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# NUTRITIONAL RESPONSE OF AGRO-INDUSTRIAL BY-PRODUCTS AS REPLACEMENTS OF CONCENTRATE FEED MIXTURE IN SHEEP DIETS

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**ABSTRACT:** *Date seeds and olive pulp were treated with 12% lime solution for 4- week incubation period. The treated materials were used as a mixture (1: 1) in Barki lamb rations. The present experiment aimed to evaluate partial substitution (20 or 40%) of traditional concentrate diet by mixture of treated by-products, on growth performance, rumen fermentation and wool characteristics. Thirty growing Barki male lambs (27.98±1.97 kg), were randomly assigned to three similar groups to be fed the experimental rations. The tested rations were 30% clover hay plus 70% traditional concentrate feed mixture (CFM) (control, C), replacing 20% and 40% of CFM in the control ration by the same part of mixture of treated by-products to form T1 and T2 diets, respectively. Results indicated that higher average daily gain and best feed conversion were recorded for the control group followed by T1 and T2 groups, respectively. Nitrogen and calcium balances ($P<0.05$) were 7.15 – 1.45, 6.78-1.51 and 5.40 -1.23 g/d for animal groups fed C, T1 and T2, respectively. Clean wool yield ($P<0.05$) recorded to be 343, 326 and 290 g/head for the same order of diets. Mean values of rumen $NH_3$-N (mg/dl) and TVFA's (meq/dl) were 22.29, 8.07; 21.82, 10.08 and 20.86, 8.93 for C, T1 and T2, respectively. Microbial protein synthesized in the rumen calculated to be ranged between 114 and 159 g/d.*
*In conclusion, a 20% substitution of alkali treated mixture (1:1) including date seeds and olive pulp for conventional concentrate feed mixture (CFM) in growing diets of Barki lambs achieved similar response to CFM, whereas substitution above 20% reduced animal performance.*

**Key words:** *Date seeds, olive pulp, sheep, growth, rumen, wool*

## INTRODUCTION

The lack of sufficient feeds to meet the nutritional requirements of existing animal population is one of the most critical problems of animal production in Egypt. Furthermore, increasing cost of conventional feeds have stimulated interest in easily available and less costly feed substitutes. Many agro-industrial by-products such as date seeds (224378 ton) and olive pulp (204722 ton) are abundantly available in Egypt (Kewan *et al.,* 2011). It has been suggested that the poor digestibility and reduced voluntary intake of low quality by-products result from extensive lignifications of cell walls. Alkali treatment of these feeds may alter fiber structure to permit penetration by microorganisms (Ghose and King, 1963). The use of NaOH to treat low quality feeds has been limited in many countries where it places a high Na load on the animal and causes soil salinity problems (Soofi *et al.,* 1982). Other chemicals, such as calcium hydroxide (lime) have not been so intensively investigated. Lime treatment has been proven to be cheaper and safer than most other chemicals (Klopfenstein, 1974), and provides beneficial extra Ca in the diet. Few studies have evaluated lime for its effect on cell wall degradation. Kewan *et al.* (2011) concluded that, treatment of date seeds or olive pulp with 12% lime for 4 weeks incubation period was effective for improving their nutritive value and *in situ* DM and OM disappearance. Consequently, these treated materials are promising to be used for ruminants feeding in an attempt to save concentrate feed mixture and participate in solving feed shortage in Egypt. These treatments are easy for application on small scale farmers to reduce cost of feeding.

The main objective of the present study was to investigate the impact of partial substitution (20 and 40%) of concentrate feed mixture (CFM) in growing Barki sheep rations by a mixture (1:1) of date seeds and olive pulp treated with 12% lime solution for 4 weeks incubation period, on growth performance, water, feed and mineral utilization, rumen fermentation and wool characteristics.

# MATERIALS AND METHODS

## Study area and animals management

The study was conducted at Maryout Research Station, Desert Research Center, located 35 km southwest of Alexandria, Egypt. Thirty healthy Barki male lambs, five months old and average live body weight of 27.98±1.97 kg were assigned randomly to three similar groups based on body weight in a growth trial. Each group was housed separately in shaded pen (5 X 6 meter) and assigned to receive one of the three experimental rations. In addition, three ruminally cannulated Barki rams were used for *in situ* evaluation of the experimental diets.

## Alkali Treatment methodology

Crushed date seeds and olive pulp were treated separately with 12% (w/w) commercial lime powder. Lime powder dissolved in required amount of water were sprayed and mixed manually with raw materials. The moisture was maintained at 35-40%. The treated materials were sealed in double polyethylene bags and kept at room temperature for 4 week reaction period. The available lime concentration for reaction was 3.96% at 12% as lime powder (unslacked) had only 33% solubility.

## Experimental diets

Three experimental diets were formulated using lime treated date seeds and olive pulp, Control (C): 30% clover hay + 70% traditional feed mixture (CFM), treatment 1 (T1): 30% Clover hay + 50% CFM + 10% treated date seeds (TDS) + 10% treated olive pulp (TOP), and treatment 2 (T2): 30% Clover hay + 30% CFM+ 20% TDS + 20% TOP. The CFM consisted of un-decorticated cotton seed cake (35%), wheat bran (33%), yellow corn grains (22%), rice bran (4%), molasses (3%), salt (1%), limestone (2%). The amount of diets offered to each group was adjusted biweekly during the experimental period at about 4% of average body weight. Feed was offered once daily at 8:00 am, refusals (if any) were collected just before offering diets on the next day. The growth trial lasted for 100 days.

Fresh water was available to animals ad libitum. Recording of body weight and daily gain for each animal was done at biweekly interval. The efficiency of feed conversion into live weight was calculated (kg DM/kg gain).

## Metabolism trial

At the end of the growth trial, five animals from each group were randomly selected for metabolism trial to determine digestible nutrients, balances of nitrogen, calcium (Ca), sulphur (S) and water. Details of the digestibility trials were described previously (Kewan *et al.*, 2011). The metabolism trial lasted for 17 days; first 10 days were a preliminary period followed by seven days as collection period. Feces, refusal (if any) and urine were quantitatively collected daily from each animal and a 10% aliquot of each of fecal and urine was sampled. Representative samples from feeds, feces and urine were kept for analysis.

Rumen liquor samples were collected from four animals in each group at the end of the metabolism study. Rumen samples were collected by a stomach tube before feeding, 1h and 2h after feeding. Rumen pH was recorded immediately using a pH-meter with glass electrode. Rumen digesta was strained through four layers of cheese cloth. Rumen fluid samples were acidified with 10% HCl and frozen at -20 ºC until analyzed for ammonia-N ($NH_3$-N) and total volatile fatty acids (TVFA).

## Wool measurements

An area of 10 x 10 $cm^2$ on the right mid-side of each animal was clipped at 100 day of experiment. Weight of greasy wool samples were recorded and total greasy wool was calculated as follows: Greasy wool, g/h = wool ($g/cm^2$) * body surface area. Body surface area (BSA) calculated by regression equation for Barki sheep reported by Abou El-Ezz *et al.* (2000) which was BSA = (4024.42 + (154.6*kg BW)). Greasy samples was washed for 20 min in hot water (65°C) and scoured by heavy-duty wool scouring compound, samples were then dried in a humidified room for 72h before weighing. Clean dried wool samples were analyzed for N and sulphur contents.

## In situ evaluation of diets

*In situ* dry matter (*ISDMD*) and organic matter (*ISOMD*) disappearances were conducted (Mehrez and Ørskov, 1977) by using three ruminally cannulated Barki rams, fed clover hay at 2.5% of live body weight. Polyester bags, 7 x 15 cm and 45µm pore size, containing 2g air dried sample were incubated in the rumen for 24h (two bags/ diet/ animal). After incubation, bags were washed with cold water for 20 minutes, and then dried for 48h at 60 ºC. Dry matter and OM disappearance at 24h was calculated after subtracting the washing loss fraction.

## Chemical analysis

Chemical composition of feeds, residues, feces, urine and wool were determined (AOAC, 1990). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed (Van Soest *et al*., 1991). Hemi-cellulose (HC) and cellulose (C) were calculated by difference. Non fibrous carbohydrates (NFC) was calculated according to Calsamiglia *et al.* (1995) using the following equation: NFC = 100 – (CP + EE + Ash + NDF). Total tannins was analyzed according to Makkar and Googchild (1996). Calcium (Ca) was determined using the atomic absorption spectrophotometer (Pye Unicam model 220) according to Chapman and Patt (1961).

Rumen samples were thawed at room temperature and then analyzed for $NH_3$-N by the micro Kjeldahl method and TVFA by steam distillation as described by Warner (1964) using the Markham distillation apparatus.

## Calculation of microbial protein synthesis

Microbial protein (MCP) synthesized in the rumen was calculated depending upon ruminally digested OM along with some published figures and assumptions i.e.: 21.0 g MCP/ 100g DOM in the rumen (Smith, 1975); 38.0 g microbial cells/ 100g DOM in the rumen (Bucholtz and Bergen, 1973); Rumen bacteria contains 53% of their DM as CP (Hutton *et al*., 1971); 2.2 mol ATP produced per 100g OM fermented in the rumen (Hendericks *et al*., 1972); $Y_{ATP}$ is 15.2g microbial cells produced per one mole ATP (Van Nevel *et al.,* 1975).

## Statistical analyses

Data were statistically analyzed using SAS (1998). Significant differences among groups were assessed by Duncan's Multiple Range Test (Duncan, 1955).

# RESULTS AND DISCUSSION

## Chemical composition of the experimental diets

The chemical composition of feed ingredients and experimental diets are presented in Table (1). The results indicated that treated olive pulp (TOP) contain the highest values of ash, calcium, NDF, ADF, ADL and total tannins but low level of EE and NFC as compared to treated date seeds (TDS) and CFM. On the other hand, TDS was higher for NFC and cellulose content and lower for CP and hemicelluloses comparing with CFM and TOP. These results are in agreement with those reported by Hassan and Irhaif (2009). All components of chemical composition except Ca, total tannins, ADF, ADL and cellulose of the formulated rations (T1 and T2) were nearly similar to the control (C). Total tannins, ADF and cellulose were higher in T1 and T2 compared with control diet owing to replacement of CFM by 20 and 40% of treated by-products. Dry matter and OM disappearance were evaluated in situ (ISDMD & ISOMD %) and data are presented in Table (1). The lowest values were reported for TOP; while TDS showed the highest values. Dry matter and OM disappearance were nearly similar for the experimental diets.

**Table (1). Chemical composition (DM basis) and *in situ* dry matter and organic matter disappearance (ISDMD & ISOMD %) of feed ingredients and experimental diets**

| Item | Feed ingredients | | | | Experimental diets | | |
|---|---|---|---|---|---|---|---|
| | Hay | CFM[A] | TDS[B] | TOP[C] | C | T1 | T2 |
| DM (%) | 86.57 | 91.47 | 92.55 | 92.75 | 89.94 | 90.10 | 90.26 |
| | ……………………….g/ kg DM…………………………………… | | | | | | |
| Ash | 95.9 | 21.6 | 63.5 | 80.1 | 43.9 | 50.9 | 57.9 |
| OM | 904.1 | 978.4 | 936.5 | 919.9 | 956.1 | 949.1 | 942.1 |
| CP | 132.1 | 140.8 | 68.5 | 85.0 | 138.2 | 129.2 | 120.3 |
| EE | 23.1 | 55.4 | 20.7 | 10.2 | 45.7 | 40.1 | 34.5 |
| Sulphur | 0.37 | 1.00 | 0.83 | 0.82 | 0.81 | 0.78 | 0.74 |
| Calcium | 12.7 | 7.5 | 21.5 | 45.5 | 9.1 | 12.7 | 14.1 |
| NDF | 746.7 | 529.1 | 536.5 | 613.8 | 594.4 | 600.8 | 607.3 |
| ADF | 471.8 | 214.0 | 469.6 | 477.6 | 291.3 | 324.2 | 357.0 |
| ADL | 78.0 | 97.6 | 114.3 | 202.3 | 91.7 | 100.2 | 108.7 |
| HC[D] | 274.9 | 315.1 | 66.9 | 136.2 | 303.1 | 276.6 | 250.3 |
| Cel.[E]. | 393.8 | 116.4 | 355.3 | 275.3 | 199.6 | 224.0 | 248.3 |
| NFC[F] | 2.2 | 253.1 | 310.8 | 210.9 | 177.8 | 179.0 | 180.0 |
| Tannins[G] | 4.97 | Nil | 4.86 | 9.53 | 0.11 | 2.55 | 2.96 |
| ISDMD%[H] | 45.03 | 63.80 | 68.54 | 42.83 | 58.17 | 56.68 | 56.29 |
| ISOMD%[I] | 44.19 | 62.71 | 70.88 | 43.37 | 57.15 | 56.02 | 55.76 |

A: concentrate feed mixture
B: treated date seeds
C: treated olive pulp
D: hemi-cellulose
E: cellulose
F: non-fibrous carbohydrates
G: total tannins
H: in situ dry matter disappearance
I: in situ organic matter disappearance

## Daily gain and feed conversion

Final body weight and average daily gain (ADG) was similar among the control and T1 groups, while T2 group showed the lowest ($P<0.05$) values (Table 2). The decrease in average daily gain might be due to the reduction in dry matter intake as well as digested protein intake (Table 3) with increasing the substitution level. These results are in agreement with the findings of Mioč *et al.* (2007). The best feed conversion was recorded for the control group followed by T1 group and then T2 group (Table 2). The present results of daily gain and feed conversion were within the range reported by Al-Ani and Farhan (2009). Increasing the inclusion level of olive pulp from 10% to 20% in lamb ration resulted in a reduction in live body weight, average daily gain and feed conversion in lambs (Mostafa, 2003).

**Table (2). Feed intake, live body weight changes and feed conversion for growing Barki lambs fed diets (for 100 day) including alkali-treated by-products.**

| Items | Experimental diets | | | ±SE |
|---|---|---|---|---|
| | C | T1 | T2 | |
| *Feed intake as DM (g/head. day)* | | | | |
| Clover hay intake | 415 | 422 | 382 | ----- |
| Concentrate feed mixture | 969 | 714 | 590 | ----- |
| Treated by-products * | ------ | 179 | 227 | ----- |
| Total intake | 1384 | 1315 | 1199 | ----- |
| *Live body weight changes* | | | | |
| Initial body weight (kg) | 27.60 | 29.00 | 27.33 | 1.45 |
| Final body weight (kg) | 45.20[a] | 45.40[a] | 40.33[b] | 1.78 |
| Average daily gain (g/d) | 176[a] | 164[a] | 130[b] | 7.01 |
| *Feed conversion* | | | | |
| kg DM /kg gain | 7.86 | 8.02 | 9.22 | ----- |

* Mixture of alkali treated date seeds and olive pulp (1:1) and replaced CFM by 20% in T1 and 40% in T2.
[a,b,c] values in the same raw with different superscripts are significantly different (P<0.05).

**Table (3). Daily digestible nutrients intake (g/h.d) by growing Barki lambs fed diets including alkali-treated by-products**

| Item | Experimental diets | | |
|---|---|---|---|
| | C | T1 | T2 |
| Digestible OM intake* | 978.0 | 895.4 | 765.3 |
| Digestible CP intake | 140.7 | 119.1 | 99.1 |
| Digestible CF intake | 154.9 | 146.9 | 140.2 |
| Digestible NFE intake | 644.3 | 580.6 | 493.5 |
| Digestible NDF intake | 620.1 | 583.8 | 511.7 |
| Digestible ADF intake | 259.0 | 280.5 | 241.2 |
| Digestible ADL intake | 36.9 | 38.1 | 28.1 |
| Total digestible nutrients intake | 1017.4 | 908.0 | 777.4 |

* = Diet OM (%) × OM digestibility (%) × average DM intake (g/h/d)

## Daily intake of digestible nutrients

The intake of digestible nutrients (OM, CP, CF, NDF, ADF, ADL and TDN) was the lowest for T2 group compared with C and T1 groups (Table 3). These finding may be due to high content of poorly digested component in TOP as a result of increasing the level of TOP in diet T2 (Tortuero *et al.* 1989).

## Balances data

Data of nitrogen, calcium, sulphur (S) and water balances by Barki lambs fed the experimental diets are presented in Table (4). Total N intake and excretion through urine was higher (P<0.05) in control than T1 and T2 groups. The increase of N balance for control group might be due to the higher DCP intake of the control diet than T2 diet however, T1 was in between as shown in Table (3). Values of the apparent N utilization (N retained as % of N intake) indicated that lambs can utilize N of T1 diet (19.97%) more efficiently (P<0.05) than N of control diet (18.19%) or that T2 (16.66%). This result might be due to more diet components sources in T1 compared with control and/or lower inclusion of date seeds (10%) compared with T2. In agreement with the present results, Awadalla *et al.* (2002) found that 25 or 50% date seeds in lamb diets decreased N retained by 11.3 and 16.6% with control diet, respectively.

The calcium intake by lambs in T1 and T2 were the highest as a result of high calcium percentage in their diets compared with C group (Table 4). Calcium excreted in feces followed the same pattern of feed Ca intake. The urinary Ca was higher (P< 0.05) in T2 group compared with other treatments. Lambs fed the T2 diet was lower (P<0.05) in Ca balance compared with the other treatment groups. This result might be due to decrease of Ca absorption. Furthermore, high DCP and TDN intake (Table 3) may increase Ca retention in growing sheep as reported by McDowell (1992).

Sulphur intake (Table 4) for lambs received the experimental diets was lower than the NRC (1975) recommendation for S requirement in sheep which is 0.14 to 0.26%. The proportion of S excreted in the feces to S intake were 41.44, 44.12 and 47.82% for C, T1 and T2 groups respectively. Similarly, Langlands *et al.* (1973) obtained a significant relationship between fecal sulfur and S intake for sheep fed temperate and tropical forages. It can be noted that, the apparent availability of S was low in lambs fed treated by-products compared to lambs fed control ration. No data are found in the literature on effects of by-products on apparent availability of S in Barki sheep. Overall apparent absorption coefficient for S in this trial was 55.64%. This value was lower than value 64.7% that reported on lambs fed fresh herbage Powell *et al.* (1978). It is concluded that, ration included date seeds or olive pulp needs to be supplemented with S. Also, more investigations are required into the mechanisms by which $Ca(OH)_2$ treatments to by-products can be effective in decreasing S utilization by sheep.

Higher (P< 0.05) combined feed water intake (ml/ $kg^{0.82}$) was recorded for animals fed control diet followed by T2 and T1 groups while no significant differences were detected in free drinking water. The highest (P<0.05) value of fecal water in C and T1 groups compared to T2 group might be due to higher roughage and total DM intake. Lambs fed T2 diet excreted higher (P<0.05) amount of urinary water than lambs fed C and T1 diets. These results might be due to high alkalinity of diet and also high ash intake. These finding agreed with those obtained by Eid (2003) who reported that the high intake of ash lead to push animals to increase excretion of urine as a natural channel to excrete minerals. Water balance was similar among experimental groups.

**Table (4). Nitrogen, calcium, sulphur and water balances by Barki lambs fed diets including alkali-treated by-products**

| Item | Experimental rations | | | SEM | Sig. |
|---|---|---|---|---|---|
| | C | T1 | T2 | | |
| | *Nitrogen utilization (g/d)* | | | | |
| N intake | 39.31[a] | 33.95[b] | 32.41[b] | 1.11 | * |
| Fecal N | 10.36 | 10.19 | 10.15 | 0.14 | NS |
| Urinary N | 21.80[a] | 16.98[b] | 16.86[b] | 0.88 | * |
| N balance | 7.15[a] | 6. 78[ab] | 5.40[b] | 0.35 | * |
| N balance /N intake, % | 18.19[b] | 19.97[a] | 16.66[c] | 0.52 | * |
| | *Calcium utilization (g/d)* | | | | |
| Ca intake | 12.54[b] | 16.71[a] | 16.88[a] | 1.13 | * |
| Fecal Ca | 9.91[b] | 13.44[a] | 13.68[a] | 0.97 | * |
| Urinary Ca | 1.18[c] | 1.76[b] | 1.97[a] | 0.18 | * |
| Ca balance | 1.45[a] | 1.51[a] | 1.23[b] | 0.07 | * |
| | *Sulfur utilization* | | | | |
| Sulphur intake SI, (g/d) | 1.11[a] | 1.02[b] | 0.92[c] | 0.02 | * |
| Fecal Sulphur, FS *(g/d)* | 0.46 | 0.45 | 0.44 | 0.01 | NS |
| FS/ SI (%) | 41.44[c] | 44.12[b] | 47.82[a] | 0.86 | * |
| Apparent. Absorption, % | 58.56[a] | 55.88[b] | 52.17[c] | 0.85 | * |
| | *Water utilization (ml/kg$^{0.82}$)* | | | | |
| Feed water | 8.50[a] | 8.10[b] | 8.14[b] | 0.01 | * |
| Free drinking water | 303.3 | 298.0 | 301.3 | 3.76 | NS |
| Fecal water | 30.75[ab] | 34.6[a] | 25.74[b] | 1.57 | * |
| Urinary water | 67.27[b] | 69.74[b] | 84.27[a] | 3.11 | * |
| Water balance | 214.0 | 202.0 | 199.0 | 6.01 | NS |

[a,b,c] values in the same raw with different superscripts are significantly different (P< 0.05).

## Rumen fermentation parameters

Results of rumen pH (Table 5) indicated that; type of diet had no significant effect on rumen liquor pH values. The overall mean of pH values were 6.75, 6.33, 6.25 for C, T1 and T2 diets, respectively. So that, the rumen pH values in the present study are within the normal range (4.96 – 7.92) reported for sheep, which is suitable for maximal cellulytic activity and microbial protein synthesis (Salem, 2006), Furthermore, suitable for maximizing the fiber digestion so that there is similarity among groups in digestible fiber intake (Table 3), but not suitable for maximizing digestion of fermentable carbohydrates so that, lamb group fed diet included 20% treated date seeds (T2) showed the lowest digestible NFE intake (Table 3) (Grant and Weidner, 1992). Sampling time had a significant effect (P<0.05) on pH values, this finding might be attributed to feeding behavior among groups within the sampling time. Minimum pH values were detected at 1hr post feeding for all tested diets. Lower pH at different times could be associated with treated date seeds feeding attributed to fermentation process by the rumen micro-organisms which took place on soluble carbohydrate, was partially a result of higher concentration of TVFA (Awadalla *et al.* (2002).

**Table (5). Mean concentrations values of pH, ammonia-N and volatile fatty acid in the rumen of sheep fed diets including alkali-treated by-products**

| Items | Time (h) | Experimental diets | | | SEM[A] | Significance[B] | | |
|---|---|---|---|---|---|---|---|---|
| | | C | T1 | T2 | | D | T | D X T |
| pH | 0 | 7.03[A] | 6.96[A] | 6.74[A] | 0.08 | NS | * | NS |
| | 1 | 6.24[B] | 5.91[B] | 5.95[B] | | | | |
| | 2 | 6.97[A] | 6.11[B] | 6.05[B] | | | | |
| $NH_3$-N | 0 | 22.95[Ba] | 21.43[Ba] | 19.22[Cb] | 0.48 | * | * | * |
| (mg/dL) | 1 | 25.64[Aa] | 24.82[Aa] | 23.22[Ab] | | | | |
| | 2 | 18.27[Cb] | 19.21[Bb] | 20.14[Ba] | | | | |
| TVFA | 0 | 6.54[Bc] | 8.11[Ca] | 7.93 [Bb] | 0.25 | * | * | * |
| (meq/dl) | 1 | 9.45[Ab] | 11.69[Aa] | 10.18[Ab] | | | | |
| | 2 | 8.21[Ab] | 10.43[Ba] | 8.67[Bb] | | | | |

[A] Standard error of the means;
[B] D= Diet effect;
T= Tim effect.
[A,B,C,a,b,c] means with different superscript letter (capital letters within column, small letters within row ) are significantly differ ($P < 0.05$).
* = ($P<0.05$).
NS = Non significant difference.

The rumen $NH_3$-N concentrations in sheep fed experimental rations ranged from 18.27 to 25.64 mg/100 ml RL (Table 5), these values were higher than the threshold (5 mg/100 ml) for maximal microbial growth (Satter and Slyter, 1974). The lower $NH_3$-N concentration observed in the rumen of lambs fed T2 diet might be due to decrease in nitrogen degradation in the rumen than all other test diets (Khattab, 2007). However, the higher overall mean of $NH_3$-N concentration for control diet (22.29 mg/dL) compared with T1 (21.82 mg/dL) and T2 (20.86 mg/dL) diets may indicate higher NPN concentration in diets which is rapidly degraded in the rumen and low efficient utilization for ammonia release (Awadalla *et al.* 2002) or reflect on higher solubility protein contents (Kewan, 1996). Moreover, higher DCP intake (Table 3) (Yadav and Yadav, 1988) and also, lower tannin content (Table 1).

The higher values of VFA in T1 group (Table 5) might be due to the alkali treatment of by-products (Chen *et al.*, 2008), which increased availability of surface area cell walls for rumen bacteria attachment and easily degradation of cell walls to VFA (Roland and Danny, 1980). The same trend reported by El-Taweel (2000) who found a positive correlation between cellulose digestion coefficient and TVFA's concentration. Moreover, the higher ruminal TVA's concentration associated TDS feeding may indicate increased NFE intake of TDS and more utilization of dietary energy and positive fermentation in the rumen (Tagari *et al.,* 1964). Higher digestible fiber intake for diet C and T1 (Table 3) might had slower rates of passage for solid and liquid phases (Kewan 1996), this may explain the higher concentration of VFA obtained in this study. Overall mean TVFA's concentration in T1 (10.08 meq/dL) group was higher than T2 (8.93 meq/dL) and control (8.07 meq/dL) groups. Sampling time had significant ($P<0.05$) effect on the rumen TVFA concentration for all rations except T1. The experimental group T1 showed the highest ($P<0.05$) values for rumen TVFA concentration at 0, 1 and 2 h after feeding than lambs of control and T2 group. The increase in VFA concentration post-feeding for all groups was associated with a decrease in rumen pH (Table 5) when clover hay plus concentrate were given as reported by Kewan (1996).

Digestion fraction (Table 6) tended to decrease as DM intake decreased. In the present study, DM digested post-rumen ranged from 8.58 – 12.86%. When digestion in lower tract was expressed as a fraction of total digestion, the percentage tended to increase as feed intake increased. Similar trend was observed by Baraghit *et al.* (1995). The higher total digestible nutrients intake for diet C and T1 (Table 3) are explained by the higher digestion post-rumen.

The similarity of MCP synthesis per day (Table 6) may indicate that all diets used in this study had enough N (rumen $NH_3$-N) and energy (rumen VFA) to satisfy the microbial growth factors and requirements. Satter and Roffler (1977) reported that MCP synthesis peaked when diet containing approximately 12 to 13% CP. Above this level $NH_3$-N concentration will increase without a concurrent increase in microbial protein production.

## Wool yield and composition

Results in Table (7) showed that lambs of C group had significantly higher ($P<0.05$) clean wool yield (343) followed by T1 group (326) then T2 group (290 g/h). This finding might be due to higher feed intake as reported by Adams *et al.* (2000), and/or higher digestible dry matter intake (Allden, 1979), and higher protein absorbed (Black *et al.*, 1973) which was indicated by N retained (Table 4).

**Table (6). Fraction of DM Digestion and calculated microbial protein synthesis in the rumen of lambs fed diets including alkali-treated by-products**

| Item | Experimental diets | | | SEM | Sig. |
|---|---|---|---|---|---|
| | C | T1 | T2 | | |
| Total tract DM digestibility (%) | 71.03$^{a}$ | 68.71$^{ab}$ | 64.87$^{b}$ | 0.34 | * |
| Rumen DM digestibility (%) | 58.17$^{a}$ | 56.68$^{b}$ | 56.29$^{b}$ | 0.30 | * |
| Post rumen DM digestibility (%) | 12.86$^{a}$ | 12.03$^{b}$ | 8.58$^{c}$ | 0.66 | * |
| Fraction of total digestion post rumen (%) | 18.10$^{a}$ | 17.51$^{a}$ | 13.23$^{b}$ | 0.78 | * |
| Rumen digested OM (g/d) | 756$^{a}$ | 699$^{b}$ | 629$^{c}$ | 18.95 | * |
| MCP synthesized, x 0.21 (g) | 159$^{a}$ | 147$^{b}$ | 132$^{c}$ | 4.00 | * |
| MCP, $Y_{ATP}$ x 0.53 (g) | 134$^{a}$ | 124$^{b}$ | 114$^{c}$ | 3.36 | * |
| Range of MCP synthesized (g) | 134-159 | 124-147 | 114-132 | - | - |

**Table (7). Wool yield and composition for Barki lambs fed diets including alkali-treated by-products**

| Item | Experimental rations | | | SEM | Sig. |
|---|---|---|---|---|---|
| | C | T1 | T2 | | |
| Greasy wool, g/head | 671[a] | 636[a] | 589[b] | 10.5 | * |
| Clean wool (%) | 51.23[a] | 51.18[a] | 49.25[b] | 0.25 | * |
| Clean wool Yield, g/head | 343[a] | 326[a] | 290[b] | 6.07 | * |
| Sulphur (%) | 3.31 | 3.37 | 3.23 | 0.34 | NS |
| N (%) | 11.53[a] | 10.90[b] | 10.70[b] | 0.17 | * |
| Sulphur: N ratio | 0.29 | 0.31 | 0.30 | - | - |

[a,b,c] values in the same raw with different superscripts are significantly different (P< 0.05).

## CONCLUSION

It can be concluded that, a 20% substitution of alkali treated mixture (1:1) including date seeds and olive pulp for traditional concentrate feed mixture (CFM) in diets of growing Barki lambs achieved similar response to CFM, whereas substitution above 20% reduced animal performance.

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# الاستجابة الغذائية لاحلال مخلفات التصنيع الزراعي محل العلف المركز في علائق الاغنام

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## الملخص العربي

اجريت هذه التجربة في محطة بحوث مريوط حيث استخدم ٣٠ حمل برقي بمتوسط وزن ٢٧.٩٨ كجم) في ثلاث مجموعات متساوية لدراسة تأثير الاحلال الجزئي للعلف المركز التقليدي بمخلوط (١:١) من نوى البلح وكسب الزيتون المعاملين بماء الجير بنسبة ١٢% والكمر لمدة شهر في تغذية الحملان البرقي لمدة مائة يوم. وكانت العلائق التجريبية كالاتي:

عليقة المقارنة : ٣٠% دريس برسيم + ٧٠% علف مركز تقليدي

عليقة المعاملة الاولي: ٣٠% دريس برسيم + ٥٠% علف مركز تقليدي + ٢٠% مخلفات

عليقة المعاملة الثانية: ٣٠% دريس برسيم + ٦٠% علف مركز تقليدي+ ٤٠% مخلفات

**وأظهرت النتائج ما يلي:**

١- معدل النمو لمجموعة المعاملة الاولى (٢٠% احلال) لم تختلف معنويا عن مجموعة المقارنة وكادت القيم ان تكون متساوية ويسلك معدل التحويل الغذائي نفس الاتجاه.

٢- كانت قيم النيتروجين والكالسيوم المحتجز (جم/يوم) ٧.١٥ – ١.٤٥ ، ٦.٨٧ – ١.٥٠ ، ٥.٤٠ – ١.٢٣ للمجموعات الثلاثة على الترتيب.

٣- كان متوسط تركيز الامونيا (مجم/١٠٠مل) والاحماض الدهنية الطيارة (ملليمكافئ/١٠٠مل) في سائل الكرش ٢٢.٢٩ – ٨.٠٧ ، ٢١.٨٢ – ١٠.٠٨ ، ٢٠.٨٦ – ٨.٩٣ للمجموعات الثلاثة على الترتيب

٤- تراوحت قيم بناء البروتين الميكروبي بين ١١٤-١٥٩ جم/يوم.

٥- كانت كمية الصوف النظيف عند نهاية التجربة ٣٤٣ ، ٣٢٦ ، ٢٩٠ جم/رأس

نستنتج من هذه الدراسة انه تحت ظروف عدم وفرة العلف المركز التقليدي فانه يمكن احلال ٢٠% منه بمخلوط (١:١) من نوى البلح وكسب الزيتون المعاملين بماء الجير بنسبة ١٢% والكمر لمدة شهر يؤدي الى نفس التأثير الغذائي على الحملان البرقي والناتج عن تغذيتها على العلف المركز التقليدي وان الاحلال بنسبة ٤٠% يؤثر سلبا على الاداء الانتاجي للحيوان.