J.Animal and Poultry Prod., Mansoura Univ., Vol.3 (2): 83 - 97,2012

EFFECT OF PROTECTING DIETARY PROTEIN WITH ZINC SULPHATE ON PERFORMANCE OF LACTATING COWS

El-Shabrawy, H. M.[1] ; K. E. I. Etman[1]; S. A. Ibrahim [1] and A. Z. Mehrez [2]

1. Animal Production Res. Inst., Agric. Res. Centre, Dokki, Giza, Egypt.
2. Animal Production Dept., Fac. Agric., Mansoura University.

ABSTRACT

Fifteen lactating crossbred Friesian cows in early lactating were randomly assigned into three groups (five animals each). Three experimental diets were formulated to study the effect of protected protein of concentrate feed mixture (CFM) by zinc sulphate on nutrients digestibility, some rumen fermentation characteristics, some plasma metabolite concentrates and their reflection on milk production and its components of cows fed berssem hay (BH) based diet. The ratio of BH to CFM was 40 to 60 on dry matter basis. Diets were supplemented with CFM; Zn- CFM and combination of Zn- CFM and CFM at rate of (1:1).

The obtained results indicated that digestibility coefficients of OM, CP and NFE were significantly ($P<0.05$) higher for cows fed combination of Zn-CFM/CFM and Zn-CFM diets than those fed CFM diet. The improvements in digestibility of nutrients reflected better feeding values in terms of TDN and DCP for diets containing treated CFM than the untreated CFM diet.

Ruminal NH_3-N and NPN concentrations were lower ($P<0.05$) for cows fed treated CFM by zinc sulphate than those fed untreated diet, indicating efficiency of the protection and/or better synchronization between availability of energy and release of NH_3. On the other hand, ruminal true protein nitrogen (TPN) was higher ($P<0.05$) for cows fed combination of Zn-CFM/CFM and Zn-CFM diets than those fed CFM diet.

The concentration of plasma urea-N was decreased when cows were given protected CFM-protein than those fed unprotected one, whereas, the concentrations of total protein, albumin and globulin were increased.

Yields of milk, 4% fat-corrected milk (4%FCM) and its components were higher ($P<0.05$) when cows were fed combination of Zn-CFM/CFM or Zn-CFM diet than those fed CFM diet. Milk non-protein nitrogen (NPN) was lower on Zn-CFM/CFM or Zn-CFM diets. On the other hand, yields of true protein nitrogen, casein nitrogen, non- casein nitrogen and whey nitrogen in milk were higher ($P<0.05$) for cows fed protected protein than those fed unprotected protein.

Feed cost per one kg 4% FCM was lower for cows fed combination of Zn-CFM and CFM diet than those fed Zn-CFM diet or CFM diet. Accordingly, economic efficiency value was the best with Zn-CFM/CFM diet.

Keywords: zinc sulphate, concentrate feed mixture, protected protein, lactating cows.

INTRODUCTION

In Egypt, most farm animal species depend mainly on berseem hay (BH) as a forage during summer along with concentrate feed mixture (CFM) as a supplement. Many sources of plant proteins are used to formulate CFM for lactating and growing animals. Among those, undecorticated cotton seed meal, linseed meal, soybean meal and wheat bran which are characterized by high rumen degraded protein (Mehrez, 1981; NRC, 1989 and El-Shabrawy, 1996).

Milk yield and its protein content can be affected by amount of CP flow into the small intestine (Hof *et al.,* 1994). Previous studies (Pires *et al.,* 1997; El-Shabrawy, 2006 and El-Shabrawy *et al.,* 2010b) showed that milk yield and its components have increased in response to increased intake of undegradable CP. In order to magnify available protein level, undegradable protein synthesized in the rumen has to be assessed (NRC, 1989). There are many methods for protein protection to increase the undegradable CP in the rumen, e.g. zinc salts treatment (Britton and Klopfenstein, 1986), formaldehyde treatment (Ferguson et al., 1967), heat treatment (El-Shabrawy, 1996) and tannin treatment (Pace et al., 1993) and hence increasing the amount of CP escaping to the small intestine.

Britton and Klopfenstein (1986) demonstrated that treating soybean meal with zinc salts at 1.5 to 2.0% of feed DM reduced *In vitro* degradation of SBM- protein and improved efficiency of N utilization by calves fed diets supplemented with zinc treated SBM compared with solvent-extracted SBM.

Under Egyptian conditions, few studies have been made on the effect of protected protein by zinc salts on milk production by farm animals. So, the main objective of the present study was to investigate the effects of protecting protein of CFM by zinc sulphate in diets of lactating crossbred Friesian cows on nutrients digestibility, some rumen fermentation characteristics, plasma constituents and their reflection on milk yield and its components. Milk protein profile and economic efficiency were also studied.

MATERIALS AND METHODS

The current investigation was carried out at El-Serw Experimental Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt.

Fifteen lactating crossbred Friesian cows in early lactation were balanced for body weight, milk yield, days after calving and parity. The animals were divided into three groups and received one of three experimental diets.

The three experimental diets used (Table 1) were as follows: 1) untreated concentrate feed mixture (CFM) + berseem hay (BH), 2) combination (1:1) of Zinc sulphate treated CFM/untreated CFM (Zn-CFM / CFM) + BH. 3) Zn-CFM + BH. The CFM consisted of 27% yellow maize, 33% wheat bran, 34% undecorticated cotton seed meal, 3% molasses, 2% limestone and 1% sodium chloride. The CFM pellets were ground (6 mm particle size) and sprayed with Zn–sulphate at rate of 1.5% of feed DM (Brittion and Klopfenstein, 1986). All animals were fed on the tested diets formulated of 60% CFM (untreated or treated) and 40% BH to satisfy their requirements, according to NRC (1989).

The diets were weighed and fed individually for animals and offered twice daily. Animals were fed individually in tie – stalls, kept in their stalls (usually 8h), then were exercised in a drylot with free access to water.

The experiment began after 10 days of adaptation to the different diets and lasted 12 weeks. Daily amounts of feed were readjusted every two weeks based on the average milk production and body weight changes.

Table 1. Formulation of the experimental diets (% of DM)

Ingredients	Experimental diets		
	Diet 1 (CFM)	Diet 2 (Zn-CFM/CFM)	Diet 3 (Zn-CFM)
Berssem hay (BH)	40	40	40
Concentrate feed mixture (CFM)	60	30	-
Zinc-CFM (Zn-CFM)	-	30	60

Samples of BH and CFM were weekly collected throughout the experiment. Dry matter was assayed after the samples were ground through a 1 mm screen hammer mill and dried at 105°C for 3 hours and analyzed for ash, crude fiber, crude protein and ether extract according to A.O.A.C (1990).

Animals were machine milked twice daily at 5.00 a.m. and 5.00 p.m. and milk yield of individual animals was recorded at each milking. Milk was sampled biweekly from two consecutive milkings, and composited according to milk yield. Composite milk samples were analyzed for contents of total solids (TS), ash, fat, total nitrogen (TN), non-casein nitrogen (NCN), and non-protein nitrogen (NPN).

Total solids in milk were determined by drying at 105°C for 4 hours to a constant weight, milk fat was analyzed following the Gerber method (British Standard Institution's Method, 1955), and protein was analyzed using the Kjeldahl method (N x 6.38). Lactose was determined by difference after ashing in a muffle furnace (Model RHF, 1200, England) at 750°C for 4 hours. Solids-not fat (SNF) were calculated as the difference between TS and fat. Non-casein nitrogen (NCN) was determined by Kjeldahl analysis of the filtrate by using Whatman paper No. 42 after precipitation with 10% acetic acid and 1 N sodium acetate (Ling, 1963). Non-protein nitrogen (NPN) was determined by Kjeldahl analysis of the filtrate by using Whatman paper No. 42 after precipitation with 15% trichloroacetic acid, TCA (Ling, 1963).

Casein-N was calculated as the difference between TN and NCN, true protein-N was calculated as the difference between TN and NPN. Whey N was calculated as the difference between true protein-N and casein-N.

Digestibility trials were carried out at the end of the feeding experiment using three random animals from each group to determine the digestion coefficients and nutritive values of the tested rations used in the feeding trial. Acid insoluble ash (AIA) was used as a natural marker (Van Keulen and Young, 1977). Fecal samples were gripped from the rectum of each animal twice daily during the collection period (5 days).

At the end of digestibility trial, rumen fluid samples were taken from three animals of each group just before offering morning meal and 4 hours post-feeding using stomach tube. Rumen-fluid pH was measured immediately on a fresh aliquot using battery operated pH meter and then samples were filtered through two layers of surgical gauze. Total volatile fatty acids (TVFA's) concentration were estimated using steam distillation method (Warner, 1964). Ammonia-N (NH_3-N) concentration was assayed according to Conway and O'Mally (1957). Ruminal total nitrogen (TN) and non-protein nitrogen (NPN) were determined according to A.O.A.C (1990). True protein nitrogen (True-PN) was estimated by the difference between TN and NPN.

During the last week of the experimental period, blood samples were collected in heparinized test tubes from the jugular vein from three animals of each group before morning feeding and 4 hours post-feeding. Blood samples were centrifuged immediately at 3500 revolution per minute (rpm) for 15 minutes to separate blood plasma and stored at -20°C until further analysis. Blood plasma was analyzed for urea-N (Patton and Crouch, 1977), total protein (Peters, 1968), and albumin (Webster, 1974). Globulin concentration was calculated by difference (total protein-albumin).

Data were subjected to statistical analysis by the computer program of SAS (1996) using the General Linear Model (GLM).The data of digestibility coefficient and milk yield and its components were subjected to one-way analysis of variance of examing of effects of treatments (diet 1 , diet 2 and diet 3) , according to the following Model :

$Yij = u + Ai + eij$

Where: yij = observed traits, u = overall mean, Ai = experimental diets 1-3 (1=diet 1, 2 = diet 2 and 3 = diet 3), eij = Random error.

The data of rumen parameters and blood metabolites were subjected to analysis of variance for examing of effects of treatments (diet 1, diet 2 and diet 3) and time of sampling (0 and 4 hours) and their interaction according to the following

Model:

$Yijk = u + Ai + Tj + ATij + eijk$

Where: $yijk$ = observed traits, u = overall mean, Ai = experimental diets 1-3 (1=diet 1, 2 = diet 2 and 3 = diet 3), Tj = Time of sampling, $ATij$ = interaction experimental diets x time of sampling, $eijk$ = Random error.

Means were compared according to Duncan's Multiple ranges test at 0.05 level (Duncan, 1955). Since the interactions were not significant, the main effects will by only presented in the results and discussion.

RESULTS AND DISCUSSION

Experimental diets:

The results presented in Table (2) show that the chemical analysis of the different ingredients used in this study were within the normal range of similar materials as previously discussed and reviewed by El-Shabrawy and El-Fadaly (2006) and Abou-Elenin et al. (2011).

Table 2. Chemical composition of the ingredients and the experimental diets

Ingredients	DM (%)	Chemical composition on DM basis (%)					
		OM	CP	EE	CF	NFE	Ash
BH	88.30	89.50	13.25	2.24	27.40	46.61	10.50
CFM	90.20	91.70	16.25	2.89	12.20	60.36	8.30
Zn-CFM	88.10	91.72	16.30	2.87	12.17	60.38	8.28
Calculated chemical composition of the tested diets (%)							
CFM	89.44	90.82	15.05	2.62	18.28	54.87	9.18
Zn-CFM/CFM	88.81	90.83	15.06	2.62	18.27	54.88	9.17
Zn-CFM	88.18	90.83	15.08	2.61	18.26	54.88	9.17

The calculated chemical composition of the tested formulated diets using these ingredients seemed to be similar in all nutrients. The CP contents in the tested diets (about 15.0%) were in the normal recommended ranges reported by NRC, (1989) CP for lactating cow producing between 15 to 25 kg milk/day.

Digestibility coefficients and nutritive values:

The nutrients digestibility coefficients and nutritive values of the experimental diets are presented in Table (3). It was clear that were significant differences (P<0.05) in digestibility of OM, CP and NFE among the tested diets. On the other hand, digestibility of DM, EE and CF did not differ among the tested diets. The highest values for DM, CP and NFE digestibility was those of diet CFM and Zn-CFM combination and the lowest values were of CFM diet. The CFM and Zn-CFM combination diet was higher by about 9.20% or 4.28% for CP digestibility than CFM or Zn-CFM diets, respectively. The improvement in CP digestibility may be a result of zinc treatment as a protection method of protein, hence, reducing protein solubility and degradability in the rumen and there for provided more dietary protein for digestion and absorption in the small intestine, which is probably better than microbial protein (Karr *et al.,* 1991, Cecava, *et al.,* 1993 and El-Shabrawy *et al.,* 2010a). The obtained results are on a line with those reported by Karr *et al.,* (1991) and Cecava *et al.,* (1993) who reported that ruminal escape N content for Zn-SBM was 70% to 90% greater than for solvent-extracted SBM.

Moreover, regarding OM digestibility trend in the present study, it seems that protection method improved its values with combination of CFM and Zn-CFM diet compared with those recorded for CFM diet (being 74.63 *vs*. 70.0%). In this respect, El-Shabrawy *et al.,* (2010a) found significant effect on OM digestibility for calves fed Zn-SBM than those fed untreated-SBM. On the other hand, Cecava *et al.,* (1993) reported that total tract OM digestibility was similar among treatments when they were fed Zn-SBM compared with those given untreated SBM.

Table 3. Effects of the experimental diets on means of digestion coefficients and nutritive values

Item	Experimental diets			±SE
	CFM	ZN-CFM/CFM	ZN-CFM	
Digestibility coefficients (%)				
DM	68.36	69.68	68.70	0.47
OM	70.00^{c}	74.63^{a}	72.25^{b}	0.28
CP	68.07^{c}	74.33^{a}	71.28^{b}	0.20
EE	71.15	70.98	70.89	0.52
CF	66.23	66.81	66.48	0.38
NFE	69.87^{c}	74.06^{a}	71.87^{b}	0.42
Nutritive value (%)				
TDN	64.88^{c}	68.23^{a}	66.49^{b}	0.29
DCP	10.24^{c}	11.20^{a}	10.75^{b}	0.03

Means within the same row having different superscripts are significantly different (P< 0.05).

Positive improvement were recorded for TDN and DCP values with combination of CFM and Zn-CFM diet compared to those of Zn-CFM and CFM diets in a decreasing rate, respectively with significant differences (P<0.05) among them. The higher DCP with the protected protein was probably because of higher crude protein digestibility.

Certainly, the influences on the digestibility of nutrients along the whole alimentary tract are mainly reflections of fermentation in the rumen in terms of availability of N for rumen microbes as a result of protein protection.

El-Shabrawy *et al.,* (2004) and El-Shabrawy *et al.,* (2010b) reported that the digestibility coefficients of OM and CP for lactating goats increased when rumen undegradable protein (RUP) content of their diets increased.

Ruminal fermentation parameters:

The results in Table 4 indicated that the ruminal pH values and total VFA's concentration did not differ among the tested diets. The results obtained in this experiment showed that pH values were in normal ranges for maximal proteolytic activity as reported by El-Fadaly *et al.,* (2003) and EL-Deeb *et al.,* (2010) to lie between 6 to 7. These results are in agreement with El-Shabrawy (2000) and El-Shabrawy *et al.,* (2004) did not detect any effect for protein protection on ruminal pH values or VFA concentrations. On the other side, El-Shabrawy *et al.,* (2010a) reported higher ruminal pH values for calves fed high RUP than Those fed low RUP.

For sampling time effect, it is clear that the normal pattern showed in both of pH values and VFA concentration, since, pH values were significantly ($P<0.05$) decreased after feeding while, VFA concentration significantly ($P<0.05$) increased as recorded in several studies (El-Shabrawy, 2006) on lactating zaraibi goats.

Nitrogen fraction in the rumen liquor of cows in Table (4) revealed that TN and TPN values were the highest ($P<0.05$) and were the lowest ($P<0.05$) for ruminal NPN and NH_3-N concentrations when cows were fed a combination of Zn-CFM/CFM diet and Zn-CFM diet compared with those fed CFM diet. These results are in agreement with the previous results of El-Shabrawy *et al.,* (2010a) on growth of crossbred Friesian calves. Also, Abo-Donia *et al.,* (2003) reported that ruminal NPN and NH_3-N were decreased and ruminal TN and TPN were increased for lactating cows fed heated- soybean seeds compared to those fed untreated soybean seeds. Moreover, El-Fadaly *et al.,* (2003) and El-Shabrawy (2006) reported that protecting dietary protein leads to decreased ruminal NH_3-N concentration. Although, Cecava *et al.,* (1993) indicated the ruminal NH_3-N concentration did not differ for steers fed Zn-SBM compared to those fed SBM.

Table 4. Effects of feeding the experimental diets on the means of some rumen liquor parameters of lactating cows

Items	Experimental diets			±SE	Sampling time (hr)		±SE
	CFM	Zn-CFM/CFM	Zn-CFM		0	4	
pH	6.41	6.44	6.45	0.03	6.59^a	6.27^b	0.02
VFA (meq./100 ml RL)	7.97	8.09	8.01	0.06	6.98^b	9.07^a	0.05
NH3-N (mg/100 ml RL)	19.88^a	16.98^c	18.20^b	0.18	16.31^b	20.39^a	0.15
Total nitrogen (TN, mg/100 ml RL)	124.4^c	134.6^a	129.5^b	0.47	97.1^b	161.9^a	0.39
Non-protein nitrogen (NPN, mg/100 ml RL)	51.62^a	41.12^c	44.26^b	0.83	38.83^b	52.50^a	0.68
True-protein nitrogen (TPN, mg/100 ml RL)	72.81^c	93.48^a	83.73^b	0.17	58.3^b	108.4^a	0.14

Means within the same row having different superscripts are significantly different (P< 0.05).

All nitrogen fractions in rumen liquor of cows were significantly (P<0.05) increased after 4 hrs post feeding compared to those recorded before feeding. Generally, the low values of both NPN and NH_3-N and the increased values of TPN obtained in the present study could be reflection to the declined solubility and degradability of protein in the rumen as a result of Zn treatment, which would in turn positively increase the RUP.

Blood constituents:

Concerning the effect of protected protein on some plasma metabolites (Table5), lower (P<0.05) value of urea-N was found in plasma of cows receiving combination of Zn-CFM/CFM and Zn-CFM diets than those receiving CFM diet. The reduction plasma in urea-N concentration for cows fed combination of Zn-CFM/CFM diet and Zn-CFM diet were 2.58 and 1.25 mg/100 ml compared to those fed CFM diet. The obtained results in this study were closer to the previous findings reported by El-Shabrawy *et al.,* (2010a) who found that feeding calves on diet containing zinc treated soybean meal (SBM) and undicorticated cotton seed meal (UCSM) reduced plasma urea-N by 3.46 mg/100ml compared to those fed the diet containing untreated SBM and UCSM.

Moreover, El-Shabrawy *et al.,* (2004), El-Shabrawy (2006) and El-Shabrawy *et al.,* (2010b) found that feeding goats on diet containing high-RUP reduced plasma urea-N compared to those fed the diet containing low-RUP.

Table 5. Mean values of the concentrations of some blood constituents of lactating cows fed the different experimental diets

Items	Experimental diets			±SE	Sampling time (hr)		±SE
	CFM	Zn-CFM/CFM	Zn-CFM		0	4	
Urea-N (mg/100 ml)	18.14[a]	15.56[c]	16.89[b]	0.07	16.48[b]	17.25[a]	0.05
Total protein (g/100 ml)	6.52[c]	7.69[a]	7.07[b]	0.04	7.08	7.11	0.03
Albumin (A, g/100 ml)	3.70[c]	4.44 [a]	4.08[b]	0.02	4.07	4.08	0.01
Globulin (G, g/100 ml)	2.82[c]	3.25[a]	2.98 [b]	0.03	3.01	3.02	0.02
A / G ratio	1.31[b]	1.37[a]	1.37[a]	0.01	1.35	1.35	0.01

Means within the same row having different superscripts are significantly different (P< 0.05).

The reduction in blood plasma urea-N concentration for cows given diets contained protected protein may be due to the decrease in rumen degradable protein, consequently decreased NH_3-N and NPN concentrations in the rumen liquor (Table 4). Whereas, higher (P<0.05) values of total protein and its fractions (albumin and globulin) were recorded for cows given Zn-CFM: CFM and Zn-CFM diets than those given CFM diet. The results obtained in this study were similar to the previous findings reported by El-Ayek *et al.,*(1999), El-Shabrawy (2006) and El-Shabrawy *et al.,* (2010b) who found significantly higher level of protein in plasma of animals fed protected protein. This may be due to higher RUP, which consequently increased amino acids supply in the small intestine. Generally, all values were within the normal ranges for healthy cows.

Milk yield and its components:

The results in Table (6) indicated that milk yield was significantly ($P<0.05$) increased by 13.22 and 12.62% for cows fed Zn-CFM: CFM and Zn-CFM diets than for cows fed untreated CFM diet, respectively. The 4% FCM yield took the same trend as milk yield. The results in Fig. (1) indicted that milk yield for cows fed combination of Zn-CFM/CFM diet was increased and maintained higher through the whole experimental period compared to those fed Zn-CFM diet and CFM diet, respectively. On the same flock, El-Shabrawy and El-Fadaly (2006) showed that milk yield improved by 8.4% for lactating cows fed formaldehyde treated CFM than those fed untreated one. Similarly, Abo-Donia *et al.,* (2003) and El-Shabrawy *et al.,* (2004) noticed an increase in milk production by lactating cows or goats fed heated-soybean seeds or formaldehyde treated alfalfa silage as compared to those fed untreated one. These results are also in agreement with the previous results of Atwal *et al.,* (1995) El-Shabrawy (2000) who found that milk yield increased by 2.2 kg/h/d in dairy cows fed high RUP than those fed low RUP. On the other hand, Gaynor *et al.,* (1988) reported similar results in milk yield for lactating cows fed Zn-SBM diet and untreated-SBM.

These results are probably because of the higher value of CP (18%) 18 CP in untreated-SBM diet compared to 15% CP in diet Zn-SBM or lack of level of protected-SBM (0.65% zinc sulphate).

Table 6. Effects of feeding the experimental diets on the means of milk production and its components

Item	Experimental diets			±SE
	CFM	ZN-CFM/CFM	ZN-CFM	
Milk yield (kg/day)	15.45^{b}	17.40^{a}	17.08^{a}	0.13
4% FCM (kg/day)	14.75^{c}	16.70^{a}	16.35^{b}	0.04
Fat				
%	3.70	3.73	3.72	0.05
kg/day	0.572^{c}	0.650^{a}	0.635^{b}	0.004
Protein				
%	2.80^{b}	3.20^{a}	3.17^{a}	0.04
kg/day	0.432^{c}	0.557^{a}	0.542^{b}	0.003
Lactose				
%	4.73	4.72	4.73	0.04
kg/day	0.731^{b}	0.821^{a}	0.808^{a}	0.011
Solids not fat (SNF)				
%	8.22^{b}	8.58^{a}	8.58^{a}	0.02
kg/day	1.270^{b}	1.494^{a}	1.466^{a}	0.010
Total solids (TS)				
%	11.92^{b}	12.32^{a}	12.30^{a}	0.05
kg/day	1.841^{c}	2.143^{a}	2.102^{b}	0.008
Ash				
%	0.68	0.67	0.68	0.02
kg/day	0.106^{b}	0.116^{a}	0.117^{a}	0.003

Means within the same row having different superscripts are significantly different ($P< 0.05$).

Higher percentages of milk components ($P<0.05$) were recorded with cows fed combination of Zn-CFM/CFM and Zn-CFM diets, except milk fat, lactose and ash percentages than those fed CFM diet. On the other hand, production of fat, protein, lactose, SNF and TS milk were greater ($P<0.05$) on combination of Zn-CFM/CFM and Zn-CFM diets than on CFM diet. These results are in good agreements with El-Ayek et al., (1999); El-Shabrawy et al., (2004) and El-Shabrawy et al., (2010b) who reported that yields of milk components increased when lactating animals were fed protected proteins. Milk fat, protein and lactose yield were increased in average by 70, 117 and 83 g/d for cows fed on diets containing Zn-CFM than for cows fed diet containing CFM. Atwal et al., (1995) reported that milk fat, protein and lactose yield were increased by 54.26 and 76 g/d for cows fed on diets containing protected SBM-protein than for cows fed on diets containing untreared-SBM.

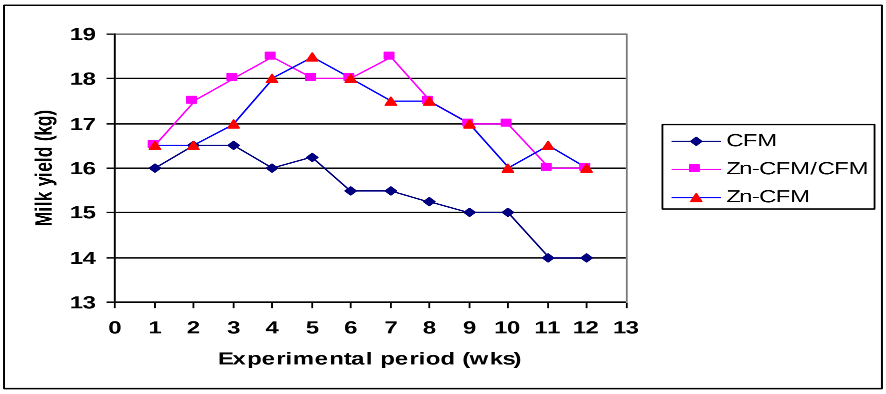

Fig. 1. Milk yield during the experimental period of cows fed the tested diets

In the present study, the increase in RUP levels in the tested diets containing protected protein achieved by using zinc sulphate treatment of CFM-protein, improved the yield of milk and its components, probably because of higher flow of N and essential amino acids to the intestine (Cunningham *et al.,* 1996).

Milk protein fractions:

Table (7) presents the effect of feeding the experimental diets on fractions of milk nitrogen. Milk total-N, true protein-N, non-casein-N, casein-N and whey-N contents were increased ($P<0.05$) for cows receiving combination of Zn-CFM/CFM and Zn-CFM diets than those receiving untreated CFM diet. On the other hand, using of zinc sulphate to protected dietary protein decreased ($P<0.05$) NPN content in milk, which reflects dietary differences in rumen degradable protein (El-Shabrawy *et al.,* 2004, El-Shabraw 2006, and El-Shabrawy *et al.,* 2010b).

The increase in milk protein content (Table 6) corresponded to an increase in true protein-N content, non-casein-N, casein-N and whey-N contents in milk.

Table 7. Effects of feeding the experimental diets on the means of fractions of milk nitrogen

Item	Experimental diets			±SE
	CFM	ZN-CFM/CFM	ZN-CFM	
Total - N				
%	0.429^{b}	0.502^{a}	0.498^{a}	0.006
g/day	67.80^{c}	87.28^{a}	85.02^{b}	0.50
True protein - N				
%	0.401^{b}	0.476^{a}	0.469^{a}	0.006
g/day	61.93^{c}	82.76^{a}	80.06^{b}	0.53
Non-protein - N				
%	0.038^{a}	0.026^{b}	0.029^{b}	0.001
g/day	5.87^{a}	4.53^{b}	4.95^{b}	0.20
Non-casein – N				
%	0.093	0.090	0.091	0.001
g/day	14.36^{b}	15.66^{a}	15.60^{a}	0.15
Casein – N				
%	0.346^{b}	0.412^{a}	0.406^{a}	0.005
g/day	53.43^{c}	71.62^{a}	69.41^{b}	0.41
Whey – N				
%	0.055^{b}	0.064^{a}	0.062^{a}	0.002
g/day	8.50^{b}	11.13^{a}	10.65^{a}	0.29

Means within the same row having different superscripts are significantly different (P< 0.05).

Milk NPN concentration has been used as an indicator of relative protein to energy intake and efficiency of ruminal N capture (Oltner and Wiktorsson, 1983). Milk NPN concentration in the present study followed a pattern similar to ruminal NH3-N (Table 4) and plasma urea-N concentration (Table 5). Milk NPN content decreased by 22.83% in combination of Zn-CFM/CFM diet and by 15.67% in Zn-CFM diet compared with CFM diet.In this concern, El-Shabrawy *et al.* (2004) found that milk NPN content was lower by 22.0% for goats fed diets contained formaldehyde treated alfalfa silage than those fed on diet containing untreated alfalfa silage. Also, El-Shabrawy (2006) found that milk NPN content decreased by 18.5% in formaldehyde-SBM diet and by 38.0% in heated-SBS diet compared with U-SBM diet.

Decreasing NPN and increasing casein-N of goat's milk as a result of feeding diets containing protected protein by zinc sulphate would improve the yield and properties of cheese made from it. Milk containing high casein ratio produces suitable firm curd and so cheese with good body and texture and raise the yield, while, increasing of NPN content in milk retard the rennet action and made weak curd and the resultant chesses has low yield and bad properties (Davis, 1965).

Generally, the increase in milk true protein-N and casein-N contents were associated with decreases in milk NPN for cows fed diets containing protected protein (Zn-CFM/CFM and Zn-CFM diets) compared to those fed diet containing un-protected protein (CFM diet). This may be due to the decreased protein solubility and degradability in the rumen, consequently, were ruminal undegradable-protein for digestion and absorption in the small intestine was available, thus increased the availability of amino acids in the small intestine and improved protein status of the host animal (Chanjula *et al.,* 2004).

Economic evaluation:

Economical efficiency parameters listed in Table (8) indicated that feed cost to produced one kg 4% FCM was lower for cows received combination of Zn-CFM and CFM than those fed Zn-CFM diet and CFM diet, being 0.99, 1.05 and 1.05 L.E., respectively.

Table 8. Economical efficiency of the experimental diets used in lactating cows

Item	Experimental diet		
	CFM	Zn-CFM/CFM	Zn-CFM
Feed intake (kg/h/d) as fed			
BH	5.44	5.62	5.62
CFM	7.98	4.12	-
Zn-CFM	-	4.22	8.44
Feedcost (L.E/day)	15.51	16.58	17.15
Milk price (L.E/day)	44.25	50.10	49.05
Feed cost / kg 4% FCM	1.05	0.99	1.05
Economic efficiency*	2.85	3.02	2.86

The price list of one ton BH,CFM,Zn-CFM were 650,1500,1600 L.E, respectively and price of kg for row milk was 3.0 L.E (Based on year 2008 prices).
*** Economic efficiency = money output / money input**

Consequently, the economic efficiency was improved for cows fed combination of Zn-CFM and CFM by 6.0% than those fed CFM diet or Zn-CFM diet. El-Shabrawy *et al.,* (2010a) recommended that using protected protein by zinc sulphate of the complete rations in growing calves diet's resulted in superior economical efficiency compared with the control diet.

CONCLUSION

From these results, it could be concluded that using protected CFM-protein by zinc sulphate in rations of lactating cows tended to improve digestibility coefficients of nutrients and feeding values, with no adverse effects on some parameters of rumen liquid and some blood measurements. These improvements were reflected on producing more ($P<0.05$) milk and 4% FCM yields and improved its milk characteristics.

Generally, using combination of Zn-CFM and CFM in lactating cows rations was better to get more milk yield and better economical efficiency.

REFERENCES

Abo-Donia, F.M.A.; Ibrahim, S.A.; El-Shabrawy, H.M. and Salama, A.M.A. (2003). Milk production and composition of Friesian crossbred cows fed rations containing different sources of energy. The 9th Conf. on Anim. Nutr., Hurghada, 14-17 October, Egyptian J. Nutr. and Feeds (Special Issue): 507.

Abou – Elenin; Ebtehage I . M .; E L – Hosseiny, Hoda M . and EL – Shabrawy , H . M . (2011) . Comparing Effect of organic acid (malate) and yeast culture as feed supplement on dairy cows performance . International J . Nature and Science , 9 (7) : 132 – 140 .

A.O.A.C. (1990). *Official Methods of Analysis*. The Association of Official Analytical Chemists, 15th Ed. Washington, D.C., USA.

Atwal , A . S . ; Mahadevan , S . and Wolynetz , M . S . (1995) . Increasing milk production of cows in early lactation fed chemically treated soybean meal . J . Dairy Sci . , 78 : 595 .

British Standard Institution "BSI" (1955). Gerber Method for the Determination of Fat in Milk and Milk Products. B.S.I. Publication No. 696, Part 1 and 2.

Britton, R.A. and Klopfenstein, T.J. (1986). Zinc treated soybean meal: A method to increase bypass. Nebraska 1986, Beef Cattle Rep. MP-50. P45 Lincoln.

Cecava, M.J.; Hancock, D.L. and Parker, J.E. (1993). Effects of zinc-treated soybean meal on ruminal fermentation and intestinal amino acid flows in steers fed corn silage-based diets. J. Anim. Sci. (71):3423-3431.

Chanjula, P.; M. Wanapat; Wachirapakorn, C. and Rowlinson, P. (2004). Effect of synchronizing starch sources and protein N on feed intake, rumen microbial fermentation, utilization and performance of lactating dairy cows. J. Anim. Sci., 17 (10): 1400-1410.

Conway, E.J. and O'Mally, E. (1957). Micro diffusion methods. Ammonia and urea using buffered absorbents. Biochem. J., 36:655.

Cunningham , K . D . ; Cecava , M . J . ; Johnson , T . R . and Ludden , P . A . (1996). In fluence of source and amount of dietary protein on milk yield by cows in early lactation . J . Dairy Sci . , 79 : 620 .

Davis, J.G. (1965). Cheese. Vol. 1, J. & A. Churchill Ltd, London.

Duncan, D.B. (1955). Multiple range and multiple F-test. Biometrics, 11:1-42.

EL – Ayek , M . Y . ; Mehrez , A . Z . ; EL – Ayouty , S . A . and EL – Shabrawy , H . M . (1999) . Influence of source of protein and protection methods on the performance of lactating Friesian cows . J . Agric . Sci . Mansoura Univ . , 24 (8) : 3891 – 3903 .

EL – Fadaly , H . A ; EL – Shabrawy , H . M ; EL – Deeb , M . M . and Mehrez , A . Z . (2003) . Effect of formaldehyde trearment of concentrate feed mixture and source of roughage on fermentation and some bacterial activities in the rumen of sheep . The 9th Conf . On Anim . Nutr . , Hurghada , 14 – 17 october , Egyptian J . Nutr . and Feeds (Special Issue) : 1131 – 1142 .

El- Shabrawy, H.M. and El-Fadaly, H.A. (2006). Effect of feeding regime and formaldehyde treatment of diets for crossbred Friesian cows on their milk productivity and microbiology. Egyptian J .Anim. Prod.,43(1):25-39.

El-Deeb, M.M.; El-Shabrawy, H.M. and El-Fadaly, H.A. (2010). Effect of ruminal degradability of crude protein and nonstructural carbohydrates on the performance of lactating goats. 1. Some rumen fluid parameters and microbial activities. J.Anim.and Poult.Mansoura Univ., 1(10):535-555.

El-Shabrawy, H.M. (2006). Performance of goats fed protected protein during gestation and lactation. Egypt. J. of Sheep, Goats and Desert Animals Sciences, Vol. 1 (1): 213-232. Supl. Issue for the 1st Conference of Enhancement of Small Ruminants Production, 7-9 Feb. 2006 (Cairo).

El-Shabrawy, H.M.,(1996). Utilization of dietary protein in ruminant. Solubility and rumen degradability of some proteins and their protection. M.Sc. Thesis, Fac. Agric. Mansoura Univ., Mansoura, Egypt.

El-Shabrawy, H.M.,(2000). Effect of protected proteins on the milk yield. Influence of protecting cotton seed and soybean proteins by either heat or formaldehyde treatments on some metabolic and performance traits of cows. Ph.D. Thesis, Fac. of Agric., Mansoura Univ., Egypt.

El-Shabrawy, H.M.; El-Deeb, M.M.; Etman, K.E.I. and Mehrez, A.Z. (2010a).Effect of protected protein on growth performance of crossbred friesian calves fed corn silage-based diets . J.Anim.and Poult.Mansoura Univ., 1(10):441-454.

El-Shabrawy, H.M.; El-Deeb, M.M.; Ismaiel, M.M. and Mehrez, A.Z. (2010b). Effect of ruminal degradability of crude protein and nonstructural carbohydrates on the performance of lactating goats. 2. Feed digestibility, some blood constituents and milk production and its composition. J.Anim.and Poult.Mansoura Univ., 1(10):557-574.

El-Shabrawy, H.M.; Mehrez, A.Z. and Shehata, E.I. (2004). Evaluation of alfalfa hay and silage in complete diets for lactating goats. The 12th Conf. of the Egyptian Society of Animal Production, Mansoura, 30th Nov. 2nd Dec., Proc. of the Egypt. J. Anim. Prod., 41 (Suppl. Issue): 181-194.

Ferguson, K.A. Henslely, J.A. and Reis, P.J. (1967). Nutrition on wool growth. The effect of protecting dietary protein from microbial degradation in the rumen. Aust. J. Sci.,30:215.

Gaynor , P. J. ; M ontgomery , M . J . and Holmes , C . R . (1988) . Effect of zinc chloride or zinc sulphate treatment of protein supplement on milk production – J. Dairy Sci . , 71 : 2175 – 2180 .

Hof, G.,; Tamminga, S. and Lenaers, P.J. (1994). Efficiency of protein utilization in dairy cows. Livest. Prod. Sci., 38:169.

Karr, K.J.; Dawson, K.A. and Mitchell, Jr. G.E. (1991b). Ruminal flow of nitrogen and amino acids in sheep fed Zn-treated soybean meal. 21st Biennial Conf. on rumen function, No. 35. (Abstr.).

Ling, E.R. (1963). A Textbook of Dairy Chemistry. Vol. 2. Practical, 3rd Ed., Champan and Hall, London.

Mehrez, A.Z. (1981). Influence of basal diet and rate of passage on degradability of protein supplements in the rumen. Mansoura Univ. J. Agric. Sci., 6:106-117.

National Research Council (NRC) , 1989 . Nutrient Requirements of Dairy cattle . 9th Rev . ed . , Natl . Acad . Sci ., Washington , DC .

Oltner, R. and Wiktorsson, H. (1983). Urea concentrations in milk and blood as influenced by feeding varying amounts of protein and energy to dairy cows. Livest. Prod. Sci., 10:457.

Pace, V., Settineri, D. and Cattillo, G. (1993). Influence of tannin treatments on the *in vitro* digestibility of soybean meal. Zootecnica Nut. Animal, 19:73-79.
Patton, C.J. and Crouch, S.R. (1977). Anal. Chem., 49:464-469. (Cited from Diamond Company, France).
Peters, T. (1968). Determination of serum total protein. Clin. Chan., 14:1147.
Pires, A.V.; Eastridge, M.L. Firkins, J.L. and Lin, Y.C. (1997). Effect of heat treatment and physical processing of cotton seed on nutrient digestibility and production performance by lactating cows. J. Dairy Sci., 80: 1685.
SAS (1996). SAS User's Guide Statistics. Version 6, Fourth Ed., SAS Institute, Inc. Cary, NC., USA.
Van Keulen, J. and Young, B.R. (1977). Evaluation of acid-insoluble ash as a natural marker in ruminant digestibility studies. J. Anim. Sci., 44:282.
Warner, A.C.I. (1964). Production of volatile fatty acids in the rumen. Methods of measurements. Nutr. Abst. Rev., 34:339.
Webster, D. (1974). Determination of serum albumin. Clin. Chem. Acta, 53:109.

تأثير حماية بروتين الغذاء بكبريتات الزنك على الآداء الإنتاجي للأبقار الحلابة

حامـد محمـد الشـبرواي[1]- كامـل عثمـان إبـراهيم عثمـان[1]- سـمير علـى إبـراهيم[1]و أحمد زكي محرز[2]

1- معهد بحوث الإنتاج الحيواني – مركز البحوث الزراعية- الدقي – الجيزة - مصر.
2- قسم إنتاج الحيوان – كلية الزراعة – جامعة المنصورة.

أجريت هذه الدراسة في محطة بحوث الإنتاج الحيواني بالسرو على عدد 15 بقرة خليط فريزيان في مرحلة الإنتاج العالي و قسمت عشوائياً إلي 3 مجموعات (5 حيوانات بكل مجموعة) في تصميم تام العشوائية على علائق اشتملت الأولي على مخلوط العلف المركز الغير معامل، اشتملت العليقة الثانية على مخلوط العلف المركز المعامل بكبريتات الزنك و مخلوط العلف المركز غير المعامل بنسبة (1:1)، بينما اشتملت العلبقة الثالثة على مخلوط العلف المركز المعامل و ذلك لدراسة تأثير حماية بروتين مخلوط العلف المركز في العلائق المختبرة باستخدام كبريتات الزنك على معاملات الهضم و بعض خصائص التخمر في الكرش و بعض تركيز مكونات الدم و إنعكاسها على إنتاج و مكونات اللبن الناتج من الحيوانات التجريبية المغذاة على دريس البرسيم عليقة إساسية.

- و قد أظهرت النتائج المتحصل عليها زيادة معاملات هضم المادة العضوية و البروتين الخام و مستخلص خالي الأزوت للأبقار المغذاة على العلائق المحتوية على مخلوط العلف المركز المعامل بكبريتات الزنك بالمقارنة بالعليقة المحتوية على مخلوط العلف المركز غير المعامل.
- إنعكس التحسن في معاملات الهضم في إظهار قيمة غذائية عالية في صورة مادة كلية مهضومة و بروتين خام مهضوم للعلائق المحتوية على مخلوط العلف المركز المعامل.
- انخفضت تركيزات الأمونيا و المواد الأزوتية غير البروتينية في سائل الكرش للأبقار المغذاة على مخلوط العلف المركز المعامل مقارنة بتلك التي غذيت على مخلوط العلف المركز غير المعامل. و على الجانب الآخر ازداد تركيز نتروجين البروتين الحقيقي في سائل الكرش.
- انخفض تركيز يوريا الدم، بينما ازدادت تركيزات البروتينات الكلية و الألبيومين و الجلوبيولين في الأبقار المغذاة على البروتين المحمي مقارنة بمثيلاتها المغذاة على بروتين غير محمي.
- ازداد إنتاج اللبن واللبن معدل الدهن (4%) و مكونات اللبن عند مستوى معنوية (0.05) في الحيوانات المغذاة على العلائق المحتوية مخلوط العلف المركز المعامل بالمقارنة بمثيلاتها المغذاة

على العليقة المحتوية مخلوط العلف المركز غير المعامل. و كانت تركيزات المواد الأزوتية غير البروتينية في اللبن منخفضة في حالة التغذية على العلائق المحتوية مخلوط العلف المركز المعامل، و على الجانب الآخر ارتفع محصول نتروجين البروتين الحقيقي، و النتروجين الكازيني و النتروجين غير الكازيني و نتروجين الشرش (عند مستوى معنوية 0.05).

- إنخفضت تكلفة الغذاء لكل كجم لبن معدل الدهن (4%) للابقار المغذاة على العليقة المحتوية على مخلوط العلف المركز المعامل و غير المعامل بالمقارنة بمثيلاتها المغذاة على العليقة المحتوية على مخلوط العلف المركز المعامل و العليقة المحتوية على مخلوط العلف المركز غير المعامل مما أدى ذلك إلي حدوث تحسن في الكفاءة الإقتصادية في العليقة المحتوية على مخلوط العلف المركز المعامل و غير المعامل.

و على ضوء ما سبق ذكره من نتائج توصي هذه الدراسة باستخدام كبريتات الزنك كطريقة لحماية بروتين مخلوط العلف المركز من التكسر في الكرش في علائق الأبقار الحلابة المغذاة على دريس البرسيم كعليقة أساسية خاصة العليقة المحتوية على مخلوط من العلف المركز المعامل و غير المعامل لما له من مردود إيجابي على صفات و إنتاج اللبن و الكفاءة الأقتصادية.

قام بتحكيم البحث

أ.د / محمود يوسف العايق — **كلية الزراعة – جامعة المنصورة**

أ.د / هدى محمد الحسينى احمد — **مركز البحوث الزراعية**