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The impact of various protein concentrations in total mixed ration on rumen fermentation and haemato-biochemical indicators in Vechur cattle[#]

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Abstract

A feeding trial of four months duration was carried out in Vechur cattle to analyse the impact of various protein concentrations in total mixed ration on rumen fermentation and haemato-biochemical parameters. Fifteen Vechur cattle between the ages of six and ten months were chosen from Vechur Cattle Conservation Unit, Mannuthy and were randomly allotted to three dietary treatments, T1 – Total mixed ration containing 16 per cent CP and 60 per cent TDN, T2 – Total mixed ration containing 14 per cent CP and 60 per cent TDN and T3 – Total mixed ration containing 12 per cent CP and 60 per cent TDN. All the dietary treatments were isocaloric. Rumen fermentation parameters such as rumen pH and total volatile fatty acid did not show any significant difference among the treatment groups, whereas rumen ammonia nitrogen was significantly higher (P<0.01) in T1, compared to T2 and T3. The mean per cent of methane emission levels were similar among the treatment groups. The haemato-biochemical parameters were analysed at the beginning and at monthly interval and the values were comparable among the treatment groups. But the BUN concentration was higher in T1 compared to T2 and T3 (P<0.01). Therefore, it could be resolved that Vechur cattle can be reared on TMR containing 12 per cent CP and 60 per cent TDN without any negative effects on the health of animals.

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Vechur cattle are the only recognised indigenous cattle breed of Kerala. Vechur cattle are presently listed under the critically maintained breed category by Food and Agriculture Organisation (Shashidharan *et al*., 2011). According to the 20th livestock census, India has 142.11 million indigenous/non-descript cattle. India has a large number of indigenous cattle and extensive animal genetic resources. The preservation and conservation of indigenous cattle breeds have gained priority in the recent past. The total number of Vechur cattle in Kerala is assessed to be 2000 animals (Iype, 2013).

The protein requirement of ruminants encompasses the requirement of the rumen microorganisms to maintain optimum growth and proliferation in the rumen and the need of the host animals for various physiological functions in the body. Ruminal microbial synthesis provides ruminants with 50–100 per cent of their daily protein needs. Protein supplementation is costly and can result in excess nitrogen (N) excretion (Zhang *et al*., 2017). Proper determination of protein requirement of animals is crucial for maximising production and minimising nitrogen input in dairy production systems. The reports on rumen fermentation parameters and haemato-biochemical parameters of Vechur cattle are scanty. Hence the research work was envisaged to study the influence of various protein concentrations in complete feed block / total mixed ration on rumen fermentation parameters and haemato-biochemical parameters in Vechur cattle.

Materials and methods

Fifteen Vechur cattle of six to ten months of age were selected from Vechur Cattle Conservation Unit, CASAGB, Kerala Veterinary and Animal Sciences University, Mannuthy Kerala, India and housed in the experimental shed with facilities for individual feeding and watering. Stall-feeding was practiced throughout the experimental period. They were divided into three groups of five animals each as uniformly as possible. All the experimental animals were fed with complete feed block/ total mixed ration (TMR) with a concentrate: roughage ratio of 70:30. They were divided into three groups of five animals each and were allotted randomly to one of the three dietary treatments T1, T2 and T3; T1 - Total mixed ration containing 16 per cent CP and 60 per cent TDN, T2 - Total mixed ration containing 14 per cent CP and 60 per cent TDN and T3 - Total mixed ration containing 12 per cent CP and 60 per cent TDN. Feeding trial for a period of 120 days was carried out using total mixed ration. Clean fresh

Table 1. Ingredient composition of complete feed block

Ingredient (%)	Percentage composition of compound feed mixture		
	T_1	T_2	T_3
Maize	26	24.5	26
Rice Polish	6.5	7.5	8
De-oiled Rice Bran	5.5	5.5	6.5
Alfalfa pellet	15	9	5.5
Black Gram Husk	1.5	6	8
Corn gluten fibre	8	9.5	7
Coconut Oil Cake	3.5	4	5
Paddy Straw	30	30	30
Calcite	1.5	1.5	1.5
Salt	0.5	0.5	0.5
Mineral mixture	2	2	2
Total	100	100	100
Vitamin AB2D3K g/100 kg	20	20	20

drinking water was offered to all the animals *ad libitum.* Weighed quantities of TMR were fed individually based on the requirement of all the animals and the balance feed in the manger was collected manually and weighed twice a day, in the morning and afternoon at 9 AM and 2 PM, respectively. Representative samples of experimental feed were analysed for proximate principles as per the methods of the Association of Official Analytical Chemists (AOAC, 2016). The ingredient composition of rations is depicted in Table 1. Blood samples were collected from all the animals at the beginning and then at monthly intervals to estimate blood urea nitrogen (modified Berthelot method), haemoglobin (cyanmethemoglobin method), protein (Biuret method), glucose (GOD-PAP methodology), creatinine, albumin, globulin and albumin: globulin ratio (AOAC, 2016). Serum minerals such as calcium, phosphorous, magnesium, copper and zinc were estimated by atomic absorption spectrophotometry (AOAC, 2016). Rumen gas samples were collected in 50 ml sterile syringe by rumen puncture using 16 gauge needles from all the animals. Samples were collected at four hours after feeding. The concentration of methane (percentage) in the total gas produced was determined by using a methane analyser (0-100%; Precision Equipment Private Limited) at Central Instrumentation Laboratory, CVAS, Mannuthy (Sadan *et al*., 2018; Rani *et al.* 2022). Rumen liquor was collected at the end of the feeding trial from all the animals in each treatment group, two hours after feeding using a stomach tube in a pre-warmed thermos flask at 39 °C and brought to the laboratory and subjected to further analysis. Samples were analysed for pH using digital pH meter and rumen ammonia nitrogen by colorimetry (Beecher and Whitten, 1970) using UV spectrophotometer. The molar concentrations of total volatile fatty acids were estimated using gas liquid chromatography (Nucon 5765 EPC gas chromatograph). Data obtained on the various parameters during the course of the experiment were analysed statistically as per Snedecor and Cochran (1994) by using the software statistical package for service solutions (SPSS) version 24.0.

Results and discussion

The nutrient composition of complete feed block/ TMR has been presented in Table 2.

Data on the rumen fermentation parameters such as rumen pH, rumen ammonia nitrogen and TVFA of rumen liquor collected from experimental Vechur cattle is given in Table 3. The data revealed that rumen pH recorded for animals retained on treatments T1, T2 and T3 were 7.36, 7.25 and 7.32, respectively. The corresponding values for total

Table 2. Chemical composition[1] of total mixed ration

Nutrients (%)	T1	T2	T3
Dry matter	91.88 ± 0.18	91.66 ± 0.13	91.50 ± 0.23
Organic matter	90.03 ± 0.16	90.41 ± 0.05	90.57 ± 0.09
Crude protein	16.31 ± 0.31	14.12 ± 0.12	12.55 ± 0.19
Ether extract	3.40 ± 0.07	3.54 ± 0.09	3.57 ± 0.05
Crude fibre	13.76 ± 0.04	13.55 ± 0.03	13.72 ± 0.04
Total ash	9.97 ± 0.21	9.59 ± 0.08	9.43 ± 0.10
Nitrogen free extract	56.57 ± 0.50	59.19 ± 0.20	60.74 ± 0.21
Acid insoluble ash	5.23 ± 0.07	4.60 ± 0.07	3.83 ± 0.04
Calcium	1.13 ± 0.06	0.94 ± 0.07	1.06 ± 0.06
Phosphorous	0.46 ± 0.02	0.47 ± 0.02	0.49 ± 0.02
Neutral detergent fibre (NDF)	43.64 ± 0.16	43.50 ± 0.17	44.55 ± 0.27
Acid detergent fibre (ADF)	25.91 ± 0.05	25.61 ± 0.08	28.31 ± 0.05
Total digestible nutrients (TDN)	64.55 ± 0.71	65.21 ± 1.33	63.93 ± 1.58

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

Table 3. Rumen fermentation parameters[1] of experimental Vechur cattle

Parameters	T1	T2	T3	P- value
Mean per cent of methane emission	27.47 ± 0.14	27.23 ± 0.19	27.04 ± 0.14	0.190^{ns}
Rumen pH	7.36 ± 0.04	7.25 ± 0.09	7.32 ± 0.04	0.485^{ns}
Rumen ammonia nitrogen (mg/100mL)	19.05^{a} ± 0.07	18.33^{b} ± 0.05	17.19^{c} ± 0.09	0.000*
TVFA (m*M*/L)	78.82 ± 0.37	79.32 ± 0.28	79.55 ± 0.28	0.274^{ns}

[1]Mean values are based on five replicates with SE. *Means having different superscripts within a row differ significantly at one per cent level (P < 0.01). ns- non significant

volatile fatty acid (TVFA) were 78.82, 79.32 and 79.55 mM/L respectively and on statistical analysis it was noted that pH and TVFA were similar (P>0.05) among different treatment groups. Purushothaman (2018) observed comparable values of rumen ammonia nitrogen in Vechur heifers fed with TMR containing soya sauce waste (TMR 1 CP-15.2 per cent) and tapioca starch waste (TMR 2 with CP-14.7 per cent). Gowda (2019) noted comparable values of rumen pH in crossbred cattle fed TMR containing straw based densified complete feed block (DCFB), DCFB incorporating 20 per cent *dhanvantharam* oil residue and DCFB incorporating 20 per cent tapioca starch waste.

Rumen ammonia nitrogen (mg/100 ml) for animals maintained on treatments T1, T2 and T3 were 19.05, 18.33 and 17.19, respectively. Statistical analysis of the data revealed that rumen ammonia nitrogen was significantly higher (p<0.01) in T1, compared to T2 and T3. Similarly, Xia *et al*. (2018) also observed that rumen ammonia nitrogen concentration (P<0.01) was significantly higher in the bulls receiving mixed feed containing medium CP (12.35 per cent CP and 5.17 per cent RDP) and high CP (14.24 per cent CP and 6.03 per cent rumen degradable protein (RDP)) diets than in those receiving the low CP (10.21 per cent CP and 4.22 per cent RDP).

The mean per cent of methane emission levels for animals maintained on treatments T1, T2 and T3 were 27.47, 27.23 and 27.04, respectively. On statistical analysis there was no significant difference (P>0.05) among the treatment groups. In accordance with the results obtained in the present study Sadan *et al.* (2018) also reported comparable mean per cent of methane emission levels in Vechur cattle (27.34).

The haemato-biochemical parameters of the experimental Vechur cattle are listed in Table 4. The monthly average haemoglobin level of the experimental Vechur cattle retained on treatments1, 2 and 3 ranged from 9.54 to 10.04, 9.69 to 10.10 and 9.87 to 10.18 g/dL, respectively. No discernible distinction (P>0.05) could be made between the treatment groups. The values in the current study fall in the normal range (8.0-15 g/dL) for the species (Kaneko *et al*., 2008). Rani *et al*. (2016) also observed comparable values in crossbred calves when fed diet containing 24.34 and 24.71 per cent CP.

The monthly average serum glucose concentrations of experimental Vechur cattle ranged from 64.72 to 70.29, 65.69 to 72.75 and 60.87 to 71.55 mg/dL, respectively for treatments 1, 2 and 3. The values obtained were in the normal physiological range in all the three groups (Kaneko *et al*., 2008). Analysis of the data revealed that there was no significant difference (P > 0.05) in glucose concentrations between the three dietary treatments. These values are consistent with the findings of Kim *et al*. (2018) in Hanwoo steers fed TMR. Similarly, Rani *et al*. (2016) also observed comparable glucose concentrations when fed a diet containing 24.34 and 24.71 per cent CP and Rani *et al*. (2019) also reported similar comparable glucose concentration in crossbred calves when fed a diet having 24.34 per cent CP.

The blood urea nitrogen values of experimental animals at the beginning of experiment were 10.57, 10.39 and 10.65 mg/dL for group T1, T2 and T3, respectively. At the start of the experiment, there was no significant difference (P>0.05) in the BUN levels between the groups. From the first month onwards the

Table 4. Haemato-biochemical parameters[1] of experimental Vechur cattle

Parameter	Month	T1	T2	T3	p- value
Haemoglobin (g/dL)	0	9.54 ± 0.20	9.69 ± 0.20	9.87 ± 0.33	0.649 ^{ns}
	1	9.89 ± 0.19	9.93 ± 0.51	10.07 ± 0.43	0.950 ^{ns}
	2	9.83 ± 0.12	9.99 ± 0.22	10.14 ± 0.19	0.482 ^{ns}
	3	9.88 ± 0.07	9.93 ± 0.07	10.03 ± 0.15	0.625 ^{ns}
	4	10.04 ± 0.12	10.10 ± 0.06	10.18 ± 0.15	0.711 ^{ns}
Glucose (mg/dL)	0	70.29 ± 2.47	72.75 ± 1.36	71.55 ± 1.43	0.644^{ns}
	1	68.75 ± 2.26	71.66 ± 1.44	68.23 ± 1.82	0.404 ^{ns}
	2	66.49 ± 2.26	68.82 ± 1.44	63.64 ± 1.82	0.269 ^{ns}
	3	65.52 ± 2.70	66.52 ± 1.83	62.46 ± 2.09	0.434 ^{ns}
	4	64.72 ± 2.75	65.69 ± 1.99	60.87 ± 2.06	0.324 ^{ns}
Blood urea nitrogen (mg/dL)	0	10.57 ± 0.21	10.39 ± 0.15	10.65 ± 0.14	0.555 ^{ns}
	1	14.57^{a} ± 0.26	12.83^{b} ± 0.17	10.49^{c} ± 0.25	0.010 *
	2	14.87^{a} ± 0.19	12.53^{b} ± 0.22	10.34^{c} ± 0.19	0.010 *
	3	14.64^{a} ± 0.14	12.38^{b} ± 0.14	10.72^{c} ± 0.39	0.010 *
	4	14.79^{a} ± 0.22	12.45^{b} ± 0.21	10.19^{c} ± 0.34	0.010 *
Total protein (g/dL)	0	6.57 ± 0.11	6.87 ± 0.12	6.95 ± 0.17	0.145 ^{ns}
	1	6.70 ± 0.06	6.80 ± 0.11	6.83 ± 0.11	0.637 ^{ns}
	2	6.76 ± 0.08	6.84 ± 0.11	6.84 ± 0.08	0.765 ^{ns}
	3	6.86 ± 0.09	6.79 ± 0.06	6.88 ± 0.04	0.605 ^{ns}
	4	6.75 ± 0.14	6.79 ± 0.07	6.88 ± 0.05	0.608 ^{ns}
Albumin (g/dL)	0	3.23 ± 0.06	3.13 ± 0.05	3.28 ± 0.05	0.227 ^{ns}
	1	3.13 ± 0.04	3.18 ± 0.04	3.29 ± 0.04	0.052 ^{ns}
	2	3.12 ± 0.04	3.23 ± 0.09	3.34 ± 0.02	0.055 ^{ns}
	3	3.24 ± 0.04	3.29 ± 0.05	3.34 ± 0.04	0.373 ^{ns}
	4	3.22 ± 0.07	3.40 ± 0.04	3.39 ± 0.06	0.110 ^{ns}
Globulin (g/dL)	0	3.34 ± 0.09	3.74 ± 0.09	3.67 ± 0.19	0.121 ^{ns}
	1	3.56 ± 0.09	3.62 ± 0.12	3.53 ± 0.11	0.839 ^{ns}
	2	3.63 ± 0.06	3.62 ± 0.18	3.50 ± 0.09	0.702 ^{ns}
	3	3.62 ± 0.09	3.50 ± 0.09	3.54 ± 0.05	0.565 ^{ns}
	4	3.52 ± 0.15	3.39 ± 0.09	3.48 ± 0.07	0.690 ^{ns}
Albumin: Globulin ratio	0	0.97 ± 0.03	0.84 ± 0.02	0.91 ± 0.06	0.139 ^{ns}
	1	0.88 ± 0.03	0.88 ± 0.03	0.94 ± 0.03	0.436 ^{ns}
	2	0.86 ± 0.01	0.91 ± 0.06	0.96 ± 0.03	0.256 ^{ns}
	3	0.90 ± 0.03	0.94 ± 0.04	0.94 ± 0.02	0.478 ^{ns}
	4	0.92 ± 0.05	1.00 ± 0.04	0.98 ± 0.04	0.378 ^{ns}

[1]Mean values are based on five replicates with SE. *Means having different superscripts within a row differ significantly at one per cent level (P < 0.01). ns- non significant

values of BUN were higher in cattle fed T1 ration compared with those fed T2 and T3 (P<0.01). However, the values obtained were in the normal physiological range in all the three groups (Kaneko *et al*., 2008). The findings in the current study are in accordance with Chantiratikul *et al*. (2009) and Chumpawadee *et al*. (2009) who observed that increased CP levels (6, 8,10

Table 5. Blood mineral profile[1] of Vechur cattle maintained on dietary treatments.

Parameter	Month	T1	T2	T3	p- value
Calcium (mg/dL)	0	9.14 ± 0.13	9.37 ± 0.18	9.58 ± 0.20	0.252 ns
	1	9.17 ± 0.07	9.30 ± 0.14	9.13 ± 0.02	0.387 ns
	2	8.90 ± 0.40	8.95 ± 0.46	8.78 ± 0.46	0.962 ns
	3	8.77 ± 0.36	9.27 ± 0.16	8.90 ± 0.28	0.444 ns
	4	9.30 ± 0.31	9.08 ± 0.25	9.80 ± 0.24	0.190 ns
Phosphorous (mg/dL)	0	6.25 ± 0.40	7.23 ± 0.31	6.52 ± 0.58	0.304 ns
	1	6.73 ± 0.46	6.70 ± 0.37	6.48 ± 0.49	0.910 ns
	2	6.47 ± 0.13	6.34 ± 0.15	6.16 ± 0.08	0.241 ns
	3	6.18 ± 0.20	6.03 ± 0.16	5.83 ± 0.16	0.379 ns
	4	6.25 ± 0.03	7.23 ± 0.06	6.52 ± 0.09	0.116 ns
Magnesium (mg/dL)	0	2.44 ± 0.06	2.41 ± 0.08	2.40 ± 0.02	0.887 ns
	1	2.36 ± 0.05	2.28 ± 0.06	2.34 ± 0.04	0.546 ns
	2	2.27 ± 0.05	2.37 ± 0.05	2.32 ± 0.10	0.557 ns
	3	2.50 ± 0.01	2.36 ± 0.09	2.46 ± 0.02	0.211 ns
	4	2.45 ± 0.02	2.50 ± 0.04	2.41 ± 0.04	0.219 ns
Copper (ppm)	0	0.76 ± 0.01	0.89 ± 0.15	0.79 ± 0.06	0.372 ns
	1	0.80 ± 0.07	0.85 ± 0.13	0.85 ± 0.07	0.933 ns
	2	0.97 ± 0.02	0.88 ± 0.04	0.87 ± 0.04	0.053 ns
	3	0.94 ± 0.09	1.06 ± 0.23	0.96 ± 0.02	0.830 ns
	4	0.88 ± 0.04	0.85 ± 0.03	1.00 ± 0.09	0.199 ns
Zinc (ppm)	0	0.90 ± 0.03	0.93 ± 0.04	0.91 ± 0.03	0.819 ns
	1	1.01 ± 0.05	1.00 ± 0.04	1.01 ± 0.02	0.961 ns
	2	1.00 ± 0.04	0.94 ± 0.01	0.93 ± 0.03	0.148 ns
	3	0.97 ± 0.08	0.90 ± 0.04	0.96 ± 0.02	0.683 ns
	4	0.92 ± 0.03	0.92 ± 0.02	0.98 ± 0.04	0.255 ns

[1]Mean values are based on five replicates with SE. ns- non significant

and 12 per cent CP) in diet elevated the BUN concentration. The high concentration of BUN was associated with high CP in diet. Yuangklang *et al.* (2010) also observed linear increase in plasma urea nitrogen with rising protein levels in Brahmin bulls of about two years of age when fed with diet containing different protein levels (8, 10, 12 and 14 per cent crude protein). Similar result was also obtained by Queiroz *et al.* (2012) in crossbred Holstein × Gir heifers fed with increasing levels of crude protein (13, 15, 19 and 22 g/100 g of dry matter, DM) in the diet. Likewise, Sun and Christopherson (2005) as well as Promkot and Wanapat (2005) had noted a positive association between blood or plasma urea-nitrogen levels and dietary CP in ruminant animals.

The average serum total protein of experimental animals maintained on treatments1, 2 and 3 ranged from 6.57 to 6.86, 6.79 to 6.87 and 6.83 to 6.95 g/dL, respectively. The analysis of the data showed that there was no significant difference (P>0.05) in total protein values between the three dietary treatments. The values obtained were in the normal physiological range in all the three groups (Kaneko *et al*., 2008). In accordance with present results, Lohakare *et al*. (2006) reported that serum total protein was non-significant, in three to five month old cross-bred calves fed on different protein levels (100, 75 and 125 per cent of protein requirement) and the values were 63.30 ± 0.18, 64.20 ± 0.13 and 66.00 ± 0.14 g/L, respectively. Comparable values of

serum protein concentration were stated by Purushothaman (2018) in Vechur heifers and Gowda (2019) in cross bred heifers fed TMR.

The average serum albumin of Vechur cattle maintained on dietary treatments T1, T2 and T3 ranged from 3.12 to 3.24, 3.13 to 3.40 and 3.28 to 3.39 g/dL, respectively and serum globulin concentration ranged from 3.34 to 3.63, 3.39 to 3.74 and 3.48 to 3.67 g/dL, respectively. The albumin: globulin ratio ranged from 0.86 to 0.97, 0.84 to 1.00 and 0.91 to 0.98 for treatments 1, 2 and 3, respectively. Statistically there was no variation (P>0.05) observed in the albumin, globulin and albumin:globulin ratio in animals maintained on different dietary treatments. The values obtained were in the normal physiological range in all the three groups (Kaneko *et al*., 2008). Consistent with the present findings, Singh *et al*. (2016) likewise identified that there was no significant change in albumin, globulin, albumin:globulin ratio levels in crossbred female calves that were fed wheat (13.60, 13.72 per cent CP) or rice based (13.26, 13.66,13.32 per cent CP) complete ration as mash or block form. Comparable values of serum albumin concentration were stated by Nair (2021) in cross bred cows fed TMR containing 12, 14, 16 and 18 per cent CP.

Blood mineral profile

Table 5 contains information on blood mineral levels, such as serum calcium, phosphorus, magnesium, zinc and copper in Vechur cattle.

Animals fed the three experimental feeds, T1, T2, and T3 had monthly average serum calcium levels that ranged from 8.77 to 9.30 mg/dL, 8.95 to 9.37 mg/dL, and 8.78 to 9.80 mg/dL, respectively. In all three groups, the results were within the normal physiological range (Kaneko *et al*., 2008). The analysis of the data indicated that there was no significant difference (P>0.05) in serum calcium concentration between the three dietary treatments. Purushothaman (2018) also obtained almost similar serum calcium values in Vechur heifers fed TMR containing soya sauce waste (TMR 1 CP-15.2 per cent) and tapioca starch waste (TMR 2 with CP-14.7 per cent).

The monthly average phosphorus levels in animals fed on the three experimental rations T1, T2 and T3 were in the range of 6.18 to 6.73, 6.03 to 7.23 and 5.83 to 6.52 mg/dL, respectively and there was no significant change (P>0.05) between the three dietary treatments. According to Kaneko *et al*. (2008), the values of all three groups were within the normal physiological range. Rani *et al*. (2011) reported comparable serum phosphorous concentration in cross-bred calves fed with diet having CP per cent of 25.78, which was consistent with the findings of the current study.

In animals kept on treatments 1, 2, and 3, the average monthly serum magnesium levels ranged from 2.27 to 2.50 mg/dL, 2.28 to 2.50 mg/dL, and 2.32 to 2.46 mg/dL, respectively. There was no discernible difference (P>0.05) between the treatment groups. In all three treatments, the values were within the normal range (Kaneko *et al*., 2008). The values are comparable to those of Purushothaman (2018) who stated magnesium levels in the range of 2.35 to 2.42 mg/dL in Vechur heifers fed different TMR containing soya sauce waste (TMR 1 CP-15.2 per cent) and tapioca starch waste (TMR 2 with CP-14.7 per cent).

The monthly average serum copper levels in animals fed on the three experimental rations T1, T2 and T3 were in the range of 0.76 to 0.97, 0.85 to 1.06 and 0.79 to 1.00 ppm, respectively. In all three groups, the results were within the normal physiological range (Kaneko *et al*., 2008). Analysis of the data revealed that there was no significant difference (P>0.05) in copper values between the three dietary treatments. The values obtained in the current experiment are comparable to those of Purushothaman (2018) who stated copper values in the range of 1.55 to 1.68 ppm in Vechur heifers fed different TMR.

The monthly average serum zinc levels in animals fed on the three experimental rations T1, T2 and T3 were in the range of 0.90 to 1.01, 0.90 to 1.00 and 0.91 to 1.01 ppm, respectively. In all three groups, the results were within the normal physiological range (Kaneko *et al*., 2008). No significant difference (P>0.05) in zinc values was found between the

three dietary interventions, according to the statistical analysis. The findings of the current experiment are in complete agreement with the results of Lee *et al*. (2015) who reported zinc levels in crossbred cows in the range of 0.80 to 1.40 ppm when given TMR containing CP of 64 g/kg of TMR.

Conclusion

On summarising the overall results of present study, it is inferred that Vechur cattle can be economically reared on TMR containing 12 per cent CP and 60 per cent TDN without any adverse effects on rumen fermentation parameters and health status of animal.

Conflict of interest

The authors declare that they have no conflict of interest.

References

AOAC [Association of Official Analytical Chemists]. 2016. *Official Methods of Analysis*. (20th Ed.). Association of Official Analytical Chemists, Washington DC, 1885p.

Beecher, G.R. and Whitten, B.K. 1970. Ammonia determination: reagent modification and interfering compounds. *Analyt. Biochem*. 36: 243.

Chantiratikul, A., Chumpawadee, S., Kanchanamayoon, W. and Chantiratikul, P. 2009. Effect of dietary protein on nutrient digestibility and nitrogen metabolism in Thai-indigenous heifers. *J. Anim. Vet. Adv.* **8**: 297-300.

Chumpawadee, S., Chantiratikul, A., Rattanaphun, V., Prasert, C. and Koobkaew, K. 2009. Effects of dietary crude protein levels on nutrient digestibility, ruminal fermentation and growth rate in Thai-indigenous yearling heifers. *J. Anim. Vet. Adv.* **8**: 1131-1136.

Gowda, S. 2019. Evaluation of densified complete feed blocks in crossbred cattle. *M.V.Sc thesis*, Kerala Veterinary and Animal Sciences University, Pookode. 82p.

Iype, S. 2013. Vechur cattle-from extinction to sustainability. *Anim. Gen. Resour.* **52**: 105-110.

Kaneko, J.J., Harvey, J.W. and Bruss, M.L. 2008. *Clinical Biochemistry of Domestic Animals*. (6th Ed.). Elsevier Academic Press, USA, 916p.

Kim, T., Mayakrishnan, V., Lim, D.H., Yeon, J.H. and Back, K.S. 2018. Effect of fermented total mixed rations on the growth performance carcass and meat quality characteristics of Hanwoo steers. *Anim. Sci. J.* **89**: 606-615.

Lee, S.J., Kim, D.J., Guan, L.L., Ahn, S.K., Cho, K.W. and Lee, S.S. 2015. Effect of medicinal plant by-products supplementation to total mixed ration on growth performance, carcass characteristics and economic efficiency on the late fattening period of Hanwoo steers. *Asian-Aust. J. Anim. Sci*. **29**: 1729-1735.

Lohakare, J.D., Pattanaik, A.K. and Khan, S.A. 2006. Effect of dietary protein levels on the performance, nutrient balances, metabolic profile and thyroid hormones of crossbred calves. *Asian- Aust. J. Anim. Sci*. **19**: 1588-1596.

Nair, S.S., Ally, K., Dildeep, V., Mathew, J.J. and Gleeja, V.L. 2021. Influence of different levels of dietary protein on serum biochemical parameters of dairy cows during the transition period. *J. Vet. Anim. Sci*. **52**: 149-154.

Promkot, C. and Wanapat, M. 2005. Effect of level of crude protein and use of cottonseed meal in diets containing cassava chips and rice straw for lactating dairy cows. *Asian-Aust. J. Anim. Sci.* **18**: 502-511.

Purushothaman, S. 2018. Evaluation of rumen fermentation pattern and nutrient utilisation in Murrah buffalo, Vechur and crossbred cattle on different feeding

regimen. *Ph.D thesis,* Kerala Veterinary and Animal Sciences University, Pookode, 170p.

Queiroz, M.F.S., Berchielli, T.T., Signoretti, R.D., Ribeiro, A.F. and Morais, J.A.D.S. 2012. Metabolism and ruminal parameters of Holstein× Gir heifers fed sugarcane and increasing levels of crude protein. *Braz. J. Vet. Res. Anim. Sci*. **41**: 2101-2109.

Rani, K. J., Devi, P.G. and Mercy, A.D. 2011. Effect of restricted milk feeding on blood biochemical profile in cross bred calves. *J. Indian Vet. Ass.* **9**: 19-23.

Rani, K. J., Ally, K., Seethal, C.R., Bunglavan, S.J., Gangadevi, P. and Shyama, K. 2016. Dietary incorporation of Ksheerabala residue and its effect on nutrient utilisation, growth performance and blood biochemical parameters in crossbred calves. *Indian J. Anim. Nutr*. **33**: 383-387

Rani, K.J., Ally, K., Shyama, K. and Purushothaman, S. 2019. Nutritional evaluation and effect of feeding hydroponic fodder maize on the haemato-biochemical parameters in cross bred calves. *J. Vet. Anim. Sci*. **50**: 57-62.

Rani, K.J., Dildeep, V., Ally, K., Syam Mohan, K.M., Aravindakshan, T.V. and Anil, K.S. 2022. Effect of supplementation of biotin in total mixed ration of dairy cows on rumen fermentation characteristics by *in vitro* gas production technique. *J. Vet. Anim. Sci*. **53**: 285-291.

Sadan, T., Aravindakshan, T.V., Radhika, G., Anand, L.F. and Ally, K. 2018. Assessment of ruminal methanogen composition and methane emission levels in crossbred and Vechur cows under the same dietary regimen. *J. Vet. Anim. Sci*. **50**: 100-107.

Shashidharan, A., Singh, R., Bhasker, S. and Mohankumar, C. 2011. Physicochemical characterization and functional site analysis of lactoferrin gene of Vechur cow. *Bioinformation.* **6:** 275.

Singh, P.K., Chandramoni, Kumar, K. and Kumar, S. 2016. Effect of feeding wheat and rice straw based complete feed blocks on nutrients utilization, blood biochemical and growth performance in crossbred calves. *Indian J. Anim. Sci*. **86**: 771-776.

Snedecor, G.W. and Cochran, W.G. 1994. *Statistical Methods* (8th Ed.). The Iowa state university press, Ames, Iowa, U. S. A. 503p.

Sun, S. and Christopherson, R.J. 2005. Urea kinetics in wethers exposed to different ambient temperatures at three dietary levels of crude protein. *Asian-Aust. J. Anim. Sci*. **18**: 795-801.

Xia, C., Rahman, M.A.U., Yang, H., Shao, T., Qiu, Q., Su, H. and Cao, B. 2018. Effect of increased dietary crude protein levels on production performance, nitrogen utilisation, blood metabolites and ruminal fermentation of Holstein bulls. *Asian-Aust. J. Anim. Sci*. **31**: 1643.

Yuangklang, C., Vasupen, K., Wongsuthavas, S. and Bureenok, S. 2010. Effect of protein level on nutrient digestion and nitrogen utilisation in beef cattle. *J. Anim. Vet. Adv*. **9**: 1776-1779.

Zhang, B., Wang, C., Liu, H., Liu, J. and Liu, H. 2017. Effects of dietary protein level on growth performance and nitrogen excretion of dairy heifers. *Asian-Aust. J. Anim. Sci*. **30**: 386. ■