EFFECT OF FEED ADDITIVES ON DAILY GAIN, DIGESTION COEFFICIENTS, RUMIN FERMENTATION AND ECONOMIC EFFICIENCY OF FRIESIAN CALVES.

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SUMMARY

Twenty male Friesian calves 13 months old and a mean live body weight of 267.25 Kg were randomly divided into four similar groups (five for each group) to study the effects of adding Pro-Bio-Fair (yeast culture) and fenugreek seeds on growth performance, digestibility, rumen fermentation and economic efficiency of calves. The duration of the field study was 6 months. Treatments were: T_1 (control): concentrate feed mixture + berseem hay + rice straw, T_2: control ration + 10g Pro-Bio– Fair/ head/ day, T_3: control ration + 20g Pro-Bio-Fair / head day and T_4: control ration + 3% fenugreek seeds/ head/ day (as total diet DM). Results showed that T_3 had the highest TDNI, DCPI and SVI / head/ day while no significant differences were observed among treatments in DM, OM, CF and NFE digestibility. however T_3 was significantly higher in CP digestibility than T_1 and T_2. Ruminal pH in T_1 was significantly higher than that of the other groups. Ruminal NH_3 – N was non-significantly lower ($P>0.05$) in T_2, T_3 and T_4 than T_1. T_4 recorded the highest TVFA's while the lowest value was recorded with T_1. DM, TDN and SV conversion were non significantly different among groups. The highest average total gain, daily gain and economic efficiency were recorded for T_3.

Keywords: *Fenugreek, Pro-Bio-Fair, growth performance, Digestion, Rumen activity, Economic Efficiency, Friesian Calves.*

INTRODUCTION

One of the best methods to increase the production performance of farm animals is by improving their feed conversion especially if there is a shortage of animal feeds as in Egypt. Fenugreek is a leguminous plant cultivated in Egypt. Fenugreek seeds contain alcoholic compound which acts as an oxitocin hormone and has hypocolesterolemic and anti diabetic action (Petit *et al* 1995 and John & Sons, 1996), Fenugreek seeds also are rich in protein, fat and minerals (Ca, P, Fe, Zn and Mg) (James, 1984; Sharma, 1986; Gupta *et al* 1996 and Abo-Donia *et al* 2003).

Direct-fed microbes are feed additives that function as modifyers of rumen fermentation. The most important direct-fed microbial used in ruminant nutrition is a strain of yeast (*Saccharomyces cervaesae*) (Chiquette, 1995). Some results showed that supplementation of *Saccaromyces cervisia* into ruminant animals rations may improve weight gain (McLeod *et al* 1990 and El-Ashry *et al* 2001), feed intake (Adams *et al* 1981 and Hanafy, 1997) , digestion (Wiedmeier *et al* 1987) while anaerobic and cellulolytic bacteria increased rumen activity .(Harrison *et al* 1988).

The objective of the present study was to evaluate the effect of Pro-Bio-Fair and feugreek seeds supplementation on Friesian male calves' growth performance, digestibility and rumen fermentation .

MATERIALS AND METHODS

The present experiment was carried out at El-Karada Animal Experimental Station, Kafer El-Sheikh governorate, Animal Production Research Institute, Ministry of Agriculture.

Twenty Friesian male calves of about 13 months of age and a mean of 267.25 kg live body weight (LBW) were divided into four groups (five calves per group) according to their body weight.

The experimental treatment diets were as follows:

Treatment (1): control: concentrate feed mixture (60%, CFM) + berseem hay (20%) + rice straw (20%).

Treatment (2): control plus 10 g Pro-Bio-Fair / head/day.

Treatment (3): control plus 20 g Pro-Bio-Fair/ head/ day.

Treatment (4): Control plus 3% fenugreek seeds/ head/ day as DM).

The chemical composition of feedstuffs used for formulation of the experimental rations are presented in Table (1) .

Animals were housed (During the experimental period) in semi-open pens and were fed individually. The CFM was offered twice daily at 8 a.m. and 3 p.m., berseem hay was given daily at 11a.m. and rice straw was given once daily subsequent to berseem hay. Rice straw and CFM were adjusted monthly according to changes in animals fasting live body weight. Fresh water was offered twice daily post feeding in the morning and in the afternoon.

At the end of the experimental period, a digestibility trial was conducted. Three animals from each experimental group were used to carry out the digestibility trials using Grab sample method was used and acid insoluble ash was applied as an internal marker. Samples of feeds and feces were collected two times daily for five days and analyzed according to A.O.A.C. (1995). The digestibility coefficient of certain nutrients was calculated.

Table (1): Chemical composition of the concentrate feed mixture, berseem hay and rice straw (% of DM basis).

Feedstuffs	DM	On DM basis %					
		OM	CP	CF	EE	Ash	NFE
CFM	91.03	88.45	12.77	25.05	1.54	11.55	49.09
Berseem hay	92.09	84.13	9.44	39.29	1.03	15.87	34.37
Rice straw	88.98	88.14	3.7	38.55	1.19	11.86	44.7

Concentrate feed mixture consisted of yellow corn 30%, cotton seed cake 20%, wheat bran 12%, rice bran 16%, soybean cake 16%, molasses 3%, lime stone 2% and salt 1%.

Mineral blocks (38% Na, 5.5% Ca ,4.12% P ,0.55% Mg, 0.25% Mn, 0.3% Fe, 0.03% I ,0.03% Cu ,0.01% Co, presented as free choice. Animals were fed to cover the requirements of growing calves according to (NRC, 1984).

Three animals from each experimental group (the same animals used in the digestibility trials) were used to collect rumen liquor at the start of the study then at two months intervals. Samples were collected 3 and 6 hrs post morning feeding. About 200 ml of rumen liquor was collected from each animal using a stomach tube attached to an automatic suction machine. The rumen liquor was strained through four layers of cheese cloth and divided into two portions: one for the immediate determination of pH using digital pH meter (Orion research model 680) and NH_3-N. The second portion was reserved with 2 ml toluene, 2 ml paraphen oil and a few drops of saturated mercuric chloride solution to stop micro-organisms activity it was stored at -20°C until total volatile fatty acids determination by steam distillation was carried out as described by Abou-Akkada and El-Shazly (1964). Feed conversion for animals in each group was calculated as the number of kilograms of dry matter (DM), total digestible nutrients (TDN), digestible crude protein (DCP) and starch value (SV) needed to produce one kilogram gain in weight. The economical efficiency (EC) was estimated using the following formula.

EC= Price of weight gain, LE/ cost of feed consumed, LE

The data was analyzed statistically according to SAS (1988). The Duncan's multiple range test was used to test the significance between means (Duncan, 1955).

RESULTS AND DISCUSSION

Feed intake:

Data presented in Table (2) shows that the low and high levels of Pro-Bio-Fair and Fenugreek supplementations had no significant effects on DMI relative to the control group. The DCPI was increased ($P<0.05$) by the addition of the high level of Pro-Bio-Fair compared with the low level and the control. Calves that received rations supplemented with Fenugreek had similar DCPI like T_2 and T_1. These results are in agreement with those of Mutsvangwa (1992) and El-Sharkawy (2006) who reported that more yeast addition had no effect on DMI .However DCPI significantly increased with more yeast. Our data are in agreement with Allam *et al* (1999) and El-Saadany (1999) who reported no significant effects of fenugreek addition on DMI and TDNI. The results showed a gradual increase in DMI, TDNI, DCPI and SVI as time progressed, which was possibly related to the increase in animal requirements as a result of increasing live body weight.

Table (2): Effect of treatment diets on feed intake of Friesian calves fed the different experimental rations at different periods of the experiment.

Treatment	Traits			
	DMI (kg/ d)	TDNI (kg/ d)	DCPI (kg/ d)	SVI (kg/ d)
T_1	7.83 ± 0.30	5.08 ± 0.20	0.544^{b} ± 0.02	3.77 ± 0.15
T_2	7.80 ± 0.30	5.08 ± 0.20	0.543^{b} ± 0.02	3.77 ± 0.15
T_3	7.78 ± 0.27	5.24 ± 0.18	0.615^{a} ± 0.02	3.93 ± 0.13
T_4	7.77 ± 0.32	5.21 ± 0.21	0.581^{ab} ± 0.02	3.91 ± 0.16
Period				
0-time	6.59^{c} ± 0.10	4.35^{c} ± 0.07	0.483^{c} ± 0.01	3.25^{c} ± 0.06
2-months	7.81^{b} ± 0.12	5.16^{b} ± 0.08	0.572^{b} ± 0.01	3.85^{b} ± 0.06
4-months	8.99^{a} ± 0.13	5.94^{a} ± 0.09	0.658^{a} ± 0.01	4.43^{a} ± 0.07

a, b and c: means with different superscripts in the same column are significantly ($P < 0.05$) different. T1 : treatment 1; T 2 : treatment 2 ; T3 : treatment 3 ;T4:treatment4

Digestibility coefficient:

Results in Table (3) show that all treatments had similar DM, OM.CF and NFE digestion coefficients. Calves in T_3 group showed a tendency for higher values than the other groups. Also, T_3 recorded the highest ($P<0.05$) CP and EE digestibility values followed by T_4, T_2 and T_1. The increase in CP digestibility as a result of yeast culture addition was reported by Wiedmeier *et al* (1987). This improvement in digestibility values may be attributed to the fact that Pro-Bio-Fair contains yeast culture. Abo-Donia *et al*

(2003) reported that animals fed rations which contained fenugreek seed had higher EE digestibility compared with the monensin fed groups. The improvement in EE digestibility as a result of adding fenugreek seeds to the ration may be due to the high content of EE and fatty acids in fenugreek as well as the fatty acid constituents in fenugreek.

Table (3): Averages ±SE of digestibility coefficients and nutrients values of the different experimental rations.

Item	Treatments			
	T_1	T_2	T_3	T_4
Digestibility %				
DM	69.82±1.13	70.45±1.84	73.30±2.16	72.87±0.39
OM	72.20±1.43	72.32±1.95	74.79±2.16	74.53±0.43
CP	67.30^{b}±2.59	67.42^{b}±3.62	76.57^{a}±1.32	72.47^{ab}±1.54
CF	58.10±3.36	61.61±5.81	66.61±4.66	64.65±0.43
EE	78.91^{b}±1.80	81.25^{ab}±1.29	85.18^{a}±2.10	81.93^{ab}±1.60
NFE	80.63±0.70	79.25±0.10	78.81±1.32	80.43±0.44
Nutritive values %				
TDN	64.96±1.27	65.11±1.73	67.36±1.87	67.07±0.39
DCP	6.95^{b}±0.27	6.96^{b}±0.37	7.91^{a}±0.14	7.48^{ab}±0.16
SV	48.21±1.26	48.35±1.71	50.53±1.87	50.28±0.39

a and b: means with different superscripts in the same row or significantly (P<0.05).

Data in Table (3) shows non significant (P>0.05) differences among treatments in TDN and SV values. T_3 recorded the highest DCP value followed by T_4, T_2 and T_1.

Ruminal pH value:

Results presented in Table (4) indicated that the overall means of T_3 recorded the lowest (P<0.05) in ruminal pH values as compared to T_1 and T_2. Also there was a gradual decrease in ruminal pH values as the period progressed for all treatments. The maximum pH value (P<0.05) through all the different periods of the feeding trial were shown at zero hrs of feeding, while the lowest (P<0.05) were recorded at 3hrs post feeding and tended to increase (P<0.05) after 6 hrs post feeding. This can be attributed to the fermentation process by rumen microorganisms which took place on the soluble carbohydrate very soon producing more propionate, decreasing pH value, while fermentation of the structural carbohydrates needed more time to produce more acetate delaying the decrease of pH value (Nagah, 2002).

Ruminal ammonia-nitrogen concentration:

Data in Table (5) showed that non significant differences were observed during the entire period for all treatments.

Data indicated that NH_3-N concentration was minimum before feeding, and increased after feeding, it reached the peak 3 hrs post feeding than decreased at 6 hrs post feeding throughout all feeding trial period. These results are in good agreement with those obtained by, Khattab *et al* (1997) and El-Mekass (2002).

Table (4): Averages ± SE of ruminal pH of Friesian calves fed the different experimental rations at different periods of the experimental trial.

Treatments	Periods			
	0-time	2-months	4-months	Overall means
T_1	6.29 ± 0.11	6.32^{a} ± 0.12	6.28^{a} ± 0.10	6.30^{a} ± 0.06
T_2	6.25 ± 0.11	6.28^{ab} ± 0.14	6.24^{b} ± 0.11	6.25^{b} ± 0.07
T_3	6.30 ± 0.11	6.20^{b} ± 0.14	6.15^{c} ± 0.12	6.22^{c} ± 0.07
T_4	6.27 ± 0.11	6.24^{ab} ± 0.13	6.19^{c} ±0.11	6.23^{bc} ± 0.07
Overall means	6.28^{a} ± 0.05	6.26^{a} ±0.06	6.22^{b} ±0.05	6.25
Time of sampling				
0-hrs	6.72^{a} ± 0.02	6.76^{a} ± 0.01	6.64^{a} ± 0.01	6.71^{a} ± 0.01
3-hrs	5.99^{c} ± 0.02	5.92^{c} ± 0.02	5.91^{c} ± 0.03	5.94^{c} ± 0.01
6-hrs	6.13^{b} ± 0.02	6.09^{b} ± 0.03	6.11^{b} ± 0.02	6.11^{b} ± 0.01

a, b and c: means with different superscripts in the same column are significantly (P<0.05) different.T1: treatment 1 ; T2: treatment 2 ; T3: treatment 3 ;T4: treatment4

Table (5): Averages±SE of ruminal NH_3-N concentration (mg/100ml) of Friesian calves fed the different experimental rations at different periods of the experimental trial.

Treatments	Periods			
	0-time	2-months	4-months	Overall means
T_1	18.03 ± 0.71	18.09 ± 0.73	18.24 ± 0.80	18.12 ± 0.42
T_2	18.05 ± 0.73	17.80 ± 0.72	18.03 ± 0.75	17.96 ± 0.41
T_3	18.04 ± 0.73	17.33 ± 0.60	17.50 ± 0.58	17.63 ± 0.36
T_4	18.05 ± 0.73	17.38 ± 0.59	17.60 ±0.63	17.68 ± 0.38
Overall means	18.05 ± 0.35	17.65 ± 0.32	17.84 ± 0.34	
Time of sampling				
0-hrs	15.75^{c} ± 0.11	15.61^{c} ± 0.14	15.73^{c} ± 0.29	15.70^{c} ± 0.11
3-hrs	20.51^{a} ± 0.26	19.87^{a} ± 0.27	19.95^{a} ± 0.38	20.11^{a} ± 0.18
6-hrs	17.88^{b} ± 0.18	17.48^{b} ± 0.27	17.8^{b} ± 0.22	17.74^{b} ± 0.13

a, b and c: means with different superscripts in the same column are significantly (P < 0.05) different.

Lower ammonia concentrations in the rumen of animals fed Pro-Bio-Fair may reflect increased transportation of ammonia into microbial protein and it may be the direct result of stimulated microbial activity and increasing the bacterial growth (Newbold, 1990).

Ruminanl NH_3-N concentration decreased non-significantly with feeding Fenugreek seeds may give a best utilization of NH_3-N by rumen microbes as indicated by Saxena *et al* (1971).

Ruminal total volatile fatty acids (TVF's) concentrations:

Data presented in Table (6) showed a significant ($P<0.05$) elevation in ruminanl TVFA's concentration in all periods after feeding rations. Also there was a gradual ($P>0.05$) increase in ruminal TVFA's concentration as the period progressed. The ruminant TVFA's concentration of all ration reached the peak ($P<0.05$) after 3 hrs post feeding then declined after 6 hrs. feeding. The peak concentration observed at 3 hrs post feeding may be due to ample availability of nutrients and maximum fermentation activity during this time (Samy *et al* 1994). Mean values for TFFA's concentration are in line with the corresponding ruminal pH value at 3 hrs post feeding. These results are in agreement with those of Nagah (2002) and Sharkawy (2005). The higher TVFA's concentrations shown with Fenugreek might indicate a stimulated rumen microflora activity through , a) decrease in number and activity of antagonistic organisms and, b) saving some important micro factors to rumen micro-flora as micro-elements, vitamins, hormones, enzymes or unknown factors which are required for the efficient digestion, absorption and metabolism.

Table (6): Averages±SE of ruminal *total volatile fatty acids* TVFA's concentration (mg/100ml) of Frisian calves fed the different experimental rations at different periods of the experimental trial.

Treatments	Periods			
	0-time	2-months	4-months	Overall means
T_1	11.09 ± 0.35	$11.13^{c} \pm 0.38$	$11.19^{c} \pm 0.36$	$11.14^{c} \pm 0.20$
T_2	11.09 ± 0.36	$11.75^{b} \pm 0.50$	$11.85^{b} \pm 0.52$	$11.56^{b} \pm 0.27$
T_3	11.10 ± 0.38	$12.71^{a} \pm 070$	$12.76^{a} \pm 0.72$	$12.19^{a} \pm 0.38$
T_4	11.09 ± 0.37	$12.67^{a} \pm 0.68$	$12.71^{a} \pm 0.69$	$12.16^{a} \pm 0.36$
Overall means	$11.09^{b} \pm 0.17$	$12.07^{a} \pm 0.30$	$12.13^{a} \pm 0.30$	
Time of sampling				
0-hrs	$9.76^{b} \pm 0.13$	$9.86^{b} \pm 0.09$	$9.91^{b} \pm 0.11$	$9.84^{c} \pm 0.06$
3-hrs	$11.80^{a} \pm 0.08$	$13.23^{a} \pm 0.31$	$13.41^{a} \pm 0.32$	$12.81^{a} \pm 0.19$
6-hrs	$11.73^{a} \pm 0.14$	$13.10^{a} \pm 0.30$	$13.06^{a} \pm 0.29$	$12.63^{b} \pm 0.18$

a, b and c: means with different superscripts in the same column are significantly ($P<0.05$) different.T1: treatment 1 ; T2: treatment 2 ; T3: treatment 3 ;T4: treatment4 .

Body weight and weight gain:

Data in Table (7) indicated that the highest ($P>0.05$) values for total and daily gain were recorded for T_3 while the lowest values were recorded for T_1 ,with non significant differences. The average daily gain (ADG) in the second period was significantly higher than in P_1 and P_3 with no significant differences between P_1 and P_3. The previous results are in accordance with those obtained by Khattab *et al* (1997) and El-Ashry *et al* (2001) who reported that calves fed the supplemented yeast culture diets were always heavier than the control group at all intervals of the experimental periods. Also, Abo-Donia *et al* (2003)

observed that final body weight, total and daily weights were improved with Fenugreek supplementation.

Table (7): Averages (kg) ± SE of initial and final live body weight, total and daily body weight gain of Friesian calves fed the different experimental rations at different periods of the experimental trial.

Treatments	Body weight		Av. total gain, kg	Av. Daily gain, kg
	Av. initial, kg	Av. final, kg		
T_1	267.00 ± 11.79	454.60 ± 21.21	93.80 ± 13.32	1.042 ± 0.05
T_2	268.00 ± 9.03	467.20 ± 15.39	99.60 ± 13.47	1.107 ± 0.03
T_3	266.00 ± 8.86	479.60 ± 13.94	106.80 ± 14.64	1.187 ± 0.04
T_4	268.00 ± 14.54	479.40 ± 18.65	105.70 ± 14.24	1.175 ± 0.03
Periods				
0-2 months	267.25^{c} ± 5.19	331.75^{c} ± 5.86	64.50^{b} ± 2.38	1.075^{b} ± 0.04
2-4 months	331.75^{b} ± 5.86	405.25^{b} ± 6.85	73.50^{a} ± 2.03	1.225^{a} ± 0.03
4-6 months	405.25^{a} ± 6.85	470.20^{a} ± 8.38	64.95^{b} ± 2.55	1.082^{b} ± 0.04

a, b, c and d: means with different superscripts in the same column are significantly (P <0.05) different. T1: treatment 1 ; T2: treatment 2 ; T3: treatment 3 ;T4: treatment4

It is interesting to note that results of means for total and daily gain are in agreement with the results obtained in digestibility trials which showed that supplementation with Pro-Bio-Fair and Fenugreek seed improved the digestion coefficients of nutrients in most cases as compared with the control group.

Feed conversion and economic efficiency:

Data in Table (8) showed that calves fed rations supplemented with high levels of Pro-Bio-Fair were more efficient (P<0.05) in DM, TDN and SV conversions than those while received low levels of Pro-Bio-Fairs and the control groups. These results are in agreement with those obtained by El-Sharkawy (2006) who showed that the DM, TDN and DCP were decreased with more yeast/ kg gain. Data obtained data are in agreement with those of El-Hossieny *et al* (2000) who showed that Fenugreek addition insignificantly improved feed conversion as DM and TDN.

Table (8): Average of feed conversion and economical feed efficiency of the different experimental rations used during the experimental trial.

Item	Treatments			
	T_1	T_2	T_3	T_4
Feed conversion				
Kg DMI/ kg gain	7.51a±0.23	7.05ab±0.2	6.55b±0.13	6.62b±0.28
Kg TDNI/kg gain	4.88±0.15	4.59±0.13	4.41±0.09	4.44±0.19
Kg DCPI/kg gain	0.52±0.02	0.49±0.01	0.52±0.01	0.50±0.02
Kg SVI/ kg gain	3.62±0.11	3.41±0.10	3.31±0.07	3.33±0.14
Economical feed efficiency				
Av. Daily FI, as fed, kg/h/d				
Concentrate, kg	6.88	6.85	6.84	6.83
Berseem hay, kg	0.88	0.88	0.87	0.87
Rice straw, kg	0.85	0.85	0.84	0.84
Supplements, g	0.00	10.0	20.0	200.0
Av. Daily WG, Kg	1.04	1.11	1.19	1.17
Cost of feed consumed, LE	8.20	8.30	8.40	8.59
Price of WG, LW	14.59	15.49	16.61	16.44
Feed cost/ kg WG, LE (1)	7.87	7.50	7.08	7.32
Economical feed efficiency (2)	1.78	1.87	1.98	1.914
Economical feed efficiency(%)	100	105.05	111.24	107.31

(1): Based on price of the ingredients in the market during the experimental period (2005). The prices were: concentrate feed mixture 1100 (LE)/ ton, Bersem hay 600 (LE) / ton, rice straw 135 (LE)/ ton, Pro-Bio-Fair 15(LE)/kg, Fenugreek 2 (LE)/ kg and and price of 1 kg live weight 14 (LE)

(2): Economical efficiency= price of weight gain, LE/cost of feed consumed (LE).

DMI: dry matter intake ; DCPI: digestible crude protein intake; SVI: starch value intake; Av .Daily FI: average daily feed intake; Av Daily WG :average daily weight gain; price of WG,LW: price of weigh gain, live weigh .

Data of Table (8) showed that calves received high level of Pro-Bio-Fair (T3) recorded the lowest feed cost / kg weight gain values and achieved the best economic efficiency values followed by T4. This observation may be due to the higher body weight gain recorded by both treatments as compared with the other ones (T1 and T2). Obtained data are in agreement with Abo-Donia *et al.* (2003) who showed the best economical efficiency was achieved by Friesian calves fed Fenugreek supplemented rations.

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تأثير بعض الإضافات العلفية على معدلات النمو، معاملات الهضم ، مقاييس الكرش والكفاءة الاقتصادية لعجول الفريزيان

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تهدف هذه الدراسة إلى تأثير إضافة بروبيوفير (خميرة الخباز) وحبوب الحلبة لعليقة الحيوانات على الأداء الإنتاجي لعجول الفريزيان. استخدم في هذه الدراسة ٢٠ عجل فريزيان متوسط عمر ١٣ شهر ومتوسط وزن هى ٢٦٧,٢٥ كجم قسمت إلى ٤ مجاميع متساوية وكانت العلائق التجريبية المستخدمة كالتالي: معاملة (١): علقة مقارنة تتكون من علف مركز + دريس برسيم+ قش أرز. معاملة (٢): تتكون من عليقة مقارنة مضاف إليها ١٠ جرام بروبيوفير/ رأس/ يوم. معاملة (٣) عليقة مقارنة مضاف إليها ٢٠ جم بروبيوفير/ رأس/ يوم. معاملة (٤): عليقة مقارنة مضاف إليها ٣% حبوب حلبة/ رأس / يوم (كمادة جافة). وأوضحت النتائج ما يلي:

- أظهرت المجموعة الثالثة زيادة غير معنوية للمأكول اليومي من المركبات الغذائية المهضومة والبروتين المهضوم والقيمة النشوية بينما سجلت المجموعة الأولى والثانية أقل القيم.
- لم تظهر فروق معنوية بين المجاميع المختلفة في معاملات هضم المادة الجافة والمادة العضوية والألياف الخام والمستخلص الخالي من الأزوت، بينما تفوقت المجموعة الثالثة معنوياً في معامل هضم البروتين وذلك بالمقارنة بالمجموعتين الأولى والثانية.
- كانت درجة حموضة الكرش للمجموعة الأولى أعلى معنوياً من باقي المجاميع. انخفض تركيز أمونيا الكرش بدرجة غير معنوية في المجموعة الثانية والثالثة والرابعة بالمقارنة بالمجموعة الأولى: سجلت المجموعة الرابعة أعلى قيمة في تركيز الأحماض الدهنية الطيارة بينما كان أقل تركيز للمجموعة الأولى.
- تحسنت الكفاءة التحويلية لكل من المادة الجافة والمركبات الغذائية المهضومة والقيمة النشوية للمجموعة الثالثة بدرجة أعلى من باقي المجاميع.
- تفوقت المجموعة الثالثة في كل من معدلات النمو اليومية والكفاءة الاقتصادية على بقية المجاميع.

أوضحت نتائج الدراسة أنه يمكن إضافة ٢٠ جم بروبيوفير/ رأس/ يوم وذلك لتحسين كفاءة الهضم وزيادة معدلات النمو مما ينتج عنه أعلى عائد اقتصادي للمربي.