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EFFECT OF DRY FAT SUPPLEMENTATION ON DIGESTIBILITY, FEEDING VALUE AND RUMEN FERMENTATION OF OSSIMI SHEEP

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ABSTRACT: *This study was carried out in order to study the effects of supplemental protected dry fat on nutrient digestibility, nutritive value and rumen parameters. Three Ossimi Rams (average body weight of 50 ± 3kg) were used in 3×3 Latin square design with three experimental rations. The first one served as a control ration (60% clover hay + 40% concentrate feed mixture) without added fat (R_0); the second and third rations were the control supplemented with either 3% (R_3) or 5% (R_5) dry fat (on DM basis), respectively. The results revealed that digestibility of DM was non-significantly higher with sheep fed the 5% dry fat supplemented ration (R_5, 61.54%) than those received the 3% dry fat (R_3, 60.01%) or the control ration (R_0, 58.96%). The same trend was observed with OM digestibility being higher for R_5 (63.96%) followed by R_3 (62.48%) and least for R_0 (61.64%). Digestibility of CP differed between the dietary treatments being high for R_5 (69.46%) and low for R_0 (58.12%) and intermediate for R_3 (62.64%); differences were highly significant ($P<0.01$). Digestibility of EE was significantly ($P<0.01$) increased from 81.17% in R_0 to 84.09% in R_3 and to 85.34% in R_5. Dietary treatments did not have any significant effects on the digestibility of NFE. Dietary fat supplementation increased the digestibility of CF from 54.15 in the control diet to 58.09 and 60.95% in R_3 and R_5, respectively. Fat treatments improved the nutritive value as TDN and DCP. Values of TDN were 57.04, 60.72 and 66.19% for R_0, R_3 and R_5, respectively. Digestible CP also improved from 7.22 to 7.66 and 8.29% for R_0, R_3 and R_5, respectively. Rumen VFA was significantly higher for the control group than the treated ones. In general, VFA increased in all treatment groups to reach its peak at 4-hr post feeding and declined thereafter. Concentration of rumen ammonia-N was significantly higher ($P<0.05$) for the control group than the fat-treated groups (at both levels). Values of rumen pH among groups were found to be higher for the control and R_3 ration than R_5. Logically, pH values took the opposite trend of the VFA.*

Key words: *Fat, Supplementation, Digestibility, Fermentation, Sheep.*

INTRODUCTION

The publication of NRC (1970) recommended that the use of fat supplements in ruminant rations should be limited to the levels which do not induce metabolic changes; also fat in ruminant diets should not be more than 5%.

To increase energy density without the ruminal acidosis and depressing milk fat due to the use of high starch and low fiber diets, attention has been directed to the inclusion of fats and feed stuffs with high concentration of fat and oils in ruminant rations (Choi and Palmquist, 1996; Chan *et al.*, 1997; Simas *et al.*, 1997 and 1998; Bruckmaier *et al.*, 1998; Zervas *et al.*, 1998; Casals *et al.*, 1999; Kowalski *et al.*, 1999 and Offer *et al.*, 1999).

Fats have received increasing interest and full fat seeds are considered to be a useful source of dietary fat for dairy cows (Palmquist, 1984). Use of free fats in diets is usually limited to 3% of dietary DM but more fat (5 to 6% of dietary DM) in the form of Ca salts can be fed without deleterious effects on ruminal digestion (Palmquist, 1988). However, the use of whole seeds in the diet increase energy intake, percentage of milk fat, and FCM production and have variable effects on milk protein contents (Harrison, 1991).

Whole oil seeds can be fed without marked ruminal inhibition, probably because of a slow release of the oil into rumen (Coppock and Wolks, 1991). Moreover, oil in seeds is encapsulated by deed coat which had beneficial effects as a natural protection (Ekeren *et al.* 1992) preventing the side effects of chemicals that are used in fat protection (El-Bedawy *et al.* 1994).

Digestibility of DM, OM and ADF was reported to decrease with adding fat (Hill and West, 1991); however, others (Bayourthe *et al.*, 1993; EL-Bedawy *et al.* 1994; El-Bedawy *et al.* 1996 and Talha, 1996) found an increase in digestibility of almost all nutrients. White *et al.* (1992) reported that 2.5 or 5% blended animal-vegetable fat did not affect DM digestibility, whereas increased CP and EE digestibility. Supplemental fat reduces ADF and NDF digestibility. Bendary *et al.* (1994) found that digestibility of OM and NFE were not affected but CP and EE were significantly increased on supplemented-fat ration compared with the control. Digestibility of CF was not decreased by addition of 5% fat while the 7.5% fat ration caused a significant depression.

Only 3 to 5% of fat added to common feeds seems to be tolerated by ruminal microorganisms (Palmquist and Jenkins, 1980), research has been conducted to develop high-fat feeds that do not impair fermentative digestion i.e. encapsulated fat, prilled fat, and calcium salt of fatty acids (Grummer, 1988). The use of these fats suggests the potential to employ lipids up to 8 to 9% of the diet DM (Ostergaard *et al.*, 1981).

The objective of this work was to study the effects of supplemental protected dry fat on nutrient digestibility, nutritive value and rumen parameters.

MATERIALS AND METHODS

This experiment was carried out at animal research station animal production department faculty of agriculture Minufiya University. Three Ossimi rams aged 3 years with average body weight of 50 ± 3kg were used. Rams were used in 3×3 Latin square design with three experimental rations. This experiment was designed in three periods; every period lasted for 4 weeks; 2wks as an adaptation period and 2 wks as a collection period. Rams were housed individually in metabolic crates (1.60m×0.53m) for separate collection of feces.

Three experimental rations were applied. The first one served as a control ration (60% clover hay + 40% concentrate feed mixture) without added fat (R_0); the second and third rations were the control supplemented with either 3% (R_3) or 5% (R_5) dry fat (on DM basis), respectively. The DM allowance offered to the experimental animals was 3.5% of body weight. Rations and fresh water were given to the animals once a day at 8.30 a.m. Residuals were weighed daily every morning in the collection period and subtracted from the offered amount to obtain the actual feed consumed.

The chemical composition of the ingredients used in the formulation of the experimental rations is presented in Table (1). The chemical composition of the experimental rations is presented in Table (2).

In order to verify the results, samples were collected during two successive weeks; during which, feces were quantitatively collected at 8:00 a.m. before feeding. A quantity of 10% from feces was withdrawn and dried to a constant weight in a forced air oven at 70°C for 24 hrs. Dry fecal samples were ground to pass a 2mm screen and kept in plastic bags for later analysis.

Table (1): Chemical composition of the ingredients used in the formulation of the experimental rations

Item	CFM*	Clover hay
	%	
Dry matter, DM%	91.28	86.21
	on DM basis	
Organic matter, OM	85.36	89.78
Crude protein, CP	10.81	13.66
Ether extract, EE	1.95	3.43
Nitrogen-free extract, NFE	60.15	45.46
Crude fiber, CF	12.45	27.23
Ash	14.64	10.21

*CFM, concentrate feed mixture consisted of wheat bran; yellow corn; wheat straw; soybean cake; extracted bran; molasses; limestone and common salt (production of EL-Gaafrawy feeds).

Table (2): Chemical composition of the experimental rations

Item	The experimental rations*		
	R_0	R_3	R_5
Dry matter, DM%	88.23	88.24	88.8
	---------- On DM basis ----------		
Organic matter, OM	88.01	88.36	88.58
Crude protein, CP	12.52	12.16	11.93
Ether extract, EE	2.84	5.67	7.46
Nitrogen-free extract, NFE	51.34	49.83	48.89
Crude fiber, CF	21.32	20.7	20.3
Ash	11.98	11.63	11.41

*The experimental rations, R_0, control; R_3, control ration supplemented with 3% dry fat; R_5, control ration supplemented with 5% dry fat.

Rumen fluid samples were collected using the stomach tube attached to a vacuum pump, before feeding and then at 2, 4 and 6 hrs after feeding. Ruminal *p*H was measured immediately after collection using a digital *p*H meter (Sophisticated microprocessor, *p*H meter). Rumen fluid was strained through four layer of cheesecloth into plastic containers and kept frozen for later analysis. Half of the samples were acidified using concentrated ortho-phosphoric acid and 0.1N hydrochloric acid to determine the volatile fatty acids (VFA). The second half of samples was alkalized using 0.1N NaOH to determine the concentration of rumen ammonia.

The determination of dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE), nitrogen-free extract (NFE by differences) and ash in the feed and feces were carried out according to the official methods of AOAC (1990). Ruminal ammonia-nitrogen determination was carried out as soon as possible using the steam distillation method described by Ahmed (1976). Total volatile fatty acids (VFA) were measured according to AOAC (1990).

Data were analyzed using SPSS (2003) analysis program version 11.5. The significant differences among individual means were analyzed by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Data in Table (3) represent the digestibility of the nutrients as affected by the dietary fat supplementation.

Table (3): Digestion coefficients of the experimental rations as affected by dry fat supplementation (Means ± SE)

Treatment*	DM	OM	CP	EE	NFE	CF
R_0	58.96 ± 0.82	61.64 ± 0.79	58.12^{a} ± 0.27	81.17^{a} ± 0.26	63.76 ± 0.88	54.15^{a} ± 1.24
R_3	60.01 ± 1.41	62.48 ± 1.22	62.64^{b} ± 1.25	84.09^{b} ± 0.40	62.54 ± 1.29	58.09^{ab} ± 1.93
R_5	61.54 ± 1.57	63.96 ± 1.39	69.46^{c} ± 1.11	85.34^{c} ± 0.26	62.34 ± 1.49	60.95^{b} ± 1.83
Sig.	NS	NS	0.01	0.01	NS	0.05

^{a,b} Means with different superscripts within each column for each parameter are significantly different.

*R_0, control ration without fat supplementation; R_3 and R_5, control rations supplemented with 3% or 5% dry fat, respectively.

Digestibility of DM was non-significantly higher with sheep fed the 5% dry fat supplemented ration (R_5, 61.54%) than those received the 3% dry fat (R_3, 60.01%) or the control ration (R_0, 58.96%).

The same trend was observed with OM digestibility being higher for R_5 (63.96%) followed by R_3 (62.48%) and least for R_0 (61.64%), however, differences failed to be statistically significant ($P \geq 0.05$). Bayourthe *et al.* (1993) reported a significant ($P<0.05$) increase in the digestibility of DM with supplemented fat. Hussein *et al.* (1995) found that the addition of Ca-soap increased DM digestibility from59.7% to 64.3%). Zedan (2003) found that both dry fat and oil at all levels used significantly increased the digestibility of DM and OM. White *et al.* (1992), however, reported that 2.5 or 5% blended animal-vegetable fat did not affect DM digestibility. Bendary *et al.* (1994) reported a non-significant difference for OM digestibility between fat-supplemented ration and the control. Also, El-Ashry *et al.* (1997) reported that there was no significant effect of the different oil type at 6% level on digestibility of DM, OM and starch. Differences could be attributed to the different fat sources along with the chemical treatment of fat during the preparation.

Digestibility of CP differed among the dietary treatments being high for R_5 (69.46%) and low for R_0 (58.12%) and intermediate for R_3 (62.64%); differences were highly significant ($P<0.01$). White *et al.* (1992) reported that adding 2.5 or 5% blended animal-vegetable fat to the diet increased CP digestibility. Also, Bayourthe *et al.* (1993) reported that feeding sheep a supplement of a mixture of animal fat and vegetable oil led to an increase in the digestibility of CP ($P<0.05$). Hussein *et al.* (1995) reported an increase in CP digestibility ($P<0.05$) due to the addition of Ca-soap. Bendary *et al.* (1994) found that CP

digestibility significantly increased in supplemented fat ration compared with the control, Zedan (2003) reported a non-significantly higher CP digestibility with fat-supplemented ration (72.25%) than the control (66.08%) during the early stage of growth of buffalo calves. Differences reached a significant level ($P<0.05$) during the middle stage with the same trend of the early stage, being higher for the fat supplemented ration (70.12%) than for the control one (55.91%). During the final fattening stage, however, it came back to the non-significant level with the previously mentioned trend. Earlier

Data in Table (3) also show that digestibility of EE was in general very high in all rations (more than 80%). Digestibility of EE significantly ($P<0.01$) increased from 81.17% in R_0 to 84.09% in R_3 and to 85.34% in R_5. Zedan (2003) reported a similar trend for EE digestibility; He found that fat supplementation improved EE digestibility up to 95.55%. Addition of dietary fat (2.5 or 5% blended animal-vegetable fat) increased EE digestibility (White *et al.*, 1992). Bayourthe *et al.* (1993) fed sheep on hay supplemented with a mixture of fat and oil; they found that the digestibility of EE increased ($P<0.05$) with supplemented fat. El-Bedawy *et al.* (1996) studied fat-substitute 7.5% of the concentrate feed mixture and yellow corn (on DM basis) which represents 5.52% of the total ration DM of Baladi bulls. They found that fat supplement significantly decreased the digestibility of all nutrients except EE. Hussein *et al.* (1995) reported that the addition of Ca-soap significantly ($P<0.05$) improved the EE digestibility in both untreated and alkali-treated rations. El–Bedawy *et al.* (1994) reported that fat supplement in general increased the digestibility of EE in comparison with the control. Bendary *et al.* (1994) found that EE digestibility significantly increased in supplemented fat ration compared with the control.

Dietary treatments did not have any significant effects on the digestibility of NFE. Digestibility of NFE was 63.76, 62.54 and 62.34% for R_0, R_3 and R_5, respectively. During all stages of growth, Zedan (2003) reported no differences for NFE digestibility as a result of feeding buffalo calves on diets supplemented with different kinds of dietary fat. Hussein *et al.* (1995) found that dietary fat and alkali treatment had no significant effect on NFE digestibility while Ca-soap addition elevated it. Dietary fat supplementation (Table 3) increased ($P<0.05$) the digestibility of CF from 54.15 in the control diet to 58.09 and 60.95% in R_3 and R_5, respectively. The early papers reviewed, reported that digestibility of CF responded differently to the dietary fat supplementation. Hussein *et al.* (1995) found that the addition of Ca-soap significantly improved ($P<0.05$) crude fiber digestibility (62.6 and 78.9 vs. 37.8 and 46.0). Zedan (2003) reported that dietary treatments significantly ($P<0.05$) increased the digestibility of CF from 50.84 to 65.78%. White *et al.* (1992) reported that diet supplemented with either 2.5 or 5% blended animal-vegetable fats reduced ADF and NDF digestibility. Digestibility of CF was not decreased by addition of 5% fat while the 7.5% fat ration caused a significant ($P<0.01$) depression (Bendary *et al.*, 1994). Zinn (1992) reported no effect of

addition of 5% yellow grease on total tract digestion of ADF by beef cattle. El-Bedawy (1995) found that oil supplement decreased ($P<0.05$) the digestibility of CF from 57.76 to 47.78%; but supplementation with Ca-soap had no significant effect on CF digestibility (54.38%). It could be attributed to one or more of the following; 1) the different fat and/or oil sources used, 2) the chemical treatment of fat during the preparation, 3) the ingredients of the basal ration and 4) the experimental animal species and the stage of growth.

Data in Table (4) present the results of the feeding value of the experimental rations as affected by the dietary fat treatments. It is obvious that fat treatments improved the nutritive value as TDN and DCP. Values of TDN were 57.04, 60.72 and 66.19% for R_0, R_3 and R_5, respectively; differences were significant ($P<0.01$). Digestible CP also improved from 7.22 to 7.66 and 8.29% for R_0, R_3 and R_5, respectively. The nutritive ratio was almost similar in all groups (1:6.06-6.99).

The improvement of feeding value was mainly due to the higher content of EE in the treated diet (Table 2) along with the improvement in the digestibility of most ingredients (Table 3).

A similar effect on the nutritive value was found in many reports. El-Bedawy (1995) showed that means of TDN were 57.84, 64.39 and 64.54% for control, oil and Ca-soap, respectively; while average values of DCP were 10.75, 9.58 and 9.43%, respectively. He found that the nutritive value of fat supplemented diets was higher than control because of their high contents of ether extract of high digestibility. Bendary *et al.* (1994) reported values of TDN to be 53.49, 59.22 and 58.18% for control and two supplemented fat groups.

Table (4): Feeding value of the experimental rations as affected by dry fat supplementation (Means ± SE)

Treatment*	TDN, %	DCP, %	NR, 1:
R_0	$57.04^a \pm 0.46$	$7.22^a \pm 0.10$	6.92 ± 0.16
R_3	$60.72^b \pm 0.34$	$7.66^b \pm 0.09$	6.06 ± 0.073
R_5	$66.19^c \pm 0.37$	$8.29^c \pm 0.44$	6.99 ± 0.056
Sig.	0.01	0.01	NS

[a,b] Means with different superscripts within each column for each parameter are significantly different.

*R_0, control ration without fat supplementation; R_3 and R_5, control rations supplemented with 3% or 5% dry fat, respectively.

Zedan (2003) reported that TDN increased from 66.27% in the control ration to 73.47% and to 76.33% in oil and fat treated rations, respectively. He also reported that DCP improved from 7.2% in the control to 7.85% and 8.31%

for oil- and dry fat supplemented rations, respectively. El-Bedawy *et al.* (1996) reported that TDN values were 63.51, 56.50 and 69.33% for control, fat substitution and fat supplement, respectively. They also found that DCP were 7.99, 7.88 and 7.15%, respectively. Omer (1999) found significant differences of DE (kcal/kg DM) and TDN between fat supplemental (4 or 8% Ca-SFA) and control groups. Values of TDN were 61.05, 67.39 and 71.56%, respectively. He also found that DCP were 6.70, 6.49 and 6.25%, respectively. Basiony (1998) reported a significant difference of TDN between fat supplemented group (69.33%) and fat substituted group (56.50%). However, no significant differences were found between control (63.51%) and the two supplemented groups. He found that DCP% were 7.99, 7.88 and 7.15 in the same diets. Zinn and Shen (1996) reported that addition of 5% yellow grease with 0.45 or 0.90% calcium increased ($P<0.10$) NE values than that without calcium supplement. Ngidi *et al.* (1990) reported that DE was 2.68, 2.76, 2.86 and 2.90 Mcal/kg for 0, 2, 4 and 6% Ca-soap, respectively. Schneider *et al.* (1988) reported that adding 4% Ca-salts of fatty acids (CSFA) to basal diet of cows increased net energy for lactation by 11.5% than the control. Hill and West (1991) found that adding Ca-soap enhanced digestible energy (DE) compared with either barley or corn grain. Bayourthe *et al.* (1993) found that addition of protected fat into sheep diets at levels of 10 or 20% significantly increased the digestible energy by 5.9% and 11.3%, respectively. The corresponding energy retention values were improved due to the decrease in fecal energy excretion. Aldrich *et al.* (1997) reported that adding 5.6% Ca-LCFA enhanced DE compared with control diet.

Data of rumen fermentation (VFA, NH_3-N and *p*H) as affected by the level of dry fat supplementation are illustrated in Figures (1, 2 and 3).

Rumen VFA (Fig 1) was not different among the dietary treatments at 0 (before feeding), 2 and 6hrs post-feeding; however, it was significantly ($P<0.05$) different at 4hrs post feeding. Values were higher for the control group than the treated ones. Total VFA was 9.66, 9.26 and 9.05 meq/dl of rumen liquor before feeding, for R_0, R_3 and R_5, respectively. In general, VFA increased in all treatment groups to reach its peak at 4-hr post feeding and decline thereafter. The higher values were reported for the control group (14.47, 19.11 and 13.29 meq/dl at 2, 4 and 6hrs post-feeding, respectively); the respective values were 13.26, 16.02 and 10.94 meq/dl for R_3 and 12.94, 15.97 and 11.2 meq/dl for R_5.

The lowest VFA values reported for the dry fat-treated rations may be due to a lower microbial activity in the rumen of sheep fed these rations than those received the control ration, perhaps because it contained less fermentable carbohydrate due to the supplementation of fat (less NFE, Table 2).

The published articles have some conflicts regarding the effect of dietary fat on ruminal VFA concentration. Differences may have been due to different

factors such as the form and/or level of fat used, the level of the dietary energy, the other ingredients in the diet, feeding frequency... etc.

Jenkins and Fotouhi (1990) noted that total VFA were 64.7, 54.1 and 62.0 mmol for control, lecithin and corn oil, respectively. Total VFA concentration generally declines when lipid supplements inhibit fiber digestion.

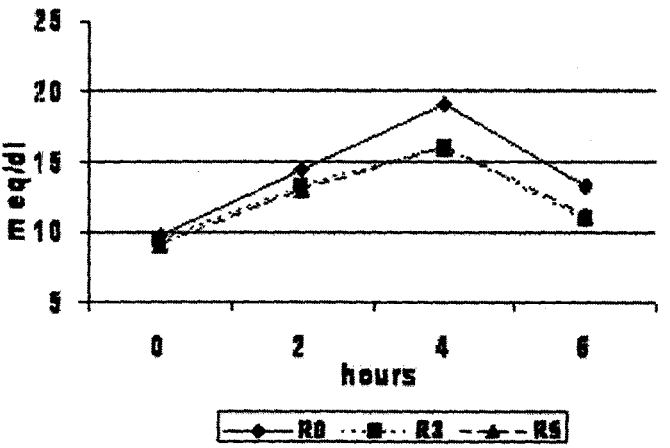

Fig. 1. Total ruminal VFA as affected by the dry fat supplementation

El-Bedawy *et al.* (1994) noted that lower ruminal VFA concentration were associated with feeding oil tallow supplemented hay. The VFA concentration increased after feeding. El-Bedawy (1995) found that feeding oil decreased the concentrations of ruminal total VFA before and 4-hrrs after feeding compared with control. Hussein *et al.* (1995) reported higher VFA concentration in fat supplemented diet being 15.48, 20.53, 16.64 and 15.23 at 0 time, 1, 3 and 6hrrs after feeding, respectively. El-Bedawy *et al.* (1996) and Tackett *et al.* (1996) noted that feeding fat decreased VFA concentration. Elliott *et al.* (1997) reported the higher value of VFA with un-supplemented control diet than the other groups fed different kinds of fats. Basiony (1998) reported some lower values of total VFA concentration, while others (Elizalde *et al.*, 1999) reported higher values than those reported in the present study. Zedan (2003) reported similar trend as that obtained in the present study. Difference may have been due to different ingredients of the diets used in these studies with different levels of fermentable carbohydrates and/or the experimental animals (sheep, steers and buffalo calves). Omer (1999) reported no significant differences in total VFA concentration. The mean values of total VFA were 7.56, 7.47 and 7.24 for control, 4% and 8% Ca-SFA, respectively.

Data of ammonia nitrogen concentration in the rumen of sheep as affected by the dietary dry fat supplementation are presented in Fig (2). Before feeding, NH_3-N was 14.58, 13.42 and 13.18 mg/dl rumen liquor. Differences were not significant. Ammonia-N increased after feeding to reach the highest values for all dietary treatments at 2-hrs being 23.22, 21.58 and 21.12 mg/dl rumen liquor. Concentration of NH_3-N was significantly higher ($P<0.05$) for the control group than the fat-treated groups (at both levels); ammonia-N decreased thereafter. Zedan (2003) reported similar trend and suggested that the higher NH_3-N values reported in the control group may have been due, at least in part, to a higher rate of protein breakdown within the rumen, or to a better utilization in the fat-treated groups.

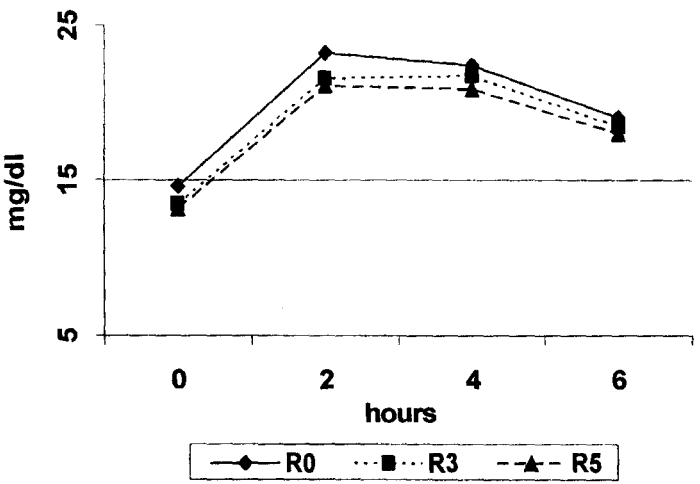

Fig. 2. Ruminal ammonia-N concentration as affected by the dry fat supplementation

El-Bedawy *et al.* (1994) reported that oil and tallow supplements significantly decreased ruminal ammonia-N concentration. Ruminal ammonia-N increased by increasing sampling time reaching its peak value at two hrs post-feeding and declined thereafter. In another study, EL-Bedawy (1995) found that ammonia-N concentrations (mg/100 ml rumen liquor) before feeding were 14.40, 14.38 and 13.65 for hay alone, hay + oil and hay + Ca-soap, respectively. He also reported that ammonia-N levels (mg/100 ml) at 4 hrrs post-feeding were 16.00, 15.30 and 16.00 at the same diets. Hussein *et al.*

(1995) observed better ammonia utilization with diet supplemented with 4% fat. EL-Bedawy *et al.* (1996) noted that ammonia-N was 43.57 and 39.82 mg/100 ml for control and fat supplemented ration. Talha (1996) noted that ruminal NH_3 concentrations decreased with increasing of black oil level up to 12%. El-Ashry *et al.* (1997) found that ammonia-N concentration was 18.2, 10.5 and 11.3 mg/100 ml rumen fluid for control, 6% oil and 6% free fatty acids, respectively. Ruminal ammonia nitrogen was significantly decreased ($P<0.05$) by both fat treatments. Omer (1999) found that ammonia-N levels (mg/100 ml rumen fluid) at 0 time were 12.27, 12.12 and 12.09 for control, 4% Ca-SFA and 8% Ca-SFA, respectively. The values at 4 hrs post-feeding were 17.77, 17.64 and 17.40 for the same diets.

Values of *p*H (Fig. 3) before feeding were 7.22, 7.33 and 7.23 for the treatment groups R_0, R_3 and R_5, respectively. Differences were not significant. At 2-hrs post feeding, *p*H declined with all treatment groups to reach the lowest values (being 6.20, 6.39 and 6.38 for the same respective groups). Differences among groups were found at all times post feeding being higher for the control and R_3 ration than R_5. Logically, *p*H values took the opposite trend of the VFA.

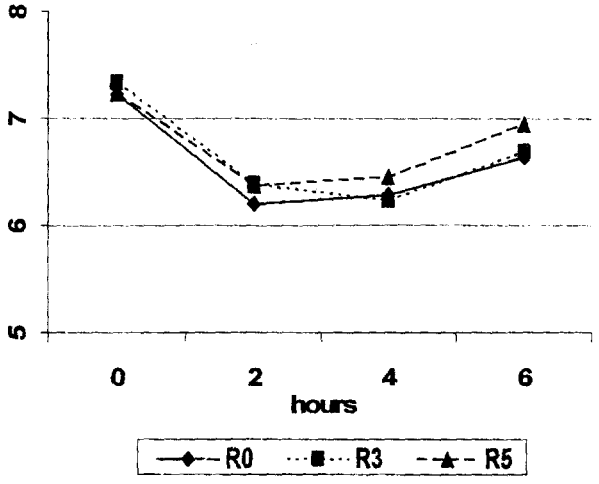

Fig. 3. Ruminal pH value as affected by the dry fat supplementation

Many investigators have reported different effects of dietary fat sources and levels on ruminal *p*H values. Jenkins and Fotouhi (1990) found that *p*H values were 6.19, 6.34 and 6.24 for control, lecithin and corn oil, respectively.

El-Bedawy *et al.* (1994) showed that feeding oil or hydrogenated vegetable oil supplemented hay without calcium addition decreased ruminal *p*H at all sampling times (before feeding, 2, 4 and 8 hrs. post–feeding). However, ruminal *p*H of sheep fed tallow supplemented hay showed comparable values to the control except for the zero time (before–feeding). El-Bedawy (1995) found that *p*H values before feeding were 6.72, 6.18 and 6.33 for hay, hay + oil and hay + Ca-soap, respectively; while *p*H values at 4 hrs post feeding were 6.25, 6.04 and 6.22 in the same diets. Later, El-Bedawy *et al.* (1996) found that *p*H values were 6.78 and 7.34 for control and fat supplemented ration, respectively. Similar results were also reported by Zedan (2003) who found that *p*H values decreased in the rumen of buffalo calves fed oil and fat supplemented diets. Earlier, Talha (1996) found that *p*H values decreased with increasing black oil levels (0, 3, 6, 9, 12, 15 and 18%) and time after feeding. El-Ashry *et al.* (1997) found that *p*H values were 6.14, 6.07 and 5.99 for control, 6% oil and 6% free fatty acids, respectively. Elliott *et al.* (1997) reported that *p*H values were 6.31, 650, 6.41, 6.45, 6.33 and 6.49 for control, tallow (T), partially hydrogenated tallow (PHT), hydrogenated tallow (HT), blend of HT and hydrogenated fatty acids (HFA), respectively. Basiony (1998) found that *p*H values at zero time were 5.90, 6.10 and 6.19 for control, fat substitution and fat supplement, respectively, while *p*H values at 4 hrs post feeding were 5.75, 5.83 and 5.91 in the same diets. Tjardes *et al.* (1998) found that *p*H values were 6.29, 6.38, 6.37 and 6.29 for whole corn, cracked corn, no supplemental fat and 4% supplemental fat, respectively. Elizalde *et al.* (1999) found that *p*H values were 5.87, 5.80, 5.90 and 5.77 for 5% prilled fatty acids (PFA), 5% liquefied triglyceride (LTG), 2.5% PFA + 2.5% LTG and 2.5% liquefied fatty acids + 2.5 LTG, respectively. Omer (1999) fond that *p*H values were 6.24, 5.71, 6.26, 5.68, 6.35 and 5.78 for control (zero time, 4 hrs post feeding), 4% Ca-SFA (Zero time, 4 hrs post feeding) and 8% Ca-SFA (before feeding and 4 hrs post feeding), respectively. He reported no significant differences in the mean values of ruminal *p*H.

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تأثير إضافة الدهن الجاف إلى العلائق على الهضم والقيمة الغذائية وتخمرات كرش الأغنام الوسيمي

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الملخص العربي

أجري هذا البحث بهدف دراسةِ تأثيراتَ إضافة الدهنِ الجافِ المحميِ على معاملات الهضم والقيمة الغذّائية وتخمرات الكرش. استخدم ثلاثة كباشِ أوسيمي (بمتوسط وزن جسمِ ٥٠ ± ٣ كيلوغرام) في تصميم تجريبي المربع اللاتيني ٣ ×٣ غذيت على ثلاث علائق تجريبيةِ. الأولى منها (المقارنة) ، (٦٠ % دريس برسيمِ + ٤٠% علف مركز مخلوطِ) بدون دهنِ إضافيِ؛ العليقة الثانية والثالثة كَانتْ عبارة عن العليقة المقارنة مضافا اليها أمّا ٣ % أو ٥ % دهن جاف. أظهرت النَتائِج أن معامل هضم المادة الجافة كَان أعلى في الكباش المغذاة على ٥% دهنَ جافَ (٦١,٥٤%) عِنْ تلك المغذاة على ٣ % دهن جاف (٦٠,٠١ %) أو العليقة المقارنة (٥٨,٩٦%). سجل نفس الإتجاهِ لمعاملات هضم المادة العضوية. اختلفت معاملات هضم البروتين الخام بين المعاملات الغذائيةِ بحيث كُانت أعلى في المجموعة الثالثة عن المجموعة الثانية بينما كانت المجموعة المقارنة هي الأقل معنويا. تحسنت معاملات هضم الدهن الخام بشكل معنوي مِنْ ٨١,١٧ % في المقارنة إلى ٨٤,٠٩ % في العليقة الثانية وإلى ٨٥,٣٤ % في العليقة الثالثة. لم يكن للمعاملة الغذائية أيّ تأثيرات على معامل هضم الكربوهيدرات الذائبة. إضافة الدهن زادَ من معادل هضم الألياف الخام مِنْ ٥٤,١٥ في العليقة

المقارنة إلى ٥٨,٠٩ و٦٠,٩٥ % في العليقة الثانية والثالثة، على التوالي. حسنت المعاملة الدهنية القيمةَ الغذّائيةَ فكانت المركبات المهضومة الكلية ٥٧,٠٤، ٦٠,٧٢ و٦٦,١٩ % للعلائق الثلاثة على التوالي. كما تَحسّنَ البروتين المهضوم مِنْ ٧,٢٢ إلى ٧,٦٦ و٨,٢٩ % على نفس الترتيب. الأحماض الدهنية الطيارة في سائل الكرش كَانت أعلى معنويا للمجموعة القياسيةِ عِنْ المجموعات المعاملة. عُموماً، بلغت تركيزات الأحماض الطيارة ذروتها عند ٤ ساعات بعد الأكل. تركيز أمّونيا الكرش كَانَ أعلى معنويا للمجموعة القياسيةِ عِنْ المجموعاتِ المُعَاملةِ بالدهنَ (في كلتا المستويات). قِيَم حموضة الكرش بين المجموعاتِ تَبَيَّن أنها كَانتْ أعلى للمجموعة المقارنة عن المجموعتين الأخرتين. وقد أَخذتْ قِيَمَ الحموضة الإتجاهَ المعاكسَ للأحماض الطيارة.