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EFFECTS OF CRUDE PROTEIN CONTENT, DRY-MATTER INTAKE AND HAY RATIO ON DIGESTIBILITY OF CRUDE PROTEIN IN A MIXED RATION FOR GROWING CALVES

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Introduction

The coefficients of digestibility of the nutrients in a diet have been recognized to decrease, when the feeding level has increased. It has been also generally accepted that the coefficient of digestibility of crude protein increased with an increment of its content in a diet⁷⁾. The effect of protein content on its digestibility, however, has been demonstrated in such a single diet as several kinds of hay and concentrate^{4,8-10)}. The digestibility of crude protein has been affected by the sources of protein supply¹³⁾ and hay: concentrate ratio of a ration^{1,3,5,11)}. When concentrate has been mixed with roughage to compose a ration, supplement of concentrate has influenced on the digestibility of nutrients in the ration^{1-3,5,11)}. FORBES *et al.*²⁾ have first named the influence of concentrate on the digestibility of a mixed ration as "associative effect" for the nutritive value. SEKINE *et al.*¹¹⁾ have reported that the influence of concentrate contributed much greater on the digestibility of crude protein than that of other nutrients in a ration.

Present study has purposed to study effects of crude protein content, level of dry-matter intake and hay ratio on the digestibility of crude protein in a mixed ration for growing calves.

Materials and Methods

Data were obtained from 46 digestion trials of 28 Holstein castrated male calves. Methods of digestion trials were elsewhere reported in detail¹¹⁾. The 2-week digestion trial started at 24 weeks of age. Rations used were

4 kinds of a mixture of first or second cut orchardgrass hay and commercial formula feed with the ratios of 6:4 and 4:6. Calves were fed the ration with the allowance⁹ to satisfy the metabolizable energy required for 0.75 kg of daily gain. Using a half number of calves used in the first digestion trial, a second trial started at 26 weeks of age to determine the digestibility of nutrients of hay as a sole diet.

Contents of crude protein in the ration varied from 8.8 to 17.1% on the dry-matter basis. Chemical composition of the ration were the same as those reported elsewhere¹¹. Amounts of dry matter consumed ranged from 64 to 98 g/kg^{0.75} per day.

Methods of statistical analyses were adopted from those described by STEEL and TORRIE¹².

Results and Discussion

Coefficient of digestibility for crude protein (%) significantly correlated with crude protein content (%), dry-matter intake (g/kg^{0.75}) and hay ratio of a ration as shown in Table 1. Crude protein content and dry-matter intake positively correlated to the digestibility of crude protein, while hay ratio of

TABLE 1. Coefficients of correlation among several parameters

	Hay ratio	Crude protein content	Dry-matter intake
Crude protein digestibility	-0.821	0.789	0.765
Hay ratio		-0.835	-0.803
Crude protein content			0.788

Figures are statistically significant at 1% level.

TABLE 2. Equations of multiple regression for the crude protein digestibility (CPdig, %), crude protein content (CP%, %), dry-matter intake (DMI, g/kg^{0.75}) and hay ratio (HR)

Equation	R	s. e.
1. CPdig = 1.66CP% + 0.324DMI + 9.7	0.823	±0.71
2. CPdig = 1.16CP% - 19.4HR + 56.7	0.842	±0.71
3. CPdig = 0.257DMI - 21.2HR + 52.2	0.839	±0.68
4. CPdig = -15.7HR + 0.88CP% + 0.182DMI + 42.7	0.850	±0.68

Equations and partial regression coefficients are statistically significant at 1% level.

a ration correlated negatively. Hay ratio also negatively correlated with crude protein content and dry-matter intake. Crude protein content positively correlated with dry-matter intake. Hay ratio has suppressed the digestibility of crude protein, while crude protein content and dry-matter intake have improved the digestion of crude protein.

Table 2 shows multiple regression equations of crude protein digestibility regressed on protein content, dry-matter intake and hay ratio. Coefficient of digestibility for crude protein regressed as significant on crude protein content and dry-matter intake as the equation 1. The standard partial regression coefficients were 0.497 and 0.376 for crude protein content and dry-matter intake, respectively. Crude protein content contributed more than dry-matter intake to the variation of crude protein digestibility. Then, regression analysis was carried out using crude protein content and hay ratio as independent variables. The statistically significant equation was obtained as shown in Table 2, for the equation 2. Hay ratio negatively effected on the crude protein digestibility as expected from the coefficients of correlation shown in Table 1. The equation had a higher multiple correlation coefficient than that obtained in the equation 1, while the standard error of the estimate was the same in both equations. Considering the standard partial regression coefficients for hay ratio and crude protein content (0.533 vs. 0.344), the contribution to the variation of crude protein digestibility was much larger in the hay ratio. When crude protein content was replaced by dry-matter intake, the regression equation had a little bit less multiple correlation coefficient and a somewhat lower standard error as shown for the equation 3. The standard partial regression coefficients showed that the hay ratio contributed much larger to the variation of crude protein digestibility than dry-matter intake (0.582 vs. 0.298). When crude protein digestibility regressed on crude protein content, dry-matter intake and hay ratio, significant regression equation 4 was obtained as shown in Table 2. The multiple correlation coefficient was the highest among the equations. The standard error of the estimate was 0.68 being the same as in the equation 3. The standard partial regression coefficients were 0.024, 0.211 and 0.432 for crude protein content, dry-matter intake and hay ratio, respectively. Of these variables, hay ratio had the highest contribution to the variation of crude protein digestibility. Crude protein content in a ration was found to have the lowest contribution to the variation of crude protein digestibility. Thus, crude protein content may have been concluded to have the least effect on the crude protein digestibility of the mixed ration and hay ratio the highest.

Summary

1. Data obtained from 46 digestion trials of 28 Holstein castrated male calves were analysed to determine effects of crude protein content, dry-matter intake and hay ratio on digestibility of crude protein in a mixed ration for growing calves.

2. The digestibility of crude protein positively correlated with crude protein content of a ration and dry-matter intake, and negatively with hay ratio of a ration.

3. Multiple regression analyses revealed that the digestibility of crude protein significantly regressed on crude protein content, dry-matter intake and hay ratio with the highest multiple correlation coefficient.

4. Considering standard partial regression coefficients, crude protein content has been concluded to have the least effect on the crude protein digestibility of the mixed ration for growing calves and hay ratio the highest.

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