Comparing Effects Of Organic Acid (Malate) And Yeast Culture As Feed Supplement On Dairy Cows Performance

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Abstract : This study was conducted to compare the effect of two chemical forms of malate supplementation (malic acid and a commercial malate salt) and a natural feed additive (yeast culture) in rations of lactating crossbred Friesian cows on nutrients digestibility, nutritive values, milk yield, milk composition, blood metabolites and economical return of the tested rations. Sixteen lactating crossbred Friesian cows averaged 496.06 ± 1.51 kg live body weight (LBW) at the 3rd and 4th parities were assigned after parturition to four similar groups (4 animals each). Animals were fed concentrate feed mixture and berseem hay at the rate of 70: 30 % on DM basis (as a basal ration). The first group was a control group (C) fed a basal ration without feed additive, the second group (MA) was fed the basal ration supplemented with 10 g/h/d of malic acid, the third group (YC) was fed a basal ration plus 10 g/h/d of yeast culture (*Saccharomyces Cerevisiae* 1×10^9 CFU/g) and the fourth group (MS) was fed a basal ration supplemented with 10 g/h/d of malate salt during 75 days of lactation period. Results indicated that rations supplemented with malic acid (MA) and Yeast culture (YC) increased significantly (P<0.05) DM and OM digestibilities in comparison with C ration and MS ration. Malic acid supplementation decreased significantly (P<0.05) CF digestibility and significantly (P<0.05) increased NFE digestibility as compared to control and other additives rations. There were no significant differences among animals fed rations supplemented with MA, YC and MS in both values of CP and EE digestibilities. The nutritive values as TDN % and DCP% showed that C ration had (P<0.05) the lowest value than the other supplemented rations, while, the ration supplemented with YC had the highest value followed by MA and MS rations. Milk yield and fat corrected milk (4% FCM) of dairy cows increased by (10.36% and 8.31%) for MA, (6.83 % and 4.84 %) for YC and (6.17 % and 4.89 %) for MS supplementation, respectively, compared to the control group. Animals fed MA ration had greater milk persistency till the 10th week of lactation period followed by those fed MS and YC rations, respectively. Milk content of fat, lactose and TS were significantly (P<0.05) lower in cows fed rations with MA, YC and MS when compared with those fed control ration. There were no significant differences among groups in milk protein, SNF and ash percent. Feed efficiency values as kg 4% FCM per one kg DM, TDN or DCP were higher with MA, MS and YC rations than that of C ration. Blood parameters were in the normal physiological ranges with no adverse effect on dairy cows health. Economic efficiency value was the highest with YC followed by MS while, MA had the lowest value as compared to the control ration C.

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1. Introduction:

Increasing per capita animal protein for the Egyptian citizen is one of the most important goals in the sustainable agricultural development strategy until 2030.

This objective comes through up grading productivity of animal wealth to increase human annual consumption of milk from 63 to 90 kg / year, this require increasing milk productivity of cattle and buffaloes. A goal of ruminant microbiologists and nutritionists is to manipulate the ruminant microbial ecosystem to improve the efficiency of converting feed to products consumable by humans.

Feed additives are important materials that can improve animal performance and feed efficiency. Yeast cultures has been used as a dietary supplement for dairy cattle and buffaloes to increase dry matter intake, milk production and milk composition (Adams,1995, Dann *et al*. 2000, Allam *et a*l., 2001 and El-Ashry *et al.*, 2001) by stimulating growth of rumen bacteria, particularly cellulolytic species and improve fiber digestibility (Harrison *et al.* 1988). Yeast culture in ruminants diet has been shown to alter molar proportion of ruminal volatile fatty acid, increase acetate and decrease propionate and reduced ruminal NH_3 concentration (Harrison *et al.*, 1988, Newbold *et al.*, 1990 and Dawson, 1993). Organic acids that are currently being evaluated as feed additive such as malic acid, fumaric acid and aspartic acid, malic acid and fumaric acid are four–carbon dicarboxylic acids that are found in biological tissues (plants) as intermediates of the citric acid cycle and are intermediates in the succinate-propionate pathway of ruminal bacteria, such as *selenomonas ruminantium* (Castillo *et al*., 2004). Malic acid supplementation in lactating cow diets was effective in increasing microbial nitrogen production and microbial efficiency measured *in vitro* and milk yield (Sniffen *et al*., 2006). Commercial malate salt is another chemical forms of malate use in ruminant diets, malate addition increased the amount of lactate utilized and concentration of protein and cellular carbohydrate synthesized by strain HD4. Lactate utilization ranged between 77 and 80 % in the presence of malate compared with only 40 and 70 % in the absence of malate (Martin, 1998).

Therefore, this study was conducted to compare the effect of the two chemical forms of malate supplementation (malic acid and a commercial malate salt) and natural feed additives, yeast culture (*Saccharomyces Cerevisiae*) in cattle rations on nutrients digestibility, nutritive value, milk yield, milk composition and some blood metabolites of lactating crossbred cows as well as economical return of the tested rations.

2. Material and Methods:

The present study was carried out at the El-Serw Research Station, belonging to Animal Production Research Institute, Agricultural Research Center. The objective of this study was conducted to compare the effect of the two chemical forms of malate supplementation (malic acid and a commercial malate salt) and natural feed additives, yeast culture (*Saccharomyces Cerevisiae*) in cattle rations on nutrients digestibility, nutritive value, milk yield, milk composition and some blood metabolites as well as economical return of the tested rations in lactation crossbred Friesian cows from 1 to 75 days in milk.

Sixteen lactating crossbred Friesian cows averaged 496.06 ± 1.51 kg LBW at 3^{rd} and 4^{th} parities after parturition were assigned to four similar groups according to parity, their body weight and average milk yield (four animals each). The feeding trial lasted 75 days. Animals were fed concentrate feed mixture and berseem hay at rate of 70: 30 % on DM basis, respectively (as a basal ration). The first group as a control group (C) was fed a basal ration without feed additive, the second group (MA) was fed the basal ration supplemented with 10 g/h/d of malic acid, the third group (YC) was fed a basal ration plus 10 g/h/d of yeast culture (*Saccharomyces Cerevisiae* 1×10^9 CFU/g) and the fourth group (MS) was fed a basal ration supplemented with 10 g/h/d of malate salt (59.25% calcium malate, 10.75% sodium malate, 3% calcium propionate,1.7% sodium propionate, 0.3% propionic acid, and carrier up to 100%). The concentrate feed mixture consists of 34 % yellow corn, 32.3 % wheat bran, 20 % undecorticated cotton seed meal, 10% soybean meal, 2 % limestone, 1.0 % sodium chloride, 0.5% minerals and vitamins mixture and 0.2 % dicalcium phosphate. The concentrate feed mixture was offered two times daily just before milking at 7 a.m. and at 4 p.m. The amount of berseem hay was divided into two equal parts and offered at 9 a.m. and 6 p.m. Fresh water was offered twice daily before milking. Cows were hand milked twice daily at 6 a.m. and 3 p.m. Milk yields (morning and evening) were individual daily recorded. Actual milk yield was corrected to 4% FCM according to the formula of Gaines (1923). Representative milk samples of collected evening and morning milking were taken and refrigerated at -4° C for milk analysis every three weeks. Four digestibility trials were conducted using three cows from each group. Dry matter and nutrient digestibilites were determined using acid insoluble ash (AIA) technique of Van Keulen and Young (1977). Composite samples of feed and faces were analyzed according to A.O.A.C (2000). Milk samples were analyzed for total solid % (Majenier, 1949), fat% (Gerber method) by British Standard Instituting (1951), total protein and ash (Ling, 1963) and lactose were calculated by difference. The chemical composition of the ingredients and basal rations without additives are illustrated in Table (1).

Table (1): Chemical composition of feed ingredients and calculated chemical composition of the basal ration (% on DM basis)

Item	DM%	Nutrients % of DM					
		OM	CP	CF	EE	Ash	NFE
Concentrate feed mixture	88.55	91.97	18.06	8.26	3.54	8.03	62.11
Berseem hay	90.47	84.77	13.91	31.35	1.68	15.23	37.83
Control (as a basal ration)	89.13	89.82	16.82	15.19	2.98	10.18	54.82

Blood plasma samples were taken from jugular vein at the end of feeding trial at zero, 3 and 6 hours post feeding from all animals and stored at -20^0 c till analysis. Plasma total protein, albumin and transaminases (AST and ALT) activities and creatinine were analyzed using commercial kits of Bio-Merieux, lab, France.

Data were statistically analyzed using general linear model program of SAS (1999). Digestibility and performance data were analyzed as one way analysis of variance according to the following model: $Y= u +x_1+ e_{ij}$

where: Y=observation. U= mean, X_1=the effect of treatment, e_{ij} =experimental error.

The significance of the differences among treatments was tested by Duncan (1955).

3. Results and Discussion:

Nutrient digestibility and nutritive values:

Data in (Table 2) indicated that supplementing rations with malic acid (MA) and yeast culture (YC) were significantly (P<0.05) increased DM and OM digestibilities as compared with those of control ration (C) and malate salt (MS) ration. Carro *et al*.(1999) noticed that DM and OM digestibility were increased with malic acid additive.

Table (2): Nutrients digestibility and nutritive values of the supplemented rations fed to lactating Friesian cows .

Items	Experimental rations			
	C	**MA**	**YC**	**MS**
Digestibility coefficients, %				
DM	77.67^{b}	78.45^{a}	78.49^{a}	77.36^{b}
OM	75.06^{b}	77.06^{a}	77.75^{a}	76.48^{b}
CP	78.91^{b}	82.72^{a}	83.14^{a}	81.60^{a}
CF	70.84^{ab}	65.99^{b}	75.37^{a}	73.47^{a}
EE	69.22^{b}	80.69^{a}	81.17^{a}	79.01^{a}
NFE	75.96^{b}	79.91^{a}	76.58^{b}	75.77^{b}
Nutritive values, %				
TDN%	70.01^{b}	72.23^{a}	72.87^{a}	71.64^{ab}
DCP%	14.22^{b}	14.90^{a}	14.98^{a}	14.70^{a}
*DE kcal/Kg DMI	3.09	3.19	3.21	3.16

*DE (Mcal / Kg DMI) = 0.04409 x TDN% . **NRC (1988)**

a and b: Means in the same rows with different superscripts are significantly different at (P< 0.05).

C= control , MA= malic acid , YC= yeast , MS = malate

While, malic acid supplementation was significantly (P< 0.05) decreased CF digestibility and significantly (P<0.05) increased NFE digestibility compared with control and the other supplemented rations with YC and MS.

On the other hand, there are no significant differences among animals fed rations supplemented with MA, YC and MS in both values of CP and EE digestibilities (Table 2), while, control ration without additive recorded the lowest value in CP and EE digestibilities. The differences were significant (P<0.05) between control ration and other supplementing rations. Sniffen *et al.* (2006) found that total tract digestibility of DM, OM, CP, ADF, NDF, hemicellulose, cellulose, ether extract, starch and non-fiber carbohydrate (NFC) was not affected (P>0.05) by malic acid supplementation. Also, Kung *et al.* (1982) reported no effect of malate on diet digestibility and N retention in steers fed a diet based on whole-shelled maize – maize silage (50:50, w/w) ***ad libitum.*** They explained these results due to the differences in the composition of the diet and/or to the dose of malate fed to animals.

Control ration without additive was the lowest value in all nutrient digestibilities excepted with DM, CF and NFE digestibility. Furthermore, YC supplementation had the highest values of

DM, OM, CP, EE and CF digestibilities. El-Ashry *et al.* (2001), Allam *et al.* (2001) and Abdel-Khalak (2003) showed that supplemented yeast to rations improving all nutrient digestibilities. The improvement of protein digestibility with yeast culture supplementation may be due to the stimulation of rumen protelytic bacteria (William 1991). However, improving CF digestibility may be due to the increasing number of rumen cellulolytic bacteria (Gomez-Alarcon *et al.*, 1987). Also, Yoon and Stern (1996) found that increasing DM, OM, CP and EE digestibility with animals fed supplemented rations with yeast culture compared with those fed control ration without supplementation may be due to the reflection of microbial supplements stimulated the growth and activity of certain ruminal microorganisms .

The nutritive values as TDN % in Table (2) noticed that control ration without additive had

(P<0.05) the lowest value while, the ration supplemented with YC was recorded the highest value followed by MA and MS supplementation. The differences were not significant among MA, YC and MS supplemented rations. The improvement rates of TDN values were 3.17 %, 4.09 % and 2.33 % for MA, YC and MS, respectively, compared with control ration. El-Ashry *et al.* (2001) noticed that supplemented rations with yeast (P< 0.05) increased feeding value of ration. Wang *et al.* (2009) suggested that nutrient digestibilities and energy availability may have been improved by malic acid additive.

The DCP values were significantly (P<0.05) increased with supplemented rations by MA, YC and MS than that in control ration (C).The highest values were recorded with YC supplementation with no significant differences. The improvement rates of DCP values were 4.78 %, 5.35 % and 3.38 % for MA, YC and MS, respectively, compared with control ration (C). Also, MA, YC and MS supplementation recorded the higher value with DE (Mcal/ Kg DMI) than those fed the control ration (C).

Feed intake and body weight changes:

Data in Table (3) showed that concentrate feed mixture, berseem hay and roughage/concentrate ratios were similar among all the tested rations with or without supplements. Feed intake (kg/h/d) as DM, TDN and DCP did not affected with supplemented rations compared with control ration (C). These results are in agreement with Kung *et al.*, 1982, Martin *et al.*, 1999, Montano *et al.*, 1999, Salama *et al.*, 2002, Carro *et al.*, 2006, McCourt *et al.*, 2008, Foley *et al.*, 2009 and Wang *et al.*, 2009 for malate supplementation. Also, these results agreed with Aramel and Kent (1990) who found that no effect of YC supplementation on DM intake. In contrast, Allam *et al.* (2001), El-Ashry *et al.* (2001 , 2003) and Salem *et al.* (2001) reported that there was a significant improvement in DM intake when yeast culture was given to lactating animals.

Table (3):Average feed intake and body weight changes (kg) of lactating Friesian cows fed supplemented rations.

Item	C	MA	YC	MS
Feed intake (kg/h/d) as fed:				
Concentrate feed mixture(CFM)	11.40	11.40	11.40	11.40
Berseem hay	4.75	4.86	4.75	4.81
Feed additives	----	0.01	0.01	0.01
Total	16.15	16.27	16.16	16.22
Feed intake (kg/h/d) on DM basis:				
Concentrate feed mixture (CFM)	10.10	10.10	10.10	10.10
Berseem hay	4.30	4.40	4.30	4.35
Feed additives	----	0.01	0.01	0.01
Total DM intake	14.40	14.51	14.41	14.46
TDN intake	10.08	10.48	10.50	10.36
DCP intake	2.05	2.16	2.16	2.13
Roughage/concentrate	30:70	30:70	30:70	30:70
Body weight, kg:				
Initial body weight	497.5	496.3	493.8	497.0
Final body weight	492.3	493.3	490.3	495.8
Duration, days	75	75	75	75
Change in body weight	-5.2	-3	-3.5	- 2.2

Data in Table (3) showed that body weight changes was slightly decreased with animals fed malate salt (MS) followed by malic acid (MA) and then yeast culture supplemented ration, respectively. While, animals fed control ration without supplement had a highest reduction in live body weight (– 5.2 kg). These results reflecting the mobilization of body reserves, as indicated by the negative energy balance. These results are in agreement with Wang *et al.* (2009) who noticed that malic acid supplemented cows showed a trend (P=0.07) toward less loss of BW during the 63-DMI period.

Milk production and composition:

Data in Table (4) showed that the yield of milk and 4% FCM (kg/h/d) of the lactating crossbred Friesian cows were significantly (P<0.05) increased with supplemented rations by MA,YC and MS than those fed control ration. The yield of milk and 4% FCM of lactating crossbred Friesian cows were increased by 10.36% and 8.31% for MA, 6.83 % and 4.84 % for YC and 6.17 % and 4.89 % for MS supplementation, respectively, compared with the control group. Similar results were observed by Kung *et al*., 1982, Devant and Bach, 2004, Sniffen *et al*., 2006, Wang *et al*., 2009 and Hayat *et al*., 2009 who reported that malate supplementation to dairy cows or buffaloes increased milk production and its persistence Mallinckerodt *et al*. (1993) considering that milk production is moderately to highly correlate with calf performance. In addition, Hayat *et al*. (2009) noticed that malate supplementation improved calves performance as well as milk production of their dam. On the other hand, similar result was detected with yeast culture supplementation, significantly (P<0.05) increase milk yield during early lactation compared to control group (Gaafar *et al*., 2009 and Rahma *et al*., 2009).

The increase in milk yield with malic acid (MA) or malate salt supplementation might be due to increasing microbial nitrogen production (Sniffen *et al*., 2006 and Khampa and Wanapat, 2007), reducing methane production in the rumen (Newbold *et al*., 2005, Khampa and Wanapat, 2007 and Foley *et al*., 2009) and improve microbial efficiency by maintaining higher pH, optimum ammonia nitrogen and essential volatile fatty acid (VFA's). Also, increasing milk yield with yeast culture (YC) supplementing ration than in control ration might be attributed to the fact as a source of B vitamins which may occasionally be beneficial, increasing the microbial protein flow from rumen (Williams *et al*., 1990), reducing ammonia nitrogen concentration in the rumen by the inhibitory effect of growth promoters on proteolysis, amino acid determination and ruminal ureas activity (Khattab *et al*., 2003).

Table (4) : Daily milk yield and composition of lactating crossbred Friesian cows

Item	C	MA	YC	MS
Milk yield (kg/h)	19.78^{c}	21.83^{a}	21.13^{b}	21.00^{b}
4% FCM yield (kg/h)	19.02^{c}	20.60^{a}	19.94^{b}	19.95^{b}
Improvement in milk yield	100	110	107	106
Improvement in 4% FCM yield	100	108	105	105
Milk composition %:				
Fat	3.74^{a}	3.63^{b}	3.63^{b}	3.67^{ab}
Protein	3.08	3.08	3.03	3.05
Lactose	4.81^{a}	4.73^{b}	4.75^{b}	4.78^{ab}
SNF	8.56	8.41	8.47	8.53
TS	12.30^{a}	12.04^{b}	12.09^{b}	12.19^{ab}
Ash	0.69	0.69	0.69	0.69

a, b and c: Means in the same rows with different superscripts are significantly different at (P< 0.05).
SNF: solid not fat
TS: total solid.

On the other hand, lactating crossbred Friesian cows fed supplemented ration with MA showed significantly (P<0.05) higher yield of milk and 4% FCM compared with those fed supplemented rations with YC and MS (Table 4) .The increased in yield of milk and 4% FCM of lactating cows fed supplemented ration with MA were (3.31% and 3.31%) and (3.95% and 3.26%), respectively, compared with those fed YC and MS supplemented rations. While, there are no significant differences between those fed YC and MS supplemented rations in both of milk yield or 4% FCM yield.

Figure (1) showed that the peak of lactation curve ranged between the fifth and sixth week of lactation period. Animals fed ration supplemented with malic acid (MA) had the highest peak value (22.6 kg) followed by those fed malate salt additive (22.0 kg) and yeast culture additive (21.6 kg), the lowest one was observed with those fed control ration without additive (20.3kg). Regarding the milk production persistency (Fig. 1), animals fed ration with malic acid had greater persistency till at the tenth weeks of lactation period followed by those fed ration supplemented with yeast culture and malate salt, respectively, in comparison with those fed control ration which, declined sharply till the end of the experimental period. The same trend was reported by Kung *et al*. (1982). In contrast, Salama *et al*. (2002) found that supplementation with yeast and malic acid was not beneficial for lactation performance with dairy goats because of the high concentration of malic acid in the forages (high proportion of alfalfa) in the basal diet. The reason for the difference among studies is unclear but may be due to differences in the basal content of malic acid in the diets or the dose of malic acid supplemented. In addition, Castillo *et al*. (2004) suggested that dietary factors, such as forage to concentrate ratio and forage type, are important in determining responses to malic acid of forage varies with forage type (legumes > grasses), forage variety, maturity (immature > mature), and processing (fresh > hay or pelleting (Callaway *et al*., 1997) .

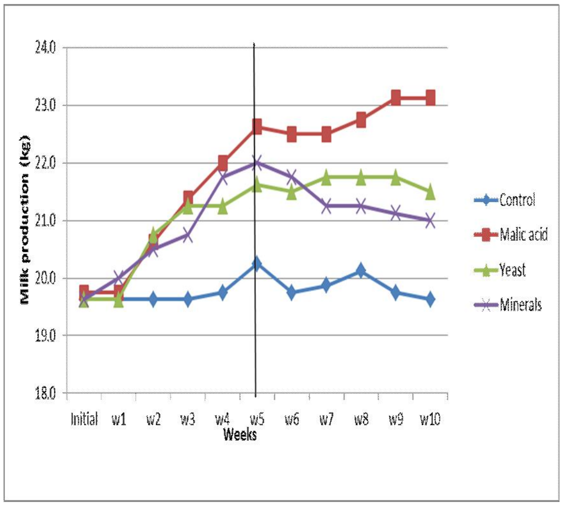

Figure (1): Effect of supplemented rations with MA, YC and MS on milk yield

Data in Table (4) showed that milk content of fat, lactose and TS% were significantly (P<0.05) decreased with cows fed supplemented rations by MA, YC and MS compared with those fed control ration. Whereas, there were no significant differences among groups in milk protein, SNF and ash percent. Similar results was found by Kung *et al*. (1982), Devant and Bach (2004) and Wang *et al*. (2009). They observed that cows fed supplemented malic acid had no effect on milk composition. Also, Sniffen *et al*. (2006) found that cows fed supplemented malic acid had no effect on content of fat, true protein or lactose in milk.

On contracts, Hayat *et al*. (2009) observed that there was significant (P<0.05) increase in milk protein, lactose and solid not fat percent while, the increase in milk fat percentage was non-significant with malate supplementation in early lactating Egyptian buffaloes.

Furthermore, Gaafar *et al*. (2009) found that the contents of all milk constituents except ash significantly (P<0.05) increased with baker's yeast supplementation in lactating Buffaloes. While, Masek *et al*. (2008) observed that supplementation with live yeast cells significantly increased total milk yield but the chemical composition of milk was not influenced by the treatments with the exception of milk fat that was significantly higher in yeast culture group.

Blood plasma metabolites:

Estimates of the studied blood parameters were within the normal range. Data in Table (5) showed that concentration of plasma total protein (TPR) tended to be significantly (P<0.01) higher in groups fed rations supplemented by malic acid (MA) or malate salt (MS) in comparison with groups C and YC. Generally group MA showed the highest value of TPR due to a significant increase of globulin fraction. In all groups, albumin (ALB) concentrations declined slightly by advanced time post feeding. The overall mean showed that MS group had a significant (P <0.05) higher concentration of ALB and a significantly (P <0.05) lower content was recorded with MA group. After 6 hours post feeding, differences between groups in concentrations of ALB, GLOB, A/G ratio and creatinine (CRT) were highly significant (P<0.01) although difference in TPR was insignificant among groups. Buch (1991) reported a positive correlation between plasma TPR, ALB and the absorbed or synthesized protein. Also, Ashour *et al*. (2004) reported that ALB level is a reflection of liver function, the increase of ALB indicate higher ability of the animal to synthesize and store more protein.

On the other hand, concentration of plasma CRT in group MS was the highest among different treated groups throughout times after feeding. This finding may indicate a significant role of malate salts in increasing level of protein turnover. Data of AST and ALT (transaminase activity) tended to be significantly (P <0.01) different between the groups before feeding while, it became insignificant thereafter. Group MS showed the highest activity of both transaminases (P<0.05). The aforementioned results pointed out that both forms of malate are different in their metabolic activity and mode of action.

Feed efficiency and economic evaluation:

Data in Table (6) noticed that feed efficiency as kg 4% FCM per one kg DM, kg TDN and kg DCP were higher with those fed supplemented ration with organic acids (malic acid and malate salt) and yeast culture ration than those fed control ration. The highest value was recorded with malic acid ration (MA) followed by malate salt and then yeast culture rations.

Regarding the economic evaluation data (Table 6) indicated that feed cost to produced one kg 4% FCM was decrease with those fed yeast culture ration (YC) and malate salt (MS) by 4.6% and 2.8%, respectively, compared with the control ration while, those fed malic acid ration had the highest cost per kg 4 % FCM than control and other supplemented rations.

Table (5): Concentrations of some blood plasma metabolites in lactating crossbred Friesian cows as affected by different treatments and time of feeding.

Blood Parameter	Time of feeding hr.	Treatments C	MA	YC	MS	Significances
Total protein (g/dl)	0	6.46 ^{b}	7.76 ^{a}	5.71 ^{c}	7.00 ^{b}	HS
	3	5.25 ^{b}	6.27 ^{a}	6.09 ^{a}	5.95 ^{ab}	S
	6	6.29 ^{a}	5.89 ^{ab}	5.47 ^{b}	5.76 ^{ab}	NS
	Overall mean	6.00 ^{b}	6.64 ^{a}	5.76 ^{b}	6.23 ^{ab}	S
Albumin (g/dl)	0	4.19	3.76	3.71	4.00	NS
	3	3.49 ^{ab}	3.37 ^{b}	3.86 ^{a}	3.68 ^{ab}	NS
	6	3.56 ^{b}	2.90 ^{c}	2.83 ^{c}	3.89 ^{a}	HS
	Overall mean	3.75 ^{ab}	3.34 ^{c}	3.47 ^{bc}	3.86 ^{a}	S
Globulin (g/dl)	0	2.27 ^{c}	4.00 ^{a}	2.00 ^{c}	3.01 ^{b}	HS
	3	1.76 ^{b}	2.90 ^{a}	2.23 ^{ab}	2.27 ^{ab}	S
	6	2.73 ^{a}	3.00 ^{a}	2.64 ^{a}	1.86 ^{b}	HS
	Overall mean	2.25 ^{b}	3.30 ^{a}	2.29 ^{b}	2.38 ^{b}	HS
A / G Ratio	0	1.91 ^{a}	0.96 ^{b}	1.89 ^{a}	1.34 ^{b}	HS
	3	2.06 ^{a}	1.17 ^{b}	1.77 ^{ab}	1.78 ^{ab}	NS
	6	1.31 ^{b}	1.03 ^{b}	1.08 ^{b}	2.09 ^{a}	HS
	Overall mean	1.76 ^{a}	1.05 ^{b}	1.58 ^{a}	1.74 ^{a}	HS
Creatinine (mg/dl)	0	1,24 ^{b}	1.58 ^{a}	1.19 ^{b}	1.86 ^{a}	HS
	3	1.24 ^{b}	1.19 ^{b}	1.25 ^{b}	1.74 ^{a}	HS
	6	1.11 ^{b}	1.12 ^{b}	1.25 ^{b}	1.54 ^{a}	HS
	Overall mean	1.20 ^{b}	1.29 ^{b}	1.23 ^{b}	1.71 ^{a}	HS
ALT activity (U/L)	0	12.09 ^{b}	12.52 ^{b}	12.53 ^{b}	13.55 ^{a}	HS
	3	12.40	13.32	12.29	12.55	NS
	6	12.88	13.38	12.81	13.47	NS
	Overall mean	12.46 ^{c}	13.07 ^{ab}	12.54 ^{bc}	13.19 ^{a}	NS
AST activity (U/L)	0	46.88 ^{b}	48.88 ^{ab}	46.93 ^{b}	51.73 ^{a}	HS
	3	47.70	48.78	45.80	44.85	NS
	6	49.13	49.33	46.05	50.05	NS
	Overall mean	47.90	48.98	46.28	48.88	NS

a, b and c: Means in the same rows with different superscripts are significantly different at ($P < 0.05$).
HS = ($P < 0.01$), S=($P < 0.05$), NS= Not significant

Table (6): Feed efficiency and economical evaluation of cross bred lactating Friesian cows fed basal ration and supplemented ration with MA,YC and MS

Item	C	MA	YC	MS
Feed efficiency :				
kg 4%FCM/ kg DM feed intake	1.32	1.42	1.38	1.38
kg 4%FCM/ kg TDN feed intake	1.89	1.97	1.90	1.93
kg 4%FCM/ kg DCP feed intake	9.28	9.54	9.23	9.37
Economic evaluation:				
Milk price (LE /day)	66.57	72.10	69.79	69.83
Feed cost (LE/day)	20.50	22.37	20.62	20.90
Feed cost / kg 4%FCM	1.08	1.09	1.03	1.05
Net revenue(LE/h/d)*	46.07	49.73	49.17	48.93
Increasing rates of net revenue (%)	100	107.94	106.73	106.21
Economic efficiency **	3.25	3.23	3.39	3.34
Improvement	100	99.39	104.31	102.77

Price of feedstuffs and supplementation of 2011: 1500 LE/Ton of concentrate feed mixture (CFM) and 650 LE/Ton of berseem hay, 180 LE/kg of malic acid, 12 LE/kg of yeast culture, 36 LE/kg of malate salt and 3**.5** LE/kg raw milk**.**
*Revenue (LE/h/d) = money output – money input ** Efficiency = money output/money in put

The highest revenue (LE/h/d) was shown with malic acid (MA) ration followed by yeast culture (YC) and then malate salt (MS) rations in comparison with control ration. The increasing rates of net revenue were 107.94 %, 106.73 % and 106.21% comparing with control ration.(100%) While, economic efficiency was the higher value with yeast culture (YC) followed by malate salt (MS) while, malic acid ration (MA) was the lowest value compared with control ration and other ration, its mean that the extra increase in milk production (20.60 kg/h/d) did not match the increase in feed cost. Martin (1998) showed that the inclusion of malate as a feed additive into the diets of ruminants is currently not economically feasible; however, forages rich in organic acids might serve as vehicles for providing malate to ruminants.

4. Conclusion:

Results of the current study indicated that using malic acid, malate and yeast culture as feed additives in lactating cows rations increased nutrients digestibility, feeding values, milk yield prolonged the persistency period and maintained body weight change. From the economical point, it is clear that malic acid supplementation is not preferable since it is expensive so that the extra increase in milk production did not match the increase in feed cost. Perhaps, malic acid treatment can be more efficient with high yielding animals. Further study is required to confirm results of feeding malic acid and malate salt with different roughages and different doses. On the other hand, yeast culture proofed to be a cheap additive and economically profitable in dairy cows rations.

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