Open Access

Check for updates

Short Communication

Journal of Veterinary and Animal Sciences
ISSN (Print): 0971-0701, (Online): 2582-0605
https://doi.org/10.51966/jvas.2026.57.2.353-358

Effects of dietary neutral detergent fibre to starch ratios on body weight, body condition score and blood biochemical parameters in early lactating crossbred cows#

Liyanta Babu[1], Lasna Sahib[3*], K. Ally[1], Sajith Purushothaman[1], Surej Joseph Bunglavan[1] and M.K. Muhammad Aslam[2]

[1]Department of Animal Nutrition, [2]Department of Livestock Production Management, College of Veterinary and Animal Sciences, Mannuthy, Thrissur-680651, [2]Livestock Research Station, Thiruvazhamkunnu, Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala, India

Citation: Babu, L., Sahib, L., Ally, K, Purushothaman, S., Bunglavan, S.J. & Aslam, M.M.K (2026). Effects of dietary neutral detergent fibre to starch ratios on body weight, body condition score and blood biochemical parameters in early lactating crossbred cows. *Journal of Veterinary and Animal Sciences, 57(2),353-358*
https://doi.org/10.51966/jvas.2026.57.2.353-358

Received: 03.12.2025 Accepted: 22.12.2025 Published: 30.06.2026

Abstract

This study investigated the effects of varying dietary neutral detergent fibre (NDF) to starch ratios on body weight, body condition score and blood biochemical parameters in early lactating crossbred dairy cows. Eighteen healthy crossbred cows within 10 days post-calving were randomly allocated to three dietary treatment groups (n=6) in a completely randomised design for 90 days. The experimental concentrate mixtures were isonitrogenous (22% crude protein) and isocaloric (70% total digestible nutrients), differing only in NDF to starch ratios: T1 (control, 1.58), T2 (2.08, 25% higher than control), and T3 (1.17, 25% lower than control). All groups were fed a 70:30 concentrate to roughage ratio using paddy straw as roughage. Body weight and body condition scores were recorded fortnightly and monthly, respectively. Blood samples were collected at the end of the trial to assess serum glucose, total protein, blood urea nitrogen, calcium and phosphorus concentrations. Results showed no significant differences in body weight amongst treatment groups throughout the study period (P>0.05), with final mean values of 415.33±16.65, 387.67±16.34 and 418.00±19.10 kg for T1, T2 and T3, respectively. Body condition scores remained within the optimal range (2.87-3.23) with no between-treatment differences (P>0.05), although T3 showed significant improvement over time (3.08 to 3.20; P=0.008). Blood biochemical parameters including glucose (59.48-67.84 mg/dL), total protein (7.78-8.15 g/dL), blood urea nitrogen (26.39-29.14 mg/dL), calcium (8.78-8.94 mg/dL) and phosphorus (6.09-7.16 mg/dL) remained within normal physiological ranges with no significant differences amongst treatments. The study concluded that varying NDF to starch ratios within the tested range (1.17-2.08) did not adversely affect body weight maintenance or blood metabolite profiles, while the low NDF: starch ratio (1.17) improved body condition during early lactation in crossbred cows.

Keywords: *Neutral detergent fibre, starch ratio, body weight, body condition score, blood biochemistry, early lactation*

Early lactation represents a critical phase in the production cycle of dairy cows, characterised by elevated energy demands for milk synthesis concurrent with limited dry matter intake capacity. During this period, cows

#Part of MVSc thesis submitted to Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala

**Corresponding author: lasna@kvasu.ac.in Ph: 9495133891*

commonly experience negative energy balance, resulting in the mobilisation of body reserves to meet the energy deficit (Ensminger et al., 1990). The dietary balance between structural carbohydrates, represented by neutral detergent fibre (NDF) and non-structural carbohydrates, primarily starch, plays a crucial role in determining nutrient utilisation efficiency, rumen health and overall production performance in lactating dairy cattle (NRC, 2001).

Neutral detergent fibre provides the physical stimulus necessary for rumination and maintenance of optimal rumen pH, whilst starch serves as a rapidly fermentable energy source for both microbial protein synthesis and propionate production (NRC, 2001). The ratio between these two carbohydrate fractions influences rumen fermentation patterns, volatile fatty acid profiles, and the efficiency of energy utilisation (Beckman and Weiss, 2005). Previous research has demonstrated varied responses to alterations in dietary NDF to starch ratios, with effects observed on milk production, milk composition, and nutrient digestibility. However, the specific impacts on body weight dynamics, body condition maintenance, and blood metabolite profiles during the critical early lactation period remain inadequately characterised, particularly in crossbred dairy cattle under tropical production systems.

Body weight and body condition score serve as practical indicators of energy balance and nutritional adequacy in lactating cows. Blood biochemical parameters, including glucose, total protein, blood urea nitrogen and mineral concentrations, provide insights into metabolic status, protein metabolism, and mineral homeostasis. Understanding how dietary NDF to starch ratios influence these parameters can inform more precise nutritional management strategies during early lactation. The present study was therefore undertaken to evaluate the effects of varying dietary NDF to starch ratios on body weight, body condition score, and selected blood biochemical parameters in early lactating crossbred cows.

The study was conducted at the University Livestock Farm and Fodder Research Development Scheme, Mannuthy, Kerala Veterinary and Animal Sciences University, Thrissur, Kerala, India. Eighteen healthy crossbred dairy cows in early lactation, within 10 days post-calving, were selected for the experiment. The animals were randomly divided into three groups of six animals each, following a completely randomised design. All experimental cows were maintained in a single well-ventilated shed under uniform housing and management conditions throughout the 90-day experimental period.

Three isonitrogenous (22% crude protein) and isocaloric (70% total digestible nutrients) concentrate mixtures differing in NDF to starch ratios were formulated in pelleted form. The dietary treatments were: T1 (control) with an NDF to starch ratio of 1.58; T2 with an NDF to starch ratio of 2.08 (25% higher than T1); and T3 with an NDF to starch ratio of 1.17 (25% lower than T1). Paddy straw was provided as roughage source. All experimental animals were fed according to Indian Council of Agricultural Research feeding standards (ICAR, 2013) with diet consisting of 70 per cent concentrate and 30 per cent roughage. Daily feed allowance was revised fortnightly based on recorded body weights. Clean drinking water was offered ad libitum throughout the study period. The ingredient and chemical composition of experimental feeds are given in table 1 and table 2 respectively.

Table 1. Ingredient composition of compound feed mixture offered to cows maintained on three dietary treatments

Ingredient	Per cent composition of compound feed mixtures		
	T1	T2	T3
Yellow maize	20	10	31
Corn gluten fibre	17	26	1
De oiled rice bran	15	26	23
Rice polish	8	8	8
Coconut oil cake	16	10	10
Groundnut oil cake	5	5	5
Alfalfa meal	15	11	18
Calcite	2	2	2
Salt	1	1	1
Mineral mixture	1	1	1
Total	100	100	100

The chemical analysis of concentrate feed and paddy straw samples were conducted as per AOAC, 2016. The fibre fractions were estimated using detergent method (Goering and Van Soest, 1970).

The body weight of experimental animals was recorded at the commencement of the feeding trial and subsequently at fortnightly intervals throughout the experimental period using a platform weighing scale. Body condition scores were recorded monthly using a five-point scale (Smijisha, 2012), ranging from one (emaciated) to five (obese). Feed and roughage allowances were adjusted fortnightly based on the recorded body weights.

Blood samples were collected from each cow towards the end of the feeding trial via jugular venipuncture into plain vacutainer tubes. Samples were allowed to clot at room temperature and then centrifuged at 3000 rpm for 15 minutes to separate serum. The serum was stored at -20°C until analysis. Serum glucose concentration was estimated using the glucose oxidase-peroxidase (GOD-POD) method (Trinder, 1969). Total protein was determined following the procedure of Jong and Vegeter (1950). Blood urea nitrogen was measured using the modified Berthelot method. Serum calcium (Morin,1974) and phosphorus (Fiske and Subbarow, 1925) concentrations were estimated using commercially available diagnostic

Table 2. Chemical composition of the concentrate feed and paddy straw fed to the experimental animals, %

Parameters	T1	T2	T3	Paddy straw
Moisture	8.26±0.05	8.21±0.08	8.19±0.04	6.09±0.24
Dry matter (DM)	91.74±0.05	91.79±0.07	91.81±0.04	93.91±0.24
Crude protein (CP)	21.75±0.06	22.11±0.05	22.22±0.05	2.98±0.08
Ether extract (EE)	4.64±0.05	4.26±0.03	3.99±0.03	1.06±0.03
Total ash (TA)	9.96±0.06	12.02±0.03	11.17±0.07	15.87±0.17
Neutral detergent fibre (NDF)	36.42±0.13	42.19±0.13	33.61±0.27	68.22±0.59
Acid detergent Fibre (ADF)	11.60±0.06	14.61±0.26	12.80±0.55	46.11±0.55
Acid detergent lignin (ADL)	1.05±0.03	1.08±0.03	1.25±0.06	5.28±0.42
Non fibrous carbohydrates (NFC)	27.23±0.16	19.42±0.19	29.02±0.28	11.87±0.67
Calcium	1.24±0.01	1.24±0.02	1.30±0.02	0.28±0.22
Phosphorus	0.67±0.06	0.87±0.01	0.75±0.02	0.09±0.07
Total digestible nutrients (TDN)*	71.89	70.28	71.23	_
Starch	23.03±0.11	20.31±0.18	28.64±0.11	_
NDF: Starch ratio*	1.58	2.08	1.17	_

Mean ± SE of six observations, values from third row onwards in dry matter basis

* Calculated values

kits following standard protocols. All these parameters were analysed using Alpha Chem 100 semi-automated biochemistry analyser.

Data collected on various parameters were subjected to statistical analysis following standard procedures (Snedecor and Cochran, 1994) in SPSS software version 24. Comparison of Body weight between group was done by using one-way ANOVA and between period within each group was done by using repeated measures ANOVA followed by least significant difference test (LSD) for pair wise comparison. Comparison of BCS between group was done by using Kruskal Walli's ANOVA and between period within each group was done by using Friedman's test followed by Dunn's for pair wise comparison. Results are expressed as mean ± standard error.

The fortnightly average body weights of experimental animals are presented in Table 3. Initial body weights were comparable across treatments (P=0.806), with mean values of 408.00 ± 12.73 kg (T1), 399.17 ± 18.21 kg (T2), and 415.33 ± 20.10 kg (T3). Throughout the 12-week experimental period, between-treatment comparisons revealed no significant differences (P>0.05) at any fortnight, indicating that dietary NDF:starch ratio did not influence body weight maintenance.

Analysis of within-treatment changes over time showed that T1 animals exhibited a marginal increase in body weight (P=0.050), while T2 and T3 groups maintained stable weights throughout the study (P>0.05). These findings suggest that all three experimental rations adequately supported the maintenance requirements of early lactating crossbred cows without causing significant body weight loss, which is particularly important during the critical early lactation period characterised by negative energy balance.

Table 3. Fortnightly average body weight of the experimental animals maintained on the three experimental rations, kg

Fortnights	Dietary treatments			F-value (P-value)
	T1	T2	T3	
Initial	408.00^{ab} ± 12.73	399.17 ± 18.21	415.33 ± 20.10	0.806^{ns}
1	404.00^{b} ± 15.64	388.83 ± 17.23	410.67 ± 19.58	0.673^{ns}
2	407.67^{b} ± 15.93	384.33 ± 15.43	409.67 ± 18.77	0.510^{ns}
3	413.50^{ab} ± 16.70	384.50 ± 16.93	415.33 ± 19.57	0.410^{ns}
4	411.00^{ab} ± 14.9	385.50 ± 16.17	420.33 ± 18.39	0.332^{ns}
5	414.33^{a} ± 16.05	382.00 ± 16.07	415.17 ± 18.16	0.310^{ns}
6	415.33^{a} ± 16.65	387.67 ± 16.34	418.00 ± 19.10	0.416^{ns}
F-value (P-value)	0.050*	0.095^{ns}	0.125^{ns}	

Values are mean ± SE of six observations; P>0.05 (non-significant), *values with different superscript in a column differ significantly (P<0.05).

The present results are in agreement with several previous studies investigating the effects of varying NDF to starch ratios on body weight. Beckman and Weiss (2005) evaluated NDF to starch ratios of 0.74, 0.95 and 1.27 in lactating dairy cows and reported no effect on body weight change. Rottman et al. (2015) found no effect on body weight when cows were fed rations with NDF to starch ratios of 0.93, 1.16 and 1.28. Tharangani et al. (2020) also reported that body weights were unaffected when cows received ratios of 0.7, 1.0 and 1.3.

Table 4. Monthly average body condition score of the experimental animals maintained on the three experimental rations, %

Months	Dietary treatments			P-value
	T1	T2	T3	
Initial	3.03 ± 0.19	2.87 ± 0.16	3.08^{b} ± 0.11	0.449^{ns}
1	3.07 ± 0.18	2.90 ± 0.15	3.17^{ab} ± 0.12	0.380^{ns}
2	3.07 ± 0.17	2.93 ± 0.14	3.23^{a} ± 0.14	0.287^{ns}
3	3.15 ± 0.16	2.93 ± 0.15	3.20^{a} ± 0.12	0.334^{ns}
P-value	0.087^{ns}	0.587^{ns}	0.008**	

Values are mean ± SE of six observations; P>0.05 (non-significant), **values with different superscript in a column differs significantly (P<0.01).

Body condition score remained similar across all treatment groups throughout the study period, ranging from 2.87 to 3.23 (Table 4), which falls within the optimal range for lactating dairy cows. Although no significant differences (P>0.05) were observed between treatments at any time point, within-treatment analysis revealed that T3 animals showed a significant improvement in body condition score from 3.08 to 3.20 (P=0.008) over the three-month period, while T1 and T2 maintained stable scores.

The improvement in body condition in T3 can be attributed to the lower NDF: starch ratio (1.17), which provided a more energy-dense ration. This is consistent with the findings of Chacko (2015), who reported maintained body condition in cows fed paddy straw-based complete rations. The maintenance of adequate body condition scores across all treatments indicates that none of the experimental rations caused excessive mobilization of body reserves, suggesting that energy supply was sufficient to support milk production requirements during early lactation without compromising body condition.

Blood biochemical parameters, including serum glucose, total protein, blood urea nitrogen, calcium and phosphorus concentrations, are presented in Table 5. Statistical analysis revealed no significant differences (P>0.05) amongst treatment groups for any of the measured parameters, indicating that varying dietary NDF to starch ratios did not significantly influence blood metabolite profiles or mineral homeostasis in early lactating crossbred cows.

Serum glucose concentrations for T1, T2 and T3 were 67.84, 59.67 and 59.48 mg/dL, respectively, with no significant differences amongst treatments. These values fall within the normal physiological range for lactating dairy cattle (45-75 mg/dL, Kaneko et al*.,* 2008), indicating adequate energy status across all dietary treatments. These findings are consistent with Ranathunga et al. (2010) and Rottman et al. (2015) who reported no effects of varying NDF to starch ratios on plasma glucose concentrations.

Serum total protein concentrations ranged from 7.78 to 8.15 g/dL across treatments, with no significant differences observed. These values are within the normal physiological range for dairy cattle (6.0-8.5 g/dL, Cozzi et al*.,* 2011), suggesting adequate protein nutrition and normal protein metabolism across all experimental groups. The similar total protein concentrations across treatments indicate that variations in carbohydrate composition did not adversely affect protein metabolism or nutritional status. These results were consistent with the studies of Chacko (2015) and Akhlaghi et al. (2022), in which the serum total protein showed similar values across the treatment groups.

Blood urea nitrogen concentrations for T1, T2 and T3 were 26.39, 29.14 and 27.12 mg/dL, respectively, with no significant differences amongst treatments. These values fall within the normal range for lactating dairy cattle and are consistent with the findings of Ranathunga et al. (2010) and Zambom et al. (2012), who reported no effects of varying NDF to starch ratios on blood urea nitrogen. The similar BUN concentrations across treatments suggest balanced nitrogen metabolism, with no indication of

Table 5. Blood biochemical parameters of the experimental animals maintained on the three experimental rations, %

Parameters	Dietary treatments			P value
	T1	T2	T3	
Glucose (mg/dL)	67.84±2.87	59.67±3.48	59.48±1.02	0.070
Total protein (g/dL)	8.00±0.38	8.15±0.28	7.78±0.16	0.671
Blood urea nitrogen (mg/dL)	26.39±1.51	29.14±2.00	27.12±1.59	0.515
Calcium (mg/dL)	8.90±0.30	8.78±0.24	8.94±0.16	0.888
Phosphorus (mg/dL)	7.16±0.46	6.62±0.55	6.09±0.25	0.246

Values are mean ± SE of six observations; P>0.05 (non-significant)

excessive protein degradation or inadequate microbial protein synthesis in any dietary group.

Serum calcium concentrations ranged from 8.78 to 8.94 mg/dL, whilst phosphorus concentrations ranged from 6.09 to 7.16 mg/dL across treatments, with no significant differences observed for either mineral. Both calcium and phosphorus concentrations remained within normal physiological ranges for lactating dairy cattle, indicating adequate mineral nutrition and normal mineral homeostasis across all dietary treatments. These findings suggest that variations in dietary NDF to starch ratios did not adversely affect calcium and phosphorus absorption, metabolism or retention. The maintenance of normal mineral status is particularly important during early lactation when demands for these minerals are elevated due to milk production and potential mobilisation of skeletal reserves.

Summary

Dietary NDF to starch ratios (1.17, 1.58 and 2.08) in isonitrogenous and isocaloric concentrates fed with paddy straw had no significant effect on body weight, body condition score, or blood biochemical parameters in early lactating crossbred cows. Hence, the NDF to starch ratios between 1.2 and 2.0 can be safely used in early lactation rations without compromising metabolic health or body condition.

Acknowledgements

The authors are grateful to Kerala Veterinary and Animal Sciences University for providing the necessary facilities and support for conducting this research. The assistance provided by the staff of University Livestock Farm and Fodder Research Development Scheme, Mannuthy, is thankfully acknowledged.

Conflict of interest

The authors declare that they have no conflict of interest.

References

Akhlaghi, B., Ghasemi, E., Alikhani, M., Ghaedi, A., Nasrollahi, S. M. & Ghaffari, M. H. (2022). Influence of reducing starch in diets with similar protein and energy contents on lactation performance, ruminal fermentation, digestibility, behaviour, and blood metabolites in primiparous and multiparous dairy cows. *Veterinary Medicine and Science*, *8*(2), 808–821. https://doi.org/10.1002/vms3.722

AOAC Association of Official Analytical Chemists. (2016.) *Official methods of analysis.* (20th ed.). AOAC International. Association of Official Analytical Chemists, Washington DC, 1885p.

Beckman, J.L. & Weiss, W.P. (2005). Nutrient digestibility of diets with different fibre to starch ratios when fed to lactating dairy cows. *Journal of Dairy Science. 88(3)*: 1015–1023. https://doi.org/10.3168/jds.S0022-0302(05)72769-7

Chacko, B. (2015). *Evaluation of complete feeds with varying levels of neutral detergent fibre for lactating dairy cows* (Doctoral dissertation). Kerala Veterinary and Animal Sciences University, Pookode. India.

Cozzi, G., Ravarotto, L., Gottardo, F., Stefani, A.L., Contiero, B., Moro, L., Brscic, M. & Dalvit, P. (2011). Reference values for blood parameters in Holstein dairy cows: effects of parity, stage of lactation, and season of production. *Journal of Dairy Science, 94*(8), 3895–3901. https://doi.org/10.3168/jds.2010-3687

Ensminger, M. E., Oldfield, J. E., & Heineman, W. W. (1990). *Feeds and Nutrition.* (2nd Ed.), The Ensminger publishing company.

Fiske C.H., & Subbarow, Y. (1925). The colorimetric determination of phosphorus. *Journal of Biological Chemistry*, 66, 375–400.

Goering, H. K. & Van Soest, P.J. (1970). *Forage Fiber Analyses (Apparatus, Reagents, Procedures and Some Applications)*. US Government Printing Office. https://www.govinfo.gov/content/pkg/GOVPUB-A-PURL-gpo24229/pdf/GOVPUB-A-PURL-gpo24229.pdf

Indian Council of Agricultural Research. (2013). *Nutrient Requirements of cattle and buffalo*. (3rd Ed.), ICAR.

Jong, H.H. & Vegeter, J.J. (1950). Determination of serum proteins with the biuret test. *Pharmaceutisch Weekblad*. 85, 755-764.

Kaneko, J.J., Harvey, J.W. & Bruss, M.L. (2008). *Clinical Biochemistry of Domestic Animals*. (6th Ed.). Academic Press. https://doi.org/10.1016/B978-0-12-370491-7.X0001-3

Morin, L.G. (1974). Direct colorimetric determination of serum calcium with o-cresolphthalein complexone. *American Journal of Clinical Pathology, 61*(1), 114–117.

National Research Council. (2001). *Nutrient requirements of dairy cattle* (7th Ed.). National Academies Press. https://doi.org/10.17226/9825

Ranathunga, S.D., Kalscheur, K.F., Hippen, A.R. & Schingoethe, D.J. (2010). Replacement of starch from corn with nonforage fiber from distiller's grains and soyhulls in diets of lactating dairy cows. *Journal*

*of Dairy Science. 93*9(3), 1086–1097. https://doi.org/10.3168/jds.2009-2332

Rottman, L.W., Ying, Y., Zhou, K., Bartell, P.A. & Harvatine, K.J. (2015). The effects of feeding rations that differ in neutral detergent fiber and starch concentration within a day on production, feeding behavior, total-tract digestibility, and plasma metabolites and hormones in dairy cows. *Journal of Dairy Sciences. 98*(7), 4673–4684. https://doi.org/10.3168/jds.2014-8859

Sahib, L. (2024). *Standardisation of nutrient content of straw-based total mixed rations for crossbred dairy cows* (Doctoral dissertation). Kerala Veterinary and Animal Sciences University, Pookode.

Smijisha, A.S. (2012). *Body condition score system for predicting performance of crossbred cattle* (Doctoral dissertation). Kerala Veterinary and Animal Sciences, University, Pookode.

Snedecor, G.W. & Cochran, W.G. (1994). *Statistical Methods*. (8th Ed.). Iowa State University Press.

Tharangani, H., Lu, C., Zhao, L., Ma, L., Guo, X., Weiss, W.P. & Bu, D. (2020). Estimation of between-cow variability in nutrient digestion of lactating dairy cows fed corn-based diets. *Animals* 10(8), 1363. https://doi.org/10.3390/ani10081363

Trinder, P. (1969). Determination of glucose in blood using glucose oxidase with an alternative oxygen acceptor. *Annals of Clinical Biochemistry*, *6*(1), 24–27.

Zambom, M. A., Alcalde, C. R., Kazama, D. C. S., Martins, E. N., Hashimoto, J. H., Matsushita, M., Ramos, C. E. C. O. & Grande, P. A. (2012). Soybean hulls replacing ground corn in diets for early lactation Saanen goats: Intake, digestibility, milk production, and quality. *Revista Brasileira de Zootecnia, 41*(6), 1525–1532. https://doi.org/10.1590/S1516-35982012000600029 ■