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Nutrient Digestibility and Growth Performance of Small Ruminants Fed on Date Palm Leaves Treated with Mono and Combined Enzymes

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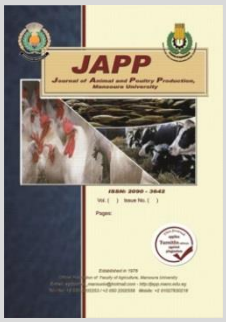

ABSTRACT

lambs performance, economic conversion, feed efficiency, rumen fermentation characteristics, rumen ciliate protozoa and bacteria counts, blood parameters, nutrients digestibility, nutritive value, nitrogen and water balance as affected by feeding date palm leaves supplemented with cellulase, fibrolytic enzymes or combination of each other were investigated in the current study. Thirty weaning Barki lambs (3-4 months old and 12.50 kg live body weight) were randomly divided into five groups (6 lambs each) to conduct growth trail followed by digestibility trail. Lambs received five treatments: T(1):Concentrate feed mixture (CFM) + berseem hay (BH) (control), T(2): CFM + untreated DPL + BH, T(3): CFM + DPL incubated with cellulase enzyme + BH, T(4): CFM + DPL incubated with Fibrolytic enzyme + BH, T(5): CFM + DPL incubated with cellulase and fibrolytic enzymes+ BH. Concentrate: roughage ratio was 50: 50%, DPL: BH ratio was 40: 10%. Enzymes supplementation improved lambs performance, whereas T5, T4 and T3 increased (P<0.05) feed intake, live body weight, total and daily gain, economic conversion and feed efficiency compared with T2. Also, lambs received T5, T4 and T3 showed better concentrations of rumen fermentation products, rumen microbes and blood serum parameters more than T2. All nutrients, digestibility, nutritive values and nitrogen balance significantly (P<0.05) improved as compared with T2. The results of treatments supplemented with enzymes were close to the results of control. Feeding date palm leaves treated with cellulase, fibrolytic enzymes or combination of each at ratio of 40 % from roughage had positive effect on lambs performance.

Keywords: lambs performance, date palm leaves, enzymes.

INTRODUCTION

Agricultural by-products are known as lignocellulosic materials; in general, there are problems of feeding agricultural by-products to farm animals including their low protein content, high crud fiber, low digestibility coefficients and the presence of anti-nutrimental factors such as tannins and alkaloids (Kholif *et al*., 2005). It is important to destroy the linkage between cellulose, hemicellulose and lignin of cell wall of these by-products or destroy the compact nature of its tissues to improve its digestibility and nutritive value. Biological treatments are from the attempts that have been to do that by using yeast, fungi, bacteria or enzymes.

The biodegradation of cellulose by cellulase enzyme that produced by numerous micro-organisms is very important in several improvements of agricultural by-products (Das and Singh, 2004; Haight, 2005). Enzymes supplementation is often accompanied by increasing palatability of the diet due to the release of sugars by fiber hydrolysis, which may increase feed intake by animal. Also, enzymes supplementation increased digestion rate and extent of digestion in the rumen (Krueger *et al*., 2008), enhanced microbial colonization in the rumen by increasing numbers of ruminal fibrolytic microbes (Morgavi *et al*., 2000; Nsereko *et al*., 2000) thus increasing degradation rate of fiber in the rumen (Giraldo *et al*., 2008), microbial protein synthesis (Yang *et al*., 1999; Nsereko *et al*., 2002). Gado *et al*. (2007 and 2009) found an improvement in nutrient digestibility, nitrogen balance and ruminal fermentations by using exogenous enzyme mixture.

Date palm tree annually produces approximately 20 kg of leaves thus it can add to the feeds of livestock. Bahman *et al*. (1997) have concluded that date palm leaves could be used as an acceptable alternative to barley straw for feeding goats and cows. Date palm leaves has been used in the total mixed rations for lambs (Valizade *et al*., 2011) and dairy goats (Salahi *et al*., 2011). It is necessary to make attempts to establish the potential of date palm leaves as an alternative source of livestock feed.

The present study was conducted to investigate the effect of feeding date palm leaves supplemented with cellulase, fibrolytic enzymes or combination of each on lambs performance, economic conversion, feed efficiency, rumen fermentation characteristics, rumen ciliate protozoa and bacteria counts, some blood parameters, nutrients digestibility, nutritive value and nitrogen balance.

MATERIALS AND METHODS

The field experiments were carried out at Ras Sudr Experimental Research Station, Desert Research Center, located in Southern Sinai Governorate, Egypt, from February to July (2019). Green date palm leaves were pruning at October, (2018) and chopped to 2-3 cm then air-dried for 15 day to reach 10-15% moisture then packed till used. A growth and digestibility trails were conducted to investigate the effect of feeding control and diets contained

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untreated date palm leaves or incubated with mono and combined enzymes on growing lambs' performance, profit analysis, feed efficiency, rumen fermentations and microbes, some blood components, digestibility coefficients, nutritive values, nitrogen balance.

Growth trials:

Thirty weaning Barki ewe lambs about 3-4 months old and 12.50 kg live body weight were used in this experiment. Lambs were randomly divided into five groups of 6 lambs each and received five diets as follow:

T (1): Concentrate feed mixture (CFM) + berseem hay (BH) (Control).

T (2): CFM + untreated DPL + BH.

T (3): CFM + DPL treated with Cellulase enzyme +BH.

T (4): CFM + DPL treated with Fibrolytic enzyme + BH.

T (5): CFM + DPL treated with Cellulase and fibrolytic enzymes+ BH.

Concentrate: roughage ratio was 50: 50%, DPL: BH ratio was 40: 10%.

All animals were fed their daily diets free in feedlot according to average body weight, which was changing every two weeks. The concentrate and roughage were offered twice daily at 7 am and 1 pm. The offered and the refusals were weighted daily and the animals were weighted every two weeks. Fresh water had excess to the animals twice daily at 8 am and 2 pm. This experiment lasted for 180 days. Chemical compositions of feedstuffs, date palm leaves untreated or incubated with enzymes, control and experimental treatments are presented in Table (1).

Table 1. Chemical composition (%) of feedstuffs, date palm leaves untreated or incubated with enzymes and experimental treatments.

Items	Feedstuffs						Treatments				
	CFM	BH	UDPL	CDPL	FDPL	CFDPL	T1	T2	T3	T4	T5
DM	92.66	90.61	92.74	94.36	93.89	94.14	91.75	92.44	93.10	93.28	93.83
OM	91.68	89.34	88.24	93.46	93.40	93.44	89.79	90.78	91.62	91.88	91.82
Ash	8.32	10.66	11.76	6.54	6.60	6.56	10.21	9.22	8.38	8.12	8.18
EE	2.20	1.95	0.92	1.88	1.90	1.94	2.32	2.10	2.30	2.62	2.72
CP	11.84	13.27	5.26	14.12	14.24	14.46	12.63	9.22	12.98	13.82	14.10
CF	10.40	25.13	40.76	16.82	16.74	16.62	18.39	24.31	16.45	15.66	14.92
NFE	67.24	48.99	41.30	60.64	60.52	60.42	56.45	55.15	59.89	59.78	60.08
NDF	29.34	59.69	59.11	40.13	39.12	39.62	44.91	44.81	36.86	36.77	35.71
ADF	16.06	42.27	41.88	28.87	28.23	28.10	29.88	29.76	23.75	23.18	22.18
ADL	6.87	6.53	21.87	7.14	7.10	6.86	7.11	12.71	7.30	7.11	7.00
Cellulose	9.19	35.74	20.01	21.73	21.13	21.24	22.77	17.05	16.45	16.07	15.18
Hemicellulose	13.28	17.42	17.23	11.26	10.89	11.52	15.03	15.05	13.11	13.59	13.53

CFM: concentrate feed mixture, BH: berseem hay, UDPL: Untreated date palm leaves, CDPL: DPL incubated with cellulase enzyme, FDPL: DPL incubated with fibrolytic enzyme, CFDPL: DPL incubated with cellulase and fibrolytic enzymes.

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme +BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

Digestibility trails:

At the end of the growing trail, four lambs from each treatment were randomly chosen and used in digestibility trial to determine nutrients digestibility, nutritive value, nitrogen balance and water utilization. Lambs were placed in metabolic cages for 20 days, the first 15 days were considered as an adaptation and preliminary period, the last 5 days were as collection period. The daily amount of feed consumed, residuals, feces, urine and drinking water were estimated for each animal during the collection period. Lambs through the experiments were fed their daily ration according to their live body weight according to Kearl (1982).

Laboratory analysis:

Feeds and feces were determined according to the AOAC (1995). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent leginin (ADL) were determined according to the procedures of Van Soest (1994). Quantitative analysis of total phenols (TP), total condensed tannins (TCT) and total tannins (TT) were estimated using Folin Ciocalteau reaction (Makkar *et al*., 1993).

Rumen liquor parameters and microbes:

Samples of rumen liquor were collected at the end of each month at 4 hours post feeding from the six lambs of each treatment. pH was immediately measured using a digital pH meter. Total volatile fatty acids were estimated according to Warner (1964). Total nitrogen, non-protein nitrogen and ammonia nitrogen concentrations was determined using the methods of AOAC (1995), true protein nitrogen was calculated (TN-NPN). Ruminal microbial protein was estimated as described by Makkar *et al*. (1982).

Description by Dehority (1993) used to publish the identification of genera and species of ruminal ciliate protozoa, while it's counts were determined using the method described by Ogimoto and Imai (1981). Dilution series were prepared under O_2 –free CO_2 by the anaerobic method of Bryant (1972) using the anaerobic diluents described by Mann (1968) to determine total number of bacteria and cellulolytic bacteria number.

Analysis of blood sampling:

Blood samples were collected at the end of each month at 4 hours post-feeding from the six lambs of each treatment. Total protein was determined by using electronic apparatus, albumin was analyzed according to Doumas and Biggs (1971) and globulin was calculated by subtracting. Patton and Crouch (1977) method was used to analyze urea concentration. Blood GOT and GPT was analyzed according to Wikison *et al*. (1972).

Statistical analysis:

Statistical analysis of data was done using Statistical analysis system of SAS (2009). One-way analysis design was used to analyze body weight, daily gain, digestibility coefficients, nutritive value, nitrogen and water utilizations, the model was:

$$Y_{ij} = \mu + T_i + e_{ij}.$$

Where: Y_{ij} **= experimental observation,** μ **= general mean.** T_i **= effect of treatment (i =1:5).**

Repeated measures were used for analyzing rumen fermentations, rumen microbes and blood parameters, the model was:

$$Y_{ijk} = \mu + T_i + R_j + (TR)_{ij} + M_k + (TM)_{ik} + e_{ijk}$$

Where: Y_{ijk} = experimental observation, μ = general mean. T_i = effect of treatment (i =1:5), R_j: replicate (j=1:6), (TR)ij: interaction (TR), M_k = effect of month (k=1:6). TM_{ik}= interaction (TM). e_{ijk}= experimental error.

Duncan's multiple test used to carry out the separation among means (Duncan, 1955).

RESULTS AND DISCUSSION

Secondary metabolites compounds:

The effect of treatments in secondary metabolites compounds are represented in Table (2).There was a change in the content of total phenols, total condensed tannins and total tannins (g/kg DM) among all treatments. It is clear that incubation of date palm leaves (DPL) with cellulase enzyme (CDPL), fibrolytic enzyme (FDPL) or a combination of each other (CFDPL) decreased TP, TCT and TT contents comparing with untreated DPL. The lowest contents of TP, TCT and TT were for CFDPL followed by FDPL then CDPL, while the highest contents were for UDPL. Similar results obtained by Abdou (2017) who reported that incubation of olive cake with enzymes reduced secondary metabolites compounds.

Table 2. Total phenols, total condensed tannins and total tannins of untreated DPL and enzymatic treated DPL.

Items	Treatments			
	UDPL	CDPL	FDPL	CFDPL
Total phenols (g/kg DM)	61.60	47.8	45.10	42.32
Total condensed tannins (g/kg DM)	36.30	20.32	17.48	15.86
Total tannins (g/kg DM)	49.00	35.10	32.41	29.66

UDPL: untreated DPL, CDPL: DPL treated with cellulase enzyme, FDPL: DPL treated with fibrolytic enzyme, CFDPL: DPL treated with cellulase and fibrolytic enzymes.

Growing lambs performances:

Feed intake:

The data of Table (3) indicate that treatments included DPL incubated with enzymes increased concentrate, roughage (hay or DPL) and total dry matter intake (g/h/d) comparing with control group, lambs fed T3 had the highest intakes, followed by that fed T4 then T5. While lambs fed T2 had the lowest intakes comparing with other treatments.

Table 3. Mean feed intake of growing lambs fed on control and diets contained DPL.

Items	Treatments				
	T1	T2	T3	T4	T5
Number of animals	6	6	6	6	6
Average live body weight kg	28.27	25.68	27.20	27.59	27.99
Dry matter intake g/h/d:					
CFM	525.99	506.91	603.45	560.93	555.58
Hay	525.99	101.38	120.69	112.19	111.11
DPL	0.00	405.53	482.76	448.75	444.47
Total	1051.99	1013.82	1206.91	1121.86	1111.18

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

Krueger *et al.* (2008) stated that the supplementation of rations by enzymes is often accompanied by increasing feed intake, which due to the increase of the palatability of the diet due to the release of sugars by pre-digestive fiber hydrolysis.

The present results are close to the results of Gado *et al.* (2009) who showed that feeding forage treated with fibrolytic enzyme increased feed intake for cows. Also, Abdou (2017) reported that sheep fed diets treated with enzyme recorded the highest value of feed intake than control group. Also, Salahi *et al.* (2011) stated that there was no any adverse effect of feeding date palm leaves on feed intake.

Live body weight changes:

Body weights for lambs throughout the whole experimental period are illustrated in Table (4). It is clear that the initial body weight was almost the same for the different lamb groups being 12.23, 12.62, 12.46, 12.64 and 12.84 kg for T1, T2, T3, T4 and T5, respectively. However, the final body weight was significantly ($P<0.05$) differed among treatments, as control group had the highest final body weight (38.11 kg), lambs fed DPL incubated with enzymes increased final body weight with no significant difference among them, being 37.15, 37.15 and 36.60 kg for T5, T4 and T3, respectively. However, untreated DPL was the lowest one (32.84 kg). Body weight changes at first, fourth and fifth month and average body weight through the whole period showed the same trend of final body weight, while body weight showed non-significant difference among treatments at second and third month. The average body weights were 28.27, 27.99, 27.59, 27.20, and 25.68 kg for T5, T4 and T3, respectively. It is of interest to note that the difference among T1, T5 and T4 was not significant during the whole period.

Table 4. Mean body weight changes of growing lambs fed on control and diets contained DPL.

Items	Treatments					±SEM
	T1	T2	T3	T4	T5	
Initial body weight (kg)	12.23	12.62	12.46	12.64	12.84	0.257
Body weight at 1st month (kg)	16.32^{a}	15.40^{b}	15.51^{ab}	15.60^{ab}	15.64^{ab}	0.255
Body weight at 2nd month (kg)	19.14	18.40	18.53	18.56	18.70	0.659
Body weight at 3rd month (kg)	23.24	22.10	22.24	22.35	22.71	0.718
Body weight at 4th month (kg)	27.72^{a}	25.43^{c}	26.63^{b}	26.75^{b}	27.44^{ab}	0.689
Body weight at 5th month (kg)	32.88^{a}	28.30^{c}	31.87^{b}	32.52^{a}	32.66^{a}	0.466
Final body weight (kg)	38.11^{a}	32.84^{c}	36.60^{b}	37.15^{ab}	37.94^{a}	0.554
Average body weight (kg)	28.27^{a}	25.68^{c}	27.20^{b}	27.59^{ab}	27.99^{a}	0.290

Means with different letters with each row are significantly different ($P<0.05$).

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

Average daily and total gains:

Control group (T1) showed higher daily gain (g) through all periods and average daily gain through the whole period followed by T5, T4 and T3 with no significant difference among the four treatments except at the first month (Table 5), while T2 showed the lowest daily gain through the whole period. Average daily gain through the whole period was 143.77, 140.92, 139.44, 136.16 and 106.74 g for T1, T5, T4, T3 and T2, respectively. As for total gain (kg), T1 had the highest gain followed by T5 and

T4 with no significant difference among them then T3 while T2 had the lowest gain, being 25.88, 25.10, 24.51, 23.55 and 19.21 kg for T1, T5, T4, T3 and T2, respectively.

The improvement in body weight and daily gain as a result of incubation with enzymes may be due to its effect on microbial efficiency and organic matter digestibility. It is of interest to note that the present results of live body weight and average daily gain are in parallel with the results obtained in digestibility trial (Table 5) which showed that enzymatic treated rations had the highest nutrients digestibility than that of untreated.

Table 5. Mean average daily gain of growing lambs fed on control and diets contained DPL.

Items	Treatments					±SEM
	T1	T2	T3	T4	T5	
Daily gain at 1st month (g)	136.33[a]	92.39[b]	101.63[b]	98.66[b]	93.33[b]	9.554
Daily gain at 2nd month (g)	94.00	100.13	100.66	115.33	102.00	11.813
Daily gain at 3rd month (g)	136.66	123.19	154.77	109.61	109.61	20.515
Daily gain at 4th month (g)	149.33[a]	111.05[b]	146.33[a]	146.66[a]	157.66[a]	5.800
Daily gain at 5th month (g)	172.00[a]	95.61[b]	203.94[a]	192.33[a]	174.22[a]	21.779
Daily gain at 6th month (g)	174.33[a]	118.05[b]	138.22[a]	154.33[a]	175.77[a]	21.024
Average daily gain through 6 months (g)	143.77[a]	106.74[b]	140.92[a]	136.16[a]	139.44[a]	5.996
Total gain (kg)	25.88[a]	19.21[c]	23.55[b]	24.51[ab]	25.10[ab]	0.678

Means with different letters with each row are significantly different (P<0.05).

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

Similar results were found by Fayed *et al.* (2008) who reported that the greatest feed intake, body weight average daily gain were achieved with sheep fed mixture of plant silage fermented with biological treatments. Also, Aziz (2009) estimated that growing female lambs fed olive tree leaves subjected to biological treatments increased feed intake, body weight, average and total body gain by progressed time of feeding. Aziz (2020) found an increase in feed intake and body weight of sheep rams fed ration contained DPL treated with cellulase or fibrolytic enzymes or a combination of them.

Profit analysis and feed conversion:

Data of Table (6) clearly showed that total feed costs of control group T1 was higher than treatments contained DPL. Treatment contained UDPL had the lowest feed costs while T3 was higher than T4 and T5, being 899.45, 853.35, 795.33, 788.04 and 691.63 EP for T1, T3, T4, T5 and T2, respectively. The return from body gain was higher for control group (T1) and the experimental groups contained enzymatic treated DPL (T5, T4 and T3) than those of untreated DPL (T2), being 2588, 2510, 2451, 2355 and 1921 EP for T1, T5, T4, T3 and T2, respectively. Final margin for lambs fed T5 was higher than other treatments followed by control group (T1) then T4, while the lowest margin was for untreated group (T2), being 1721.96, 1688.55, 1655.66, 1501.65 and 1229.37 EP for T5, T1, T4, T3 and T2, respectively. The lowest feed cost/kg gain was achieved for T5 (31.40 EP/kg gain) followed by T4(32.45 EP/kg gain) then T1 (34.75 EP/kg gain), while the highest values was for T3 and T2 (36.24 and 36.00 EP/kg gain). Economic efficiency showed that T5 and T4 were more efficient than other treatments followed by T1 then T3 and T2, being 3.19, 3.08, 2.88, 2.78 and 2.76 for T5, T4, T1, T3 and T2, respectively. Data of feed conversion expressed as kg DM, TDN and DCP needed for one kg gain indicated that, T2 was the highest efficient among all treatments followed by T3, However, there were slight difference among T5, T1 and T4. T5 and T4 were slightly more efficient in converting TDN into gain compared to T1. Although they were slightly less efficient in converting DCP into gain compared to T1.

The improvement in feed conversion of treatments contained DPL treated with enzymes may be attributed to the increase in apparent digestibility of OM, DCP, CF that could be explained by the effect of those treatments on the changes of microflora in the rumen.

Table 6. Mean profit analysis and feed conversion of growing lambs fed on control and diets contained DPL.

Items	Treatments				
	T1	T2	T3	T4	T5
DM intake g/head/d	1275.11	1288.38	1375.9	1164.53	1354.03
TDN intake g/head/d	1060.19	1069.28	1164.57	1034.95	1159.18
DCP intake g/head/d	140.15	137.2	135.01	77.35	102.41
Total body gain (kg)	25.88	19.21	23.55	24.51	25.1
Return from body gain (EP)*	2588	1921	2355	2451	2510
concentrate DMI kg /h/180d	94.68	91.24	108.62	100.97	100.01
hay DMI kg /h/180d	94.68	18.25	21.72	20.19	20.00
DPL DMI kg /h/180d	0.00	72.99	86.90	80.77	80.00
Total feed intake kg /h/180d	189.36	182.49	217.24	201.94	200.01
concentrate costs(EP)	520.73	501.84	597.42	555.32	550.03
hay costs(EP)	378.71	72.99	86.90	80.77	80.00
DPL costs(EP)	0.00	116.79	139.04	129.24	128.01
enzyme costs(EP)	0.00	0.00	30.00	30.00	30.00
Total feed costs(EP)	899.45	691.63	853.35	795.33	788.04
Final margin (EP)	1688.55	1229.37	1501.65	1655.66	1721.96
Feed cost EL/kg gain	34.75	36.00	36.24	32.45	31.40
Economic efficiency	2.88	2.78	2.76	3.08	3.19
Feed conversion:					
Kg dry matter feed/1kg gain	8.87	12.07	10.52	8.55	9.71
Kg TDN/1kg gain	7.37	10.02	8.90	7.60	8.31
g DCP/1kg gain	0.97	1.29	1.03	0.57	0.73

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

***Price of kg live body =100 EL.**

The cost of one kg of CFM, BH, DPL and 1 kg enzyme were 5.5, 4, 1.6 and 200 Egyptian pounds, respectively.

Similar results were obtained by Abd El-Aziz (2002) who observed that replacing 40% of the CFM by biologically treated rice straw reduced the cost of feeding by 28.8%. Also, Yacout *et al*. (2007) indicated that feed conversion for lambs fed agriculture by-products inoculated with bacteria or bacteria plus enzymes was better than those fed the control ration. Aziz (2009) showed that incubation of olive tree leaves with biological treatments decreased feed cost and increased economic efficiency compared with control group, while feed conversion was slightly differed than control. Also, Valizade *et al*. (2011) stated that there was no any adverse effect of feeding date palm leaves on growth and feed conversion efficiency.

Rumen parameters:

Data of rumen parameters are illustrated in Tables (7&8). Treatments contained untreated DPL or incubated with enzymes increased (P<0.05) ruminal pH values comparing with control group, the highest values were for T5 and T4 with no significant difference followed by T3 then T2, while the lowest value was for T1. Total volatile fatty acids, total nitrogen, true protein, non-protein nitrogen, ammonia nitrogen and microbial protein concentrations (mg/100mlR.L) showed high significant (P<0.05) difference among all treatments. Lambs fed treatments contained DPL incubated with enzymes had the highest concentrations comparing with control and untreated treatments, T5 had the highest values of all concentrations followed by T4 then T3, while T2 that was untreated had the lowest concentrations followed by T1. All rumen parameters showed gradual increase (P<0.05) by progressed age of lambs, the lowest values of ruminal pH, total volatile fatty acids, total nitrogen, non-protein nitrogen and ammonia nitrogen were at the first month, while the highest values were at the sixth month. True protein and microbial protein concentrations take another trend; true protein was swing as it showed the highest value at the first month then showed gradual decrease then increased again at the fourth month then showed the lowest value at the six month. While microbial protein concentration showed gradual increase to reach the highest at the third month then decreased again.

Table 7. Rumen pH value and total volatile fatty acids of growing lambs fed on control and diets contained DPL.

Items	Month	Treatments					±SEM	Overall mean
		T1	T2	T3	T4	T5		
pH	1st	5.55	5.74	5.88	6.30	6.16	0.093	5.92^{e}±0.041
	2nd	5.82	5.99	6.22	6.63	6.72	0.093	6.28^{d}±0.041
	3rd	5.99	6.12	6.47	6.58	6.91	0.093	6.41^{c}±0.041
	4th	6.42	6.63	7.13	7.35	7.53	0.093	7.01^{b}±0.041
	5th	6.65	6.92	7.28	7.57	7.63	0.093	7.21^{a}±0.041
	6th	6.55	7.03	6.96	7.61	7.66	0.093	7.16^{a}±0.041
Overall mean		6.16^{d}	6.41^{c}	6.66^{b}	7.01^{a}	7.10^{a}	0.038	
TVFA's ml equivalent /100 ml R.L	1st	6.85	6.39	7.63	7.59	7.71	0.145	7.23^{e}±0.064
	2nd	8.13	7.91	8.74	9.04	9.05	0.145	8.57^{d}±0.064
	3rd	8.83	8.23	8.93	9.06	9.24	0.145	8.85^{c}±0.064
	4th	8.79	8.13	9.04	9.18	9.37	0.145	8.90^{c}±0.064
	5th	9.40	8.22	9.42	9.64	9.79	0.145	9.29^{b}±0.064
	6th	10.05	8.77	10.12	10.65	10.82	0.145	10.08^{a}±0.064
Overall mean		8.67^{c}	7.94^{d}	8.98^{b}	9.19^{a}	9.33^{a}	0.059	

Means with different letters with each row and column are significantly different (P<0.05).

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

The reason of the increase in the concentrations of ruminal parameters may be due to crude protein content increasing and fiber content decreasing which cause digestibility coefficients increasing of all nutrients, or due to ruminal microbial populations improvement that have important effect on rumen fermentations.

The present results are supported by the results of McAllister *et al*. (2001) who stated that addition of exogenous enzymes in ruminant diets may affect overall fermentations and the end-product formation in the rumen. El-Sayed *et al*. (2002) found that ruminal ammonia nitrogen, total nitrogen, NPN and true protein nitrogen concentrations were significantly higher for goats fed biologically treated cotton stalks than control. Yacout *et al*. (2007) who found that the highest (P<0.05) TVFA and NH3-N concentrations were shown by lambs fed agriculture by-products inoculated with bacteria or bacteria and enzymes than those fed the control ration.

Aziz (2009) reported that feeding biologically treated olive trees leaves improved ruminal pH, TVFA's, total nitrogen, true protein, NPN and ammonia nitrogen concentrations in sheep rumen. Moreover, Kholif and Aziz (2014) found that addition of cellulytic enzymes to goat diets slightly decreased ruminal pH, while TVFA's, NPN, NH_3-N, TN, TP and MP were significantly (P<0.01) increased. Abdou (2017) found that addition of enzymes to sheep diets contained agriculture by-products improved ruminal pH, VFA's and NH_3concentrations compared to control. Aziz (2020) reported high increase in concentrations of ruminal pH, TVFA's, NPN, NH_3-N, TN, TP and MP in the rumen of sheep fed DPL treated with Cellulase or Fibrolytic enzymes or a combination of them compared with that fed untreated. Moreover, Salahi *et al*. (2011) with dairy goats had 20% DPL and 20% ensiled DPL and Valizade *et al*. (2011) with lambs had 8, 16 and 24% DPL and Parmar *et al*. (2016) found that ruminal pH, total-N, ammonia-N, soluble-N, NPN and TVFA were statistically similar with control.

Table 8. Rumen parameters of growing lambs fed on control and diets contained DPL.

Items	Month	Treatments					±SEM	Overall mean
		T1	T2	T3	T4	T5		
NPN mg/100 ml R.L	1st	17.65	15.50	17.32	17.64	18.02	0.175	17.22^{f}±0.078
	2nd	19.24	17.68	19.35	19.55	19.63	0.175	19.09^{e}±0.078
	3rd	21.17	20.21	21.63	21.70	21.88	0.175	21.32^{d}±0.078
	4th	22.38	21.59	22.69	22.71	23.84	0.175	22.64^{c}±0.078
	5th	23.03	22.08	23.26	23.71	24.07	0.175	23.23^{b}±0.078
	6th	24.25	23.76	24.80	25.06	26.18	0.175	24.81^{a}±0.078
Overall mean		21.29^{d}	20.14^{e}	21.51^{c}	21.73^{b}	22.27^{a}	0.071	
Ammonia nitrogen mg/ 100 ml R.L	1st	11.76	10.33	11.55	11.76	12.01	0.116	11.48^{f}±0.078
	2nd	12.83	11.79	12.90	13.03	13.09	0.116	12.73^{e}±0.078
	3rd	14.11	13.47	14.42	14.47	14.58	0.116	14.21^{d}±0.078
	4th	14.92	14.39	15.12	15.13	15.89	0.116	15.09^{c}±0.078
	5th	15.35	14.72	15.50	15.81	16.04	0.116	15.49^{b}±0.078
	6th	16.17	15.84	16.53	16.70	17.45	0.116	16.54^{a}±0.078
Overall mean		14.19^{d}	13.42^{e}	14.34^{c}	14.48^{b}	14.84^{a}	0.047	
Total nitrogen mg/100 ml R.L	1st	43.84	40.81	44.49	46.12	47.27	0.191	44.51^{f}±0.085
	2nd	45.33	42.80	46.39	47.94	48.91	0.191	46.27^{e}±0.085
	3rd	47.22	45.06	48.37	49.90	50.97	0.191	48.30^{d}±0.085
	4th	48.24	46.67	49.53	51.01	52.89	0.191	49.67^{c}±0.085
	5th	49.20	47.26	50.33	52.11	53.21	0.191	50.42^{b}±0.085
	6th	49.98	48.79	51.69	53.01	55.12	0.191	51.72^{a}±0.085
Overall mean		47.30^{d}	45.23^{e}	48.47^{c}	50.02^{b}	51.39^{a}	0.078	
True protein nitrogen mg/ 100 ml R.L	1st	26.19	25.31	27.16	28.48	29.25	0.133	27.28^{a}± 0.059
	2nd	26.08	25.11	27.03	28.38	29.28	0.133	27.18^{ab}± 0.059
	3rd	26.05	24.85	26.74	28.20	29.09	0.133	26.98^{c}± 0.059
	4th	25.86	25.07	26.84	28.30	29.04	0.133	27.02^{bc}± 0.059
	5th	26.17	25.18	27.07	28.40	29.14	0.133	27.19^{ab}± 0.059
	6th	25.72	25.03	26.89	27.95	28.93	0.133	26.90^{c}± 0.059
Overall mean		26.01^{d}	25.09^{e}	26.95^{c}	28.28^{b}	29.12^{a}	0.054	
Microbial protein mg/100mlRL	1st	74.91	69.88	75.55	76.18	77.77	0.191	74.86^{e}±0.085
	2nd	74.41	70.86	74.43	76.99	78.97	0.191	75.13^{d}±0.085
	3rd	79.52	75.13	79.43	79.97	82.13	0.191	79.24^{a}±0.085
	4th	76.41	73.75	77.59	79.05	82.03	0.191	77.76^{b}±0.085
	5th	75.26	73.33	77.49	79.38	81.67	0.191	77.43^{c}±0.085
	6th	75.25	74.97	77.85	78.39	81.40	0.191	77.57^{bc}±0.085
Overall mean		75.96^{d}	72.98^{e}	77.06^{c}	78.33^{b}	80.66^{a}	0.078	

Means with different letters with each row and column are significantly different (P<0.05).
T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

Ruminal ciliate protozoa:

Tables (9&10) represented the data of identification and density of ruminal ciliate protozoa species (x10^{4}cell/ml rumen liquor). Nine genus with nine species of ruminal protozoa were identified in lambs ruminal liquor. These genera are *Entodinum spp*., *Epidinium spp*., *Isotrchia spp*., *Dasytrachia spp*., *Ophryoscolox spp*., *Diplodinum spp*., *Polyplastron spp*., *Metadinum spp*., and *Eudiplodinum spp*. The data indicated that treatments included enzymatic DPL significantly (P<0.05) increased the density of most species and total protozoa count comparing with untreated and control treatments. T5 followed by T4 were the large density of *Entodinum, Epidinium, Dasytrachia, Ophryoscolox* and *Polyplastron spps*. WhileT3 was the large density of *Diplodinum* and *Metadinum spps.*, while it took the second or the third position of the other species. T1 was the large density of *Eudiplodinum spp.*, while it did not significantly differed from T5 or T4 and T3 for the density of *Epidinium, Isotrchia, Dasytrachia, Ophryoscolox* and *Metadinum spp.* T2 was the lowest density of all species except that it was the large density of *Isotrchia spp.*, also, it was higher than T1 for *Diplodinum spp.* The most appearance among all differential kinds of ciliate protozoa species was for *Entodinum spp.* as it ranged between 3.838 and 2.685 (x10^{4}cell/ml rumen liquor), while other species ranged between 0,045 and 0.5 (x10^{4}cell/ml rumen liquor). Total protozoa counts were 5.000, 4.844, 4.709, 4.469 and 3.755 (x10^{4}cell/ml rumen liquor) for T5, T4, T3, T1 and T2, respectively.

All protozoa species showed gradual increase (P<0.05) by progressed age of lambs, the lowest densities of all species were at the first month, while the highest densities were at the six month, except that for *Diplodinum spp*. showed non-significant difference from the second month till the sixth month.

The present results indicated that diets contained DPL (untreated or incubated with enzymes) were efficient as the control ration which contained hay only. Colombatto *et al*. (2003) reported that the improvement in ruminal ciliate protozoa by enzymes may be due to that enzymes were able to degrade complex substrate to simpler substrates that allowing faster microbial colonization and fermentations in the rumen. The reason for the beneficial effect of protozoa may be their digestive capacity, their effect on the specific growth rate of the bacteria or some

general effects on the rumen environment (Kurihara *et al*., 1968).

The present results are supported by the results of Franzolin and Dehorty (1996) who reported that *Entodinium* constituted approximately 90% of the total protozoal numbers. Nsereko *et al*. (2000) stated that microbial colonization was enhanced by increasing numbers of ruminal fibrolytic microbes as a result of direct-fed enzymes. Also, Shakweer (2003) observed that biological treatments for rice straw and sugarcane bagasse increased protozoa counts. Kholif and Aziz (2014) found that addition of cellulytic enzymes to goat diets significantly (P<0.01) increased ruminal ciliate protozoa counts. Aziz (2020) found that feeding sheep on diets contained DPL treated with cellulase or fibrolytic enzymes or a combination of them increased number of ruminal protozoa compared with that fed untreated.

Ruminal bacteria:

The data of total bacteria ($x10^8$ cell/ml rumen) and cellulolytic bacteria numbers ($x10^6$ cell/ml rumen) during the whole period are illustrated in Table (11). It is clear that lambs fed treatment contained untreated DPL (T2) significantly (P<0.05) reduced total bacteria and cellulolytic bacteria numbers more than all other treatments. While treatments contained enzymatic treated DPL significantly (P<0.05) increased total bacteria and cellulolytic bacteria numbers more than control treatment. The highest total bacteria density was for T5 followed by T4 then T3 then T1 and the lowest was for T2, being 4.080, 3.906, 3.813, 3.500 and 3.225 ($x10^8$ cell/ml rumen), respectively. The highest cellulolytic bacteria density was for T3 and T4 with no significant deference followed by T5 then T1 and the lowest was for T2, being 4.241, 4.235, 4.215, 3.006 and 2.831($x10^6$ cell/ml rumen), respectively.

Table 9. Identification and density of ruminal ciliate protozoa species of growing lambs fed on control and diets contained DPL.

Items	Month	Treatments					±SEM	Overall mean
		T1	T2	T3	T4	T5		
Entodinum spp.	1st	1.780	1.703	2.046	2.180	2.426	0.071	2.027^{f}±0.032
	2nd	2.093	2.173	2.586	2.730	2.891	0.071	2.495^{e}±0.032
	3rd	2.876	2.330	3.488	3.553	3.625	0.071	3.174^{d}±0.032
	4th	3.740	2.760	3.820	4.031	4.040	0.071	3.678^{c}±0.032
	5th	4.243	3.476	4.485	4.808	4.776	0.071	4.358^{b}±0.032
	6th	4.998	3.670	4.946	4.995	5.271	0.071	4.776^{a}±0.032
Overall mean		3.288^{d}	2.685^{e}	3.562^{c}	3.716^{b}	3.838^{a}	0.029	
Epidinium spp.	1st	0.024	0.020	0.027	0.026	0.028	0.025	0.025^{f}±0.023
	2nd	0.034	0.032	0.039	0.034	0.039	0.025	0.036^{e}±0.032
	3rd	0.050	0.048	0.057	0.049	0.058	0.025	0.052^{d}±0.032
	4th	0.061	0.058	0.061	0.059	0.065	0.025	0.061^{c}±0.032
	5th	0.071	0.071	0.073	0.071	0.079	0.025	0.073^{b}±0.032
	6th	0.092	0.089	0.100	0.095	0.099	0.025	0.095^{a}±0.032
Overall mean		0.055^{b}	0.053^{b}	0.059^{a}	0.055^{b}	0.061^{a}	0.083	
Isotrchia spp	1st	0.019	0.049	0.016	0.019	0.016	0.052	0.023^{f}±0.023
	2nd	0.069	0.069	0.059	0.065	0.068	0.052	0.066^{e}±0.023
	3rd	0.100	0.099	0.091	0.091	0.100	0.052	0.096^{d}±0.023
	4th	0.123	0.121	0.109	0.116	0.118	0.052	0.117^{c}±0.023
	5th	0.137	0.136	0.127	0.128	0.135	0.052	0.133^{b}±0.023
	6th	0.148	0.146	0.138	0.142	0.148	0.052	0.144^{a}±0.023
overall mean		0.099^{ab}	0.103^{a}	0.090^{c}	0.093^{bc}	0.097^{ab}	0.002	
Dasytrachia spp.	1st	0.066	0.057	0.069	0.076	0.069	0.025	0.067^{f}±0.011
	2nd	0.105	0.097	0.104	0.116	0.107	0.025	0.106^{e}±0.011
	3rd	0.142	0.132	0.142	0.155	0.146	0.025	0.143^{d}±0.011
	4th	0.185	0.179	0.183	0.199	0.187	0.025	0.187^{c}±0.011
	5th	0.230	0.225	0.230	0.247	0.233	0.025	0.233^{b}±0.011
	6th	0.328	0.309	0.330	0.342	0.329	0.025	0.327^{a}±0.011
Overall mean		0.176^{b}	0.167^{c}	0.176^{b}	0.189^{a}	0.178^{b}	0.014	
Ophryoscolox spp.	1st	0.010	0.008	0.011	0.012	0.0175	0.016	0.012^{f}± 0.071
	2nd	0.012	0.014	0.014	0.020	0.026	0.016	0.017^{e}±0.023
	3rd	0.020	0.021	0.023	0.030	0.035	0.016	0.026^{d}±0.023
	4th	0.047	0.048	0.048	0.056	0.064	0.016	0.053^{c}±0.023
	5th	0.076	0.074	0.075	0.079	0.091	0.016	0.079^{b}±0.023
	6th	0.105	0.105	0.1066	0.109	0.121	0.016	0.109^{a}±0.023
Overall mean		0.045^{c}	0.045^{c}	0.046^{c}	0.051^{b}	0.059^{a}	0.065	
Diplodinum spp.	1st	0.013	0.010	0.014	0.016	0.014	0.078	0.013^{b}±0.012
	2nd	0.023	0.058	0.028	0.032	0.124	0.078	0.053^{a}±0.012
	3rd	0.042	0.103	0.043	0.046	0.045	0.078	0.056^{a}±0.012
	4th	0.052	0.048	0.125	0.053	0.055	0.078	0.067^{a}±0.012
	5th	0.062	0.057	0.158	0.068	0.067	0.078	0.082^{a}±0.012
	6th	0.076	0.074	0.078	0.081	0.083	0.078	0.078^{a}±0.012
overall mean		0.045^{d}	0.058^{c}	0.075^{a}	0.049^{d}	0.065^{b}	0.011	

Means with different letters with each row and column are significantly different (P<0.05).

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

Table 10. Identification and density of ruminal ciliate protozoa species of growing lambs fed on control and diets contained DPL.

Items	Month	Treatments					±SEM	Overall mean
		T1	T2	T3	T4	T5		
Polyplastron spp.	1st	0.067	0.055	0.072	0.079	0.088	0.055	0.072^{f}±0.069
	2nd	0.116	0.102	0.118	0.123	0.131	0.055	0.118^{e}±0.069
	3rd	0.141	0.128	0.143	0.146	0.157	0.055	0.143^{d}±0.069
	4th	0.171	0.157	0.175	0.179	0.189	0.055	0.174^{c}±0.069
	5th	0.203	0.182	0.201	0.206	0.216	0.055	0.201^{b}±0.069
	6th	0.287	0.267	0.288	0.292	0.301	0.055	0.287^{a}±0.069
Overall mean		0.164^{d}	0.148^{e}	0.166^{c}	0.171^{b}	0.180^{a}	0.063	
Metadinum spp.	1st	0.329	0.320	0.370	0.341	0.353	0.042	0.343^{f}± 0.019
	2nd	0.371	0.348	0.390	0.376	0.381	0.042	0.373^{e}± 0.019
	3rd	0.406	0.377	0.419	0.402	0.405	0.042	0.402^{d}± 0.019
	4th	0.425	0.404	0.440	0.428	0.434	0.042	0.426^{c}± 0.019
	5th	0.487	0.449	0.493	0.474	0.476	0.042	0.476^{b}± 0.019
	6th	0.527	0.490	0.533	0.517	0.525	0.042	0.518^{a}± 0.019
Overall mean		0.424^{b}	0.398^{c}	0.441^{a}	0.423^{b}	0.429^{b}	0.017	
Eudiplodinum spp.	1st	0.095	0.011	0.018	0.019	0.017	0.010	0.032^{f}±0.045
	2nd	0.122	0.088	0.040	0.043	0.038	0.010	0.066^{e}±0.045
	3rd	0.145	0.062	0.067	0.071	0.066	0.010	0.082^{d}±0.045
	4th	0.182	0.097	0.103	0.106	0.100	0.010	0.118^{c}±0.045
	5th	0.218	0.135	0.140	0.145	0.138	0.010	0.155^{b}±0.045
	6th	0.255	0.171	0.177	0.177	0.175	0.010	0.191^{a}±0.045
Overall mean		0.169^{a}	0.094^{b}	0.091^{b}	0.093^{b}	0.089^{b}	0.041	
Total protozoa count x10^4 cell /ml rumen liquor	1st	2.405	2.237	2.646	2.771	3.029	0.075	2.618^{f}± 0.033
	2nd	2.949	2.985	3.382	3.540	3.809	0.075	3.333^{e}± 0.033
	3rd	3.925	3.302	4.476	4.547	4.640	0.075	4.178^{d}± 0.033
	4th	4.989	3.874	5.066	5.230	5.253	0.075	4.883^{c}± 0.033
	5th	5.73	4.808	5.985	6.228	6.213	0.075	5.793^{b}± 0.033
	6th	6.818	5.324	6.698	6.751	7.053	0.075	6.529^{a}± 0.033
Overall mean		4.469^{d}	3.755^{e}	4.709^{c}	4.844^{b}	5.000^{a}	0.030	

Means with different letters with each row and column are significantly different (P<0.05).
T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

Table 11. Ruminal bacteria of growing lambs fed on control and diets contained DPL.

Items	Month	Treatments					±SEM	Overall mean
		T1	T2	T3	T4	T5		
Total bacterial numbers x10^8 cell /ml rumen	1st	2.798	2.517	3.136	3.230	3.388	0.019	3.014^{f}± 0.086
	2nd	2.958	2.698	3.288	3.361	3.570	0.019	3.175^{e}± 0.086
	3rd	3.236	2.946	3.526	3.641	3.791	0.019	3.428^{d}± 0.086
	4th	3.671	3.413	3.991	4.108	4.286	0.019	3.894^{c}± 0.086
	5th	4.038	3.738	4.343	4.436	4.598	0.019	4.231^{b}± 0.086
	6th	4.301	4.041	4.596	4.658	4.848	0.019	4.489^{a}± 0.086
Overall mean		3.500^{d}	3.225^{e}	3.813^{c}	3.906^{b}	4.080^{a}	0.078	
Cellulolytic bacteria numbers x10^6 cell /ml rumen	1st	2.500	2.328	3.753	3.723	3.696	0.012	3.200^{f}±0.057
	2nd	2.658	2.495	3.893	3.875	3.858	0.012	3.356^{e}±0.057
	3rd	2.828	2.645	4.080	4.086	4.046	0.012	3.537^{d}±0.057
	4th	3.026	2.848	4.251	4.268	4.255	0.012	3.730^{c}±0.057
	5th	3.391	3.211	4.606	4.600	4.565	0.012	4.075^{b}±0.057
	6th	3.633	3.463	4.863	4.860	4.871	0.012	4.338^{a}±0.057
Overall mean		3.006^{c}	2.831^{d}	4.241^{a}	4.235^{a}	4.215^{b}	0.052	

Means with different letters with each row and column are significantly different (P<0.05).
T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

The present results are supported by those obtained by Aziz (2014) who found that feeding agriculture by-products treated with different kinds of biological treatments increased total bacteria and cellulolytic bacteria numbers in sheep rumen especially that treated with *Cellulomonas cellulasea*.

Blood parameters:

The data of kidney and liver functions (Table 12) the data indicated that treatments contained DPL (T5, T3 and T4) significantly (P<0.05) reduced blood serum urea (mg/dl) and AST (U/L) activity comparing with control (T1) or untreated DPL (T2) treatments, T5 values were less than T3 and T4. While the highest (P<0.05) values of urea and AST were for T1 followed by T2. At the contrast, T5, T3 and T4 significantly (P<0.05) increased blood serum creatinine (mg/dl) and ALT (U/L) more than T1 and T2, as T5 had the highest (P<0.05) values, while T3 and T4 were less than T1, the lowest (P<0.05) values were for T2.

Table 12. Blood kidney and liver functions parameters of growing lambs fed on control and diets contained DPL.

Items	Month	Treatments					±SEM	Overall mean
		T1	T2	T3	T4	T5		
Urea mg/dl	1st	21.45	17.78	15.23	16.21	14.43	0.088	17.02^{f}±0.039
	2nd	23.58	20.14	17.52	18.38	16.60	0.088	19.24^{e}±0.039
	3rd	25.59	22.60	19.43	20.64	18.86	0.088	21.42^{d}±0.039
	4th	27.89	24.79	21.55	22.82	21.04	0.088	23.62^{c}±0.039
	5th	30.13	26.76	23.82	24.91	23.13	0.088	25.75^{b}±0.039
	6th	32.19	28.96	25.73	26.89	25.11	0.088	27.78^{a}±0.039
Overall mean		26.80^{a}	23.50^{b}	20.54^{d}	21.64^{c}	19.86^{e}	0.036	
Creatinine (mg/dl)	1st	0.62	0.50	0.64	0.63	0.66	0.042	0.613^{f}±0.018
	2nd	0.64	0.52	0.66	0.65	0.68	0.042	0.632^{e}±0.018
	3rd	0.65	0.53	0.68	0.66	0.70	0.042	0.647^{d}±0.018
	4th	0.67	0.55	0.69	0.68	0.72	0.042	0.663^{c}±0.018
	5th	0.68	0.56	0.70	0.69	0.73	0.042	0.675^{b}±0.018
	6th	0.70	0.58	0.72	0.71	0.75	0.042	0.695^{a}±0.018
Overall mean		0.66^{d}	0.54^{e}	0.68^{b}	0.67^{c}	0.70^{a}	0.007	
AST (U/L)	1st	13.60	13.08	12.50	10.61	10.79	0.200	12.11^{f}±0.089
	2nd	15.73	14.59	14.34	12.70	12.29	0.200	13.93^{e}±0.089
	3rd	17.07	15.92	15.54	14.29	13.54	0.200	15.27^{d}±0.089
	4th	19.30	18.75	18.08	16.70	15.87	0.200	17.74^{c}±0.089
	5th	23.00	21.72	20.95	19.53	18.55	0.200	20.75^{b}±0.089
	6th	25.40	24.16	23.43	21.94	21.01	0.200	23.19^{a}±0.089
Overall mean		19.01^{a}	18.03^{b}	17.47^{c}	15.96^{d}	15.34^{e}	0.081	
ALT (U/L)	1st	4.79	4.45	5.69	5.00	5.58	0.068	5.10^{f}±0.037
	2nd	5.05	4.71	5.75	5.22	5.73	0.068	5.29^{e}±0.037
	3rd	5.22	5.05	5.82	5.56	5.87	0.068	5.50^{d}±0.037
	4th	5.49	5.21	5.83	5.65	6.03	0.068	5.64^{c}±0.037
	5th	6.36	5.48	6.11	6.07	6.20	0.068	6.04^{b}±0.037
	6th	8.03	7.15	6.28	6.44	6.34	0.068	6.85^{a}±0.037
Overall mean		5.82^{b}	5.34^{d}	5.92^{c}	5.66^{d}	5.96^{a}	0.028	

Means with different letters with each row and column are significantly different (P<0.05).

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

Generally, serum creatinine level is a useful indicator of glomerular filtration in the kidney. From the present data, it is clear that the values of serum creatinine for sheep were within the normal levels. The data indicated that T5 was the most efficient treatment for kidney and liver functions, also, the present results indicated that treatments including untreated DPL or DPL incubated with enzymes did not showed any harmful effects in liver and kidney functions of lambs as the values of serum urea, creatinine AST and ALT were within the normal levels of sheep.

The data of blood biochemical parameters (Table 13) showed that serum total proteins and albumin concentrations (g/dl) showed significant (P<0.05) increase with treatments contained treated DPL more than treatment with untreated DPL, T5 was the highest one followed by T4 then T3; While T1 had the highest (P<0.05) values of total proteins and albumin at all.

Table 13. Blood biochemical parameters of growing lambs fed on control and diets contained DPL.

Items	Month	Treatments					±SEM	Overall mean
		T1	T2	T3	T4	T5		
Total proteins g/dl	1st	5.33	3.95	4.11	4.74	5.04	0.037	4.63^{f}±0.068
	2nd	5.79	4.38	4.67	5.21	5.60	0.037	5.13^{e}±0.068
	3rd	6.14	4.74	5.10	5.51	5.90	0.037	5.48^{d}±0.068
	4th	6.53	5.18	5.52	5.95	6.45	0.037	5.92^{c}±0.068
	5th	6.95	5.58	5.93	6.36	6.88	0.037	6.34^{b}±0.068
	6th	7.62	6.21	6.53	7.00	7.42	0.037	6.95^{a}±0.068
Overall mean		6.39^{a}	5.00^{e}	5.31^{d}	5.79^{c}	6.22^{b}	0.015	
Albumin g/dl	1st	3.51	2.39	2.56	2.75	2.91	0.029	2.82^{f}± 0.013
	2nd	3.74	2.65	2.73	2.93	3.08	0.029	3.03^{e}± 0.013
	3rd	3.92	2.80	2.86	3.04	3.21	0.029	3.17^{d}± 0.013
	4th	4.09	2.98	3.03	3.23	3.38	0.029	3.34^{c}± 0.013
	5th	4.27	3.20	3.32	3.50	3.62	0.029	3.58^{b}± 0.013
	6th	4.59	3.47	3.64	3.90	3.98	0.029	3.92^{a}± 0.013
Overall mean		4.02 ^{a}	2.92 ^{e}	3.02 ^{d}	3.22 ^{c}	3.36 ^{b}	0.011	
Globulin g/dl	1st	1.82	1.56	1.54	1.99	2.12	0.049	1.80^{f}±0.022
	2nd	2.04	1.93	1.93	2.27	2.51	0.049	2.10^{e}±0.022
	3rd	2.22	2.19	2.23	2.47	2.69	0.049	2.31^{d}±0.022
	4th	2.44	2.37	2.49	2.72	3.07	0.049	2.58^{c}±0.022
	5th	2.68	2.37	2.61	2.86	3.26	0.049	2.75^{b}±0.022
	6th	3.02	2.73	2.89	3.09	3.44	0.049	3.03^{a}±0.022
Overall mean		2.37^{c}	2.08^{e}	2.28^{d}	2.57^{b}	2.85^{a}	0.020	
A/G ratio	1st	1.94	1.65	1.67	1.43	1.41	0.049	1.62^{a}±0.022
	2nd	1.84	1.67	1.42	1.32	1.26	0.049	1.50^{b}±0.022
	3rd	1.79	1.56	1.28	1.25	1.21	0.049	1.42^{c}±0.022
	4th	1.69	1.44	1.22	1.20	1.12	0.049	1.33^{d}±0.022
	5th	1.61	1.43	1.27	1.24	1.14	0.049	1.34^{d}±0.022
	6th	1.53	1.31	1.26	1.28	1.17	0.049	1.31^{d}±0.022
Overall mean		1.73^{a}	1.51^{b}	1.35^{c}	1.28^{d}	1.22^{e}	0.020	

Means with different letters with each row and column are significantly different (P<0.05).

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

The data showed that T5 followed T4 increased (P<0.05) globulin concentration (g/dl) more than T1 and T2, while T3 was less than T1, although, T5, T4 and T3 respectively decreased albumin/globulin ratio more than T1 and T2. It is important to note that values of A/G ratio were higher than 1.0 which indicated that animals did not suffer from any health problems that might affect the performance of the experimental animals.

The results indicated that treatments including DPL incubated with enzymes decreased serum urea concentration and increased serum creatinine, total proteins, albumin and globulin concentrations, these results may be supported by the finding cited early, that rumen ammonia-nitrogen, total nitrogen and true protein concentrations were higher (P<0.05) in these treatments compared with other treatments, also may be supported by the higher digestibility confections of these treatments.

The present values of tested blood parameters are within the normal range and in good agreement with those obtained by El-Ashry *et al*. (1997), Khorshed (2000) and Aziz (2009) working with sheep and Kholif *et al*. (2005) working with goats, who reported that biological treatments increased serum total protein and albumin, however A/G ratio was not affected by the treatments. Also, Khorshed (2000) Bassuny *et al*. (2003) and (2009) indicated that creatinine concentration in serum of sheep fed biologically treated roughage was higher (P<0.01) than values of those fed controls, and the values ranged from 1.06 to 1.25 (mg/dl) for creatinine. Moreover, Aziz (2020) stated an improvement in blood serum total protein, Albumin, Globulin, urea, AST and ALT for sheep fed DPL treated with cellulase or fibrolytic enzymes or a combination of them compared with that fed untreated.

Digestibility trail:

Feed intake:

Feed intake of lambs during digestibility trail showed significant (P<0.05) difference among treatments (Table 14). Treatments included DPL incubated with enzymes increased (P<0.05) dry matter intake (g/h/d) comparing with lambs fed untreated DPL. Lambs fed T3 had the highest DMI, followed by T1 then T4 and T5, while lambs fed T2 had the lowest DMI. Also, T3 had the highest intakes of NFE, DOMI, DOMR and TDN (g/h/d), while T5 had the highest intakes of EE, CP and DCP (g/h/d). However, T1 had the highest intakes of OM, NDF and ADF, while, T2 had the highest intakes of CF, and ADL.

Similar results are obtained by Aziz (2020) who found that feeding diets contained DPL treated with cellulase or fibrolytic enzymes or a combination of them increased feed intake of sheep compared with that fed untreated diet.

Table 14. Feed intake of lambs during digestibility trail.

Items	Treatments					±SEM
	T1	T2	T3	T4	T5	
Number of animals	4	4	4	4	4	
Live body weight	38.82^{a}	32.10^{b}	37.27^{a}	37.62^{a}	38.16^{a}	0.636
Intakes g/h/d:						
DM	1354.03^{a}	1164.53^{d}	1375.90^{a}	1288.38^{c}	1275.11^{c}	4.397
OM	1215.79^{a}	1057.15^{e}	1260.60^{b}	1183.76^{c}	1170.80^{d}	3.987
EE	31.41^{c}	24.45^{d}	31.64^{c}	33.75^{b}	34.68^{a}	0.095
CP	171.01^{c}	107.37^{d}	178.59^{ab}	178.05^{b}	179.79^{a}	0.469
CF	249.00^{b}	283.10^{a}	226.33^{c}	201.76^{d}	190.24^{e}	0.991
NFE	764.35^{b}	642.23^{c}	824.03^{a}	770.19^{b}	766.08^{b}	2.465
NDF	608.09^{a}	521.82^{b}	507.15^{c}	473.73^{d}	455.34^{e}	1.937
ADF	404.58^{a}	346.56^{b}	326.77^{c}	298.64^{d}	282.82^{e}	1.286
ADL	96.27^{c}	148.01^{a}	100.44^{b}	91.60^{d}	89.26^{e}	0.500
Cellulose	308.31^{a}	198.55^{d}	226.33^{b}	207.04^{c}	193.56^{e}	0.813
Hemicellulose	203.51^{a}	175.26^{c}	180.38^{b}	175.09^{c}	172.52^{d}	0.652
DOMI	921.30^{b}	778.70^{c}	966.72^{a}	914.23^{b}	908.01^{b}	5.955
DOMR	598.84^{b}	506.16^{c}	628.37^{a}	594.25^{b}	590.20^{b}	3.871
TDN g/h/d	1159.18^{a}	1034.95^{b}	1164.57^{a}	1069.28^{b}	1060.19^{b}	13.660
TDN g/kg BW	29.90^{bc}	32.24^{a}	31.32^{ab}	28.42^{c}	27.78^{d}	0.584
DCP g/h/d	102.41^{c}	77.35^{d}	135.01^{b}	137.20^{ab}	140.15^{a}	1.448
DCP g/kg BW	2.64^{b}	2.41^{c}	3.63^{a}	3.65^{a}	3.67^{a}	0.0659

Means with different letters with each row are significantly different (P<0.05).

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

Digestibility coefficients and nutritive values:

Digestibility coefficients and nutritive values are illustrated in Table (15). The data of digestibility coefficients indicated significant (P<0.0505) differences among treatments. Treatments contained DPL incubated with enzymes (T5) significantly (P<0.05) improved the nutrients digestibility coefficients of most nutrients more than those of other treatments. While T2 had the lowest values of nutrients digestibility coefficients. On the other hand, T1 significantly (P<0.05) increased digestibility coefficient of EE comparing with other treatments. The difference among T5, T4, T3 and T1 was not significant for the digestibility coefficients of DM, OM, NFE, NDF, ADF, ADL, cellulose and hemicellulose.

Relatively low digestibility of nutrients in the untreated DPL could be explained by their high contents of cell wall constituents as reported by Van Soest, (1982). The improvement in DM digestibility might be due to the better palatability of treated groups than untreated group and better utilization by the host animal.

Yang *et al*. (1999) and Nsereko *et al*. (2000) stated that the enhancement in digestibility coefficients by the

addition of exogenous enzymes may be due to the increase of microbial colonization or due to increase the attachment of ruminal microorganisms to feed particles which result in accelerating the rate of digestion.

As for nutritive values, the data indicated non-significant difference among the three enzymatic treatments and control treatment for TDN (% of DMI) values, the highest value was for T1followed by T3 then T5 then T4. However, T2 had the highest TDN value with significant difference with other treatments. Nutritive values expressed as DCP was significantly (P<0.05) differed among treatments; enzymatic treatments T5 followed by T4 then T3 had the highest (P<0.05) values, while T2 had the lowest value.

Table 15. Digestibility coefficients and nutritive value of control and diets contained DPL.

Items	Treatments					±SEM
	T1	T2	T3	T4	T5	
Digestibility%:						
DM	75.85^{a}	72.05^{b}	76.06^{a}	76.50^{a}	76.93^{a}	0.363
OM	75.77^{b}	73.66^{c}	76.69^{ab}	77.23^{a}	77.55^{a}	0.383
EE	76.37^{a}	56.62^{e}	62.24^{d}	68.54^{c}	70.65^{b}	1.979
CP	61.35^{c}	72.04^{b}	75.59^{ab}	77.05^{a}	77.95^{a}	0.780
CF	70.72^{c}	69.05^{e}	69.93^{d}	72.84^{b}	76.36^{a}	0.741
NFE	79.14^{a}	74.17^{b}	79.55^{a}	77.58^{ab}	77.47^{ab}	1.481
NDF	56.29^{bc}	54.17^{c}	56.97^{bc}	57.88^{b}	63.98^{a}	0.954
ADF	55.09^{b}	53.91^{c}	55.63^{b}	56.01^{b}	66.85^{a}	1.223
ADL	49.55^{cd}	47.96^{d}	50.47^{c}	59.84^{b}	65.58^{a}	1.957
Cellulose	56.69^{c}	54.24^{d}	58.34^{b}	56.72^{c}	67.24^{a}	1.721
Hemicellulose	57.89^{b}	51.52^{c}	58.29^{b}	58.56^{b}	65.72^{a}	2.077
Nutritive value:						
TDN % of DMI	85.60^{b}	88.87^{a}	84.64^{b}	82.99^{b}	83.14^{b}	0.939
DCP% of DMI	7.56^{d}	6.64^{e}	9.81^{c}	10.65^{b}	10.99^{a}	0.103
DE (Mcal kg DM)*	3.77^{b}	3.92^{a}	3.73^{b}	3.65^{b}	3.66^{b}	3.66
ME (Mcal kg DM)**	3.66^{b}	3.74^{b}	4.21^{a}	3.87^{b}	3.83^{b}	0.049

Means with different letters with each row are significantly different (P<0.05).

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

***DE= Digestible energy = TDN % ×0.04409 (Crampton, et al., 1957).**

****ME = Metabolic energy = TDN g/head ×3.6 (Church and Pond (1982).**

Digestible energy (Mcal kg DM) was significantly (P<0.05) higher in T2 more than other treatments, although T2 was lower in metabolic energy (Mcal kg DM) more than other, the difference among T1, T3, T4 and T5 was not significant. The results of digestibility coefficients and nutritive value are in accordance with the data of ruminal parameters, ruminal ciliate protozoa and bacteria (Tables 6, 7, 8, 9&10) which indicated the efficient of using DPL instead of berseem hay in rations. The improvement in fiber fraction digestibility as a result of using enzymes may be due to the effect of the cellulytic and fibrolytic enzymes which may be responsible for the stepwise hydrolysis of cellulose to glucose.

Several authors, Shoukry *et al*. (1985), Gado (1997), Khorshed (2000), Kholif *et al.* (2005), Aziz (2009), Khattab *et al*. (2012), Aziz and Kholif (2015), Abdou (2017), Aziz (2020) observed an improvement in DM, OM, CP, CF and its friction digestibility coefficients and nutritive value expressed as TDN and DCP over a wide range of low quality roughages treated by biological treatments as yeast, fungi, bacteria or enzymes.

Nitrogen balance:

The data of Table (16) indicated that treatments contained DPL incubated with enzymes significantly (P<0.0505) increased nitrogen intake (g/h/d) and digested nitrogen (g/h/d and % of NI) values compared with untreated or control. T5 had the highest intake and digested nitrogen, followed by T4 then T3 with no significant difference among them, while T2 had the lowest (P<0.05) values. Control treatment (T1) increased (P<0.05) fecal (FN) and urinary nitrogen, UN (g/h/d and % of NI), while T2 had the lowest FN, which reflected on total nitrogen excretion values as T1 had the lowest (P<0.05) value (g/h/d and % of NI), while T2 had the lowest total nitrogen excretion (g/h/d). DPL treatments (T5, T4 and T3) had the lowest FN, UN and total N excretion (% of NI) which reflected on nitrogen utilization, as that lambs fed T5, T4 and T3 improved nitrogen utilization (g/h/d, % of N intake and % of digested N) with no significant difference among them by about 5.6 and 9.63 (g/h/d) more than T1 and T2, respectively.

Table 16. Nitrogen balance by lambs fed on control and diets contained DPL.

Items	Treatments					±SEM
	T1	T2	T3	T4	T5	
Nitrogen intake g/h/d	27.36^{c}	17.18^{d}	28.57^{ab}	28.48^{b}	28.76^{a}	0.074
Digested nitrogen						
g/h/d	16.38^{c}	12.37^{d}	21.60^{b}	21.95^{ab}	22.42^{a}	0.231
% of N intake	59.87^{c}	72.04^{b}	75.59^{a}	77.05^{a}	77.95^{a}	0.780
Fecal nitrogen						
g/h/d	10.98^{a}	4.80^{c}	6.97^{b}	6.53^{b}	6.34^{b}	0.215
% of N intake	40.12^{a}	27.95^{b}	24.40^{c}	22.95^{c}	22.04^{c}	0.780
Urinary nitrogen						
g/h/d	0.395^{ab}	0.412^{a}	0.380^{bc}	0.360^{cd}	0.337^{d}	0.007
% of N intake	1.44^{b}	2.40^{a}	1.32^{c}	1.26^{c}	1.16^{d}	0.030
Total N excretion						
g/h/d	11.37^{a}	5.21^{c}	7.35^{b}	6.89^{b}	6.67^{b}	0.212
% of N intake	41.57^{a}	30.35^{b}	25.73^{c}	24.21^{cd}	23.21^{d}	0.767
Nitrogen balance						
g/h/d	15.99^{c}	11.96^{d}	21.22^{b}	21.59^{ab}	21.59^{a}	0.228
% of N intake	58.43^{d}	69.64^{c}	74.27^{b}	75.79^{ab}	76.78^{a}	0.767
% of digested N	97.58^{c}	96.66^{d}	98.24^{b}	98.36^{b}	98.49^{a}	0.038

Means with different letters with each row are significantly different (P<0.05).

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

The results of the present study are in agreement with El-Ashry *et al*. (1997), Khorshed (2000), Kholif *et al*. (2005), Fayed *et al*. (2008), Aziz (2009) and Aziz and Kholif (2015) who used rations containing biologically treated crop-residues and showed positive nitrogen balance. In addition, Gado (1997), Kholif and Aziz (2014), Abdou (2017) and Aziz (2020) reported that addition of cellulytic or fibrolytic enzymes to crop-residues improved nitrogen balance for sheep or goats compared with untreated or control diets.

Water balance:

The data of Table (17) indicated no significant difference among all treatments for free drinking water (ml/h/d), total water intake (ml/h/d), water excretion, except for Fecal water and water balance (ml/h/d and % of intake). Although, metabolic and combined water showed significant (P<0.05) differences as T1 had the highest values, also, fecal water excretion showed significant difference (P<0.05) as T2 had the highest value. Treatments contained DPL reduced free drinking water, total water intake and water excretion (ml/h/d), and increasing water balance by about 2.36 and 2.98 (% of intake) more than T1 and T2, respectively.

Our results are close to the results obtained by Fayed et al. (2008) who found that the greatest water balance was achieved with sheep fed diets fermented with a mixture of cellulolytic bacteria and nitrogen bacteria followed by that fed treatment containing nitrogen bacteria alone. Also, Aziz (2009 and 2014) stated insignificant (P<0.05) differences in total water intake and water balance for sheep fed biologically treated agriculture by-products, although biological treatments was slightly higher than control and untreated.

Table 17. Water balance for lambs fed on control and diets contained DPL.

Items	Treatments					±SEM
	T1	T2	T3	T4	T5	
Water intake:						
Free drinking water, ml/h/d	3937.50	3937.50	3617.50	3612.50	3620.00	129.05
Metabolic water, ml/h/d*	799.83^{a}	714.12^{b}	803.55^{a}	737.80^{b}	731.53^{b}	9.425
Combined water, ml/h/d	111.70^{a}	88.04^{c}	94.93^{b}	86.58^{d}	78.67^{e}	0.336
Total water intake, ml/h/d	4849.04	4427.15	4515.99	4436.88	4430.20	129.29
Water execration:						
Fecal water, ml/h/d	75.19^{b}	116.80^{a}	88.82^{b}	83.29^{b}	76.72^{b}	5.662
Fecal water, % of intake	1.54^{b}	2.64^{a}	1.97^{b}	1.88^{b}	1.73^{b}	0.154
Urinary water, ml/h/d	528.00	461.25	392.00	382.50	371.25	48.37
Urinary water, % of intake	10.92	10.44	8.73	8.65	8.38	1.074
Total water execration, ml/h/d	603.19	578.05	480.82	465.79	447.97	48.67
Total water execration, % of intake	12.47	13.09	10.70	10.53	10.11	1.111
Water balance:						
ml/h/d	4245.84	3849.10	4035.17	3971.09	3982.23	141.8
% of intake	87.52	86.90	89.29	89.46	89.88	1.111

Means with different letters with each row are significantly different (P<0.05).

T1: CFM + BH (control), T2: CFM + UDPL + BH, T3: CFM + DPL treated with cellulase enzyme + BH, T4: CFM + DPL treated with fibrolytic enzyme + BH, T5: CFM + DPL treated with cellulase and fibrolytic enzymes + BH.

CONCLUSION

Including date palm leaves in lambs diets instead of berseem hay had no any undesirable effect on lambs performance. Treating date palm leaves with cellulase, fibrolytic enzymes or a combinations of each other had a beneficial results as control on lambs performance, which included the increasing in feed intake, live body weight and daily gain as a result of improving rumen fermentations and ruminal ciliate protozoa and bacteria counts which reversed on nutrients digestibility coefficients, nitrogen balance and blood parameters compared with lambs fed untreated date palm leaves.

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الهضم الغذائى واداء النمو للمجترات الصغيرة المغذاه على سعف النخيل المعامل بالانزيمات الفردية والمتحدة.

هند أحمد على عزيز

قسم تغذية الحيوان - مركز بحوث الصحراء-القاهرة- مصر

تم دراسة كل من أداء الحملان، الكفاءة الاقتصادية، كفاءة تحويل الغذاء، خصائص تخمرات الكرش، بروتوزوا الكرش الهدبية و البكتريا، بعض مكونات الدم، معاملات الهضم الغذائى والقيمة الغذائية و ميزان النتروجين والماء المتأثرة بالتغذية على سعف النخيل المعامل بإنزيم السليوليز، الإنزيم المحلل للألياف أو خليط من كلا منهم مع الأخر فى الدراسة الحالية. تم تقسيم ثلاثون حمل من الأناث البرقى المفطومة (متوسط عمر 3-4 شهور و12.5 كجم وزن حى) عشوائياً فى خمس مجاميع بكل منها 6 حيوانات لاجراء تجربة نمو يليها تجربة هضم فى نهايتها. حيث تم تغذية الحملان على خمس معاملات: معاملة (1): مخلوط مركز+ دريس برسيم (مقارنة). معاملة (2): مخلوط مركز + سعف النخيل غير معامل + دريس برسيم. معاملة (3): مخلوط مركز + سعف النخيل المحضن مع إنزيم السليوليز + دريس برسيم. معاملة (4): مخلوط مركز + سعف النخيل المحضن مع الإنزيم المحلل للألياف + دريس برسيم. معاملة (5): مخلوط مركز + سعف النخيل المحضن مع إنزيم السليوليز و الإنزيم المحلل للألياف+ دريس برسيم. استخدام الانزيمات حسن أداء الحملان حيث أن المعاملة الخامسة و الرابعة والثالثة أدت إلى زيادة معنوية فى الغذاء المأكول، وزن الجسم،الزيادة اليومية والكلية، الكفاءة الاقتصادية، كفاءة تحويل الغذاء مقارنة بالمعاملة الثانية. كما أن الحملان المغذاه على المعاملة الخامسة و الرابعة والثالثة أظهرت تركيزات أفضل لنواتج تخمرات الكرش و ميكروبات الكرش وقياسات سيرم الدم مقارنة بالمعاملة الثانية. بالإضافة إلى تحسن معنوى فى معاملات الهضم الغذائى والقيمة الغذائية و ميزان النتروجين والماء مقارنة بالمعاملة الثانية. وكان من المهم توضيح أن نتائج المعاملات المزودة بالإنزيمات كانت قريبة من نتائج معاملة المقارنة.