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PREPUBERTAL EFFECTS OF CALCIUM SOAP SUPPLEMENTATION IN RAHMANI EWE-LAMBS

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SUMMARY

The effect of calcium soap supplementation on the puberty attainment was investigated in twelve Rahmani ewe-lambs of 6-7 months of age and average body weight 24.75±0.16 Kg. Animals were allocated into two groups of 6 ewe-lambs each; the first group kept as a control and received the basal diet while the animals in the second group received the basal diet supplemented with 3% calcium soap for twelve weeks. During the study period, two types of samples from each animal were obtained; weekly blood samples from which sera were separated and used for assaying of blood metabolites and progesterone and rumen juice samples which were collected twice, the first collection was taken in the middle of the study period (the 6th week) and the second one at the end of the study (the 12th week). The results revealed that calcium soap supplemented Rahmani ewe-lambs attained puberty 5 weeks earlier than control ones; this earlier puberty attainment may be due to the possible beneficial effects of calcium soap at both rumen metabolic pool, which was characterized by increased rumen propionate concentration, decreased methane production and decreased ammonia nitrogen concentration, and general metabolic pool as indicated by increased serum glucose, total lipids, total cholesterol and high density lipoproteins and decreased urea concentrations. In summary, the beneficial effects of calcium soap supplementation at rumen and general metabolic pools led to improvements in the energy and lipid status of the supplemented Rahmani ewe lambs and earlier attainment of puberty; this may be through the increased trophic signals of hypothalamo-pituitary origin to the ovary together with increased provision of energy yielding substrate (s) and steroid hormones precursors.

Key words: Blood Metabolites, Calcium Soap, Puberty, Rumen Profile, Rahmani Ewe-Lambs.

INTRODUCTION

Age at puberty is an important trait concerning overall reproductive performance; therefore, early attainment of puberty is one way of extending female sheep lifetime reproductivity. Quirke (1978) reported that sheep puberty is attained at age 6-18 month and the average body weight at first estrus within the range of 30-50 Kg b.w. Additionally, Rahmani ewe-lambs, one of Egyptian native breed, attained puberty at age ranged from 233-420 day and body weight range of 25-38 Kg b.w (Sharafeldin et al., 1969).

On the other hand, The central mechanisms timing puberty are sensitive to a critical level of metabolic signals that are implicated in activation of the hypothalamo-hypophyseal-gonadal axis (Foster et al., 1999). Moreover, Oxidizable metabolic fuels, regardless of their source (fat, carbohydrates or proteins) have been implicated as a regulators of gonadotropin releasing hormone (Snyder et al., 1999), luteinizing hormone (Cameron, 1997) and ovarian hormones (Hawkins et al., 1995).

In the light of the previous views, calcium soap represents a rich source of metabolic fuel (s) due to its fatty acids content (84% fatty acids); so it was recently implicated in ruminant ration to increase its caloric density (Palmquist, 1994); moreover, the presence of calcium alleviates the undesirable effects of fat on rumen fermentation pattern (El-Bedawy et al., 1994).

Bearing in mind the previous considerations and that there is scarcity in the studies that dealt with the effect of calcium soap on sheep reproduction in general and puberty in particular; the current study was carried out to investigate the effect of calcium soap supplemented to Rahmani ewe-lambs on puberty attainment and to record the associated ruminal and metabolic alterations that modulate energy and lipid status in search for cues timing puberty

MATERIALS AND METHODS

Animals and Rations:

The present study was conducted in experimental stable belonging to Dept. of Nutrition and Clinical nutrition, Fac. Vet. Med., Cairo university. Twelve prepubertal Rahmani ewe-lambs of 6-7 months and average body weight of 24.75±0.16 Kg were randomly allocated into two groups of 6 ewe-lambs each. The first group was kept as a control and fed basal diet; only in the second group ewe-lambs were fed on basal diet supplemented with calcium soap at a rate of 3% of dry matter intake (MagnapacTM, Norel, S.A., Spain) for twelve weeks.

Additionally, The average dry matter intake

(DMI) was 1.2 kg/ head/ day. Clean water was available free choice at all times. The ewe-lambs were given ad libitum access to feed and weighed at the start and at the end of the study after a fast of 24 hours from feed and 16 hours from water. Moreover, body condition scores of the animals, at the end of the study, was assessed.

Table (1): Ingredients and chemical composition of the basal and supplemented diets fed to Rahmani ewe-lambs:

Ingredients (%)	Basal diet	Supplemented diet
Barely, grain	35	31.2
Barseem, hay	64.2	65
Calcium soap	0	3
Salt	0.5	0.5
Minerals and vitamin premix	0.3	0.3
Minerals and vitamin premix[1]		
Chemical analysis (%) (calculated)		
CP	12.9	12.6
TDN	61.11	64.01
Ca	1.46	1.75
P	0.2	0.17

Minerals and vitamin mixtures[1] (Rovimix, Egypt) contain/ 3 Kg: vitamin A 10000000 Iu, vitamin D3 2000000 Iu, vitamin E 2oooo mg, Selenium 250 mg, Cobalt 500 mg, Iodine 1000 mg, Iron 45 mg, Manganese 120 mg and Zinc 100 mg.

Table (2): Chemical composition and fatty acids profile of calcium soap supplemented to Rahmani ewe-lambs:

Chemical composition	(%)
Fatty acids	84
Ash	11 (9% calcium)
Moisture	5

Fatty acids profile		(%)
Miristic acid	(C14)	1.5
Palmitic acid	(C16)	44
Stearic acd	(C18)	5
Oleic acid	(C18:1)	40
Linoleic acid	(C18:2)	9.5

Sampling:

Two types of samples were obtained during the study period which were rumen juice and blood samples.

1- Rumen juice samples:

Rumen juice samples were collected twice form all animals four hours post feeding; the first collection was taken in the middle of the study period (the 6th week) and the second one at the end of the study (the 12th week). Immediately, samples were strained through four layers of sterile gauze and the resultant strained rumen liquor (SRL) was used for measuring of ruminal ammonia nitrogen, propionate and molar methane concentrations.

2- Blood samples:

Individual blood samples were collected prior to the beginning of the study (pretreatment or 0 blood samples); thereafter, blood samples were weekly obtained till the end of the study period. Blood samples were allowed to clot and sera were separated by centrifugation at 3000 rpm for 15 minutes. Sera samples were divided into aliquots and frozen at -20°C until assayed for urea, glucose, total lipids, total cholesterol, high density lipoproteins and progesterone.

Data Collection Techniques:

1- Rumen chemistry:

Ruminal ammonia nitrogen concentration was determined spectrophotometrically according to the method of Gips and Wibbens-Alberts (1968) using commercial kit obtained from Biodiagnostics, Egypt; propionic acid concentration was measured by gas chromatography according to Erwin et al. (1961) and ruminal methane production was estimated according to Orskov (1975).

2- Blood metabolites:

serum glucose, urea, total lipids, total cholesterol and high density lipoprotein levels were determined spectrophotometrically in. sera samples collected at 0 time, the 6th week and the 12th week of the study period according to Trinder (1969), Tabacco et al. (1979), Zollner and Kirsch (1962), Richmond (1973) and Finley et al. (1978), respectively. Glucose, total lipids and total cholesterol kits were obtained from Biodiagnostics, Egypt; while, urea and high density lipoprotein kits were brought from Stanbio Laboratory, Texas, USA.

3- Progesterone estimation:

Progesterone level was estimated in weekly collected sera samples by competitive ELISA according to Wisdom (1976) using kits purchased from Dima, Germany.

4- Statistical analysis:

Data were presented as mean±SE and analyzed by two way analysis of variance (ANOVA) according to Snedecor and Cochran (1980). Treatment means were compared by the least significance difference test (LSD). Moreover, unpaired "t" test was used to evaluate the differences between the two groups in their body weight, body weight gain, dry matter intake and body condition score. Additionally, chi square was applied to compare between both groups in the cumulative numbers and proportions of ewe-lambs attaining puberty. Significant differences were set at P < 5%.

RESULTS

Table (3) shows that Rahmani ewe-lambs supplemented with calcium soap for twelve weeks have higher final body weight, body weight gain and body condition score than those of the control. Moreover, dry matter intake was increased in the supplemented ewe-lambs.

Table (3): Effect of calcium soap supplementation for twelve weeks on final body weight, body weight gain, dry matter intake and body condition score of Rahmani ewe-lambs:

Items	Treated groups		Significance
	Control	Supplemented	
Number of animals/group	6	6	-
Initial live body weight (Kg)	24.5±0.13	25±0.26	-
Final live body weight (Kg)	30.67±0.95	34.67±0.54	S
body weight gain (g/day)	73.17±11.27	115±6.4	S
Dry matter intake (Kg/day)	1.2±0.02	1.35±0.03	S
Body condition score	2±0	3.33±0.07	S

S: Significant

It is evident from table (4) that the advancement of age is associated with reduction in rumen propionate concentration. However, calcium soap-supplementation led to an increase in rumen propionate concentration in comparison with that of the control ewe-lambs. Moreover the overall increment effect of the supplement was 46.34% relative to that of the control. Nevertheless, the influence of calcium soap-supplementation on rumen propionate concentration was time-independent.

Table (4): Prepubertal effect of calcium soap supplementation on rumen propionate concentration (meq/L) in Rahmani ewe-lambs:

Duration of supplementation	Treated groups		Overall means of duration effect
	Control	Supplemented	
6 weeks	10.11 ± 0.15	13.36 ± 0.51	11.74[a] ± 0.55
12 weeks	5.47 ± 0.20	9.44 ± 0.50	7.46[a] ± 0.65
Overall means of supplement effect	7.79[b] ± 0.71	11.4[b] ± 0.68	

L.S.D. of overall duration effect = 0.792
L.S.D. of overall supplement effect = 0.972
No supplement x duration interaction.
Values having the same letter in the same row or column are significantly different.

As shown in table (5), there was an overall decreasing effect of age on rumen ammonia nitrogen concentration. Furthermore, rumen ammonia nitrogen concentration in the calcium soap-supplemented group was lower than that of the control one; the overall decreasing effect of the supplement was 23.46% versus that of the control. However, the lowering effect of the supplement was time-independent.

Table (5): Prepubertal effect of calcium soap supplementation on ruminal ammonia nitrogen concentration (mg/dl) in Rahmani ewe-lambs:

Duration of supplementation	Treated groups		Overall means of duration effect
	Control	Supplemented	
6 weeks	41.6 ± 1.86	31.08 ± 0.79	36.56[a] ± 1.81
12 weeks	33.67 ± 0.24	26.52 ± 1.89	30.09[a]± 1.4
Overall means of supplement effect	37.6[b] ± 1.49	28.8[b] ± 1.19	

L.S.D. of overall duration effect = 2.889
L.S.D. of overall supplement effect = 2.889
No supplement x duration interaction.
Values having the same letter in the same row and column are significantly different.

Table (6) identifies that age is associated with an increase in rumen methane production. Conversely, rumen methane production in the calcium-soap supplemented Rahmani ewe-lambs was lower than that of the control; the overall decrement effect of calcium soap-supplementation was 26.55% relative to that of the control. It is worth noting that the lowering effect of calcium soap-supplementation on rumen methane production was time-dependent since it was found that the 12-weeks supplementation decrement influence (30.33% vs that of the control) outdid that of the 6-weeks supplementation (19.15% vs that of the control)

Table (6): Prepubertal effect of calcium soap supplementation on rumen methane production (moles) in Rahmani ewe-lambs:

Duration of supplementation	Treated groups		Overall means of duration effect
	Control	Supplemented	
6 weeks	9.83 ± 0.18	7.99 ± 0.19	$8.91^{a} \pm 0.30$
12 weeks	20.44 ± 0.93	14.24 ± 0.11	$17.34^{a} \pm 1.03$
Overall means of supplement effect	$15.14^{b} \pm 1.66$	$11.12^{b} \pm 0.95$	

L.S.D. of overall duration effect = 1.011
L.S.D. of overall supplement effect = 1.011
L.S.D. of supplement x duration interaction = 1.430
Values having the same letter in the same row and column are significantly different..

It is obvious from table (7) that there were an overall increment effects of age and calcium soap-supplementation on serum glucose level. Furthermore, the increasing effect of calcium soap-supplementation was time-dependent. Moreover, the increasing effect of the 6-weeks supplementation was lower than that of the 12-weeks supplementation; 18.81% and 21.48% relative to that of the control, respectively.

Table (7): Prepubertal effect of calcium soap supplementation on serum glucose level (mg/dl) in Rahmani ewe-lambs:

Duration of supplementation	Treated groups		Overall means of duration effect
	Control	Supplemented	
0 month	53.33 ± 3.46	51.11 ± 2.03	$52.23^{a,b}$ ± 1.94
6 weeks	68.31 ± 1.17	81.16 ± 2.72	74.73^{a} ± 2.40
12 weeks	67.68 ± 0.19	82.22 ± 4.79	74.95^{b} ± 3.17
Overall means of supplement effect	63.11^{b} ± 2.03	71.5^{b} ± 3.95	

L.S.D. of overall duration effect = 5.77
L.S.D. of overall supplement effect = 4.71
L.S.D. of supplement x duration interaction = 8.16
Values having the same letter in the same row and column are significantly different.

Data presented in table (8) reveal that while there was an overall increment effect of age on serum urea-nitrogen concentration; that of supplement effect was of decrement nature. Moreover, the lowering effect of calcium soap-supplementation was time-dependent. The comparison between groups shows that the lowering effect of 6-weeks calcium soap-supplementation (36.28% relative to that of the control) outperformed that of 12-weeks supplementation (13.5% that of the control).

Table (8): Prepubertal effect of calcium soap supplementation on serum urea nitrogen level (mg/dl) in Rahmani ewe-lambs:

Duration of supplementation	Treated groups		Overall means of duration effect
	Control	Supplemented	
0 month	9.79 ± 0.57	10.77 ± 0.47	10.28^{a} ± 0.38
6 weeks	13.12 ± 0.67	8.36 ± 0.19	10.74^{b} ± 0.79
12 weeks	14.00 ± 0.14	12.11 ± 0.24	$13.05^{a,b}$ ± 0.31
Overall means of supplement effect	12.3^{b} ± 0.52	10.41^{b} ± 0.41	

L.S.D. of overall duration effect = 0.875
L.S.D. of overall supplement effect = 0.714
L.S.D. of supplement x duration interaction = 1.238
Values having the same letter in the same row and column are significantly different.

Table (9) shows an overall increment effects of both age and supplement on serum total lipids concentration. Moreover, the increment effect of calcium soap-supplementation was time-dependent and the increment effect was 20.4% and 24.1% that of the control after 6 and 12 weeks of supplementation, respectively.. Further-more, the within supplemented group comparison shows that the 12-weeks elevating effect was higher than that of the 6-weeks supplementation.

Table (9): Prepubertal effect of calcium soap supplementation on serum total lipids concentration. (mg/dl) in Rahmani ewe-lambs:

Duration of supplementation	Treated groups		Overall means of duration effect
	Control	Supplemented	
0 month	137.98 ± 5.89	131.09 ± 13.34	134.53[a] ± 7.03
6 weeks	259.89±16.27	312.85±10.8	286.37[a]±10.72
12 weeks	312.5±2.46	387.71±10.39	351.14[a]±12.16
Overall means of supplement effect	237.45[b]±18.3	277.22[b]±26.88	

L.S.D. of overall duration effect = 18.93

L.S.D. of overall supplement effect = 15.99

L.S.D. of supplement x duration interaction = 26.77

Values having the same letter in the same row and column are significantly different.

Table (10) denotes that there were an overall in-crement effects of both age and calcium-soap supplementation on serum total cholesterol con-centration. Moreover, the increasing effect of calcium-soap supplementation was time-dependent. Additionally, the elevating effect of 12-weeks supplementation was higher than that of the 6-weeks supplementation.

Table (10): Prepubertal effect of calcium soap supplementation on serum total cholesterol concentration (mg/dl) in Rahmani ewe-lambs:

Duration of supplementation	Treated groups		Overall means of duration effect
	Control	Supplemented	
0 month	24.5 ± 0.17	23.62 ± 0.52	24.06[a] ± 0.29
6 weeks	30.79 ± 1.28	41.72 ± 3.5	36.26[a] ± 2.42
12 weeks	36.64 ± 2.15	57.17 ± 4.11	46.91[a] ± 3.8
Overall means of supplement effect	30.64[b] ± 1.44	40.84[b] ± 3.73	

L.S.D. of overall duration effect = 4.98
L.S.D. of overall supplement effect = 4.066
L.S.D. of supplement x duration interaction = 7.04
Values having the same letter in the same row and column are significantly different.

It is clear from table (11) that there were an overall increment effects of age and calcium-soap supplementation on serum high density lipoprotein concentration in Rahmani ewe-lambs. Furthermore, the increasing effect of calcium-soap supplementation was time-dependent. However, the difference between the increasing effects of 6-weeks and 12-weeks supplementation were statistically equipotent.

Table (11): Prepubertal effect of calcium soap supplementation on serum high density lipoprotein concentration (mg/dl) in Rahmani ewe-lambs:

Duration of supplementation	Treated groups		Overall means of duration effect
	Control	Supplemented	
0 month	27.37 ± 1.68	28.29 ± 3.55	27.83[a,b] ± 1.87
6 weeks	40.48 ± 1.74	52.26 ± 1.99	46.37[a] ± 2.18
12 weeks	40.73 ± 1.06	50.64 ± 0.55	45.69[b] ± 1.6
Overall means of supplement effect	36.19[b] ± 1.72	43.73[b] ± 2.9	

L.S.D. of overall duration effect = 4.07
L.S.D. of overall supplement effect = 3.32
L.S.D. of supplement x duration interaction = 5.75
Values having the same letter in the same row and column are significantly different.

It is evident from table (12) that the calcium soap supplementation effect on puberty was first detected 5 weeks after the start of the experiment, when 4/6 of the supplemented Rahmani ewe-lambs started to attain puberty. In the control group, puberty was first detected 6 weeks after the beginning of the investigation, when 2/6 of control ewe-lambs began to attain puberty. Additionally, all ewe-lambs in the calcium soap supplemented and control groups attained puberty 7 and 10 weeks, respectively after the beginning of the study.

Table (12): Cumulative numbers and percentages of calcium soap supplemented Rahmani ewe-lambs attaining puberty*:

Weeks of experiment	Treated groups		Significance
	Control	Supplemented	
4 weeks	0/6 (0%)	0/6 (0%)	-
5 weeks	0/6 (0%)	4/6 (66.7%)	S
6 weeks	2/6 (33.3%)	5/6 (83.3%)	S
7 weeks	2/6 (33.3%)	6/6 (100%)	S
8 weeks	2/6 (33.3%)	-	-
9 weeks	3/6 (50%)	-	-
10 weeks	6/6 (100%)	-	-

S: Significant

* Defined as the first day on which serum progesteroone reached ≥ one ng/ml for two consecutive weeks (Simpson et al., 1991 & Boulanouar et al., 1995).

Table (13) shows that there were an overall increment effect of both age and calcium-soap supplementation for four weeks on serum progesterone level in prepubertal Rahmani ewe-lambs. Moreover, the increasing effect of calcium-soap supplementation for 4 weeks was time-dependent.

Table (13): Prepubertal effect of calcium soap supplementation for four weeks on serum progesterone level (ng/ml) in Rahmani ewe-lambs:

Groups	Weeks of supplementation					Overall means of supplement effect
	0-Week	1st-Week	2nd-Week	3rd-Week	4th-Week	
Control	0.056 ± 0.0004	0.064 ± 0.002	0.108 ± 0.011	0.094 ± 0.007	0.095 ± 0.007	0.083[a] ± 0.005
Supplemented	0.054 ± 0.0005	0.096 ± 0.006	0.134 ± 0.007	0.135 ± 0.004	0.091 ± 0.007	0.102[a] ± 0.006
Overall means of duration effect	0.055[a,b,c,d] ± 0.0004	0.08[a,e,f,g] ± 0.006	0.121[b,e,h] ± 0.007	0.115[c,f,i] ± 0.007	0.093[d,g,h,i] ± 0.005	

L.S.D. of overall duration effect = 0.012
L.S.D. of overall supplement effect = 0.00776
L.S.D. of supplement x duration interaction = 0.017
Values having the same letter in the same row and column are significantly different.

It is evident from table (14) that there was an overall increasing effects of both age and calcium-soap supplementation for eight weeks on serum progesterone level. The elevating effect of calcium-soap supplementation was time-dependent.

Table (14): Prepubertal effect of calcium soap supplementation for eight weeks on serum progesterone level (ng/ml) in Rahmani ewe-lambs:

Groups	Weeks of supplementation				Overall means of supplement effect
	5th-Week	6th-Week	7th-Week	8th-Week	
Control	0.764 ± 0.06	0.777 ± 0.117	0.763 ± 0.203	0.805 ± 0.099	0.777[a] ± 0.061
Supplemented	1.333 ± 0.304	1.725 ± 0.215	0.846 ± 0.017	0.549 ± 0.118	1.113[a] ± 0.131
Overall means of duration effect	1.048[b] ± 0.171	1.251[c,d] ± 0.184	0.805[c] ± 0.098	0.677[b,d] ± 0.083	

L.S.D. of overall duration effect = 0.336
L.S.D. of overall supplement effect = 0.237
L.S.D. of supplement x duration interaction = 0.475
Values having the same letter in the same row and column are significantly different.

able (15) clears that while the overall effect of alcium-soap-supplementation for twelve weeks was of increasing nature, that of duration was statistically insignificant. On the other hand, the increment effect of calcium-soap-supplementation was time-dependent.

Table (15): Prepubertal effect of calcium soap supplementation for twelve weeks on serum progesterone level (ng/ml) in Rahmani ewe-lambs:

Groups	Weeks of supplementation				Overall means of supplement effect
	5th- Week	6th- Week	7th- Week	8th- Week	
Control	1.291 ± 0.21	1.553 ± 0.31	0.455 ± 0.065	0.481 ± 0.087	0.945[a] ± 0.136
Supplemented	1.408 ± 0.31	0.809 ± 0.093	1.455 ± 0.195	1.945 ± 0.368	1.404[a] ± 0.149
Overall means of duration effect	1.349 ± 0.18	1.181 ± 0.191	0.955 ± 0.18	1.213 ± 0.285	

No overall duration effect.
L.S.D. of overall supplement effect = 0.333
L.S.D. of supplement x duration interaction = 0.665
Values having the same letter in the same row and column are significantly different.

DISCUSSION

The energy intake appears to be the primary determinant for ruminants reproductive performance as ruminants are good nitrogen preservers. Furthermore, ruminant performance and responses are dependent on the source of energy fed rather than variations of rumen degradable and undegradable protein contents of the diet (Asplund, 1994 and Abdelgadir et al., 1996).

The current investigation showed a beneficial effect of calcium soap supplementation on rumen fermentation pattern as indicated by increased rumen propionate and decreased methane production and ammonia nitrogen concentration.

The increased propionate concentration and decreased methane production may be resulted from the shifting of hydrogen produced from the fermentative process toward propionate-producing bacterial populations (Wolin and Miller 1988).

This consequently led to reduced hydrogen availability for methanogenic bacteria and so about 10% of the gross energy of the diet will be saved due to reduced methanogenesis (VanNevel and Demeyer,1988).

On the other hand, the reduced rumen ammonia nitrogen concentration in calcium soap supplemented Rahmani ewe-lambs reflected better ammonia assimilation for microbial protein biosynthesis due to the presence of adequate energy yielding substrates; because microbial protein synthesis requires these energy yielding substrates to supply the carbon skeletons of the amino acids and to provide the energy needed for the synthetic processes (Asplund, 1994).

It is worth noting that the increment and the decrement effects of calcium soap supplementation on ruminal propionate and ammonia nitrogen concentration, respectively were associated with corresponding changes in serum glucose and urea concentrations in the supplemented Rahmani ewe-lambs.

The reported increase in serum glucose level in the supplemented group could be attributed to increased propionate production in the rumen and enhanced propionate metabolism by the liver. Since dietary changes greatly affect glucose production by gluconeogenesis in the liver via their effect on propionyl Co. A carboxylase activity in the liver, an enzyme essential in the biochemical pathway through which propionate is normally incorporated in the tricarboxylic acid cycle (Elliot, 1980).

Furthermore, the decreased rumen ammonia nitrogen and serum urea concentrations may be additional effect by which calcium soap supplementation increased serum glucose level through saving extra ATP for hepatic gluconeogenesis; this notion is supported by the finding of (Leonard et al., 1977) that hepatic detoxification of ammonia into urea has been reported to reduce plasma glucose level possibly by its direct inhibitory effect on liver gluconeogenic activity through a competition for ATP by increased activity of urea cycle.

Moreover, the increased serum total lipids, total cholesterol and high density lipoproteins, recorded in the present study, represents an additional beneficial effect of calcium soap feeding at general metabolic pool level of Rahmani ewe-lambs. The increased serum total lipids in the supplemented group may be ascribed to the depressing effect of long chain fatty acids content of calcium soap on lipogenic enzymes activities in adipose tissue, since it has been found that feeding long chain fatty acids was reported to induce shifting in the balance from active protomeric to inactive polymeric forms of acetyl Co. A carboxylase in bovine adipose tissue (Bauman and Davis, 1975).

Furthermore, The recorded increase in serum total cholesterol and plasma high density lipoproteins associated with calcium soap-supplementation could be attributed to increased formation of chylomicrons required for cholesterol absorption from the small intestine (Grummer and Carroll, 1991).

Thus it could be concluded that calcium soap supplementation altered beneficially the rumen fermentation pattern and so was the effect at general metabolic pool as indicated by increased serum glucose and cholesterol; metabolites critical to the reproductive function. These alterations were manifested at the animal level by earlier attainment of puberty in calcium soap-fed Rahmani ewe-lambs as indicated by serum progesterone level. Additionally, in the light of the information presented by Simpson et al. (1991) and Boulanouar et al. (1995) that Puberty was defined as the first day on which serum progesterone reached ≥ one ng/ml for two consecutive weeks; it could be mentioned that the onset of puberty was achieved in supplemented Rahmani ewe-lambs earlier than control ones by 5 weeks, since in the supplemented group serum progesterone levels reached ≥ one ng/ml at the 5th week of the supplementation; while in the control gorup it was delayed to the 9th week from the start of the investigation.

The earlier attainment of puberty in the supplemented group may be due to creation of favorable conditions that forward puberty; these conditions may be represented by increased trophic signals to the ovary of hypothalamo-pituitary origin, higher levels of metabolites critical to the reproductive function (glucose and cholesterol) and improved energy and lipid status.

The proposed increase in the trophic signals of hypothalamo-pituitary origin with consequent earlier ovarian activity could be attributed to the increased rumen propionate and/or serum glucose concentration in the treated Rahmani ewe-lambs; since Rutter et al. (1983) found in Brangus heifers, with propionate-induced increases in blood glucose, released more LH in response to GnRH than control heifers did. Furthermore, Bushmich et al. (1980) showed an enhanced ovarian sensitivity to gonadotropins in heifers with increased molar proportions of ruminal propionate.

With reference to glucose, the expected increase of glucose availability to gonadotrophs, due to the increased serum glucose recorded in the present study, with consequent enhanced capability of pituitary response to GnRH seems to be likely. This postulation is supported by the findings of Snyder et al. (1999) that glucose increased the responsiveness of the pituitary to the released GnRH probably through IGF-1 system in the anterior pituitary. Moreover, Funston et al. (1995) demonstrated that depletion of glucose availability in ewes through the use of 2-deoxy-D-glucose (glucose antagonist) suppressed pituitary release of LH and prevented expression of estrus and corpus luteum formation. Furthermore, Randel (1990) mentioned that a threshold circulating concentration of glucose appears to be required for GnRH release.

Thus, in the light of the previous information it could be stated that the ovaries of the treated ewe-lambs has stronger trophic signals than that of the control together with increased availability of the nutrients required for ovarian metabolism. The possible role of glucose in this regard canít be refuted; since Rabiee and Lean (2000) suggested that glucose may promote cholesterol uptake into the ovine ovarian cells or vice versa. Additionally, Chase et al. (1992) suggested that the requirements for steroid hormones precursors depend on the simultaneous availability of glucose. Additionally, Stevenson et al. (1985) reported that the stimulatory effect of ATP (resulted from glucose metabolism) on mitochondrial utilization of cholesterol was similar to that of gonadotropin.

On the other hand, the current study reported hyperlipidemic effect of calcium soap supplementation; this effect may lead to increased steroid hormones synthesis by the ovary; since the blood cholesterol is the primary source of ovarian steroidogenesis among mammalian species (Talavera et al. 1985).

It is worth mentioning that the hyperlipidemic effect of calcium soap supplementation could be extended to the ovarian microenvironment; this notion is supported by the findings of Wehrman et al. (1991); Ryan et al. (1992) and Hawkins et al. (1995) that during fat supplementation, cholesterol and high density lipoprotein are not only increased in blood but also follicular fluid concentrations have been increased.

In summary, the beneficial effects of calcium soap supplementation at rumen and general metabolic pools led to improvements in the energy and lipid status of the supplemented Rahmani ewe lambs and earlier attainment of puberty; this may be through the increased trophic signals of hypothalamo-pituitary origin to the ovary together with increased provision of energy yielding substrate (s) and steroid hormones precursors.

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