SHORT COMMUNICATION

Milk performance of dairy cows supplemented with a combination of slow-release nitrogen and exogenous fibrolytic enzyme

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Abstract: The purpose of this on-farm trial was to evaluate the impact of supplementing slow-release nitrogen (SRN; min. 40% N) and exogenous fibrolytic enzyme (EFE; cellulase, xylanase, glucanase, mannanase and xylanase-potentiating factor) products on milk yield and composition in dairy cows. Twelve early-to-midlactating crossbred cows were divided into 2 groups with comparable milk production. Animals were fed on a total mixed ration comprising of green maize, wheat straw and concentrate mixture. Group T₁ was supplemented with urea at 80 g/animal/d, whereas that of T₂ received a novel combination of cellulose-polymer-coated SRN at 80 g and EFE at 4 g/animal/d for a period of 20 days. Results showed no difference in milk yield (13.8 vs. 15.1 kg/d; P=0.559) between the groups; however, milk fat (3.49 vs. 3.87%) and solid not fat (7.92 vs. 8.35%) levels were higher (P<0.05) in group T₂ than T₁. Furthermore, on applying 2-axis milk payment system, group T₂ demonstrated a return on investment of 8.3:1. It was, therefore, concluded that supplementing a combination of SRN and EFE carries practical worth to enhance milk composition, thereby boosting economic gain in dairy farming under Indian context.

Keywords: Farm profitability, Fibrolytic enzyme, Milk production, Nutrient synchrony, Slow-release nitrogen

Feeding a balanced diet adequate in all essential nutrients is the cornerstone of productive performance of dairy animals. Protein sources are considered as the most expensive ingredient components in dairy rations. However, ruminants can utilise non-protein nitrogen (NPN) in presence of available fermentable energy to synthesise rumen microbial crude protein (MCP; AFRC, 1993; NRC, 2001). The MCP is of high nutritional significance, given the fact that it could meet as much as 70-100% of protein requirements of cows depending on the level of productivity (Thirumalesh and Krishnamoorthy, 2013). While urea is the most commonly employed NPN source, due to its instant solubility and ammonia (NH₃) release in the rumen, it becomes a real challenge to achieving optimum synchrony with that of carbohydrate sources to maximise MCP production (Inostroza et al. 2010; Salami et al. 2021). Consequently, NH₃ that is not captured by microbial cells would get absorbed across ruminal wall and excreted (wasted) through urine. On the other hand, if urea is made to deaminate slowly—thus controlling NH₃ release over a sustained period of time in the rumen—it could theoretically enhance the yield of MCP (AFRC, 1993; NRC, 2001; Cherdthong and Wanapat, 2010), minimise urinary N losses and safeguard the health of dairy cows from possible adverse effects of urea (Salami et al. 2021). It is interesting that on ‘protein equivalent’ basis, 1 kg of slow-release N (SRN) could equate to 5-7 kg of traditional oilseed cakes/meals, and hence appears to lessen the feed cost.

Although rumen represents a fountain of enzyme systems, there seems a limitation for the digestion of lignocellulosic fibre fractions, owing to the highly recalcitrant structure of forage cell walls (Mahesh and Mohini, 2013). Hence, researchers have explored the possibility to improve fibre utilisation and subsequent performance with the use of exogenous fibrolytic enzymes (EFE; Gado et al. 2009; Shekhar et al. 2010; Meale et al. 2014) under diverse dietary and productivity scenarios (Tirado-González et al. 2018).

Considering the above points, it was our general hypothesis that supplementing novel feed additives influencing protein and energy metabolism could boost production, whilst also impacting bottom-line farm profits. The objective of the present experiment

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was to assess the response of dairy cows supplemented with a combination of SRN and EFE under field conditions.

This trial was performed at a commercial dairy farm located in north India. Twelve crossbred cows in their early-to-midlactation stage were selected and stratified into 2 groups (T_1 and T_2) of 6 each in such a way that both had similar milk yield before commencement of the trial. All the animals were fed a total mixed ration comprising of specified proportion of chopped green maize (18.3% dry matter, 8.2% crude protein and 42% neutral detergent fibre), concentrate mixture (20.8% crude protein, 4.2% ether extract and 10.8 MJ of metabolisable energy/kg) and wheat straw to meet/exceed the nutrient requirements (ICAR, 2013). Cows in group T_1 were supplemented with technical grade urea at 80 g/animal/d, while that of T_2 received a novel combination of cellulose-polymer-coated SRN (Zenitro™ with min. 40% N) at 80 g and EFE (Kemzyme® containing cellulase, xylanase, glucanase, mannanase and xylanase-potentiating factor) at 4 g/animal/d for a period of 20 days (Table 1). Both the additives were manufactured by Kemmin Industries South Asia Pvt. Ltd., Chennai, India. Animals were hand-milked twice a day and quantity of milk produced was recorded daily on individual basis. Similarly, milk composition in terms of fat and solid not fat (SNF) was analysed by EKOMILK analyser (BULTEH 2000 Ltd, Bulgaria). Ad libitum fresh drinking water was made available for all cows throughout the day. Statistical analysis was carried out using Statgraphics Centurion XVI software (version 16.2.04). The data were analysed by t-test and a P-value < 0.05 was considered statistically significant.

Results showed that milk yield did not differ between cows of groups T_1 and T_2 (13.8 vs. 15.1 kg/d; $P=0.559$; Table 2). However, composition of milk expressed as fat and SNF improved ($P<0.05$) in group T_2 than that of T_1 . Furthermore, the economic benefit measured as return on investment (ROI) was found to be 8.3:1 in group T_2 (Table 2).

A positive milk response to dietary supplementation is expected when one or many nutrients are deficient in the basal diet, and both the diets fed in the present experiment were similar in all nutrient profile, matrix values and even had similar DMI (~15 kg/d; data not shown). This might explain the absence of any effect of supplementation on milk yield.

Despite the diets were balanced to match the current production levels, it is interesting to observe an improvement in milk fat and SNF by 10.9% and 5.4%, respectively in group T_2 . This can be justified by the individual role of SRN in improving rumen N metabolism (AFRC, 1993; Cherdthong and Wanapat, 2010; Mahesh et al. 2017; Salami et al. 2021) and EFE in augmenting fibre digestion (Shekhar et al. 2010) – put together resulting in higher availability of nutrient precursors such as acetate for milk fat (Inostroza et al. 2010) and MCP for milk protein synthesis (Thirumalesh and Krishnamoorthy, 2013). On quantitative terms, it appears that MCP fulfilled approximately 78% of total protein

Table 1 Ingredient composition of total mixed ration (kg, as-is basis)

Ingredient	T_1	T_2
Green maize	30	30
Wheat straw	3	3
Concentrate mixture ^a	8	8
Urea	0.08	-
Slow-release nitrogen	-	0.08
Exogenous fibrolytic enzyme	-	0.004

^aInclusive of micronutrients and additives

Table 2 Production performance and economics of novel additive supplementation in dairy cows (n=6)

Attribute	T_1	T_2
Production		
Milk yield (kg/d)	13.8 ± 1.37	15.1 ± 1.48
Fat (%)	3.49 ^A ± 0.06	3.87 ^B ± 0.08
Solid not fat (%)	7.92 ^A ± 0.04	8.35 ^B ± 0.02
Economics		
Price of milk (INR/kg) ^a	30	33
Milk revenue (INR/d)	414	500
Incremental revenue (INR/animal/d)	-	86
Inclusion cost of additives (INR/d)	-	10.4
Return on investment ^b	-	8.3

1\$ = INR 74

^aBased on prevailing 2-axis farm-gate milk pricing system in the market

^bIncremental revenue due to treatment ÷ additional cost of supplementation

Means bearing different superscripts (A, B) in each row differ significantly at $P\leq 0.05$

requirements (1.4 kg MCP vs. 1.8 kg protein requirement/d; ICAR, 2013) assuming a theoretical MCP yield of 170 g/kg organic matter fermented in the rumen (DOMR; Blümmel et al. 1999). Indeed, the level of both the NPN sources used were 80 g representing not >15% of total N intake, which is within the safer dietary inclusion level of 135 g and/or 20% of total daily N intake recommended for dairy cows (Kertz et al. 2010). Furthermore, it is also reasonable that, along with sustained release effect of NH_3 by SRN, the fibre degradation carried out by EFE might have additionally supported the availability of fermentable carbohydrates, as has been reported previously (Gado et al. 2009; Shekhar et al. 2010; Meale et al. 2014). In this direction, a recent meta-analysis by Tirado-González et al. (2018) conclusively revealed an increase of 99.4 g milk protein and 83 g fat per day upon supplementing EFE in dairy cows, as obtained for group T_2 in the present experiment. According to the best of authors' knowledge, this is the first-of-its-kind of study demonstrating the practical worth of a

combination of SRN and EFE to benefit milk components in dairy cows under Indian context.

A good 'economic return' is the central determinant of sustainability of any dairy enterprise. As feed alone is factored towards >60% of recurring expenses, any dietary regimen is expected to have a direct impact on farm economy. Considering fat and SNF-based 2-axis milk payment system, the outcome of present trial clearly deduces that an ROI of 8.3:1 is practically achievable when dairy producers use a novel combination of SRN and EFE for lactating rations. This is principally attributed to an increased farm-gate milk realisation as a result of improved milk composition. Consistent with our findings, when SRN partly substituted soya bean meal, a better income over feed cost was observed in high producing Wisconsin dairy herds (Inostroza et al. 2010).

Conclusions

It was concluded from this on-farm trial that dairy cows supplemented with a combination of slow-release nitrogen and exogenous fibrolytic enzyme improved milk composition and net economic returns. Future studies may explore the trade-offs between feed cost optimisation with these additives through energy-protein ingredient reformulation and performance measures in dairy cows.

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Conflicts of interest

Authors declare that there are no known financial or any other conflicts of interest associated with the data presented in this publication.

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