growth by ensuring adequate nutrient uptake by the fetus and also maintained

**Table 1: Effect of ascorbic acid level on doe performance, litter size and litter weight of rabbit does**

| Parameters | Ascorbic acid level (mg/kg) | | | | | P value |
|---|---|---|---|---|---|---|
| | 0 | 100 | 200 | 300 | 400 | |
| Pregnancy rate (%) | 100.00±10.00 | 100.00±10.00 | 100.00±11.00 | 100.00±10.00 | 100.00±11.00 | 0.431 |
| Kindling rate (%): | 100.00±10.00 | 100.00±10.00 | 100.00±11.00 | 100.00±10.00 | 100.00±11.00 | 0.374 |
| **Litter size:** | | | | | | |
| At birth | 6.00±0.61$^{c}$ | 7.00±0.61$^{bc}$ | 7.55±0.61$^{ab}$ | 7.86±0.61$^{ab}$ | 8.29±0.58$^{a}$ | 0.050 |
| Alive at birth | 6.00±0.75 | 6.98±0.75 | 7.55±0.75 | 7.86±2.31 | 8.29±1.88 | 0.945 |
| First week | 6.00±0.81 | 6.50±0.81 | 7.25±0.81 | 7.65±0.81 | 8.29±1.79 | 0.866 |
| Second week | 5.25±0.86$^{c}$ | 6.25±0.86$^{bc}$ | 7.00±0.86$^{ab}$ | 7.20±0.86$^{ab}$ | 7.85±0.71$^{a}$ | 0.054 |
| Third week | 4.75±0.73$^{c}$ | 5.80±0.73$^{bc}$ | 6.85±0.73$^{ab}$ | 6.86±0.73$^{ab}$ | 7.50±0.62$^{a}$ | 0.047 |
| Fourth week | 4.75±0.80$^{c}$ | 5.55±0.80$^{bc}$ | 6.50±0.80$^{ab}$ | 6.55±0.80$^{ab}$ | 7.45±0.59$^{a}$ | 0.042 |
| Fifth week | 4.50±0.85$^{c}$ | 5.30±0.85$^{bc}$ | 6.50±0.85$^{ab}$ | 6.25±0.85$^{ab}$ | 6.95±0.76$^{a}$ | 0.037 |
| At weaning | 4.48±0.60$^{c}$ | 5.30±0.60$^{bc}$ | 6.50±0.60$^{ab}$ | 6.25±0.60$^{ab}$ | 6.95±0.55$^{a}$ | 0.050 |
| **Litter weight (g):** | | | | | | |
| At birth | 300.00±28.41$^{d}$ | 350.00±28.41$^{cd}$ | 400.00±28.41$^{bc}$ | 475.00±28.41$^{ab}$ | 500.00±23.20$^{a}$ | 0.020 |
| Alive at birth | 300.00±29.52$^{d}$ | 325.50±29.52$^{cd}$ | 400.00±29.52$^{bc}$ | 475.00±28.41$^{a}$ | 500.00±23.20$^{a}$ | 0.010 |
| First week | 620.00±85.74 | 587.50±85.74 | 650.00±85.74 | 675.00±85.74 | 720.00±80.50 | 0.459 |
| Second week | 700.50±83.59$^{c}$ | 812.50±83.59$^{bc}$ | 875.00±83.59$^{ab}$ | 900.00±83.59$^{a}$ | 995.67±79.14$^{a}$ | 0.040 |
| Third week | 1000.50±86.09$^{b}$ | 1150.50±86.09$^{b}$ | 1280.50±86.09$^{a}$ | 1290.00±86.09$^{a}$ | 1340.00±84.62$^{a}$ | 0.030 |
| Fourth week | 1460.50±89.03$^{c}$ | 1500.00±89.03$^{c}$ | 1800.00±89.03$^{b}$ | 1900.00±89.03$^{b}$ | 2500.67±86.40$^{a}$ | 0.027 |
| Fifth week | 2750.50±92.26$^{c}$ | 2900.50±92.26$^{c}$ | 3575.00±92.26$^{b}$ | 3950.00±92.26$^{b}$ | 4050.67±90.62$^{a}$ | 0.010 |
| At weaning | 3870.50±99.86$^{d}$ | 4000.00±99.86$^{d}$ | 4850.00±99.86$^{b}$ | 4500.00±96.86$^{c}$ | 5850.33±96.88$^{a}$ | 0.020 |

$^{abc}$: Means with different superscripts in the same row are significantly (P<0.05) different

the integrity of the fetal membranes in the does. Ascorbic acid could ameliorate heat-induced deterioration of the embryo and capable of rapidly scavenging a number of reactive oxygen species which cause damages to re-implantation embryos leading to impaired cellular growth, embryo fragmentation and apoptosis all which could lead to lower litter size at birth (Moss *et al.,* 2009; Drouin *et al.,* 2011; Talebi and Khademi, 2011). Higher litter size observed in does fed dietary ascorbic acid supplementation (200, 300 and 400 mg/kg diet) compared to does fed the control diet from the second week all through to weaning suggests that ascorbic acid enhanced postnatal survival and growth performance of kits of the rabbit does at those levels of supplementation. This result also indicates that ascorbic acid supplementation help to overcome the negative effects of heat stress (one of the major cause of pre-weaning mortality in kit). Morsy *et al.* (2012) reported that rabbit does fed diets containing ascorbic acid supplementation (250 mg/kg diet) had higher litter size in the 21$^{st}$ day (4.57 vs. 5.63) and at weaning (3.71 vs. 5.38) than those fed control diet.
Similarly, litter weight at birth, alive at birth and from the second week all through to weaning significantly (P<0.05) increased as the levels of ascorbic acid supplementation increased in the diet. Improved litter weight at birth was observed in does fed dietary ascorbic acid supplementation and alive at birth in does fed 200, 300 and 400 mg ascorbic acid/kg diet compared to does fed the control diet. The Results of the current study suggest that ascorbic acid prevented oxidative damage on the embryo and improved litter weight at birth of kits of does fed the supplemented diets at those levels.

Previous studies by Salem *et al.* (2018) indicated that oxidative damage on DNA, protein, and lipids during pregnancy may be associated with reduced birth weight and increased embryonic mortality resulting in low birth weight in rabbit does. However, antioxidant vitamins including ascorbic acid could decrease embryonic mortality and improve birth outcomes (Cederberg *et al.,* 2001). Rödel *et al.* (2008) suggested that heavier kits at birth obtain more milk, gain weight more rapidly and have higher probability of surviving the early postnatal period. In addition, this result could be linked to the improved weight gain by the does compared to does fed the control diet (43.14, 43.86, 45.71vs. 30.42 g/day) in the fourth week of pregnancy. Abeer *et al.* (2011) suggested that during pregnancy, as feed intake and weight gain of rabbit does decreases under high temperature, the litter weight at kindling also reduces.

Improved litter weight was observed in does fed ascorbic acid supplementation (200 and 400 mg/kg diet) in the second week of lactation and in does fed 200, 300 and 400 mg ascorbic acid/kg diet in the third and fourth week compared to does fed the control diet. This result suggests that ascorbic acid ameliorates the harmful effects of heat stress on growth, development and survivability of kits of the does at those levels of supplementation. Higher litter weight observed in does fed ascorbic acid supplemented diet compared to does fed the control diet in the fifth week and at weaning could be traced to their improved litter weight at birth due to ascorbic acid supplementation. Rödel *et al.* (2017) suggested that heavier pups at birth, being more central in the litter huddle, showed higher postnatal growth and high survival rate. Improved litter weight at 21st day (1380.6 vs. 997.1 g) and at weaning (2175.6 vs. 1402.9 g) was reported by Morsy *et al*. (2012) in rabbit does fed 250 mg ascorbic acid/kg diet compared to does fed the control diet and by Badr (2015) also in rabbit does fed 300 and 600 mg ascorbic acid/kg diet compared to does fed the control diet at 21st day (1320.4, 1575.0 vs. 1170.6 g) and at weaning (2052.2, 2419.0 vs. 1550.1 g).

Table 2 shows the effect of ascorbic acid levels on doe and kit mortality of rabbit does. Kit mortality in the second, third and fifth week as well as total kit mortality significantly ($P<0.05$) decreased as the levels of ascorbic acid supplementation increased in the diet. This Results suggest that ascorbic acid ensured more nutrient retention and utilization which eventually led to more milk produced/synthesized in the does. More milk intake could relatively keep the kits warmer within the litter, increased their body mass and reduced their mortality (Rödel *et al.,* 2015). Gilbert *et al.* (2012) suggested that newly born rabbits, being naked at birth and not brooded by the mother, depend on body contact with littermates to maintain an adequate body temperature at presumably less energetic cost for survival and able to direct more of the milk they obtain to growth. Morsy *et al.* (2012) reported significantly lower kit mortality in rabbit does fed ascorbic acid supplemented diet (250 mg/kg).

**Table 2: Effect of ascorbic acid level on doe and kit mortality of rabbit does**

| | Ascorbic acid level (mg/kg) | | | | | |
|---|---|---|---|---|---|---|
| Parameters | 0 | 100 | 200 | 300 | 400 | P value |
| Doe mortality (%) | 25.00±13.94 | 0.00±13.94 | 0.00±13.94 | 0.00±13.94 | 16.67±13.94 | 0.736 |
| **Kit mortality (%):** | | | | | | |
| Stillbirth | 0.00±0.30 | 0.29±0.30 | 0.00±0.30 | 0.00±0.30 | 0.00±0.30 | 0.363 |
| First week | 0.00±4.70 | 6.88±4.70 | 3.97±4.70 | 2.67±4.70 | 0.00±3.83 | 0.458 |
| Second week | 12.50±2.18$^{a}$ | 3.85±2.18$^{b}$ | 4.14±2.18$^{b}$ | 5.88±2.18$^{b}$ | 5.31±2.50$^{b}$ | 0.047 |
| Third week | 9.52±2.05$^{a}$ | 7.20±2.05$^{a}$ | 6.47±2.05$^{ab}$ | 4.52±2.05$^{b}$ | 4.46±2.76$^{b}$ | 0.050 |
| Fourth week | 0.00±4.87 | 4.31±4.87 | 0.00±4.87 | 6.67±4.87 | 3.33±4.79 | 0.458 |
| Fifth week | 5.26±2.48$^{a}$ | 4.50±2.48$^{a}$ | 0.00±2.48$^{b}$ | 0.79±2.48$^{b}$ | 0.67±2.02$^{b}$ | 0.040 |
| At weaning | 0.44±1.21 | 0.00±1.21 | 0.00±1.21 | 0.00±1.21 | 0.00±1.10 | 0.656 |
| Total | 27.28±2.10$^{a}$ | 27.00±2.10$^{a}$ | 14.58±2.10$^{c}$ | 20.53±2.10$^{b}$ | 13.77±2.09$^{c}$ | 0.039 |

$^{abc}$: Means with different superscripts in the same row are significantly ($P<0.05$) different

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