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Fattening of young cattle and buffalo on straw based rations, increasing their digestibilities and effect of whole and crashed barley

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1 Introduction

The digestive process of the ruminant animals depends upon microbial activity in the rumen. The higher amount of cell wall components of the low quality roughages contain relatively more lignin, cutin and silica which resluts in an obviously lower OM digestibility. One of the most abundantly utilized low quality roughage is straw. OHLDE and BECKER (1982) found that

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ADF expresses a clearly closer negative correlation to OMD. The organic matter digestibility of the straws range from 35 to 55% (JACKSON 1978), depending on the species, plantation, harvesting time, extent of ligification and subsequent handling and the significance of differences in untreated crop residue digestibility is that remain after alkali treatment. When the response was not obtained with animals (KLOPFENSTEIN 1972), it may indicate that some nutrients were deficient or imbalanced; or that some other factors, such as rate of passage was reducing digestibility in treated low quality roughage rations.

A variety of methods of treating straw with alkalis have been developed and treated straw can replace hay or silage in the diet when protein content increased with an oil meal supplement or urea (HASIMOGLU et al. 1969; KLOPFENSTEIN 1972; JACKSON 1978).

Chemical treatment of straw has been well reviewed (KLOPFENSTEIN 1972; 1976; HOMB et al. 1977; JACKSON 1978; MÜLLER 1978) and methods of treating straw were discussed. Treatment of straw increases its nutritive value by increasing its digestibility by 5–20 percentage units depending upon the method used. It has been determined that 1,8 kg 5% NaOH treated straw contains the same amount of digestibility energy as 1 kg dried molasses beet pulp pellets did, (BECKER et al. 1970).

The effectiveness of the treatment depends upon amound and alkali used (KLOPFENSTEIN 1976; HOMB et al. 1976; PIATKOWSKI et al. 1977), on environmental temperature (OLOLADE et al. 1970); lenght of treatment time (JACKSON 1978) and pressure (OLOLADE et al. 1970; KLOPFENSTEIN and BOLSEN 1971; GUGGOLZ et al. 1971). Besides those indicated above, the amount of straw in the ration has an effect on the nutritive value. JACKSON (1978) summarized the work of REXEN et al. (1975) and in one trial with growing bulls fed 30% straw diets no difference in weight gain was found, because of high proportion of concentrates in the diets of treated and untreated straw rations. In another trial, growing heifers fed diets containing 60% straw, the untreated straw group gained at a rate of 0,67 kg/day and the treated straw group at a rate of 0,79 kg/day. Supplementation and other ration components have also a great effect on the utilization of treated and untreated straws. The effect of 4% NaOH treatment on the digestibility and nutritive efficiency of wheat straw fed with ground wheat and urea of SBM was studied by HASIMOGLU et al. 1969. The organic matter digestibility of the wheat straw increased from 49% to 60% by 4% NaOH treatment in SBM supplemented wheat straw rations; from 51 to 59% in NaOH treated urea supplemented wheat straw rations. SAXENA et al. (1971) obtained similar results in a similar experiment. KLOPFENSTEIN and WOODS (1970) used treated and untreated wheat straw in combination with dehydrated alfalfa in a growth trial, performances were increased but still not great enough to be economical. In a recent study, BECKER et al. (1983) fount that NaOH treated straw + urea ration consuming lambs N and mineral (Na, K, Mg, Ca and P) balances were better and positive (except P) as compared to untreated straw + urea and NH_3 treated straw ration consuming lambs which the N and mineral balances were negative. JACKSON (1978) also stated that ammonia is in general, less effective than NaOH being a weak alkali but does add extra N to treated straw.

The review of literature indicated that hydroxide treatment of low quality roughages gave good results on animal performance. It was the purpose of this study to evaluate fattenning young steers and buffaloes on straw based rations and increase their digestibility by treating straw portion or the whole ration with 3% NaOH *in vivo* and *in vitro*.

2 Materials and Methods

2.1 In vivo study

One to one and a half year old 15 castrated Red Sindhi steers and 5 buffalos averaging 96,86 kg were fed *ad libitum* individually during 98 day experimental period according to a randomized block design in Pakistan. All three ration compositions were the same, Table 1. First ration contained untreated straw and fed to 5 cattle and 5 buffaloes, second ration's straw portion was treated with 3% NaOH and the third, whole ration was treated with 3% NaOH and last two treatments had 5 steers each. Sodium hydroxide was dissolved in the water and ground straw or whole ration was thorougly, mixed with this solution and moisture contents were increased up to 50%. The treated straw or whole ration were kept in plastic bags and incubated for 24 hrs., and next day treated straw was mixed with other ration components. All treatment rations contained whole barley during first 70-day and crashed during last 28-day experimental periods.

The experimental animals were fed on a once daily feeding schedule, watered twice a day and salt was present at all times. Unconsumed feed was removed and weighed. The experimental animals were weighed every 14 days and twelve hours before weighing, the unconsumed feed was removed and water was not offered. Feed consumption, feed efficiency and average daily gains were determined.

2.2 In vitro studies and laboratory analysis

Related to the experiment *in vitro* studies were conducted in Germany similar rations were prepared as is shown on Table 1 at the same percentage levels which the berseem was replaced by alfalfa and prese cotton seed cake was Egypt origin. The prepared rations CP contents ranged 11.08–11.23% and the treatments were: 1. Untreated straw ration, 2. Straw portion was treated with 3% NaOH, 3. Whole ration was treated with 1.0032% NaOH in order to equilize amount of NaOH of the ration 2. and 4. whole ration was treated with 3% NaOH. Similar mixing procedures were applied as described previously and samples were dried at 105°C for 24 hr. after 24 hr. reaction time, then ground for *in vitro* DM, OM and ash digestibility determinations by the method of Tilley and Terry (1963). The rumen liquors were obtained from two fistulated 65 kg sheep which were fed 1600 g ration daily (900 g straw, 600 g 16% CP concentrate and 100 g SBM), containing 10.60% CP. *In vitro* run was repeated twice, 3 tubes for each treatment. After each run 10 ml rumen liquor from

Table 1

Experimental rations

Rations number	1.2.3.4.
Feedstuffs (On 90% DM basis)	%
Wheat straw	34,44
Berseem (Green)	5,47
Molasses[a]	5,47
Barley[b]	24,60
Wheat bran	19,68
Cotton seed cake	9,84
Bone meal	0,50
Salt	+

Treatments
1. Untreated fed to steers
2. Untreated fed to buffaloes
3. Only straw portion was treated with 3% NaOH and fed to steers
4. Whole ration was treated with 3% NaOH and fed to steers

a. On such as basis
b. Whole barley during the first 70 days then crashed barley during last 28 days. The CP and calculated TDN values of the rations were: (1) 11.10; 63.3; (2) 11.10; 63.3; (3) 10.50; 63.3 and (4) 10.20; 63.3 percent respectively.

each tube was obtained for total volatile fatty acid (TVFA) analysis by the method described by Markham (1942). The proportions of the volatile fatty acids by Perkin-Elmer F. 20 Fraktometer Computirized Gaschromatography on two rumen liquor sample per treatment, per *in vitro* trial and no statistical analysis were run on the % molar paritítions however since the two different methods of TVFA-determinations values (Markham 1942) and Gas Chromatography were close to each other the two data were pooled and statistictically analyzed. DE/kg DM of the rations were calculated through the equation given by El-Shazly et al. (1963) as, Y = 1310.90 + 283.63 FS yx where Y = DE/kg DM; X = *in vitro* production of VFA and Syx = standard deviation from regression (F 225.8).

Hohenheim Gas Production method, (Menke et al. 1979) on the prepared rations was run in order to determine the ME and NEL (NE lactation) MJ/kg DM energy values of the rations with a new developed equations for concentrate and roughage containing rations; ME = 0.139 Gb + 0.074 XP + 0.178 XL + 1,56; NEL = 0.101 GB + 0.05 XP + 0.11 XL respectively and OM digestibility with the equation, d0 = 0.76 Gb + 0.637 XP + 22.5 where Gb = Gas production ml, XP = % CP and XL = % EE. The rumen liquor for the method was obtained from two fistulated cows weighing approximately 450 kg which were fed 5 kg hay and 2,5 kg 16% CP concentrate/day.

Dry matter contents of the samples were determined in an oven at 100°C; in a muffle furnace at 550°C the ash contents of the samples were determined. Nitrogen contents of the samples were determined by the Kjeldahl method and ether extracts described by AOAC (1965).

2.3 Statistical Analysis

The statistical analysis of the results of the fattening periods and *in vitro* runs were calculated by the methods given by Steel and Torrie (1960) for randomized block design experiments. An approach to the problem of comparing each treatment mean was carried out by the method of Duncan's new multiple range test.

3 Results and discussions

3.1 In vivo

The steers and buffalos performance results of the respective treatments for the whole 98-day; first 70-day; last 28-day of experimental periods are shown on Table 2. During the whole 98-day experimental period the average daily gain of the untreated-straw ration consuming buffaloes was significantly ($P < 0,05$) higher than untreated-straw, straw portion treated and whole ration treated-straw ration consuming steers. The average daily gains of the steers consuming untreated-straw, straw portion-treated and whole ration treated-straw rations were almost the same and were not significantly ($P > 0,05$) different.

Daily DM consumption of the steers fed straw portion-treated ration was significantly ($P < 0,05$) higher than untreated straw consuming steers and buffaloes and whole ration treated-straw ration consuming steers. The buffaloes consumed more DM than the steers fed the same untreated-straw ration.

Buffaloes fed untreated-straw ration needed significantly ($P < 0,5$) less dray matter per kg of gain than untreated straw, straw portion treated ration and whole ration treated straw ration

Table 2

The performances of the steers and buffaloes for the whole 98-day; first 70-day and last 28-day experimental periods.

	Treatments 1	2	3	4
Experimental period, days	98	98	98	98
No of animals, head	5	5	5	5
Initial wt., kg	97.38	95.63	96.84	97.59
Final, wt., kg	159.35	174.00	160.48	160.39
Total wt., gain, kg	61.97	78.37	63.64	62.80
Av. daily wt., gain, kg	0.63^{a}	0.80^{b}	0.64^{a}	0.64^{a}
Av. DM cons. kg./day	4.03^{a}	4.19^{a}	4.73^{b}	4.19^{a}
Feed efficiency (Av. DM cons., kg/Av. day. wt. gain kg.)	6.38^{a}	5.24^{b}	7.29^{c}	6.54^{a}
Experimental period days		First 70-day (Whole barley)		
Initial wt., kg	97.38	95.63	96.84	97.59
Final wt., kg	140.66	150.43	140.99	137.01
Total wt., gain, kg	43.28	54.80	44.15	39.42
Av. daily wt. gain, kg	0.61^{a}	0.78^{b}	0.63^{a}	0.56^{ac}
Av. DM cons. kg./day	3.76^{a}	3.97^{a}	4.39^{b}	3.88^{a}
Feed efficiency	6.08^{a}	5.08^{b}	6.97^{c}	6.89^{c}
Experimental period, days		Last 28-day (cracked barley)		
Initial wt., kg	140.66	150.43	140.99	137.01
Final wt., kg	159.35	174.00	160.48	160.39
Total wt., gain, kg	18.69	23.57	19.49	23.38
Av. daily wt. gain, kg	0.66^{a}	0.84^{b}	0.69^{a}	0.83^{b}
Av. DM cons. kg./day	4.73^{a}	4.75^{a}	5.61^{b}	4.97^{a}
Feed efficiency	7.06^{a}	5.65^{b}	8.14^{c}	5.71^{b}

^{abc} Values in the same line with different superscripts are significantly different ($P < 0.05$).

consuming steers. The steers fed straw portion treated were significantly ($P < 0,05$) less efficient in feed conversion than steers fed untreated-straw and whole ration treated straw consuming steers. The steers fed untreated straw ration needed less dry matter per kg of gain then the steers fed whole ration treated straw, but the difference was not significant ($P > 0,05$).

During the last 28-days the performances of the experimental animals were better than their performances during first 70-day experimental period which might due to including cracked barley instead of whole barley and full adaptations of the experimental animals to the rations which those animals never had any grain or protein supplementation before. During the 70-day (Whole barley containing rations) the average daily weight gain of the buffaloes on untreated-straw ration was significantly ($P < 0,05$) higher than the steers consuming other untreated and treated rations. The average daily gain of the steers fed whole ration treated straw ration was less than the steers fed untreated-straw and straw portion treated rations but the differences were not significant ($P > 0,05$). Average daily DM consumption of the steers fed straw-portion treated ration was significantly ($P < 0,05$) higher than the whole ration treated and untreated rations fed steers and buffaloes.

The feed efficiency of the buffaloes was significantly ($P < 0,05$) better than the other whole ration treated-straw, straw portion treated and untreated-straw rations fed steers. Feed efficiency of the steers fed untreated-straw ration was significantly ($P < 0,05$) higher than the straw portion and whole ration treated-straw ration fed steers. The steers fed whole ration treated-straw needed less dry matter per kg of gain than straw-portion treated ration but the difference was not significant ($P > 0,05$).

During the last 28 days of experimental period buffaloes were still superior to the steers in their performances. During this period the experimental animals showed greater average daily gain than first 70-day experimental period due to the reasons given above and the performances of the steers fed whole ration treated straw ration was significantly ($P < 0,05$) higher than the steers fed untreated and straw portion treated rations consuming steers and average daily gain of buffaloes was still better but the difference was not significant ($P < 0,05$). Straw portion treated ration fed steers average daily gain was higher than untreated-straw ration fed steers but the difference was not significant ($P > 0,05$).

The daily DM consumption of straw-portion treated ration fed steers was significantly ($P < 0,05$) higher than the whole ration treated-straw ration fed steers and untreated-straw fed steers and buffaloes. The DM consumption of the steers fed whole ration treated-straw ration was higher than untreated-straw ration fed steers and buffaloes but the differences were not significant ($P > 0,05$).

The buffaloes fed untreated-straw ration needed significantly ($P < 0,05$) less dry matter per kg of gain than untreated-straw and straw portion treated ration fed steers, however difference between whole ration treated straw ration fed steers which required higher dry matter per kg of gain was not significant ($P > 0,05$). The steers fed whole ration treated-straw were significantly ($P < 0,05$) more efficient than untreated-straw and straw portion treated ration fed steers. The steers fed untreated-straw ration also needed less DM per kg of gain than the steers fed straw portion treated ration. During the last 14-day experimental period the performances of the whole ration treated-straw ration fed steers were much higher than the steers fed straw portion treated ration and untreated-straw ration fed steers and buffaloes and the average daily gain, average dry matter consumption and feed efficiencies for the respective treatments were 0.930, 5.496, 5.441; 0.692, 5.351, 7.755; 0.557, 4.986, 8.903, and 0.729, 4.889 and 6.697.

The results of 98-day indicated that buffaloes are much more efficient than steers on the same ration and there are many research and review papers indicating that the buffaloes are more efficient than cattle and higher feed intake in cattle than buffaloes (SETHI and AROSA 1977; BORHAMI and EL-SHAZLY 1979; SALERNO 1974, OGNJANOVIĆ 1974) and the best feed efficiency is always at the early ages of growth and lowest after 18-month of age and this might due to some physiological differences in digestive system, saliva secretion and composition and also differences in rumen function and digestibilities (NOUR and HASIMOGLU 1983). Treatment of the straw portion of the ration or the whole ration with 3% NaOH gave almost similar average daily weight gains however straw portion treated ration fed steers average dry matter consumption was higher but feed efficiency was less even than untreated-straw ration fed steers feed efficiency. The experimental rations contained 34,4% straw and JACKSON (1978), reported that in one trial with growing bulls fed 30% straw diets, no difference in weight gain was found because of the high proportion of concentrates in the diets in this trial, there may not have been difference in digestibility between treated and untreated straw. In another trial with growing heifers fed diets containing 60% straw, the untreated groups gained at a rate of 0,67 kg/day and the treated straw group at a rate of 0,79 kg/day. In other studies the daily feed intake expecially in the case of NaOH treated straw increased markedly compared to untreated straw rations (HASIMOGLU et al. 1969; SAXENA et al. 1971; KLOPFENSTEIN and WOODS 1971; JACKSON 1978).

During first 70-day (Whole barley containing rations) the performances of the buffaloes were better than the treated and untreated rations fed steers. Straw portion treated ration fed steers average daily weight gain and average daily DM consumption were higher than untreated straw and whole ration treated straw ration fed steers average daily weight gain and average daily DM consumption were higher than untreated straw and whole ration treated straw ration fed steers however they needed more dry matter per kg of gain. The feed efficiency of untreated straw fed steers were better than straw portion and whole ration treated straw ration fed steers. However during last 28-day including cracked barley in the rations improved the performances of the steers and buffaloes. Improvement in the performances of the experimental animals was highest with the steers fed whole ration treated-straw ration and their performances especially increased during last 14-day experimental period which might be the indication of complete adaptation to the ration and effect of processing of barley. Church (1970) indicated that adaptation may be relatively complete within two-week when changing from one forage to another; however, high levels of concentrates would appear to require 4–6 or longer for adaption to be reasonably complete. This view has also been shown by Oltjen et al. (1963; 1966). Including crashed barley in the ration plus the 3% NaOH treatment of whole ration with an extended adaptation period to the ration might have an increased concentrate level effect on the ration which *in vitro* studies (see *in vitro* results) revealing that 3% NaOH treatment of straw or whole ration treatment increased the TVFA-levels which is a reflection of microbial activity. It has been very well determined that processing of grain with different methods (crushing, grinding, steam-flaking, roasting, popping and extrusion) have positive effect of the ration utilization as compared to unprocessed grains (Beeson 1973;, Williamson 1973). Ørskov and Greenhalgh (1977) fed 6 bullocks whole barley, 3.5% NaOH treated whole barley and rolled barley to appetite and DM digestibilities were significantly less for whole (67,2%) as compared treated (75,2%) and rolled barley (78,9%). In a digestion trial processed barley increased the macro mineral utilization by sheep (Xano et al. 1979).

Morgan and Campling (1978) found that starch digestibility of whole barley was less than the oat and starch digestion coefficients were 0,62 and 0.83 respectively and concludes that barley should be rolled before feeding. Ørskov and Grubb (1977) conclude that fortification of whole barley in growing lamb rations with solutions of urea, minerals and vitamins increased the performances of lambs and whole barley with fish meal 100 g/kg pelleted with limestone and trace elements gave the highest average daily weight gain. From above results it is obvious that processing gave better performances for the lifestock as compared to whole barley. *In vivo* results especially for the last 28-day experimental period indicate that when a ration containes 30–35% straw, treatment of the whole ration with 3% NaOH might be more effective than the treatment of the straw portion of the ration.

3.2. Results of *in vitro* studies

In vivo trial results showed that feed efficiency of the whole ration treated with 3% NaOH fed steers were as much or more effective as compared to straw portion treated ration fed steers especially during last 28-day when cracked barley included in the rations. *In vitro* (Tilley and Terry 1963) dry matter, organic matter, ash, TVFA concentrations calculated DE and ME values calculated on TVFA productions are presented on Table 3 and TVFA concentrations and their molar and % values TVFA are presented on Table 4.

In vitro DM, OM and ash digestibilities of straw portion treated with 3% NaOH and whole ration treated with 1.0032% NaOH were similar and differences were not significant ($P > 0.05$). This might be the indication that treating the whole ration with equal amount of NaOH of the

Table 3

In vitro **dry matter, organic matter, ash digestibilities, TVFA concentrations and calculated DE and ME values of the rations**

Rations	DMD %	OMD %	Ash. digest. %	TVFA mmol/100 ml	DE kcal/kg DM	ME^{+} kcal/kg DM
1. Untreated	64.85^{a}	61.14^{a}	79.62^{a}	5.5206^{a}	2871.18 F 225.8 (12.01 F 0.945)$^{++}$	2454.36 F 185.1 (9.85 F 0.77)$^{++}$
2. Straw portion treated with 3% NaOH	70.56^{b}	65.80^{b}	83.47^{b}	6.6531^{b}	3191.26 F 225.8 (13.85 F 0.945)$^{++}$	2616.62 F 185.1 (10.95 F 0.77)$^{++}$
3. Whole ration treated with 1.0032% NaOH	70.61^{b}	65.81^{b}	84.43^{b}	6.7380^{b}	3215.26 F 225.8 (13.45 F 0.945)$^{++}$	2636.51 F 185.1 (11.03 F 0.77)$^{++}$
4. Whole ration treated with 3% NaOH	74.73^{c}	68.16^{c}	88.83^{c}	6.8945^{b}	3259.49 F 225.8 (13.64 F 0.945)$^{++}$	2672.38 F 185.1 (11.19 F 0.77)$^{++}$

^{abc} Values in the same column with different superscripts are significantly different ($P < 0,05$).
$^{+}$ DE, kcal/kg × 0,82 = ME
$^{++}$ ( ) MJ/kg DM

Table 4

***In vitro* VFA concentrations and molar and % ratio**

Rations	TVFA mmol/100 ml	PARTITION of VFA mmol/100 ml (% in total VFA) Acetic	Propionic	Isobutyric	Butyric	Isovaleric	P.P[+]ratio
1. Untreated	5.5206[a]	3.4540 (62.56)[++]	1.1651 (21.10)[++]	0.1281 (2.32)[++]	0.6484 (11.74)[++]	0.1245 (2.267)[++]	2.964
2. Straw portion treated with 3% NaOH	6.6531[b]	4.0990 (61.61)[++]	1.6650 (25.02)[++]	0.0552 (0.83)[++]	0.6845 (10.28)[++]	0.1485 (2.237)[++]	2.462
3. Whole ration treated with 1.0032% NaOH	6.7380[b]	4.2218 (62.65)[++]	1.5250 (22.63)[++]	0.0861 (1.27)[++]	0.8334 (12.44)[++]	0.1749 (2.59)[++]	2.768
4. Whole ration treated with 3% NaOH	6.8945	4.2990 (62.35)[++]	1.5474 (22.44)[++]	0.1339 (1.94)[++]	0.7831 (11.35)[++]	0.1486 (2.15)[++]	2.778

[ab] Values in the same column with different superscripts are significantly different ($P < 0.05$).
[+] Acetic/Propionic ratio
[++] ( ) % in TVFA

straw portion treated has equal or more amount of effectiveness in increasing DM; OM and ash digestibilities and increases were 5,7; 4,7 and 4,8 percentage units over untreated ration respectively and the differences were significant ($P < 0,05$). However treatment of whole ration with 3% NaOH was more effective and DM, OM and ash digestibilities were increased 9,88, 4,12, 4,17; 7,02, 2,35, 2,36; 9,21, 4,40 5,36 percentage units over the untreated, whole ration treated with 1,0032% and straw portion treated with 3% NaOH ration respectively and the differences were significant ($P < 0,05$).

In vitro total volatile fatty acid mmol/100 ml showed an increasing trend for the straw portion treated with 3% NaOH, whole ration treated with 1.0032% and 3% NaOH rations but the differences were not significant ($P > 0,05$) however the TVFA concentrations of the treated three rations were significantly ($P < 0,05$) higher than the TVFA concentration of the untreated ration.

The digestion of food constituents in the rumen follows different pathways, the ultimate metabolic products of a wide range of substrates are the VFA. The DE kcal/kg of untreated ration was calculated from tabulated values (Crampton and Harris 1969) and found to be 253/kcal/kg. The DE kcal/kg DM were calculated for the respective rations from the regression equation of El-Shazly et al. (1963) from TVFA concentrations. The DE kcal/kg for the untreated ration ranged between 2645.3–3096.98 DE kcal/kg DM with a 2871.18 DE kcal/kg mean value which is higher than the calculated table values. DE kcal/kg DM of untreated ration was increased with NaOH treatment and those increases were 319.82; 344.08 and 388.31 DM kcal/kg DM with the straw portion treated with 3% NaOH, whole ration treated with 1.0032% NaOH and 3% NaOH rations respectively. The increases in DE values were higher in whole ration treated with NaOH as a function of higher TVFA production.

The molar ratios of different VFA showed variations within and among the treatments. However acetic acid concentrations showed increasing trend with the respective rations (Table 4), expecially with NaOH-treatments and was highest with whole ration treated with 3% NaOH. The % ratios of the acetic, propionic and butyric acids were similar to the results summarized by Church (1970) for similar rations.

The calculated ME value of untreated ration (Crampton and Harris, 1969) was 1931.3 kcal/kg DM (8.084 MJ/kg DM), and the determined ME value for the untreated ration by Hohenheim Gas Production Method was 2053 kcal/kg DM (8.593 MJ/kg DM) and the difference was not as great as determined by Tilley and Terry (1963) and El-Shazly et al. (1963) methods and the difference was 121.7 kcal/kg DM (0,509 MJ/kg DM) higher and seemed more realistic and higher value might due to the fineness of the samples which were ground finer than the fineness required for the Hohenheim Gas Production Method.

Table 5

***In vitro* gas production, ME, NEL, OM digestibilities, determined by Hohenheim Gas Production Method**

Rations	Gas produced ml/24 h	ME MJ/kg DM (kcal/kg DM)	NEL MJ/kg DM (kcal/kg DM)	OM digestibility %
1. Untreated	43.9 ± 1.0^a	8.520^a $(2053)^+$	5.250^a $(1250)^+$	63.02^a
2. Straw portion treated with 3% NaOH	48.0 ± 0.4^b	9.490^b $(2267)^+$	5.664^b $(1353)^+$	66.13
3. Whole ration treated with 1.0032% NaOH	47.8 ± 0.4^b	9.462^b (2260)	5.644^b $(1348)^+$	65.99^b
4. Whole ration treated with 3% NaOH	48.6 ± 0.2^b	9.574^b $(2287)^+$	5.725^b $(1368)^+$	67.98^b

[ab] Values in the same column with different superscripts are significantly different ($P < 0.05$).
[+] ( ) kcal/kg DM.

Gas Production, ME, NEL and OM digestibilities of untreated ration was significantly ($P < 0{,}05$) less than the treated rations. The same parameters straw portion treated with 3% NaOH and whole ration treated with 1.0032% NaOH were also similar and differences were not significant ($P > 0{,}05$) but treatment of whole rations with 3% NaOH was more effective but the difference with two other treatments were not significantly ($P > 0{,}05$) different which is in agreement with the results obtained with Tilley and Terry (1963) and El-Shazly et al. (1963) expecially in percentage OM digestibilities. Results from Table 3, 4 and 5 which were determined by different methods indicate that by treating straw portion or the whole ration with NaOH significantly increase the DM, OM and ash digestibilities, TVFA concentrations and increase DE, ME values of the rations. It has already been found by many scientiests (Stone et al. 1965; Hasimoglu et al. 1969; Klopfenstein 1972; Jackson 1978; Kossila et al. 1978; Becker 1980) that NaOH treatment of the straw portion of the rations which increases the carhohydrate fermentation by the rumen microorganisms and favorably effects utilization in the rumen by breaking the lignin-holocellulose complex. The results also indicated that whole ration treatment in high CF containing rations (34% straw containing rations) is also effective as much as or more on the same NaOH level of straw portion treated ration and increasing the level of the NaOH of whole ration treatments is much more effective in increasing the digestibility. However, at present these is no any available *in vivo* and/or *in vitro* data to compare the effect of whole ration treatment of DM, OM ash digestibilities and TVFA production ad the *in vivo* trial results especially during last 28-day experimental period is in agreement with the *in vitro* results. However this new approach needs further investigations.

Summary

One to one and half year old 15 castrated Red Sindhi steers and 5 buffaloes averaging 96.86 kg were fed *ad libitum* individually during 98 day experimental period. All three rations compositions were the same but first ration contained untreated straw (US) and fed to 5 steers and 5 buffaloes, second rations straw portion was treated with 3% NaOH (SP) and the third whole ration was treated with 3% NaOH (WRT) and last two treatment diets were fed to five steers each. During first 70-day all treatment rations contained whole barley and crashed barley during last 28 day experimental periods. Average daily gains, dry matter consumption in kg, feed efficiency for the treatments and for respective periods were: US steer – 0.618, 3.760, 6.084; US-buffalo – 0.782, 3.979, 5.088; SP-steer – 0.630, 4.396, 6.977 and WRT steer – 0.563, 3.882, 6.895/US steers – 0.667, 4.734, 7.065; US buffalo – 0.841, 4.751, 5.655; SP steer – 0.696, 5.617, 8.140 and WRT steer – 0.835, 4.974, 5.717 respectively.

Including crashed barley in the rations improved the performances and this was highest with whole ration treatments steers however buffaloes were more efficient and superior to the other treatments steers.

In vitro DMD, OMD and TVFA production and ME, NE lactation and OMD determined with Hohenheim Gas Production Methode on similar rations indicated that whole ration treatment in high crude fiber containing rations is also effective as much as or more on the same NaOH level of straw portion treated ration and increasing the level of the NaOH of whole ration treament is much more effective in increasing.

Zusammenfassung

Die Fütterung von Rindern und Büffeln mit aufgeschlossenem Stroh und der Einfluß von heiler bzw. gequetschter Gerste

An 15 1–1½-jährigen kastrierten Red Sindhi Stieren und 5 Büffeln – ebenfalls kastriert und im gleichen Alter – mit einem durchschnittlichen Körpergewicht von 96–86 kg wurden über 98 Tage folgende Rationen ad libitum verfüttert:

1. Grundfuttermischung + unbehandeltes Stroh
2. Grundfuttermischung + NaOH (3%) behandeltes Stroh
3. Grundfuttermischung + Stroh insgesamt NaOH (3%)-behandelt.

Ration 1 wurde 5 Rindern und 5 Büffeln verabreicht, Ration 2 und 3 jeweils 5 Rindern.

Während der ersten 70 Tage der Versuchsperiode enthielt die Grundfuttermischung ganze Gerstenkörner, die während der letzten 28 Tage durch gequetschte Gerstenkörner ersetzt wurden.

Für die durchschnittlichen Tageszunahmen (in kg), Trockenmasseaufnahmen (in kg) und Futterverwertungen wurden in den Fütterungsperioden je nach Behandlung folgende Ergebnisse ermittelt:

Der Austausch der Gerstenkörner durch gequetschte Gerste erhöhte die Leistungsparameter und diese waren hier bei Anwendung des 3. Verfahrens am höchsten. Die Büffel waren den Rindern in beiden Behandlungsformen überlegen.

Die Verdaulichkeit der TS in vitro, die Verdaulichkeit der organischen Substanz und die FFS-Produktion, sowie die UE-, NE-Laktation und Verdaulichkeit der organischen Substanz mit Hilfe des Hohenheimer Gastestes in ähnlichen Rationen deuten darauf hin, daß die Behandlung der Gesamtration mit hohem Rohfasergehalt und gleich hoher NaOH-Konzentra-

tion genauso, wenn nicht sogar effektiver ist als die alleinige Behandlung des Strohanteils in der Ration. Die Erhöhung der NaOH-Menge scheint die Verdaulichkeit und den Energiegehalt des Futters stärker zu beeinflussen.

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