EFFECT OF NATURAL FEED ADDITIVES ON PERFORMANCE OF GROWING FRIESIAN CALVES

A.M.A. Mohi El-Din, H.M.A. Gaafar, H.M. El-Nahas, E.E. Ragheb and A.F. Mehrez

Animal Production Research Institute, Agricultural Research Center, Dokki, Egypt

SUMMARY

Eighteen Friesian calves averaging 159.39±3.37 kg initial LBW and aged 7.0±0.23 months were randomly divided into 3 similar groups, 6 animals in each. All calves were fed a basal ration consisting of 65% concentrate feed mixture (CFM) plus 15% fresh berseem (FB, Trifolium alexandrinum) during the first feeding interval (for 180 days) or berseem hay (BH) during the second feeding interval (120 days, from day 181 to 300 of the experimental period) beside 20% rice straw (RS) during both feeding intervals (on DM basis). Calves in the 1st group were fed un-supplemented basal ration (R1, control), while those in the 2nd (R2) and 3rd (R3) groups were fed the basal ration supplemented with 25 g Kelp meal/head/day (Ascophyllum nodosum seaweed) and 40 g Acid buff/head/day (a novel product working as a natural rumen buffer for use in dairy and beef cattle), respectively. Results showed that contents of CP, EE, NFE and ash tended to be higher, and contents of OM and CF tended to be lower in R1 than in R2. Dietary addition of kelp meal and acid buff improved (P<0.05) digestion coefficients of all nutrients and subsequently nutritive values during the 1st and 2nd feeding periods. The pH value and TVFA's concentrations were higher (P<0.05) in rumen liquor (RL) of calves fed R2 and R3 than in those fed R1 during the 1st and 2nd intervals. However, concentration of NH_3-N in RL did not differ significantly by dietary additives. Concentrations of total protein, albumin and globulin were higher (P<0.05) in blood plasma of calves fed R2 and R3 than in R1 during the 1st and 2nd intervals. However, the concentration of urea-N in blood plasma showed an opposite trend. Activities of trans-aminases (AST and ALT) were nearly similar in blood plasma of calves in different groups. Feed intake from different feedstuffs as fed or as DM, TDN and DCP were higher (P<0.05) by calves fed R2 and R3 than by those fed R1 during the 1st interval, 2nd interval and the whole period. Final body weight, total weight gain and average daily gain were higher (P<0.05) in calves fed R2 and R3 than in those fed R1, during the 1st interval, 2nd interval and the whole period. Dietary additives (kelp meal and acid buff) in R2 and R3, respectively, improved feed conversion by reducing (P<0.05) the amounts of DM, TDN and DCP per kg gain compared with R1 during the 1st interval, 2nd interval and the whole period. Average daily feed cost, price of daily weight gain and economic efficiency were higher (P<0.05), while feed cost per kg gain was lower (P<0.05) for calves fed R2 and R3 for those fed R1, during the 1st interval, 2nd interval and the whole period. From these results, it could be concluded that kelp meal and acid buff additives improved nutrients digestion, rumen activity, which reflected in higher weight gain, feed conversion, and economic efficiency of growing Friesian calves in comparison with those fed without additives.

Keywords: Friesian calves, kelp meal, acid buff, growth, digestion, rumen activity, blood parameters

INTRODUCTION

Throughout the recent years in Egypt, there are many attempts to solve the shortage in meat production to meet the increasing demands of human consumption. Some of these efforts were conducted by using feed supplements such as yeast culture, minerals, vitamins and buffering agents for ruminal condition. Sea life is a rich and dependable source of 60 minerals and elements including iodine, 21 amino acids, and 12 vitamins (including A, C, B_{12}, thiamin, and vitamin E or tocopherol). Because the minerals are in plant tissue they are easily digested and assimilated. Many of the trace minerals contained in sea life are essential for producing enzymes which in turn promote healthy body functions (Agri-Growth International Inc., 2007).

There is a great attention on using seaweed in ruminant feeding in the recent years in Egypt. Kelp meal is *Ascophyllum nodosum* seaweed and has been used as a natural source feed supplement for organic macro and micro minerals. Seaweed is plentiful in many areas of the world, but most research work indicates that it is not good of either energy or protein and should be used mainly as mineral supplement. It contains about 2% Ca, 0.4-0.5% P and is a good source of Fe and is extremely high in I (Church and Pond, 1988). In addition, acid buff is a novel product working as a natural rumen buffer for use in dairy and beef cattle, which has been derived from mineralized seaweed. Typical analysis of acid buff was calcium 28-30% and magnesium 5-7%, loss on drying 5% max and residue on ignition 89-94%. Addition of acid buff dramatically prevents change of pH in the rumen, thereby stabilizing the microbial population (El-Saadany *et al.* 1999). Using seaweed in feeding growing calves significantly improved digestibility coefficient of most nutrients and growth performance of supplemented animals than the controls (Mehany *et al.*, 2003).

The objective of this study was to investigate the effect of kelp meal and acid buff additives on digestibility, rumen activity, blood constituents, feed intake, body weight gain, feed conversion and economic efficiency of growing Friesian calves.

MATERIAL AND METHODS

This work was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture during the period from December 2005 to September 2006.

Animals and feeding system:

Eighteen Friesian calves averaged 159.39±3.37 kg as an initial LBW and 7.0±0.23 months of age were randomly divided into 3 similar groups, 6 animals each. All calves were fed a basal ration consisting of 65% concentrate feed mixture (CFM) plus 15% fresh berseem (FB, *Trifolium alexandrinum*) during the first feeding interval (for 180 days) or berseem hay (BH) during the second feeding interval (120 days, from day 181 to 300 of the experimental period) beside 20% rice straw (RS) during both feeding intervals (on DM basis). Calves in the 1st group were fed un-supplemented basal ration (Control, R1), while those in the 2nd (R2) and 3rd (R3) groups were fed the basal ration supplemented with 25 g Kelp meal/head/day and 40 g Acid buff/head/day, respectively.

Animals in all groups were fed their allowances to cover the recommended requirements according to NRC (1996) for growing calves. Amount of feeds were adjusted every two weeks according to body weight changes. The CFM was offered two times daily at 8 a.m. and 4 p.m., while FB or BH was offered once daily at 11 a.m. Rice straw was given two times at 9 a.m. and 5 p.m. The determined feed supplements (Kelp meal or Acid buff) were added only to CFM during the morning feeding. Calves in all groups were allowed to drink water three times a day at 7 a.m., 1 p.m. and 7 p.m. and kept under the routine veterinary supervision through the completely feeding period.

Experimental procedures:

Growth performance:

Throughout feeding period, calves were individually weighed in the morning before drinking and feeding at the beginning of the experiment and biweekly intervals thereafter to calculate total weight gain and average daily gain. Also, feed intakes from different feed stuffs as well as feed intakes as total DM. TDN and DCP were recorded, then feed conversion as the amounts of DM, TDN and DCP (kg) required per kg live body weight gain was calculated.

Digestibility trials:

Two digestibility trials during the first and second intervals of the feeding period to determine nutrients digestibility coefficients and nutritive values of the experimental rations were conducted using three animals from each group. Feces samples were taken from the rectum of each calf twice daily with 12 hour-interval during a collection period of 7 days. Samples of tested feedstuffs were taken at the beginning, middle and end of collection period. The samples of feedstuffs and feces were composted and representative samples were analyzed according to AOAC (1990). Digestibility coefficients were determined using acid insoluble ash (AIA) as a natural marker according to Van Keulen and Young (1977).

Rumen parameters:

Rumen fluid samples were collected 4 h post-feeding using stomach tube attached to vacuum pump during the 1^{st} and 2^{nd} feeding intervals. Ruminal pH was immediately measured by the pH meter (Model HI 8424) after filtering the rumen liquor samples through two layers of surgical gauze. Total VFA's concentration was determined by steam distillation as mentioned by Warner (1964). Ammonia-N concentration was determined using micro diffusion technique of Conway and O'Mally (1957).

Blood sampling:

Blood samples were taken via the jugular vein from all calves immediately before feeding during the 1^{st} and 2^{nd} feeding intervals. Blood samples were collected in clean test tubes and blood plasma was separated by centrifugation of the collected blood for 10 min then, plasma was kept frozen at -20^0C until chemical analyses. Concentration of total protein (Gornall, *et al.*, 1949), albumin (Weichselbaum, 1946) and urea-N (Patton and Crouch, 1977) were determined in blood plasma. However, concentration of globulin was calculated by subtracting concentration of albumin from total proteins. Activity of transaminases (AST and ALT) was also determined in blood plasma according to Reitman and Frankal (1957). Biochemical parameters in blood serum were analyzed using commercial kits produced by Diagnostic System

Laboratories, Inc USA.

Economic feed efficiency:

Economic efficiency was calculated on the basis of daily feed cost and price of daily weight gain, feed cost per kg gain and the ratio between daily feed cost and price of daily weight gain.

Statistical analysis

The obtained data were subjected to statistical analysis using General Linear Model (GLM) procedure adapted by SPSS for Windows (2004) with one-way ANOVA. Duncan test within program SPSS was done to determine the degree of significance between group means.

RESULTS AND DISCUSSION

Chemical composition:

Data concerning the chemical composition of different feedstuffs and calculated composition of the basal rations during first and second feeding intervals (Table 1) show that the content of DM in the ration of first feeding interval was lower than that of the second feeding interval as a result of increasing moisture contents in FB than in BH. While, slight differences were found between both rations in the other contents. These differences were mainly attributed to the marked variation in composition of FB and BH. Generally, the contents of CP and CF in ration of the first and second feeding intervals were within the recommended requirements of growing calves.

Table 1. Chemical composition of different feedstuffs and calculated composition of the rations during 1st and 2nd feeding intervals

Item	DM %	Composition of DM (%)					
		OM	CP	CF	EE	NFE	Ash
CFM[1]	90.11	89.84	16.41	8.64	3.19	61.60	10.16
FB	14.74	86.36	15.30	23.50	2.60	44.96	13.64
BH	90.25	88.09	13.16	29.01	2.38	43.57	11.91
RS	91.90	83.02	3.32	35.74	1.41	42.55	16.98
Calculated composition of basal ration during:							
First feeding interval	51.11	87.95	13.63	16.29	2.75	55.28	12.05
Second feeding interval	90.48	88.22	13.30	17.12	2.69	55.11	11.78

1- CFM consisted of 30% cotton seed cake, 10% linseed meal, 27% yellow corn, 17% wheat bran, 10% rice bran, 3% molasses, 2% limestone and 1% common salt.

Digestibility coefficients and nutritive values:

During the 1st feeding interval, calves fed R2 (Kelp meal ration) showed significant ($P<0.05$) higher digestion coefficients of all nutrients than the control ration (R1). Digestibility coefficients of calves fed Acid buff ration (R3) did not differ significantly ($P>0.05$) than those fed R1 and R2 except for digestion coefficient of NFE where R3 value surpassed R1 significantly ($P<0.05$), however those fed control ration (R1) showed the lowest values (Table 2). During the second feeding interval (Table 2), calves fed R3 (Acid buff) showed significantly (P<0.05) higher digestion coefficients of DM, OM, CP and CF and calves fed Kelp meal (R2) showed significantly (P<0.05) higher digestion coefficients of CP, CF and EE than those fed the control. However, all digestibility coefficients estimated did not differ significantly between R2 and R3. No significant differences (P>0.05) were detected among the whole experimental groups in NFE digestibility.

Table 2. Digestibility coefficients and nutritive values of the experimental rations fed to calves during the 1st and 2nd feeding intervals

Item	Experimental ration			SEM
	R1 (Control)	R2 (Kelp meal)	R3 (Acid buff)	
1st interval (180 days green feeding):				
Digestibility coefficients (%):				
DM	72.45^{b}	75.84^{a}	73.79^{ab}	0.47
OM	73.41^{b}	76.70^{a}	74.63^{ab}	0.46
CP	72.97^{b}	77.87^{a}	76.10^{ab}	0.51
CF	69.00^{b}	72.97^{a}	71.22^{ab}	0.59
EE	79.21^{b}	81.87^{a}	80.02^{ab}	0.66
NFE	74.16^{b}	77.04^{a}	76.13^{a}	0.42
Nutritive values (%):				
TDN	67.08^{b}	70.15^{a}	69.01^{a}	0.31
DCP	9.94^{b}	10.61^{a}	10.37^{ab}	0.07
2nd interval (dry feeding)				
Digestibility coefficients (%):				
DM	69.38^{b}	71.63^{ab}	72.72^{a}	0.45
OM	70.31^{b}	72.92^{ab}	73.87^{a}	0.48
CP	69.17^{b}	75.40^{a}	73.34^{a}	0.71
CF	64.72^{b}	70.03^{a}	68.81^{a}	0.81
EE	72.75^{b}	78.79^{a}	75.78^{ab}	1.20
NFE	73.68	74.52	74.35	0.32
Nutritive values (%):				
TDN	65.29^{b}	67.86^{a}	67.10^{a}	0.26
DCP	9.20^{b}	10.03^{a}	9.76^{ab}	0.08

a and b: Means in the same row with different superscripts differ significantly (P<0.05).

The observed increase in digestibility coefficients of most nutrients in Kelp meal and Acid buff was mainly attributed to the buffering capacity of seaweeds on rumen condition of calves. Addition of such buffers alters ruminal pH value leading to stability in the ruminal microbial population. The population of desirable cellulolytic bacteria diminishes when pH drops below 6 and is replaced by lactic acid producing bacteria (Mould *et al.*, 1984) which is not the case in our study where values of pH exceed 6 reasonably (see Table 3). These results are in agreement with those obtained by Worley *et al.* (1986), who added a buffering agent to the silage diet which increased (P<0.05) digestion of CF by 9.1%. Also, Zinn (1991) reported that supplemental buffer increased total tract digestion (P<0.05). The improvement in digestibility coefficients of calves fed the supplemented diets led to a significant (P<0.05) increase in TDN values in R2 and R3 during both feeding periods and as DCP values for R2 as compared to the control diet only during the 1st and 2nd period. Mehany *et al.* (2003) found that the digestion of most nutrients and nutritive values increased significantly when animals were fed ration contained seaweed.

Rumen liquor parameters:

Data of ruminal parameters in rumen liquor (Table 3) revealed that pH value and TVFA's concentrations were significantly ($P<0.05$) higher in rumen liquor of calves fed R2 and R3 than in those fed R1 during the 1st and 2nd intervals. However, the concentration of NH_3-N in rumen liquor of calves was not affected significantly by dietary additives. The observed higher pH value associated with higher concentration of TVFA's may indicate that kelp meal and acid buff additives enhance rumen fermentation of Friesian calves by increasing buffering capacity of ruminal condition. This effect was reported by Ghorbani *et al.* (1989), who found that rumen pH value was higher for cows fed buffered diets than for control cows. Also, Ross *et al.* (1994) indicated that ruminal pH increased linearly ($P<0.05$) by increasing dietary electrolyte balance. In accordance with the effect of feed additives in this study, it was indicated that the addition of buffer resulted in elevated concentration of TFVA's in rumen liquor of cows (Kennelly *et al.*, 1999), but did not affect ruminal ammonia (NH3) level (Mees *et al.*, 1985). In addition, Zinn (1991) and Tucker *et al.* (1992) reported that dietary buffers increase ruminal fluid pH.

Table 3. Rumen activity of Friesian calves fed experimental rations during the 1st and 2nd feeding intervals

Item	Experimental ration			SEM
	R1 (Control)	R2 (Kelp meal)	R3 (Acid buff)	
1st interval (180 days green feeding):				
pH value	6.21^b	6.30^a	6.32^a	0.02
TVFA's (Meq/ dl)	12.99^b	14.83^a	15.15^a	0.22
NH_3-N (mg/ dl)	23.49	22.36	22.65	0.23
2nd interval (120 days dry feeding):				
pH value	6.22^b	6.40^a	6.42^a	0.02
TVFA's (Meq/ dl)	14.18^b	16.89^a	17.10^a	0.25
NH_3-N (mg/ dl)	25.18	24.76	24.60	0.20

a and b: Means in the same row with different superscripts differ significantly ($P<0.05$).

Blood parameters:

During both feeding intervals, concentrations of total proteins (TP), albumin (AL) and globulin (GL) were significantly ($P<0.05$) higher in blood plasma of calves fed R2 and R3 than those fed R1 (Table 4). Such trend was reflected in higher AL/GL ratio in calves fed R2 and R3, significantly ($P< 0.05$) during the 1st interval and insignificantly ($P>0.05$) during the 2nd interval. However, concentration of urea-N in blood plasma showed an opposite trend. On the other hand, AST and ALT activities during both feeding intervals were nearly similar. In general, the present values of blood constituents are within the normal range reported on Friesian calves (Metwally et al. 1999). The pronounced improvement in concentration of total proteins and their fractions was mainly related to a marked increase in digestion coefficients of CP and nutritive values of the supplemented rations (R2 and R3) as compared to the control and may indicate better protein metabolism.

The observed reduction in concentration of urea-N in spite of the observed increase in CP digestion and nutritive values as DCP in calves fed R2 and R3 compared to those fed the control ration may suggest higher protein efficiency with normal kidney function of calves fed both supplemented rations (R2 and R3). Similar findings were observed by Abdel-Khalek *et al.* (2000) on Friesian calves fed Lacto-Sacc added ration. The trend of change in activity of AST and ALT, being similar in plasma of calves fed R2 and R3 to that in those fed the control ration (R1) may reflect normal liver function of calves fed the experimental rations (Abdel-Khalek *et al.*, 2000). Many workers showed that feed additives had significant effect on blood serum or plasma constituents (Khattab *et al.*, 2003 and Khinizy *et al.*, 2005). The observed reduction in concentration of urea-N in spite of the observed increase in CP digestion and nutritive values as DCP in calves fed R2 and R3 compared to those fed the control ration may suggest higher protein efficiency with normal kidney function of calves fed both supplemented rations (R2 and R3). Similar findings were observed by Abdel-Khalek *et al.* (2000) on Friesian calves fed Lacto-Sacc added ration. The trend of change in activity of AST and ALT, being similar in plasma of calves fed R2 and R3 to that in those fed the control ration (R1) may reflect normal liver function of calves fed the experimental rations (Abdel-Khalek *et al.*, 2000). Many workers showed that feed additives had significant effect on blood serum or plasma constituents (Khattab *et al.*, 2003 and Khinizy *et al.*, 2005).

Table 4. Concentration of some biochemical's and trans-aminases activity in blood plasma of Friesian calves fed experimental rations during the 1st and 2nd feeding intervals

Item	Experimental ration			SEM
	R1 (Control)	R2 (Kelp meal)	R3 (Acid buff)	
1st interval (180 days green feeding):				
Total protein (g/dl)	6.84^{b}	7.81^{a}	7.76^{a}	0.09
Albumin, AL (g/dl)	3.70^{c}	4.53^{a}	4.50^{b}	0.09
Globulin, GL (g/dl)	3.14^{b}	3.28^{a}	3.26^{a}	0.03
AL:GL ratio	1.18^{b}	1.38^{a}	1.38^{a}	0.03
Urea-N (mg/dl)	45.43^{a}	42.28^{b}	41.25^{b}	0.42
AST (IU/l)	38.13	39.54	39.61	0.35
ALT (IU/l)	21.63	21.72	22.05	0.22
2nd interval (120 days dry feeding):				
Total protein (g/dl)	7.45^{b}	7.99^{a}	8.16^{a}	0.09
Albumin, AL (g/dl)	3.81^{c}	4.15^{a}	4.29^{a}	0.05
Globulin, GL (g/dl)	3.64^{b}	3.84^{a}	3.87^{a}	0.05
AL:GL ratio	1.05	1.08	1.11	0.02
Urea-N (mg/dl)	53.96^{a}	50.84^{ab}	49.63^{b}	0.66
AST (IU/l)	40.41	40.80	41.42	0.48
ALT (IU/l)	23.05	23.97	24.44	0.45

a, b and c: Means in the same row with different superscripts differ significantly (P<0.05).

Feed intake

Kelp meal and acid buff additives increased feed intake by Friesian calves (Table 5). The intake as fed from different feedstuffs and intake as DM, TDN and DCP were significantly (P<0.05) higher by calves fed R2 and R3 than that by control ration (R1) during all experimental periods. The intake as DM, TDN and DCP increased by 9.01, 14.21 and 17.24% during the first period; 4.61, 8.88 and 14.10% during the second period and 6.80, 11.60 and 15.15% during the whole experimental period by calves fed R2 compared with those fed R1, respectively. However, the corresponding increases for calves fed R3 were 8.33, 11.68 and 13.79% during the first period; 5.67, 8.70 and 11.54% during the second period and 7.08, 10.28 and 12.12% during the whole experimental period, respectively. Similar trend was obtained by Zinn (1991), who found that dietary supplemental buffer increased DM intake by 4.6% as compared to control. Xu *et al.* (1994) reported that the DM intake was greater for cows fed buffered diets than control diet. Also, West *et al.* (1992) stated that intake of DM increased linearly with increasing dietary cation -anion balance. In addition, Ross *et al.* (1994) found that average daily DM intake increased linearly (P<0.01) with increasing dietary electrolyte balance for the first 28 d then increased quadratically (P<0.05). Mehany *et al.* (2003) showed that calves fed ration-contained seaweed consumed significantly more feed.

Table 5. Average daily feed intake by Friesian calves fed experimental rations during the 1st, 2nd and whole experimental feeding intervals

Item	Experimental ration			SEM
	R1 (Control)	R2 (Kelp meal)	R3 (Acid buff)	
1st interval (180 days green feeding):				
Concentrate feed mixture (kg)*	4.24^b	4.60^a	4.57^a	0.06
Fresh berseem (kg)*	5.99^b	6.49^a	6.45^a	0.08
Rice straw (kg)*	1.28^b	1.39^a	1.38^a	0.02
DM (kg)	5.88^b	6.41^a	6.37^a	0.08
TDN (kg)	3.94^b	4.50^a	4.40^a	0.07
DCP (kg)	0.58^b	0.68^a	0.66^a	0.01
2nd interval (120 days dry feeding):				
Concentrate feed mixture (kg)*	6.10^b	6.36^a	6.42^a	0.04
Berseem hay (kg)*	1.41^b	1.47^a	1.48^a	0.01
Rice straw (kg)*	1.84^b	1.92^a	1.94^a	0.01
DM (kg)	8.46^b	8.85^a	8.94^a	0.06
TDN (kg)	5.52^b	6.01^a	6.00^a	0.06
DCP (kg)	0.78^b	0.89^a	0.87^a	0.01
The whole period (300 days):				
Concentrate feed mixture (kg)*	4.99^b	5.30^a	5.31^a	0.04
Fresh berseem (kg)*	3.59^b	3.89^a	3.87^a	0.05
Berseem hay (kg)*	0.56^b	0.59^a	0.59^a	0.004
Rice straw (kg)*	1.50^b	1.60^a	1.60^a	0.01
DM (kg)	6.91^b	7.38^a	7.40^a	0.06
TDN (kg)	4.57^b	5.10^a	5.04^a	0.06
DCP (kg)	0.66^b	0.76^a	0.74^a	0.01

a and b: Means in the same row with different superscripts differ significantly (P<0.05).
* As fed.

Body weight gain:

Results of growth performance (Table 6) revealed that final body weight (FBW), total weight gain (TWG) and average daily gain (ADG) were significantly (P<0.05) higher in calves fed R2 (kelp meal) and R3 (acid buff) than in those fed control ration (R1) during all experimental periods. Average FBW during the whole experimental period increased by 13.45 and 13.69%, and ADG increased by 24.71 and 23.53% for the first period, 17.28 and 19.75% for the second period and 21.69 and 22.89% for the whole experimental period for calves fed R2 and R3 than in those fed R1, respectively (Table 6). These improvements in body weight and body weight gain were primarily due to increased DM, TDN and DCP intake. Zinn (1991) showed that supplemental buffer increased ($P<0.05$) ADG by 5.9%. Also, Ross *et al.* (1994) found that ADG quadratically increased ($P<0.10$) by dietary electrolyte balance. Moreover, Mehany *et al.* (2003) reported that calves fed diets supplemented with seaweed recorded significantly higher total weight gain and average daily gain.

Table 6. Live body weight gain of Friesian calves fed experimental rations during the 1st, 2nd and whole experimental feeding intervals

Item	Experimental ration			SEM
	R1 (Control)	R2 (Kelp meal)	R3 (Acid buff)	
1st interval (180 days green feeding):				
Initial weight (kg)	159.00	160.00	159.17	3.37
Final weight (kg)	311.50^b	350.00^a	347.50^a	4.65
Total weight gain (kg)	152.50^b	190.00^a	188.33^a	5.33
Daily weight gain (kg)	0.85^b	1.06^a	1.05^a	0.03
Daily weight gain improvement %	100.00^b	124.71^a	123.53^a	2.76
2nd interval (120 days dry feeding):				
Initial weight (kg)	311.50^b	350.00^a	347.50^a	4.65
Final weight (kg)	409.00^b	464.00^a	465.00^a	6.42
Total weight gain (kg)	97.50^b	114.00^a	114.50^a	2.32
Daily weight gain (kg)	0.81^b	0.95^a	0.97^a	0.02
Daily weight gain improvement %	100.00^b	117.28^a	119.75^a	1.16
The whole period (300 days):				
Initial weight (kg)	159.00	160.00	159.17	3.37
Final weight (kg)	409.00^b	464.00^a	465.00^a	6.42
Total weight gain (kg)	250.00^b	304.00^a	305.83^a	6.75
Daily weight gain (kg)	0.83^b	1.01^a	1.02^a	0.02
Daily weight gain improvement %	100.00^b	121.69^a	122.89^a	2.08

a and b: Means in the same row with different superscripts differ significantly ($P<0.05$).

Feed conversion:

Results presented in Table (7) indicated that kelp meal and acid buff additives improved feed conversion as DM, TDN and DCP/gain. As compared to the control ration (R1), the amounts (kg) of DM, TDN and DCP required per kg gain significantly ($P<0.05$) reduced for calves fed R2 and R3 compared with those fed R1 during all experimental periods. The amounts of DM, TDN and DCP per kg gain for calves fed R2 reduced by 12.57, 8.41 and 5.88% during the first period; 10.73, 7.05 and 2.08% during the second period and 12.24, 8.35 and 6.25% during the whole experimental period. The corresponding reduction for calves fed R3 11.71, 9.71 and 7.35% during the first period; 11.69, 9.10 and 6.25% during the second period and 12.97, 10.34 and 8.75% during the whole experimental period, respectively. Ross *et al.* (1994) found that feed conversion improved by dietary electrolyte balance. Mehany *et al.* (2003) reported that calves fed ration contained seaweed significantly increased feed efficiency.

Table 7. Feed conversion of Friesian calves fed experimental rations during the 1st, 2nd and whole experimental feeding intervals

Item	Experimental ration			SEM
	R1 (Control)	R2 (Kelp meal)	R3 (Acid buff)	
1st interval (180 days green feeding):				
DM kg/ kg gain	6.92^{a}	6.05^{b}	6.11^{b}	0.18
TDN kg/ kg gain	4.64^{a}	4.25^{b}	4.19^{b}	0.12
DCP kg/ kg gain	0.68^{a}	0.64^{b}	0.63^{b}	0.02
2nd interval (120 days dry feeding):				
DM kg/ kg gain	10.44^{a}	9.32^{b}	9.22^{b}	0.17
TDN kg/ kg gain	6.81^{a}	6.33^{b}	6.19^{b}	0.10
DCP kg/ kg gain	0.96^{a}	0.94^{ab}	0.90^{b}	0.01
The whole period (300 days):				
DM kg/ kg gain	8.33^{a}	7.31^{b}	7.25^{b}	0.15
TDN kg/ kg gain	5.51^{a}	5.05^{b}	4.94^{b}	0.09
DCP kg/ kg gain	0.80^{a}	0.75^{b}	0.73^{b}	0.01

a, b and c: Means in the same row with different superscripts differ significantly ($P<0.05$).

Economic efficiency:

Data of the economic efficiency are shown in Table (8). Average daily feed cost, price of daily weight gain and economic efficiency were significantly ($P<0.05$) higher and feed cost per kg gain was significantly ($P<0.05$) lower for calves fed R2 and R3 compared with those fed R1, during the first, second and whole experimental periods.

Table 8. Economic efficiency of Friesian calves fed experimental rations during the 1st, 2nd and whole experimental feeding intervals

Item	Experimental ration			SEM
	R1 (Control)	R2 (Kelp meal)	R3 (Acid buff)	
1st interval (180 days green feeding):				
Daily feed cost (L.E.)*	5.79^{b}	6.66^{a}	6.64^{a}	0.11
Price of daily gain (L.E.)	11.25^{b}	14.03^{a}	13.90^{a}	0.44
Feed cost (L.E.)/ kg gain	6.81^{a}	6.28^{b}	6.32^{b}	0.16
Economic efficiency	1.94^{b}	2.11^{a}	2.09^{a}	0.06
2nd interval (120 days dry feeding):				
Daily feed cost (L.E.)*	8.38^{b}	9.11^{a}	9.22^{a}	0.10
Price of daily gain (L.E.)	10.72^{b}	12.57^{a}	12.84^{a}	0.29
Feed cost (L.E.)/ kg gain	10.35^{a}	9.59^{b}	9.51^{b}	0.14
Economic efficiency	1.28^{b}	1.38^{a}	1.39^{a}	0.02
The whole period (300 days):				
Daily feed cost (L.E.)*	6.83^{b}	7.64^{a}	7.67^{a}	0.10
Price of daily gain (L.E.)	11.04^{b}	13.45^{a}	13.50^{a}	0.34
Feed cost (L.E.)/ kg gain	8.23^{a}	7.60^{b}	7.60^{b}	0.10
Economic efficiency	1.62^{b}	1.76^{a}	1.76^{a}	0.03

a, b and c: Means in the same row with different superscripts differ significantly ($P<0.05$).

* Price of CFM, FB, BH and RS was 1200, 100, 650 and 80 L.E./tone, respectively. While, price of Kelp meal and Acid buff was 15 and 10 L.E./kg, respectively. Price of each kg body weight gain was 15 L.E. according to the market prices during 2006 year.

Addition of Kelp meal and acid buff in R2 and R3 reduced feed cost per kg gain compared with the control diet (R1) by 7.78 and 7.20% during the first period; 7.34

and 8.12% during the second period and 7.65 and 7.65% during the whole experimental period, respectively. This was reflected in significant (P<0.05) improvement in economic efficiency of calves fed R2 and R3 by 8.76 and 7.73% during the first period; 7.81 and 8.59% during the second period and 8.64 and 8.64% during the whole experimental period compared with those fed R1, respectively. In similarity with the present results, Mehany *et al.* (2003) found that calves fed ration contained seaweed recorded the lowest feed cost per kg gain and the highest economic efficiency.

CONCLUSION

From these results it could be concluded that kelp meal and acid buff additives improved nutrients digestion, rumen activity, body weight gain, feed conversion and economic efficiency of growing Friesian calves.

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تأثير الإضافات الغذائية الطبيعية على أداء العجول الفريزيان النامية

عبدالحليم محمد عبدالسلام محى الدين، حامد محمد عبدالمجيد جعفر، حسن محمـــود النحـــاس، السعيد السيد راغب، علاءالدين فؤاد محرز

معهد بحوث الإنتاج الحيوانى، مركز البحوث الزراعية، الدقى، مصر

استخدم فى هذه الدراسة 18 عجل فريزيان متوسط وزنها 159.39±3.37 كجم وعمر 7±0.23 شهر قسمت عشوائيا الى 3 مجموعات. غذيت عجول المجموعة الأولى على العليقة الأساسية بدون إضافة (المقارنة، ع1) والتى تتكون من 65% مخلوط علف مركز + 15% برسيم طازج (الفترة الأولى،1-180 يوم) أو دريس برسيم (الفترة الثانية،181-300 يوم) + 20% قش أرز. بينما غذيت عجول المجموعتين الثانية (ع2) والثالثة (ع3) على العليقة الأساسية مع إضافة 25 جم أعشاب بحرية (كلب ميل) أو 40 جم مواد منظمة لحموضة الكرش (أسد بف) /رأس/يوم على التوالى.

توضح النتائج المتحصل عليها أن محتوى كل من البروتين والمستخلص الاثيرى والمستخلص الخالى من الأزوت والرماد يميل إلى الارتفاع، بينما يميل محتوى كل من المادة العضوية والألياف الى الانخفاض فى عليقة الفترة الأولى مقارنة بعليقة الفترة الثانية. أدت إضافة الأعشاب البحرية والمواد المنظمة لحموضة الكرش إلى تحسن معنوى فى معاملات الهضم وبالتالى القيم الغذائية خلال الفترتين الأولى والثانية.

ارتفاع قيمة درجة حموضة الكرش وتركيز الأحماض الدهنية الطيارة الكلية فى سائل الكرش للمجموعتين الثانية والثالثة عنه فى المجموعة الأولى خلال الفترتين الأولى والثانية. بينما تركيز نيتروجين الأمونيا فى سائل الكرش لم يتأثر معنويا بإضافة الأعشاب البحرية والمواد المنظمة لحموضة الكرش. ارتفاع تركيز كل من البروتينات الكلية والألبيومين والجلوبيولين فى بلازما الدم معنويا فى المجموعتين الثانية والثالثة مقارنة بالمجموعة الأولى خلال فترتى التجربة. بينما أظهر تركيز أزوت اليوريا اتجاها مضاداً. فضلاً عن ذلك كان نشاط أنزيمات الكبد متماثل تقريبا للمجموعات المختلفة.

ارتفاع المأكول من مواد العلف المختلفة والمادة الجافة والمركبات الغذائية المهضومة والبروتين المهضوم معنويا فى المجموعتين الثانية والثالثة مقارنة بالمجموعة الأولى خلال فترات التجربة المختلفة. ارتفاع الوزن النهائى والزيادة الكلية واليومية معنويا لعجول المجموعتين الثانية والثالثة مقارنة بعجول المجموعة الأولى خلال فترات التجربة المختلفة.

أدت إضافة الأعشاب البحرية والمواد المنظمة لحموضة الكرش للمجموعتين الثانية والثالثة إلى تحسن معدل التحويل الغذائى حيث انخفضت الكميات المستهلكة من المادة الجافة والمركبات الغذائية المهضومة والبروتين المهضوم لكل كجم نمو معنويا بالمقارنة بالمجموعة الأولى خلال فترات التجربة المختلفة. ارتفعت تكلفة التغذية اليومية وثمن الزيادة اليومية فى الوزن والكفاءة الاقتصادية، بينما انخفضت تكلفة التغذية لكل كجم نمو معنويا للمجموعتين الثانية والثالثة مقارنة بالمجموعة الأولى خلال فترات التجربة.

نستخلص من هذه الدراسة أن إضافة كل من الأعشاب البحرية والمواد المنظمة لحموضة الكرش أدت الى تحسن هضم العناصر الغذائية ونشاط الكرش ومعدل النمو ومعدل التحويل الغذائى والكفاءة الاقتصادية للعجول الفريزيان النامية.