

GROWTH TRAITS AND METABOLIC PROFILE OF NEW ZEALAND WHITE RABBITS FED ON MASH OR PELLETTED DIETS SUPPLEMENTED WITH A YEAST CULTURE

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ABSTRACT

This study aims to investigate the effect of feeding mash (T1) or pelleted (T2) diets supplemented with a pure broth culture of *Saccharomyces cerevisiae* on growth performance and metabolic activity of New Zealand White rabbits (NZW). Two trials were conducted using 42 NZW rabbits (18 in T1 and 24 in T2, respectively) of 6 weeks-old with 1.16 kg average live body weight. The treated diets were composed of the same ingredients of basal diet (D0) supplemented with 25% (D1) or 50% (D2) yeast culture (VW) in mash form of T1. The diets composed in pelleted form were the control (PD0) +10% wheat bran (WB) as (D3), PD0 +20% WB as (D4), PD0 +10% yeast-loaded WB, as (D5) and PD0 +20% yeast-loaded WB as (D6). The total counts of *Saccharomyces cerevisiae* culture in the treated diets D1, D2, D5 and D6 were 7.0×10^6 and 1.4×10^7 , 1.4×10^6 and 2.8×10^6 / ml, respectively.

Growth traits and efficiency of feed utilization were superior in treated groups of T2 over those of T1. Yeast culture treated diets realized a significant increase ($P < 0.05$) in daily weight gain and exhibited higher efficiency of feed utilization than untreated groups. Feed conversion and economic efficiency were optimized for D2 and D6 groups.

Estimates of total blood proteins or its fractions did not show any obvious changes due to type of ration. Feeding rabbits on the mash diet resulted in a significant ($P < 0.05$) elevation of blood glucose, increased activity of alkaline phosphatase, while significantly ($P < 0.05$) reduced the transaminases activity. Concentrations of blood total protein, albumin and creatinine were the minimum when feeding the rabbits on the basal diet (D0). Yeast culture treatments increased significantly ($P < 0.05$) the blood content of total protein, albumin, blood urea nitrogen, glucose and the activity of alkaline phosphatase. Group D6 had greater content ($P < 0.05$) of albumin and blood urea nitrogen as well as higher transaminases activity in comparison with other groups. It could be concluded that application of *Saccharomyces cerevisiae* have a vital role in improving nutritive value of rabbits diet hence promoting their metabolic activity and growth rate.

Keywords: NZW rabbits, Yeast culture, Growth, Metabolic profile.

INTRODUCTION

Probiotics are microbial preparations that are added to animal feed to colonize the gut hence improving digestive process. Probiotics are recently used as growth promoting substances in the livestock production industry. Providing live yeast culture and natural lactic acid producing bacteria to the digestive tract is known to improve digestibility of nutrients, hence increasing efficiency of feed conversion as well as weight gain of rabbits (Yamani *et al.*,

1992 and El Gaafary *et al.*, 1992). A disadvantage of most probiotics, is that it is killed by heat and so cannot be used in pelleted diets (Cheek, 1987).

Little attention was directed to study the effect of pure strains of yeast on growth performance of rabbits. The yeast culture *Saccharomyces Cerevisiae* has shown promising effect on increasing availability of nutrients for chickens and rabbits (Abou El-Ella *et al.*, 1996 and Hollister *et al.*, 1990). However, such effects have not been found consistent and differ due to nature of diets and method of application. On the other hand, assessment of metabolic activity is needed to explain the role of pure strains of yeast in nutrient utilization and growth modulation. Therefore, The objective of the present work is to investigate the impact of feeding mash or pelleted diets supplemented with a pure broth culture of *Saccharomyces cerevisiae* on growth performance and metabolic activity of New Zealand White rabbits.

MATERIALS AND METHODS

The present study was conducted at the experimental farm of By-products Utilization Research Department, Animal Production Research Institute.

Isolation and purification of the tested probiotic:

A pure strain of *Saccharomyces cerevisiae* was isolated from the commercial Baker's yeast using the serial dilutions technique and pour plate method using malt extract agar medium (Wickerham, 1951). Preparation of the yeast culture for experimental application was conducted according to the method described by Gomaa, (1995). The total count of the harvested culture was 2.8×10^5 CFU/ml.

Experimental treatments :

The experimental basal diet used in the present study composed of Yellow corn, 21.7%; clover hay, 30.0%; wheat bran, 27.0%; soybean, 14.5%; Molasses, 5.0%; limestone, 1.0%; salt, 0.4%; premix, 0.3% and methionine, 0.1%. The yeast culture of *Saccharomyces cerevisiae* was used in two feeding trials as follow:

Trial 1 :

The yeast culture was added immediately to a mash form diet which left at room temperature for drying. The treated diets were composed of the same ingredients of basal diet (D0) supplemented with 25% (D1) or 50% (D2) yeast culture (V/W). The total count of *Saccharomyces cerevisiae* in the treated diets (D1 and D2) reached 7.0×10^6 and 1.4×10^6 CFU/ ml, cosecutively.

Trial 2 :

The yeast culture was directly mixed with wheat bran, as a carrier at the rate of 60% of its water holding capacity. The yeast loaded wheat bran was left at room temperature for drying before feeding. Wheat bran as such (WB)

or yeast-loaded wheat bran (TWB) were added to the basal pelleted diet in two ratios i.e. 10% or 20% (w/w) to form the following treatments:

- Basal pellets diet +10%wheat bran, WB (D3)
- Basal pellets diet +20%wheat bran, WB (D4)
- Basal pellets diet +10%yeast-loaded wheat bran, TWB (D5)
- Basal pellets diet +20%yeast-loaded wheat bran, TWB (D6)

The total count of *Saccharomyces cerevisiae* in the treated diets (D5 and D6) were 1.4×10^6 and 2.8×10^6 CFU/ ml, in turn.

Experimental animals and management :

A total number of 42 New Zealand White rabbits (NZW) of 6 weeks-old with 1.16 kg average live body weight were used in the study. Eighteen growing rabbits were randomly divided in trial 1 into three experimental groups (six rabbits for each), whereas 24 growing rabbits were randomly divided in trial 2 into four experimental groups (six rabbits for each). The experimental animals were housed (three per cage) in metal galvanized cages under the same managerial conditions. The concentrate mixture was given in pelleted form to meet requirements for growth (NRC, 1977). The experimental diets were offered to rabbits *ad lib.* in a mash form (trial 1) or pelleted form (trial 2) and fresh water was automatically available all time by stainless steel nipples for each cage. The tested rabbits were weighed biweekly throughout the 10 weeks feeding trial. Daily weight gain, feed intake and feed conversion (feed/ gain) were recorded. Feeds and faeces samples were prepared and analyzed according to A.O.A.C. (1990). The proximate analysis of the various dietary treatments are shown in table (1).

Table (1): Proximate analysis of the experimental diets (on DM basis).

Treatments	DM%	Composition of DM (%)				
		OM	CP	CF	EE	NFE
Trial 1 (Mash diets)						
D0	91.21	93.77	16.16	15.18	1.44	60.99
D1	90.79	93.83	17.72	14.16	1.30	60.65
D2	91.06	94.28	18.75	13.48	1.51	60.54
Trial 2 (Pellet diets)						
D3	90.90	92.49	16.24	14.55	1.41	60.29
D4	90.09	92.88	16.81	13.80	1.36	60.91
D5	91.22	92.51	16.63	14.42	1.39	60.07
D6	91.52	92.13	18.20	13.03	1.46	59.44

Blood analysis:

Blood samples were collected from the experimental animals at biweekly intervals (at 8 a.m. before feeding) via orbital sinus of each rabbit into a heparinized capillary tubes. Blood plasma was used for the colorimetric determination of the following blood constituents: glucose, total protein, albumin, blood urea nitrogen (BUN), creatinine, aminotransferases (ALT & AST) and alkaline phosphatase. Ready made diagnostic kits were used for plasma analysis according to the procedure outlined by the manufacturer.

Statistical analysis

Statistical analysis was carried out using the General Linear Model program of SAS (1988). Data of growth traits and feed utilization were analyzed separately in each of trial 1 and 2 to detect the effect of treatment. The effects of treatment, week of feeding and type of diet were considered to analyze data concerning the studied blood metabolites.

RESULTS AND DISCUSSION

1- Chemical analysis of the experimental diets

The chemical analysis of various dietary treatments illustrated in table (1) showed that DM content of the treated diets of both trials 1 and 2 was approximately similar. However, in trial 1 crude protein content was slightly increased, whereas crude fiber content was slightly decreased in the yeast treated diets. In trial 2, a reasonable increase in CP was only observed for D6 treatment (supplemented with 20%TWB). On the other hand, slight differences were recorded between the dietary treatments for EE and NFE contents.

2- Growth performance of rabbits and efficiency of feed utilization :

As shown in table (2) the overall means of growth traits and efficiency of feed utilization pointed out the superiority of treated groups in trial 2 over those of trial 1. In this context, Cheek (1987) reported that growth is significantly improved when a pelleted diet is fed rather than meal. The final LBW and total gain of rabbits were maximized in groups D2 of trial 1 and D6 of trial 2. However, the maximum daily weight gain (DWG) and relative growth rate (RGR) were achieved only by group D6 while it were minimized by group D0 and D4. The promising values of DWG and RGR in D6 treatment may be attributed to the associative effect of yeast culture with the carrier material (wheat bran) as a substrate enriching nitrogenous content of the diet (Gomaa, 1995 and Hammad and Gomaa, 2001).

Generally, yeast culture treated diets within each trial realized significant increases ($P < 0.05$) in DWG when compared with the untreated ones. This finding is in accordance with Soliman et al. (2000) who confirmed that rabbits fed on the diet supplemented with yeast culture attained significantly the maximum DWG, feed conversion and the highest caecum microbial counts in comparison with other groups treated with flavomycin, zinc bacitracin, *Lactobacillus* or poultry formula.

Intake of DM was increased by 12.63% in trial 2 groups than those of trial 1 due to higher intake of groups D5 and D6. This observation may be referring to the high preference of rabbits for pelleted diets rather than mash diets (Cheek, 1987). It is noticeable that inclusion of the yeast culture in diets of both trials reduced DM intake required to produce unit of gain indicating higher efficiency of feed utilization. Some authors attributed the higher efficiency of feed utilization by yeast culture treatment to increased palatability of the diet (Maertens, 1992), improved digestibility of nutrients and the higher cecum content of total microbial, yeast and cellulose-decomposing

microorganisms counts (El-Adawy, 2000, Hammad and Gomaa, 2001 and Aziza and Gomaa, 2002). In the present work, feed conversion estimates were optimized for D2 and D6 groups, so that economic efficiency of production was the greatest for the same groups. The difference in economic efficiency of production between the mash and pelleted diets was partially referring to wheat bran addition in pelleted diets. Generally, supplementing the diet with yeast culture resulted in remarkable reduction in feed cost / kg live weight gain.

Table (2): Growth performance and efficiency of feed utilization by NZW rabbits as affected by various dietary treatments.

Item	Trial 1 (mash diets)			Overall mean	Trial 2 (pelleted diets)				Overall Mean
	D0	D1	D2		D3	D4	D5	D6	
No. of animals	6	6	6		6	6	6	6	
Initial LBW (g)	1108	1116	1263	1162	988	1353	1183	1060	1146
Final LBW (g)	2172	2377	2647	2399	2192	2642	2606	2732	2543
Total gain (g)	1064	1261	1384	1236	1204	1289	1423	1672	1397
DWG (g / day)	15.21 ^c	18.01 ^b	19.77 ^a	17.65	17.20 ^b	18.41 ^b	20.33 ^b	23.88 ^a	19.96
RGR % *	1.37	1.61	1.57	1.52	1.74	1.36	1.72	2.25	1.77
DM intake (g/h/d)	93.73 ^b	95.46 ^a	93.45 ^b	94.20	98.08 ^b	105.6 ^b	108.5 ^b	112.3 ^a	106.1
Feed conversion (DM intake/ gain)	6.23 a	5.38 b	4.78 c	5.46	5.97	6.08	5.54	4.72	5.58
Feed cost / kg gain L.E	3.72	3.29	3.04	3.35	4.23	4.47	3.98	3.49	4.04
Economic efficiency (%)	1.29	1.59	1.80	1.56	1.22	1.09	1.36	1.52	1.30

Means bearing different superscripts in the same raw within each trial are significantly ($P < 0.05$) different.

*Relative growth rate (RGR) was determined as the percentage of the daily weight gain (DWG) was divided by the initial live body weight (LBW).

3- Metabolic profile :

As shown in table (3) All of the studied blood metabolites were within the physiological normal values of the specie. Estimates of total blood proteins or its fractions did not show any obvious changes due to type of ration. Differences between subsequent weeks of rabbit age were only significant ($P < 0.01$) for concentrations of blood glucose and transaminases activity. However, It was observed that concentrations of blood proteins, BUN, as well as alkaline phosphatase activity were slightly increasing with advancement of rabbit age. In this concern, Ashour (2001) concluded that the peak of rabbits growth rate during 6-8 weeks of age, coincided with the greatest periodical increase in blood major metabolites, glucose and total protein. He found that values of total protein at 10 and 12 weeks of age of NZW male rabbits were 4.23 and 3.44 g/dl while those of glucose were 129.7 and 129.6 mg/dl, respectively.

Feeding rabbits on the mash diet resulted in a significant ($P < 0.05$) elevation of blood glucose, increased activity of alkaline phosphatase, while significantly ($P < 0.05$) reduced the transaminases activity in comparison with pelleted diets. It is worth mentioning that, addition of wheat bran in the non supplemented diets D3 and D4, elevated concentrations of BUN over that of the basal diet (D0) concomitant with a slight increase in blood protein and a sharp decrease in the activity of alkaline phosphatase.

Table (3): Least square means of some blood constituents of New Zealand White rabbits as affected by type of ration, week of feeding and dietary yeast culture supplementation.

Item	N	63	6.53	3.76	2.77	1.41	12.59	117.52	1.57	25.40	15.65	19.92
Overall mean	63	6.53	3.76	2.77	1.41	12.59	117.52	1.57	25.40	15.65	19.92	
Type of ration												
Pellets	36	6.55	3.74	2.81	1.39	12.61	110.35	1.63	25.89 ^a	16.23 ^a	17.70 ^b	
Mash	27	6.51	3.80	2.71	1.43	12.56	123.97	1.49	24.75 ^b	14.87 ^b	22.87 ^a	
± SE		0.09	0.06	0.08	0.06	12.61	9.52	1.50	0.30	0.29	0.32	
Weeks												
6	21	6.45	3.72	2.73	1.40	12.48	114.42	1.55	24.53 ^b	15.96	12.48	
10	21	6.58	3.78	2.80	1.39	12.65	117.65	1.63	25.55 ^{ab}	15.61	12.65	
14	21	6.57	3.79	2.78	1.43	12.64	120.77	1.53	26.14 ^a	15.38	12.64	
± SE		0.12	0.08	0.11	0.07	0.51	9.34	0.09	0.39	0.40	0.51	
Treatments												
D0	9	5.99 ^e	3.37 ^c	2.62 ^{bc}	1.31 ^{cd}	8.76 ^f	107.29 ^{cd}	2.08 ^a	24.53 ^{cd}	16.66 ^a	22.95 ^a	
D1	9	6.70 ^{bc}	4.11 ^a	2.59 ^c	1.62 ^b	14.05 ^b	124.24 ^{ab}	1.51 ^c	23.90 ^d	16.32 ^a	23.08 ^a	
D2	9	6.83 ^b	3.90 ^b	2.93 ^b	1.35 ^c	14.87 ^a	129.38 ^a	0.88 ^d	25.81 ^{bc}	11.64 ^b	22.57 ^a	
D3	9	6.23 ^{de}	3.42 ^c	2.82 ^{bc}	1.24 ^{cd}	10.52 ^e	90.84 ^e	1.54 ^c	24.05 ^d	16.54 ^a	15.80 ^c	
D4	9	6.19 ^{de}	3.50 ^c	2.69 ^{bc}	1.31 ^{cd}	11.63 ^d	106.15 ^{de}	1.56 ^c	24.78 ^{cd}	16.52 ^a	15.37 ^c	
D5	9	7.38 ^a	3.85 ^b	3.53 ^a	1.10 ^d	13.05 ^c	122.95 ^b	1.85 ^b	27.03 ^{ab}	15.85 ^a	19.65 ^b	
D6	9	6.42 ^{cd}	4.18 ^a	2.24 ^d	1.91 ^a	15.25 ^a	115.96 ^c	1.58 ^c	27.71 ^a	16.00 ^a	19.99 ^b	
± SE		0.10	0.06	0.11	0.08	0.19	10.11	0.06	0.44	0.26	0.35	
Significance ;												
Type of ration		NS	NS	NS	NS	NS	HS	NS	HS	HS	HS	HS
Weeks		NS	NS	NS	NS	NS	HS	NS	HS	HS	NS	NS
Treatments		HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS

Means bearing different superscripts in the same row are significantly (P < 0.05) different.

Regarding the effect of dietary treatments, the differences between treatments for all of the studied blood parameters were highly significant ($P < 0.01$). It was observed that concentrations of blood total protein and albumin were the minimum when feeding the rabbits on the basal diet (D0). Furthermore, D0 treatment had the lowest ($P < 0.05$) content of creatinine and the activity of AST. Generally, yeast culture treatments increased significantly ($P < 0.05$) the blood content of total protein, albumin, BUN, glucose and the activity of alkaline phosphatase. Among those treatments, the group D6 had greater content ($P < 0.05$) of albumin and BUN as well as higher transaminases activity in comparison with the other groups. This finding denotes acceleration of metabolic activity and protein turnover in particular due to yeast culture supplementation. These results were in agreement with those obtained by Soliman et al. (2000) who noticed greater values of blood creatinine, transaminases activity and alkaline phosphatase in yeast culture supplemented diets than the control ones. Also, El-Tantawy et al. (2001) found that Bouscat rabbits fed on *Lactobacillus* supplemented diets (2 or 4 g/kg diet) had higher plasma total protein, albumin and globulin than control group. In contrary, El-Gaafary et al. (1992) found that total lipids, ALT, AST, alkaline phosphatase and creatinine were not affected by *Lactobacillus* supplementation (1g/kg food) to pelleted diets, whereas total protein showed significant ($P < 0.05$) increase in *Lactobacillus* supplemented group.

CONCLUSION

According to the aforementioned results, yeast culture supplementation in rabbits diets generally realized significant increase in DWG, RGR and feed conversion of animals. Such effects were coincided with acceleration of metabolic activity and protein turnover due to yeast culture treatment. Furthermore, enclosure of the yeast culture (*Saccharomyces cerevisiae*, 2.8×10^6 CFU/ml) using 20% wheat bran as a carrier (group D6) maximized growth traits of rabbits and increased blood content of albumin as well as transaminases activity in comparison with the other groups. It could be concluded that application of *Saccharomyces cerevisiae* have a vital role in improving nutritive value of rabbits pelleted diet hence promoting their metabolic and growth rate. Therefore, replacement of the yeast loaded wheat bran as a part of the rabbits pellets diet is recommended. Further study is needed to assess the effect of applying greater doses of yeast culture to pelleted diets on rabbits performance.

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معايير النمو والتمثيل الغذائي في الأرناب النيوزيلندي المغذاة على العلائق
المجروشة أو المكعبات والمدعمة بمزرعة الخميرة
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أجريت تجربتان لدراسة تأثير التغذية بعلائق مجروشة (ت ١) أو مكعبات (ت ٢) مدعمة
بمزرعة نقية من الخميرة (*Saccharomyces cerevisiae*) على أداء النمو والتمثيل الغذائي
للأرناب النيوزيلندي. أستخدم في التجريبتين ت ١، ت ٢ على التوالي عدد ١٨، ٢٤ أرناب
نيوزيلندي عمر ٦ أسابيع ومتوسط وزن الجسم ١,١٦ كج. وتكونت علائق المعاملات في تجربة
العلف المجروش ت ١ من نفس مكونات العليقة الأساسية (معاملة د صفر) مدعمة بنسبة ٢٥%
(معاملة ١د) أو ٥٠% (معاملة ٢د) من الخميرة (حجم/ وزن). وتكونت علائق المعاملات في
تجربة علف المكعبات (ت ٢) من عليقة المكعبات الأساسية (م د صفر) + ١٠% نخالة (ق)
كمعاملة (٣د)، (م د صفر) + ٢٠% ق كمعاملة (٤د)، (م د صفر) + ١٠% ق مدعمة بالخميرة
كمعاملة (٥د)، (م د صفر) + ٢٠% ق مدعمة بالخميرة كمعاملة (٦د). كان عدد خلايا الخميرة
في العلائق المعاملة ١د، ٢د، ٥د، ٦د على التوالي ١٠*٧، ١٠*٤، ١٠*٤، ١٠*٤، ١٠*٤،
١٠*٢، ١٠*٢ وحدة مكونة لمستعمرة / مل.

تفوقت معايير النمو وكفاءة التحويل الغذائي في مجاميع التجربة ت ٢ عن التجربة ت ١.
العلائق المدعمة بالخميرة حققت زيادة معنوية (٠,٠٥) في معدل النمو اليومي وأظهرت كفاءة
تحويل غذائي أعلى من تلك غير المدعمة بالخميرة. تقديرات معامل التحويل الغذائي والكفاءة
الاقتصادية كانت الأمثل في معاملات ٢د، ٦د.

تقديرات بروتين الدم الكلية أو عناصر لم تظهر تغيرات واضحة بتأثير نوع العليقة. تغذية
الأرناب على العليقة المجروشة سببت زيادة معنوية في جلوكوز الدم وزيادة فى نشاط أنزيم
الفوسفاتيز القاعدى بينما قللت معنويا (مستوى ٥%) نشاط الأنزيمات الناقلة للأمين . المجموعة د
صفر التى تغذت على عليقة أساسية فقط أظهرت أقل القيم بالنسبة لبروتين الدم الكلى والألبومين
والكرياتينين. نتج عن معاملات الخميرة زيادة معنوية (مستوى ٥%) فى محتوى الدم من البروتين
الكلى والألبومين وأزوت اليوريا والجلوكوز ونشاط أنزيم الفوسفاتيز القاعدى. احتوى دم
المجموعة ٦د على تركيزات أعلى من الألبومين وأزوت اليوريا ونشاط أعلى للأنزيمات الناقلة
للأمين مقارنة بباقي المجموعات. ويمكن أستنتاج أن استخدام مزارع الخميرة النقية كان لسه دور
حيوى فى تحسين القيمة الغذائية لعلائق الأرناب وبالتالي تحفيز نشاط التمثيل الغذائى ومعدل نمو
الأرناب.