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PERFORMANCE OF GROWING MALE RABBITS FED DIETS CONTAINING BANANA LEAVES AND YEAST CULTURE

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A factorial experiment (5×2) was conducted to evaluate the effects of using dried banana leaves (BL) in rabbit diets with or without yeast culture (YC) supplementation on growth performance, nutrients digestibility and carcass traits of male New Zealand White (NZW) rabbits. One hundred and twenty growing NZW male rabbits at 6 weeks of age were divided into 10 equal groups and housed in individual cages. Ten pelleted experimental diets were formulated to contain five levels of dried banana leaves (0, 10, 20, 25 and 30%), with yeast culture (Diamond V) at levels of 0 and 4 g/kg diet. Each group of rabbits was fed on one of ten experimental diets from 6 up to 14 weeks of age. The traits studied were live body weight, feed intake, feed conversion, protein and energy utilization, performance index, economic efficiency, nutrient digestibility, carcass traits and certain measurements of digestive tract segments and some blood parameters.

Regarding to the use of banana leaf levels, digestibility of nutrients was not affected by feeding the BL-levels with the exception of crude fiber digestibility which was significantly (P≤0.01) higher for rabbits fed the BL-containing diets than for the control rabbits. BL-containing diets showed significantly (P≤0.01) higher means of daily feed intake. When dietary level of BL reached 30%, significantly (P≤0.05) inferior means were recorded in feed conversion, protein efficiency ratio and efficiency of energy utilization than in the control diet. During the experimental period (6-14 weeks of age), economic efficiency values were significantly (P≤0.01) higher for rabbits fed 20-30% BL in their diets than in the control group. However, feeding the BL-diets showed no significant effects on live body weight, daily weight gain, performance index, carcass traits or blood constituents of rabbits. Similarly, feeding the BL-diets exerted no significant effect on the measurements of alimentary tract of rabbits, except on the cecum length which were greater significantly in rabbits fed 20-30 the BL-diets than that of the control.

With the use of YC levels, the economic efficiency values decreased significantly (P≤0.01), while those of live body weight, daily *weight gain, daily feed intake and performance index were increased in response to dietary YC supplementation. However, feeding the YC-supplemented diets produced no significant effects on nutrient digestibility, feed conversion, protein efficiency ratio, and efficiency of energy utilization, blood constituents or alimentary tract measurements. BL and YC were not interrelated for all criteria measured in the present study. From the previous results, it can be concluded that dried banana leaves can safely be used with good growth performance, carcass traits and economic efficiency in complete pelleted rabbit diets up to 25% alone or at 30% plus yeast culture.*

Key words: Banana leaves, carcass traits digestibility, yeast culture.

Domestic rabbits possess high potential to produce animal protein for human consumption with relatively cheap cost due to their high ability for utilization of wide range of fibrous feeds and agricultural by-products in addition to grains. It is well known that there is a great shortage of animal feedstuffs, especially clover hay, due to decreasing its cultivation area as a result of the competition between human and animal for foods and feeds. Therefore, there is a need to seek for cheap and available alternative sources of uncommon agricultural wastes to be used in rabbit feeding.

About 23,400 feddans are cultivated with banana plants in Egypt. Pruning and cut leaves of banana plants can yield about 12 tons DM/feddan annually, without any economical utilization. There are limited reports in the literature concerning the use of banana leaves in rabbit feeding. Fomunyam (1985) evaluated the effects of incorporating banana leaves at 30% in rabbit diets as sun dried, fresh, or their combination on growth performance of rabbits. He found that dietary treatments had no adverse effects on weight gain of rabbits but daily feed intake was significantly higher for animals fed fresh leaves compared to those fed both fresh and dry leaves. Gidenne (1986) indicated the possibility of feeding the growing rabbits on fresh whole banana plant up to 32% of total dry matter consumption without any adverse effect on the performance.

Yeast culture (*Saccharomyces cerevisiae*) is rich in protein, energy and many essential amino acids, particularly lysine. Therefore, it could serve as a complementary ingredient. Furthermore, yeast culture, which has undergone controlled fermentation, contains large amounts of metabolites with some viable yeast cells (Miles and Bootwella, 1991). Such components of yeast culture inhibit harmful bacteria, alter microbial metabolism and decrease intestinal pH and so can be used as probiotics, which can enhance animal and poultry production (Makled, 1991; Miles and Bootwella, 1991). However, the utilization of such yeast cultures is varied among animal species (Savage and Mirosh, 1990). Mode of action of yeast as growth promoter in poultry diets has been recently identified. Stanley *et al.* (1993) attributed the beneficial effect of yeast to its effectiveness in counteracting aflatoxins or reducing aflatoxicosis in the small intestine. Onifade *et al.* (1999) studied the effects of dietary supplementation with a pure culture of *Saccharomyces cerevisiae* up to 3.0 g/kg on growth performance, blood composition and clinical enzyme activities in serum of rabbits. They found that yeast addition significantly improved growth performance, reduced serum cholesterol and maintained the serum enzymes at normal ranges.

The present study designed to investigate the effects of including graded levels of banana leaves in rabbit diets with or without yeast culture (Diamond V) supplementation on growth performance, digestibility of nutrients, economic efficiency, carcass traits, and blood plasma constituents.

MATERIALS AND METHODS

The experimental work was carried out at the Rabbit Production Unit, Abo-Gridah Agricultural Research Center which belongs to Faculty of Agriculture, Mansoura University, Mansoura, Egypt. One hundred and twenty males of growing New Zealand White rabbits (NZW) at 6 weeks of age were divided into 10 groups of 12 animals each. All groups had approximately equal means of initial live body weight (from 837.1-846.7 g). Each group of rabbits was fed on one of ten experimental diets. Ten pelleted experimental diets were formulated to contain five levels of dried banana leaves (0, 10, 20, 25 and 30%) with yeast culture (Diamond V) at levels of 0 and 4 g/kg diet. Diamond V is a yeast culture imported by Bio Tech Company (El-Shrok City) from USA. The composition and proximate analyses of the experimental diets are presented in Table 1. The determined chemical composition of banana leaves was 83.87, 16.13, 8.92, 30.65, 3.23 and 41.07% for organic matter, ash, crude protein, crude fiber, ether extract and nitrogen free extract, respectively on dry matter basis. The yeast culture contains 12% crude protein, 3% crude fat and 6.5% crude fiber as well as its digestible energy was 3040 kcal/kg.

The rabbits were individually housed in two tiers galvanized wire flat cages in well-ventilated pens. Each cage measured 45×45×35 cm and supplied by a feeder and a stainless steel nipple for drinking. Fresh water and pelleted diets were offered *ad libitum* throughout the whole experimental period from 6 to 14 weeks of age. No heating or artificial lighting was applied in the rearing pen. The experimental rabbits were kept under the same managerial and hygienic conditions.

Weekly live body weight and feed intake were recorded on an individual basis. During the experimental period, live body weight, feed

Table 1: Formulation and chemical composition of the experimental diets containing different levels of banana leaves with or without yeast culture

Ingredients (%)	Banana leaves level (BL) ۞									
	0. 0% Control		10%		20%		25%		30%	
		+YC		+YC		+YC		+YC		+YC
	(B1Y1)	(B1Y2)	(B2Y1)	(B2Y2)	(B3Y1)	(B3Y2)	(B4Y1)	(B4Y2)	(B5Y1)	(B5Y2)
Yellow corn	4.5	4.1	6.0	5.6	7.5	7.1	7.48	7.08	7.78	7.38
Soybean meal (44)	9.0	9.0	12.6	12.6	16.2	16.2	18.0	18.0	19.7	19.7
Wheat bran	23.0	23.0	16.0	16.0	13.3	13.3	10.0	10.0	8.0	8.0
Barley	25.0	25.0	25.0	25.0	23.0	23.0	24.0	24.0	24.0	24.0
Clover hay	33.5	33.5	25.4	25.4	15.0	15.0	10.5	10.5	5.5	5.5
Banana leaves	-----	-----	10.0	10.0	20.0	20.0	25.0	25.0	30.0	30.0
Yeast culture	-----	0.4	----	0.4	----	0.4	----	0.4	----	0.4
Molasses	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Dicalcium P.	-----	----	----	----	----	----	0.2	0.2	0.2	0.2
Limestone	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.8	0.8	0.8
Common salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Premix*	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
DL-methionine	0.2	0.2	0.2	0.2	0.2	0.2	0.22	0.22	0.22	0.22
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated analysis (on air dry basis):**										
DE; kcal/kg	2705	2703	2708	2706	2706	2705	2707	2706	2706	2705
Crude protein, %	17.01	17.02	17.03	17.04	17.04	17.05	17.05	17.07	17.04	17.05
Crude fiber, %	12.86	12.88	13.11	13.13	13.12	13.14	13.19	13.21	13.22	13.24
Ether extract , %	2.51	2.51	2.42	2.41	2.42	2.41	2.35	2.35	2.33	2.33
Calcium, %	0.91	0.91	0.93	0.93	0.91	0.91	0.88	0.88	0.87	0.88
Total P, %	0.52	0.52	0.45	0.46	0.43	0.43	0.43	0.44	0.41	0.42
TDN, %	60.70	60.70	62.00	61.60	62.33	62.31	62.20	62.76	63.16	63.14
Lysine, %	0.82	0.82	0.82	0.82	0.81	0.81	0.81	0.81	0.80	0.80
Methionine, %	0.40	0.40	0.40	0.40	0.40	0.40	0.42	0.42	0.42	0.42
Meth.+Cys., %	0.68	0.69	0.67	0.67	0.66	0.66	0.67	0.67	0.66	0.66
Price /kg diet (LE)[1]	1.04	1.15	0.99	1.10	0.94	1.05	0.92	1.04	0.90	1.01
Chemical analysis on dry matter basis:										
DM, %	90.88	90.88	90.25	90.25	90.38	90.38	91.01	91.01	91.00	91.00
OM, %	89.82	89.82	89.06	89.06	87.83	87.83	87.64	87.64	87.51	87.51
CP, %	18.62	18.65	18.76	18.78	18.76	18.77	18.64	18.63	18.87	18.59
CF, %	14.33	14.43	14.59	14.63	14.72	14.68	14.64	14.69	14.70	14.75
EE, %	2.47	2.59	2.77	2.68	2.49	2.40	2.42	2.45	2.47	2.51
NFE, %	54.40	54.15	52.94	52.97	51.86	51.98	51.94	51.87	51.77	51.66
Ash, %	10.18	10.18	10.94	10.94	12.17	12.17	12.36	12.36	12.49	12.49
DE, kcal/kg**	2768	2789	2779	2789	2789	2777	2725	2729	2720	2800

* **Each kilogram contains:** Vit A, 2000000 IU; Vit D_3, 150000 IU; Vit E, 8.33 g; Vit K, 0.33 g; Vit B_1, 1.0 g; Vit B_2, 1.09; Vit B_6, 0.33 g; Vit B_{12}, 1.7 mg; Vit B_5, 8.33 g; Pantothenic acid, 3.33 g; Niacin, 8.33 g; Biotin, 33 mg; Folic acid, 0.83 g; Choline chloride, 20 g; Zn, 11.79 g; Fe, 12.5 g; Cu, 0.5 g; Co, 1.33 mg; Se, 16.6 mg; Mg, 66.79 mg and Mn, 5 g.

** These values were calculated according to NRC (1977) except for BL which was calculated according to its determined chemical analysis.

[1]: The price of one kg of diet was calculated according to the prevailing market prices of feed ingredients during the experimental period.

۞: BL= Banana leaves; B1, B2, B3, B4 and B5= Banana leaves level (0.0, 10, 20, 25 and 30%); Y1 and Y2= Yeast culture (YC) levels (0.0 and 4 g/kg diet), respectively.

intake and feed conversion ratio (g feed/g gain) were determined weekly. Protein efficiency ratio (PER) was calculated as Weight gain (g) / Crude protein consumed (g). Efficiency of energy utilization (EEU) was calculated as the Digestible energy consumed (kcal)/Weight gain (g). Performance index (PI) was calculated as Live body weight (kg) ×100/ Feed conversion according to North (1981). Feed cost/kg gain (LE) was calculated as the Feed conversion value × Price of one kg diet.

Economic efficiency was calculated as follows: Economic efficiency = [(Price of one kg weight gain – Feed cost/kg gain) / Feed cost/kg gain)] × 100. The selling price of one kg weight gain was considered to be 12.0 LE.

During the last week of the experiment, ten digestibility trials were carried out according to the European reference method for rabbits (Perez *et al.*, 1995). Apparent nutrient digestibility (AND) was calculated as follows:

AND=[(Total nutrient intake–Total nutrient in feces) / (Total nutrient intake)] × 100.

Digestible energy (DE) was calculated according to Schiemann *et al.* (1972), as follows:

DE (kcal/kg) = 5.28 (DCP g/kg) + 9.51 (DEE g/kg) + 4.20 (DCF g/kg) – 4.20 (DNFE g/kg).

Total digestible nutrients (TDN) were calculated according to the classical formula of Cheeke *et al.* (1982), as follows:

TDN% = % DCP + % DCF + % DNFE + % DEE × 2.25.

Where: DCP = Digestible crude protein, DEE = Digestible ether extract, DCF = Digestible crude fiber and DNFE = Digestible nitrogen free extract.

Diets and feces were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF), and ash according to AOAC (1980). At the end of the experiment, four male rabbits from each treatment were randomly chosen and slaughtered after fasting for 18 hours. Rabbits were weighed before slaughtering, then, they were skinned and emptied. The weights of hot carcass, liver, heart, abdominal fat and head were recorded. The weights of head and kidneys were included in carcass weight. The total edible parts consisted of the carcass with head, liver, heart, abdominal fat and kidneys. Fur and blood losses, stomach weight (empty) and weight and length of cecum and small and large intestines were also measured.

Four blood samples were taken from each experimental group of rabbits at slaughtering in heparinized test tubes. One part of each sample was used for the determination of blood hemoglobin. The remaining blood samples were centrifuged for separating blood plasma. The concentrations of plasma glucose, total protein, total lipids and cholesterol were determined using commercial kits. Activities of GOT and GPT were also determined colorimetrically by commercial kits.

A factorial design (5×2) was performed using statistical software program (Statgraphics, Version 5.0 STSC Rockville, 1991). A multi-factors analysis of variance was used to estimate the significant differences among means of the tested criteria. Differences were considered significant at P≤0.05.

RESULTS

Apparent digestibility of nutrients:

Level of BL insignificantly affected the digestibility of DM, OM, CP, EE and NFE; except CF digestibility which was significantly improved (Table 2). The rabbits fed 10% BL-diets showed slightly better, but not significant digestibility values of these nutrients than those of the control diet. On the other hand, the NFE digestibility decreased slightly by BL inclusion at any level, except diets containing 10% BL, which was nearly similar to that of the control group. The inclusion of BL in rabbit diets at levels of 10, 20, 25 and 30% resulted in improvement of the nutrient digestibility by about 4.1, 3.3, 4.2 and 4.9% for CP and by about 10.9, 22.9, 14.7 and 21.9% for CF, respectively as compared with the control group. Although the YC supplementation showed no significant effects on digestibility of all nutrients, it was observed that the rabbits fed the YC supplemented diets slightly surpassed those fed the control diet for all nutrients and the improvements were considerable in OM and CF, being 2.3 and 5.5%, respectively. Although the interactions between the level of BL and YC supplementation were not significant for the digestibility of all nutrients, it was observed that YC supplementation had, in general, positive effects with all BL levels.

Live body weight and daily weight gain:

Data in Table 3 show that inclusion of BL in the diet of rabbits at any level from 0.0 up to 30% had no significant effect on live body weight or daily weight gain during the experimental period (from 6 to 14 weeks of age). The yeast culture (YC) supplementation affected significantly (P≤0.01) live body weight and daily weight gain during the experimental period. The improvement was clear in final body weight and daily weight gain during the whole experimental period of the study (6-14 weeks of age). The rabbits fed diets containing yeast culture gained more (P≤0.01) than those fed the un-supplemented diets. The interaction effect between levels of BL and YC was non-significant on live body weight or weight gain, during the entire experimental period (6-14 weeks of age).

Table 2: Digestibility of nutrients for 14-wk-old NZW male rabbits as affected by feeding BL-containing diets with or without yeast culture and their interactions

Treatments	Digestibility of nutrients %					
	DM	OM	CP	EE	CF	NFE
Banana leaves level % (B):						
B1 0.0	67.36	67.16	72.09	74.21	51.23^{c}	69.36
B2 10	69.01	68.80	75.06	74.59	56.83^{b}	69.59
B3 20	67.74	67.42	74.47	73.32	62.95^{a}	65.85
B4 25	68.00	67.37	75.13	73.92	58.74^{ab}	66.72
B5 30	68.72	68.29	75.65	73.21	62.43^{a}	67.06
SEM	**0.89**	**0.84**	**0.96**	**1.29**	**1.85**	**1.25**
Significance[1]	**NS**	**NS**	**NS**	**NS**	**	**NS**
Yeast culture level g/kg (Y):						
Y1 0.0	67.57	67.04	73.86	73.36	56.86	67.10
Y2 4.0	68.77	68.58	75.10	74.34	60.01	68.33
SEM	**0.57**	**0.53**	**0.61**	**0.82**	**1.17**	**0.79**
Significance[1]	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interactions (B Y):						
B1Y1	67.18	66.89	71.60	76.22	53.06	68.51
B1Y2	67.55	67.41	72.58	72.19	49.41	70.20
B2Y1	67.92	67.32	74.31	74.84	53.33	68.29
B2Y2	70.10	70.28	75.79	74.33	60.32	70.88
B3Y1	66.66	66.38	72.81	69.92	62.38	65.02
B3Y2	68.81	68.45	76.12	76.72	63.52	66.68
B4Y1	68.11	67.33	74.75	74.41	55.36	67.72
B4Y2	67.90	67.41	75.51	73.44	62.11	65.72
B5Y1	67.95	67.26	75.81	71.42	60.16	65.96
B5Y2	69.48	69.33	75.48	74.99	64.71	68.17
SEM	1.27	1.19	1.36	1.84	2.62	1.77
Significance[1]	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

a-c: For each of the main factors, means within each column having different superscripts are significantly different ($P \leq 0.05$). 1: NS= Not significant; ** Significant at $P \leq 0.01$.

Daily feed intake:

Inclusion of BL in the diet of rabbits at any level increased significantly ($P \leq 0.01$) daily feed intake during the experimental period (6-14 weeks of age). Rabbits fed diets containing 10, 20, 25 and 30% BL consumed more feed than the control by about 5.1, 5.7, 3.4 and 7.4%, respectively (Table 3). Yeast culture supplementation (4g / kg diet) resulted in significant ($P \leq 0.01$) increase in daily feed intake for rabbits by about 2.7%, comparing with the non-supplemented animals. The interaction between the level of BL and YC with regard to daily feed intake was not significant (Table 3).

Feed conversion ratio (g feed/g gain):

Throughout the whole experimental period (6-14 weeks of age), the rabbits

Table 3: Body weight, daily weight gain, daily feed intake and feed conversion ratio of NZW male rabbits as affected by feeding BL-containing diets with or without yeast culture and their interactions

Treatments	Initial body weight, g (6 wks)	Final body weight, g (14 wks)	Daily weight gain, g (6-14 wks)	Daily feed intake (g) (6-14 wks)	Feed conversion ratio (g:g) (6-14 wks)
Banana leaves level % (B):					
B1 0.0	846.7	2366.0	27.13	113.48^{c}	4.20^{a}
B2 10	840.0	2397.7	27.82	119.26^{ab}	4.31^{a}
B3 20	841.5	2390.0	27.65	120.01^{ab}	4.35^{ab}
B4 25	844.8	2370.2	27.24	117.29^{b}	4.32^{a}
B5 30	839.8	2370.6	27.34	121.86^{a}	4.49^{b}
SEM	**13.0**	**30.99**	**0.53**	**1.22**	**0.06**
Significance[1]	**NS**	**NS**	**NS**	**	*
Yeast culture level g/kg (Y):					
Y1 0.0	843.4	2342.6^{b}	26.77^{b}	116.79^{b}	4.38
Y2 4.0	841.7	2415.3^{a}	28.09^{a}	119.97^{a}	4.29
SEM	**8.23**	**19.60**	**0.34**	**0.77**	**0.04**
Significance[1]	**NS**	**	**	**	**NS**
Interactions (BY):					
B1Y1	846.7	2281.7	25.63	108.59	4.26
B1Y2	846.7	2450.4	28.64	118.36	4.15
B2Y1	839.6	2376.7	27.45	118.03	4.32
B2Y2	840.4	2418.8	28.18	120.48	4.31
B3Y1	842.9	2352.1	26.95	119.55	4.45
B3Y2	840.0	2427.9	28.36	120.48	4.26
B4Y1	845.4	2340.8	26.70	114.68	4.30
B4Y2	844.2	2399.6	27.78	119.92	4.35
B5Y1	842.5	2361.7	27.13	123.15	4.57
B5Y2	837.1	2379.6	27.54	120.58	4.42
SEM	**18.40**	**43.83**	**0.75**	**1.73**	**0.08**
Significance[1]	**NS**	**NS**	**NS**	**NS**	**NS**

a-b: For each of the main factors, means within each column having different superscripts are significantly different ($P \leq 0.05$).

1: NS= Not significant; *= Significant at $P \leq 0.05$; ** Significant at $P \leq 0.01$.

fed diet containing 30% BL achieved significantly ($P \leq 0.05$) the worst feed conversion value among all the experimental groups. Yeast culture supplemented rabbits showed slightly insignificant better value of feed conversion than that of the non-supplemented groups. The interaction between dietary BL level and YC supplementation regarding the feed conversion through the whole experimental period was not significant (Table 3).

Protein efficiency ratio (PER):

Rabbits fed the BL-diets had less PER values ($P \leq 0.05$) than that of the control by about 2.1, 3.6, 2.9 and 6.4% for the 10, 20, 25 and 30% BL-diets, respectively during the whole period of study (6-14 weeks of age). The rabbits fed diets supplemented with YC showed insignificant slightly better value of PER than that of the non-supplemented rabbits (Table 4). Differences due to the interaction between BL and YC in PER were not significant.

Efficiency of energy utilization (EEU):

Incorporating BL into rabbit diets at levels of 10, 20, 25 and 30% increased the amount of DE required to gain one unit of live weight during the whole experimental period compared with the control by about 2.6, 3.5, 2.9 and 7.0%, respectively (Table 4). It was noticed that the rabbits fed 30% BL were the poorest ($P \leq 0.05$) among the experimental treatments in EEU.

During the experimental period (6-14 weeks of age), the supplementation of diets with YC resulted in insignificant slightly better values of EEU than those of rabbits fed the non-supplemented diets. The interaction between BL and YC with respect to EEU was not significant.

Performance index (PI):

During the whole experimental period the PI decreased gradually with elevating the level of BL in the diets from 0.0 up to 30%, without significant differences among them (Table 4). The YC supplementation to the diets of rabbits showed positive effect ($P \leq 0.05$) on PI values, where they improved by about 5.4%. The effect of the interaction between the dietary BL and YC in respect to PI was not significant. Generally, it was observed that YC supplementation had positive effect with all dietary BL levels, but the more evident improvement was recorded with the BL levels of 20, 30 and 10% in a decreasing order in comparison to the non-supplemented group.

Economic efficiency:

The economic efficiency differences due to BL level in the diet were significant ($P \leq 0.01$) during the period from 6 to 14 weeks of age (Table 4). It was also observed that all BL treatments had better values of economic efficiency except for 10% BL. The improvements in economic efficiency than the control at the whole experimental period were about 3.7, 9.8, 14.2 and 12.1% for rabbits fed 10, 20, 25 and 30% BL in their diets, respectively. The experimental groups fed diets containing BL at level of 25 and 30% surpassed the other experimental groups in economic efficiency. Feeding the YC supplemented diets significantly ($P \leq 0.01$) decreased the economic efficiency of rabbits by about 13.2% in comparison to the non-supplemented group. The effects of the interaction between the levels of BL and YC supplementation in respect to economic efficiency were not significant.

Carcass traits:

The dietary level of BL had no significant effect on the percent of abdominal fat, carcass and total edible parts of rabbits at 14 weeks of age

Table 4: Protein efficiency ratio (PER), efficiency of energy utilization (EEU), performance index (PI), economic efficiency and carcass traits of NZW male rabbits as affected by feeding BL-containing diets with or without yeast culture and their interactions

Treatments	PER (g:g) 6-14 wks	EEU (kcal:g) 6-14 wks	PI (%) 6-14 wks	Economic efficiency (%) 6-14 wks	*Carcass traits at 14 weeks of age♀* Fasted live wt. (g)	Abdominal fat %	Carcass wt. %	*Total edible parts %¤*
Banana leaves level % (B):								
B1 0.0	1.40a	11.37^{a}	56.71	162.28^{c}	2329.4	0.77	50.21	60.03
B2 10	1.37ab	11.67^{a}	56.08	168.29^{bc}	2281.9	0.73	50.76	60.88
B3 20	1.35bc	11.77^{ab}	55.12	178.23^{ab}	2251.3	0.79	50.86	61.06
B4 25	1.36ab	11.70^{a}	55.11	185.35^{a}	2350.0	0.69	51.21	60.97
B5 30	1.31c	12.17^{b}	53.34	181.92^{a}	2338.1	0.77	49.87	59.60
SEM	**0.02**	**0.16**	**1.38**	**3.71**	**28.85**	**0.06**	**0.77**	**0.79**
Significance[1]	*	*	NS	**	NS	NS	NS	NS
Yeast culture level g/kg (Y):								
Y1 0.0	1.35	11.85	.83^{b}	187.63^{a}	2306.8	0.70	50.92	60.73
Y2 4.0	1.37	11.62	56.71^{a}	162.80^{b}	2313.5	0.79	50.25	60.29
SEM	**0.01**	**0.10**	**0.87**	**2.35**	**18.25**	**0.04**	**0.49**	**0.49**
Significance[1]	NS	NS	*	**	NS	NS	NS	NS
Interactions (BY):								
B1Y1	1.39	11.52	53.98	172.22	2361.3	0.61	50.46	60.29
B1Y2	1.42	11.22	59.43	152.34	2297.5	0.93	49.96	59.77
B2Y1	1.36	11.69	55.38	181.61	2277.5	0.69	50.45	60.47
B2Y2	1.37	11.65	56.78	154.96	2286.3	0.76	51.08	61.29
B3Y1	1.32	12.04	53.07	187.59	2216.3	0.78	52.09	62.03
B3Y2	1.38	11.51	57.16	168.87	2286.3	0.81	49.64	60.09
B4Y1	1.37	11.64	54.54	203.73	2306.3	0.75	52.32	62.23
B4Y2	1.36	11.76	55.68	166.97	2393.8	0.63	50.09	59.71
B5Y1	1.29	12.38	52.17	192.99	2372.5	0.69	49.26	58.60
B5Y2	1.34	11.96	54.51	170.85	2303.8	0.84	50.48	60.59
SEM	**0.03**	**0.23**	**1.95**	**5.25**	**40.81**	**0.08**	**1.09**	**1.11**
Significance[1]	NS	NS	NS	NS	NS	NS	NS	NS

♀: all carcass traits were calculated relative to pre slaughter fast live weight.
¤: Total edible parts consisted of the carcass with head, liver, heart, abdominal fat and kidneys.
a-c: For each of the main factors, means within each column having different superscripts are significantly different ($P \leq 0.05$).
1: NS= Not significant; *= Significant at $P \leq 0.05$; ** Significant at $P \leq 0.01$.

(Table 4). The total edible parts ranged between 59.60 and 61.06% for all groups. This means that banana leaves inclusion in rabbit diets up to 30% of the diet had no detrimental effects on all carcass traits especially the total edible parts percentage. The supplementation of the diet by the yeast culture had no obvious effects on the studied carcass traits where the supplemented and non-supplemented groups had nearly equal values of carcass traits. The interactions between the level of BL and YC supplementation in respect of carcass traits were not significant, where the effect of YC supplementation did not differ among dietary treatments.

Blood constituents:

Values of some blood constituents (hemoglobin, total protein, glucose, total lipids, cholesterol, GOT and GPT) as affected by BL level and YC supplementation in the diets are shown in Table 5. The level of dietary BL had no significant effects on all studied blood constituents at 14 weeks of age. In addition, the YC supplementation to rabbit diet did not significantly affect all blood parameters measured in the present study. The interactions between the BL and YC with respect to studied blood constituents were not significant.

Alimentary tract measurements:

Measurements of some alimentary tract segments as affected by BL level and YC supplementation in the diets at 14 weeks of age are shown in Table 6. The dietary level of BL had no effects on the empty weights of stomach, small intestine, large intestine and cecum with appendix. The cecum lengths of the groups fed on 10, 20, 25 and 30% BL-containing diets were longer than that of the control group by about 2.6, 11.0, 11.5 and 12.5%, respectively. The supplementation of the diet with YC did not show any pronounced effect on the measurements of all alimentary tract segments at 14 weeks of age. Also, the interactions between the dietary levels of BL and YC supplementation in respect to the measurements of alimentary tract segments were not significant.

DISCUSSION

Digestibility of nutrients was not affected by feeding the BL-diets with the exception of crude fiber digestibility which was significantly high for rabbits fed the BL-containing diets. Rabbits fed the BL-containing diets displayed significantly higher daily feed intake. When dietary level of BL reached 30%, significantly inferior means were recorded in feed conversion, protein conversion ratio and efficiency of energy utilization than in the control diet. During the experimental period, economic efficiency values were significantly higher for rabbits fed 20-30% BL in their diets when compared with the control group. However, feeding the BL-diets had no significant effects on live body weight, daily weight gain, performance index, carcass traits or blood constituents of rabbits. Similarly, feeding the BL-diets exerted no significant effect on the measurements of alimentary tract of rabbits, except on significant greater cecum length of rabbits fed 20-30% BL-diets. The higher

Table 5: Some blood constituents for 14-wk-old male NZW rabbits as affected by feeding BL-containing diets with or without yeast culture and their interactions

Treatments	Criteria						
	Hemoglobin, g/dl	Total protein, g/dl	Glucose, mg/dl	Total lipids, g/l	Cholesterol, mg/dl	GOT, U/l	GPT, U/l
Banana leaves level % (B):							
B1 0.0	9.75	6.41	127.13	3.18	75.11	15.00	13.38
B2 10	9.56	6.43	139.63	3.67	70.96	17.38	14.25
B3 20	9.44	6.51	127.50	3.17	62.68	17.88	16.13
B4 25	9.13	6.74	132.38	3.13	62.15	16.50	14.63
B5 30	10.19	6.38	130.75	2.96	62.90	14.50	15.00
SEM	**0.27**	**0.20**	**6.05**	**0.27**	**4.38**	**1.47**	**1.28**
Significance[1]	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Yeast culture level g/kg (Y):							
Y1 0.0	9.80	6.35	134.25	3.16	67.58	16.50	14.75
Y2 4.0	9.43	6.63	128.70	3.29	65.94	16.00	14.60
SEM	**0.17**	**0.13**	**3.83**	**0.17**	**2.77**	**0.93**	**0.81**
Significance[1]	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interactions (BY):							
B1Y1	9.63	6.61	129.00	3.34	81.78	14.25	12.75
B1Y2	9.88	6.20	125.25	3.03	68.45	15.75	14.00
B2Y1	10.00	6.19	144.50	3.77	65.68	18.50	15.25
B2Y2	9.13	6.67	134.75	3.58	76.25	16.25	13.25
B3Y1	9.50	6.55	134.50	2.95	65.38	19.50	16.75
B3Y2	9.38	6.46	120.50	3.40	59.98	16.25	15.50
B4Y1	9.50	6.34	131.50	2.76	60.60	15.75	13.75
B4Y2	8.75	7.13	133.25	3.49	63.70	17.25	15.50
B5Y1	10.38	6.07	131.75	2.97	64.48	14.50	15.25
B5Y2	10.00	6.69	129.75	2.95	61.33	14.50	14.75
SEM	**0.38**	**0.29**	**8.56**	**0.39**	**6.20**	**2.08**	**1.81**
Significance[1]	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

1: NS= Not significant.

daily feed intake for rabbits fed the BL-diets compared with their control group might be related to presence of some dietary components which had positive effect on feed palatability and/or appetite of rabbits. The inferior feed conversion ratio of rabbits fed the diet containing 30% BL could be associated with their higher feed intake since body weight gains were not significantly different among all dietary treatments. Another contributing factor for the less efficient utilization of the 30%-BL-diet might be related to the crude fiber composition of BL. In this regard, Maertens and DeGroote (1984) reported that feeds of high cellulose and lignin contents generally have a crude fiber digestibility of less that 15% in rabbits whereas in non-lignified materials the digestibility of crude fiber can be as high as 60%. On the other hand, Martin *et al.* (1977) reported that banana leaves contain

Table 6: Measurements of some alimentary tract segments for 14-wk-old NZW male rabbits as affected by feeding BL-containing diets with or without yeast culture and their interactions

Treatments	Stomach	Small intestine		Large intestine		Cecum	
	Empty wt, g	Length, cm	Empty wt, g	Length, cm	Empty wt, g	Length, cm	Empty wt, g
Banana leaves level % (B):							
B1 0.0	24.84	365.13	38.85	124.00	24.70	47.88[b]	35.45
B2 10	24.64	365.50	40.56	116.13	24.01	49.13[b]	35.61
B3 20	23.21	345.25	37.58	112.75	21.73	53.13[a]	30.36
B4 25	24.84	358.75	34.79	126.00	24.39	53.38[a]	31.36
B5 30	26.63	370.13	40.94	126.38	27.21	53.88[a]	33.24
SEM	**1.18**	**12.04**	**1.61**	**5.64**	**1.73**	**1.32**	**1.63**
Significance[1]	**NS**	**NS**	**NS**	**NS**	**NS**	**	**NS**
Yeast culture level g/kg (Y):							
Y1 0.0	24.72	359.85	37.92	116.80	24.97	51.40	34.41
Y2 4.0	24.94	362.05	39.17	125.30	23.85	51.55	32.00
SEM	**0.74**	**7.61**	**1.02**	**3.56**	**1.09**	**0.83**	**1.03**
Significance[1]	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interactions (BY):							
B1Y1	26.28	371.25	38.23	118.50	27.23	48.25	36.80
B1Y2	23.40	359.00	39.48	129.50	22.18	47.50	34.10
B2Y1	24.88	379.50	41.95	114.25	24.78	48.25	37.60
B2Y2	24.40	351.50	39.18	118.00	23.25	50.00	33.63
B3Y1	23.88	333.00	32.63	97.00	20.60	52.75	28.80
B3Y2	22.55	357.50	42.53	128.50	22.85	53.50	31.93
B4Y1	24.20	361.50	35.00	122.75	26.65	52.75	33.03
B4Y2	25.48	356.00	34.58	129.25	22.13	54.00	29.70
B5Y1	24.38	354.00	41.78	131.50	25.60	55.00	35.83
B5Y2	28.88	386.25	40.10	121.25	28.83	52.75	30.65
SEM	**1.66**	**17.02**	**2.28**	**7.97**	**2.45**	**1.86**	**2.31**
Significance[1]	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

a-b: For each of the main factors, means within each column having different superscripts are significantly different ($P \leq 0.05$). 1: NS= Not significant; ** Significant at $P \leq 0.01$.

moderate levels of toxic oxalates, which may be involved in the poor efficiency of feed utilization. In addition, although the present experimental diets had similar contents of crude fiber and digestible energy the improved digestibility of crude fiber for the BL-containing diets might be related to some factors associated with fiber which may influence its utilization such as bulk density and water holding capacity, as suggested by Cheeke (1987). He also added that it is plausible that feed of the same fiber and energy contents, but differing in bulk density and swelling capacity, could have different transit rates through the digestive tract, and differentially affect feed intake via swelling effects on stomach capacity.

Although, little data has been published on feeding value of banana leaves for rabbits, the results in this study partially agree with those reported by Fomunyam (1985) who found that rabbits fed up to 30% fresh or sun dried banana leaves did not differ significantly in their body weight or weight gain when compared with their control group. Also, Gidenne (1986) indicated the possibility of feeding the growing rabbits on fresh whole banana plant up to 32% of total dry matter consumption without any adverse effect on the performance.

The beneficial effects of yeast culture in this study on weight gain, feed intake, performance index and economic efficiency are in harmony with those reported by Miles and Bootwella, (1991) who reported that yeast (*Saccharomyces cerevisiae*) culture is rich in protein, energy and many essential amino acids particularly lysine. Therefore, it could be serving as a complementary ingredient. Also, Makled (1991), Miles and Bootwella (1991) mentioned that such components of yeast culture inhibit the harmful bacteria, alter microbial metabolism and decrease intestinal pH and so can be used as probiotics which can enhance poultry production. Mode of action of yeast as growth promoter in poultry diets has been recently identified. Stanley *et al.* (1993) attributed the beneficial effect of yeast to its effectiveness in counteracting aflatoxins or reducing aflatoxicosis in the small intestine. In addition, Onifade *et al.* (1999) found that rabbits fed yeast culture at a level of 3 g/kg diet attained the heaviest body weight, consumed the highest quantity of feed and had best feed conversion comparing with the un-supplemented group. They found that yeast addition significantly improved growth performance, reduced serum cholesterol and maintained the serum enzymes at normal ranges.

The interactions between the level of banana leaves and yeast culture supplementation were not significant. This means that BL and YC were not interrelated for all criteria measured in the present study.

Conclusively, it can be concluded that dried banana leaves can safely be used with good growth performance, carcass traits and economic efficiency in complete pelleted rabbit diets up to 25% alone or 30% with yeast culture.

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أثر تغذية ذكور الأرانب النامية علي علائق محتوية علي أوراق الموز والخميرة

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تم تصميم تجربة عاملية (٥×٢) بهدف تقييم تأثير إضافة أوراق الموز المجففة إلي العلائق المدعمة أو غير المدعمة بالخميرة علي أداء النمو ومعاملات هضم العناصر الغذائية وصفات الذبيحة لذكور أرانب النيوزيلندي الأبيض النامية. أجريت هذه الدراسة علي عدد ١٢٠ أرنبا عمر ستة أسابيع قسمت إلي عشرة مجاميع تجريبية متساوية وسكنت في أقفاص فردية مزودة بالمعالف وحلمات للشرب في عنابر جيدة التهوية. تم تكوين عشرة علائق تجريبية (في صورة مضغوطة) تحتوي علي خمسة مستويات من أوراق الموز المجففة (صفر، ١٠، ٢٠، ٢٥، ٣٠%) واستخدمت الخميرة بمعدل صفر، أربعة جرامات/كجم من العليقة. تم تغذية كل مجموعة من الأرانب (١٢ أرنب) عل أحد هذه العلائق التجريبية العشرة من ٦ حتى ١٤ أسبوعا من العمر. وتم أخذ قياسات عن وزن الجسم واستهلاك الغذاء ومعامل التحويل الغذائي ومعامل الاستفادة من الروتين والطاقة ودليل اداء النمو والكفاءة الاقتصادية ومعاملات هضم العناصر الغذائية وصفات الذبيحة وبعض القياسات لبعض أجزاء القناة الهضمية وبعض مقاييس الدم.

وتتلخص أهم النتائج المتحصل عليها فيما يلي: بالنسبة لتأثير أوراق الموز:- لم تؤثر التغذية علي العلائق المحتوية علي أوراق الموز معنويا علي معاملات هضم العناصر الغذائية باستثناء تحسن معامل هضم الألياف الخام للأرانب التي غذيت علي تلك العلائق. كما سجلت الأرانب المغذاة علي العلائق المحتوية علي أوراق الموز متوسطات أعلي معنويا لاستهلاك الغذاء اليومي، بينما حققت التغذية علي العليقة المحتوية علي ٣٠% من أوراق الموز متوسطات أقل معنويا لكل من معامل التحويل الغذائي، معدل الاستفادة من البروتين وكفاءة استخدام الطاقة بالمقارنة بمتوسطات عليقة مجموعة المقارنة. سجلت العلائق المحتوية علي أوراق الموز بنسب تتراوح بين ٢٠ – ٣٠% كفاءة اقتصادية أفضل معنويا خلال فترة التجربة (٦-١٤أسبوعا من العمر) من نظيرتها لمجموعة المقارنة. لم تؤثر التغذية علي العلائق المحتوية علي أوراق الموز معنويا علي كل من وزن الأرانب، دليل أداء النمو، صفات الذبيحة أو مكونات الدم للأرانب. لم تؤثر التغذية علي العلائق المحتوية علي أوراق الموز معنويا علي قياسات القناة الهضمية باستثناء حدوث زيادة لطول الأعور للأرانب التي غذيت علي العلائق المحتوية علي أوراق الموز بنسب ٢٠ – ٣٠%.

بالنسبة لتأثير إضافة الخميرة:- أدت إضافة الخميرة إلي إنخفاض معنوي للكفاءة الإقتصادية بينما حدث تحسنا معنويا في كل من وزن الأرانب واستهلاك الغذاء ودليل أداء النمو. لم تؤثر التغذية علي العلائق المدعمة بالخميرة معنويا علي كل من معاملات هضم العناصر الغذائية، معامل التحويل الغذائي، معدل الاستفادة من البروتين وكفاءة إستخدام الطاقة ومكونات الدم وقياسات القناة الهضمية للأرانب بالمقارنة بمتوسطات عليقة مجموعة المقارنة. كذلك لم يكن للتفاعل بين مستويات أوراق الموز وإضافة الخميرة تأثيرا معنويا علي جميع الصفات المدروسة.

نستخلص من نتائج هذه الدراسة أنه يمكن إدخال أوراق الموز الجافة بشكل آمن في علائق الأرانب النامية حتي مستوي ٢٥% بمفرده أو ٣٠% مع إضافة الخميرة دون أي تأثيرات سلبية علي أداء النمو وصفات الذبيحة والكفاءة الاقتصادية.