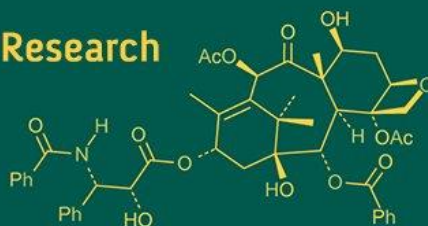


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## Effect of supplementing fortified single cell protein with concentrate on milk yield and milk quality in cross bred dairy cows

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### Abstract

Fortified Single Cell Protein (FSCP), produced using *Methylococcus capsulatus* and enriched with essential vitamins and minerals, serves as a high-protein, alternative feed source for dairy cattle. This study evaluated the impact of FSCP supplementation on milk yield and quality in crossbred dairy cows. A total of 18 animals of similar age and weight were divided into three groups: control (T<sub>1</sub>), 500 g/day FSCP (T<sub>2</sub>) and 1000 g/day FSCP (T<sub>3</sub>) replacing equivalent concentrate feed. The trial lasted 45 days, including a 3-day adaptation period. FSCP showed 22.23% crude protein, 3.23% crude fat and 4125 kcal/kg gross energy. Results indicated a statistically significant ( $p < 0.05$ ) improvement in milk yield, fat, and SNF in treatment groups compared to control. Additionally, significant differences in milk yield (T<sub>2</sub> 614.2 and T<sub>3</sub>-655.9 litres) and fat (T<sub>2</sub> 4.21 and 4.43%) were noted between the two FSCP-supplemented groups, while SNF remained comparable. Economic analysis revealed profit of Rs 3.45 (21.71%) in 500 g FSCP supplemented group and Rs 4.51 (28.4%) profit in 1000 g supplemented group over control group. So, it is recommended to incorporate FSCP at 1000 g/day as a sustainable and cost-effective strategy to enhance milk production and quality in crossbred dairy cattle.

**Keywords:** Fortified single cell protein, FSCP, milk yield, fat, SNF and dairy cows

### Introduction

India's livestock sector is one of the largest in the world and about 20.5 million people depend upon livestock for their livelihood. Livestock sector contributes 4.11% Gross Domestic Product (GDP) and 25.6% of total Agriculture GDP. The main product of livestock farming is milk and India is the largest producer of milk and milk product reached 210 MMT during 2020-21 (FAO, STAT). However, dairy farmers, in India are facing various challenges due to high cost of conventional feed ingredients. Due to this, the farmers compromise on the quality of feed to reduce cost. This in turn leads to low productivity in livestock. As the milk yield, milk fat and solid not fat increase with better feed quality, feed ingredients with low quality always leads to reduced milk quality and composition, further reducing the revenue for the farmer. In India, traditional feed supplements based on De-oilseed cakes are used as a major protein source in ruminant ration. Farmers and nutritionists are always on the same issue. Considering that FSCP has more than 80 percent crude protein and 10 percent crude fat (Suman *et al.*, 2015) [5], the present study was carried out to study the effect of supplementation of FSCP on milk yield and milk quality (Fat and SNF) in cross bred cattle with the following objectives of FSCP production (bacterial origin) and to study the effect of FSCP on milk yield, milk quality parameters (Fat and SNF) in cross bred cows.

### Materials and Methods

FSCP obtained from *Methylococcus capsulatus*, a Gram-negative coccoid bacterium known for its high protein yield (Zepka *et al.*, 2008) [6], was used in the current trial. The dried bacterial biomass is mixed with De-oiled rice bran (DORB) as a carrier substrate. For every 100 g of DORB, 20 g of chelated minerals and vitamins are added to enhance the nutritional value. This fortified SCP mixture is then used in biological trial for performance evaluation in cross breed dairy cattle. The samples including concentrate feed, paddy straw and FSCP mixed concentrate feed were analyzed for the proximate composition by following the standard methods of AOAC (2023).

A biological experiment of 45 days feeding trial was conducted to study the effect of supplementation of FSCP on milk yield and milk quality (Fat and SNF) in cross breed dairy cattle available in a private farm located in Tirupathur District. All the animals available in the farm were weighed based on the Shaffer's formula and then eighteen lactating cross bred cows (Holstein Friesian) with a mean live weight of  $337.37 \pm 16.02$  kg and an average milk yield of  $13.46 \pm 0.95$  kg/day were selected and randomly divided into three experimental groups (6 animals in each group). Group T<sub>1</sub> served as the control, receiving only the basal diet, while groups T<sub>2</sub> and T<sub>3</sub> received the basal diet with partial replacement of concentrate with FSCP at the rate of 500 g/day/animal and 1000 g/day/animal, respectively (Table 1). The initial three days of the trial was served as an adaptation period, followed by a 42-day experimental period for data collection. Prior to the start of trial, all animals were

dewormed for ecto-and endo-parasites using ivermectin injection to ensure health and prevent infection. Milking was done two times per day for the experimental cows. Daily milk yield of individual cows was recorded immediately after milking both in the morning and evening, throughout the experimental period. Further, daily records were maintained for feed intake. Milk samples were collected for 45 days and analysed for milk fat percentage and Solids-Not-Fat (SNF) content using an automatic milk analyser (Milkoscreen, Indifoss). The concentrate feed offered was calculated (up to 5 litre of milk production no concentrate was fed and after 5 litre, for every one litre of milk production, 450 g of concentrate was fed) and divided into two equal doses and offered at 8.00 am and 4.00 pm separately. Finally, after completion of the trial, costs of feeding FSCP as a partial replacement with concentrate feed was calculated.

**Table 1:** Details of the experimental design

| Group                    | Details of Experimental feed                                                                                                                                                            |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| T <sub>1</sub> (Control) | Roughage + 100% commercial concentrate diet (Average milk yield 14.5 litres/day, 3.1 Kg of concentrate)                                                                                 |
| T <sub>2</sub>           | Roughage + partial replacement of concentrate diet with FSCP at the rate of 500 g/day/animal (Average milk yield 14.5 litres/day, 3.55 Kg of concentrate feed + 500 g of FSCP was fed)  |
| T <sub>3</sub>           | Roughage + partial replacement of concentrate diet with FSCP at the rate of 1000 g/day/animal (Average milk yield 14.5 litres/day, 2.5 Kg of concentrate feed + 1000 g of FSCP was fed) |

## Results and Discussions

The FSCP mixed concentrate exhibited 9.25% moisture, 22.23% crude protein and 5.20% crude fibre, 3.23% crude fat and gross energy (4125 kcal/kg), compared to the concentrate feed (Table 2). As expected, paddy straw recorded the highest levels of crude fibre (27.47%), total ash (17.62%), acid-insoluble ash (15.85%) and calcium (0.77%) in comparison with both the concentrate feed and FSCP.

A statistically significant difference ( $p < 0.05$ ) was observed in milk yield and milk fat between the treatment groups

(Table 3). Both treatment groups exhibited significantly ( $p < 0.05$ ) higher milk yield and milk fat compared to the control group. Furthermore, group receiving 1000 g/day of FSCP replacement demonstrated a significantly ( $p < 0.05$ ) higher milk yield and milk fat than the group receiving 500 g/day. With respect to solids-not-fat (SNF) content, both treatment groups showed significantly higher values ( $p < 0.05$ ) compared to the control group. However, no significant difference in SNF content was observed between the two treatment groups.

**Table 2:** Nutrient composition of concentrate feed and FSCP mixed concentrate feed

| S. No | Parameter              | Commercial concentrate feed | FSCP mixed concentrate feed |
|-------|------------------------|-----------------------------|-----------------------------|
| 1     | Moisture (%)           | $9.71 \pm 0.01$             | $9.25 \pm 0.20$             |
| 2     | Crude protein (%)      | $19.15 \pm 0.01$            | $22.23 \pm 0.44$            |
| 3     | Crude fibre (%)        | $9.93 \pm 0.01$             | $5.20 \pm 0.07$             |
| 4     | Crude fat (%)          | $2.75 \pm 0.01$             | $3.23 \pm 0.32$             |
| 5     | Total ash (%)          | $8.60 \pm 0.06$             | $1.20 \pm 0.07$             |
| 6     | Gross energy (Kcal/kg) | $3733 \pm 0.58$             | $4125 \pm 7.84$             |
| 7     | Acid insoluble ash (%) | $2.20 \pm 0.06$             | $2.30 \pm 0.07$             |
| 8     | Calcium (%)            | $0.53 \pm 0.23$             | $0.85 \pm 0.26$             |
| 9     | Phosphorous (%)        | $1.05 \pm 0.01$             | $1.35 \pm 0.08$             |

\* Mean of three observations

**Table 3:** Mean ( $\pm$  SE) daily milk yield, milk fat, solid not fat (SNF) content and Total DM intake of Paddy straw (Kg) in the experimental cows maintained on three dietary treatments

| Treatment                    | Milk yield (litre)/day | Milk fat (%)      | SNF (%)           | Total DM intake of Paddy straw (Kg) |
|------------------------------|------------------------|-------------------|-------------------|-------------------------------------|
| T <sub>1</sub> -Control      | $13.00^c \pm 0.06$     | $3.85^c \pm 0.05$ | $8.13^b \pm 0.03$ | $130.69 \pm 0.07$                   |
| T <sub>2</sub> (500 g FSCP)  | $13.99^b \pm 0.06$     | $4.21^b \pm 0.04$ | $8.28^a \pm 0.04$ | $124.04 \pm 0.06$                   |
| T <sub>3</sub> (1000 g FSCP) | $14.62^a \pm 0.09$     | $4.43^a \pm 0.04$ | $8.30^a \pm 0.03$ | $126.12 \pm 0.08$                   |

Mean of 42 observations <sup>a,b,c</sup>-Means with different superscript within the same column differ significantly ( $p < 0.05$ )

The increase in milk yield, milk fat and SNF observed with the inclusion of 500 g and 1000 g/day of FSCP in the current study can be attributed to its high-quality protein content and enhanced availability of essential amino acids, particularly Lysine and Methionine. These nutrients play a critical role in supporting rumen microbial protein synthesis

and improving overall nutrient digestibility. The improved amino acid balance and digestibility enhance energy efficiency and reduce metabolic stress on the animal, thereby promoting milk synthesis at the mammary gland and improving overall lactation performance. Additionally, FSCP serves as a valuable source of non-fibre carbohydrates

and nitrogen, which stimulate microbial growth and enhance fermentation efficiency in the rumen. These findings are consistent with previous studies by Chatterjee (2019) <sup>[1]</sup>, who also reported significant improvements in milk yield following dietary supplementation with single cell protein in dairy cattle.

The economic analysis of the feeding trial revealed that milk yield of the cows was 19.4% increase in T<sub>2</sub> and 27.5% increase in T<sub>3</sub> over the control. As a result, the profit per litre of milk increased from Rs. 15.89 in T<sub>1</sub> to Rs. 19.34 in T<sub>2</sub> and Rs. 20.40 in T<sub>3</sub>. This reflects an additional profit of Rs. 3.45 (21.71%) and Rs. 4.51 (28.4%) per litre of milk in T<sub>2</sub> and T<sub>3</sub>, respectively, compared to the control. These results are in agreement with the findings of Sharma (2021) <sup>[4]</sup> and Nagalakshmi (2012) <sup>[3]</sup>, who also reported improved profitability and production efficiency with the inclusion of protein-rich supplements in dairy cattle diets. These findings clearly indicate that the partial replacement of conventional concentrate feed with FSCP not only enhances milk production but also significantly improves economic returns. The benefit is more pronounced at the 1000 g/day replacement level, making it a viable strategy for cost-effective and sustainable dairy production.

### Conclusion

The results of present study revealed that FSCP supplementation was both nutritionally and economically advantageous, leading to significant improvements in milk yield and quality parameters. Based on the results of biological trials conducted on crossbred dairy cows, it is recommended that FSCP may be incorporated at a level of 1000 g/day, replacing an equivalent amount of conventional concentrate feed, to enhance milk production and economic efficiency. However, further studies under diverse management and environmental conditions are warranted to validate and strengthen the findings of the present study.

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