



Nutrient Intake and Digestibility of Jersey Crossbred Cattle

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Variation of Nutrient Intake and Digestibility in Jersey Crossbred Cattle at Various Physiological Stages and Production Levels

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ABSTRACT

To compare the nutrient intake and digestibility of thirty-six (lactating, n=12; non-lactating pregnant, n=8; heifers aged >1.5 years up to first conception, n=8; and calves aged under 3month-1.5 years, n=8) Jersey crossbred cattle (Jersey × Red Sindhi × Tharparkar) at various physiological stages and production levels, a digestibility trial of seven days was conducted. Lactating cows were again divided based on their production levels into two groups. Group A had animals with average milk production of 5.5±0.40 kg/d (range 4-7.99 kg/d). Group B had animals with average milk production of 11.1±0.40 kg/d (range 8-12 kg/d). Total dry matter intake (%), acid detergent fiber digestibility (%) and dry matter intake (%) from straw and fodders were significantly (P<0.05) higher for the calves aged under 3month-1.5 years. Dry matter intake and ether extract digestibility (%) was significantly (P<0.05) higher for heifers aged >1.5 years up to first conception. Total dry matter intake (kg/d), and dry matter intake (%) from concentrate were significantly (P<0.05) higher for the lactating cows. Total dry matter intake (%) and dry matter intake (%) from concentrate were significantly (P<0.001) higher for group B as compared to group A cows. Based on the findings of this study, it can be concluded that heifers aged >1.5 years up to first conception and high-yielding cows are better utilizers of nutrients from the diet.

KEYWORDS: Digestibility, Jersey crossbred, Nutrient intake, Physiological stage, Production level

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INTRODUCTION

Feed inputs are a significant predictor of profitability and the most variable cost in animal production (Nielsen et al., 2013). Profitability can be increased by selecting feed-efficient animals. The selection of a high gain-to-feed ratio increased the growth rate and mature cow size (Schenkel et al., 2004), impacting in turn the intake of the cow herd. Due to their better feed efficiency, Jersey crossbred cows may be more cost-effective than native cows (Santra et al., 2021). But, data on the performance of Jersey crossbred cows at different physiological phases and production levels are still scarce in our literature. However, such data is more commonly seen for dairy cows with a high percentage of Jersey blood, which are better adapted to the temperate production system. Physiological stages and production level currently affects the nutritional

intake and digestibility of cows (Torre et al., 2019). Therefore, research is required to determine how Jersey crossbred cows respond to the same feeding regimens in terms of nutrient intake and digestibility at different physiological stages and production levels. The purpose of this study was to determine how nutrient intake and digestibility differed in Jersey crossbred (Jersey × Red Sindhi × Tharparkar) cattle at various physiological phases and production levels.

MATERIAL AND METHODS

This digestion trial was conducted on thirty-six Jersey crossbred (Jersey × Red Sindhi × Tharparkar) cattle maintained at the cattle farm of ICAR-National Dairy Research Institute, Eastern Regional Station, Kalyani, located in the lower Gangetic Plain Region of West Bengal, India. The climatic condition is hot and humid. The average annual maximum

temperature was 31°C and the minimum temperature was 20°C. The maximum and minimum humidity were 91% and 58%, respectively. The annual rainfall is around 1250 mm.

Digestibility trial of different physiological stages and production levels

To estimate the nutrients intake and digestibility of cows at different physiological stages and production levels, a digestibility trial of seven days was conducted on thirty-six cattle (Twelve lactating cows and eight animals from each other physiological stages) i.e. lactating, non-lactating pregnant, heifers aged more than >1.5 years up to first conception and calves age under 3month-1.5 years. These lactating cows were again divided based on their production levels into two equal groups, i.e. A and B. Group A had animals with average milk production of 5.5±0.40 kg/d (range 4-7.99 kg/d). Group B had animals with average milk production of 11.1±0.40 kg/d (range 8-12 kg/d). The digestion trial was conducted by housing all the animals in the shed individually with arrangements. Animals were given two days of adaptation in the shed before commencing the actual collection. The AOAC (2012) and Van Soest et al. (1991) methods of analysis were followed for the estimation of nutrients of feeds and dung after grinding the sample to pass through a 1mm sieve.

Diets and feeding practices of jersey crossbred cattle

Throughout the digestion trial, the cows were fed a 60:40 mix ratio of roughage and concentrate. The chemical composition of offered feedstuffs during the study is presented in Table 1. The ingredient composition of offered concentrate mixture was yellow maize 10%, de-oiled mustard cake 18%, de-oiled rice bran 45.8%, dried distiller grains with solubles 7%, rice bran 5%, molasses 10%, salt 1%, and mineral mixture 3.2%.

Statistical analysis

All the data were analyzed with the help of Statistical Package for Social science (SPSS, 2010) version 16 software using t-test and one-way ANOVA.

RESULT AND DISCUSSION

Chemical composition of offered feeds

Our estimated dry matter (DM), crude protein (CP), organic matter (OM), ether extract (EE), total ash (TA), neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose (HC), and total carbohydrate (TCHO) of concentrate mixture, paddy straw and green fodder is presented in Table 1. Similar to our Study, Santra et al. (2021) reported that paddy straw had 86.6% OM, 3.40% CP, 1.90% EE, 81.3% TCHO, 71.5% NDF, and 41.1% ADF. Likewise, the concentrate mixture had 93.7% OM, 18.2% CP, 4.70% EE, 70.8% TCHO, 34.8% NDF, and 11.8% ADF (Santra et al., 2021). The estimated chemical composition of feedstuffs was also similar to Kedare et al. (2021) who reported 93.7% OM, 18.9% CP, 4.51% EE, 6.28% TA, 32.5% NDF, and 11.2% ADF on dry matter basis. They also reported that green fodder had 86.8% OM, 12.8% CP, 2.66% EE, 12.9% TA, 57.6% NDF, and 35.9% ADF on a dry matter basis (Kedare et al., 2021).

Table 1 Chemical composition of offered feed stuffs on dry matter basis

| Attributes | Concentrate mixture | Paddy straw | Green fodders |
|-------------------------|---------------------|-------------|---------------|
| Crude protein | 18.1±0.48 | 3.9±0.06 | 9.7±0.23 |
| Organic matter | 88.3±0.36 | 86.1±0.22 | 89.8±0.17 |
| Ether extract | 2.1±0.30 | 1.6±0.09 | 2.8±0.07 |
| Total ash | 11.7±0.36 | 13.9±0.22 | 10.2±0.17 |
| Neutral detergent fiber | 39.3±1.84 | 72.6±1.39 | 47.9±0.74 |
| Acid detergent fiber | 14.6±0.69 | 45.9±1.71 | 32.5±0.33 |
| Hemicellulose | 24.7±2.21 | 26.7±0.56 | 15.4±1.07 |
| Total carbohydrates | 67.9±0.34 | 80.5±0.25 | 77.3±0.28 |

Nutrient digestibility of Jersey crossbred cows at various physiological stages

The body weight (kg) of lactating cows was highest and comparable ($P>0.05$) to non-lactating pregnant cows. The body weight (kg) of calves under age 3 month-1.5 years was significantly ($P<0.001$; Table 2) lower than another group of

animals. Total dry matter intake (TDMI) (%) of calves under aged 3 month-1.5 years was significantly ($P<0.001$; Table 2) higher than lactating and non-lactating pregnant cows but comparable ($P>0.05$) to heifers aged >1.5 years up to first conception. The dry matter (DM) digestibility of heifer aged >1.5 years up to first conception was significantly ($P<0.001$; Table 2) higher than lactating and non-lactating pregnant cows but comparable to calves aged under 3 month-1.5 years. The crude protein (CP) digestibility of heifers aged >1.5 years up to first conception was significantly ($P<0.05$; Table 2) higher than another group of animals. Ether extract (EE) digestibility of heifers aged >1.5 years up to first conception was significantly ($P<0.013$; Table 2) higher than non-lactating pregnant cows but comparable ($P>0.05$) to calves aged under 3 month-1.5 years. Neutral detergent fiber (NDF) of calves aged under 3 month-1.5 years was non-significantly ($P>0.05$) higher than other groups of animals. Acid detergent fiber (ADF) of calves aged under 3 month-1.5 years was significantly ($P<0.037$; Table 2) higher than non-lactating pregnant cows but comparable ($P>0.05$) to another group of animals. Organic matter (OM) digestibility, total carbohydrates (TCHO) and non-fiber carbohydrates (NFC) digestibility (%) were comparable in each group of cows. DMI (%) of straw of calves aged under 3 month-1.5 years was significantly ($P<0.001$; Table 2) higher than other groups of cows and it was significantly lowest for non-lactating pregnant cows. Dry matter intake (DMI) (%) of fodder of calves aged under 3 month-1.5 years was significantly ($P<0.001$; Table 2) higher than in other groups but the DMI (%) of fodder was comparable ($P>0.05$) in non-lactating pregnant cows

and heifer age >1.5 years up to first conception. DMI (%) from the concentrate mixture was significantly ($P<0.001$; Table 2) higher for lactating cows than other groups of cows and it was lowest for non-lactating pregnant cows. Hayirili et al. (2002) observed that the DMI of pregnant animals is found to drop by 39% in the last 3 weeks of pregnancy. The DMI of cows was higher than heifers and the DMI of cows dropped quadratically as EE increased and decreased linearly as NDF increased (Hayirili et al., 2002). Conrad et al. (1964) noted that when digestibility increases, physical and physiological elements controlling feed intake alter. Bodyweight (which reflects roughage capacity), undigested residue per unit of body weight per day (which reflects the rate of transit), and dry matter digestibility were the variable at low digestibility. Consumption seemed to be influenced by the metabolic size, output, and digestibility at higher levels of digestibility. Allen (2000) reported that specific physical and chemical elements of diets that can impact DMI, such as fiber content, the ease with which starch and fiber can be hydrolyzed, particle size and fragility, silage fermentation products, fat concentration and characteristics, the volume and rate of ruminal protein degradation. The absorbed propionate seems to be more hypophagic than absorbed lactate or glucose, the site of starch digestion influences the kind of metabolic fuel received, which can affect the DMI of animals. Shortening forage particles reduced dry matter intake ($P<0.05$) and dry matter intake rose ($P<0.05$) as forage concentration increased (Muhammad et al., 2016). It is unclear, however, whether the improved digestive ability of feed-efficient animals is inherent or simply due to a slower passage of digesta through the rumen to lower dry matter intake (Kenny et al., 2018).

Table 2. Nutrient intake and digestibility coefficient of Jersey crossbred cattle at various physiological stages

| Attributes | Lactating (n=12) | Non-lactating pregnant (n=8) | >1.5 years up to first conception (n=8) | 3month-1.5 years (n=8) | P value |
|--------------------------------|--------------------------|------------------------------------|---|---------------------------|------------|
| Body weight (kg) | 330.1 ^C ±8.52 | 321.9 ^C ±18.60 | 255.4 ^B ±16.88 | 107.4 ^A ±18.60 | <0.001 |
| TDMI (%) | 3.1 ^A ±0.10 | 2.8 ^A ±0.09 | 3.0 ^{BC} ±0.06 | 3.2 ^B ±0.05 | <0.001 |
| TDMI (Kg/d) | 10.2 ^D ±0.22 | 8.8 ^C ±0.28 | 7.7 ^B ±0.52 | 3.4 ^A ±0.59 | <0.001 |
| DM digestibility (%) | 60.8 ^A ±0.91 | 59.7 ^A ±1.76 | 63.9 ^B ±0.76 | 63.6 ^B ±0.50 | <0.001 |
| CP digestibility (%) | 65.0 ^a ±1.50 | 66.6 ^a ±1.81 | 71.2 ^b ±1.00 | 69.6 ^a ±2.20 | NS |
| OM digestibility (%) | 64.5±1.44 | 63.6±1.61 | 66.8±0.78 | 67.4±0.71 | NS |
| EE digestibility (%) | 71.0 ^b ±2.35 | 65.7 ^{ab} ±3.60 | 78.1 ^{bc} ±1.72 | 76.0 ^{bc} ±2.25 | <0.013 |
| NDF digestibility (%) | 56.1±1.74 | 53.6±3.60 | 57.8±1.71 | 58.2±2.40 | NS |
| ADF digestibility (%) | 51.5 ^b ±1.19 | 45.9 ^a ±2.61 | 52.1 ^b ±1.22 | 52.6 ^b ±1.62 | <0.037 |
| TCHO digestibility (%) | 64.6±1.52 | 63.4±1.69 | 66.2±0.91 | 67.1±0.68 | NS |
| NFC digestibility (%) | 84.5±3.15 | 85.7±4.65 | 84.8±7.65 | 89.3±3.91 | NS |
| DMI from straw (kg/d) | 3.1 ^C ±0.04 | 2.5 ^B ±0.13 | 2.4 ^B ±0.16 | 1.1 ^A ±0.19 | <0.001 |
| DMI from fodders (kg/d) | 3.6 ^C ±0.05 | 4.0 ^{CD} ±0.19 | 3.5 ^{BC} ±0.27 | 1.5 ^A ±0.24 | <0.001 |
| DMI from Concentrate (kg/d) | 3.4 ^D ±0.19 | 2.3 ^B ±0.14 | 1.9 ^B ±0.13 | 0.78 ^A ±0.13 | <0.001 |
| DMI (%) from straw | 0.95 ^C ±0.01 | 0.78 ^A ±0.03 | 0.93 ^B ±0.06 | 1.0 ^D ±0.05 | <0.001 |
| DMI (%) from fodder | 1.1 ^B ±0.02 | 1.3 ^A ±0.02 | 1.3 ^A ±0.08 | 1.5 ^C ±0.08 | <0.001 |
| DMI (%) from concentrate | 1.0 ^B ±0.04 | 0.70 ^A ±0.02 | 0.74 ^A ±0.01 | 0.73 ^A ±0.03 | <0.001 |

TDMI-total dry matter intake; DMI-dry matter intake; DM-dry matter; CP-crude protein; OM-organic matter; EE-ether extract; NDF-neutral detergent fiber; ADF-acid detergent fiber; TCHO-total carbohydrate; NFC-non-fiber carbohydrate; NS-non-significant

^{abc} in different rows (P<0.05) and ^{ABC} in different rows differ significantly (P<0.001).

Nutrient digestibility of Jersey crossbred cows at various production levels

Milk yield, total dry matter intake (TDMI) (kg/d) and dry matter intake (DMI) (kg/d) and DMI (%) from the concentrate of Group B cows (milk yield; 8-12 kg/d) were significantly (P<0.001) higher than group A (milk yield; 4-7.99kg/d) cows. The body weight, dry matter intake (%), dry matter (DM), crude protein (CP), organic matter (OM), ether extract (EE), neutral detergent fiber(NDF), acid

detergent fiber(ADF), total carbohydrates (TCHO), non-fiber carbohydrates (NFC) digestibility (%), DMI (%) from straw, and DMI (%) from fodders were comparable (P>0.05; Table 3) in both groups of cows. By adding more straw to the diet, dry matter intake fell linearly (Greter et al.,2008). While feeding rate, meal size, and frequency all dropped when straw was added to the diet, feeding time and meal duration rose linearly as a result. According to our findings, the higher straw probably boosted the effect

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of the diets on rumen filling, which led to lower DMI. Oba and Allen (1999) found that feed with improved NDF digestibility greatly increased milk production and DMI. Cows on the low-fiber diet consumed more dry matter while feeding less often, resulting in a higher intake than cows on the high-

fiber diet (DeVries et al., 2007). Similar to our result, lactating dairy cows' total dry matter intake was unaffected by forage percentage (Woodford et al., 1986). Higher dietary neutral detergent fiber intake was associated with enhanced digestion of neutral detergent fiber and increased ruminal turnover of particulate digesta (West et al., 1999).

Table 3. Nutrient intake and digestibility coefficient of Jersey crossbred cattle at various production levels

| Attributes | Group A (milk yield; 4-7.99kg/d; n=6) | Group B (milk yield; 8-12 kg/d; n=6) | P value |
|----------------------------|--|---|---------|
| Body weight (kg) | 318.6±10.54 | 341.5±12.49 | NS |
| TDMI (%) | 3.0±0.14 | 3.2±0.14 | NS |
| TDMI (Kg/d) | 9.6 ^A ±0.20 | 10.8 ^B ±0.17 | <0.01 |
| DM digestibility (%) | 59.7±1.31 | 61.9±0.76 | NS |
| Milk yield(L/d) | 5.5 ^A ±0.40 | 11.1 ^B ±0.40 | <0.01 |
| CP digestibility (%) | 63.7±2.07 | 66.3±2.22 | NS |
| OM digestibility (%) | 63.6±2.41 | 65.5±1.73 | NS |
| EE digestibility (%) | 71.1±3.87 | 71.0±3.07 | NS |
| NDF digestibility (%) | 54.9±2.58 | 57.2±2.49 | NS |
| ADF digestibility (%) | 51.3±1.75 | 51.7±1.77 | NS |
| TCHO digestibility (%) | 63.6±2.63 | 65.5±1.70 | NS |
| NFC digestibility (%) | 84.6±5.03 | 84.4±4.29 | NS |
| DMI from straw(kg/d) | 3.1±0.01 | 3.2±0.07 | NS |
| DMI from fodders(kg/d) | 3.7±0.07 | 3.6±0.06 | NS |
| DMI from concentrate(kg/d) | 2.9 ^A ±0.14 | 3.9 ^B ±0.18 | <0.001 |
| DMI (%) from straw | 0.97±0.03 | 0.93±0.01 | NS |
| DMI (%) from fodder | 1.2±0.04 | 1.0±0.02 | NS |
| DMI (%) from concentrate | 0.90 ^A ±0.04 | 1.16 ^B ±0.04 | <0.002 |

TDMI- total dry matter intake; DMI- dry matter intake; DM- dry matter; CP- crude protein; OM- organic matter; EE- ether extract; NDF- neutral detergent fiber; ADF- acid detergent fiber; TCHO- total carbohydrate; NFC- non-fiber carbohydrate; NS- non-significant

^{abc} in different rows (P<0.05) and ^{ABC} in different rows (P<0.001) differ significantly.

CONCLUSION

Based on the findings of this study, it can be concluded that the nutrient intake and digestibility of Jersey crossbred cattle have varied with physiological stages and production levels. Heifers aged >1.5 years up to first conception and high-yielding lactating Jersey crossbred cows are better utilizers of nutrients from the diet.

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REFERENCES

- AOAC. 2012. Official Methods of Analysis of the Association of Official Analytical Chemistry, 19th Edn. AOAC International, Washington, USA.
- Allen, M. S. 2000. Effects of diet on short-term regulation of feed intake by lactating dairy cattle. *Journal of Dairy Science*. 83: 1598-1624.
- Conrad, H. R., Pratt, A. D. and Hibbs J. W. 1964. Regulation of feed intake in dairy cows. I. Change in importance of physical and physiological factors with increasing digestibility. *Journal of Dairy Science*. 47: 54-62.
- DeVries, T. J., Beauchemin, K. A. and Von Keyserlingk M. A. G. 2007. Dietary forage concentration affects the feed sorting behavior of lactating dairy cows. *Journal of Dairy Science*. 90: 5572-5579.
- De La Torre, A., Andueza, D., Renand, G., Baumont, R., Cantalapiedra-Hijar, G. and Nozière, P. 2019. Digestibility contributes to between-animal variation in feed efficiency in beef cows. *Animal*. 1-9. doi:10.1017/s1751731119001137
- Greter, A. M., DeVries, T. J. and Von Keyserlingk, M. A. G. 2008. Nutrient intake and feeding behavior of growing dairy heifers: Effects of dietary dilution. *Journal of Dairy Science*. 91: 2786-2795.
- Oba M. and Allen M. S. 1999. Evaluation of the importance of the digestibility of neutral detergent fiber from forage: effects on dry matter intake and milk yield of dairy cows. *Journal of Dairy Science*. 82: 589-596.
- Kenny, D.A., Fitzsimons, C., Waters, S. and Mc Gee, M. 2018. Invited review: Improving feed efficiency of beef cattle – the current state of the art and future challenges. *Animal*. 21, 1-12.
- Kedare, G.M., Karunakaran, M., Mandal, A., Ghosh, M.K. and Naskar S. 2021. Effect of area specific mineral mixture supplementation on milk production, biochemical and blood mineral status of Black Bengal goat. *Indian Journal of Dairy Science*. 74:145-149
- Hayirli, A., Grummer, R. R., Nordheim, E. V. and Crump P. M. 2002. Animal and dietary factors affecting feed intake during the prefresh transition period in Holsteins. *Journal of Dairy Science*. 85: 3430-3443.
- Muhammad, A. U. R., Xia, C. Q. and Cao, B. H. 2016. Dietary forage concentration and particle size affect sorting, feeding behaviour, intake and growth of Chinese holstein male calves. *Journal of Animal Physiology and Animal Nutrition*. 100: 217-223.
- Nielsen, M.K., MacNeil, M.D., Dekkers, J.C.M., Crews, D.H., Rathje, T.A., Enns, R.M. and Weaber, R.L. 2013. Review: Life-cycle, total-industry genetic improvement of feed efficiency in beef cattle: Blueprint for the Beef Improvement Federation. *Professional Animal Scientist*. 29, 559-565
- Santra, A., Tripura S., Vipin, V. and Das, S.K. 2021. Effects of dietary supplementation of *Mallotus philippensis* leaf powder on rumen fermentation pattern, enzyme profile and ciliate protozoal population in growing crossbred calves. *Indian Journal of Animal Sciences*. 91:940-946
- Schenkel, F. S., Miller, P. and Wilton, J. W. 2004. Genetic parameters and breed differences for feed, growth, and body composition traits in young beef bulls. *Canadian Journal of Animal Science*. 84, 177-185
- SPSS. 2010. Statistical Packages for Social Sciences, Version 16, SPSS Inc., Illinois, USA.
- Van Soest, P.J., Robertson, G.B. and Lewis, B.A. 1991. Symposium: Carbohydrate methodology, metabolism and nutritional implications in dairy cattle. *Journal of Dairy Science*. 74: 3583-3597.
- Woodford, J. A., Jorgensen, N. A. and Barrington, G. P. 1986. Impact of dietary fiber and physical form on performance of lactating dairy cows. *Journal of Dairy Science*. 69:1035-1047.
- West, J. W., Hill, G. M., Fernandez, J. M., Mandebvu, P. and Mullinix, B. G. 1999. Effects of dietary fiber on intake, milk yield, and digestion by lactating dairy cows during cool or hot, humid weather. *Journal of Dairy Science*. 82: 2455-2465.