EFFECT OF MINERALS- NPN AND VİTAMIN B-COMPLEX ON DRY MATTER DIGESTIBILITY OF RICE STRAW BY CELLULOIYTIC RUMEN BACTERİA

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SUMMARY

The activity of four strains of cellulolytic rumen bacteria from Ruminococcus species were compared on rice straw in pure culture. The strains belong to *R. flavefaciens* (A2-10, 14 and 15) and *R. albus* (A2-16). Rice straw was employed as such and after addition of different levels f KCI (0,2;0,4 ; 0,6 and 0,8%); ferrous sulfate (0.1%); magnesium sulfate (0.I%); manganese chloride (0.1%); cobalt chloride (0.1%); urea; urea plus minaral mixture; ammonimum sulphate; ammonium sulphate plus mineral mixture; vitamin B-complex. The effect of treatment on the *in vitro* dry matter digestibility (IVDMD%) and volatile fatty aeids (VFA's) accumulation after 48 hrs. incubation of rice straw with the tested strains of cellulolytic bacteria were studied.

The results indicated that:

1. Addition of potassium chloride increased both IVDMD (%) and VFA's accumulation and acetic acid (%) after incubation with rice straw as compared to control. The level between. 0.4-0.6% KCI seemed to be the optimum level of addition for rumen bacterias.

2. Manganese chloride enhanced both IVDMD (%) and VFA's accumulation. Cobalt chloride and magnesium sulphate increased IVDMD (%) more than VFA's accumulation, however ferrous sulphate, increased VFA's accumulation more than IVDMD (%). Addition of trace elements increased acetic acid (%) and decreased the proportion of the other VFA's manganese chloride had better response in this respect followed by ferrous sulphate, cobalt chloride and magnesium sulphate respectivels.

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3. Ammonium sulphate increased IVDMD (%) of rice straw more than urea, however addition of mineral mixture did not improve IVDMD (%). On the other hand, it was found that the addition of mineral mixture greatly improved VFA's accumulation with both urea or ammonium sulfate.

4. Vitamin B- complex slightly increased IVDMD and VFA's accumulation from rice straw

INTRODUCTION

All over the world espacially in developing countries, (Turkey, Egypt Pakistan etc.) the gap between available and required amounts of animal feed is increasing rapidly. Under these conditions, the utilization of nontraditionally consumed field by products become obligation. It has been determined that some agricultural by products that have been utilized traditionally as fuel or are left in the soil as fertilizers can also be used in animal feed. Some of the are corn stalks and cobs, sorghum stalks, rice straw and hulls sugar cane bagasse and pith, cotton stalks. These by-products generally have low nutritive value due to their relatively high content ot lignocellulose low content of nitrogen, minerals and vitamins. Improving the nutritive value of these materials can be achieved by applying some physial and /or chemical and/or microbiological treatments, by adding the deficient nutrients and correcting the nutrient imbalance.

It was noted that NaOH treatment increased the *in vitro* dry matter digestibility of low guality roughages (Haşimoğlu, *et al.* 1969; 1972, 1982; Jackson 1977; Kolepfenstein, 1975 and Müller, 1978). On the other hand, the NaOH toreatment decreased the ability of microbes to digest fiber, however, it increased the possibility of fermantation to VFA's (Nour, 1980).

Inorganic elements are known to interact in complex-ways *in vitro* (Chicco, *et al* 1973; Ammerman and Miller, 1972) but have not been investigated throughly to determine interections on digestion of poor quality roughgages. Bales, *et al* (1978) noted that iron, strontium and zinc had no effect on dry matter disappepearence of milo stalks, however calcium and magnesium lowered the digestibility.

The presents work desceribes an investigation on the effect of some nutrients on the digestibility and fermantation of rice straw by cellulolytic rumen bacterias in pure cultures. The objective of the study was to found out the effect of;

1. Mineral salts of K, Fe-Mg, Mn and Co.
2. NPN sources from urea and ammonium sulphate with or without mineral mixture of Fe, Mg, Mn and Co.
3. Vitamin B complex on the activity of four strains of cellulolytic bacteria after 48 hr. incubation with rice straw.

MATERIALS AND MEHTHODS

Ruminococcus Blavefaciens -A_2 10-14 and 15 and *Ruminococcus albus* A_3 16 were previosuly isolated and identified by Nour and Latham, (1982) (Unpulelished data) from two cows fed long barley straw plus a concentrate mixture or barley-urea mixture. The organisms were grown using the Hungate technique of strict *aneorobic* culture as described by Bryant, (1972) in a broth medium, Rum 10 containing cellebiose, (Latham *et al* 1978) for 24 hr. in the incubator at 39°C The bugs were spinede down *aneorobically* by centrifugation at 4000 rpm. for lh. Decant supernatent resuspended by using autoclaved mineral solution (Tilley and Terry. 1963) with 25 % replaced by clarified rumen liquore. The optical density of each isolate in the resuspended media was adjusted to 0.2 and under Co_2 in tlhe incibator at 39°C.

Rice straw was ground (0.2 mm screen) before treatment. Fourten treatments were tested through this experiment. The *in vitro* dry matter digestibility of the treated and untreated rice straw (control) were compared by using the two stage technique of Tilley and Terry. (1963). Total and individual volatile fatty acide estimations after the first stage of incubation were made as-described by Thomson, *et al* (1978).

Analysis of variance and Duncan's multible range test were caried out according to Snedecor, (1959);

RESULTS AND DISCUSSION

The biotechnological conversion of cellulose into protein rich biomass can be accomplished directly by microorganisms. This biological conversion is accomplished primarily by rumen microorganisms. The cellulose is broken down to glucose and subsequantly converted VFA's and higher fatty acide, (Habson and Shaw, 1973). The fermantation products of cellulolytic rumen bacteria are acetic. propionic, butyric, succunic acids, ethanol and methane, (Oxford, 1964). Of these products, only acetic, butyric acide accumulate, the other substances participate in furter microbial activities. Propionic acid does not seem to be a significant direct product of cellulose fermantation but is derived from succinic acid by decarboxylation reactions of other bacterial species, (Johns, 1951).

In the present work, IVDMD, total VFA'sı and differential VFA's (%) were the selected criterias to study the effect of rice straw and some additions (minerals, NPN and vitamin B-complex) on the activity of cellulolytic rumen bacteria in pure cultures.

It is well known that NaOH treatment of poor quality roughages resulted in significant increase in the IVDMD °(%) and total VFA's accumulation after

Table 1. Composition of the incubation media used throughout the experiment

Treatment	Dried rice straw (g)	Incubation media (ml)	Stock solution (ml)	Composition of the stock solution
1- Control	0.2	20	1.0	— (W/v)[1]
2- 0.2 % KCL	0.2	19	1.0	4 % KCL (W/v)
3- 0.4 % KCL	0.2	19	1.0	8 % KCL (W/v)
4- 0.6 % KCL	0.2	19	1.0	12 % KCL (W/v)
5- 0.8 % KCL	0.2	19	1.0	16 % KCL (W/v)
6- 0.1 % $FeSO_4$	0.2	19	1.0	2 % FeSO (W/v)
7- 0.1 % $MgSO_4$	0.2	19	1.0	2 % $MgSO_4$ (W/v)
8- 0.1 % $MnCl_2$	0.2	19	1.0	2 % $Mncl_2$ (W/v)
9- 0.1 % $CoCl_2$	0.2	19	0.5	2 % $CoCl_2$ (W/v)
10- 0.125 % urea[2]	0.2	19.5	0.5	10 % $Wrea_2$ (W/v)
11- 0.55 % $(NH_4)So_4$	0.2	19.5	0.5	22 % $(NH_4)_2SO_4$ (W/v)
12- 0.125 % urea + mineral mixture	0.2	19.0 —	0.5	10 % Urea 0.5 Mixture of $FeSO_4$, 4%; $MgSO_4$, 4% $McnCl_2$, 4% and $CoCl_2$, 4%- (W/v)
13- 0.55 $(NH_4)_2SO_4$ + mineral mixture	0.2	19.0 —	0.5	22% $(NH_4)_2SO_4$ 0.5 Mixture of $FeSO_4$, 4%; $MgSO_4$, 4% $MnCl_2$, 4% and $CoCl_2$, 4%- (W/v)
14- 0.1 % vitamin B complex[3]	0.2	19.0 —	1.02 %	vitamin B complex (Previously prepared by BDH company) (W/v)

1 Weight/volume

2 Urea was Lildered

3 Vitamin B solution contained; (20 mg of each) thiamine hydrochloride, calcium D- pantothenate, nicotin amide, riboflavin and pyridoxine hydrochloride; 0.1 mg. vit. B_{12}; 1 mg P- aminobenzoik acid; 0.25 mg. biotin and 0.25 mg. folic acid dissolved in 100 ml. water.

incubation with cellulolytic bacteria in mixed culture (Haşimoglu *et al*, 1969) and in pure culture, (Nour, 1980 and Nour Latham, 1980). The NaOH treatment dissolved lignin and hemicellulose but not cellulose and the degree of solubulization depended on the level of alkali, (Jakson, 1977) and type of roughage. (Fisest, *et al*, 1970). Howewer it was found that beside raising by alkali treatment NaOH treatment of roughages decreased the ability of microbes to digest fiber, (Nour, 1980). Also the highes *concentration* of alkali inhibits the bacterial activity and hence

prevents the recycling of the fermantation process, (Bomar, 1981.) There fore in the present work an attent was made to enhance the activity of those microbes through natural treatments by addition of the probably deficient nutrients in the incubation media.

In this respect it was found that KCL (Tables 2 and 3), trace metals of Mg, Mn, Co and Fe (Tables 4) and NPN with or without mineral mixture (Tables 6 and 7) and vitamin B- complex (Tables 8 and) to a certain extent increased the activities of te cellulolytic bacteria, incubated with straw in pure culture.

Table 2. Effect of KCL on IVDMD (%) and total VFA's (M mol/ml. incubation media) accumulted froma rice straw after 48 hrs incubation with cellulolytic rumen bacteria in pure culture.[1]

Item	Strain No	Control	KCL % 0.2	0.4	0.6	0.8
IVDMD %	A_2 14	34.42	37.50	37.83	38.41	38.50
	A_2 10	34.24	38.97	38.41	38.43	39.21
	A_2 15	34.83	39.00	39.19	39.82	40.63
	A_2 16	34.81	38.60	40.85	40.52	39.81
	x∓S.D	34.58	38.52	39.07	39.30	39.54
		∓0.29	∓0.70	∓1.31	∓1.05	∓0.90
Total VFA's m mol/ml.	A_2 14	10.22	10.78	10.78	10.98	10.28
	A_2 10	10.12	11.49	11.17	11.03	11.09
	A_2 15	10.44	11.89	11.54	11.62	11.62
	A_2 16	10.48	11.45	12.41	11.32	11.82
		10.32	11.40	11.48	11.24	11.20
		∓0.17	∓0.46	∓0.68	∓0.30	∓0.69

1 Each value was an avarage of two experiments.

2 Strain No= *R. Flavefaciens* (A_2 14, 10 and 15): *R. Albus* (A_2 16)

The results showed that manganese sulphate greatly increased IVDMD (%) and VFA's concentrations accumulated after incubation. Bomer, (1981) noted that the fermantation was limited by the omission of the metals of Co, Cu, Fe, Fe, Mn, Mo and Zn. This conclusive evidence that Mn is strongly required and presence of Mn as the only trace element led to similar values as the medium containing all trace elements concerned (Bomer, 1981) These findings show that Mn holds a key position in the breakdown ofcellulose by cellulolytic bacteria.

The presence of ammonium sulphate in the medium increased dry matter digestibility and total VFA's more than urea as the source of nitrogen. This pro-

Tablo 3. Effect of different levels of potassium chloride on the differential VFA's after incubation of rice straw with cellulolytic rumen bacteria in pure cultures.[1]

Level of KCL %	Treatment	Differential VFA's % Acetic	Propionic	Iso-butyric	Butyric	Iso-valeric	Valeric
	A[1]	71.19∓1.40	18.00∓0.59	0.50∓0.05	8.52∓0.54	0.79∓0.54	0.98∓0.15
Control	B[1]	72.80∓1.40	17.50∓0.07	0.46∓0.01	7.62∓0.30	0.75∓0.09	0.87∓0.11
	%[1]	+2.20	—2.80	—8.0	—10.60	—5.1	—11.30
	A[1]	71.94∓1.07	17.78∓0.25	0.50∓0.04	8.33∓0.53	0.81∓0.10	0.91∓0.16
0.2	B[1]	72.86∓0.56	17.30∓0.10	0.47∓0.03	7.71∓0.42	0.75∓0.06	0.85∓0.10
	%[1]	+1.28	—2.70	—6.0	—7.4	—7.4	—6.6
	A[1]	71.40∓0.44	17.88∓0.28	0.51∓0.03	8.52∓0.43	0.81∓0.04	0.93∓0.08
0.4	B[1]	73.41∓0.87	17.03∓0.76	0.54∓0.03	7.53∓0.47	0.72∓0.07	0.84∓0.16
	%[1]	+2.86	—4.80	—.12.0	—12.0	—11.0	—9.7
	A[1]	71.04∓0.23	17.94∓0.15	0.51∓0.02	8.68∓.0.20	0.81∓0.07	1.02∓0.11
0.6	B[1]	73.57∓0.55	16.71∓0.36	0.46∓0.02	7.58∓0.38	0.74∓0.04	0.87∓0.12
	%[1]	+3.57	—7.00	—10.0	—12.7	—8.7	—15.0
	A[1]	71.26∓1.02	17.92∓0.51	0.51∓0.03	8.50∓0.40	0.81∓0.04	0.99∓0.11
0.8	B[1]	73.60∓0.09	16.78∓0.19	0.54∓0.03	7.64∓0.02	0.72∓0.05	0.83∓0.17
	%[1]	+3.28	—6.40	5.88	—10.0	—11.1	—16.2

[1]A-Initial, B-Final, %-Pencentage change from initial.

Each value was the average of four strains in two experiments.

Table 4. Effect of some trace elements on the IVDMD (%) and VFA's accumulation from rice straw after 48- hr. incubation with celluloyltic rumen bacteria in pure cultures.[1]

Item	Strain No.:	$FeSo_4$			$MgSo_4$			$MnCL_2$			$CoCL_2$		
		A	B	%	A	B	%	A	B	%	A	B	%
	A2 14	33.48	36.95	4.14	34.30	38.20	11.37	35.75	38.81	8.56	35.40	37.90	7.06
	A2 10	35.00	36.25	3.59	34.50	36.30	5.22	35.20	41.33	17.41	35.70	39.85	11.62
IVDMD	A2 15	33.25	36.50	9.77	35.70	40.35	12.75	33.25	40.26	21.08	34.40	41.30	20.06
%	A2 16	36.77	38.00	3.35	36.40	41.30	13.46	36.89	41.95	13.72	35.90	40.60	13.10
	∓ ∓S.D	35.13	36.93	5.21	35.23	39.01	10.70	35.27	40.59	15.19	35.35	39.91	12.96
		∓1.46	∓0.77	∓306	∓1.00	∓2.21	∓3.75	∓1.52	∓1.38	∓5.35	∓0.67	∓1.47	∓5.38
	A2 14	10.42	10.66	2.31	9.99	10.83	8.41	10.08	10.68	9.92	10.62	10.81	1.80
	A2 10	10.28	10.90	6.03	9.68	9.58	0.00	10.14	11.65	14.89	10.44	11.16	6.90
VFA's	A2 11	9.87	11.10	12.46	10.11	11.52	8.23	9.73	11.48	17.99	10.44	11.82	13.22
M mol/ml	A2 16	10.51	11.31	7.51	10.48	11.81	12.69	10.54	11.66	10.63	10.45	11.66	11.16
	S.D	10.19	10.90	7.08	10.07	10.94	7.33	10.12	11.37	13.36	10.49	11.36	8.27
		∓0.29	∓0.27	∓4.20	∓0.33	∓0.99	∓5.30	∓0.33	∓0.47	∓3.79	∓0.09	∓0.46	∓5.05

[1]A- Initial B-F al %- Percentage change from initial

Strain No : R flavefaciens (A_2 14, 10 and 15)

R. albus (A_2 16)

Each value was an avarge of two experiments.

Table 5. Effect of some trace elements on the differential volitile fatty acids (%) after incubation of rice straw with cellulolytic rumen bacteria in pure culture [1].

Mineral salts	Treatment	Acetic	Propinonic	Isobutric	Butyric	Isovaleric	Valeric
	A	71.00∓0.65	18.20∓0.27	0.50∓0.05	8.54∓0.34	0.78∓0.07	0.99∓0.10
$CoCL_2$	B	73.10∓0.24	17.12∓0.22	0.46∓0.02	7.72∓0.18	0.76∓0.09	0.85∓0.11
	%	2.96	—6.0	—8.0	—10.0	—3.0	—14.0
	A	71.44∓0.93	18.04∓0.18	0.49∓0.03	8.21∓0.48	0.78∓0.10	0.98∓0.17
$MnCL_2$	B	74.14∓1.92	17.25∓0.26	0.45∓0.02	7.68∓0.14	0.72∓0.07	0.84∓0.08
	%	3.8	—4.6	—8.2	—6.5	—7.7	—4.3
	A	72.13∓1.1	17.83∓0.32	0.49∓0.05	8.28∓0.61	0.77∓0.08	0.93∓0.28
$MgSO_3$	B	73.32∓0.18	17.04∓0.43	0.46∓0.03	7.61∓0.18	0.73∓0.08	0.84∓0.11
	%	1.7	—4.6	—6.1	—8.1	—5.3	—9.6
	A	71.36∓0.46	18.09∓0.36	0.49∓0.04	8.50∓0.33	0.83∓0.07	0.99∓0.16
$FeSO_4$	B	73.55∓0.79	17.19∓0.46	0.44∓0.02	7.65∓0.30	0.74∓0.08	0.88∓0.15
	%	3.07	—5.0	—10.2	—10.0	—10.8	—11.0

[1]A- Inital, B-Final, %- Percantege change from initial

Each value was an avarage of four strains of cellulolytic bacteria, (A_2 14, 10, 15 and 16).

bably due to higher release of urea to ammonia; however the addition of mineral mixture with urea increased both IVDMD (%) and total VFA's accumulation.

The addition of vitamin B- complex had a little role increasing the activity of microbes. This could be explained that vitamin B- complex is not essential for growth of the tested microorganisma. It was reported by Bomen, (1981) that the biomass content of cellulolytic rumen bacteria contain 3 times of Vitamin B1 and 5 times of vitamin B_2 more than its content in beef. The values were 286 vs 8 mg B1/100g and 980 Vs 18 mg of bacterial biomass and beef respectively.

Digestibility of rice straw improved from 34 up to percent when it is treated with Mn. It means untreated rice straw provides hardly enough nutrients to maintain the live weight of cattle; in other words it could covers its maintenance requirements. Assuming that 90 % of the feeds is used for maintenance, 10 % is available for increasing weight. If digestibility would be increased by 20 % and it would provide a two fold increase in nutrients avalilable for meat and milk production. Atention from now on should be focused on the best nutritional levels for optimum growth of cellulolytic bacteria in rumen of animal fed poor quality rougughages.

TURKISH SUMMARY

SELÜLOTİK RUMEN BAKTERİLERİNİN-PİRİNÇ SAMANININ KURU MADDE SİNDİRİMİ VE FERMANTASYONUNA, MİNARELLER, PTONB VE B VİTAMİNİ KOMPLEKSLERİNİN ETKİSİ

Saf Kültürlerden oluşan Ruminococcus selulotik Rumen bakterilerinin pirinç samanının sindirimi üzerindeki aktiviteleri incelenmiştir. Suşlar *R. flavefaciens* türüne mensub olup, bu suşları A_2-10, 14 ve 15 ve R. albus suşundan da A_2-16 oluşturmuştur. Pirinç samanı olduğu gibi alınmış veya farklı kimyasal maddeler, farklı düzeylerde ilave edilmişlerdir. KCL, (0.2; 0.4; 0.6 ve % 0.8), demir sülfat (% 0.1) ; magnezyum sülfat, (% 0.1); kobalt klorid, (%0.1); üre, ; üre artı mineral karışımı ve amonyum sülfat; amonyum sülfat artı mineral karışımı ve vitamin B kompleksi. Yukarıdaki muamelelerin pirinç samanının *in vitro* kuru madde sindirim düzeyine (KMSD) (%) ve uçucu yağ asitleri (UYA) prodüksiyonuna 48 saatik inkübasyon sonucu farklı suşların etkileri araştırılmış ve aşağıdaki sonuçlar saptanmıştır.

1. Potasyum klorit lilavesi sonucu KMSD (%) ve toplam UYA ve asetik asit konsantrasyonları (%) kontrole nisbetle daha fazla bulunmuştur. Pirinç samanına % 0.4-0.6 düzeyinde KCL ilavesinin bakteri aktiviteleri için optimum seviye olduğunu göstermiştir.

1 PTONB- Protein tabiatında olmayan nitrojenli bileşikler.

Table 6 Effect of source of NPN with or without mineral mixture on IVDMD (%) and VFA's accumulation from rice straw after 48 hrs. incubation with cellulolytic rumen bacteria in pure culture.[1]

		Urea			Ammonium			sulphate					
	Strain	Without mineral mix.			With mineral mix.			Without mineral mix.			With mineral mix.		
Item	No	A	B	%	A	B	%	A	B	%	A	B	%
	A_2 14	34.58	39.40	13.94	33.34	38.45	15.33	34.97	39.43	12.75	34.25	39.51	15.36
	A_2 10	35.10	38.39	9.37	34.50	39.31	13.94	34.21	41.55	21.46	34.46	40.49	17.51
IVDMD	A_2 15	34.23	41.75	21.97	33.59	40.49	20.54	35.32	41.90	18.63	33.46	41.00	22.53
%	A_2 16	35.51	40.84	15.01	35.21	38.08	10.99	36.02	41.20	14.38	35.06	42.95	22.50
	∓∓SD	34.86	40.10	15.07	34.16	39.33	15.20	35.13	41.02	17.61	34.31	40.99	19.47
		∓0.56	∓1.49	∓5.20	∓0.86	∓0.85	∓3.99	∓0.75	∓1.10	∓4.44	∓0.66	∓1.44	∓3.62
	A_2 14	9.82	10.62	10.81	8.92	9.69	8.60	10.56	10.89	3.14	9.73	10.79	10.89
	A_2 10	10.11	10.90	7.92	9.79	11.16	13.94	10.14	11.53	13.71	9.78	11.02	11.65
VFA's	A_2 15	10.58	11.57	9.36	9.45	11.36	20.21	10.65	11.76	10.42	9.45	11.36	19.08
m mol/ml.	A_2 16	10.09	11.44	13.37	10.00	11.06	10.10	10.82	11.53	6.56	10.00	11.95	19.95
	∓∓SD	10.15	11.13	10.37	9.54	10.82	13.19	10.53	11.43	8.46	9.74	11.28	15.39
		∓0.32	∓3.45	∓2.32	∓0.47	∓0.76	∓5.20	∓0.28	∓0.37	∓4.60	∓0.23	∓0.51	∓4.78

[1] A-Initial, B-Final, % Percentage change from initial

Strain No: R *Flavefaciens* (A_2 14, 10 and 15)

R. albus ($A_2$16)

Table 7. Effect of NPN sources without or with mineral mixture on the differential volatile fatty acid (%) after incubation of rice straw with cellulolytic rumen bacteria in pure culture.

Treatment	Treatment	Acetic	Propionic	Isobutyric	Butyric	Isovaleric	Valeric
	A	71.74∓0.96	17.80∓0.41	0.48∓0.03	8.29∓0.39	0.73∓0.09	0.95∓0.16
Urea	B	73.69∓0.97	16.54∓0.26	0.46∓0.03	7.77∓0.33	0.74∓0.09	0.87∓0.14
	%	2.72	—7.1	—4.2	—6.3	1.3	—8.4
Urea plus	A	71.15+0.57	18.02∓0.13	0.50∓0.03	8.48∓0.37	0.81∓0.10	0.99∓0.12
mineral mixture	B	73.96∓0.55	16.46∓0.32	0.43∓0.03	7.59∓0.26	0.71∓0.10	0.86∓0.10
	%	3.95	—8.6	—14.0	—10.0	—12.3	—13.1
Ammonium	A	71.69∓1.22	17.64∓0.37	0.48∓0.05	8.48∓0.59	0.76∓0.11	0.96∓0.18
sulfhate	B	74.46∓2.97	17.56∓1.12	0.47∓0.06	7.87∓0.56	0.76∓0.10	0.89∓0.16
	%	3.86	—0.5	—2.0	—7.2	—0.0	—11.0
Ammonium	A	71.47∓0.58	17.96∓0.17	0.49∓0.04	8.35∓0.35	0.78∓0.11	0.93∓0.11
sulphate plus	B	74.21∓0.78	16.44∓0.69	0.43∓0.01	7.35∓0.29	0.74∓0.10	0.84∓0.18
mineral mixture	%	3.82	—8.5	—12.0	—12.0	—5.1	—10.0

Table 8 Effect of vitamin B complex on IVDMD (%) and VFA's (M. mol/ml. incubation media) accumulation from rice straw after 48 hrs incubation with cellulolytic rumen bacteria in pure culture. [1]

Item	Strain No:	Treatment A	B	%
IVDMD %	$A_2$14	34.34	37.06	7.92
	$A_2$10	34.68	36.04	3.92
	$A_2$15	35.36	38.76	9.62
	$A_2$16	33.32	38.12	14.41
	∓∓SD	34.42∓0.85	37.50∓1.20	8.97∓4.34
VFA's M mol/ml.	$A_2$14	10.31	10.74	6.02
	$A_2$10	10.21	10.64	4.21
	$A_2$15	10.39	11.47	10.39
	$A_2$16	9.53	11.07	5.67
	∓∓SD	10.07∓0.38	10.98∓0.37	6.57∓2.66

A- Initial, B- Final- % -Percentage change from inital
Strain No: R. Flavefaciens (A_2 14. 10 and 15, R. Albus (A_2 16)
x Each value was an avarage of two experiments.

Table 9 Effect of vitamin B- complex on the differential VFA's (%) after 48 hrs. incubation of rice straw with cellulolytic rumen bacteria in pure culture.

Treatment	Acetic	Propionic	Isobutyric	Butyric	Isovaleric	Valeric
A	71.29	17.78	0.49	8.29	0.81	0.97
	∓0.56	∓0.34	∓0.03	∓0.24	∓0.06	∓0.10
B	73.25	17.13	0.45	7.61	0.73	8.95
	∓0.56	∓0.49	∓0.2	∓0.23	∓0.9	∓0.09
%	2.75	—3.7	—8.20	—8.20	—9.00	—8.00

A- Initial, B-Final-%- Percentage change from initial
x Each value was an avarage of four strains in two experiments.

2. Mangan klorid ilavesi KMSD'ni ve toplam UYA akümulasyonunu hızlandırıcı ve artırıcı bir rol oynamıştır.

3. Pirinç samanına kobalt klorit ve magnezyum süflfat ilavesi KMSD'ni (%) toplam UYA konsantrasyonunu oranla daha fazla artırmasına karşılık demir sülfat toplam UYA konsantrasyonuna KMSD'den (%) daha fazla artırmıştır.

4. Pirinç samanına iz elementlerin ilavesi asetik asidin % olarak düzeyini artırırken diğer UYA'leri oranını düşürmüştür. Bu konuda mangan klorid ila-

vesi daha iyi sonuç verirken bunu sırasıyla demir sülfat, kobalt klorit ve magnezyum sülfat izlemiştir.

5. Amonyum sülfatın pirinç samanına ilavesi üre ilavesine oranla KMSD'ni (%) daha fazla artırmış fakat minearel karışımının bunlara ilavesi bu parametrenin artmasında pozitif bir etki yapmamıştır. Öte yandan, hem üre ve hem de amonyum sülfata mineral karışımı ilavesi toplam UYA'leri konsantrasyonunu önemli ölçüde arttırmıştır.

6. Vitamin B komplekslerinin pirinç samanına katılması sonucu KMSD (%) ve toplam UYA'leri konsantrasyonunda çok az bir düzeyde bir artma meydana gelmesine neden olmuştur.

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