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Untreated and formaldehyde treated protein concentrate mixture in the feeds of bulls

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Abstract Twelve bulls within the age period 113—294 days were used in an experiment in which the effect of formaldehyde treatment of protein on the live weight gain and feed utilization was studied. Their rations were a combination of a protein concentrate mixture, barley, mineral and vitamins according to nutrient requirements for a growth rate of 1 000 g/animal/day. Oats and barley straw was available *ad libitum*. In the experimental group the protein concentrate mixture was treated with formaldehyde, 0,88 g/100 g crude protein, whereas in the control group it was untreated. The proportion of treated protein was 45 % of the total protein in the diet. The study involved feeding trials, digestibility and nitrogen balance trials, and rumen fluid investigations.

The live weight gain of the bulls in the experimental group was 10 % better than that of the control group. The amount of feed used per kg live weight gain was 8 % less in the former group than in the latter. The differences in both cases were, however, not significant ($P > 0,05$). The differences in the digestibility and nitrogen balance and in the pH, ammonia and VFA concentrations of the rumen fluid between the groups were small and insignificant ($P > 0,05$).

Introduction

The protection of the dietary protein against ruminal degradation has, during recent years, been the object of many studies in order to improve the utilization of protein by ruminants. The first experiments concerning protected protein were performed with sheep (CHALMERS et al. 1954, FERGUSON et al. 1967). The results were very promising. The wool growth increased, in some case, even more than 120 %. When the effect of protected protein on the live weight gain of sheep and cattle or on milk production was examined, the results were not as positive. In some experiments the protection had an improving effect, but more often it had no effect (WALDO et al. 1973, SCHMIDT et al. 1973, WACHIRA et al. 1974, CLARK et al. 1974, SYRJÄLÄ et al. 1978 a, 1978 b). The differing results depend to a great degree on the differences in the composition of the ration, especially its protein/energy ratio, in the protein source and the technique and level used in protection. All these factors influence what benefit the protein protection gives.

The purpose of this experiment was to find out the effect of a protected protein concentrate mixture on the live weight gain and feed utilization of growing bulls. The study involved feeding trials, digestibility and nitrogen balance trials and rumen fluid investigations.

Experimental procedures

Feeds and feeding

The experiment was performed with 12 growing bulls which were divided by age, live weight, breed and sex into two comparable groups. The animals' mean age at the experiments beginning was 114 days and their mean weight 139 kg.

The experiment was of 6 months duration including an adaptation period of one week in which the bulls' diet was gradually changed to that of the experimental regime. The experimental diet consisted of oats and barley straw, barley and protein concentrate, plus additional minerals and vitamins. The animals received chopped straw *ad libitum*. The mixture was prepared from barley and protein concentrate, this fed at a level which satisfied the energy and protein demands of the bulls growing at a rate of 1 000 g/day (DAENICKE and ROHR 1974). Energy and protein obtainable from the straw was negligible. Chemical determinations were made on the feed by standard procedures (PALOHEIMO 1969) and the feeding values obtained from NJF Tables (ANON. 1969, Table 1).

The experimental groups protein concentrate was treated with formaldehyde, used at a rate of 0,88 g/100 g of protein. The control group was given

Table 1. The mean chemical composition of the feeds.

	Straw	Barley	Protein concentrate	
			untreated	formaldehyde treated
Dry matter, %	87,7	89,1	90,5	90,3
% of dry matter:				
Ash	5,5	3,6	21,6	22,0
Organic matter	94,5	96,4	78,4	78,0
Crude protein	3,6	12,8	41,4	41,6
Crude fat	2,0	2,4	5,4	4,9
Crude fibre	42,3	7,2	9,0	9,0
N-free extract	46,6	74,1	22,6	22,5
kg/f.u.	4,0	1,0	1,35	1,35
DM kg/f.u.	3,5	0,9	1,2	1,2
DCP % in DM	—	9,6	29,5(x	31,1(x
DCP g/f.u.	—	86	398(x	420(x

x) Values are calculated from digestibility coefficients obtained in this study.
f.u. = feed unit
DM = dry matter
DCP = digestible crude protein

the same protein concentrate but without formaldehyde treatment. The protein concentrate contained 25 % crushed soya, 21,5 % brewers mash, 15 % meat and bone meal, 8 % molasses, 10 % dried molasses beet pulp, 4 % urea, minerals and vitamins.

Feeding was twice daily at 8.00 and 15.00. Refusals were weighed after morning feeding. The bulls were weighed at the beginning of the experiment, fortnightly during it, and at it's end. Adjustments were made to the quantities of grain and protein concentrate according to these weights every week. 100 g/day of a commercial mineral mixture (Se-Terki) was given.

Physiological experiments

All animals spent a two week period in the physiological experiment. The first week was an adjustment period. Samples were taken during the second week. There was no alteration to the feeding regime. The physiological experiments consisted of digestibility and nitrogen balance investigations based on total collection methods and of rumen fluid studies. The rumen samples were taken by means of a hose connected to a vacuum pump via the mouth 3 times on the last day of the two week period.

1. In the morning before feeding, at 7.45
2. Two hours after the beginning of feeding, at 10
3. Five hours » » » , at 13

Determinations of rumen fluid pH and ammonia were made immediately after sampling, pH with a Beckman Model 76 meter, and ammonium nitrogen colorimetrically after centrifuging the sample at 2 000 r.p.m. for 10 mins (McGULLOUGH 1967). The volatile fatty acids (VFA) were determined by the gas chromatographic method (HUIDA 1973).

Results and discussion

Live weight gain and feed consumption

The mean live weight gain of the bulls in the experimental group was about 10 % better than that of the control group (Table 2, Fig. 1). The feed consumption of the animals was, however, in both groups about the same. The amount of feed used per kg live weight gain by the bulls of the experimental group was about 8 % less than by the control animals.

The physiological experiments decreased the growth rate in both groups, although the composition and the intake of the diets were the same during this period as during the whole experiment. This reduction of growth rate was, however, compensated for after the physiological study period. The mean live weight gain of the animals before that period, i.e. between 121—189 days of age, was in the experimental group 1 015 g and in the control group 939 g/day. During the physiological period it was 534 g and 492 g/day, respectively. After the physiological period the experiment continued 23 days more and during this time the mean live weight gain in the experimental group was 1 756 g and in the control group 1 496 g/day.

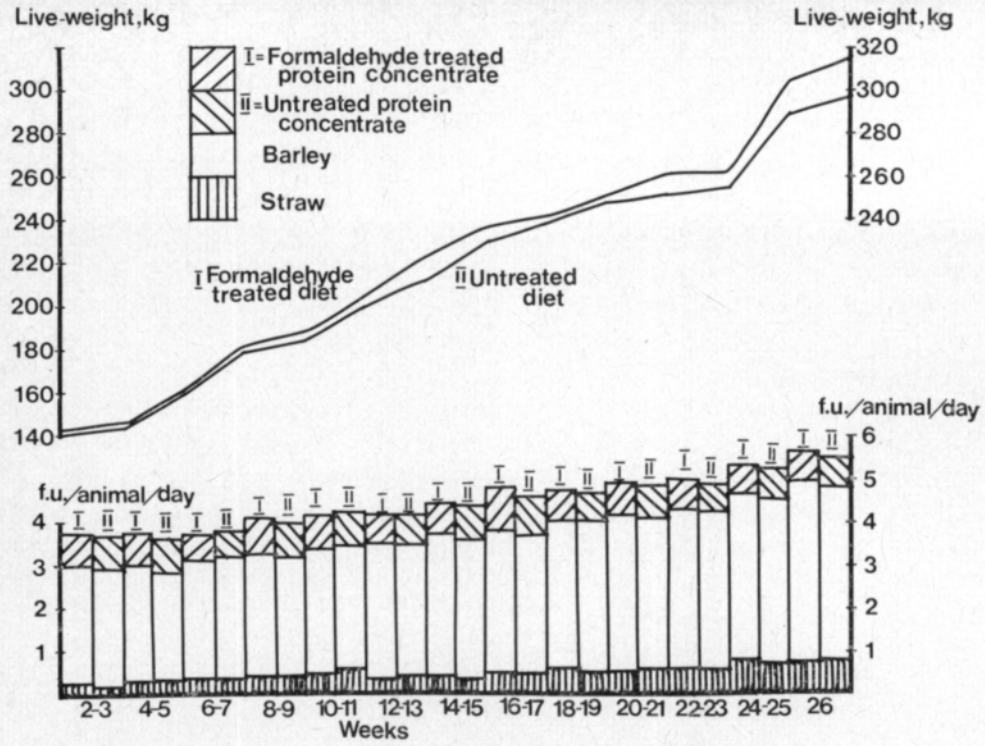

Fig.1. Live-weight gain and feed consumption on different diets

In previous investigations, where formaldehyde protected protein has been used in the diets of growing animals, there have been contradictory results. Formaldehyde treated ground-nut meal in calves diets, containing 12 % protein, increased growth by 9 %, while at the higher protein levels, 15 % and 19 %, formaldehyde treatment gave no significantly higher growth rates. Formaldehyde was used at a rate of 2 g/100 g of crude protein (FAICHNEY and DAVIES 1973). The calves growth was not different in the control group when compared with that of those on feed containing 26 % formaldehyde treated rape seed meal. Formaldehyde use in this experiment was 5,6 g/100 g of digestible crude protein (SHARMA et al. 1972). Growth and feed consumption were also found to be considerably smaller with beef animals, live weight 350 kg, on formaldehyde treated barley fed *ad libitum* (DAVIES and FAICHNEY 1973). Negative results were also obtained by SCHMIDT et al. (1974) with Holstein bulls fed soya beans treated with 40 % — formaldehyde at a rate of 1,5 and 3 ml/100 g of soya protein.

Digestibility and N-balance

The treatment with formaldehyde lowered the organic matter and crude protein digestibility of the ration but not significantly ($P > 0,05$, Table 3). The reason for such a slight decrease was the treatment with only 0,88 g formaldehyde/100 g protein concentrate and the fact, that the proportion of this treated protein in the whole diet was only 45 % (Table 2).

Table 2. Live weight gain and feed consumption.

	Experimental group	Control group
Number of animals	6	6
Age at start of exp., days	112	115
Age at end of exp., days	293	296
Live weight at start, kg	140	138
Live weight at end, kg	313	296
Live weight gain, g/day	956	873
DM supply, kg/day	5,26	5,30
from straw, %	32	32
from concentrates, %	68	68
Energy supply, f.u./day	4,29	4,23
from straw, %	11	12
from concentrates, %	89	88
Energy utilization, f.u./kg live weight gain	4,48	4,85
Crude protein supply, g/day	754	769
from straw, %	8	8
from barley, %	47	45
from protein conc., %	45	47
DCP, g/f.u.	140	142

Table 3. Digestibility, N balance and feeding values, calculated for complete diet.

	Experimental group	Control group
Digestibility, %		
Organic matter	69,1	69,5
Crude protein	62,1	63,5
N balance, g/day	16,9	15,6
Biological value	52	48

Nitrogen secretion in the urine of the experimental group was lower than that of the control group. This is the main reason why the nitrogen balance was also better in the experimental group. These differences were however not significant ($P > 0.05$).

In many studies formaldehyde treatment generally lowered feed digestibility, but N-retention has been seen to be same or a little better (Reis and Tunks 1969, Barry 1970, 1972, 1976, Poutiainen and Huida 1970, Faichney 1971, Brown and Valentine 1972, McRae et al. 1972, Syrjälä 1972, Barry and Fennessy 1973). The effect, however, has depended on the level of formaldehyde treatment and also the protein source.

Rumen fermentation

The mean pH value of all the rumen fluid samples was 6,94 (Table 4, Fig. 2). This relatively high pH value has probably been influenced by the neutralising effect of saliva as the rumen samples were taken via the mouth and at least

some saliva contamination was unavoidable. Although the rumen fluid pH values were higher in the animals in the experimental group than those of the control group the differences were not significant ($P > 0,05$). Other studies also confirm that formaldehyde treatment of feeds has no significant effect on the rumen pH values (BARRY 1975, DINIUS et al. 1975, KAUFMANN and HAGEMEISTER 1976).

Table 4. pH, ammonia and volatile fatty acids in the rumen fluid of bulls in different groups. The values are the averages of different sampling times.

	Experimental group	Control group
pH	6,94	6,94
NH_3-N, mg/100 ml	11,8	11,2
Total VFA, mmoles/100 ml	13,65	14,22
Acetic acid, molar %	67,4	68,1
Propionic acid »	15,8	15,4
Butyric acid »	13,9	13,6
Isovaleric acid »	1,7	1,5
Valeric acid »	1,3	1,4
Ratio acetic: propionic	4,3	4,4
» acetic: butyric	4,8	5,0
» propionic: butyric	1,1	1,1

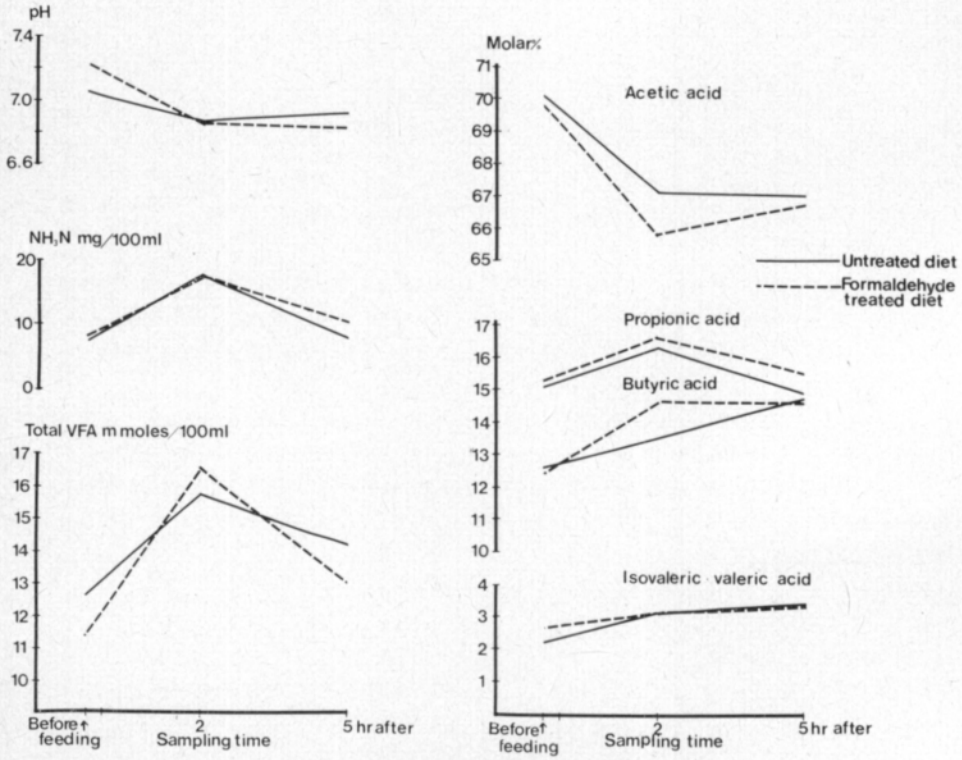

Fig. 2. pH, NH_3-N and VFA in the rumen fluid of bulls on different diets

Treatment with formaldehyde, in this experiment only slightly decreased the ammonia-N level in the rumen fluid. Differences in the values between the groups were not significant ($P > 0,05$). Generally formaldehyde treatment has been noticed to decrease the ammonia-N levels in the rumen (FAICHNEY and DAVIES 1973, DINIUS et al. 1975).

The total VFA concentration was lower, but not significantly ($P > 0,05$), in the rumen fluid of bulls in the experimental group than in those in the control group. The lowering effect of formaldehyde treatment on the rumen fluid VFA concentration has also been noticed by BARRY (1975) and DINIUS et al. (1975).

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Käsittelemätön ja formaldehydillä käsitelty valkuaistiiviste lihanaudan rehussa

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Tutkimuksen tarkoituksena oli selvittää formaldehydillä tapahtuvan rehuvalkuaisen suojauksen vaikutusta lihanaudan kasvuun ja rehun hyväksikäyttöön. Koe suoritettiin 12 mullilla ikävälillä 113—294 vrk. Väkirehuseos valmistettiin valkuaistiivisteestä, ohrasta sekä kivennäisistä ja vitamiineista, joiden keskinäinen suhde ja annostustaso muutettiin viikottain ravinnontarvetta vastaavaksi, kun kasvutavoite oli 1 000 g/el/pv. Kauran ja ohran olkea eläimet saivat vapaasti. Koeryhmän valkuaistiiviste oli käsitelty formaldehydillä, 0,88 g/100 g raakavalkuaista. Kontrolliryhmän tiiviste oli käsittelemätöntä. Formaldehydillä käsitellyn valkuaisen osuus oli vain 45 % koko rehuannoksen valkuaisesta. Ruokintakokeen lisäksi tutkimukseen kuului sulavuus- ja typpitasekokeet sekä pötsinestetutkimuksia.

Koeryhmän eläinten kasvu oli noin 10 % parempi kuin kontrolliryhman eläinten kasvu. Rehunkäyttö kasvukiloa kohti oli edellisessä ryhmässä noin 8 % vähäisempää kuin jälkimmäisessä ryhmässä. Mainitut erot eivät kuitenkaan olleet tilastollisesti merkitseviä. Myöskään rehun eri aineosien sulavuudessa ja typpitaseessa sekä pötsinesteen pH:ssa, ammoniakin ja haihtuvien rasvahappojen määrissä ei ollut merkitseviä eroja ryhmien välillä.