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GROWTH RESPONSE OF HYLA PARENTS, PURE AND CROSS F1 RABBIT DOES TO ASCORBIC ACID SUPPLEMENTATION UNDER SUB-HUMID TROPICAL ENVIRONMENT

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ABSTRACT

A study was carried out to evaluate the effect of dietary supplementation of feed grade ascorbic acid on growth performance of Hyla parents, pure and cross f1 rabbit does under tropical humid environment. A total of 81 rabbit does comprising of 35 multiparous pure New Zealand White (Parents) and 46 primiparous F1 progenies of the parents (31 pure New Zealand White and 15 cross Californian x New Zealand White F1) were used for the study. Ascorbic acid (AA) was included in the diets of the rabbits at levels of 0 (control), 200, 300 and 400 mg AA/kg feed. Feed intake, ascorbic acid intake and body weight parameters were determined weekly for 14 weeks with a 2-week adjustment period. Results indicated that does on ascorbic acid supplementation had significant ($P<0.05$) lower feed intake from the third to the sixth week of the experiment and on ascorbic acid intake in all the physiological states. Weight changes were not significantly ($P>0.05$) affected by ascorbic acid. It could be concluded that the rabbit does were exposed to a high ambient temperature as evidenced in their depressed feed intake. Ascorbic acid might be supplemented at 200 mg/kg level in order to reduce the adverse effect of high ambient temperature and improve growth performance of rabbits in the tropics.

Keywords: Ascorbic acid, Growth performance, Ambient temperature, Rabbits.

INTRODUCTION

Population growth in developing countries is increasing rapidly more than food supply, thus creating a global awareness on the level of shortage of animal protein supply in these countries, such as Nigeria (Adekunle and Ajani, 1999). Cheeke (1986) and FAO (1993) suggested that rabbit, with rapid growth rate, great adaptability to different environmental factors and high genetic selection traits (Hamouda *et al.*, 1990), can potentially alleviate the problem of animal protein supply in these developing countries. However, detrimental effects of heat stress due to high ambient temperature and oxidative stress caused by reactive oxygen species (ROS) (Heise *et al.* 2006), result in reduce libido, fertility and embryonic survival in rabbits and initiation of increased diseases associated with reduced immunoglobulin content in plasma (Makarevich *et al.*, 2006).

Balance between pro-oxidants (free radicals) and antioxidants (such as ascorbic acid) must be tightly regulated because they are extremely important for maintaining vital cellular and biochemical functions (Schafer and Buettner, 2001). This balance, if changed towards increasing pro-oxidants over the capacity of antioxidants, leads to oxidative stress which may cause oxidative damage (Hrbac and Kohen, 2000).

Antioxidant, at low concentration, significantly prevents or delays oxidation of oxidizable substrates (Halliwell, 1995). Ascorbic acid

(vitamin C) and vitamin E are the main natural antioxidants found in biological systems and feeds. In order to alleviate heat stress in rabbits, ascorbic acid is one of the most widely studied vitamins employed. Feed-grade ascorbic acid added to the diet of rabbits promoted growth, reproduction and counteracted infections by pathogenic bacteria and viruses (Abdel-Hamid and El-Adawy, 1999). Antioxidants are supplemented under *in vitro* conditions as the main defense factors against oxidative stress caused by free radicals (Agarwal *et al*., 2004). Sawyer and Valentine (1981) suggested that antioxidants must be present at the location where the radicals are produced in order to compete with radicals for biological substrates so as to prevent the interaction between free radicals and biological targets (Krieger and Loch-Caruso, 2001). To effectively inhibit oxidation reactions, naturally-occurring antioxidants have to be introduced through dietary supplementation which has been proved to be a simple and convenient strategy (Botsoglou *et al*., 2004). Ascorbic acid has been reported to improve reproductive performance of rabbits *in vivo* (Geva *et al.*, 1996). Ascorbic acid is synthesized in the liver of rabbits and thus it is not required in the diet (Amy, 2010). However, under adverse conditions, such as hot weather, stress, weaning and sub-clinical diseases, ascorbic acid production is reduced and its supplementation is beneficial during these times (Lebas, 2000). The aim of this study is to evaluate the ameliorative effect of ascorbic acid an antioxidant on physiological response of Hyla doe groups under a sub-humid tropical environment.

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. Shika is geographically situated on latitude 11° 12′42′′N of the equator and longitude 7°33’14” E with an altitude of 691m above sea level (Ovimaps, 2012). The area falls within the Northern Guinea Savannah zone of Nigeria having an average annual rainfall of 1100 mm, which starts from April to September. During the experimental period from January to April, the minimum and maximum ambient temperature and relative humidity in the morning ranged from 17.0 to 36.1°C and 15 to 41% while in the afternoon, the minimum and maximum ambient temperature and relative humidity ranged from 23.4 to 46.6°C and 15 to 39 respectively.

Experimental Animals and Management

A total of 81 rabbit does comprising of 35 multiparous pure New Zealand White (NZW: Parents), and 46 F1 progeny made up of primiparous purebred New Zealand White (NZW X NZW) and crossbred (Californian X NZW) does, progenies of the parent does, were used in this study. The rabbits having an average initial weight of 4.0kg were obtained from the flock of rabbits in the Rabbit Breeding Project, NAPRI, Shika. The animals were weighed and randomly allotted to four dietary ascorbic acid levels in a 4x2 factorial arrangement in a completely randomized design. The factors were four levels of ascorbic acid (0, 200, 300 and 400 mg/kg feed) and two doe groups (parent, F1 does).

Laboratory Analysis of the Experimental Diets

The experimental diets fed to the rabbit does was obtained from NAPRI feed mill. Samples of the diets were taken for ascorbic acid (mg/100g of feed) content at the Animal Science Biochemical Laboratory, Ahmadu Bello University, Zaria according to methods described by AOAC (1995). Result of the analysis is presented on Table 1

The experimental diets consisted of concentrate supplemented with ascorbic acid (except the control) at 200, 300 and 400 mg/kg levels.

Table 1: Ascorbic acid contents of the experimental diet

Ascorbic acid Supplementation levels (mg/kg feed)	Ascorbic acid content (mg/kg feed)
Control (0)	3.08
200	3.30
300	4.13
400	5.02

Measurement of growth performance parameters

The growth performance parameters studied included feed intake, ascorbic acid intake and weight changes in a 4x3 factorial arrangement. Ascorbic acid levels (0, 200, 300 and 400) mg/kg and doe group (Parents, pure and cross F1 does) effects as well as interaction between ascorbic acid and doe group were considered. All the does were used for these parameters. Left over feed was weighed daily and deducted from the feed offered to determine the feed intake while the ascorbic acid intake was calculated from the daily feed intake and the ascorbic acid content of the intake (daily feed intake x ascorbic acid content of the intake). The initial weight and the subsequent weekly weights were taken to determine weight changes of the does.

Statistical Analysis

Data for growth performance parameters were subjected to analysis of variance using General Linear Method (GLM) while the significant differences between means were separated using pairwise-difference method (P-DIFF: SAS, 2002).

RESULTS

The effect of ascorbic acid (AA) level on feed intake by the does before mating, during pregnancy and lactation is presented in Table 2. Before mating, does on 0 mg AA diet (unsupplemented does) had significantly ($P<0.05$) higher intake than does on 200, 300 and 400 mg AA diet. During pregnancy, from the first to the third week, control does on 0 mg AA diet have significantly higher intake than other does. However, in the third week, does on 200 mg AA diet had significantly higher intake than those on 300 mg AA diet, both levels had similar ($P>0.05$) intake as those on 400 mg AA diet. During lactation, in the first week, does on 0, 200 and 300 AA diet had significantly higher intake than those on 400 mg AA diet while in the second week, does on 0 mg AA diet had similar intake as other does on 200, 300, and 400 mg AA diet. However, does on 200 and 400 mg AA diets had similar but significantly higher intake than those on 300 mg AA diet. The result of the doe group effect on feed intake before mating, during pregnancy and lactation is presented in Table 3. Only the intake in the second week of lactation was significantly different; being higher for the F1 does than the parents. The interaction between ascorbic acid (AA) levels and doe group on feed intake by the does is presented in Figure 1. Feed intake was significantly ($P<0.05$) higher for unsupplemented parent does than for the F1 pure does before mating up to the third week of pregnancy and in the fifth week of lactation (Figure 1i). For other AA levels, all the does had similar lower feed intake from the first week before mating to the fourth week of pregnancy. However, during lactation, the F1 does (pure and cross) on 200 mg AA diet (Figure 1ii) and 300 mg AA diet (Figure 1iii)

levels had similar higher intake than the parent does while the intake was slightly lower for cross F1 does on 400 mg AA diet does than for the F1 pure does before mating up to the third week of pregnancy and in the fifth week of lactation (Figure 1i). For other AA levels, all the does had similar lower feed intake from the first week before mating to the fourth week of pregnancy. However, during lactation, the F1 does (pure and cross) on 200 mg AA diet (Figure 1ii) and 300 mg AA diet (Figure 1iii) levels had similar higher intake than the parent does while the intake was slightly lower for cross F1 does on 400 mg AA diet (Figure 1iv). Feed intake generally decreased in the fourth week of pregnancy and was higher during lactation.

Table 2: Effect of ascorbic acid level on feed intake by rabbit does before mating, during pregnancy and lactation

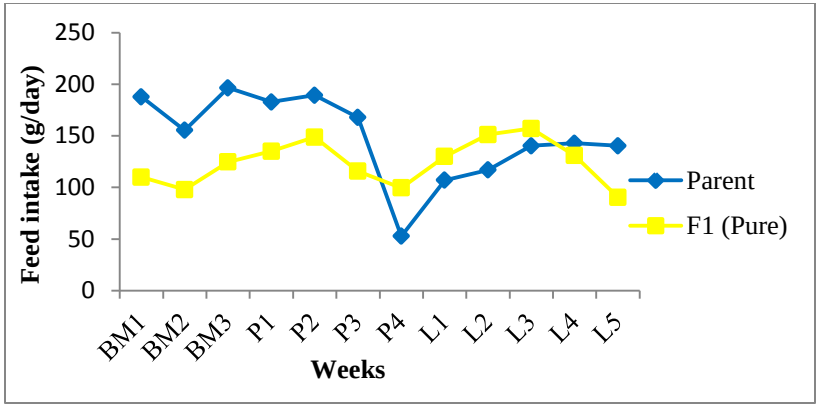
	Ascorbic acid level (mg/kg feed)				
Feed intake (g/day)	**0**	**200**	**300**	**400**	**P value**
Before mating:					
First week	148.94±8.15 [a]	103.08±5.36 [b]	117.20±6.31 [b]	110.43±5.46 [b]	0.0005
Second week	126.61±8.09 [a]	105.86±5.32 [b]	100.52±6.27 [b]	96.20±5.43 [b]	0.029
Third week	160.61±9.18 [a]	123.94±6.04 [b]	115.71±7.11 [b]	110.45±6.16 [b]	0.0007
Pregnancy:					
First week	158.94±10.79[a]	120.12±7.10 [b]	120.05±8.36 [b]	111.46±7.24 [b]	0.008
Second week	169.05±10.20[a]	122.01±6.71[b]	109.59±7.90[b]	122.81±6.84[b]	0.001
Third week	141.79±1.19[a]	119.26±6.05[b]	98.23±7.12[c]	110.80±6.17[bc]	0.006
Fourth week	76.19±12.15	99.86±8.00	101.07±9.41	98.39±8.15	0.369
Lactation:					
First week	165.50±19.14[a]	188.17±12.60[a]	162.15±14.83[a]	135.00±12.84[b]	<0.0001
Second week	176.22±26.53[ab]	207.55±17.47[a]	148.00±20.55[b]	195.14±17.80[a]	0.001
Third week	148.78±35.54	170.96±23.39	141.73±27.53	190.48±23.84	0.558
Fourth week	136.91±26.50	123.02±17.45	152.83±20.53	187.39±17.78	0.091
Fifth week	115.45±16.75	128.89±11.03	165.51±12.98	146.97±11.24	0.081

[abc]: Means with different superscripts in the same row are significantly (P<0.05) different

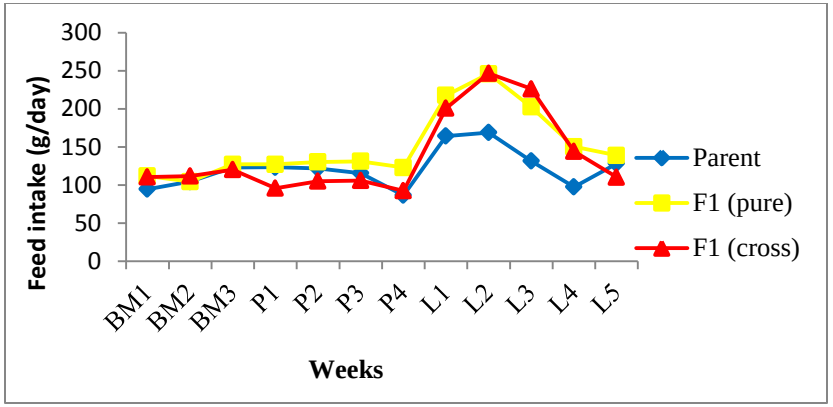
Table 3: Effect of doe group on feed intake by rabbit does before mating, during pregnancy and lactation

	Group			
Feed intake (g/day)	**Parent**	**F1(Pure)**	**F1(Cross)**	**P value**
Before mating:				
First week	118.85±6.75	115.46±5.83	109.14±7.69	0.637
Second week	104.94±5.79	108.66±5.06	98.57±6.60	0.485
Third week	131.66±7.07	118.19±6.19	114.70±8.06	0.230
Pregnancy:				
First week	121.55±7.81	126.67±6.83	119.86±8.91	0.802
Second week	125.05±7.53	130.37±6.59	116.01±8.59	0.423
Third week	115.72±6.37	120.88±5.58	99.29±7.27	0.071
Fourth week	91.21±7.71	110.92±6.74	94.06±8.79	0.126
Lactation:				
First week	134.55±15.95	180.43±13.94	169.13±18.18	0.102
Second week	141.59±19.25[b]	218.15±16.83[a]	232.27±21.94 [a]	0.004
Third week	147.30±20.39	202.89±17.83	215.56±23.25	0.059
Fourth week	139.86±17.09	170.29±14.95	172.57±19.49	0.332
Fifth week	132.27±12.01	145.29±10.51	151.14±13.70	0.557

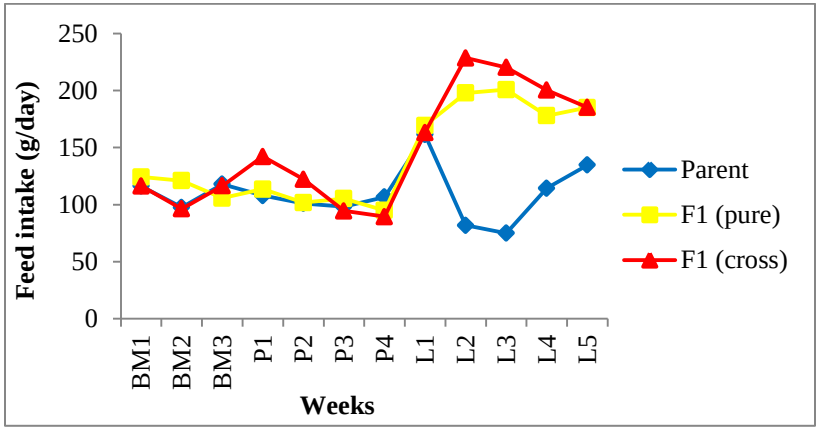
[ab]: Means with different superscripts in the same row are significantly (P<0.05) different,
F1=first filial generation (pure and cross)



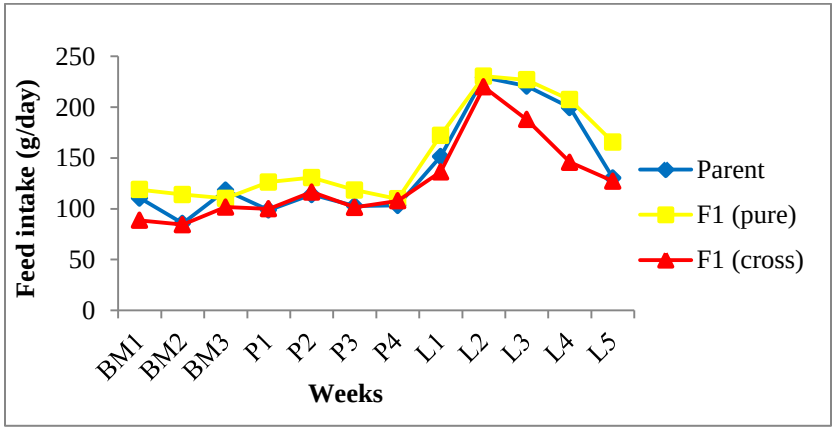
i) Does on 0 mg/kg Ascorbic acid



ii) Does on 200 mg/kg Ascorbic acid



iii) Does on 300 mg/kg Ascorbic acid



iv) Does on 400 mg/kg Ascorbic acid

BM1-3=Feed intake from 1st to 3rd week before mating, P1-4=Feed intake from 1st to 4th week of pregnancy, L1-5=Feed intake from 1st to 5th week of lactation.

Figure 1: Interaction between ascorbic acid level and doe group on feed intake by the rabbit does before mating, during pregnancy and lactation

The effect of ascorbic acid (AA) levels on AA intake by the does before mating, during pregnancy and lactation is presented in Table 4. Before mating, AA intake of the unsupplemented does was similar ($P>0.05$) as those on 200 and 300 mg AA diet. However, does on 200 mg have significantly lower intake than those on 300 mg diet. Does on 400 mg had significantly ($P<0.05$) higher intake than other does. During pregnancy, in the first and second weeks, does on 0 and 300 mg had similar but significantly higher intake than those on 200 mg while in the third and fourth weeks, does on 0, 200 and 300 mg had similar intake. Does on 400 mg AA had significantly ($P<0.05$) higher intake than other does. From the second to the fourth week of lactation, the intake of does on 0 and 200 mg was similar but significantly lower intake than those on 400 mg all of which were similar as those on 300 mg while in the fifth week, the intake of does on 0 and 200 mg AA was similar but significantly lower than those on 300 and 400 mg AA diet. The effect of doe group on ascorbic acid intake by the does before mating, during pregnancy and lactation is presented in Table 5. Doe group effect did not significantly ($P>0.05$) influence the ascorbic acid intake of the does in all the physiological states (before mating, during pregnancy and lactation) across the ascorbic acid levels. The interaction of ascorbic acid levels and doe group on ascorbic acid intake by the does before mating, during pregnancy and lactation is presented in Figure 2. Ascorbic acid intake was significantly higher for unsupplemented parent does than for unsupplemented pure F1 does before mating, during pregnancy and lactation (Figure 2i). Does on 200 (Figure 2ii), 300 (Figure 2iii) and 400 (Figure 2iv) mg had similar intake before mating and during pregnancy. However, from the fourth week of pregnancy all through to the lactation period, the F1 does on 200 and 300 mg had higher intake than the parent does but for 400 mg, the pure F1 does had higher intake than other does. Generally, the intake was lower in the fourth week of pregnancy and higher during lactation for all the does.

The effect of ascorbic acid levels on weight changes of the does before mating, during pregnancy and lactation is presented in Table 6. Ascorbic acid levels did not significantly ($P>0.05$) influence weight changes of the does in all the physiological states (before mating, during pregnancy and lactation). The effect of doe group on weight changes of rabbit does before mating, during pregnancy and lactation is presented in Table 7. Before mating, both the parents and cross F1 does gained similar ($P>0.05$) but significantly higher weight than the pure F1 does in the first week. However, in the second week, the pure F1 does gain significantly more weight than both the parents and the cross F1 does. In the first week of pregnancy, the parents gained weight while the F1 does lost weight. In the third week, parents lost weight while the F1 does gained weight. Weight changes and final weight were not significantly ($P>0.05$) different during lactation for all the groups. The interaction between ascorbic acid levels and doe group on weight changes of the does before mating, during pregnancy and lactation is presented in Figure 3. Before mating, weight changes were similar for does on 0 mg AA diet (Figure 3i) while it was variable for does on 200 (Figure 3ii), 300 mg AA diet, (Figure 3iii) and 400 (Figure 3iv) mg AA diet. However, the parents and the F1 does on 0 and 200 mg AA diet had higher weight gain in the fourth week of pregnancy respectively. On 300 mg AA diet, the parents in the third week and the F1 does in the fourth week gained weight respectively during pregnancy. The cross F1 does and pure F1 does on 400 mg AA diet gained higher weight in the third week of pregnancy than the parents while only the parents gained weight in the fourth week of pregnancy. The effect of ascorbic acid levels on final weight of does

after lactation is presented in Figure 4. Final weight significantly decreased for parents but increased for the pure F1 does on 0 mg AA diet (Figure 4i), final weight slightly increased for parents, decreased for pure F1 does and remained relatively constant for the cross F1 does on 200 mg AA diet (Figure 4ii). Weight decreased slightly for parents, remained relatively constant for pure F1 does but increased for cross F1 does on 300 mg AA diet (Figure 4iii) while it decreased slightly for parents and cross F1 does but increased for pure F1 does on 400 mg AA diet (Figure 4iv).

Table 4: Effect of ascorbic acid level on ascorbic acid intake by rabbit does from before mating, during pregnancy and lactation

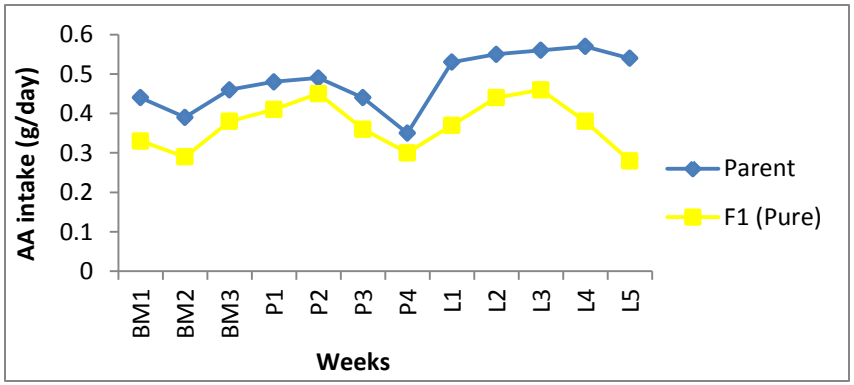
	Ascorbic acid level (mg/kg feed)				
Ascorbic acid intake (g/day)	**0**	**200**	**300**	**400**	**P value**
Before mating:					
First week	0.40 ± 0.03^{bc}	0.35 ± 0.02^{c}	0.46 ± 0.02^{b}	0.54 ± 0.02^{a}	<0.0001
Second week	0.35 ± 0.02^{bc}	0.34 ± 0.02^{c}	0.40 ± 0.02^{b}	0.49 ± 0.02^{a}	<0.0001
Third week	0.43 ± 0.03^{bc}	0.40 ± 0.02^{c}	0.47 ± 0.02^{b}	0.53 ± 0.02^{a}	<0.0001
Pregnancy:					
First week	0.47 ± 0.03^{b}	0.39 ± 0.02^{c}	0.50 ± 0.02^{b}	0.56 ± 0.02^{a}	<0.0001
Second week	0.49 ± 0.03^{b}	0.39 ± 0.02^{c}	0.45 ± 0.02^{b}	0.58 ± 0.02^{a}	<0.0001
Third week	0.41 ± 0.03^{b}	0.38 ± 0.02^{b}	0.42 ± 0.02^{b}	0.53 ± 0.02^{a}	<0.0001
Fourth week	0.33 ± 0.04^{b}	0.34 ± 0.03^{b}	0.39 ± 0.03^{b}	0.46 ± 0.02^{a}	0.001
Lactation:					
First week	0.46±0.08	0.54±0.05	0.58±0.06	0.69±0.05	0.069
Second week	0.54 ± 0.11^{b}	0.65 ± 0.07^{b}	0.71 ± 0.08^{ab}	0.89 ± 0.07^{a}	0.020
Third week	0.53 ± 0.10^{b}	0.61 ± 0.06^{b}	0.71 ± 0.07^{ab}	0.85 ± 0.06^{a}	0.020
Fourth week	0.48 ± 0.10^{b}	0.48 ± 0.06^{b}	0.65 ± 0.07^{ab}	0.75 ± 0.06^{a}	0.010
Fifth week	0.41 ± 0.08^{b}	0.41 ± 0.05^{b}	0.64 ± 0.05^{a}	0.58 ± 0.05^{a}	0.006

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

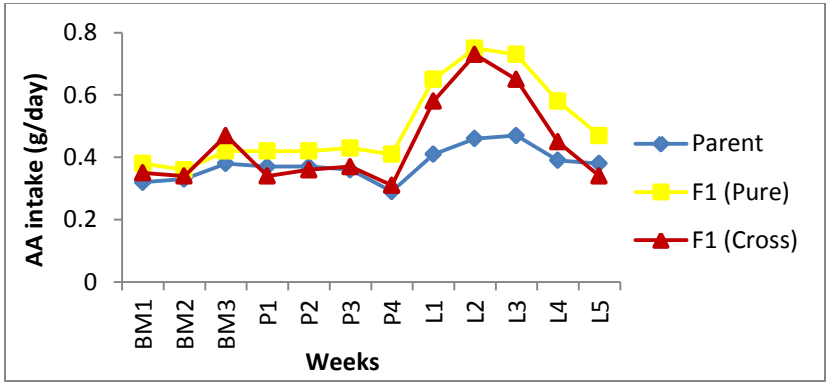
Table 5: Effect of doe group on ascorbic acid intake by rabbit does before mating, during pregnancy and lactation

	Group			
Ascorbic acid intake (g/day)	**Parent**	**F1(Pure)**	**F1(Cross)**	**P-value**
Before mating:				
First week	0.43±0.02	0.45±0.02	0.44±0.03	0.647
Second week	0.38±0.01	0.42±0.02	0.39±0.02	0.178
Third week	0.47±0.01	0.45±0.02	0.45±0.03	0.542
Pregnancy:				
First week	0.45±0.02	0.48±0.02	0.49±0.03	0.378
Second week	0.45±0.02	0.50±0.02	0.48±0.03	0.203
Third week	0.43±0.01	0.46±0.02	0.42±0.02	0.267
Fourth week	0.36±0.02	0.41±0.02	0.37±0.03	0.334
Lactation:				
First week	0.53±0.04	0.59±0.05	0.58±0.07	0.655
Second week	0.58±0.06	0.72±0.06	0.79±0.09	0.100
Third week	0.59±0.06	0.72±0.06	0.72±0.08	0.182
Fourth week	0.53±0.05	0.63±0.06	0.61±0.08	0.462
Fifth week	0.47±0.04	0.54±0.04	0.51±0.06	0.508

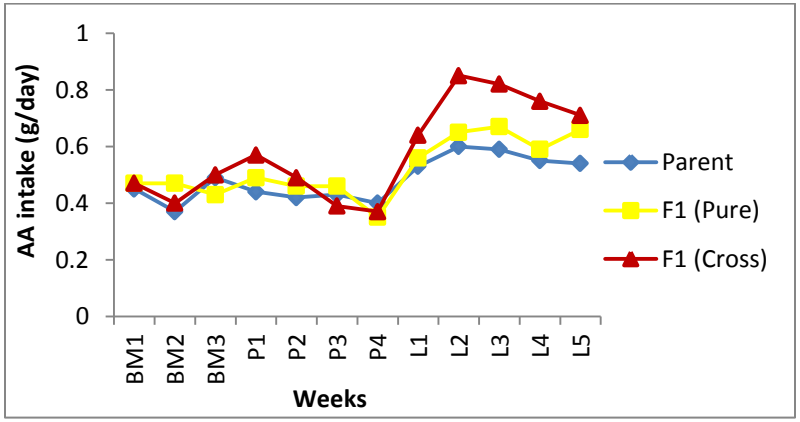
F1=first filial generation (pure and cross)



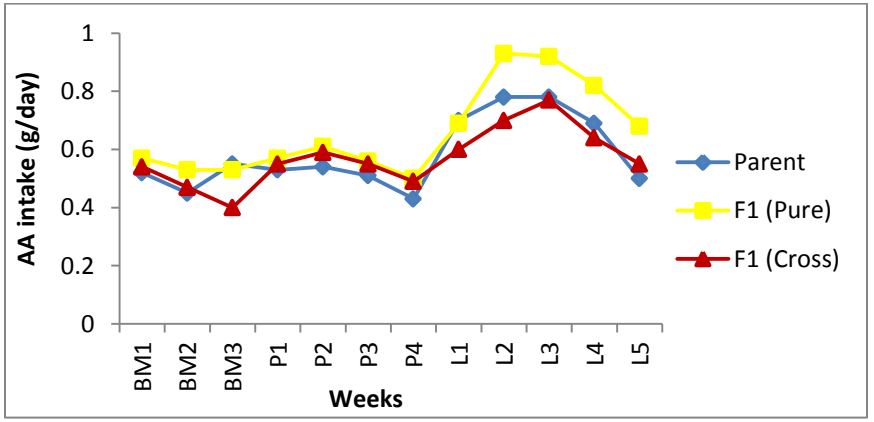
i) Does on 0 mg/kg Ascorbic acid



ii) Does on 200 mg/kg Ascorbic acid



iii) Does on 300 mg/kg Ascorbic acid



iv) Does on 400 mg/kg Ascorbic acid

AA=Ascorbic acid, BM1-3=ascorbic acid intake from 1st to 3rd week before mating, P1-4=ascorbic acid intake from 1st to 4th week of pregnancy, L1-5=ascorbic acid intake from 1st to 5th week of lactation

Figure 2: Interaction between ascorbic acid level and doe group on ascorbic acid intake by rabbit does before mating, during pregnancy and lactation

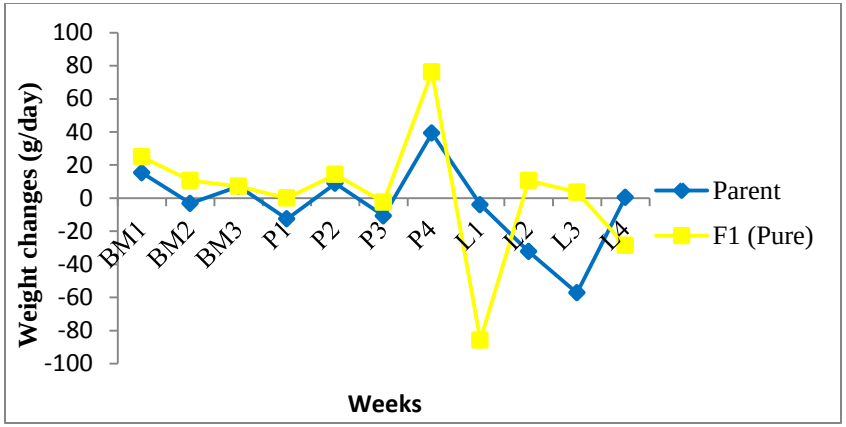
Table 6: Effect of ascorbic acid level on weight changes by rabbit does before mating, during pregnancy and lactation

	Ascorbic acid level (mg/kg feed)				
Parameters	**0**	**200**	**300**	**400**	**P value**
Initial weight (g)	4160.00±173.00	3820.00±119.00	3900.00±118.00	4070.00±114.00	0.276
Weight changes (g/day):					
Before mating:					
First week	20.16±8.80	12.06±6.15	15.96±6.05	16.43±5.87	0.891
Second week	3.83±8.39	8.73±5.80	8.90±5.72	9.23±5.54	0.954
Third week	7.14±11.71	15.38±8.10	-6.61±7.98	-8.37±7.73	0.131
Pregnancy:					
First week	-6.25±8.81	4.29±6.31	-8.06±6.75	-19.64±6.57	0.091
Second week	11.61±18.36	17.00±13.17	17.65±14.07	12.77±13.70	0.989
Third week	-6.55±21.80	0.57±15.63	20.00±16.71	42.23±16.27	0.201
Fourth week	57.74±15.03	47.86±10.78	44.49±11.53	31.61±11.22	0.541
Lactation:					
First week	-44.65±22.19	-16.07±13.59	-25.00±17.79	-28.13±13.59	0.739
Second week	-10.72±15.01	-12.05±9.19	-28.06±12.04	-9.82±9.19	0.649
Third week	-26.79±26.74	-18.75±16.37	-2.04±21.44	8.93±16.37	0.567
Fourth week	-14.04±18.14	-36.61±11.11	-21.43±14.55	-37.05±11.11	0.608
Final weight (g)	3590.00±299.00	3770.00±183.00	4040.00±240.00	4150.00±183.00	0.307

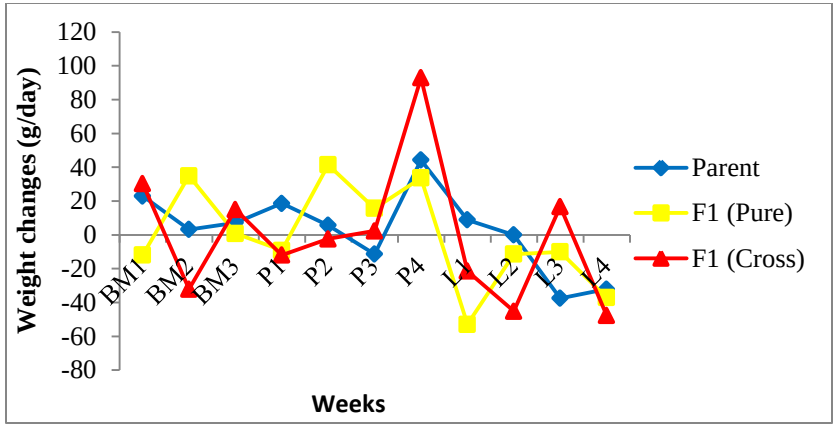
Table 7: Effect of doe group on weight changes of rabbit does before mating, during pregnancy and lactation

Parameters	Group			P value
	Parent	F1(pure)	F1(cross)	
Initial weight (g)	4300.00±92.00	3550.00±98.00	3800.00±145.00	
Weight gain (g/day):				
Before mating:				
First week	17.14±4.59[a]	6.68±4.88[b]	28.06±7.26[a]	0.047
Second week	4.26±4.20[b]	18.66±4.47[a]	-3.57±6.65 [b]	0.011
Third week	5.71±6.71	-7.70±7.13	3.06±10.61	0.377
Pregnancy:				
First week	1.50±5.54[a]	-13.49±5.69[b]	-25.71±7.64[c]	0.017
Second week	16.54±10.76	22.46±10.76	0.00±14.44	0.460
Third week	-1.88±13.05[c]	20.00±13.41[b]	59.29±17.96[a]	0.030
Fourth week	39.10±8.84	46.03±9.08	50.72±12.18	0.720
Lactation:				
First week	-7.15±12.54	-42.86±11.22	-40.71±13.74	0.087
Second week	-14.29±9.01	-11.91±8.06	-17.86±9.87	0.897
Third week	-11.91±15.63	-5.71±13.98	-1.43±17.13	0.900
Fourth week	-35.63±10.90	-26.19±9.75	-22.14±11.94	0.685
Final weight (g)	4080.00±200.00	3620.00±180.00	3850.00±220.00	0.235

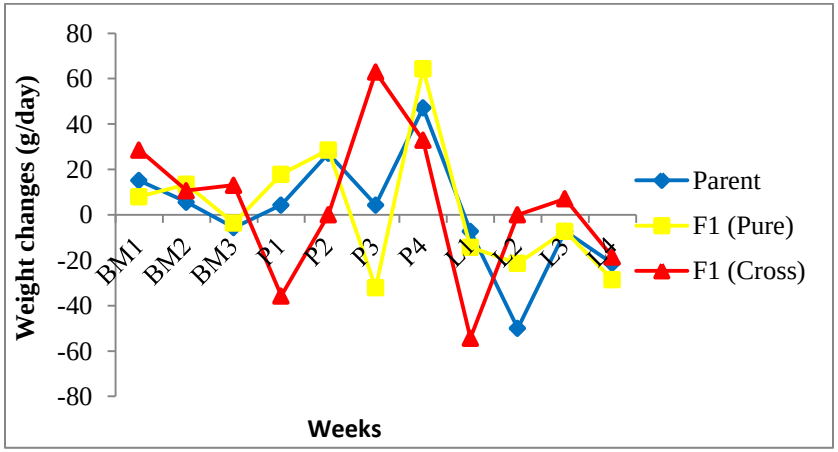
[abc]: Means with different superscripts in the same row are significantly (P<0.05) different, F1=first filial generation (pure and cross)



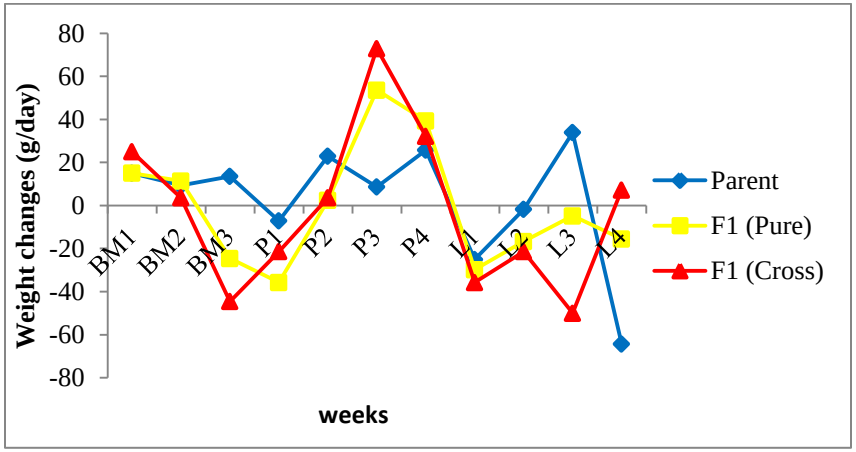
(i) Does on 0 mg/kg Ascorbic acid



(ii) Does on 200 mg/kg Ascorbic acid



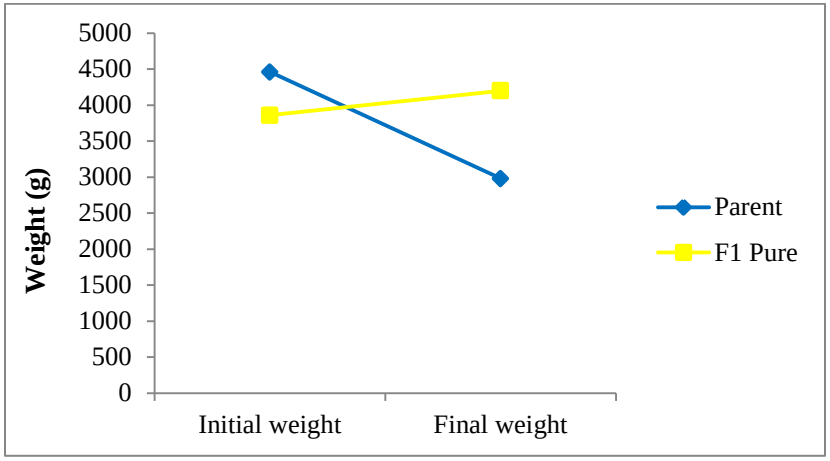
(iii) Does on 300 mg/kg Ascorbic acid



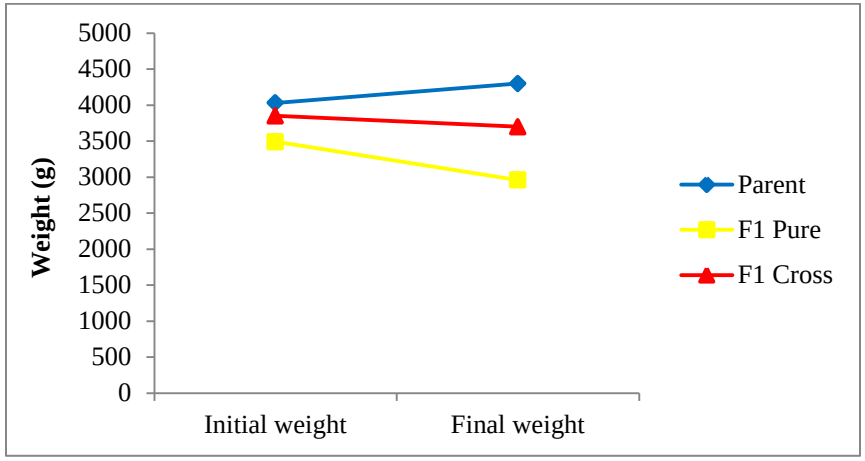
(iv) Does on 400 mg/kg Ascorbic acid

AA=Ascorbic acid levels, BM1-3=weight changes from the first to the third week before mating, P1-4=weight changes from the first to the third week of pregnancy, L1-4=weight changes from the first to the fourth week of lactation

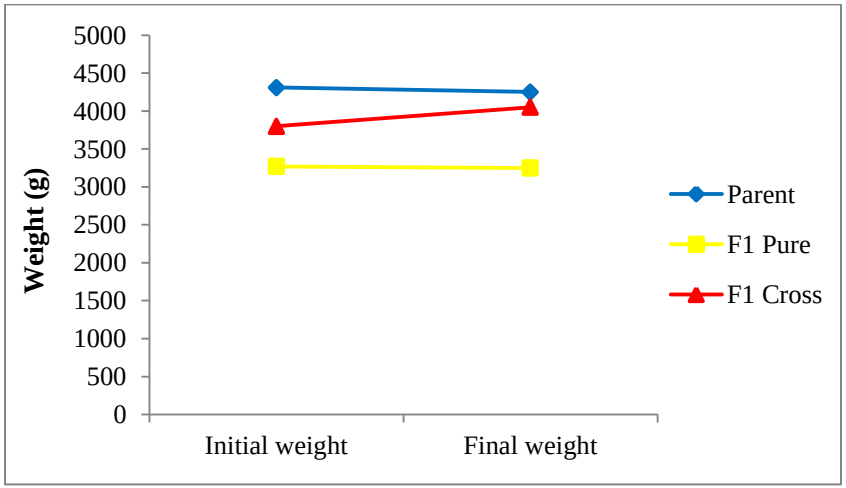
Figure 3: Interaction between ascorbic acid level and doe group on weight changes of rabbit does before mating, during pregnancy and lactation



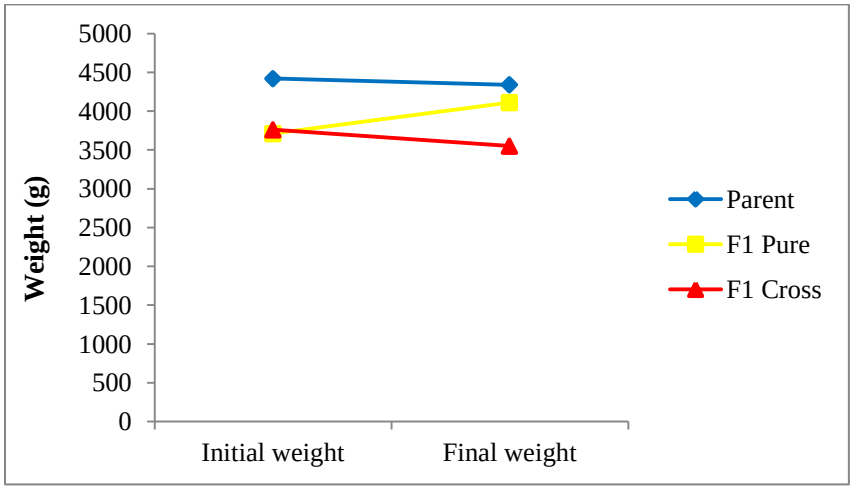
(i) Does on 0 mg/kg Ascorbic acid



(ii) Does on 200 mg/kg Ascorbic acid



(iii) Does on 300 mg/kg Ascorbic acid



(ii) Does on 400 mg/kg Ascorbic acid

Figure 4: Interaction between ascorbic acid level and doe group on final weight of rabbit does after lactation

DISCUSSION

The lower feed intake obtained for ascorbic acid supplemented does in this study disagrees with the findings of Kassim and Norziha (1995) and Yousef *et al.* (2003) who reported higher feed intake for ascorbic acid supplemented broiler birds and rabbits at (400 or 600 mg/kg). El-Fiky (1998) reported the role of ascorbic acid in activating thyroid gland which increases appetite and feed intake. However, Blaha and Kreosna (1997) and Jaffar and Blaha (1996) were among other researchers who reported that ascorbic acid supplemented at 20mg/bird/day in drinking had no appreciable effect on feed intake and weight gain of broiler birds. The harsh climatic conditions during the study period might have interfered with feed consumption among the supplemented does. The significantly higher feed intake observed for the F1 does in the second week of lactation disagrees with the findings of Guillén *et al.* (2008) who reported similar intake for both the primiparous and multiparous rabbit does. This higher intake might be to prevent negative energy balance Partridge *et al.* (1983) which is aggravated in primiparous does due to simultaneous need to meet requirements for body growth and reproduction (Maertens, 1998).

The general decrease in daily feed intake in the fourth week of pregnancy observed in this study agrees with the findings of Guyton (1992) who reported that decreased feed intake during late phase of pregnancy may be due to increased size of foetuses. Also, Fekete *et al.* (2003) reported sharp decline in feed intake in the 4^{th} week due to fast growth of foetuses and of the hypertrophied uterus. Feed intake recorded in this study during pregnancy (169.05±10.20) being lower than that recorded during lactation (207.55±17.47) agrees with the findings of Abdel-Khalek *et al.* (2008) and Koketsu and Dial (1997) who reported similar lower intake for pregnant rabbit does than for lactating does. However, Xiccato (1996) reported that high energy required for pregnancy, maternal tissue growth and milk production lead to an energy deficit due to mobilization of tissue deposits in lactating animals. Liebler (1992) reported that ascorbic acid intake even at higher dose does not cause cellular damage but has a protective action against lipid oxidation in the cell membrane. However, ascorbic acid intake appears to be a function of level of supplementation and quantity of feed consumed. The beneficial effects of ascorbic acid supplementation under stressful conditions were reported by Sahin *et al.* (2003) who demonstrated that ascorbic acid improves performance in birds.

The non-significant effect of ascorbic acid supplementation on weight changes obtained from this study disagrees with Ismail *et al.* (1992b) and Morsy *et al.* (2012) who reported significantly higher weight gain for ascorbic acid supplemented does at 1 g/kg level. However, Balogun *et al.* (1996) and Sallam *et al.* (2005) reported that ascorbic acid supplementation improved weight gain and results in better feed utilization in piglets and birds. In addition, Osei *et al.* (1998) reported no appreciable effect of ascorbic acid supplementation on weight gain of broiler birds. Abou-Zeid *et al.* (2000) reported that ascorbic acid scavenges free radicals to prevent the oxidative stress of the cell membranes of the digestive system which leads to restoration of efficient feed utilization.

During lactation, both the supplemented and non-supplemented does (the parents and F1 does) recorded general non-significant weight loss. This could be as a result of high ambient temperature or heat stress and the does' physiological state during the study period. Cervera *et al.* (1997) and Chiericato *et al.* (1993) reported that high temperature or heat stress in the tropical countries leads to a significant reduction in the daily weight gain.

Rabbits are very sensitive to extreme environmental conditions especially temperature (Ayyat *et al.,* 1996). Environmental temperature above 28°C results in heat-induced physiological stress (Al-Homidan and Ahmed, 2000). Maertens and De Groote (1990) and St-Pierre *et al.* (2003) reported that high environmental temperature generates behavioral, physiological and immunological responses which impose detrimental consequences on body weight and productivity. The general increase in weight observed for all the does in the third and fourth week of pregnancy (late phase of pregnancy) might be due to increased size of foetuses.

The higher final weight of supplemented parent does on ascorbic acid than the non-supplemented does recorded in this study agrees with the reports of Kutle and Forbes (1993) that ascorbic acid, as a coenzyme, plays an important role in metabolism of amino acid and could possibly decrease metabolic rate and energy expenditure by the body to cause increase in weight gain due to better feed utilization. Abu and Onifade (1996) reported that rabbits reared under tropical climatic conditions have lower daily body weight gain of 8-13g/day compared to values of 42 g/day/rabbit obtainable in temperate climates. This was suggested to be due to high ambient temperature, low feed intake and inbreeding depression (Abu *et al.,* 2008).

CONCLUSION

The study showed that the unsupplemented does consumed more feed before mating and during pregnancy than the supplemented does with ascorbic acid, the F1 does consumed more feed than the Parents during pregnancy and lactation.. All the does consumed less feed in the 4th week of pregnancy possibly due to increase in foetal size but more feed during lactation. Does on 400 mg level of ascorbic acid consumed more feed in all the physiological stage. Doe group had no significant (P>0.05) effect on the ascorbic acid intake by the does. The interaction between ascorbic acid and doe group on ascorbic acid intake followed similar trend as the feed intake. Ascorbic acid might be supplemented at 200 mg/kg level in order to reduce the adverse effect of high ambient temperature and improve growth performance of rabbits in the tropics.

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