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Effects of Hydroponic Maize Fodder with and Without Supplementation of Probiotics (*Saccharomysis cerevisiae*) on Rumen Parameters in Calves

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ABSTRACT

An experiment was conducted during October to January, 2018 at Gir Cattle Farm, College of Veterinary and Animal Science, Navania, Udaipur, Rajasthan, India to evaluate the effect of hydroponic maize fodder with and without supplementation of probiotics on rumen fermentation. A feeding trial of 120 days was conducted on 36 male Gir calves of same age group (6–12 months) and randomly allotted to nine dietary treatments. All the animals were offered basal feed *ad lib.* The T_1 i.e. control group were fed concentrate mixture as per requirement. For calves in T_2, T_3, T_4 and T_5 groups, 25%, 50%, 75% and 100% of crude protein (CP) supplied through concentrate mixture was replaced by hydroponics maize green fodder, respectively. Whereas, in T_6, T_7, T_8, T_9 groups, 25% 50%, 75% and 100% of crude protein (CP) supplied through concentrate mixture was replaced by hydroponics maize green fodder along with probiotics, respectively. All the rumen parameters viz. pH, Total protozoal count (10^5 ml^{-1}), Total Volatile Fatty Acids (meq l^{-1}), Ammonia nitrogen (mg dl^{-1}), Total nitrogen (mg dl^{-1}), TCA-precipitable nitrogen (mg dl^{-1}), and Non protein nitrogen (mg dl^{-1}), were estimated according to treatment and time intervals. There was non-significant effect of treatments on rumen pH but due to time intervals were found to be highly significant (p<0.01). The concentration of Total protozoal count, Total volatile fatty acids (TVFA), Total ammonia nitrogen (NH_3–N), Total nitrogen, TCA- Precipitable N and Non-protein nitrogen (NPN) were highly significant (p<0.01) effect due to treatments and time intervals.

KEYWORDS: Calves, hydroponic maize fodder, rumen parameters, probiotic

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

Fodder production and livestock feeding are the two important aspects for the sustainability of products and productivity in animal husbandry. Green fodder is an essential component of the ration for dairy cattle. Lack of green fodder in the ration will adversely affect the productive and the reproductive performance of animals. Therefore, for sustainable dairy farming, quality green fodder should be fed regularly to the dairy animals (Naik et al., 2012a) .Cultivated fodder crops and pasture grasses usually have poor nutritional value. The health, growth and production of dairy animals are adversely affected due to unavailability of good quality green fodder and concentrate. Due to many constraints in the conventional green fodder cultivation, hydroponic technology may become an alternative not only for the green fodder but also some part of concentrate in farm animals (Naik et al., 2013a, Naik et al., 2013b, Naik and Singh, 2013; Naik, 2014, Naik and Singh, 2014, Naik et al., 2015). The technology may be especially important in regions where forage production is limited (Mukhopad, 1994). It is a boon for arid and semi arid regions where water scarcity is prominent, as well as climatic and edaphic factors are adverse to grow green fodder (Limba et al., 2017). Lesser requirement of water and land, decreased labour, continuous production of fodder irrespective of climate, lesser time for fodder development, increased nutritive value, no use of fertilizer and manure and improved reproduction and production efficiency in animal are the merits of this technology (Sharma et al., 2019). Hydroponic technology can be used to grow a variety of feed crops, including barley, oats, wheat, sorghum, alfalfa, cowpea, and maize. Due to its availability, reduced cost, good biomass production, and quick growing habit, maize should be the grain of choice in India for the production of hydroponic fodder (Kumar et al., 2019). Maize is a member of grass family which has higher amounts of vitamins, proteins, fats and carbohydrates. Hence it is used as fodder for animals (Barwant et al., 2018). Sprouting of grains increases the enzymatic activity, total protein and changes amino acid profile, increase in sugars, crude fibre, certain vitamins and minerals, but decrease starch and increases simple sugars (Naik et al., 2016).This hydrolysis increases the concentration of amino acids, soluble sugars and fatty acids within the grain and resulting shoot (Chavan and Kadam, 1989). Feeding of hydroponics fodder increased the digestibility of the nutrients of the ration which could be attributed to the tenderness of the fodder (Naik et al., 2014). Additives such as organic acids, yeast, enzymes and ionophores, modify rumen fermentation and optimize performance in animal production systems. Oxygen scavenger property of yeast in rumen helps to protect obligate anaerobes from the air ingested in rumen alongwith feed. Feeding of *S. cerevisiae* also significantly improved bacterial count and volatile fatty acids production in rumen liquor. Yeast additives may exert positive effects on digestibility especially fiber components, probably by stimulating the cellulolytic microbial populations in the rumen. Yeast in ruminants has balance rumen ecosystem and increase cellulolytic bacteria numbers (Wadhwa and Bakshi, 2013). They increase the fibre digestion by stimulating cellulolytic bacteria and increases flow of microbial protein from the rumen (Jouany and Morgavi, 2007). Furthermore, when the diet supplemented with yeast decreased rumen ammonia nitrogen (N) concentration and increased ruminal pH, total volatile fatty acids (VFAs) and cellulose digestion in ruminants (Bakr et al., 2015). Therefore, considering the above facts the present research was planned to assess the effect of hydroponic maize fodder with and without supplementation of probiotics (*Saccharomysis cerevisiae*) on rumen fermentation in Gir calves.

2. MATERIALS AND METHODS

2.1. Study sites

The experiment was conducted at Gir Cattle Farm and Department of Animal Nutrition, College of Veterinary and Animal Science, Navania, Udaipur (Rajasthan), India during October to January 2018.

2.2. Experimental animals and feeding

Total 36 male Gir calves of almost same age group were selected and randomly distributed in nine groups. All the animals were offered basal feed *ad lib*. Daily allowance of concentrate and/or hydroponics maize fodder and roughage were offered to meet their nutrient requirements ICAR (2013). Chemical Composition of Experimental Feed (% DM Basis) was presented in Table 1. The calves were housed in sheds with proper ventilation, flooring and tying arrangements with facility of individual feeding. Calves in group T_1 were treated as control and were fed basal feed and concentrate mixture as per requirement. For calves in T_2, T_3, T_4 and T_5 groups, 25%, 50%, 75% and 100% of crude protein (CP) supplied through concentrate mixture was replaced by hydroponics maize fodder, respectively. Whereas, in T_6, T_7, T_8, T_9 groups, 25% 50%, 75% and 100% of crude protein (CP) supplied through concentrate mixture was replaced by hydroponics maize fodder alongwith probiotics (*Saccharomyces cerevisae*), respectively.

2.3. Method of data collection

A Metabolism trial of 7 days was conducted at the end of growth trial the rumen liquor samples were collected from the experimental calves by stomach tube at 0, 3, 6, 12 and 24 hour post feeding and was analyzed. The pH of rumen liquor was measured immediately after collection using digital pH meter and Ammonia Nitrogen (NH_3

Table 1: Chemical composition of experimental feed (% DM basis)

Attributes	DM	OM	CP	EE	CF	NFE	TA	NDF	ADF	HC	Ca	P
Concentrate mixture	89.73	88.66	20.06	3.35	10.00	55.25	11.34	38.49	20.67	17.82	1.34	0.56
Hydroponics maize fodder	18.25	96.99	18.68	3.56	8.62	66.13	3.01	34.76	15.96	18.80	0.27	0.42
Wheat straw	91.18	89.01	3.14	1.09	39.05	45.73	10.99	75.01	52.39	22.21	0.30	0.10
Yeast (*S. cerevisiae*)	99.39	93.64	39.56	2.74	3.63	47.71	6.36	-	-	-	1.83	0.76

–N) was estimated by micro-diffusion method (Conway, 1957). The samples were analyzed for TVFA concentration as per Barnet and Reid (1957). Total Nitrogen, Non protein nitrogen was estimated by Micro-Kjeldahl and the difference of total nitrogen and Non protein nitrogen was reported as TCA-precipitable Nitrogen. Total Protozoal Count of Strained rumen liquor (SRL) was done by method of Moir and Somers (1956) adopted by Purser and Moir (1959) using Sedgewick Rafter cell (50×20×1 mm) in 10x10 magnification. The data obtained in the experiment were analyzed using of analysis variance (ANOVA) by Snedecor and Cochran (1994). Significance of means differences were tested by Duncan's New multiple Range Test (DNMART) as modified by Kramer (1957).

3. RESULTS AND DISCUSSION

The average data for rumen fermentation parameters of experimental in Gir calves are presented in Table 2 and 3.

3.1. Rumen parameters

3.1.1. Rumen pH

Ruminal pH in different treatment groups showed non-significant effect. The findings are in accordance with Dadhich, et al. (2020). They showed that no significant effect due to feeding of hydroponics maize fodder on ruminal pH. However, the effects of time intervals were found to be highly significant (p<0.01). Campos et al. (2014) observed no any influence of yeast supplementation on rumen pH in cows. However, the effects according to time intervals were found to be highly significant (p<0.01). A significant fall in pH was recorded at 3 h post feeding, possibly due to greater production of volatile fatty acids obtained at hour (Mc-Allan, 1991). While at 6 h post feeding pH tended to increase and could be explained on the basis of greater inflow of bicarbonate rich alkaline saliva buffering the ruminal contents (Turner and Hodgetts, 1995).

3.1.2. Total protozoal count

Total protozoal count (10^5 ml^{-1}) were found highly significant (p<0.01) effect of hydroponics maize fodder with and without supplementation of probiotic according to treatment and time intervals (Table 2 and 3). Hassan et al. (2006), Bakr et al. (2015) Hassan et al. (2016) observed highly significant effect on rumen protozoa number in cows diet supplemented with yeast.

3.1.3. Total volatile fatty acids (TVFA)

Total volatile fatty acids (TVFA) were found highly

Table 2: Mean values of rumen pH, Total protozoal count (10^5 ml^{-1}), TVFA (mEq l^{-1}), NH_3-N (mg dl^{-1}), Total N (mg dl^{-1}), TCA-PN (mg dl^{-1}), NPN (mg dl^{-1}) in different treatment groups

Treatment	pH	Total protozoal count (10^5 ml^{-1})	TVFA (mEq l^{-1})	NH3N (mg dl^{-1})	Total N (mg dl^{-1})	TCA-PN (mg dl^{-1})	NPN (mg dl^{-1})
T_1	6.69	3.61^{ab}	71.45^{f}	19.55^{e}	79.53^{f}	51.43^{e}	33.66^{d}
T_2	6.71	3.04^{e}	74.97^{e}	20.02^{d}	81.78^{e}	53.67^{d}	34.58^{c}
T_3	6.75	3.25^{d}	78.72^{d}	20.46^{bc}	83.17^{d}	55.59^{c}	35.83^{b}
T_4	6.78	3.46^{c}	81.81^{b}	20.93^{a}	85.63^{c}	57.72^{b}	38.09^{a}
T_5	6.76	3.45^{c}	79.37^{c}	20.55^{b}	83.38^{d}	56.16^{bc}	36.30^{b}
T_6	6.73	3.61^{ab}	75.75^{e}	19.58^{e}	84.02^{d}	54.72^{cd}	33.17^{d}
T_7	6.77	3.62^{a}	79.47^{c}	20.12^{c}	86.99^{b}	56.52^{c}	34.74^{c}
T_8	6.83	3.62^{a}	83.04^{a}	20.30^{c}	92.57^{a}	59.29^{a}	36.54^{b}
T_9	6.78	3.47^{c}	80.22^{c}	20.19^{c}	85.89^{c}	56.87^{b}	34.62^{c}
Level of significant	NS	**	**	**	**	**	**
SEm±	0.098	0.058	1.145	0.293	1.228	0.855	0.633

Means with different superscripts in a row differ significantly

Table 3: Mean values of rumen pH, total protozoal count (10^5 ml^{-1}), TVFA (mEq l^{-1}), NH_3-N (mg dl^{-1}), Total N (mg dl^{-1}), TCA-PN (mg dl^{-1}), NPN (mg dl^{-1}) at different time intervals in different treatment group

Hours	pH	Total protozoal count (10^5 ml^{-1})	TVFA (mEq l^{-1})	NH_3N (mg dl^{-1})	Total N (mg dl^{-1})	TCA-PN (mg dl^{-1})	NPN (mg dl^{-1})
0	6.86^b	3.58^b	65.86^e	18.83^d	65.84^e	51.16^d	22.09^e
3	6.43^d	3.07^e	85.00^b	21.80^a	100.87^a	66.71^a	42.17^a
6	6.62^c	3.20^d	96.20^a	21.38^b	96.79^b	60.56^b	40.18^b
12	6.86^b	3.38^c	73.51^c	20.14^c	85.88^c	53.05^c	37.14^c
24	7.01^a	4.05^a	70.98^d	18.78^d	74.50^d	47.40^e	34.83^d
Level of Significant	**	**	**	**	**	**	**
Mean	6.69	3.31	80.14	20.54	87.34	57.87	35.39

Means with different superscripts in a row differ significantly

significant (p<0.01) effect of hydroponics maize fodder with and without supplementation of probiotic according to treatment and time intervals (Table 2 and 3). Similarly, Dadhich et al. (2020) found highly significantly (p<0.01) effect of feeding of hydroponics maize fodder. Fayed (2011) observed that increase in TVFA concentration on feeding hydroponics fodder was due to vitamins and enzymes which act as biocatalyst to assist in feed metabolism. Hassan et al. (2006), Desnoyers et al. (2009), Bakr et al. (2015) and Hassan et al. (2016) reported that total volatile fatty acids were increased in yeast supplemented diet in cow.

3.1.4. Rumen ammonia nitrogen (NH_3-N, Total Rumen N, TCA precipitable nitrogen (TCA-PN) and non-protein nitrogen (NPN)

Rumen ammonia nitrogen (NH_3-N) (mg dl^{-1}), Total Rumen N (mg dl^{-1}), TCA precipitable nitrogen (TCA-PN) (mg dl^{-1}) and Non-protein nitrogen (NPN) (mg dl^{-1}), were found highly significant (p<0.01) effect of hydroponics maize fodder with and without supplementation of probiotic according to treatment and time intervals (Table 2 and 3). The maximum ammonia nitrogen, Total Rumen N, TCA precipitable nitrogen (TCA-PN) and Non protein nitrogen (NPN) concentration was observed at peak level 3 h post feeding in all the experimental groups possibly due to maximum proteolytic deaminase activity at this hour, while, decrease in concentration 6 h post feeding onwards may be due to simultaneous absorption or its utilisation by microbes in synthetic activity of rumen. Similar findings were observed by Reddy and Reddy (1985), Tomar and Senger (1999). Dadhich et al. (2020) found highly significantly (p<0.01) effect of feeding of hydroponics maize fodder. The increase in rumen ammonia concentration on feeding hydroponics fodder has been reported by Fayed (2011) and Helal (2015).

4. CONCLUSION

The concentration of Total protozoal count, Total volatile fatty acids (TVFA), Rumen ammonia nitrogen (NH_3-N), Total Rumen N, TCA precipitable nitrogen (TCA-PN) and Non protein nitrogen (NPN) were found to be highly significant according to treatment and time intervals. Ruminal pH showed non-significant effect according to treatment but highly significant due to period. It can be concluded that feeding of hydroponics maize fodder with and without supplementation of probiotic showed positive effect on rumen fermentation in Gir calves.

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