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Utilization of Trimming Waste of Mandarin Trees as Feed for Small Ruminants:
3. Evaluation of Growth Performance and Carcass Traits for Barki Lambs

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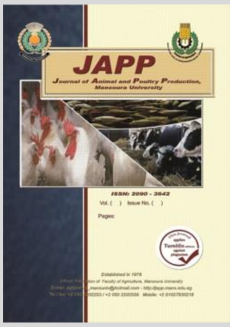

ABSTRACT

Thirty weaned Barki lambs with average body weight 27.56±0.57 kg were blocked by weight and randomly distributed into three equal groups to investigate the impact of feeding trimming waste of mandarin trees (TWMT) on productive performance of lambs. The first group of animals was fed with Berseem hay (BH) plus concentrate feed mixture (CFM) without any additives and kept as a control ration (CR). The second group was fed TWMT plus CFM as untreated ration (UR), where, the animals in group three received TWMT plus CFM supplemented with Bio-Magic with level 10kg fresh matter/ton CFM and kept as a treated ration (TR). Feed was offered as 70% CFM of the total requirements for growing lambs and the roughage was offered *ad lib*. The results were summarized as follows:- CR group had higher digestibility than other groups. Sheep fed TR ration revealed lower TDN compared to the other groups. The DCP was significantly higher for UR and TR than CR-The CR group recorded the lowest value of N-retained however no significant differences were recorded between UR and TR groups. -The ADG for TR group increased by 4% and 15.9% compared to CR and UR, respectively.- Feed conversion was the best for lambs fed TR, while UR recorded the worst value.- The best economic efficiency recorded by TR. -It may be concluded that, TWMT has the potential solve to reduce shortage of roughage feeds for animals in Egypt; furthermore reducing feed cost under desert conditions.

Keywords: Mandarin Trimming Waste, Barki lambs, Digestibility, Fermentation, Performance, Carcass.

INTRODUCTION

It becomes extremely necessary to utilize the locally available resources in order to meet the increasing demand of animal protein, especially in developing countries. In Egypt, the shortage of feeds for animals is a serious problem especially during summer season (about 6 month). The limited arable land and poor natural ranges and inadequacy of the traditional green fodders particularly in summer season has led to negative effects on mutton meat production (El Badawi, 2018). It is evident that great attention must be paid to non-traditional type of feeds with particular emphasis on roughages. There have been several successful attempts to confirm the feeding value of the potential fodders for ruminant nutrition in the tropics (Benninson and Paterson, 1997). The trimming waste of citrus trees is one of these potential residues. Citrus species constitute one of the major tree fruit crops of the subtropical regions with great economic importance (Terol *et al*., 2008). Citrus fruits, which belong to the Rutaceas family, are among the most commonly grown and consumed fruits around the world. Among these are mainly oranges, mandarins, limes, lemons, and grapefruits (Anticona *et al*., 2020).

There are different mandarin varieties cultivated in Egypt and the total cultivated area reach to 47646 ha (Abobatta, 2019). So, researchers have attempted to use citrus residues for ruminant feeding (Fayed *et al*., 2009, Phillip *et al*., 2014, Galal *et al*., 2016 and Mahrous *et al*., 2019). The utilization of crop residues has several advantages as follows:

- Reduction of environmental pollution and consequently health hazards resulting of the burning of these residues (Khir, *et al*., 2015).
- Reduction of feed cost and consequently increase the economic efficiency of livestock production (Borhami and Yacout, 2001).

Mandarin trees are usually subjected to severe pruning every second year and light pruning in the alternate year. The trimming is the result of pruning. Trimming is used at the first place to obtain oil. After extraction of oil (which is used for medical purposes) the trimming waste remains. The separation of the large branches, the leaves and twigs (ranged from 3-5 cm in diameter) can be offered to ruminants.

Meanwhile, FAOSTAT (2018) pointed out that there was more than 2.34 million head of sheep produced 72,296 tons of red meat representing approximately 7.4% of all red meat production in 2017. Barki sheep is one of the three main breeds in Egypt. More than one million head of this breed are maintained along the North Western Coastal Area (MALR, 2013). They are traditionally raised as a source of income for the Bedouin especially in the reclaimed and desert lands (Elshazly and Youngs, 2019 and Khalil *et al*., 2013). The meat produced from Barki sheep is highly preferred for consumers and has higher market prices compared to other Egyptian sheep breeds (Shehata 2013).

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So, this paper aimed to investigate the impact of feeding trimming waste of mandarin trees for lambs on productive performance and carcass characteristics.

MATERIALS AND METHODS

Experimental location

This study was carried out at Siwa station, Desert Research Center. Siwa Oasis is situated in a depression at the northern edge of Egypt's Western Desert, 80 km from the Egyptian border with Libya and 300 km south of the Mediterranean port town of Marsa Matrouh. Siwa Oasis lies as much as 18 m below sea level (Masoud & Koike 2006).

Bio-Magic Composition

Bio-Magic (BM) is a commercial name for multi-compound additives and still under testing. The BM contained mixture varity feed additives such as amino acids (301.6g/ kg mixture), vitamins (4.7 g/ kg mixture), mineral g/kg (total 145.0 g/ kg mixture), enzymes (Pepsin, Amylase, Protease, Lipase, and Hemicellulase) and bacteria (Aerobic, G^+ and anaerobic G^-). The Proximate analysis was as follows: DM 33.60%, OM 62.03%, Ash 37.97%, CP 36.34%, CF 1.99%, EE 6.19%, and NFE 17.51%.

Experimental animals and rations

Thirty weaned Barki lambs aged 4 months and weighing on average 27.56±0.57 kg were blocked by weight and randomly distributed into three groups (10 lambs each). Each group received one of three dietary regimens. The first lamb group was fed one which consist of berseem hay (BH) plus concentrate feed mixture (CFM) without any additives and kept as a control ration (CR). The second group was fed trimming waste of mandarin trees (TWMT) plus CFM as untreated ration (UR), where, the animals in group three received TWMT plus CFM supplemented with Bio-Magic (BM) with level 10kg fresh matter/ton CFM and kept as a treated ration (TR). Concentrate ingredients were good mixing and supplemented with a complex material which have different type of feed additives. The CFM consisted of corn 50.5%, wheat bran 20.0%, soybean meal 16.0%, discarded dates 10.0%, lime stone 1.6%, salt 1.6%, mineral and vitamin mixture 0.1%, yeast 0.1%, and mycotoxin adsorbent 0.1%. the experimental rations were as follows:

CR: CFM + BH
UR: CFM + TWMT
TR: (CFM + BM) + TWMT

Feed was offered as 70% CFM depending on the changes of live body weight according to Kearl (1982) and the rest amount required for growth was covered by the ad lib roughage.

Digestibility and nitrogen balance trials:

Four animals from each group were housed in individual metabolic cages (1.6 m x 0.53 m) and offered the three rations for two weeks in a preliminary period followed by one week collection period. Water was offered twice daily and water intake was recorded.

Daily excreted feces from each animal were collected. Exact 10% representative samples of the weight were taken and dried. Urine was collected daily in plastic jars, acidified (using 50 ml of 6N H_2SO_4), measured and 10% of the volume was sampled for nitrogen determination.

Sampling of rumen liquor:

Rumen liquor samples were taken by stomach tube from all animals on the day following the digestibility trials. The samples were taken before morning feeding (zero-time) and at 3 and 6h. post-feeding. The rumen samples were filtered through two layers of cheese-cloth and used quickly as possible for measurement of pH by using Beckman pH meter. Rumen liquor was stored in plastic bottles with a few drops of 0.1 N HCl and stored at a deep freeze (-20˚C) till analysis.

***In vitro* gas production and effective dry matter degradability:**

The same three experimental diets were prepared as total mixed rations according actual feed intake in each group and used to investigate the *in vitro* gas production by using the method described by Menke and Steingass (1988). Three ruminally- cannulated Barki rams were used as a source of rumen liquor inoculum. Rams were fed a diet containing BH (50%) and CFM (50%) ration.

The gas production was recorded after, 3, 6, 12, and 24 h. of incubation. Total gas volume was recorded at each time and the values were corrected for the blank value and gas values are expressed in ml per 200 mg DM. Cumulative gas production (Y) at the time (t) was fitted to the exponential model of Ørskov and McDonald (1979) as follows:

$$\textbf{Gas production (Gp)} = a + b\,(1 - e^{-ct}),$$

Where,

a= the gas production from the immediately soluble fraction,
b= the gas production from the insoluble fraction,
c= the gas production rate constant for the insoluble fraction (b),
t = incubation time.

The effective DM degradability (EDMD) for tested rations were estimated from the equation of McDonald **(**1981**),** where

$$\textbf{EDMD} = a + (bc / (c + k)$$

Where,

k is the out flow rate and assumed to be 0.03.

Microbial protein was calculated as 19.3g microbial nitrogen per kg OMD according to Czerkawaski (1986).

Slaughtering procedures:

The entire experimental animals were slaughtered at the end of the experiment after 24h fasting period. Slaughtering procedures was followed as described in a previous study of Kewan (2013). Eye muscle area was measured with planimeter in square centimeters and fat thickness was measured using calipers as described by USDA (1975).

Chemical analysis:

The samples of feed, feces and urine were analyzed for proximate analysis according to AOAC (2000), dry matter (DM; method 930.15), ether extract (EE; method 954.02), crude protein (CP; method (Kjeldhal) 955.04) and ash (method 942.05). Gross energy (GE) of feeds and feces were determined by using Calorimeter (KIKA® WERKE C5001).

The stored strained rumen liquor samples were thawed at room temperature and then analyzed for ammonia nitrogen (NH_3-N) using Markham micro-distillation apparatus (Preston 1995) and total volatile fatty acids (TVFA) by a Kjeldahl distillation method according to AOAC (1997). The molar concentration of VFA fractions was adapted according to Soltan *et al.* (2018) using gas chromatography (model TRACE1300, Thermo Fisher Scientific, Inc., Rodano, Milan, Italy) by the Central Lab for

Food and Feed (CLFF), Agricultural Research center, Ministry of Agriculture, Giza, Egypt.

Chemical analysis (moisture, protein, and fat) of the *Longissimus dorssi* samples was determined using Food Scan™ Pro meat analyzer (Foss Analytical A/S, Model 78810, Denmark), according to the manufacturer's instructions. Ash content was determined by burning samples in a muffle furnace at 600˚ C for eight hours.

Calculations and statistical analysis:

Metabolic water was calculated from TDN intake, yielding of 0.6 g. water per g. (Farid *et al*., 1985). Metabolizable energy (ME) and net energy (NE) was estimated according to the equations of Abate and Meyer (1997) where:

$$ME\ (MJ/kgDM) = 20.27 - 0.1431CF - 0.111\ NFE - 0.2200\ Ash.$$

$$NE\ (MJ/kg\ DM) = 0.096 \times GP + 0.0038 \times CP + 0.000173 \times EE + 0.54,$$

where,

GP is 24h net gas production (ml/200 mg DM), and CP, EE, ME, NE are crude protein, ether extract, metabolizable energy, and net energy, respectively.,

Microbial protein was calculated as 19.3g microbial nitrogen per kg OMD according to Czerkawaski (1986).

Data were statistically analyzed by one way of variances according to SAS (2004) using the following model;

$$Yij = \mu + Ti + eij,$$

Whers;

Yij = experimental observation, μ = overall mean, Ti = effect of treatment, eij = experimental error. Differences among means were compared by Duncan's multiple range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical composition:

Data in table (1) show the chemical composition of CFM with or without BM. Chemical analysis indicated that the values of DM, OM, CP, CF and EE were similar between CFM without or with BM. Concentration of GE decreased by 9.74% for treated versus untreated CFM.

Table 1. Chemical composition of the concentrate feed mixtures, roughages, feed additive and the experimental rations

Item	Concentrate mixtures		Roughages		Feed Additive	Experimental rations		
	CFM	CFM + BM	BH	TWMT	BM	CR	UR	TR
DM %	91.33	91.44	89.67	93.08	33.60	90.83	91.87	91.82
OM %	94.02	92.83	85.79	84.94	62.03	91.48	91.20	90.03
CP %	14.43	14.97	12.98	13.63	36.34	14.00	14.18	14.50
CF %	3.59	3.41	27.50	20.74	1.99	10.58	8.90	9.54
EE %	4.09	4.38	3.79	5.32	6.19	4.00	4.47	4.71
NFE %	71.91	70.07	41.52	45.25	17.51	62.90	63.65	61.28
Ash %	5.98	7.17	14.21	15.06	37.97	8.52	8.80	9.97
GE, MJ/kg DM	17.05	15.39	16.49	15.85	12.88	16.87	16.86	15.54

Ash content was higher by 19.89% for CFM + BM than CFM alone due to biological additive. These results are consistence with those obtained by Mahrous *et al*. (2019) for organically processed olive trees byproducts due to biological treatment.

Chemical composition showed higher contents of DM and NFE for TWMT compared with BH; however the other nutrients were similar.

The result of the chemical composition (i.e. CP and Ash%) of Mandarin trimming waste (Table 1) was nearly similar to those obtained by Karabulut *et al*., (2007) who reported that the CP contents of different citrus tree leaves ranged from 12.30 to 14.83%, while ash content ranged from 10.45 to 17.08%. Hernandez *et al*., (1998) reported that the leaves of citrus such as lemon can be incorporated into roughage at high levels as a substitute for NH_3-treated barley straw with no adverse effect on animal performance.

Digestibility coefficients and nutritive values of the experimental rations:

Digestion coefficient of nutrients and nutritive values of control (CR), UR and TR rations are presented in Table (2). Data of digestibility trials showed that CR had higher digestion coefficients of DM, CF, and NFE than the others. These results were similar to those obtained by Kewan *et al*. (2019).

They reported that DM, CP, and CF digestibility increased in growing Barki lambs fed control ration compared with group fed ration contained Moringa stalks treated with *Trichoderma reesei*. Also, Salazar *et al*, (2019) suggested that the DM, OM, CP, and EE digestibility coefficients were not different ($p > 0.05$) among control with or without different feed additives such as monensin, probiotic *Enterococcus faecium.* Furthermore, El-Sheikh (2012) found that supplemented rabbit diet with two levels of Bio Magic (1 or 2g/kg feed), resulted insignificantly decrees for nutrient digestibility compared with control. In general, lower digestion coefficient of nutrients for TR group may be due to lower CFM intake and/ or the additive level is not enough. In this concern, El-Sheikh (2012) found that, when the additives level increased to be 3g BM/kg rabbit diet, the digestibility of most nutrients was improved.

Table 2. Digestibility coefficients and nutritive values of the experimental rations fed to Barki lambs

Item	Experimental rations			SEM	P value
	CR	UR	TR		
Feed intake, g DM/ head/ d					
CFM	896^{a}	842^{ab}	777^{b}	27.45	0.039
Roughage	378^{b}	378^{b}	426^{a}	14.75	0.073
Total	1274	1220	1203	38.85	0.437
Nutrients Digestibility, %					
DM	71.60^{a}	71.36^{a}	66.49^{b}	0.92	0.005
OM	73.34^{ab}	74.09^{a}	70.23^{b}	0.81	0.019
CP	77.38^{b}	83.51^{a}	$82.1a^{b}$	1.62	0.05
CF	50.45^{a}	48.07^{a}	36.51^{b}	2.59	0.009
EE	83.91	87.29	87.4	2.52	0.560
NFE	75.66^{a}	75.00^{a}	71.34^{b}	0.9	0.016
Nutritive Values, %					
TDN	71.35^{a}	72.64^{a}	68.37^{b}	0.75	0.009
DCP	10.83^{b}	11.84^{a}	11.90^{a}	0.23	0.015

The nutritive values as TDN and DCP (Table 2) showed that sheep fed TR ration revealed significantly (p<

0.05) lower TDN compared to the other groups. On the other hand, DCP was significantly higher for UR and TR compared to CR. However, the highest value of DCP was recorded by TR. The improvement in DCP of the TR may be due to the BM addition, which contained amino acid and specific enzymes (Pepsin, Amylase, Protease) related to protein digestion.

Nitrogen and water metabolism

Nitrogen intake, N-excreted and N-retained by lambs fed different experimental rations are shown in Table (3). Data clarified that different values of nitrogen parameters (except nitrogen intake) were deferred (P<0.05) as affected by BM treatment. The CR had higher fecal nitrogen compared to other rations. The excreted urine nitrogen showed the same trend. This was reflected on total nitrogen excretion which recorded higher (P<0.05) value than UR and TR groups. This result was in agreement with results obtained by Aziz, (2020). Who found higher total nitrogen excretion for untreated date palm tree leaves compared to treated rations with different biological treatments (Cellulase, Taninnase, Fibrolytic and combinations of each with other). Generally, the current results agreed with Fayed *et al*., (2009) who found that biological treatment decreased fecal, urine and total nitrogen excretion.

Table 3. Nitrogen and water utilization in Barki lambs fed the experimental rations

Item	Experimental groups			SEM	P value
	CR	UR	TR		
Nitrogen utilization (g/d)					
Nitrogen intake (NI)	28.53	27.68	27.91	0.88	0.785
Fecal nitrogen (FN)	6.45[a]	4.55[b]	5.02[ab]	0.48	0.054
Urinary nitrogen	13.59[a]	9.73[b]	8.97[b]	0.74	0.004
Total N excretion	20.04[a]	14.28[b]	13.99[b]	0.84	0.001
Nitrogen retained (NR)	8.49[b]	13.40[a]	13.92[a]	0.62	<0.001
NR/ NI %	29.76[b]	48.41[a]	49.87[a]	2.05	<0.001
Water utilization (g/kg$^{0.82}$)					
MBW, kg$^{0.82}$	23.29	23.31	23.15	0.22	0.869
Compound feed water	5.52[a]	4.64[b]	4.63[b]	0.15	0.003
Free water intake	236[a]	174[b]	216[a]	10.16	0.006
Metabolic water	23.41	22.82	21.32	0.72	0.163
Total water intake	265[a]	201[b]	242[a]	9.49	0.003
Fecal water excretion	18.41	13.00	14.03	2.21	0.238
Urine water excretion	58.50[a]	21.01[b]	46.73[a]	7.47	0.017
Total water excretion	77[a]	34[b]	61[a]	6.75	0.005
Insensible water loss	188	167	181	9.75	0.358

On the other hand, CR recorded the lowest value of N-retained (significantly lower compared with other groups). No significant differences were recorded between UR and TR for nitrogen retained. Higher N- retained for UR and TR may be due to the lower total nitrogen excretion and the presence of BM. The present results are in line with those obtained by Aziz (2020) who reported improved N balance for sheep fed biologically treated date palm leaves compared with untreated one. However, all groups were in a positive nitrogen balance.

The effect of feeding CR, UR and TR on various water utilization parameters are shown in Table (3). The combined feed water was mainly affected by feed intake and moister content of the experimental rations and was higher (P<0.05) for CR group, while other groups showed insignificant differences. Higher combined feed water for CR group may be due to high moister content and low DM content (Table 1). Free water intake was lower (P<0.01) for UR than other groups. The CR recorded the highest value compared to other groups. The present results are disagreement with those reported by Abo Bakr *et al*., (2020) who found that the biological treatment (yeast or ZADO) of tree trimming wastes caused the increase of free water intake. Higher free water intake in CR group might be due to higher dry matter intake (Allam *et al*., 2006), and/or high crude protein intake (Allam *et al*., 2009). Metabolic water was not significantly (p> 0.05) different among groups. Water excreted via faces and urine (g/kg BW) showed significant differences (p<0.05) among groups. Regardless BH group, the higher urinary water in TR may be due to higher ash content in BM product (Table 1) and higher concentrate intake as shown later. Commonly, these results were in accordance with those obtained by Fayed *et al*., (2009) who found that sheep fed BH tented to excrete more water than sheep fed treated olive leaves (chemical or biological treatments). Insensible water loss showed insignificant differences among groups and ranged from 167 to 188 g/kg$^{0.82}$.

Rumen fermentation:

The data of Table (4) indicated significant differences for ruminal pH only at 6h and mean times.

Table 4. Rumen fermentation parameters in the experimental animals

Item	Time	Experimental Groups			SEM
		CR	UR	TR	
Rumen pH	0hr	6.55	6.30	6.22	0.06
	3hr	5.49	5.41	5.54	0.05
	6hr	5.67[b]	5.28[c]	5.47[bc]	0.06
	Mean	5.91[A]	5.74[B]	5.67[B]	-
NH_3-N (mg/dL)	0hr	37.68[ab]	40.40[ab]	50.51[a]	3.10
	3hr	49.14[a]	26.21[b]	32.49[ab]	3.56
	6hr	31.40[ab]	41.77[ab]	42.32[ab]	2.54
	Mean	39.40	36.13	41.77	-
TVFA (meq/dL)	0hr	7.27[a]	9.37[ab]	10.25[a]	0.53
	3hr	10.70[a]	8.73[ab]	10.75[a]	0.56
	6hr	10.32[a]	9.37[ab]	9.70[a]	0.32
	Mean	9.43	9.16	10.23	-
VFA fractions%					
Acetic acid	6hr	39.10	38.20	38.32	2.71
Propionic acid	6hr	12.15	15.05	13.28	1.88
Butyric acid	6hr	12.05	15.32	12.32	1.13

The highest value was for CR followed by TR then UR. The rumen pH values ranged from 6.22-6.55 at zero time post-feeding. Zhang *et al*., (2013) suggested that the acceptable value of pH for sheep ranged from 6.2 to 7.0 which led to the suitable ecological environment of rumen microorganisms and could be ensure normal rumen fermentation. The mean values of ruminal pH at 3h post feeding showed a decrease and reached the lowest value at 6h post feeding. This trend of ruminal pH maybe related to ruminal fermentation process by rumen microorganisms. In regrades with sampling time, the mean values of pH showed significantly differences between CR and other groups and ranged from 5.74 to 5.91. Also, there were no significant differences between UR and TR. These results are in agreement with Abo-Eid *et al*. (2007) who reported that ruminal pH was not significantly lower for rams fed rations containing biologically treated roughage or control.

Generally, the mean pH values of rumen liquor in the present study are within the ranges (4.9 – 7.9) reported by Choughary and Orga (1979) for different types of feeds.

Concentrations of NH_3-N were different ($P<0.05$) among groups. Regardless of CR group, the highest values were recorded by TR at various sampling time. These findings are mainly attributed to feed treatment under the present investigation which is confirmed by those of Abo-Eid *et al*. (2007) where ruminal ammonia was higher for rams fed rations containing biologically treated various roughages than those fed untreated ration. Abo Bakr *et al*., (2020) found that higher mean values of ammonia concentrations were recorded for rams fed sole diets as TWMT with or without biological additives. The maximum concentration of NH_3-N was observed at 3h post feeding for UR and TR, then tended to decrease at 6h post feeding. This result may be related to the degradation of dietary degradable protein. Generally, ammonia concentration in our study is within the range (10-45 mg/ 100 ml rumen fluid) suggested by Church (1976) depending on diet composition and sampling time.

The data of ruminal total volatile fatty acids (TVA's) values (at zero time) indicated that UR and TR had higher values (mg/100 ml R.L) than CR but the differences among the three groups were not significant. TVFA's value increased post feeding (at 3h) and the highest value recorded by TR (BM group). Commonly, the overall means of ruminal TVFAs at the different sampling times clearly showed insignificant differences and the highest value was recorded by TR (10.23) also, in all groups, the lowest TVFA's value showed at zero time and reached the highest value at 3h post-feeding and then decreased gradually (except UR). These results suggest that the fermentation of biological additives (which found in BM product) were more efficient and faster yielding more TVFA's than that of CR and UR. The results of biological treatments might be related to more utilization of dietary energy and positive fermentation in the rumen. These results are in agreement with those found by Fayed *et al*., (2009). Also, Abo Bakr *et al*., (2020) found that mean values of TVFA's concentration ranged from 7.62 to 9.95 (meq/dL.) in rams fed TWMT treated with or without biological additives. In general, the mean values of TVFA's concentration in this study were within the normal range obtained by some researcher ; Phillip *et al*., (2014), Khir, *et al*., (2015) and Mahrous *et al*.,(2019) who found that the mean values of TVFA's concentration ranged from 9.8 to 17.81 meq/dL for lambs fed treated pruning fruits by products.

Fractions of ruminal volatile fatty acid (%) recorded post-feeding at 6h are presented in (Table 4). The data showed that there were no significant differences among various rations and different sampling time. The means of molar proportions of acetic acid ranged from 38.20 to 39.10 % and were within the ranged observed by Aziz (2019), who found that the percentage of acetic acid ranged from 34.37 to 39.42 for sheep fed untreated or biologically treated rations. Propionic acid percentage showed insignificant higher value for ration contained un-traditional roughage than BH. These results agreed with those obtained by Abo Bakr *et al*., (2020). The percentage of butyric acid insignificantly decreased for TR by 19.6% compared with UR. This may be due to the ingredient found in BM product. These finding are in accordance with those of Aboul-Fotouh *et al*. (2011).

***In vitro* gas production**

The data of *in vitro* gas production at different times of incubation, gas production kinetics, energy contents and microbial protein synthesis of the experimental diets fed to Barki lambs are presented in Table (5). Data of gas production illustrated higher significant values for TR than CR and UR while the lowest value was exhibited by CR. The higher gas production which was observed by TR may be due to the organic compounds such as amino acids, enzymes and microbes. Contradictory results were reported by Salem *et al*., (2015) who observed that the addition of probiotic linearly increased the gas production (GP) during the first 12h of incubation. In the same time, minimum values of GP recorded at 3h and gradually increased by turning time to reach the maximum value at 24h. In general, the high gas production by probiotic addition may be due to the increase of available of carbohydrates for ruminal fermentation as demonstrated by Makkar (2000).

Table 5. *In vitro* gas production at different times of incubation, gas production kinetics, energy contents and microbial protein synthesis of the experimental diets fed to Barki lambs

Items	Experimental groups			SEM	P value
	CR	UR	TR		
GP ml/ 200mg DM					
GP_{3h}	7.90^{c}	8.07^{b}	8.37a	0.04	0.001
GP_{6h}	15.73^{c}	15.93^{b}	16.37a	0.06	0.001
GP_{12h}	23.67^{b}	23.70^{b}	25.00a	0.04	<0.001
GP_{24h}	36.30^{b}	36.53^{ab}	36.67a	0.07	0.03
Methane production					
Methane, ml	4.88^{b}	5.61^{a}	4.43c	0.02	<0.001
Methane, %	13.43^{b}	15.34^{a}	12.10c	0.03	<0.001
In vitro gas production *kinetics*					
a, ml	3.47^{ab}	3.43^{b}	3.57a	0.03	0.069
b, ml	21.27^{b}	21.37^{ab}	21.47a	0.03	0.016
$a+b$, ml	24.73^{b}	24.80^{b}	25.03a	0.05	0.018
c, %h^{-1}	0.107^{b}	0.113^{ab}	0.123a	0.00	0.033
In vitro parameter					
EDMD when k=0.03, %	52.77^{b}	53.01^{b}	51.15^{a}	0.13	0.013
MP, g/kg DM	118.9^{a}	120.5^{a}	115.1b	0.64	0.003
Energy contents					
ME, (MJ/kg DM)	9.89^{b}	10.04^{b}	10.27a	0.06	0.013
NE, (MJ/kg DM)	4.08	4.10	4.12	0.04	0.475
NE/ ME, %	41.25	40.84	40.12	-	-

In vitro methane production as a volume or percentage showed highly significant difference among different groups and the highest value was recorded by CR followed by UR while the lowest value was in TR. Decreasing methane production for TR may be due to components of TR which has been used to directly inhibit methanogenic archaea and/or indirectly reduce methane production by directly suppressing some microbial metabolic processes contributing to methanogenesis. This result agreed with those obtained by Mwenya *et al*. (2004) who concluded that Probiotic culture might stimulate the acetogens to compete or to co-metabolize hydrogen with methanogens, thereby, reducing CH_4 emissions. Also, Thota *et al*. 2017 concluded that probiotics can be supplemented to reduce methane emissions in sheep fed coarse roughage.

Data of GP kinetics (*a*, *b* and *c*), and EDMD shown in Tables (5) recoded higher significant differences for TR than other groups while no significant differences were observed between CR and UR. These results were similar to those obtained by Phillip *et al*. (2014) when treated grape tree pruning by products with chemical or biological treatment. They found that the efficiency of DM degradability (EDMD %) was significantly higher for treated roughage than untreated one. Also, Khir *et al.* (2015) found that the EDMD of pruning peach trees by-products, was significantly (P<0.05) increased with fungi treatment (49.35%) compared with the control (40.27%).

On the other hand, TR recorded the lowest (P<0.05) value of microbial protein (MP) compared to other rations. This may be due to the increase in flow of useful microbial protein to the small intestine (Abd El-Tawab *et al*. 2016) and may be due to the influence of bacterial amino acid flowing out of the rumen,

Energy utilization in Table (5) showed higher significant difference only for ME in TR group, while NE was not significantly differed among all groups.

Lamb performance and economic efficiency indicators

Growth performance data are summarized in Table (6). It was observed that the values of initial and final weights for lambs fed CR, UR or TR rations were insignificantly different among them. This is a good result to replace BH by untraditional roughage in sheep feeding and decrees feed cost. There was a significant higher ADG for TR than other groups. The ADG for TR group increased by 4% and 15.9% compared with CR and UR respectively. Increasing ADG reflected on total gain during all period, hence, TR recoded the highest value (P<0.05) compared to CR and UR. Increasing ADG for TR group may be due to many reasons such as improving digestion coefficient of CP, higher digested protein intake (g/d) which probably enhanced the utilization and the availability of essential nutrients especially protein (Kewan *et al*., 2019), increasing DMI (Khir, *et al*., 2015), presence of probiotic and amino acids of feed (Prado *et al*., 2015). Adding enzymes and some amino acids in diets based on grass pastures for lambs led to improvement in ADG (Prado *et al*., 2015). Generally, Wadhwa, *et al*. (2015) suggested that citrus and winery by-products have been widely used as an alternative feed and energy source in ruminant diets with no detrimental effects on animal performance.

Average dry matter intake (DMI) for UR groups showed significant decreases compared with other groups in concentrate and total dry matter intake, but there were no significant differences in roughage intake among groups. The UR recorded the lowest value of average intake in all items compared with CR and TR. The improved intake for TR to reach CR may be due to Bio-magic content which consists of amino acids, enzymes, bactria and minerals leading to improved palatability and rumen environment. These results were in agreement with those obtained by Khir *et al*., 2015, Aziz (2020) and Abo Bakr *et al*., (2020) who contributed the improvement of intake of treated trimming waste from fruit trees compared to untreated ones.

Intake of TDN showed significant differences among groups (Table 6). On the other hand, DCPI recorded higher significant value (128.9g/d) for TR than other groups. This may be due to higher digested CP and DMI. Commonalty, DCPI for all groups which showed in the present study covered the productive requirements for growing sheep according to Kearl, (1982).

Table 6. Lamb performance, and economic efficiency indicators for the experimental rations

Item	Experimental groups			SEM	P value
	CR	UR	TR		
	Body weight changes				
Lambs NO.	10	10	10	-	-
IBW, kg	28.00	27.80	26.89	1.03	0.724
FBW at 120d, kg	48.98	46.63	48.72	1.37	0.426
ADG, g/d	175[ab]	157[b]	182[a]	7.63	0.079
Total gain, kg	20.98[ab]	18.83[b]	21.83[a]	0.92	0.083
	Feed and nutrients intake				
CFM as DM, g/head/ d	741.8[a]	702.2[b]	747.4[a]	10.82	0.006
Roughage as DM, g/head/ d	335.9	308.6	335.9	10.39	0.101
Total DMI, g/d	1077.7[a]	1010.8[b]	1083.3[a]	16.36	0.003
TDNI, g/d	769.0[a]	734.3[b]	740.6[ab]	11.47	0.077
DCPI, g/d	116.7[b]	119.7[b]	128.9[a]	1.91	<0.001
	Feed conversion				
DM intake/ Gain, kg/ kg	6.16	6.44	5.96	0.15	0.053
TDN intake/ Gain, kg/ kg	4.40	4.68	4.07	0.08	0.064
DCP intake/ Gain, kg/ kg	0.667	0.763	0.709	0.03	0.075
	Economic efficiency indicators				
Cost of daily CFMI, LE	3.31	3.14	3.54	-	-
Cost of daily roughage intake, LE	1.05	0.17	0.18	-	-
Total daily feed cost, LE	4.36	3.30	3.72	-	-
T. feed cost for T. gain, LE	524	396	447	-	-
Price of total gain, LE	1049	941.5	1090	-	-
Net revenue, LE	525	545	643	-	-
Economic efficiency (Ec.E)	1.00	1.37	1.44	-	-
Improvement, %	-	37.00	43.47	-	-
Relative Ec.E to C, %	100	137	143	-	-
Relative Ec.E to CR %	-	100	105	-	-

CFM= 4080 LE/ ton, BioM-CFM= 4410 LE/ ton, Hay= 2800 LE/ ton, UTW= 500 LE/ ton, BioM= 24 LE/kg, LBW= 50 LE/kg live body weight

Feed conversion expressed as kg intake of DM, or TDN/ kg Gain tended to be improved for lambs fed TR group but with no differences (p> 0.05) with the other groups. This result is in agreement with the finding of some researchers (Phillip *et al*., 2014 Khir *et al*., 2015, Mahrous *et al*., 2019) who obtained improved feed conversion for lambs fed treated trimming waste of fruits trees compared with untreated one. In the same time, Hamasalim (2015) reviewed that protein supplementation and feed additives such as probiotic are very important materials that can enhance feed conversion ratio.

Economic efficiency indicators in the present study depended on the prevailing price of feed ingredients and live body weight. The data indicated that daily cost of CFM for TR increased by 6.9% and 12.73% compared with CR and UR respectively. On the hand, daily cost of roughage was higher for CR by 5.17% and 4.83% than UR and TR respectively. The higher cost of daily roughage intake was due to the higher price of BH (2800 LE/ton) compared with TWMT (500 LE/ton). The price of BH for CR reflected on total daily feed cost and led to increase it. Economic efficiency is affected by many factors such as the price of feed ingredients, DM intake, total weight gain and feed conversion. In this study, the best economic efficiency recorded by TR (44% improvement) followed by UR (37% improvement) and the worst was observed by CR. This result was in agreement with that obtained by Yirga (2015) who demonstrated that probiotic can be formed of Varity feed additives and led to stimulate microorganisms to capable modifying the gastrointestinal environment to increase health status and improve feed efficiency.

Carcass characteristics

Data of Fasting weight, Carcass weight, and Dressing percentage showed no significant differences among groups (Table 7). Dressing percentage passed on fasting weight ranged from 49.21% and 50.42%. These values were slightly higher than that observed by some authors Kewan *et al*., (2019), Ghandour (2015), and Abd El-Hay, *et al*., (2012) where they found that the depressing percentage for Barki lambs fed traditional ration (BH + CFM) ranged between 45.5% and 46.6%. Also, these results were agreed with those obtained by Prado *et al*., (2015), they showed that better weight gains for lambs fed rations supplemented with enzymes and amino acids. That means using of TWMT is acceptable roughage in fattening lambs under the same condition of the present study.

Table 7. Carcass traits of Barki lambs fed the experimental rations

Item	Experimental groups			SEM	P value
	CR	UR	TR		
Carcass characteristics					
Fasting wt, kg	48.32	45.3	44.11	2.09	0.399
BW after bleeding, kg	46.64	43.87	42.79	1.97	0.418
Carcass wt, kg	23.78	22.99	22.24	1.53	0.783
Dressing A, %	49.21	50.75	50.42	1.24	0.633
Dressing B, %	53.62	54.78	54.61	1.13	0.704
Rib Eye Area, cm^2	24.48	25.37	27.22	1.12	0.225
Fat thickness, mm	5.93	5.4	6.27	0.81	0.754
Lean, %	49.00	45.90	46.79	1.98	0.535
Fat, %	30.53	34.41	30.91	2.00	0.344
Bone, %	17.74[ab]	16.84[b]	19.01[a]	0.54	0.038
Lean/ Fat ratio	1.71	1.34	1.60	0.31	0.687
Lean/Bone ratio	2.76	2.73	2.46	0.22	0.665
Chemical composition(%) of L.D. lean					
Moisture	73.5	73.68	73.57	0.30	0.917
DM	26.5	26.32	26.43	0.31	0.918
CP	56.55[b]	60.03[a]	60.54[a]	1.03	0.031
EE	29.72[a]	25.95[b]	24.14[b]	1.03	0.005
Ash	3.87	3.89	4.32	0.19	0.206

Dressing A% = carcass wt/ fasting wt×100.
Dressing B% = carcass wt/ (fasting wt - rumen content wt) × 100.

The eye muscle area (cm^2) for TR and UR groups increased by 11.19 and 3.64%, respectively compared with CR but with no significant differences (Table 7). These results were being close to those (16.0 - to 27.5 cm^2) reported by Kewan *et al*., (2019) for fatting Barki lambs. However, it was higher than the range 11.37-15.05 cm^2 that reported by Ghandour (2015) for Barki lambs. Our results of fat thickness agreed with those obtained by Pelicano *et al.* (2005) who clarified that, highest values revealed for in animals supplemented with probiotics combative to un-supplemented group.

Data of Table (7) indicated that, physical composition of best ribs expressed as lean%, fat%, lean/ fat ratio and lean/ bone ratio were not significantly affected by the experimental rations. However, bone% was higher in TR group (19.01%) than UR group (16.84%).

Data of the chemical composition of eye muscle (% on dry matter basis) was shown in Table (7). The data showed that both TR and UR groups were similar and also higher ($p< 0.05$) than CR group concerning CP%, but fortunately the opposite trend was observed for EE%. These findings could be attributed to high intake of DCP and TDN in TR and UR as compared with CR group. Our results were agreement with Badawy *et al*. (2013) and Kewan *et al*. (2019) who found that the chemical composition of L.D. meat was 62.8-64.6% for CP, 27.1-27.4% for EE and 3.29-3.60% for Ash.

Carcass and non-carcass components

Carcass components of fattened male lambs are presented in Table (8). Results indicated that control group (CR) had higher values of all external offals (Head, feet and Pelt) than those fed other rations. This may be due to higher slaughter weight for CR which was higher than UR and TR by 6.7 and 9.5%, respectively. The current results are in agreement with those found of Shehata (2013) who reported that non-carcass component weights increased with increasing slaughter weight for Barki lambs.

Table 8. Carcass offals and fat distribution in Barki lambs fed the experimental rations

Item	Experimental groups			SEM	P value
	CR	UR	TR		
Non-edible parts and Edible offals					
Head wt, kg	3.22[a]	2.73[b]	2.74[b]	0.18	0.024
feet wt, kg	1097[a]	600[b]	908[ab]	112.8	0.023
Pelt wt, kg	5.66	5.03	4.86	0.27	0.12
Heart, g	156.7[b]	203.3[a]	193.3[a]	10.17	0.013
Liver wt, g	771.7[a]	765.0[a]	671.7[b]	27.74	0.039
Kidney, kg	118.3	120.0	118.3	4.55	0.957
Lungs, g	540	578.3	553.3	26.11	0.585
Spleen wt, g	100a[b]	105[a]	75b	8.43	0.050
Tests wt, g	260	270	211.7	20.2	0.126
Gut and Rumen content weights					
G.I. full wt, kg	4.84[a]	4.25[b]	4.41[ab]	0.19	0.112
G.I. empty wt, kg	0.873	0.917	1.025	0.06	0.206
Rumen content wt, kg	3.968	3.33	3.382	0.22	0.116
Carcass fat distribution					
Tail wt, kg	1.35	1.76	1.45	0.20	0.39
Kidney fat, g	455	508.3	403.30	75.57	0.639
Internal fat, g	908.3	925	896.70	105.4	0.982
Total body fat	2.71	3.19	2.75	0.23	0.322
Fat% of SW*	5.58	7.05	6.26	0.44	0.141
Fat% of EW*	11.39	13.95	12.4	0.87	0.194

SW: slaughter weight; EW: empty weight

Edible carcass offals were affected ($p<0.05$) by the experimental rations where UR group resulted in the highest weight of both heart and liver. However, kidney weight was in significant differences among groups. Lungs and Tests weights were not different among groups. While, feeding lambs TR led to decrease significantly spleen compared to other group. This may be due to higher ash intake (104.2 g/h/d). Shehata (2013) noted that Spleen was the only organ that was affected by flavomycin addition and the interaction between salinity of water and flavomycin.

Carcass fat distribution (Table 8) was not affected by the experimental rations. The present results were higher than those reported by Shehata and Hammam (2004), This may be due to CFM component, TDN intake and utilization of energy. Commonalty, Bawady (2014) suggested that results of carcass characteristics are affected by feed intake, body weight changes and digestibility.

CONCLUSION

It may be concluded that, trimming waste of mandarin trees has the potential solve to reduce shortage of feeds for animals in Egypt furthermore reducing sheep feed cost under desert conditions and new reclaimed areas. In addition, Bio- Magic product (as a type of complex probiotic) can be supplemented to rations to increase the nutrient utilization, as well as improved feed efficiency and growth performance. Fortunately, Bio- Magic product has proven effective in reduce methane emissions in sheep and hence its contribution to global warming.

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الإستفادة من مخلفات تقليم أشجار اليوسفي كعلف للمجترات الصغيرة: 3. تقييم النمو وصفات الذبيحة في الحملان البرقي

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قسم تغذية الحيوان والدواجن، مركز بحوث الصحراء، المطرية، ص. ب 11753 القاهرة.

اهتم الباحثون بإستخدام بعض المصادر العلفية غير التقليدية بهدف تقليل الفجوة العلفية وبخاصة لحيوانات إنتاج اللحم أو الضأن لتوفير احتياجات المواطن من البروتين الحيواني على مدار العام. لذا أجريت هذه الدراسة فى محطة بحوث سيوة بهدف تقييم الاداء الانتاجي ومقاييس الذبيحة للحملان البرقى المغذاة على مخلفات تقليم أشجار اليوسفي مع تدعيم العلائق ببعض الاضافات الغذائية. استخدم فى هذه الدراسة ثلاثون حمل برقى مفطوم بمتوسط وزن 27.56 ± 0.57 كجم تم توزيعها عشوائيا الى ثلاث مجموعات (10/ مجموعة). وفى نهاية فترة التسمين تم اجراء تجربة هضم على أربعة حيوانات من كل مجموعة وكانت المجاميع التجريبية كالتالى: المجموعة الاولى: دريس البرسيم + مخلوط علف مركز (مجموعة المقارنة مج1). المجموعة الثانية: مخلفات تقليم أشجار اليوسفي + مخلوط علف مركز (مج2). المجموعة الثالثة: مخلفات تقليم أشجار اليوسفي + مخلوط علف مركزمدعم بمركب البيوماجيك (منتج تجاري تحت الاختبار مكون من خليط من الاحماض الامينية، الاملاح المعدنية، الفيتامينات، بكتريا وانزيمات) (مج3). ويمكن إيجاز النتائج في ما يلي: - أشارت النتائج الى وجود ارتفاع معنوى فى كلا من العلف المركز المأكول والمأكول الكلى لصالح مج3 مقارنة بالمجموعة مج2 ولم تكن هناك اختلافات معنوية فى المأكول الخشن بين المعاملات الثلاثة. - لم تظهر الاضافة الغذائية (البيوماجيك فى المعاملة الثالثة) تحسنا ملحوظا فى معاملات الهضم الا فى معامل هضم البروتين الخام. وسجلت مج2 أعلى قيمة للنيتروجين المحتجز. -سجل أعلى معدل زيادة وزنية للحملان وأحسن معدل تحويل للغذاء بواسطة مج3 والتى أضيف لعلفها المركز مركب البيوماجيك. - انعكس زيادة سعر العلف الخشن التقليدى (دريس البرسيم) على الدخل الصافى والذى انخفض فى معاملة الكنترول، فى حين كان لانخفاض سعر العلف الخشن غير التقليدى (مخلفات تقليم أشجار اليوسفى) أثر جيد فى خفض تكاليف التغذية. هذا بالاضافة الى أن ارتفاع معدل الزيادة الوزنية فى مجموعتى مخلفات أشجار اليوسفى كان سببا فى تحسن صافى الدخل بمقدار 45 و37% لكلا من مج3 ومج2 على التوالى مقارنة بالمعاملة الاولى. - حدث تحسن غير معنوى فى خصائص الذبيحة لحيوانات المجموعة الثالثة مقارنة بتلك في المجموعات التجريبية الأخرى. نستنتج من هذه الدراسة أن استخدام مخلفات تقليم أشجار اليوسفي كمادة علفية خشنة غير تقليدية يعتبر حلا جيدا لمجابهة نقص الأعلاف المالئة بالاضافة الى خفض تكاليف التغذية فى المناطق الصحراوية وحديثة الإستصلاح .أيضا تدعيم علائق الحملان بمنتج البيوماجيك كأحد الاضافات الغذائية كان له أثر إيجابى في تحسن الكفاءة الغذائية ورفع الاداء الانتاجى للحملان مما نتج عنه خفض تكاليف التغذية وزيادة العائد من تسمين الحملان تحت ظروف واحة سيوة والمناطق الصحراوية . من الجدير بالذكر أيضا ان استخدام مخلفات تقليم أشجار اليوسفى مع إضافة البيوماجيك فى علف الأغنام له أثر جيد فى خفض إنتاج الغازات المسببة للإحتباس الحراري وكذلك الحفاظ على البيئة من التلوث بهذه االمخلفات.