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EFFECT OF ENERGY SUPPLEMENTATION USING MAIZE AND SOY LECITHIN DURING LATE GESTATION ON DIGESTIBILITY OF NUTRIENTS AND BIRTH WEIGHT OF CALVES

Athira Rajan[1], S. K. George[2*], K. Ally[3], Sajith Purushothaman[4], V. L. Gleeja[5], and V. Babitha[6]

[1.] M.V.Sc Scholar, [2*] Associate Professor, [3] Professor and Head, [4.] Assistant Professor
[5] Associate Professor and Head, [6.] Associate Professor,
[1,2,3,4] Department of Animal Nutrition, College of Veterinary and Animal Sciences, Mannuthy, Thrissur- 680 651,
[5]Department of Statistics, College of Veterinary and Animal Sciences, Mannuthy, Thrissur,
[6]Cattle Breeding Farm, Thumburmuzhy, Thrissur,
Kerala Veterinary and Animal Sciences University, Kerala, India
Corresponding author, Email id: sherin@kvasu.ac.in

ABSTRACT

To assess the effect of supplementation of maize and soy lecithin on digestibility of nutrients and birth weight of calves, a feeding experiment was carried out in cross bred cows during late gestation from the eighth month of pregnancy till the date of calving. Fifteen crossbred cattle at eighth month of pregnancy were selected from cattle breeding farm, Thumboormuzhy and were allotted to three dietary treatments (T1, T2 and T3). Selected animals were offered a diet consisting of concentrate mixture (CP- 20 per cent and TDN – 68 per cent) and green grass (ICAR, 2013). Along with this diet, T2 was supplemented with maize (500g/animal/day) and T3 was supplemented with soy lecithin (210g/animal/day), maintaining the diets T2 and T3 isocaloric. A digestibility trial for a period of five days was carried out three weeks after initiation of experiment by total collection method. Digestibility of dry matter, crude protein, crude fiber, ether extract and fiber fractions were similar among the groups however, the digestibility of nitrogen free extract was higher ($P<0.05$) in energy supplemented groups (T2 and T3). Birth weight of calves born to animals supplemented with maize (T2) was higher compared to calves born in other treatment groups (T1 and T3). The study revealed that supplementation of energy in the form of ground maize or soy lecithin to cross bred dairy cows from eighth month of pregnancy significantly improved the digestibility of non-structural carbohydrates in the diet and maize supplementation of the dam during late gestation could improve the birth weight of calves.

Key words: Soy lecithin, maize, digestibility, calf birth weight

1. Introduction

It is crucial for dairy cows to receive energy adequate ration during the later stages of pregnancy since, nutritional adequacy of the diet and the metabolic status of the dam can affect the calf health (Mee *et al*., 2023). Approximately 75% of foetal growth occurs in the final trimester of pregnancy, and as pregnancy progresses, the capacity of the rumen decreases due to the growth of the foetus and placental unit lowering the feed intake capacity. This reduction in feed intake during late gestation has to considered in the feeding of dairy cows to meet the energy requirement, both for the growing foetus and for the initiation of lactation. Moreover, increasing the energy concentration in the diet of dam during the last trimester of gestation helps to build up sufficient body reserves, which, in turn, can address the negative energy balance that occurs in high yielders during early lactation.

Dairy cow diets typically rely on significant quantities of fat and carbohydrate rich feed ingredients to provide the primary sources of energy. Cereal grains like maize are the primary energy source in these diets, with major part of digestible energy coming from starch (Ali *et al*., 2012). Furthermore, soy lecithin can serve as a dietary fat source in dairy cows (Pena *et al*., 2014). Soy lecithin is preferred due to its high fat content (99.9 per cent) and significant gross energy content (7780 kcal/kg), which is derived from a mixture of various phospholipids such as phosphatidylcholine, phosphatidylethanolamine, and phosphatidylinositol. The metabolic changes in dairy animals fed energy supplemented diets depends on the form of energy, which is offered, which indirectly influences the foetal growth. Therefore, present study was conducted to assess the effect of supplementation of maize and soy lecithin as energy supplements to crossbred cows during late gestation on nutrient digestibility and birth weight of calves.

2. Materials and methods

Fifteen crossbred cattle at eighth month of pregnancy were selected from cattle breeding farm, Thumboormuzhy. The animals were allotted to three dietary treatments (T1, T2 and T3) and were offered with concentrate mixture (CP- 20 per cent and TDN- 68 per cent) and green grass throughout the study period. The experimental animals were fed as per ICAR standards (ICAR, 2013). Along with this diet, T2 was supplemented with maize (500g/animal/day) and T3 was supplemented with soy lecithin (210g/ animal/day), maintaining the diets T2 and

T3 isocaloric. Ingredient compositions of experimental ration and green grass fed to the three experimental groups are given in Table 1. Clean drinking water was made available *ad libitum* to all animals and were maintained under identical conditions of feeding and management throughout the experimental period.

A digestibility trial for a period of five days was carried out three weeks after initiation of experiment by total collection method. Total dung voided was collected every day for each cattle, uncontaminated with dirt and urine. Collected dung was weighed separately and representative sample (10 per cent) was collected and stored in double lined polythene bags in deep freezer at -20º C for further analysis. At the end of the trial, samples of dung collected for the five consecutive days from each animal were pooled and representative samples were taken after through mixing for chemical analysis. Moisture and crude protein were determined using the fresh samples. Balance samples were dried and ground for rest of the analysis as per standard procedure (AOAC, 2016). Samples of balance feed and grass were collected from individual animals, and their moisture content was assessed on a daily basis. Feed, fodder, and dung samples were analysed for proximate principles (AOAC, 2016). Birth weight of calves born to experimental animals were recorded. Data obtained on the various parameters were analysed statistically as per Snedecor and Cochran (1994) by analysis of variance (ANOVA) technique.

3. Results and discussion

The per cent chemical composition of rations fed to experimental animals are shown in Table 2.

3.1 Nutrient digestibility

The effectiveness of the use of feed nutrients by ruminants is not only attributed to the feed quality but also determined by the various processes that occurs in the digestive tract of animals (Sycheva *et al.*, 2021). The DM digestibility per cent of experimental rations fed to dairy cows in treatments T1, T2 and T3 were 61.49±0.93, 64.09±1.24 and 63.88±0.46 respectively. Statistical analysis of the data revealed that there was no significant difference in digestibility of DM between treatment groups. Similarly, Dann *et al*. (1999), observed that replacing cracked corn with steam-flaked corn in the prepartum diet of dairy cows had no effect ($P>0.05$) on, apparent digestibility of OM and DM even though, the fermentability of the non-fibre carbohydrate was increased ($P<0.05$). In contrast to this, Souza and Lock (2019) found that cows supplemented with c 16 fatty acids (1.5 % of DM) exhibited a notable

increase (P<0.05) in DM digestibility, reaching 66.5 percent, when compared to cows fed a control diet, which achieved a digestibility of 63.9 percent during early lactation.

The average CP digestibility per cent of experimental rations T1, T2 and T3 were 58.46±1.38, 57.48±1.54 and 59.08±0.65 respectively and the values were similar (P>0.05). Pantoja *et al.* (1996) evaluated the effect of supplementation of tallow (5 per cent) in six crossbred dairy cows in a 6 X 6 Latin square design and observed no significant difference in the CP digestibility. Contrary to this, Wilson (2001) evaluated the effect of feeding maize at two levels (0.5 and 1 kg/d) in crossbred heifers and observed higher CP digestibility in the groups supplemented with maize compared to control group. Augustine (2008) also reported similar CP digestibility in crossbred cattle fed with maize (1kg/day) and fat (100g/day) as energy source during early lactation.

High-fat diets can negatively affect the population of rumen microbes, which

Table1. Ingredient composition of experimental concentrate mixture

Ingredient	Percentage composition
Maize	12
Corn gluten fibre	15
Coconut cake	15
Alfalfa residue pellet	11
Rice polish	9
Tapioca starch waste	4
Black gram husk	14
Deoiled rice bran	17
Calcite	1.5
Salt	1
Mineral mixture	0.5
Total	100

Table 2. Chemical composition[1] of concentrate mixture and green grass fed to experimental animals

Parameter	Concentrate	Green grass
Dry matter (DM)	90.81±0.18	17.98±0.16
Crude protein (CP)	20.64±0.30	10.21±0.18
Ether extract (EE)	3.04±0.10	2.01±0.11
Crude fiber (CF)	8.07±0.19	30.63±0.44
Total ash (TA)	9.87±0.20	9.98±0.31
Nitrogen free extract (NFE)	58.32±0.37	47.60±0.50
Acid insoluble ash	1.69±0.03	1.33±0.04
Calcium	0.87±0.02	0.56±0.03
Phosphorus	0.52±0.04	0.25±0.02
Neutral detergent fiber (NDF)	30.31±0.52	62.15±0.50
Acid detergent fiber (ADF)	15.14±0.35	41.07±0.20

[1]Values expressed on DM basis, average of six values

are essential for breaking down complex carbohydrates in forages. A decrease in microbial diversity and activity can lead to impaired fibre digestion (Beauchemin *et al*., 2007). Whereas, such adverse effects were not noticed with soy lecithin supplementation which may be due to the presence of phospholipids. Phospholipids can affect the structure and fluidity of cell membranes in rumen microbes, potentially influencing their activity and overall microbial ecology which can further enhance the fibre digestibility (Hwang *et al*., 2008). The CF digestibility per cent of experimental rations T1, T2 and T3 were 62.33±0.75, 58.35±1.72 and 58.55±1.74 respectively. Statistical analysis of the data revealed that there was no significant difference between treatment groups in the digestibility of fibre. Augustine (2008) also observed similar levels of CF digestibility among groups in crossbred cattle that were supplemented with maize (1 kg/day) and protected fat (100 g/day) as energy source during the early lactation period. Dominic (2013) evaluated the effect of ground maize supplementation during early lactation in crossbred cows and observed no significant difference in CF digestibility and values were in between 52 and 55 per cent.

The ether extract (EE) digestibility per cent of experimental rations T1, T2 and T3 were 72.5±0.59, 75.45±2.11 and 70.82±0.87 respectively. Statistical analysis of the data revealed that there was no significant difference between treatment groups. Wilson (2001) conducted study by feeding ground maize at 0.5 or 1 kg per day in eighteen crossbred heifers and observed that EE digestibility remained unaffected by extra energy supplementation. Similarly, Augustine (2008) reported that there were no notable distinctions in the digestibility of EE among lactating cows that received energy supplementation in the form of one kg/day of ground maize or 100g/day of protected fat. Contrary to this, Elliot *et al*. (1995) supplemented tallow at 2.5 and 5 per cent level in lactating dairy cattle and observed increased EE digestibility compared to control and Tyagi *et al*. (2009) got similar result on supplementation of bypass fat at 2.5 per cent.

The NDF digestibility coefficient of experimental rations T1, T2 and T3 were 53.55±0.81, 55.61±1.85 and 56.22±0.7 and ADF digestibility coefficient were 46.7±1 .19, 48.67±1.85 and 48.69±0.46, respectively. Statistical analysis of the data showed that there was no significant difference between treatment groups on digestibility of fibre fractions. Wilson (2001) examined the impact of feeding maize at two different levels (0.5 and 1 kg/day) in a group of eighteen crossbred heifers and found that NDF and ADF

digestibility remained consistent among the groups. Likewise, Augustine (2008) observed no significant differences in NDF and ADF digestibility among early lactating cows that were fed one kg/day of ground maize or 100g/day of protected fat compared to a control group without energy supplementation.

The average NFE digestibility percentages for the experimental rations T1, T2, and T3 were found to be 66.67±1.31, 70.66±1.32 and 70.41±0.55 respectively. It was observed that the groups supplemented with energy in the form of maize and soy lecithin showed significantly higher digestibility ($P<0.05$) for NFE which predominantly represents the non-structural carbohydrates of the diet. This finding aligns with the results of a previous study in cows during early lactation under field conditions (Augustine, 2008), with higher NFE digestibility values for the groups supplemented with 1kg/day of maize (63.20 per cent) and 100g/day of fat (63.54 per cent), when compared to the control group (52.22 per cent).

Table 3. Chemical composition[1] of dung of animals maintained on three dietary treatments, %

Parameter	Dietary treatment		
	T1	T2	T3
Dry matter	20.31±0.18	19.55±0.27	20.29±0.76
Crude protein	15.31±0.52	15.8±0.43	15.52±0.23
Ether extract	1.67±0.01	1.60±0.10	1.91±0.05
Crude fiber	22.27±0.11	24.91±0.35	25.4±0.76
Total ash	16.11±0.46	14.76±0.61	15.97±0.40
Nitrogen free extract	44.63±0.78	42.71±0.34	41.21±0.78
Neutral detergent fiber (NDF)	61.22±0.59	59.4±0.61	60.33±0.87
Acid detergent fiber (ADF)	43.99±0.68	42.92±0.19	44.32±0.34

[1]Mean values are based on five replicates, second value onwards expressed on DM basis

Table 4. Digestibility coefficient[1] of nutrients in experimental rations fed to animals, %

Parameter	Dietary treatments			P value
	T1	T2	T3	
Dry matter	61.49±0.93	64.09±1.24	63.88±0.46	0.133^{ns}
Crude protein	58.46±1.38	57.48±1.54	59.08±0.65	0.670^{ns}
Crude fiber	62.33±0.75	58.35±1.72	58.55±1.74	0.143^{ns}
Ether extract	72.5±0.59	75.45±2.11	70.82±0.87	0.090^{ns}
Nitrogen free extract	66.67^{a}±1.31	70.66^{b}±1.32	70.41^{b}±0.55	0.047*
Neutral detergent fiber	53.55±0.81	55.61±1.85	56.22±0.7	0.312^{ns}
Acid detergent fiber	46.7±1 .19	48.67±1.85	48.69±0.46	0.481^{ns}

[1]Mean values are based on five replicates

3.2 Calf birth weight

Average birth weight of calves born to experimental animals fed with dietary treatments T1, T2 and T3 were 28±1.14, 32.8±1.16 and 29.1±0.78 kg respectively. Statistical analysis of the data revealed that average birth weight of calves born to cows supplemented with maize during late gestation was higher (P<0.05) compared to other dietary treatments. These findings align with the observations of Radunz *et al*. (2010), in a study involving multiparous beef cows from mid-gestation to calving. Study compared the birth weight (kg) of calves born to cows fed a grass-hay based diet or a diet supplemented with corn and corn dried distillers' grain (DDGS) and concluded that birth weight of calves born to cows offered diet supplemented with corn (43.1) and DDGS (41.3) was higher (P<0.05) compared to calves born to cows offered with hay (38.8 kg). Similarly, Ramirez *et al*. (2012) in a study in goats noticed that kids born to goats that received diets supplemented with maize (0.6 kg/day) during the last twelve days of pregnancy had a higher weight (3.12 ± 0.07 kg) compared to those in the un supplemented group (2.84 ± 0.07 kg), agreeing the results obtained in the present study. Furthermore, Kang *et al*. (2022) observed an increase in calf birth weight when cows were provided with high-energy diets containing corn silage. Additionally, the average daily gain of these calves increased by 30.16 percent (P<0.05) compared to calves born to cows fed low-energy diets. In the present study, calf birth weight was unaffected by supplementation of fat which was similar to observations of Hess *et al*. (2002) who stated that calf birth weight was unaffected by prepartum lipid supplementation. Furthermore, Banta *et al*. (2006) found that prepartum oilseed supplementation had no effect (P>0.05) on calf birth weight.

Table 5. Average birth weight[1] of calves born to animals fed on three experimental rations, kg

Dietary treatments	Birth weight
T1	28.0^{a}±1.14
T2	32.8^{b}±1.16
T3	29.1^{a}±0.78
P value	0.017*

[1]Mean values are based on five replicates

4. Conclusion

Critical analysis of the results indicates that providing energy supplements in the form of maize and soy lecithin during the last month of gestation improved the digestibility of non-structural carbohydrate component of the ration represented as the NFE. Moreover, supplementing with maize during the later stages of pregnancy resulted in enhanced birth weights of calves.

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