Possibilities of using dairy compounds exposed to different treatments in dairy cow feeding

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ABSTRACT: This study was conducted to investigate the effects of untreated dairy compound feeds; DCF (control) and DCFs subjected to 2% fat (F); 2.5% tannic acid (TA); 2% fat + 2.5% tannic acid (F + TA) on the milk yield and composition. In the study, 4 cows of Jersey breed were used and 4 × 4 Latin square experimental design was applied. Normal milk yield, 4% fat corrected milk yield (FCM), dry matter content of milk, non-fat solids content of milk, CP content of milk, fat content of milk, lactose content of milk, crude ash content of milk, daily DM consumption of cows, feed efficiency according to normal milk yield of cows, feed efficiency according to the FCM of cows were 11.96, 12.14, 10.89 and 11.94 kg/day ($P < 0.05$); 14.16, 14.50, 13.06 and 13.70 kg/day ($P < 0.05$); 13.37, 13.34, 13.54 and 13.41% ($P > 0.05$); 8.12, 8.00, 8.35 and 8.19% ($P > 0.05$); 3.67, 3.70, 3.87 and 3.63% ($P < 0.05$); 5.25, 5.34, 5.19 and 5.22% ($P > 0.05$); 4.97, 4.812, 5.01 and 5.042% ($P > 0.05$); 0.75, 0.73, 0.74 and 0.73% ($P > 0.05$); 15.97, 15.84, 15.94 and 15.59 kg/day ($P > 0.05$); 1.34, 1.31, 1.46 and 1.31 kg feed DM/kg milk ($P > 0.05$); 1.13, 1.09, 1.22 and 1.14 kg feed DM/kg milk ($P > 0.05$), respectively. According to the results it can be stated that 2.5TA and 2F treatments had positive effects on FCM milk yield and milk protein yield.

Keywords: dairy compound feed; protected protein; tannic acid; *in situ*; milk yield; composition

High-producing dairy cows must be fed adequately to reach their genetic capacity.

In feeding of high-producing dairy cows, not only high-quality concentrates with high protein content but also high-quality forages are considered more important. Some precautions must be taken to protect these high-quality feeds from microbial degradation in the rumen because studies in recent years showed that microbial protein could not meet the protein requirements of high-producing dairy cows. This fact necessitates the protection of high-quality feeds from rumen fermentation.

There are a lot of methods that can be used to protect the proteins from rumen fermentation and to decrease their degradabilities in this way. These methods are mainly formaldehyde treatment, ionophore treatment, tannic acid treatment and fat treatment.

Erasmus *et al*. (1993) suggested that the quality of RUP affected the quality of protein passing to the small intestines.

In a study by Sengar and Mudgal (1983), untreated groundnut cake (GC), 1% formaldehyde treated GC and 10% tannic acid treated GC did not affect milk yield and milk components. Pace *et al*. (1993) also suggested that addition of tannin to high-protein feed could be a simple and effective way to protect protein against bacterial degradation in the rumen. Pan and Maitra (1992) reported that de-oiled salseed meal tannin treatment was marginally better than pure tannic acid in protecting protein from rumen degradation.

Many attempts have been made to increase milk production and milk component yields by increasing the amount of fat (Schneider *et al*., 1988; Kim *et al*., 1993; Tomlinson *et al*., 1994) in the diets of dairy cows. Kim *et al*. (1991) reported that milk production was higher in cows fed added fat, milk protein and casein tended to decrease in cows fed added fat and did not increase with higher dietary protein. Some studies showed that the intake of DM and milk production were not affected by fat

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(Erdman and Vandersal, 1983; Nianogo *et al*., 1991; Doreu *et al*., 1992). Whereas other studies showed that supplemental dietary fat depressed dry matter intake but milk production and milk protein content increased by added dietary fat.

In a preliminary study (*in situ*), ruminal dry matter (DM) degradabilities, organic matter degradabilities, crude protein (CP) degradabilities and degradation parameters belong to these degradability values (a, b, c, a + b) and pepsin soluble nitrogen contents of total 25 DCF subjected to F (1, 2, 3 and 4%), TA (2.5, 5.0, 7.5 and 10.0%) and F + TA (combination of all the levels of F and TA) were examined after 4, 8, 12 and 24 hours incubation in 3 ruminal cannulated Karayaka wethers (Saricicek, 2001).

According to the *in situ* DM, OM and CP degradability values the most resistant feed to microbial degradation is 2F + 2.5TA. The highest pepsin solubility was obtained from 2F + 2.5TA.

Out of feeds exposed to TA treatment, the most resistant to microbial degradation was 2.5TA.

When the feeds exposed to F treatment were evaluated in terms of degradation characteristics it was seen that 2F gave better results when compared with the other feeds.

This study was organised according to the results of the first trial and the effects of untreated DCF (control), DCFs subjected to 2F, 2.5TA and 2F + 2.5TA on the milk yield and composition were investigated.

MATERIAL AND METHODS

In this study, 4 cows of Jersey breed with average live weight of 350–400 kg and between 3.5 and 4.0 years of age were used on the 20th day of the second lactation to investigate lactation stage duration and milk production (average milk yield of 14.5 kg/d).

Feeds of the trial were composed of untreated dairy compound feed (DCF), treated with 2F DCF, treated with 2.5TA DCF and treated with 2F + 2.5TA DCF. Ingredient composition of feed used in the trial is given in Table 1.

Table 1. Ingredient composition of feeds used in the trial (Ensminger *et al*., 1990)

Ingredients	% in the ration
Wheat	20
Barley	25
Corn	10
SFM (sunflower meal)	20
Bran	23
Salt	1
Limestone powder	1
Calculated nutrient content	
ME (MJ/kg)	10.47
CP (%)	18

Each group weighing 300 kg, two tons of the prepared compound feeds were made up of 4 groups. One of the groups of untreated DCF was control, the others were treated with 2.5% tannic acid DCF (from 10% tannic acid solution/on DM basis), treated with 2% F DCF and treated with 2% F + 2.5% TA DCF. Experimental design was given in Table 2.

This study was arranged in 4 × 4 Latin squares to evaluate the effect of different treatments of dairy compound feeds.

Each experimental period lasted 30 days: 14 days were the adaptation period and the last 16 days constituted the data collection.

Cows were fed forage to meet their maintenance requirements and were fed concentrate feed to meet their milk production requirements.

Cows were milked twice daily and their milk weights were recorded in total in the morning and in the evening. Milk samples were collected at both milkings for 2 consecutive days every week

Table 2. Experimental design

Period/Cows	1	2	3	4
1	Untreated DCF	2.5% TA	2% F	2% F + 2.5% TA
2	2.5% TA	2% F	2% F + 2.5% TA	Untreated DCF
3	2% F	2% F + 2.5% TA	Untreated DCF	2.5% TA
4	2% F + 2.5% TA	Untreated DCF	2.5% TA	2% F

and sampled on the basis of milk yield. Dry matter (DM) and crude protein (CP) (CP:N × 6.38) and ash were determined by Weende Analyses Method (AOAC, 1984). Fat was determined by Gerber Method, milk lactose was determined by calculation (Kurt, 1984).

Fat corrected milk yield (FCM) was calculated according to the following equation:

$$4\%\ FCM = 0.4\ M + 15\ F$$

where: M = milk yield in kg
F = milk fat yield in kg

The contents of DM, Ash, CP of dairy compound feed were determined by Weende Analyses method, crude fibre (CF) was determined by Lepper method (Akyildiz, 1984). Chemical composition of feed used in the trial is given in Table 3.

Dry matter and organic matter digestibilities and energy values of feeds used in the trial are given in Table 4.

Data obtained in the milk production trial were analysed in a 4 × 4 Latin square. Comparison of treatment means for feed conversion was done by Duncan's multiple comparison test (MSTAT computer program) (Duzgunes *et al*., 1987).

Table 3. Chemical composition of feeds used in the trial (%)

Feeds	DM	OM	CP	EE	CF	Ash	NFE	UDP
Untreated DCF	91.01	83.68	18.73	2.69	10.60	7.34	51.66	
	100.00	91.94	20.58	2.95	11.65	8.06	56.76	48.70
2% F	91.31	85.01	17.73	4.10	9.44	6.30	53.74	
	100.00	93.10	19.41	4.49	10.34	6.90	58.86	50.20
2.5% TA	89.42	83.84	18.15	2.43	8.93	5.57	54.33	
	100.00	93.77	20.30	2.72	9.99	6.23	60.76	54.40
2% F + 2.5% TA	89.27	82.82	17.03	4.36	9.08	6.45	52.35	
	100.00	92.78	19.08	4.88	10.17	7.22	58.65	55.95
Hay grass	91.97	85.22	6.91	1.41	35.19	6.76	41.71	
	100.00	92.66	7.51	1.53	38.27	7.35	45.35	45.45
Corn silage	26.41	24.23	2.38	0.92	8.733	2.18	12.19	
	100.00	91.74	9.01	3.50	33.07	8.26	46.17	41.97

DCF = dairy compound feed, F = fat, TA = tannic acid, EE = ether extract, NFE = nitrogen free extract, UDP = undegradable protein

Table 4. Dry matter digestibility, organic matter digestibility, ME and NEL values of feeds used in the trial

Feeds	DMD (%)	OMD (%)	ME (MJ/kg DM)	NEL (MJ/kg DM)
Untreated DCF	70.87	69.81	10.45	6.27
2% F	67.13	65.76	10.13	6.00
2.5% TA	69.80	68.92	10.47	6.26
2% F + 2.5% TA	66.23	64.99	10.01	5.92
Grass hay	46.37	47.27	7.00	3.88
Corn silage	52.39	53.70	8.04	4.57

DMD = dry matter digestibility, OMD = organic matter digestibility, ME = metabolisable energy, NEL = net energy lactation

RESULTS AND DISCUSSION

Data obtained in this study investigating the effects of untreated DCF and DCF's subjected to 2F, 2.5TA and 2F + 2.5TA DCF on the milk yield and composition is shown in Table 5.

As seen in Table 5, significant differences were found between the treatments for milk production and corrected 4% fat milk yield. The highest milk yield and corrected 4% fat milk yield were obtained for the treatment with 2F DCF (12.14 kg/d and 14.50 kg/d). The lowest milk yield and 4% FCM were obtained for the treatment with 2.5TA DCF, medium-high values were found for untreated DCF and treated with 2F + 2.5TA DCF. While the difference between milk yields treated with 2F DCF and untreated DCF and treated with 2F + 2.5TA DCF was found insignificant ($P > 0.05$), these feeds were different from treated with 2.5TA DCF ($P < 0.05$). The differences between untreated DCF, treated with 2F + 2.5TA and 2.5TA DCF of corrected 4% fat milk yield were not significant either. The treatments of DCF had no effect on FCM. While some researchers reported that the RUP (rumen undegradable protein) percentage in the ration of dairy cows increased FCM, other researchers reported that increasing RUP and by-pass protein content in the ration increased milk production. Feeds treated with fat were numerically higher in FCM, but there were no significant differences between untreated DCF and treated with fat DCF ($P > 0.05$). It can be said that added energy by fat, the numerical increase achieved by the treated fat of DCF, thus there are some studies that report that milk production was increased by adding fat into the dairy ration.

When DM and non-fat solids of milk were investigated in the trial, it was seen that DM and non-fat solids were highest for the treatment with 2.5TA DCF, followed by the treatment with 2F + 2.5TA DCF. But there were not found any significant differences between the treatments ($P > 0.05$). While Nianogo *et al.* (1991) reported that OM of the non-fat solids of milk content was not affected by degradable decrease in the CP of the ratio, Maiga and Schingoethe (1997) stated that additional fat plus by-pass protein and melas plus by-pass protein decreased the non-fat solids in the milk.

The treatment of DCF with TA significantly increased the CP content of milk ($P < 0.05$) because the highest CP content was found for the treatment with 2.5TA (3.87%), followed by the treatment with 2F (3.70%) and untreated DCF (3.67%) and treatment with 2F + 2.5TA (3.63%), respectively. While the differences between untreated DCF, treated with 2F and 2F + 2.5TA were not found significant ($P > 0.05$) in terms of CP yield, there were significant differences between these feeds and those treated with 2.5TA DCF ($P < 0.05$). These results support the results of Aharoni *et al*. (1993), Nelson and Yu (1993), Grummer *et al*. (1994) that the level of RUP increases CP content in the ratio of dairy cows. However Sengar and Mudgal (1983),

Table 5. The milk yield and composition and feed intake, feed conversion

Characteristics	Untreated DCF	2F	2.5TA	2F + 2.5TA
Normal milk yield (kg/day)	11.96^{a}	12.14^{a}	10.89^{b}	11.94^{a}
FCM (kg/day)	14.16^{ab}	14.50^{a}	13.06^{b}	13.70^{ab}
DM (%)	13.37	13.34	13.54	13.41
Non-fat solids content (%)	8.12	8.00	8.35	8.19
CP (%)	3.67^{b}	3.70^{b}	3.87^{a}	3.63^{b}
Fat (%)	5.25	5.34	5.19	5.22
Lactose (%)	4.97	4.81	5.01	5.04
Ash (%)	0.75	0.73	0.74	0.73
DM intake (kg/d)	15.97	15.84	15.94	15.59
FC, kg feed DM/kg milk	1.336	1.305	1.464	1.305
FC, kg feed DM/kg FCM	1.128	1.093	1.221	1.138

FC = feed conversion

^{a,b,c} means in the same row with different superscripts differ ($P < 0.01$)

Nianogo *et al*. (1991), Aharoni *et al*. (1993) reported that the CP content of milk was not affected by treatments.

The highest values for fat production of milk were obtained for the treatment with 2F DCF, followed by untreated DCF (5.25%), treated with 2F + 2.5TA (5.22%) and treated with 2.5TA (5.19%), respectively. But the effects on fat production of treatments were found insignificant ($P > 0.05$). These results are in accordance with those reported by Erdman and Vandersall (1983), Nianogo *et al*. (1991), Sengar and Mudgal (1983).

The highest lactose contents of milk were obtained by the treatment with 2F + 2.5TA DCF (5.04%), followed by treated with 2.5TA (5.01%) DCF, untreated DCF (5.25%), and treated with 2F + 2.5TA (5.22%) DCF. But there were no significant differences between the treatments for lactose content ($P > 0.05$). Nianogo *et al*. (1991) reported that lactose content of milk decreased from 4.9% to 4.7% against the control in cows fed diets containing high soluble proteins, and increased from 4.9% to 5.0% against the control in cows fed diets containing less soluble proteins and however, lactose content of milk was not affected by fat addition. Robinson *et al*. (1991) with Maiga and Schingoethe (1997) reported that lactose content of milk was not affected by CP degradabilities of the ration or by by-pass protein content of the ration.

Ash content of milk was not affected by treatments ($P > 0.05$).

Daily total DM intakes of cows were not affected by treatments of DCF. Daily DM consumption was found to amount to 15.97 kg/d in cows fed untreated DCF, 15.84 kg/d in cows fed DCF treated with 2F, 15.94 kg/d for treated with 2.5TA DCF and 15.59 kg/d for treated with 2F + 2.5TA DCF. These results are accordance with those reported by Kim *et al*. (1991), Nianogo *et al.* (1991) and Grummer *et al*. (1994), who stated that DM consumption was not affected by treatments. Rodrigues *et al*. (1997) reported that DM intake decreased 6.2% by the addition of fat. However, Karunandaa *et al*. (1994) concluded that DM intake increased from 17.0 kg to 17.7 kg by the addition of fat and decreased from 17.0 kg to 15.9 kg by the addition of fat + produced amino acid.

Feed conversion according to normal milk yield was obtained as 1.34 for untreated DCF, 1.31 for treated with 2F DCF, 1.46 for treated with 2.5TA DCF and 1.31 for treated with 2F + 2.5TA DCF, respectively. No statistically differences were found between these values. Feed conversion according to corrected fat milk were found to be 1.13 for untreated DCF, 1.09 for treated with 2F DCF, 1.22 for treated with 2.5TA DCF and 1.14 for treated with 2F + 2.5TA DCF. The treatments of dairy compound feed did not affect feed conversion ($P > 0.05$).

In this study fat, tannic acid and fat + tannic acid treatments of dairy compound feeds were applied. 22.5TA treatments had a positive effect on FCM milk yield and 2F treatment also had a positive effect on milk protein yield.

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ABSTRAKT

Možnosti využití složených krmiv pro dojnice po různé úpravě

V této studii byl sledován vliv složených krmiv pro dojnice na produkci a složení mléka: (DCF) bez žádného přídavku (kontrola), DCF s přídavkem 2 % tuku (F), 2,5 % taninu (TA) a 2 % tuku + 2,5 % taninu (F + TA). Do pokusů byly zařazeny čtyři dojnice plemene jersey, pokusy byl uspořádány jako 4 × 4 latinské čtverce. Byly získány tyto hodnoty produkce normálního mléka, mléka upraveného na 4% tučnost (FCM), obsahu sušiny v mléce, obsahu beztukové sušiny v mléce, obsahu hrubého proteinu v mléce, tučnosti mléka, obsahu laktózy v mléce, obsahu hrubých popelovin v mléce, denní spotřeby sušiny dojnicemi, účinnosti krmiva podle produkce normálního mléka a účinnosti krmiva podle FCM: 11.96, 12.14, 10.89 a 11.94 kg/den ($P < 0.05$); 14.16, 14.50, 13.06 a 13.70 kg/den ($P < 0.05$); 13.37, 13.34, 13.54 a 13.41 % ($P > 0.05$); 8.12, 8.00, 8.35 a 8.19 % ($P > 0.05$); 3.67, 3.70, 3.87 a 3.63 % ($P < 0.05$); 5.25, 5.34, 5.19 a 5.22 % ($P > 0.05$); 4.97, 4.812, 5.01 a 5.042 % ($P > 0.05$); 0.75, 0.73, 0.74 a 0.73 % ($P > 0.05$); 15.97, 15.84, 15.94 a 15.59 kg/den ($P > 0.05$); 1.34, 1.31, 1.46 a 1.31 kg sušiny krmiva/kg mléka ($P > 0.05$); 1.13, 1.09, 1.22 a 1.14 kg sušiny krmiva/kg mléka ($P > 0.05$). Na základě výsledků lze konstatovat, že varianty 2,5 TA a 2 F pozitivně ovlivnily produkci mléka FCM a obsah bílkovin.

Klíčová slova: složené krmivo pro dojnice; bílkoviny; tanin; in situ; produkce mléka; složení mléka

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