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EFFECT OF DIETARY FIBER AND ENERGY LEVELS ON PERFORMANCE OF POST-WEANING RABBITS

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ABSTRACT

Sixty rabbits (New Zealand (NZW) x Californian(ACL)) of both sexes, weaned at four weeks of age were fed on low or high energy (2505 vs 2907 Kcal DE/kg) diets with high or low dietary crude fiber (14.4 vs 7.9%) to evaluate the effect in starter and finishing period. Diets were fed with or without copper sulphate supplementation. Growth, feed intake and stomach pH were measured up to 12 weeks. Five digestibility trials, were also undertaken on starter-finisher diets. The present study recorded better growth performance ($P<0.01$) results with a high fiber - low energy diet supplemented with copper sulphate (4-6 weeks of age). Mortality rate during the starter period was higher with the high carbohydrates diets and it was lower with high fiber- low energy diets in the finisher period (7-12 weeks of age) .Digestibility and nutritive values of the experimental diets improved ($P<0.01$) or ($P<0.05$) with low fiber-high energy diets with and without copper sulphate ($CuSO_4.5H_2O$) supplementation The stomach pH values were decreased after weaning and were lower ($P<0.05$) with coppersulphate addition at 6 weeks of age.

INTRODUCTION

The pH of the rabbit stomach is quite high during the suckling period and drops after weaning (Brooks, 1978). When the stomach pH drops to the adult level: 1-1.5, virtually all ingested microbes are killed in the stomach. Thus the main period for colonization of the gut with the normal microbial flora would appear to be after weaning, when the milk antibiotic is no longer present and before the stomach becomes highly acid (about 5-6 weeks of age). According to the theory of Lelkes(1987), the diet during this immediate post-weaning period is critical to normal microbial colonization of the gut. If a high-energy diet is fed, excessive fermentation may occur in the cecum, causing a drop in pH, which kills some of the normal microbes. These results in an abnormal microbial population becoming established (dysbiosis). The objective of this study was to evaluate some modification to the weaning diet, to determine if the susceptibility of weaning rabbits to enteritis could be modified.

MATERIALS AND METHODS

Animals and feeding

This research work was carried out at the commercial farm (El-Khtatba area), Sixty rabbits (NZW x ACL) of both sexes, weaned at 4 weeks of age were used. Average initial body weight (614 ± 6.5g) were randomly assigned to 4 treatments (four starter diets) and they were switched to a high energy diet or control diet during the finisher period. Weaning diets were formulated with various objectives as follows:

Starter diets: Control diets: Diet 1: Low energy concentrate: diet with high dietary crude fiber (14.4 %). This diet should minimize cecal hyperfermentation. Diet 2: Diet 1+250 ppm

Copper sulfate. Copper sulfate has been shown to reduce enteritis in rabbits (Patton et al., 1982).
Negative control diet: Diet 3: High-energy concentrate with low dietary crude fiber (7.9 %). This diet should provoke hyperfermentation and dysbiosis. Diet 4: Diet 3 + 250 ppm copper sulfate. This treatment was intended to determine if the antimicrobial properties of copper would be sufficient to overcome the dysbiosis- inducing effects of a highly fermentable diet.

*Finisher diets:*Diet 5 : High energy concentrate diet with low fiber (10.5%)+2.9% vegetable oil. Diet 1: Low energy concentrate diet with high dietary crude fiber (14.4 %) .Composition of the previous diets is shown in Table 1.

Table 1. Percentage composition of the experimental diets.

	Starter diet				Finisher diet
Diets No.	1	2	3	4	5
Soybean meal					
Clover hay	14.00	14.00	19.00	19.00	21.00
Wheat bran	40.00	40.00	11.00	11.00	16.00
Yellow corn	33.80	33.80	28.60	28.60	30.50
Barley	6.00	6.00	9.40	9.40	-
Dicalcium phosphate	-	-	26.00	26.00	23.00
Sunflower oil	0.25	0.25	0.25	0.25	0.25
DL-Methionine	-	-	-	-	2.90
Molasses	0.26	0.26	0.11	0.11	0.13
Min.& Vit. Minx	5	5	5	5	5
Limestone	0.30	0.30	0.30	0.30	0.30
Salt	-	-	0.50	0.50	0.50
***Copper sulfate	0.39	0.39	0.44	0.44	0.42
	-	+	-	+	-
PROXIMATE CHEMICAL ANALYSIS					
CF%	14.35	14.35	7.87	7.87	10.46
CP%	17.33	17.33	17.42	17.42	17.22
*DE Kcal/kg	2505	2505	2907	2907	2904
**DE Kcal/kg	2435	2559	2991	3038	2988

* Calculated according to NRC for Rabbits (1977). ** Determined by Schiemann ,et ,al ., (1972) ***Copper sulfate ($CuSO_4.5H_2O$)= 250 ppm

Management
Rabbits were housed in galvanized wire cages and were housed for a period of two weeks (4-6 weeks of age) on stater diets. They were switched to a high energy diet (diet 5) or control one (diet 1) for six weeks (7-12 weeks of age). Diets were offered ad-libitum and automatic watering system. The actual accumulated feed consumed per week was obtained and mortality was recorded daily and a veterinarian examined casualties. Rabbits were individually weighed to the nearest gram every week. The study tested 8 weeks during which daily live weight gain, feed conversion ratio (g feed/g gain) and mortality rate were recorded. Stomach pH was also estimated.

Digestibility trials

At the end of the experimental period (12 weeks of age) five digestibility trials were undertaken on starter - finisher diets with/without copper sulphate 250 ppm- supplementation, three rabbits from each group were housed individual in metabolism cages. The preliminary period continued for 7 days and the collection period was extended to 4 days. Water was offered ad-libitum. Chemical analysis of diets and faeces was carried out following the ordinary methods of the AOAC.(1990). The values of TDN were calculated according to the classic formula of Cheeke, et. al. (1982) and digestible energy content was calculated using Schiemann et al. (1972) equation. DE (Kcal/kg) = 5.28 (DCP, g/kg) + 9.51 (DEE, g/kg) + 4.2 (DCF,g/kg) + 4.2 (DNFE, g/kg). Where : DCP, DEE, DCF and DNFE = digestible CP, EE, CF and NFE respectively. .Data were statistically analysed (variance analysis) according to Steel and Torrie (1980). Differences among were determined by Duncan's test (1955).

RESULTS AND DISCUSSION

Starter period

The average live body weight LBW during the starter period was highly significant (P<0.001) as shown in Table 2. Assuming treatment 1 equals 100, it would be 107.6, 92.9 and 98.8 for treatments 2,3 and 4, respectively, showing that the only treatment which gave improved growth over T1 (control) was that which contained 250 ppm copper sulfate. It is worthy noting that the copper sulfate response (P<0.01) was noted with the high fiber - low energy diet (T2) but not with the high energy - low fiber diet (T4). The present results which are in good agreement with those obtained by Robinson et al. (1988) suggested better results with a high fiber diet supplemented with copper sulfate. The average live body weight gain (LWG) during starter period were highly significant (P<0.01) as shown in Table 2. These results indicate that higher LWG were recorded by T2 while T3 and T4 recorded lower values.

Table 2. Growth performance of experimental rabbits (Starter period 4-6 wk) .

Item	T1	T2	T3	T4	
CF%	14.25	14.25	7.87	7.87	sig.
$CuSO_4.5H_2O$	-	+	-	+	
	X±SE	X±SE	X±SE	X±SE	
No. of rabbits	15	15	15	15	
Initial body weight, g	617.75±5.37	612.92±6.2	614.17±6.09	610.42±8.26	n.s
Final body weight, g	927.14b±12.0	997.5a±10.08	861.42c±9.11	916.0b±11.85	**
%	100	107.6	92.9	98.8	
Daily live weight gain g.	22.10b±0.99	27.47a±1.29	17.66c±0.65	21.83b±1.04	**
Feed intake (g/day)	60.0a±1.85	65.24a±1.54	38.14b±1.95	44.87b±2.01	**
%	100	108.7	63.6	74.8	
Feed conversion	2.71±0.20	2.38±0.15	2.16±0.12	2.06±0.22	n.s
Mortality rate %	6.6	-	20	13.3	

a,b and c Means within the same row showing different letter are significantly different (p<0.05) .

NS.= non significant, ** = (P < 0.01)

The average daily feed consumed (FC) (g/day) during the starting two weeks were highly significant (P<0.01) as shown in Table 2. Assuming T1=100, it would be 108.7, 63.6 and 74.8 for T2, T3 and T4 respectively. This shows that T2 which achieved the highest daily

consumption (8.7% more than of T1), while that T3 which recorded lowest daily consumption (36.4% lower). Feed conversion (g feed/g gain) was not significantly different between the experimental diets as shown in Table 2. Mortality rate during the starter period reached 6.6, 0.0, 20 and 13.3% in T1, T2, T3 and T4, respectively. Showing that it was higher with the high carbohydrate diets. It is worthy noting that in the copper sulfate diet no mortality was recorded in the starter phase.

Finisher period

The average LBW during the finisher period were found to be significantly different ($P<0.05$) between groups. It is worthy noting that on the high energy diet (group 4) the highest LBW was recorded while on the low energy diet the lowest LWG was obtained (group 5) (Table 3).

The average LWG during finisher period when the rabbits were switched to control diet(LE) or high energy diet(HE) was significant different ($P<0.05$) between diets groups,while feeding high energy diet improved gains more than of low energy diet (Table 3). The average daily FC for rabbits fed were highly significantly different ($P<0.01$) between low energy-high fiber (control diet) and high energy diet (HE) (Table 3). The average FCR for rabbits fed were highly significantly different ($p<0.01$) between low energy-high fiber (control diet) and high energy diet(HE) (Table 3).. It is worthy noting that high energy-low fiber diets experimental groups were more efficient than control groups. No mortality occurred during the finisher period when fed high fiber low energy diets while for the groups fed low fiber-high energy diets mortalty was 12.5, 12.5, 33.3 and 25% for groups 2, 4, 6 and 8, respectively.

Digestibility and nutritive values of the experimental diets:

The apparent digestibilities of DM, OM, CP, CF and NFE for starter-grower diets were significantly different ($P<0.05$ or $P<0.01$) as shown in Table 4. Diet 4 recorded a higher value than diets 1, 2 and 3. Digestible crude protein (DCP) values in diets 1, 2, 3 and 4 were significantly different ($P<0.05$) showing lower values for diet 1 while diet 4 had the best values for DCP. The total digestible nutrient (TDN) and digestible energy (DE Kcal/kg) were significant ($P<0.01$), and higher for groups 4, 3, 2 and 1 respectively. Apparent digestibility of DM, OM, CP, CF and NFE of the finisher diets were significantly different ($P<0.01$) or ($P<0.05$) as shown in Table 4. The higher values were obtained with diet 5 while diet 1 recorded the lowest ones. The digestible crude protein (DCP) values for diet 1 and 5 were significantly different ($P<0.05$) being 13.03% for diet 5 and 12.17% for diet 1. The total digestible nutritive (TDN) and digestible energy (DE kcal/kg) were significantly different ($P<0.01$) for diet 1 and 5. These results indicated that low fiber high energy concentration with/without copper sulfate improved digestibility and nutritive values Aboul- Ela et,al (1996) found that digestibility and nutritive values were decreased with the increase of crude fiber in starter or finisher diets.

Stomach pH:

The stomach pH values at 4 weeks of age were high being 5.42 ± 0.65-5.68 ± 0.72 without being significantly different among treatments. Copper sulphate supplementation presented important significant differences ($P<0.05$) among treatments at 6 weeks of age. Rabbits fed on control diets supplemented with copper sulphate (T2) recorded the lowest pH values while those of T3 fed on control diet without copper supplementation recorded the highest pH value. During the finisher period the stomach pH values were similar as shown in table 5.

Table 3: Effect of modification diet-on rabbits performance during finisher period (7-12 Weeks of age).

Item	T1		T2		T3		T4		Sig.
	G1	G2	G3	G4	G5	G6	G7	G8	
	LE	HE	LE	HE	LE	HE	LE	HE	
	X±SE	X±SE	X±SE	X±SE	X±SE	X±SE	X±SE	X±SE	
Final body weight, g	1970.0b±19.06	2048ab±20.8	2130a±22.5	2165a±18.4	1892b±15.3	1921b±15.3	1902b±22.4	2070ab±22.2	*
%	100	102.5	107.0	108.9	100	100.5	100.53	109.4	
Daily live weight gain,	23.64ab±2.82	26.3ab±1.67	26.96a±0.72	28.12a±0.81	23.16b±1.22	24.71b±1.19	23.75b±1.27	27.14a±1.05	*
g	94.1a±3.51	87.32ab±3.6	95.71a±2.02	95.05a±2.25	86.16ab±2.61	74.62c±1.34	93.1a±3.45	83.86b±4.29	**
Feed intake (g/day)	100	92.8	101.7	101	100	86.6	108.1	97.3	
%	3.98a±0.54	3.32bc±0.19	3.55abc±0.32	3.38abc±0.2	3.72abc±0.22	3.02c±0.18	3.92ab±0.40	3.09c±0.08	**
Feed conversion	100	83.42	89.2	84.92	100	81.2	105.4	83.1	
%	-	12.5	-	12.5	-	33.3	-	25	
Mortality rate, %									

See table 2 LE, HE: low or high energy diet (diet 1 and 5).

Table (4) : Influence of fiber and energetic concentration on digestibility of starter-finisher diets compounds in (New x Cal) rabbits.

Diet No.	Apparent digestion coefficients %						Nutritive values		
	DM	OM	CP	EE	CF	NFE	DCP%	TDN%	DE Kcal/kg
Starter diets:									
Diet 1	55.85b±0.9	58.82b±0.33	70.26b±0.64	74.22b±0.42	31.56b±1.2	65.85b±0.77	12.17b±0.09	54.77b±0.07	2435b±20.22
Diet 2	58.67b±0.55	61.26b±0.29	73.57ab±0.49	75.56b±0.63	36.95a±0.98	68.55b±0.62	12.74b±0.05	57.59b±0.04	2559b±15.87
Diet 3	73.49a±0.49	75.48a±0.30	75.97b±0.33	84.59a±0.51	37.74a±0.88	79.88a±0.82	13.23a±082	67.74a±0.5	2991a±21.13
Diet 4	74.53a±0.32	75.8a±0.21	76.89a±0.30	86.98a±0.52	39.59a±0.90	80.98a±0.41	13.39a±040	68.81a±0.42	3038a±25.2
Sig.	**	**	*	*	*	*	*	**	**
Finisher diet:									
Diet 5	70.41a±0.82	71.21a±0.23	75.86a±0.62	83.98a±0.99	35.67a±1.2	76.84a±0.81	13.03a0.66	67.61a±0.88	2997a±12.11
Diet 1	55.85b±0.9	58.82b±0.33	70.26b±0.30	74.22b±0.42	31.56b±0.42	65.85b±0.77	12.17b±0.09	54.77b±0.07	2435b±20.22
Sig.	**	**	*	*	*	*	*	**	**

a.b and c Means within the same column showing different letter are significantly different($P<0.05$) (within each period).* ($P<0.05$) ** ($P<0.01$).

Conclusion: The weaning diets could be formulated to reduce post-weaning mortality rate and enteritis. Also in our experiment the starter period (4-6 weeks) was the most critical period for producing enteritis. The copper sulfate supplement with the high fiber - low energy diet improved the performance but not with low fiber -high energy diet (during starter period) while in case of finisher period growth performance improved with high energy -low fiber diets. The stomach pH values were decreased after weaning and the versus with increasing age.

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Table 5. pH values of stomach during starter and finisher periods.

	Starter period		Finisher period				
Items	4 wk	6 wk	Finisher diet	7 wk	8 wk	10 wk	12 wk
T1	5.42±0.65	3.51[a]±0.17	D1(G1)	2.65±0.25	2.12±0.26	1.41±0.84	1.20±0.60
			D5(G2)	2.95±0.28	2.49±0.32	1.44±0.45	1.21±0.52
T2	5.68±0.75	2.97[b]±0.12	D1(G3)	2.45±0.18	2.05±0.42	1.31±0.90	1.10±063
			D5(G4)	2.63±0.22	2.41±0.22	1.36±0.80	1.11±050
T3	5.56±0.69	3.65[a]±0.22	D1(G5)	2.65±0.22	2.21±0.36	1.44±0.72	1.20±0.67
			D5(G6)	2.66±0.32	2.39±0.5	1.46±0.80	1.25±0.59
T4	5.65±0.72	3.45[a]±0.29	D1(G7)	2.80±0.15	2.20±1.1	1.43±0.72	1.19±0.60
			D5(G8)	2.72±0.31	2.43±0.95	1.45±0.80	1.24±0.49
Sig.	n.s	*		n.s	n.s	n.s	n.s

n.s.= non significant . * (P < 0.05). Means with different letters significantly differ (P<0.05)