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Effect of premix and seaweed additives on productive performance of lactating friesian cows

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Abstract

Eighteen lactating Friesian cows with average body weight of 534.44 ± 13.04 kg, ranging from 450 to 660 kg, average milk production of 12.16 ± 0.10 kg/day, ranging from 9.52 to 14.80 kg/day and average parity of 2.22 ± 0.33 ; ranging from 1 to 5 were used during summer season from June to November 2011, for 150 days starting with one week after parturition. Animals were divided into three similar groups with six cows in each group based on body weight, milk production and parity. All animals were fed the basal ration consisted of 40% concentrate feed mixture + 40% corn silage + 20% rice straw (on DM basis) without additive (control) or with 25 g premix/head/day (premix) or with 50 g seaweed/head/day (seaweed). The seaweed treatment showed significantly ($P < 0.05$) the superior digestibility coefficients of DM, OM, CP, EE and NFE and subsequently nutritive values followed by premix treatment, while the control treatment revealed the lowest digestibility. While, CF digestibility was significantly higher ($P < 0.05$) for seaweed treatment than that of other treatments. Seaweed treatment showed significantly ($P < 0.05$) the highest average daily intake of TDN and DE followed by the premix treatment, while the lowest intake was in control treatment. The highest ruminal pH values was detected with premix treatment followed by seaweed treatment, while the lowest values were observed with control treatment. Seaweed treatment recorded the highest ruminal TVFA's concentration and the lowest $\text{NH}_3\text{-N}$ concentration followed by premix treatment, while the control had the opposite concentrations. Seaweed treatment revealed significantly ($P < 0.05$) the highest total protein and globulin concentrations followed by premix treatment, while the control treatment had the lowest concentration. Feeding treatments not significantly ($P > 0.05$) affected the concentrations of albumin, creatinine and bilirubin and the activities of AST and ALT in serum. Average daily actual milk yield and the percentages of fat, lactose, SNF, TS and ash were significantly higher ($P < 0.05$) and somatic cell count (SCC) in milk was significantly lower ($P < 0.05$) for premix and seaweed treatments compared to the control treatment. Meantime, seaweed treatment recorded significantly ($P < 0.05$) the highest 4% FCM yield and protein percentage followed by premix treatment, while the control treatment had the lowest values. The amounts of DM and DCP required for producing 1 kg 4% fat corrected milk (FCM) were significantly lower ($P < 0.05$) for premix and seaweed treatments than those of control treatment. While, the amount of TDN and DE required for producing 1 kg 4% FCM were nearly similar for the different treatments. Feed cost (LE/ day) were nearly similar for the different treatments. While, feed cost per one kg 4% FCM was significantly lower ($P < 0.05$), but the total and net revenue were significantly higher ($P < 0.05$) for premix and seaweed treatments compared to control treatment.

Keywords: Premix, seaweed, feed intake, digestibility, rumen fermentation, milk yield and composition, feed conversion, economic efficiency.

INTRODUCTION

Seaweed has plenty of essential nutrients, especially trace elements and several other bioactive substances. That explains why today seaweeds are considered as the

food supplement for 21st century as source for proteins, lipids, polysaccharides, mineral, vitamins and enzyme (Rimber, 2007). Seaweed is a totally natural multi-mineral

supplement. In contrast to conventional mineral supplements, seaweed is unique in being of plant origin containing a wide range of naturally balanced chelated minerals, trace elements, amino acids and vitamins. Seaweed contains all the minerals and trace elements of animal requires for a normal healthy life. Being totally natural and of vegetable origin seaweed is easily digested and is safely fed to animals of all ages (Sykes, 2009). The seaweed supplemented at 0.25% of diet prevented a decline in milk production during heat stress, especially for larger cows, which are more susceptible to heat stress because of the higher metabolic rate (Kadzere et al., 2002). A study at Kansas State University during summer heat stress indicated a higher milk production and higher amount of milk protein in cows fed 56.7 g of seaweed per day, while no differences in DM intake were found, suggesting that seaweed may increase lactation efficiency (Cvetkovic et al., 2005). Ead *et al.*, (2011b) reported that the supplemented 1% seaweed of the total dry matter intake to lactating cow rations feeding on the concentrate feed mixture as a basal diet increased milk yield and milk constituents. Somatic cell score was lower for cows fed seaweed (Kellogg et al., 2006).

The objective of this study was to investigate the effect of premix and seaweed additives on digestibility coefficients, rumen fermentation activity, blood serum metabolites, milk yield and composition, somatic cells count, feed conversion ratio and economic efficiency of lactating Friesian cows.

MATERIALS AND METHODS

The current work was carried out at El-Karada Animal Production Research Station, belonging to Animal Production Research Institute, Agricultural research Center, Ministry of Agriculture in co-operation with Department of Animal Production, Faculty of Agriculture, Kafrelsheikh University.

Experimental animals

Eighteen lactating Friesian cows with an average body weight of 534.44 ± 13.04 kg, ranging from 450 to 660 kg, and average parity of 2.22 ± 0.33 ; ranging from 1 to 5 were used during summer season from June to November 2011, for 150 days starting with one week after parturition. Animals were divided into three similar groups with six cows in each group based on body weight, milk production and parity.

Experimental rations

All experimental animals were fed the basal ration

consisted of 40% concentrate feed mixture (CFM) + 40% corn silage (CS) + 20% rice straw (RS) (on DM basis) without additive served as a control (group 1) or with 25 g premix / head / day (group 2) or with 50 g seaweed / head / day (group 3). Premix and seaweed additives are mixed with the ground concentrate feed mixture. The supplement seaweed meal produced by Crossgates Bioenergetics-Seaweeds Company, UK. Premix Hero-Mineral produced by Hero Pharm Company, Egypt.

Calculated chemical composition of feedstuffs of basal ration are presented in Table (1). Concentrate feed mixture consisted of 32% undecorticated cotton seed cake, 24% wheat bran, 22% yellow corn, 12% rice bran, 5% line seed cake, 3% molasses, 1% limestone and 1% common salt.

Animals management

Animals were housed under asbestos sheds in semi-open backyards and were individually fed their rations to cover their recommended requirements according to NRC, (2001). Concentrate feed mixture was offered in two equal parts daily at 8 a.m. and 4 p.m., corn silage was offered one time at 10 a.m. and rice straw was offered at 3 p.m. Premix or seaweed additives were added once to the ground concentrate feed mixture in the morning feeding. Animals watered in the mid day at 12 a.m. and left free in the backyards overnight.

Rumen liquor samples

At the middle and end of experimental period, rumen liquor was sampled from individual animals using stomach tube attach to vacuum pump before feeding (0 hour), 3 and 6 hours post the morning feeding. Rumen pH was measured immediately after collection using a digital pH meter (Hanna Instruments pH). Rumen liquor samples were strained through a double layer of cheesecloth. Rumen liquor was preserved with a few drops of saturated mercuric chloride and frozen in labelled polypropylene bottles for estimation of total volatile fatty acids (TVFA's) and ammonia nitrogen ($\text{NH}_3\text{-N}$). The TVFA's concentration was determined by a steam distillation method as described by Warner, (1964) and $\text{NH}_3\text{-N}$ concentration was determined using magnesium oxide (AOAC, 1990).

Blood Samples

Blood samples were taken from the jugular vein of each cow by clean sterile needle in a clean dry plastic tubes using after 3 hours from the morning feeding and left in the refrigerator for two hours for the blood clot. Then centrifuged at 4000 rpm for 15 minutes to separate serum

Table 1. Calculated chemical composition of feedstuffs of basal ration.

Item	Concentrate feed mixture	Corn silage	Rice straw	Basal ration
DM %	90.45	28.15	89.76	47.93
Composition of DM %				
OM	89.02	94.45	83.93	89.78
CP	15.80	8.03	2.66	10.06
CF	8.93	22.17	37.88	20.02
EE	3.21	2.86	1.25	2.68
NFE	61.08	61.39	40.14	57.02
Ash	10.98	5.55	18.07	10.22

and stored at - 20 °C. total protein, albumin, globulin (total protein - albumin), aspartate aminotransferase (AST) , alanine aminotransferase (ALT) , creatinin and bilirubin were determined colorimetrically by spectrophotometer (Spectronic 21D, USA) using commercial kits produced by Diagnostic System Laboratories, Inc., USA.

Digestibility trial

Three digestibility trial were carried out at the end of the experiment using 4 cows from each group to determine the digestibility coefficients and nutritive values of the experimental rations using acid insoluble ash (AIA) as a natural marker (Van Keulen and Young, 1977). Feces samples were taken from the rectum of each cow twice daily at 12 h intervals during the collection period. Samples of feedstuffs were taken at the beginning, middle and end of the collection period. Representative samples of feedstuffs and feces were chemically analyzed according to the methods of AOAC, (1990). Digestibility coefficients were calculated from the equations given by Schneider and Flatt, (1975).

Milk yield and samples

Cows were mechanically milked at 6 am and 5 pm. Individual morning and evening milk yields were recorded every day for each cow and the 4% FCM for each cow was calculated from daily milk yield and the percentage of milk fat using the formula of Gains (1928). Milk samples from consecutive evening and morning milkings were taken from each cow every day at the 4th week of each period and mixed in proportion to milk yield. Composite milk samples were analyzed for fat, protein, lactose, solids not fat (SNF), and total solids (TS) by Milko-Scan (model 133B), and ash by difference. Milk samples were analyzed for somatic cell count using Integrated milk Testing Fossomatic 5000 (Foss Electric A/ S 69, Slangerupgade DK 3400 Hilleroed, Denmark Comp. Reg.no.73 39 98 15.

Feed conversion ratio

Feed conversion ratio was determined as the amounts of DM, TDN and DCP required for producing 1 kg 4% FCM.

Economic efficiency

Economic efficiency was calculated as the ratio between the price of produced milk and the cost of feed consumed. The prices in Egyptian pound (LE) were 2100 LE / ton of concentrate feed mixture, 350 LE / ton of corn silage, 125 LE / ton of rice straw, 3 LE / kg premix, 6 LE / kg seaweed and 3.25 LE / kg 4% fat corrected milk produced during year 2011.

Statistical analysis

The data were analyzed using general linear models procedure adapted by SPSS for windows (2008) for user's guide with one-way ANOVA. Significant differences in the mean values among dietary treatments were analyzed by Duncan's tests set at the level of significance $P < 0.05$ (Duncan, 1955).

RESULTS AND DISCUSSION

Nutrients digestibility coefficients

The effect of premix and seaweed additives on nutrients digestibility by lactating Friesian cows are shown in Table (2). There were significant ($P < 0.05$) differences in the digestibility of all nutrients among the different treatments. The seaweed treatment showed significantly ($P < 0.05$) the superior digestibility of DM, OM, CP, EE and NFE followed by premix treatment, while the control treatment revealed the lowest digestibility. While, CF digestibility was significantly higher ($P < 0.05$) for seaweed treatment than that of premix and control treatments. The digestibility improvement by seaweed additive may be

Table 2. Effect of premix and seaweed additives on nutrients digestibility and nutritive values by lactating Friesian cows.

Item	Treatments			SEM
	Control	Premix	Seaweed	
Digestibility coefficients %				
DM	64.29 ^b	65.82 ^{ab}	66.93 ^a	0.45
OM	65.63 ^b	66.74 ^{ab}	68.48 ^a	0.50
CP	67.47 ^b	69.24 ^{ab}	70.09 ^a	0.63
CF	60.37 ^b	62.16 ^b	65.92 ^a	0.98
EE	78.42 ^b	79.68 ^{ab}	81.62 ^a	0.68
NFE	68.42 ^b	71.39 ^{ab}	73.59 ^a	0.87
Nutritive values				
TDN %	62.61 ^c	64.92 ^b	67.12 ^a	0.70
DCP %	6.79 ^b	6.97 ^{ab}	7.05 ^a	0.07
DE (Mcal/kg)	2.76 ^c	2.86 ^b	2.96 ^a	0.03

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

attributed to their contents of amino acids, fatty acids, minerals and vitamins which stimulate the activity of rumen microorganisms fermentation. Also, premix may act as a buffer of rumen pH and activate microbial metabolism in continuous culture of rumen contents. These results agreed with those obtained by Parsaad et al. (1984) who studied mineral supplementation and their influence on nutrients digestibility in buffalo calves and observed that digestibility of DM, CP and CF were improved. Hanafy et al., (2009) found that application of chelated mineral mixtures as feed additives for corn silage may help to increase nutrients digestibility by lactating buffaloes. Ead et al., (2011a) showed that the digestion coefficients of OM, NFE and NFC% were higher with seaweed supplementation, using dairy Friesian cows.

Nutritive values

Nutritive values of the experimental rations as affected by premix and seaweed additives are shown in Table (2). Seaweed treatment showed significantly ($P < 0.05$) the highest TDN, DCP and DE values followed by premix treatment, while the control treatment revealed the lowest value. Biologists believe that the amino acids, when absorbed by the animal's rumen, enhance the microbial action within the rumen and hence increase the total digestible nutrients (TDN) available from the test of the feed. These results are in accordance with those obtained by Hanafy et al., (2009) who found that application of chelated mineral mixtures as feed additives for corn silage may help to increase nutritive values by lactating buffaloes. Ead et al., (2011a) showed that the TDN%, ME and NE were higher with seaweed supplementation, using dairy Friesian cows.

Feed intake

Average daily feed intake by lactating Friesian cows fed the different treatments are shown in Table (3). The average daily intake of concentrate feed mixture, corn silage, rice straw, total DM and DCP by lactating Friesian cows were nearly similar for the different treatments without significant differences ($P > 0.05$). However, the seaweed treatment showed significantly ($P < 0.05$) the highest average daily intake of TDN and DE followed by the premix treatment, while the lowest intake was in control treatment. These may be attributed to the higher TDN and DE values of seaweed and premix containing rations as the result of improving the digestibility of all nutrients as shown in Table 7. These results are in agreement with those obtained by Ballantine et al., (2002) who reported that cows fed organic mineral consumed more DM than cows receiving inorganic mineral. Begum et al., (2010) found that dry matter intake was not affected by mineral supplementation. Spiers et al., (2004) stated that seaweed had no effect on feed intake of growing steers.

Rumen fermentation activity

The effect of feeding treatments and sampling time on rumen fermentation activity of lactating Friesian cows are shown in Table (4). There were significant differences ($P < 0.05$) in ruminal pH value and TVFA's and $\text{NH}_3\text{-N}$ concentrations among the different feeding treatments and sampling time. The highest ruminal pH value was detected with premix treatment followed by seaweed treatment, while the lowest value was observed with control treatment ($P < 0.05$). The seaweed treatment recorded the highest ruminal TVFA's concentration

Table 3. Effect of premix and seaweed additives on feed intake (kg/day) by lactating Friesian cows.

Item	Treatments			SEM
	Control	Premix	Seaweed	
Concentrate feed mixture*	7.54	7.58	7.59	0.08
Corn silage	24.23	24.34	24.40	0.24
Rice straw	3.80	3.82	3.83	0.04
Premix	-	0.025	-	
Seaweed	-	-	0.050	
Total DM	17.05	17.13	17.17	0.17
TDN	10.67 ^b	11.12 ^{ab}	11.53 ^a	0.15
DCP	1.16	1.19	1.21	0.01
DE (Mcal/day)	47.06 ^b	48.99 ^{ab}	50.83 ^a	0.64

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

Table 4. Effect of premix and seaweed additives on ruminal fermentation activity of lactating Friesian cows.

Item	pH	TVFA's	NH ₃ -N
Treatments			
Control	6.75b	16.29 ^b	16.55 ^a
Premix	7.11a	17.47 ^{ab}	15.27 ^{ab}
Seaweed	6.93ab	18.78 ^a	14.34 ^b
SEM	0.05	0.21	0.25
Sampling time			
0 hrs	7.43a	16.38b	13.60b
3 hrs	6.43c	18.35a	15.28a
6 hrs	6.93b	17.80a	14.83a
SEM	0.05	0.21	0.25

a, b, c: values and means in the same column for each item with different superscripts differ significantly ($P < 0.05$).

followed by premix treatment, while the control had the lowest concentration ($P < 0.05$). The control treatment recorded the highest ruminal NH₃-N concentration followed by premix treatment, while the seaweed treatment had the lowest concentration ($P < 0.05$). The ruminal pH value for the different feeding treatments was higher before feeding (zero time) and decreased at 3 hours post feeding and increased again afterwards at 6 hours post feeding ($P < 0.05$). However, the concentrations of TVFA's and NH₃-N for the different feeding treatments were lower before feeding (zero time) and increased at 3 hours post feeding and decreased again afterwards at 6 hours post feeding ($P < 0.05$). The premix and seaweed additives may be improved rumen fermentation by stimulating rumen microorganisms to ferment carbohydrates producing volatile fatty acids. These results agree with those obtained by Russel and Dombroski, (1980) who reported that ruminal pH, which can be considered as an important regulator microbial yield. Aga et al., (2000) used a calcified seaweed as a buffer in continuous culture of rumen contents. Mohi El-Din et al., (2008) found that kelp meal seaweed

(*Ascophyllum nodosum*) and acid buffer additives increased the concentration of TVFA's in rumen liquor of Friesian calves.

Blood serum constituents

Blood serum constituents of lactating Friesian cows fed different treatments are shown in Table (5). The concentrations of total protein and globulin were significantly higher ($P < 0.05$) for premix and seaweed treatments compared to control group. However, the concentrations of albumin, creatinine and bilirubin and the activity of AST and ALT enzymes were nearly similar for the different treatments. Serum bilirubin concentration is an indication of liver hepatic and the clinical icterus is observed when total bilirubin value exceeded 1.5 mg/ 100 ml. The activity of AST and ALT were below the normal range of AST and ALT in blood being 40 and 20 u/l, respectively (Kaneko, 1989). These results stated that the premix and seaweed additives had no disorder effect on kidneys or liver functions. A significant decrease was

Table 5. Effect of premix and seaweed additives on blood serum constituents of lactating Friesian cows.

Item	Treatments			SEM
	Control	Premix	Seaweed	
Total protein (g/100 ml)	7.27 ^b	7.87 ^a	8.05 ^a	0.11
Albumin (g/100 ml)	3.18	3.36	3.32	0.03
Globulin (g/100 ml)	4.09 ^b	4.51 ^a	4.73 ^a	0.05
Creatinine (mg/100 ml)	1.08	1.09	1.08	0.01
Bilirubin (mg/100 ml)	0.27	0.29	0.29	0.02
AST (u/l)	28.20	27.60	25.70	0.79
ALT (u/l)	7.40	7.50	6.80	0.16

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

Table 6. Effect of premix and seaweed additives on milk yield, composition and somatic cell count of lactating Friesian cows.

Item	Treatments			SEM
	Control	Premix	Seaweed	
Milk yield (kg/day)				
Actual yield	12.62 ^b	13.66 ^a	14.10 ^a	0.18
4% FCM yield	11.00 ^b	12.03 ^a	12.49 ^a	0.15
Milk composition %				
Fat	3.15 ^b	3.21 ^a	3.24 ^a	0.01
Protein	2.58 ^c	2.63 ^b	2.65 ^a	0.01
Lactose	4.58 ^b	4.63 ^a	4.66 ^a	0.01
SNF	7.85 ^b	7.98 ^a	8.03 ^a	0.01
TS	11.01 ^b	11.19 ^a	11.28 ^a	0.01
Ash	0.70 ^b	0.72 ^a	0.72 ^a	0.002
SCC x103 ml	51.13 ^a	43.89 ^b	42.03 ^b	1.99

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

observed in aspartate aminotransferase (AST) and alanine aminotransferase (ALT) in buffaloes fed minerals supplement (Sharma et al., 2002).

Milk yield.

The Effect of premix and seaweed additives on average actual milk and 4% FCM yield of lactating Friesian cows are presented in Table (6). The average daily actual milk yield were significantly higher ($P < 0.05$) for premix and seaweed treatments compared to the control treatment. The actual milk yield increased significantly ($P < 0.05$) by 1.04 and 1.48 kg/day or 8.24 and 11.73% for premix and seaweed treatments compared to control treatment, respectively. Meantime, the seaweed treatment recorded significantly ($P < 0.05$) the highest 4% FCM yield followed by premix treatment, while the control treatment had the lowest yield. The 4% FCM yield increased significantly ($P < 0.05$) by 1.03 and 1.49 kg/day or 9.36 and 13.55% for premix and seaweed treatments compared to control treatment, respectively. Results revealed also that the average daily actual and 4% FCM yield for the

successive treatments appeared to be more affected by TDN and DE intakes. It was noticeable that rations treated with premix and seaweed with the highest TDN and DE intakes as shown in Table 2. These results are in accordance with those obtained by Padekar and Bhoite, (2002) who observed significant effect of mineral additives on milk production. Ballantine et al., (2002) reported that cows fed chelated trace minerals produced 1.2 kg more ($P < 0.05$) milk, energy-corrected milk, and 3.5% fat-corrected milk than cows receiving inorganic mineral. Cvetkovic et al., (2005) found higher milk production in cows fed 56.7 g of seaweed per day. Ead et al., (2011b) reported that the supplemented 1% seaweed of the total dry matter intake when feeding on the concentrate feed mixture as a basal diet in lactating cow rations increased milk yield.

Milk composition.

Milk composition of lactating Friesian cows as affected by premix and seaweed additives are presented in Table (6). The percentages of fat, lactose, SNF, TS and ash were

Table 7. Effect of premix and seaweed additives on feed conversion ratio and economic efficiency of lactating Friesian cows.

Item	Treatments			SEM
	Control	Premix	Seaweed	
Feed conversion ratio				
DM (kg/ kg 4% FCM)	1.55 ^a	1.42 ^b	1.37 ^b	0.02
TDN (kg/ kg 4% FCM)	0.97	0.92	0.92	0.01
DCP (g/ kg 4% FCM)	105.24 ^a	99.25 ^b	96.93 ^b	1.38
DE (Mcal/ kg 4% FCM)	4.28	4.07	4.07	0.05
Economic efficiency				
Feed cost (LE/ day)	24.79	24.98	25.26	0.26
Feed cost (LE)/ kg 4% FCM	2.25 ^a	2.08 ^b	2.02 ^b	0.03
Total revenue (LE/ day)	35.75 ^b	39.10 ^a	40.59 ^a	0.54
Net revenue (LE/ day)	10.96 ^b	14.12 ^a	15.33 ^a	0.55
Net revenue improvement %	00.00 ^c	28.83 ^b	39.87 ^a	4.55

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

The prices in Egyptian pound (LE) were 2100 LE / ton of concentrate feed mixture, 350 LE / ton of corn silage, 125 LE / ton of rice straw, 3 LE / kg premix, 6 LE / kg seaweed and 3.25 LE / kg 4% fat corrected milk produced during year 2011.

significantly higher ($P < 0.05$) for premix and seaweed treatments compared to the control treatment. While, seaweed treatment showed significantly ($P < 0.05$) the highest protein percentage followed by premix treatment, while control group had the lowest percentage. These results agreed with those obtained by Ballantine et al., (2002) who reported that cows fed chelated trace minerals increased ($P \leq 0.05$) milk fat, protein and total solids by 3.02, 3.46 and 3.23%, respectively. Somkuwar et al., (2011) found that the Metho-chelated organic minerals treated group improved the milk fat percentage of animals across the various stages of lactation as compared to in control and inorganic mineral treated group of animals. Ead et al., (2011b) reported that the supplemented 1% seaweed of the total dry matter intake when feeding on the concentrate feed mixture as a basal diet in lactating cow rations increased milk fat, protein, lactose, non-fat solids and total solids.

Somatic cell count (SCC)

Somatic cell count (SCC) in milk of lactating Friesian cows as affected by premix and seaweed additives are shown in Table (6). Somatic cell count (SCC) was significantly lower ($P < 0.05$) in milk of cows fed premix and seaweed treatments compared with control treatment. The SCC in milk decreased by 14.16 and 17.80% for premix and seaweed treatments compared to control group, respectively. These results are less than the limit SCC in milk being 400×10^3 cells/ ml according to National Milk Producers Federation, USDA (Rysanek and Babak, 2005). These results could be attributed the good management of lactating cows in the station. These results agreed with those obtained by Kellogg et al.,

(2006) who found that somatic cell score was lower for cows fed seaweed.

Feed conversion

Results of feed conversion expressed as the amounts of DM, TDN, DCP and DE required for producing 1 kg 4% fat corrected milk for lactating cows as affected by premix and seaweed additives are shown in Table (7). The amounts of DM and DCP required for producing 1 kg 4% fat corrected milk (FCM) were significantly lower ($P < 0.05$) for premix and seaweed treatments than those of control treatment. While, the amount of TDN and DE required for producing 1 kg 4% FCM were nearly similar for the different treatments with insignificant differences ($P > 0.05$). These results are in accordance with those obtained by Hanafy et al., (2009) who found that application of some mineral mixtures as feed additives for corn silage may be help to increase feed efficiency of lactating buffaloes. Ead et al., (2011b) reported that the supplemented 1.5% seaweed of the total dry matter intake when feeding on the concentrate feed mixture as a basal diet in lactating cow rations increased the feed efficiency.

Economic efficiency

The effect of premix and seaweed additives on economic efficiency of lactating Friesian cows are presented in Table (7). Feed cost (LE/ day) were nearly similar for the different treatments with insignificant difference ($P > 0.05$). While, feed cost per one kg 4% FCM were significantly lower ($P < 0.05$) for premix and seaweed treatments

compared to control treatment, which decreased by 7.56 and 10.22%, respectively. Meantime, the total and net revenue were significantly higher ($P < 0.05$) for premix and seaweed treatments compared to control treatment. Total revenue increased by 3.35 and 4.84 LE/ day or by 9.37 and 13.54% and net revenue increased by 3.16 and 4.37 LE/ day or by 28.83 and 39.87% for premix and seaweed treatments than those of control treatment, respectively. These results attributed to that the premix and seaweed additives led to significant increase in the yield of both actual and fat corrected milk without any significant increase in DM feed intake. These results are in agreement with those obtained by Hanafy *et al.*, (2009) who found that application of some mineral mixtures as feed additives for corn silage may be help to increase economic efficiency of lactating buffaloes. Ead *et al.*, (2011b) reported that the supplemented 1% seaweed of the total dry matter intake when feeding on the concentrate feed mixture as a basal diet in lactating cow rations increased the economic efficiency.

From these results, it could be concluded that premix and seaweed additives improved nutrients digestibility, rumen fermentation activity, blood serum proteins, milk yield and composition, feed conversion and economic efficiency of and reduced somatic cells count in milk lactating Friesian cows and the best results with seaweed additive.

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