Plant Archives Vol. 19 No. 1, 2019 pp. 993-1002 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF ENZYME TREATMENTS FOR SOME ROUGHAGES ON AVERAGE GAIN PERFORMANCE, FEED CONVERSION RATIO AND NUTRIENT DIGESTIBILITY OF AWASSI LAMBS

Shaker A. Hassan and Yasseen A. Almaamory

Department of Animal Production, College of Agricultural Engineering Sciences, University of Baghdad, Iraq.

Abstract

This study was conducted in the Animal Farm of Animal Production Department, College of Agriculture, University of Baghdad to study the effect of treatment of two source of roughages Alfalfa hay (AH) and wheat straw (WS) with two source of exogenous fibrolytic enzymes (EFE) : local enzyme product (LEP) and commercial enzyme product (CEP) on Gain performance, Feed Conversion Ratio and Nutrient Digestibility. Twenty-four Awassi lambs with average initial weight 29.84 ± 1.37 kg and 9 months old were individually fed in a 2×3 factorial experiment. The lambs were randomly divided into six groups according to the type of diet. Concentrated diet + 8 ml LEP pre-treated WS (T1), concentrated diet + 8 gm CEP pre-treated WS (T2), concentrated diet + untreated WS (T3), concentrated diet + 8 ml LEP pre-treated AH (T4), concentrated diet + 8 gm CEP pre-treated AH (T5) and concentrated diet + untreated AH (T6). The results showed that the dry matter ,organic matter, crude fiber, NDF, ADF, ADL digestibility's, daily gain, feed conversion ratio were not affected by the source of enzyme or the source of roughages and them interaction. While, the crude protein, ether extract, and hemicelluloses digestibility were decreased ($P<0.01$) with interaction between CEP and WS. It could be concluded from this study; treated roughages with EFE had no effect on the performance of Awassi lambs.

Key words : Nutrient Digestibility, exogenous fibrolytic enzymes, feed conversion ratio, gain performance.

Introduction

In Iraq, the agricultural wastes and by-products industry are considered as a stable source of feed for ruminant animals (Hassan and Tawffek, 2009). The primary focus of the specialists in livestock field is to find strategies to improve the productivity of animals. Most researchers focus on reduce the economic cost especially the cost of feed because of the high cost of feed materials in developing countries (Sujani and Seresinhe, 2015). The idea of supplementation the exogenous enzymes in ruminant diets is not new, though a great number of research that interest in this field has been appeared in 1990s. Adding enzymes helps to overcome inadequate digestion in small animals that may have been inadequate production of gut enzymes during periods of stress, such as weaning, vaccination of environmental stress (Hutcheson, 2002). The purpose of roughage treatments is to improve the nutritional value of low quality roughages, and then to reach more accessibility to the digestive enzymes of the rumen's microorganisms to improve the digestibility, feed intake and utilization (Chenost and Kayouli, 1997; Abdel-Aziz *et al*., 2015). Zhao *et al*. (2015) reported that fibrolytic enzyme supplement did not affect fiber digestion, but high significant decreased in methane production ($P<0.01$). Phakachoed *et al*. (2013) reported that enzyme additives increased neutral detergent fiber digestibility (NDFD) and acid detergent fiber digestibility (ADFD) of corn silage. The use of different rumen enzymes (cellulases, xylanases, pectinases, glucanases and phytases) in the feed of non-ruminants support the food stuff utilization by supporting the degradation of different plant cell wall polymers and then raise the growth of the livestock (Cheng *et al*., 1999). Pinos-Rodríguez *et al*. (2002) reported that weight gain and digestibility can be improved when treated the roughages with EFE. Cruywagen and Goosen (2004) explained that use of commercial cellulases and xylanases improved the weight gain and feed conversion in lambs fed by alfalfa hay and wheat straw. Cruywagen and Van Zyl (2008) reported that there is an improvement in body weight and feed conversion ratio in Merino lambs when EFE was applied to concentrate diet at a rate 7.5 ml /kg. Bala *et al*. (2009) reported significant improvements ($P<0.05$) in diet digestibility of DM, OM, NDF, ADF and total carbohydrate when cross bred lactation Beetle-Saanen goats were fed EFE (cellulases and xylanases) added to concentrate portion of the diet. They also reported an increase in milk yield in the last quarter of lactation. Salem *et al*. (2015) concluded that it can feed sheep by *Atriplex halimus* treated with three developed enzymes (ZAD1 and/or ZAD2) as liquid enzyme preparation with 5% molasses and ensiled for 30 days, improved intake digestibility. Khattab *et al*. (2011) and Valdes *et al*. (2015) reported that cellulase and xylanase enzymes increased the digestion of low quality roughages and maize silage. Kumar *et al*. (2013) reported that rations included higher fiber do not encourage microbial growth and fermentation enough, causing decreased in ration digestibility, available energy and protein contents. Elghandour *et al*. (2015) reported that adding EFE to total mixed rations increased dry matter degradability ($P<0.05$). Alsersy *et al*. (2015) reported that enzyme treatment gives an economical benefit to farmers by increasing the digestion rate. Poonooru (2016) explained that the dietary treatments included a groundnut haulms based total mixed ration (TMR) with roughages: concentrate (R: C) ratio of 70: 30 supplemented with EFE 15 g/head/d improved ($P<0.05$) the *in vitro* digestibility (%) of DM, CP, NDF and ADF.

Therefore, the objective of this study is to improve the nutritional value of low quality roughages by using different types of enzymes and to know their effectiveness on Average Gain performance, Feed Conversion Ratio and Nutrient Digestibility of Awassi lambs.

Materials and Methods

This study was conducted in the animal farm of the College of Agriculture, University of Baghdad to study the effect of treatment of feed with exogenous fibrolytic enzymes (EFE) on rumen fermentations and some parameters of the blood.

Animal and housing

Twenty-four Awassi lambs with average initial weight of 29.84 ± 1.37 kg and average 9 months of age at the start of the experiment were taken for 10 weeks (2 August 2015 to 15 October 2015). The objective was designed to investigate the effect of two types of EFE (Local enzyme product (LEP) named HAMU extracted from *Streptomyces MS* bacteria as a lignin peroxidase crude enzyme and commercial enzyme product (CEP) named ZY 1050-I is a specific enzyme, which prepared by Lohmann company is a mixture of enzymes containing: ß-glucanase (IUB 3.2.1.6) (50 U) and xylanase (IUB 3.2.1.8) (1000 U) activities per gram of enzyme preparation and two types of roughages (alfalfa hay and wheat straw) on , daily gain, feed conversion ratio (FCR), digestibility coefficients. A 2×3 factorial experiment using completely randomized design was used in this experiment. The lambs were separately and randomly allocated to the treatment according to live weight and they housed in each treatment inside pens (4× 4 m). All animals in pens were supplied with a plastic container used to offer concentrated and roughage diets. Pens were also supplied by clean fresh water.

Roughages treatments with enzymes

Wheat straw (WS) and alfalfa hay(AH) were pre-treated with 8 ml/kg of LEP and 8 gm/kg of CEP, and then each enzyme dissolved in 50 liters of water in a large Plastic container, separately. The WS (4 kg) and AH (4 kg) soaked in enzyme solution for 24 h. At the end of treatment period, the treated wheat straw and alfalfa hay were transferred to plastic sheets to be dried by the sun (3-5 days) as described by Al-Wazeer (2015) with stirring once a day until given to animals.

Dietary treatments

Awassi lambs were divided into six groups according to the type of diet. The diets were: concentrated diet + 8 ml LEP pre-treated WS (T1), concentrated diet + 8 gm CEP pre-treated WS (T2), concentrated diet + untreated WS (T3), concentrated diet + 8 ml LEP pre-treated AH (T4), concentrated diet + 8 gm CEP pre-treated AH (T5) and concentrated diet + untreated AH (T6).

The concentrated diet was composed of barley grain (40%), wheat bran(35%), yellow corn(13%), soybean meal (7.5%), sun flower oil(2.5%), Salts and lime (2%). The roughage was as wheat straw (either treated or untreated with enzymes) and alfalfa hay (either treated or untreated with enzymes). The chemical composition of concentrate diet and roughages are presented in table 1.

Feeding trails

The concentrated diet was given to animals gradually for two weeks (preliminary period) before the beginning of the experiment. Roughages and concentrated diet were

Table 1 : Chemical composition of concentrated diet and roughages (on DM% basis).

Ingredients	Conc.	T1 (WS+LEP)	T2 (WS+CEP)	T3 (WS untreated)	T4 (AH+LEP)	T5 (AH+CEP)	T6 (AH untreated)
DM % of fresh	91.18	91.38	92.29	90.92	91.20	90.79	91.96
OM	88.14	88.35	88.80	89.71	90.25	89.01	86.87
CP	14.49	3.53	3.85	3.70	14.79	14.65	14.84
EE	5.36	1.67	1.22	2.02	4.08	4.30	2.42
CF	13.00	51.96	52.03	47.05	51.89	53.45	35.78
NFE	55.30	31.18	31.69	36.93	19.50	16.61	33.83
TDN	71.26	40.44	40.17	44.10	50.21	48.87	50.96
NDF	38.38	70.97	74.24	52.6	58.43	68.3	66.84
Hemicelluloses	31.87	28.84	21.97	15.16	16.45	25.11	39.26
ADF	6.51	42.13	52.28	37.44	41.98	43.19	27.58
Cellulose	3.15	24.94	16.41	23.14	24.38	33.61	16.14
ADL	3.36	17.19	35.87	14.3	17.61	9.58	11.44
Ash	11.86	11.65	11.20	10.29	9.75	10.99	13.13
ME*(MJ/Kg DM)	11.39	5.65	5.60	6.33	7.47	7.22	7.61

WS= Wheat straw, LEP = local enzyme product (HAMU), CEP = commercial enzyme product (ZY 1050-I).
* Metabolizable energy (ME) values are estimated according to following equation:
ME (MJ/kg DM) = [- 0.45 + (0.04453×% TDN)] × 4.184
TDN is estimated according to equations of Kearl (1982) as follows:
TDN for roughages (% of DM) = -17.2649+1.2120(%CP) +0.8352%NFE+2.4637% EE+0.4475 % CF
TDN for concentrate (% of DM) = 40.3227+0.5398 % CP+0.4448 % NFE+1.4218% EE–0.7007 % CF
NFE (% of DM) = OM%-(CP%+CF%+EE%)

given at the same time at 8.00 am. Concentrated diets were given to the animals at a rate of 2.5% of body weight. The WS and AH (either pre-treated or untreated) were given *ad libitium*.

Digestibility of experimental diets

Digestibility trial was conducted to determine the digestibility coefficients of total diets. The last week of this experiment (feeding trails) was chosen for digestibility trail by using half of the Awassi lambs (Two lamb of each treatment). The given quantities of both diets and those remained were accurately recorded to estimate daily intake during the 5 days-collection period. Feces were collected by using special handmade digestion sacs that ensured separation of urine without sticking to their movement inside the pens housed (Saeed, 2011). Fresh feces excreted by each lamb were weighed accurately, and were collected about 10% daily, and then stored in deep freezing at -20°C until to conduct chemical analysis. Feeding, collection and recording of residual continued as described in the feeding trials. Lambs were weighed at the start and the end of the digestibility period. Digestibility coefficients were estimated as a percentage of dividing the difference between the ingested quantity of ingredients and that excreted in feces on quantity ingested.

Statistical analysis

Data were statistically analyzed separately for Awassi lambs with 2×3 factorial experiment in completely randomized design (CRD) using ANOVA procedure of the SAS (2012) to study the effect of two types of roughages (AH and WS) with two type of EFE (LEP And CEP) and without enzymes (Control) on gain performance, feed conversion ratio and nutrient digestibility in Awassi lambs. Duncan's multiple range tests were used to determine the significance of differences between treatments means (Duncan, 1955). Analysis of variance was carried out on all data separately. The treatments were partitioned into main effects and their interaction using the following model:

$$Y_{ijk} = \mu + R_i + E_j + RE_{ij} + e_{ijk}$$

Where, Y_{ijk} = the response; μ = the overall mean; R_i = the effect of Source of roughage (i = 1, 2); E_j = the effect of Source of enzyme (j = 1, 2, 3); RE_{ij} = the interaction Source of roughage $_i$ × Source of enzyme $_j$; e_{ijk} = the experimental error $_{ijk}$.

Results and Discussion

First : Daily Nutrient Intake

This part will deal with the main effect of source of roughage [R1: alfalfa hay(AH) and R2: wheat straw

(WS)], source of enzyme [E1:local enzyme product (LEP), E2: commercial enzyme product (CEP) and E3: without enzyme (control)] and interaction between them (R×E) on daily feed intake expressed as (g/day).

a. The main effect of source of roughages on daily nutrient intake

The main effect of source of roughages on daily nutrients intake of dry matter, organic matter, ether extract, crude protein, crude fiber, nitrogen free extract (NFE), total digestible nutrients (TDN), NDF, ADF, ADL, cellulos, hemicelluloses and metabolic energy (ME) of roughages are shown in table 2. Daily nutrients intake of DM, OM, EE, CP, NFE, TDN, NDF, ADL cellulose, hemicelluloses and ME were highly significantly ($P<0.01$) increased with alfalfa hay compared with wheat straw, and significantly ($P<0.05$) increased with alfalfa hay compared with wheat straw for CF and ADF. The reason an increased intake of alfalfa hay compared with wheat straw may return to Palatability of alfalfa hay more than wheat straw. Many studies recorded an increase in dry matter intake of dairy cows when fibrolytic enzymes was applied to forage before mixing with other ingredients (Lewis *et al*., 1999) or applied to total mixed ration (Bowman *et al*., 2002; Ware *et al*., 2005; Hassan *et al*., 2015). Muwalla *et al*. (2007) reported that addition of EFE (Maxicel; cellulase) to the high concentrate diet did not increase total DM intake in Awassi lambs. Beauchemin *et al*. (1999) reported that no change in feed intake in mid-lactation cows with the application of mixed fibrolytic enzyme as a liquid to the ration, but observed increased total tract starch, fiber and OM digestibility. Yang *et al*. (1999) reported that addition of EFE to alfalfa hay increased total tract digestion of OM and NDF. Beauchemin *et al*. (2003) suggested that fibrolytic enzymes cause highly variable responses on intake, body weight gain and feed efficiency in cattle fed high-grain diets. Dean *et al*. (2013) explained that treated the concentrate, TMR or forage with EFE (Promote) had no effect on intakes of DM, CP, NDF in beef steers.

b. The main effect of source of enzyme on daily nutrient intake

The main effect of source of an enzyme on daily nutrients intake of DM, OM, EE, CP, CF, NFE, TDN, NDF, ADF, ADL, cellulose, hemicelluloses and ME of roughages are shown in table 2. Results showed that the daily intake of DM was not affected by the source of enzyme. Daily intake of OM was decreased ($P<0.05$) with LEP. But not significant effect ($P<0.05$) between CEP and control as shown in table 2.Daily intake of EE, CF, TDN, NDF, ADF, ADL and cellulose were high significantly increased ($P<0.01$) with CEP compared with LEP and control as shown in table 2. Daily intake of CP,NFE,hemicelluloses and ME were high significant decreased($P<0.01$) with LEP and CEP compared with control as shown in table 2. Al-Wazeer (2015) reported that the improvement of treatment of barley straw with EFE can be explained by the partial increase in digestibility of diet that may occur due to probable partial degradation of fiber. Knowlton *et al*. (2002) reported that addition of EFE to cows diet led to increased intake of NDF compared with control diet (without enzyme). Some researchers reported that DM intake was not affected by the treatment the concentrate diet or TMR with EFE in sheep (Yang *et al*., 2000; Salem *et al*., 2011; Bhasker *et al*., 2013). Exogenous fibrolytic enzyme anticipated to be greater in a situation in which fiber digestion is exposed and when energy is the first –limiting nutrient in the diets for high production animals as compared with animals fed at maintenance levels (Beauchemin *et al*., 2003).

c. Interaction effect between source of roughages and source of enzyme on daily nutrients intake

The interaction effect between source of roughages and source of enzyme on daily nutrients intake of DM, OM, EE, CP ,CF, NFE , TDN , NDF, ADF, ADL, cellulose, hemicelluloses and ME of roughages are shown in table 2. Results showed that the daily intake of DM,OM and TDN were increased ($P<0.05$) when use the CEP with alfalfa hay compared with other treatments. But, there is no significant difference with the control group as shown in table 2. Daily intake of EE was high significant increased ($P<0.01$) and affected by the interaction between CEP and alfalfa hay compared with other treatments (table 2). Daily intake of CP was decreased ($P<0.05$) with interaction between LEP and CEP with alfalfa hay and wheat straw compared with them control (table 2). Regarding to a daily intake of NFE was high significant decreased ($P<0.01$) with interaction between LEP and alfalfa hay compared with CEP and control treatment. But not affected by treated the wheat straw with the LEP compared with CEP and control (table 2). Regarding daily intake of NDF, hemicelluloses and ME. They were high significant decreased ($P<0.01$) with an interaction between LEP and alfalfa hay compared with control (Table 2). But the daily intake of ADF and cellulose was high significant increased ($P<0.01$) with interaction between LEP and CEP with alfalfa hay compared with control as shown in table 4.4.while, not significant effect ($P<0.01$) in daily intake of ADF and cellulose when using LEP with wheat

Table 2 : The main effect of source of roughages (AH or WS) and source of enzyme (LEP or CEP) and interaction between them on daily nutrients intake (g/day) in Awassi lambs.

Factors	DM intake g/day	OM intake g/day	EE intake g/day	CP intake g/day	CF intake g/day	NFE intake g/day	TDN intake g/day	ME intake MJ/kg
Source of roughage (R)								
AH (R1)	679.99±21.24a	667.31±19.62a	24.32±1.76a	91.52±3.83a	318.28±17.38a	201.19±23.54a	335.17±11.39a	4.84±0.1a
WS (R2)	516.04±23.23b	490.57±23.76b	8.46±0.65b	25.76±3.11b	278.37±16.19b	117.43±5.92b	186.15±12.74b	2.40±0.20b
Significant	**	**	**	**	*	**	**	**
Source of enzyme (E)								
LEP (E1)	550.27±39.70	520.00±44.07b	16.47±3.19b	48.17±11.77c	285.69±20.58b	117.11±8.41c	223.10±29.11b	3.02±0.47c
CEP (E2)	621.13±42.45	610.65±43.76a	18.67±4.68a	54.89±13.27b	356.52±15.84a	140.93±10.92b	268.44±37.37a	3.72±0.60b
Control (E3)	622.65±36.72	606.17±31.33a	14.03±1.27c	72.86±12.63a	252.77±4.90b	219.89±33.51a	290.44±22.05a	4.13±0.33a
Significant	NS	*	**	**	**	**	**	**
Interaction between source of roughage and source of enzyme (RE)								
R_1E_1	604.11±31.52b	603.49±31.49bc	24.65±1.28b	78.78±4.11c	313.44±16.35bc	128.32±6.69c	293.48±15.31b	4.22±0.22b
R_1E_2	721.49±24.42a	715.41±24.22a	30.99±1.04a	89.78±3.03b	385.66±13.05a	167.54±5.67b	365.24±12.36a	5.30±0.17a
R_1E_3	714.38±22.09a	683.04±21.12ab	17.32±0.53c	106.02±3.27a	255.74±7.90cd	307.70±9.51a	346.78±10.72a	5.00±0.15a
R_2E_1	496.42±66.56b	436.50±58.53d	8.29±1.11ed	17.56±2.35e	257.93±34.58cd	105.89±14.19c	152.71±20.47d	1.82±0.24d
R_2E_2	520.77±33.14b	505.90±32.20cd	6.36±0.40e	20.00±1.27e	327.37±20.83b	114.32±7.27c	171.64±10.92d	2.13±0.13d
R_2E_3	530.93±14.06b	529.29±14.02cd	10.74±0.28d	39.71±1.05d	249.81±6.61d	132.09±3.49c	234.10±6.20c	3.26±0.08c
Significant	*	*	**	*	*	**	*	**

[a,b,c]Column means for each item with unlike subscript letters different , *: (P<0.05), ** (P<0.01) NS: not significant, $R_{1\,and}$ R_2 represent Source of roughage WS= wheat straw and AH=Alfalfa Hay. E_1, E_2 and E_3 represent Source of enzyme LEP= local enzyme product, CEP = commercial enzyme product and control= without enzyme.

straw compared with control (table 2). Shekhar *et al*. (2010) reported that treatment with EFE mixture (1.5 g cellulase and 3.0 g xylanase) per kg of DM was not affected in DM intake and crude protein intake (grams per day) in Murrah buffaloes whereas total digestible nutrients intake (kilogram per day) was higher by (P < 0.05) by 12.53% compared with control group. Dean *et al*. (2013) explained that the tratment of bermuda grass forage with EFE does not affect on the DMI, NDFI or CPI. Rode *et al*. (1999) also found no significant effect of supplementation of EFE (Promote) to the concentrate diets on cows intake.

Second: Average Gain Performance and Feed Conversion Ratio

This part will deal with the main effect of source of roughage [R1: alfalfa hay(AH) and R2: wheat straw (WS)], source of enzyme [E1:local enzyme product (LEP), E2: commercial enzyme product (CEP) and E3: without enzyme (control)] and interaction between them (R×E) on average gain performance and feed conversion ratio.

a. The main Effect of Source of Roughages on Average Gain Performance and Feed Conversion Ratio

The main effect of source of roughages on average daily gain (ADG) and feed conversion ratio (FCR) are shown in table 3. Results showed that initial weight, final weight, total weight gain (TWG), ADG, and FCR when calculated as g DMI/ TWG and g MEI/TWG were not affected by source of roughages. Except the AG for the period 1-21 day was increased (P<0.05) with wheat straw compared with alfalfa hay as shown in table 4.5. Similar results showed by Bueno *et al*. (2013) who found that treatment with high doses of EFE (5 or 10 g of EFE kg-1 DM) to oat straw in lambs fed was not affected in the average daily gain and feed conversion ratio. Varlyakov *et al*. (2010) explained that the addition of an enzyme complex containing commercial cellulases, β-

Table 3 : The main effect of source of roughages and source of enzyme and interaction between them on gain parameters in Awassi lambs.

Factors	Initial weight kg	Final weight kg	Total gain kg	ADG 1-63 g/day	ADG 1-21 g/day	ADG 22-42 g/day	ADG 43-63 g/day	FCR g DM/TWG
Source of roughage (R)								
AH (R1)	30.00±1.47	36.25±1.36	6.25±0.70	99.20±11.20	92.70±11.35b	101.04±19.97	113.09±22.53	19.64±3.12
WS (R2)	29.68±2.39	35.79±2.36	6.10±0.40	96.89±6.50	149.79±24.62a	67.70±15.65	87.55±18.72	15.68±1.19
Significant	NS	NS	NS	NS	*	NS	NS	NS
Source of enzyme (E)								
LEP (E1)	29.12±3.74	34.68±3.50	5.56±0.59	88.29±9.41	96.56±16.04	104.68±22.89	74.40±19.32	18.86±4.01
CEP (E2)	30.12±1.71	36.50±1.78	6.37±0.24	101.19±3.89	120.31±16.69	60.93±13.24	130.95±25.45	15.40±0.91
control (E3)	30.28±1.30	36.87±1.31	6.59±1.03	104.66±16.46	146.87±36.95	87.50±28.24	95.62±28.97	18.72±3.16
Significant	NS	NS	NS	NS	NS	NS	NS	NS
Interaction between source of roughage and source of enzyme (RE)								
R_1E_1	29.12±4.04	34.75±3.05	5.62±1.12	89.28±17.85	100.00±14.43b	93.75±42.54	83.33±35.71	21.34±7.78
R_1E_2	30.37±1.92	36.87±1.87	6.50±0.20	103.17±3.23	100.00±20.41b	87.50±7.21	130.95±29.96	16.46±1.16
R_1E_3	30.50±1.90	37.12±2.53	6.62±1.99	105.16±31.64	78.12±26.20b	121.87±47.97	125.00±54.44	21.13±6.35
R_2E_1	29.12±6.99	34.62±6.92	5.50±0.61	87.30±9.72	93.12±31.38b	115.62±23.59	65.47±20.33	16.39±3.24
R_2E_2	29.87±3.14	36.12±3.36	6.25±0.47	99.20±7.59	140.62±24.67ab	34.37±17.21	130.95±46.10	14.35±1.33
R_2E_3	30.06±2.05	36.62±1.28	6.56±1.02	104.16±16.22	215.62±50.35a	53.12±25.19	66.24±19.41	16.32±1.57
Significant	NS	NS	NS	NS	*	NS	NS	NS

[a,b,c]Column means for each item with unlike subscript letters different *($P < 0.05$), NS: not significant, , R_1 and R_2 represent Source of roughage WS = wheat straw and AH=Alfalfa Hay. E_1, E_2 and E_3 represent Source of enzyme LEP= local enzyme product, CEP = commercial enzyme product and control = without enzyme.

glucanases, amylases, and proteases, at a dose of 1 g kg^{-1} of the substrate, with a low proportion of roughages (40%), did not affect on dry matter intake and average daily gain. Cruywagen and Goosen (2004) reported that an improvement in weight gain and FCR in lambs consuming a 66.8% from wheat straw and alfalfa hay supplemented with 5 and 10 ml kg^{-1} of EFE.

b. The main Effect of Source of Enzyme on Average Gain Performance and Feed Conversion Ratio

The main effect of source of the enzyme on ADG and FCR are shown in table 3. Results showed that initial weight, final weight, TWG, ADG and FCR were not affected by the source of enzyme as shown in table 3. On the contrary results; Cruywagen and Van Zyl (2008) reported that the treatment of diets containing high forage with commercial enzyme complex (cellulase, xylanase, and β-mannanase) was improved daily gain and increased feed conversion ratio in sheep. Malik and Bandla (2010) reported that significant effects on daily gain and feed conversion ratio by adding EFE (4,000 and 12,500 IU kg^{-1} DM of cellulase and xylanase respectively) to a diet contains equal parts of wheat straw and concentrate in buffalo (*Bubalus bubalis*). Eun *et al.* (2008) suggested that the differences in the growth performance of ruminants consuming forages previously treated with EFE may be due to factors such as specificity and enzyme activity as long as the method and time of application and the nature of the cell wall of the roughage.

c. Interaction effect between source of roughages and source of enzyme on average gain performance and feed conversion ratio

The interaction effect between the source of roughages and source of the enzyme on average gain performance and feed conversion ratio are shown in table 3. Initial weight,Final weight,Total gain, ADG and FCR were not affected by this interaction. Except the ADG for the period 1-21 day was slightly increased (P<0.05) in wheat straw without enzyme group as

Table 4 : The main effect of source of roughages, source of enzyme and interaction between them on nutrient digestibility (%).

Factors	DMD%	OMD%	EED%	CPD%	CFD%
Source of roughage (R)					
AH (R1)	89.45±0.99	78.72±1.57	83.99±1.47a	89.88±2.02a	73.53±2.52
WS (R2)	86.87±1.54	75.20±3.89	71.46±4.96b	45.42±14.54b	74.30±1.44
Significant	NS	NS	**	**	NS
Source of enzyme (E)					
LEP (E1)	86.96±1.43	75.90±2.33	77.54±3.99	75.80±11.08b	75.05±1.79
CEP (E2)	86.65±2.07	73.04±5.10	73.22±8.63	43.07±24.10c	74.32±2.82
control (E3)	90.89±0.28	81.94±1.43	82.41±1.32	84.09±4.01a	72.37±2.96
Significant	NS	NS	NS	**	NS
Interaction between source of roughage and source of enzyme (RE)					
R_1E_1	88.09±1.41ab	77.12±0.52ab	83.21±0.19ab	95.00±0.15a	76.65±1.10
R_1E_2	89.46±3.03ab	79.28±5.57ab	87.45±3.13a	84.81±0.62bc	76.28±6.12
R_1E_3	90.82±0.01a	79.76±1.45ab	81.31±1.72ab	89.84±3.07ab	67.65±2.25
R_2E_1	85.84±2.79ab	74.68±5.42ab	71.87±5.59b	56.60±0.47d	73.45±3.61
R_2E_2	83.83±0.87b	66.80±6.89b	59.00±5.76c	1.33±0.60e	72.36±1.69
R_2E_3	90.96±0.68a	84.12±0.91a	83.50±2.25ab	78.35±4.61c	77.09±1.78
Significant	*	*	**	**	NS

[a,b,c]Column means for each item with unlike subscript letters different, *: ($P<0.05$),**($p<0.01$) NS: not significant, , R_1 and R_2 represent Source of roughage WS= wheat straw and AH=Alfalfa Hay. E_1, E_2 and E_3 represent Source of enzyme LEP= local enzyme product, CEP = commercial enzyme product and control= without enzyme**.**

shown in table 4.5.In general low daily gain may be related to the first able low daily intake, heat stress and age of the animals used in this study. Except that daily gain growing the first three weeks were aceptable and that may be related to the compensatory growth of all experemental animals. The compensatory growth came from Low prevention nutrition. Mohamed *et al*. (2013) reported that treatment with EFE was increased the microbial activities in the rumen, which resulted in an enhancement of animal performance traits. Beauchemin *et al*. (2003) reported that the improvements in animal performance due to the treatment of the diet with EFE can be imputed fundamentally to improvements in ruminal fiber digestion resulting in increased digestible energy intake. Arce-Cervantes *et al*. (2013) Reported that the treated of corn stove, alfalfa hay and concentrate diet with lignocellulolytic extract (from the heat tolerant *basidiomycete* sp.) was not affected on feed intake and feed conversion ratio of the various evaluated fractions but the average daily gain was improved ($P<0.05$) compared with the control group. Cruywagen and Goosen (2004) concluded that different doses of EFE (xylanases and cellulases from *A. terreus*) significantly improved the weight gain by up to 32% and increased the feed conversion ratio by up to 25%, with a maximum dose of 40% concentrate, in lambs fed alfalfa hay and wheat straw. Arce-Cervantes *et al*. (2013) reported that the weight gain can be improved with enzyme treatment, although the response will show dissimilarity as a function of the selected enzymes.

Third: Digestibility trial

The objective of this part was to investigate the effect of source of roughages [R; alfalfa hay and wheat straw],the source of enzyme (E; LEP or CEP) and interaction between them (R×E) on nutrient digestibility in awassi lambs.

a. The main effect of source of Roughages on Nutrient Digestibility

The main effects of source of roughages on nutrient digestibility are present in table 4. Statistical analysis showed that there was no significant effect due to source of roughages on dry matter digestibility (DMD),organic matter digestibility (OMD), crude fiber digestibility (CFD), neutral detergent fiber digestibility (NDFD), acid detergent fiber digestibility (ADFD), acid detergent lignin digestibility (ADLD), cellulose digestibility (CELLD) and hemicelluloses (HEMID) as shown in table 4. Regarding ether extract digestibility (EED) and crude protein digestibility (CPD), they were high significant increased ($p<0.01$) by using alfalfa hay compared with wheat straw as shown in table 4. Gemeda *et al*. (2014) reported that the treatment with cellulase and xylanase enzymes at more than 0.5 mg/g DM improved NDF degradability of the *E. curvula* and maize Stover. Many studies reported that enzyme treatments have not affected on digestibility, in another study the treatment of silages with EFE led to relatively low NDF and lignin concentrations (Lewis *et al*., 1999; Sutton *et al*., 2003).

b. The main Effect of Source of Enzyme on Nutrient Digestibility

The main effects of source of the enzyme on nutrient digestibility are present in table 4. Results showed that there was no significant effect due to the source of the enzyme on all nutrients digestibility's except CPD was high significant decreased ($p<0.01$) with LEP and CEP compared with control groups. Many studies reported that supplementation of EFE mixtures had been beneficial effects and this mainly due to increased fiber and total tract digestibility in ruminants (Rode *et al*., 1999; Yang *et al*., 1999). Dado and Allen (1995) suggested that the improvement in the NDF digestibility by an addition of EFE may be due to increasing their degradability in the rumen which could decrease the physical fill in the rumen over time that way allowing higher voluntary feed intake. Zamora *et al*. (2015) reported that the supplementation of EFE (Fibrozyme 1.5 g enzyme/kg DM) increased *in vivo* digestibility ($p>0.05$) for king grass hay forage.

c. Interaction effect between source of roughages and Source of Enzyme on Nutrient Digestibility

The interaction effect between the source of roughages and source of the enzyme on nutrient digestibility is present in table 4. Results showed significantly decreased ($P<0.05$) due to the interaction between CEP and wheat straw (R2E2) compared with control (R2E3) in DMD and OMD but no significant differences in DMD and OMD when use LEP and CEP with alfalfa hay compared with control (R1E3) as shown in table 4. The EED was high significant decreased ($P<0.01$) with interaction between CEP and WS (R2E2) compared with other treatments that no significant difference among them as shown in table 4. Regarding CPD was high significant decreased ($P<0.01$) with interaction between CEP and WS (R2E2) compared with control (R2E3), but no significant effect with an interaction between LEP and AH (R1E1) compared with control (R1E3) as shown in table 4. Regarding CFD, NDFD, ADFD, ADLD and Cell.D. there was no significant difference among all treatments. But, the Hemi.D. was high significant decreased ($P<0.01$) with interaction between LEP and AH (R1E1) compared with control (R1E3) while Hemi.D. was no significant difference among other treatment. Beauchemin *et al*. (2003) suggested that the main effect of EFE is increased enzymatic activity inside the rumen, which increased digestibility of the total diet fed. Thus, the increases in digestibility are not limited to the dietary component to which the enzymes are used, which suggest why fibrolytic enzymes can be effective when supplemented to the concentrate portion diet. Increment hydrolytic capacity of the rumen can also lead to an increase in digestibility of the non fiber carbohydrate fraction, in addition to increasing digestibility of the fiber components of a diet; they suggest that fibrolytic enzymes can be effective in high-concentrate diets. Hutcheson (2002) reported that EFE (Cellulase enzymes) increase dry matter digestibility for alfalfa hay, cotton seed hulls, and cotton burrs. However; the digestibility of cotton seed hulls and cotton burrs was less than the improvement with alfalfa hay and could be due to the difference in energy available from the lower quality roughages. Rode *et al*. (1999) concluded that the digestibility of a corn silage-based TMR was improved by treatment with Promote (xylanase and cellulase). Similarly, Beauchemin *et al*. (1999) explained that treatment with EFE (4:1 Promote and pectinase mixture) increased total tract apparent OM digestibility of a barley silage-based TMR. Many studies suggest that the treatment with exogenous enzyme improved the digestibility by removing the phenolic barriers that limit the microbial digestion of the cell wall and then improved the colonization of the food particles by ruminal bacteria (Wang and McAllister, 2002; Wang *et al*., 2004). Hristov *et al*. (2008) reported that there is no difference in the digestibility of dry matter in the diet of animals treated with the enzymatic complex.

Conclusion

It could be concluded from this study; treatment roughages with EFE decreased the molar proportions of acetic acid and increased the molar proportions of probionic acid, butyric acid compared with control.

References

Abdel-Aziz, N. A., A. Z. Salem, M. M. El-Adawy, L. M. Camacho, A. E. Kholif, M. M. Elghandour and B. E. Borhami (2015). Biological treatments as a mean to improve feed utilization in agriculture animals–An overview. *J. Integr. Agric*., **14**: 534-543.

Alsersy, H., A. Z. Salem, B. E. Borhami, J. Olivares, H. M. Gado, M. D. Mariezcurrena, M. H. Yacuot, A. E. Kholif, M. El Adawy and S. R. Hernandez (2015). Effect of Mediterranean saltbush (Atriplex halimus) ensilaging with two developed enzyme cocktails on feed intake, nutrient digestibility and ruminal fermentation in sheep. *Animal Science Journal*, **86**: 51-58.

Al-Wazeer, A. A. M. (2015). Application of exogenous fibrolytic enzymes on the performance of Awassi lambs and Shami goats College of Agriculture,University of Baghdad (Ph.D. Dissertation).

Arce-Cervantes, O., G. Mendoza, P. Hernández, M. Meneses, N. Torres-Salado and O. Loera (2013). The effects of a lignocellulolytic extract of Fomes sp. EUM1 on the intake, digestibility, feed efficiency and growth of lambs. *Anim. Nutr. and Feed Tech*., **13**: 363-372.

Bala, P., R. Malik and B. Srinivas (2009). Effect of fortifying concentrate supplement with fibrolytic enzymes on nutrient utilization, milk yield and composition in lactating goats. *Animal Science Journal*, **80**: 265-272.

Beauchemin, K., D. Colombatto, D. Morgavi and W. Yang (2003). Use of exogenous fibrolytic enzymes to improve feed utilization by ruminants. *J. Anim. Sci.*, **81**: E37-E47.

Beauchemin, K., W. Yang and L. Rode (1999). Effects of grain source and enzyme additive on site and extent of nutrient digestion in dairy cows. *J. Dairy Sci*., **82**: 378-390.

Bhasker, T. V., D. Nagalakshmi, D. Srinivasa and T. Raghunandhan (2013). Effect of supplementing exogenous fibrolytic enzyme cocktail on nutrient utilization in sheep fed on maize stover based total mixed ration. *Indian J Anim Nutr*., **30**: 47-51.

Bowman, G., K. Beauchemin and J. Shelford (2002). The proportion of the diet to which fibrolytic enzymes are added affects nutrient digestion by lactating dairy cows. *J. Dairy Sci*., **85**: 3420-3429.

Bueno, A. L., G. Martínez, P. García, J. García and F. Pérez (2013). Evaluation of High Doses of Exogenous Fibrolytic Enzymes in Lambs Fed an Oat Straw Based Ration. *Anim.Nutr. and Feed Tech*., **13**: 355-362.

Cheng, K., S. Lee, H. Bae and J. Ha (1999). Industrial applications of rumen microbes. *Asian Australas J. Anim. Sci*., **12**: 84-92.

Chenost, M. and C. Kayouli (1997). Roughage utilization in warm climates. FAO animal production and health paper 135.

Cruywagen, C. and L. Goosen (2004). Effect of an exogenous fibrolytic enzyme on growth rate, feed intake and feed conversion ratio in growing lambs. *S. Afr. J. Anim. Sci*., **34**: 71-73.

Cruywagen, C. and W. Van Zyl (2008). Effects of a fungal enzyme cocktail treatment of high and low forage diets on lamb growth. *Anim. Feed. Sci. and Tech*., **145**: 151-158.

Dado, R. and M. Allen (1995). Intake limitations, feeding behavior, and rumen function of cows challenged with rumen fill from dietary fiber or inert bulk. *J. Dairy Sci*., **78**: 118-133.

Dean, D., C. Staples, R. Littell, S. Kim and A. Adesogan (2013). Effect of method of adding a fibrolytic enzyme to dairy cow diets on feed intake digestibility, milk production, ruminal fermentation, and blood metabolites. *Anim.Nutr. and Feed Tech*., **13**: 337-357.

Duncan, D. (1955). Multiple range and multiple F-tests. *Biometrics*, **11** : l-42. JMF Abreu, AM Bruno-Soares/Anim. Feed Sci. Technol. 70 (1998) 49-57 Sl.

Elghandour, I. Domínguez, M. Ronquillo and A. Kholif (2015). Influence of exogenous enzymes in presence of *Salix babylonica* extract on digestibility, microbial protein synthesis and performance of lambs fed maize silage. *The Journal of Agricultural Science*, **153**: 732-742.

Eun, J.-S., D. R. ZoBell, C. Dschaak and D. Diaz (2008). Effect of fibrolytic enzyme supplementation on growing beef steers.

Gemeda, B. S., A. Hassen and N. Odongo (2014). Effect of fibrolytic enzyme products at different levels on in vitro ruminal fermentation of low quality feeds and total mixed ration. *J. Anim. Plant Sci*., **24**.

Hassan, S. A. and J. A. Tawffek (2009). Effect of washing and physical form of chemical treated barley straw on nutritive value ,phenolic compound and activity of rumen bacteria. 1-Sodium hydroxide treatment. *Iraqi J. Agric. Sci*., **40**: 138-147.

Hassan, S. A., J. A.Tawffeq and A. A. M. Al-Wazeer (2015). Effect of exogenous fibrolytic enzymes on digestibility and rumen characteristics in Shami goats. *Kufa Journal for Agricultural Science*, **7** : 205-223.

Hristov, A., C. Basel, A. Melgar, A. Foley, J. Ropp, C. Hunt and J. Tricarico (2008). Effect of exogenous polysaccharide-degrading enzyme preparations on ruminal fermentation and digestibility of nutrients in dairy cows. *Anim. Feed. Sci. and Tech*., **145**: 182-193.

Hutcheson, D. (2002). Improving fibrolytic enzymes for beef and dairy diets. *FEED MIX*, **10**: 32-34.

Kearl, L. (1982). Nutrient requirements of ruminant in development contries. Logan: Utah State University.

Khattab, H., H. Gado, A. Kholif, A. Mansour and A. Kholif (2011). The potential of feeding goats sun dried rumen contents with or without bacterial inoculums as replacement for berseem clover and the effects on milk production and animal health. *Int. J. Dairy Sci.*, **6**: 267-277.

Knowlton, K., J. McKinney and C. Cobb (2002). Effect of a direct-fed fibrolytic enzyme formulation on nutrient intake, partitioning, and excretion in early and late lactation Holstein cows. *J. Dairy Sci*., **85**: 3328-3335.

Kumar, S., S. S. Dagar, S. K. Sirohi, R. C. Upadhyay and A. K. Puniya (2013). Microbial profiles, *in vitro* gas production and dry matter digestibility based on various ratios of roughage to concentrate. *Ann. Microbiol*., **63**: 541-545.

Lewis, G., W. Sanchez, C. Hunt, M. Guy, G. Pritchard, B. Swanson and R. Treacher (1999). Effect of direct-fed fibrolytic enzymes on the lactational performance of dairy cows. *J. Dairy Sci*., **82**: 611-617.

Malik, R. and S. Bandla (2010). Effect of source and dose of probiotics and exogenous fibrolytic enzymes (EFE) on intake, feed efficiency and growth of male buffalo (Bubalus bubalis) calves. *Trop. Anim. Health Prod.*, **42** : 1263-1269.

Mohamed, D. E.-D. A., B. E. Borhami, K. A. El-Shazly and S. M. Sallam (2013). Effect of dietary supplementation with fibrolytic enzymes on the productive performance of early lactating dairy cows. *J. Agric. Sci.*, **5**: 146.

Muwalla, M., S. Haddad and M. Hijazeen (2007). Effect of fibrolytic enzyme inclusion in high concentrate fattening diets on nutrient digestibility and growth performance of Awassi lambs. *Livest. Sci.*, **111**: 255-258.

Phakachoed, N., W. Suksombat, D. Colombatto and K. Beauchemin (2013). Use of fibrolytic enzymes additives to enhance *in vitro* ruminal fermentation of corn silage. *Livest. Sci.*, **157** : 100-112.

Pinos-Rodríguez, J., S. González, G. Mendoza, R. Bárcena, M. Cobos, A. Hernández and M. Ortega (2002). Effect of exogenous fibrolytic enzyme on ruminal fermentation and digestibility of alfalfa and rye-grass hay fed to lambs. *J. Anim. Sci.*, **80**: 3016-3020.

Poonooru, R. R., R. K. Dhulipalla, R. R. Eleneni and A. R. Kancharana (2016). *In vitro* Evaluation of Total Mixed Rations Supplemented with Exogenous Fibrolytic Enzymes and Live Yeast Culture. *Inter J Vet Sci.*, **5**: 34-37.

Rode, L., W. Yang and K. Beauchemin (1999). Fibrolytic enzyme supplements for dairy cows in early lactation. *J. Dairy Sci.*, **82**: 2121-2126.

Saeed, A. A. (2011). Effect of level and degradability of dietary protein fed without bakers yeast (*Saccharomyces cerevisiae*) on Turkish Awassi lamb's performance, College of Agriculture, University of Baghdad (Ph.D. Dissertation).

Salem, A., H. Alsersy, L. Camacho, M. El-Adawy, M. Elghandour, A. Kholif, N. Rivero, M. Alonso and A. Zaragoza (2015). Feed intake, nutrient digestibility, nitrogen utilization, and ruminal fermentation activities in sheep fed *Atriplex halimus* ensiled with three developed enzyme cocktails. *Czech J. Anim. Sci.*, **60**: 185-194.

Salem, A.-F. Z., M. El-Adawy, H. Gado, L. M. Camacho, M. Ronquillo, H. Alsersy and B. E. Borhami (2011). Effects of exogenous enzymes on nutrients digestibility and growth performance in sheep and goats. *Tropical and Subtropical Agroecosystems*, **14**.

SAS (2012). *Statistical Analysis System*, User's Guide. Statistical. Version 9.1th ed. SAS. Inst. Inc. Cary. N.C. USA.

Shekhar, C., S. S. Thakur and S. K. Shelke (2010). Effect of exogenous fibrolytic enzymes supplementation on milk production and nutrient utilization in Murrah buffaloes. *Trop. Anim. Health Prod.*, **42**: 1465-1470.

Sujani, S. and R. Seresinhe (2015). Exogenous Enzymes in Ruminant Nutrition : A Review. *Asian J. Anim. Sci.*, **9** : 85-99.

Sutton, J., R. Phipps, D. Beever, D. Humphries, G. Hartnell, J. Vicini and D. Hard (2003). Effect of method of application of a fibrolytic enzyme product on digestive processes and milk production in Holstein-Friesian cows. *J. Dairy Sci.*, **86** : 546-556.

Valdes, K., A. Salem, S. López, M. Alonso, N. Rivero, M. Elghandour, I. Domínguez, M. Ronquillo and A. Kholif (2015). Influence of exogenous enzymes in presence of *Salix babylonica* extract on digestibility, microbial protein synthesis and performance of lambs fed maize silage. *The Journal of Agricultural Science*, **153** : 732-742.

Varlyakov, I., N. Grigorova and T. Slavov (2010). Effect of hostazym c 100 on growth performance and some hematological and ethological indexes of yearling rams. *Bulg. J. Agric. Sci.*, **16** : 659-664.

Wang, Y. and T. McAllister (2002). Investigation of exogenous fibrolytic enzyme activity on barley straw using *in vitro* incubation. *J. Anim. Sci.*, **80** : 316.

Wang, Y., B. Spratling, D. R. ZoBell, R. Wiedmeier and T. McAllister (2004). Effect of alkali pretreatment of wheat straw on the efficacy of exogenous fibrolytic enzymes. *J. Anim. Sci.*, **82** : 198-208.

Ware, R., N. Torrentera and R. Zinn (2005). Influence of maceration and fibrolytic enzymes on the feeding value of rice straw. *J. Anim. Vet. Adv.*

Yang, W., K. Beauchemin and L. Rode (1999). Effects of an enzyme feed additive on extent of digestion and milk production of lactating dairy cows. *J. Dairy Sci.*, **82** : 391-403.

Yang, W., K. Beauchemin and L. Rode (2000). A comparison of methods of adding fibrolytic enzymes to lactating cow diets. *J. Dairy Sci.*, **83** : 2512-2520.

Zamora, J. G. Q., J. H. A. Cevallos, E. O. T. Moreno, M. M. P. Galeas, A. E. B. Álvarez and P. F. Y. Macías (2015). Enzimas fibrolíticas exógenas en la degradación ruminal in situ del pasto king grass (*Pennisetum hybridum*) en dos edades de corte. *Revista Ciencia y Tecnología*, **8** : 35-41.

Zhao, L., Y. Peng, J. Wang and J. Liu (2015). Effects of Exogenous Fibrolytic Enzyme on in vitro Ruminal Fiber Digestion and Methane Production of Corn Stover and Corn stover Based Mixed Diets. *Life Sci. J.*, **12**.