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Effect of Feeding Formaldehyde Treated Rapeseed and Cottonseed Cakes on Milk Yield and Composition at Various Stages of Lactation and Parity in Jersey Cows

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ABSTRACT

The aim of this study was to document the response of lactating Jersey cows to feeding of formaldehyde treated oil cakes of rapeseed and cottonseed on milk yield and composition at various stages of lactation and parity. Formaldehyde treatment of oil cakes was performed at 1% of crude protein, and these treated cakes were used in preparing treatment concentrate mixture. The experiment was carried out for 40 days using 27 lactating Jersey cows differing in parity 1-3, 4-6 and ≥7 with different stages of lactation i.e. early (1-3 m), mid (4-6 m) and late (7-9 m) in each lactation groups. The animals were grouped into Control and Treatment. For first 10 days, cows of Control group were offered with a control concentrate and thereafter same animals were grouped as Treatment group and fed the same concentrate having both the protein meals treated with formaldehyde, along with *ad libitum* access to barley green fodder and wheat straw. The milk yield and its component yield were decreased linearly as lactation advanced and the differences were significant ($P<0.05$) between early and late lactation. The highest increment ($P<0.05$) in milk yield was noted in early lactation (0.69 kg/d) and least during late lactation (0.56 kg/d). Milk SNF yield was improved ($P<0.05$) up to the tune of 40 g/d in mid lactation cows only. With respect to parity, the highest ($P<0.05$) milk yield was observed in 1^{st}-3^{rd} parity and lowest after 7^{th} parity, while milk fat% followed the reverse trend upon feeding formaldehyde treated oil cakes, while other parameters like fat and SNF percentage did not differ due to treatment. Furthermore, milk fat yield was increased ($P<0.05$) to the extent of 50 g/d and 20 g/d in 1^{st}-3^{rd} and above 7^{th} parity cows, respectively. It was concluded that feeding of concentrate mixture containing formaldehyde treated oil cakes (rapeseed and cottonseed) economically improved yield of milk and milk components. Furthermore, the treatment effect was more pronounced during early lactation and in lower (1-3) parity Jersey cows.

Keywords*:* Bypass protein, Fat, Lactation, Milk, SNF.

Shortage of feeds and forages for livestock leads to imbalanced nutrition that cannot support high milk production in cows. Added to this, majority of animals in the tropics subsist on agricultural by-products and crop residues like cereal straw and stovers, which have poor nutritive value and therefore, inadequate to meet the nutrient requirements of lactating animals (Mahesh and Mohini, 2013). In ruminants, protein requirement is of two folds; to support the anaerobic ecosystem in the rumen and to meet the animal needs. Highly degradable protein of oil cakes when ingested by ruminants, results in excess release of ammonia due to microbial proteolysis, much of them are wasted as urea and excreted in urine without being incorporated to form microbial protein (Thirumalesh and Krishnamoorthy, 2013). Moreover, for high yielding cows, microbial protein may not fulfill the complete protein requirement. Therefore, rumen undegradable protein (RUP) sources needs to be incorporated to meet demand of amino acids for milk synthesis (Walli, 2011). More specifically, a recent meta-analysis by Suresh *et al.* (2011) revealed that RUP of 571 g/d is necessary for production of 10 kg of 4% fat corrected milk in Indian cows.

Several methods (including heat, formaldehyde and tannins treatment) are applying to protect the protein from ruminal proteolysis to make RUP (Shelke *et al.,* 2012; Medhi *et al.,* 2014). Formaldehyde treatment has been found to be efficient and cheaper method to protect the oil cakes (Walli, 2011; Shelke *et al.,* 2012) and the resultant bypass protein feeding showed significant positive responses in terms of milk production and composition in dairy animals (Walli, 2011; Marghazani *et al.,* 2012; Aboozar and Niazi, 2013). However, utilization of protected protein to improve production performance considering the effect of parity and lactation stages has not been reported under field condition. Among oil cakes, rapeseed and cottonseed cakes are commonly used for feeding of dairy animals in India. Though cottonseed cake has a relatively moderate RUP, the same in rapeseed meal is low (Das *et al.,* 2014). Therefore, an attempt was made to study the effect of formaldehyde treated rapeseed and cottonseed cakes on milk production and composition in Jersey cows at different parity and stages of lactation.

MATERIALS AND METHODS

Formaldehyde treatment of oil cakes

Treatments of oil cakes with commercial grade formaldehyde (40%) solution @ 1% of protein content of oil cakes were carried out under field condition. The required quantities of formaldehyde were diluted (10 times) with water and were sprayed over the crushed oil cakes. Treatment of 10 kg of rapeseed cake containing 3600 g of protein needed 36 g of 100% of formaldehyde. Since formaldehyde is available in 40% solution, the quantity required was 90 g, which was diluted with 900 ml of water and was sprayed over 10 kg of cake and then kept in tightly sealed polythene bags for three days (Shelke *et al.,* 2012). The same procedure was applied for the treatment of cottonseed cake. Treated cakes were incorporated in the concentrate mixture of treatment group.

Selection of animals and their feeding

The study was conducted at the rural area of Bassi, Jaipur district of Rajasthan, India. Twenty seven healthy, previously dewormed lactating Jersey cows in their different parity groups viz. 1^{st}-3^{rd} parity, 4^{th}-6^{th} parity and ≥7th parity at different stages of lactation i.e. early (1-3 months), mid (4-6 months) and late (7-9 months) in each parity groups (Table 1) were used for this study. The duration of the trial was 40 days.

Table 1: Number of animals under each category.

Parity	Early lactation	Mid lactation	Late lactation	Total
1 – 3	3	3	3	9
4 – 6	3	3	3	9
>7	3	3	3	9
Total	9	9	9	27

Table 2: Ingredient composition of concentrate mixture.

Ingredient	Proportion
Bajra (pearl millet)	23.0
Maize	11.0
Wheat bran	20.0
Rapeseed meal	21.0#
Cotton seed	12.0#
Molasses	10.0
Mineral mixture	2.0*
Salt	1.0

Formaldehyde treated in case of group T, * % Composition: Ca 20, P 12, Zn 0.8, Cu 0.1, I 0.026, Co 0.0012 and Mn 0.12

Experimental animals were offered with known quantity of concentrate mixture (50% of milk yield), *adlib* un-chopped green barley (*Hordeum vulgare*), wheat straw and fresh clean drinking water throughout the study period. Initially all animals were fed untreated concentrate mixture for first 10 days and termed as control (C) and thereafter, same animals were fed rapeseed/cottonseed treated with formaldehyde and considered as treatment (T) for the remaining period (30 days). Dry matter intake (DMI) of individual cows were recorded by estimating DM content of forages and concentrates offered during the study period. The composition of the concentrate mixture, green fodder and wheat straw offered is furnished in Table 2 and 3.

Table 3: Chemical composition of feeds (% DM basis).

Chemical composition	Concentrate mixture	Green barley	Wheat straw
Organic matter	89.95	90.48	87.89
Crude protein	17.12	11.24	3.70
Ether extract	3.51	2.69	0.82
Ash	10.05	9.52	12.11
Neutral detergent fibre	32.54	53.77	74.89
Acid detergent fibre	12.09	29.15	52.33
Hemicellulose	20.45	24.62	22.56
Total carbohydrates*	69.32	76.55	83.37
Non-fibrous carbohydrates**	36.78	22.78	8.48

Calculation: *100-(CP+EE+Ash), **Total carbohydrates-Neutral detergent fibre, as exemplified by Sharma *et al.* (2014).

Analysis of milk

The milk fat and SNF content was analysed using pre-calibrated electronic milk analyzer (Milko Tester) in co-operative milk collection centre. Representative samples (1/100) of milk for the estimation of fat and SNF were collected from each animal twice (morning and evening) from the control group i.e. first 10 days and later on for treatment group.

Statistical analysis

Data were tabulated as mean ± standard error for all parameters and analysed by the analysis of variance (ANOVA) using Sigmastat for Windows version 3.10 (Systat Software Inc. USA). Statistical significance was declared at P<0.05.

RESULTS

Lactation wise effects

The DMI was similar before and after the treatment, and was decreased (P<0.05) during mid and late lactation than early lactation. The milk yield and its component yield were decreased linearly as lactation advanced and the differences were significant (P<0.05) between early andlate lactation (Table 4). The highest increment (P<0.05) in milk yield was noted in early lactation (0.69 kg/d) and least during late lactation (0.56 kg/d). Further, milk fat and SNF percent and fat yield did not show any incremental response to the treatments among different stages of lactation. Nonetheless, milk SNF yield was improved (P<0.05) up to the tune of 40 g/d in mid lactation cows only.

Table 4. Lactation stage-wise dry matter intake, milk yield and composition in the experimental cows.

Parameter	Feeding condition	Early lactation	Mid lactation	Late lactation
DM intake (kg)	Before treatment	15.82±0.7^{a}	16.85±1.0^{ab}	15.0±0.5^{ac}
	After treatment	15.9±0.8^{a}	16.98±0.6^{ab}	15.55±0.9^{ac}
	Difference	0.08± 0.01^{a}	0.13±0.03^{ab}	0.55±0.07^{c}
Milk yield (kg)	Before treatment	22.9±0.09^{aA}	22.28±1.13^{a}	14.61±0.72^{b}
	After treatment	23.59±1.14^{aB}	22.91±1.14^{a}	15.17±0.61^{b}
	Difference	0.69±0.05^{a}	0.62±0.05^{ab}	0.56±0.07^{b}
Milk fat (%)	Before treatment	3.63±0.08^{a}	3.6±0.16^{a}	4.35±0.09^{b}
	After treatment	3.64±0.07^{a}	3.61.±0.16^{ab}	4.2±0.08^{c}
	Difference	0.01±0.09	0.01±0.03	-0.15±0.03
Milk SNF (%)	Before treatment	8.53±0.04^{a}	8.58±0.05^{a}	8.65±0.08^{ab}
	After treatment	8.53±0.05^{a}	8.53±0.029^{ab}	8.6±0.06^{c}
	Difference	0±0.05	-0.05±0.04	-0.05±0.02
Milk fat yield (kg)	Before treatment	0.83±0.02^{a}	0.79±0.01^{b}	0.63±0.02^{c}
	After treatment	0.85±0.03^{a}	0.81±0.02^{b}	0.63±0.024^{c}
	Difference	0.03±0.02	0.03±0.01	0.02±0.007
Milk SNF yield (kg)	Before treatment	1.95±0.08^{a}	1.72±0.1^{abA}	1.26±0.06^{c}
	After treatment	2.0±0.09^{a}	1.96±0.1^{abB}	1.30±0.06^{c}
	Difference	0.05±0.01	0.04±0.01	0.039±0.007

Mean ± SE in a row bearing common superscript (lower case) and in a column bearing common superscript (upper case) do not differ significantly (P<0.05).

Parity wise effects

A modest increase (P<0.05) in DMI was recorded for cows belonging to 4th-6th parity. Milk yield was highest (P<0.05) in 1st-3rd parity and lowest after 7th parity, while milk fat% followed the reverse trend upon feeding formaldehyde

Table 5: Parity wise dry matter intake, milk yield and composition of Jersey cows with and without feeding formaldehyde treated oil cakes.

Parameter	Feeding condition	1st-3rd parity	4th-6th parity	>7th parity
DM intake (kg)	Before treatment	15.65±0.7[a]	16.12±1.0[ab]	14.86±0.5[ac]
	After treatment	15.64±0.8[a]	16.35±0.6[ab]	14.82±0.9[ac]
	Difference	-0.01±0.05[a]	0.23±0.07[c]	-0.04±0.05[ab]
Milk yield (kg)	Before treatment	22.26±1.62[a]	20.79±1.14[ab]	16.75±1.16[c]
	After treatment	22.92±1.6[ab]	21.32±1.46[a]	17.29±1.12[c]
	Difference	0.71±0.7[a]	0.53±0.09[bc]	0.53±0.08[c]
Milk fat (%)	Before treatment	3.61±0.17[a]	3.87±0.17[ab]	4.11±0.13[b]
	After treatment	3.69±0.14[a]	3.7±0.15[ab]	4.07±0.11[b]
	Difference	0.08±0.06	-0.017±0.07	-0.04±0.04
Milk SNF (%)	Before treatment	8.5±0.12a	8.64±0.07c	8.53±0.04ab
	After treatment	8.5±0.1a	8.66±0.07c	8.53±0.02ab
	Difference	-0.02±0.05	-0.09±0.05	0±0.02
Milk fat yield (kg)	Before treatment	0.78±0.03aA	0.79±0.03aA	0.68±0.03bA
	After treatment	0.83±0.04aB	0.77±0.03bB	0.70±0.004cB
	Difference	0.05±0.02a	-0.01±0.01b	0.02±0.001bc
Milk SNF yield (kg)	Before treatment	1.89±0.14a	1.81±0.12ab	1.43±0.10c
	After treatment	1.89±0.14a	1.84±0.12ab	1.48±1.1c
	Difference	0.00±0.00	0.03±0.01	0.05±0.01

treated oil cakes (Table 5). While other parameters like milk fat and SNF per cent did not vary due to treatment. Furthermore, milk fat yield was increased (P<0.05) to the extent of 50 g/d and 20 g/d in 1-3rd and above 7th parity cows, respectively. Moreover, SNF yield was not significantly affected by feeding of rumen protected protein.

Cost-benefit ratio

Cost of formaldehyde treatment for 1 kg rapeseed and cottonseed oil cake was ₹. 0.14/- Benefits of 0.69 liter more milk after formaldehyde treatment was ₹. 15.16/- So cost-benefit ratio was 1:108.

DISCUSSION

Metabolisable protein needs of high yielding cows in early lactation can't be met solely by microbial protein sythesised by rumen degradable protein in presence of energy, and excess ruminal degradation produces surplus ammonia which can't be fixed into microbial cells. Therefore, rumen protected proteins as well as amino acids are incorporated in such animals, which supplies absorbable amino acids post-ruminally (Amrutkar *et al.,* 2014) and decreases nitrogen losses to environment (Walli *et al.,* 2011).

Feeding of rumen-protected protein meals did not influence DMI in the present study. This could be due to similar energy and protein levels in both the diets, which complies with the previous reports (Sirohi *et al.,* 2011; Shelke *et al.,* 2012). Milk yield was increased in early lactating Jersey cows in our study. Our results are in line with Sherasia *et al.* (2010), who observed significantly (P<0.05) higher milk yield from 9.85 to 10.72 kg/d when one kg of formaldehyde treated rapeseed meal was fed to crossbred cows. This was ascribed to the higher methionine (1.93% of CP) and other essential amino acid supply through rapeseed meal. Shelke *et al.* (2012) also noted significantly (P<0.01) higher milk yield up to 19% in early lactating Murrah buffaloes fed with mixture of formaldehyde treated mustard and groundnut cakes. Though, milk fat can be altered over a range of 3% units

(Lee *et al.,* 2014), we did not observe any changes due to feeding of bypass proteins. Recently, many researchers reported that there was no change in milk fat percentage upon feeding of increasing levels of protected proteins in the diet of dairy cows (Sirohi *et al.,* 2011; Marghazani *et al*., 2012; Aboozar and Niazi, 2013), which corroborates with our findings. Reduction in the milk yield and components towards advanced lactation stage followed normal physiological process where milk yield declines towards the late lactation in dairy cows (Bauman *et al.,* 2011).

Response of rumen protected proteins and amino acids were more evident in Jersey cows of 1-3 parity. Many researchers demonstrated positive effects on milk yield and fat yield in this parity range in case of Holstein cows (Aboozar and Niazi, 2013), crossbred Karan-Fries cows (Amrutkar *et al.,* 2014), Murrah buffaloes (Shelke *et al.,* 2012) and Mehsana buffaloes (Safimahmad *et al.,* 2013). As lactation advanced, milk yield was reduced, as has been previously reported by Gurmessa and Melaku (2012) in crossbred Holstein cows.

The technology of formaldehyde treatment of protein meals was found to be economical in our study due to premium of higher milk production. Similarly, Safimahmad *et al.* (2013) documented a lower cost of milk production (₹ 7.95) upon feeding of rumen protected *guar* (*Cyamopsis tetragonoloba*) meal to lactating Mehsana buffaloes than control (₹ 9.26).

CONCLUSION

It was concluded that feeding of concentrate mixture containing formaldehyde treated oil cakes of rapeseed and cottonseeds economically improved yield of milk and its components. Furthermore, the treatment effects were more pronounced during early lactation and in lower (1-3) parity Jersey cows.

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