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Nutrient Digestibility and Plane of Nutrition of Different Varieties of Normal and High Quality Protein Maize (HQPM) Fodder at Pre-cob and Post-cob Stage in Lactating Sahiwal Cows

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ABSTRACT

The objective of the study was to evaluate the nutrient intake and digestibility of four different varieties (HTHM 5101, DHM 117, HM 5 and Shaktiman/900M Gold) of normal and three (HQPM 5, HQPM 7, HQPM 9/ Vivek) HQPM fodder at pre-cob and post-cob stage in lactating sahiwal cows. Thirty-two multiparous Sahiwal cows in early to mid lactation were selected from herd maintained at ILFC, Mathura and were divided into eight group of four animal each. The seeds of experimental varieties were procured from International Maize and Wheat Centre (CIMMYT) New Delhi and the fodders were cultivated under identical conditions in different plots.. Each group was fed with different variety of maize along with basal diet.. Two digestibility trials of seven days were conducted both at the end of feeding of pre and post cob stages of fodder respectively.. The variety DHM 117 have shown higher ($P<0.05$) DCP and TDN intake at both pre and post-cob stages of the fodder. The digestibility of DM, OM and CP was significantly ($P<0.05$) higher for DHM 117 whereas, in post cobs stage the normal varieties (DHM 117, HM 5, and HTHM 5101) exhibited higher DM and OM digestibility. However, the digestibility of DM, OM and CP was lower for HQPM 9 and HQPM 5 varieties at both stages respectively. From the present study varietal effect was observed and the variety DHM 117 have shown higher intake and digestibility at both pre and post-cob stages however long-term study with large number of animals is advisable. for recommendation.

Keywords: Digestibility, HQPM, maize, sahiwal, varieties

Maize assumes worldwide significance owing to its utilization as a human food and livestock feed. India is the second-most important maize growing country in Asia, and is the world's sixth largest producer and the fifth largest consumer of maize (Prasanna, 2014). Total maize production in India could be around 20.53 MMT in 2015-16. Nearly 23% of the maize produced, is used for human food, while approximately 63% is utilized for poultry- and animal feed (Yadav *et al.,* 2014). It is the third most produced grain after wheat and rice but leads in crop fodder production globally. Although the maize kernel generally contains 8-10% protein, but is deficient in essential amino acids like lysine, tryptophan and threonine (Lauderdale, 2000). The lower nutritional value of maize protein is attributed to high concentration of prolamins storage protein fraction, which is deficient in lysine and tryptophan (Salamini and Soave, 1982). Lysine being the most limited followed by tryptophan in maize protein (Kies *et al.,* 1965). So, improving the amino acid profile was the major concern, for which mutant germplasm with high level of lysine (3.3- 4g/100g of endosperm protein, which was almost doubled of normal maize) has been identified (Mertz *et al.,* 1964). But these mutants along with high lysine content also carried certain undesirable features because of which its wide spread use was discouraged. Thereafter, through several cycles of recurrent selection, the maize breeders in the International Maize and Wheat Improvement Centre (CIMMYT) Mexico, have combined the high lysine property of *o-2* gene with a modifiers gene without the negative effect of soft endosperm and resulted in production of 'HQPM' (High Quality Protein Maize). The normal existing varieties of maize fodder are routinely used in ruminants diet. It possesses most of the characteristics of an ideal type of fodder the quality aspects of which are well evaluated in terms of voluntary intake, palatability, digestibility, nutrient utilization and production performances. With the evolution of bio fortified HQPM varieties, the grains are effectively utilized in monogastric feeding. Moreover, limited data is available on the nutritional profile of its green fodder. Considering these facts, the present study was designed to evaluate the intake and nutrient digestibility of different normal and QPM varieties green fodder in their pre and post cob stage in lactating Sahiwal cows.

MATERIALS AND METHODS

Selection and distribution of animals

Thirty-two lactating Sahiwal cows from herd maintained at Institutional Livestock Farm Complex (ILFC), College of Veterinary Sciences, Mathura were selected for the study. The cows were multiparous (lactation number 2 and 3) and in early to mid lactation. The experimental animals were randomly divided into 8 dietary groups of 4 animals each on the basis of milk yield and body weight.

Cultivation and harvesting of fodder

Sorghum (Purva) along with four normal maize varieties (HTHM 5101, DHM 117, HM 5 and Shaktiman/900M Gold) and three QPM varieties (HQPM 5, HQPM 7, HQPM 9/ Vivek) were cultivated in the different plots of ILFC, Mathura to carry out the experimental feeding. The seeds of experimental varieties were procured from International Maize and Wheat Centre CIMMYT Centre, New Delhi. All the varieties under test were maintained under identical agronomy and climatic conditions. The pre-cob fodder was ready after about 45-50 days of sowing, and then after harvesting cobs post cob fodder was obtained i.e. nearly after 85-90 days of sowing.

Housing and feeding of animals

The lactating cows were housed in a well-ventilated byre having facilities for individual feeding. Proper care of animals and cleanliness of shed were maintained throughout the experimental period. All the animals were

Table 1: Chemical composition (% DM basis) of different varieties of maize fodder at pre-cob and post-cob stage

Parameters (%)	Normal Varieties										HQPM varieties					
	Sorghum		HTHM5101		DHM117		HM5		Shaktiman		HQPM5		HQPM7		HQPM 9	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
DM	24.45	29.83	17.11	54.49	19.93	47.04	20.64	45.34	19.48	38.97	17.28	33.47	17.26	40.99	23.52	59.41
OM	94.18	93.89	92.08	92.86	94.97	91.00	92.16	92.04	91.09	92.80	90.64	93.69	92.12	91.92	91.93	92.44
EE	1.00	1.23	1.07	2.07	2.70	1.93	1.68	1.72	1.22	1.39	1.33	1.57	1.46	1.89	1.00	0.89
CP	6.80	6.70	9.72	8.39	10.62	6.56	7.29	7.09	9.23	7.80	6.80	6.29	7.21	6.19	7.53	7.35
CF	26.31	36.00	18.10	32.76	16.16	32.00	23.11	40.06	18.36	31.65	22.48	33.33	20.40	34.66	22.37	37.66
TA	5.82	6.11	7.92	7.14	5.03	9.00	7.84	7.96	8.91	7.20	9.36	6.31	7.88	8.08	8.07	7.56
NFE	60.07	49.96	63.19	49.64	65.49	50.51	60.08	43.17	62.28	51.96	60.03	52.50	63.05	49.18	61.03	46.54
NDF	72.34	79.87	70.39	77.65	67.39	71.01	70.49	72.81	73.36	77.25	73.36	77.25	70.09	76.25	67.62	72.29
ADF	48.08	55.93	44.54	48.35	40.02	42.26	43.08	43.42	42.10	44.43	46.43	47.93	44.26	47.20	38.82	42.67
HC	24.26	23.94	25.85	29.30	27.37	28.75	27.41	29.39	27.84	28.93	26.93	29.32	25.83	29.05	28.80	29.62

DM=Dry Matter, OM=Organic Matter, EE=Ether Extract,CP=Crude Protein, CF=Crude Fibre, TA=Total Ash, NFE=Nitrogen Free Extract, NDF=Neutral Detergent Fibre, ADF=Acid Detergent Fibre, HC=Hemi cellulose.

Table 2: Nutrient intake and plane of nutrition of Sahiwal cows fed on different varieties of maize fodder pre- cob stage

Parameters	T1	T2	T3	T4	T5	T6	T7	T8	SEM	P value
Avg. Body weight (kg)	299.25	278.37	291.62	287.12	299.37	295.50	306.37	274.94	5.69	0.898
Metabolic body size ($W^{0.75}$kg)	71.85	65.74	70.52	69.65	71.92	71.24	71.59	67.23	1.05	0.792
DCP (g/day)	449.26^{bc}	481.76^{b}	632.32^{a}	510.21^{b}	476.86^{b}	345.50^{c}	407.13^{bc}	355.54^{c}	19.22	0.000
DCP (g/100 kg BW)	150.19^{cd}	171.46^{bc}	216.72^{a}	177.92^{b}	159.64^{bc}	116.78^{e}	132.99^{de}	129.70^{de}	5.92	0.000
DCP (g/ kg$W^{0.75}$)	6.23^{bc}	7.00^{b}	8.95^{a}	7.31^{b}	6.63^{b}	4.84^{d}	5.56^{cd}	5.27^{cd}	0.245	0.000
TDN (kg)	4.71^{cd}	4.57^{d}	6.20^{a}	5.52^{b}	5.30^{bc}	4.57^{d}	5.14^{bcd}	4.77^{cd}	0.116	0.000
TDN (kg/100 kg BW)	1.59^{cd}	1.65^{cd}	2.13^{a}	1.93^{b}	1.77^{bc}	1.54^{d}	1.68^{cd}	1.74^{bc}	0.037	0.000
TDN (g/kg$W^{0.75}$)	65.94^{de}	67.24^{de}	88.14^{a}	79.38^{b}	73.85^{bc}	64.15^{e}	70.32^{cd}	70.97^{cd}	1.460	0.000
Digestibility coefficient (%)										
DM	60.13^{abc}	59.23^{bc}	66.18^{a}	64.39^{ab}	61.91^{abc}	58.69^{bc}	61.09^{abc}	56.97^{c}	0.781	0.041
OM	62.30^{cd}	61.2^{cd}	68.17^{a}	65.25^{ab}	63.27^{bc}	61.34^{cd}	62.09^{bcd}	60.11^{d}	0.512	0.002
CP	58.57^{a}	55.79^{ab}	59.66^{a}	61.94^{a}	54.00^{ab}	45.87^{b}	52.61^{ab}	45.19^{b}	1.458	0.011
EE	55.68	59.41	68.85	58.66	57.95	65.33	64.33	63.62	1.222	0.086
CF	55.34^{bc}	52.17^{bc}	60.83^{ab}	64.72^{a}	56.02^{bc}	51.38^{c}	56.49^{abc}	54.10^{bc}	1.134	0.036
NFE	59.89	63.87	71.82	67.38	73.41	65.82	70.96	65.85	1.222	0.079

Means bearing different superscripts differ significantly at ($P<0.05$)

dewormed before the start of experiment. Animals were fed to meet the nutrient requirement as per NRC (1989). The ration consisted of wheat straw, concentrate mixture and maize fodder of different varieties. In different groups of cows the wheat straw and concentrate mixture was same while different varieties of green fodder was fed to different group as, T1 (Control)=Sorghum (Purva), T2= HTHM 5101, T3=DHM117, T4=HM5, T5= Shaktiman, T6= HQPM 5, T7= HQPM 7, T8= HQPM 9 maize variety. The concentrate mixture was prepared within the farm and composed of barley grain (45%), mustard cake (28%), wheat bran (25%) and mineral mixture (BIS type II) 2%. The chemical composition of the different varieties of maize at pre and post cob stage is presented in the Table 1. The animals were first fed with concentrate then after wheat straw and greens were offered. The ratio of concentrate: roughage was 30:70 in all the groups. The feeding of ration was done twice a day. Clean drinking water was available *ad lib*.

Digestibility trial

Two digestibility trials of seven days collection period were conducted during the experimental period to determine the nutrients digestibility, one of which was conducted at the end of feeding of pre-cob stage and the other was done at the end of feeding of post- cob stage of fodder. During the trial proper record of feed offered and residue left were maintained. Animals were weighed for 2 consecutive days before and after conducting the trial.

Collection of feed and faeces

Faeces were collected on 24h basis along with the feed offered and orts. DM was recorded by drying in a hot air oven (AOAC, 2005), pooled for all the days of collection, ground to pass 1mm sieve and kept in airtight containers for future analysis. The dried and ground samples of concentrate mixture, wheat straw, green fodder of different varieties, orts and faeces from each cow were analyzed for proximate principles (AOAC, 2005)

Statistical analysis

The data obtained were subjected to statistical analysis by using analysis of variance (Snedecor and Cochran, 1994). Means were compared by Duncan's Multiple Range test (Duncan, 1995) at 5% level of probability.

RESULTS AND DISCUSSION

The results for nutrient intake and plane of nutrition of Sahiwal cows fed on different varieties of maize fodder at pre and post cob stage are presented in Table 2 and 3 respectively. Different cultivars of normal and HQPM varieties at pre and post cob stages exhibited variation in the nutrient intake and digestibility. In pre cob stage, the DCP (g) was significantly ($P<0.05$) higher for DHM 117 and lowest for HQPM 5 variety. However, in post cob stage, the DCP (g) was significantly ($P<0.05$) higher for HTHM 5101 and was lowest for HQPM 5 variety. Higher DCP intake of DHM 117 and HTHM 5101, the normal maize varieties at pre cob and post cob stage of fodder respectively, might be due to high availability of protein, as the CP content of DHM 117(10.62%) and HTHM 5101 (8.92%) variety at pre and post cob stages was higher than other varieties. The DCP at both the stages were found lower for HQPM 5 variety. (Irungu *et al.,* 2016) also reported the effect of different cultivars of sweet potato on intake of crude protein in sheep. The TDN (kg/100kg body weight) in both pre and post cob stage was significantly ($P<0.05$) higher for DHM 117 and lowest for HQPM 5 variety. The higher TDN intake of DHM 117 variety at both the stages might be because of higher intake and better palatability of DHM 117 variety.

In pre cob stage, the dry matter, organic matter and crude protein digestibility (%) was significantly ($P<0.05$) higher for DHM 117 and lowest for HQPM 9 variety. In the post cob stage, the normal maize varieties (DHM 117, HM 5, and HTHM 5101) had higher dry matter and organic matter digestibility. However, the digestibility of DM, OM and CP was lower for HQPM 9 and HQPM 5 varieties at pre and post cob stage respectively. The present result differed with the findings of Gupta and Dey, (2016) who observed higher ($P<0.05$) CP digestibility in heifers fed QPM fodder than baby corn and hybrid maize fodder. The disparity might be attributed to factors like different cultivars, season, agronomic practices etc in these experiments. The variations in digestibility among the cultivars may be related to differences in the chemical composition (Åman and Nordkvist, 1983) or variations in physical structure, such as the distribution of lignified cells within the tissues (Ramanzin *et al.,* 1991). Cultivars and stage of maturity of fodder were observed to have significant effect on dry matter digestibility (Firdous and Gilani, 1999) indicated that digestibility of maize fodder was affected by stage of maturity and cultivars. Thus the high CP digestibility of DHM 117 in pre cob and HTHM 5101 in post cob is reflection of its high CP content. The high nutrient digestibility, nutrient intake and digestible

Table 3: Nutrient intake and plane of nutrition of Sahiwal cows fed on different varieties of maize fodder at post -cob stage

Parameters	T1	T2	T3	T4	T5	T6	T7	T8	SEM	P value
Avg. Body weight (kg)	292.37	269.25	293.5	285.12	297.13	295.75	287.13	273.87	6.51	0.964
Metabolic body size ($W^{0.75}$kg)	70.62	66.27	70.84	69.29	71.47	71.29	69.65	67.20	1.19	0.96
DCP (g/day)	343.11^{cd}	462.87^{a}	368.79^{bcd}	422.76^{ab}	399.00^{bc}	323.38^{d}	385.04^{bcd}	372.63^{bcd}	9.20	0.001
DCP (g/100 kg BW)	117.77^{de}	173.90^{a}	127.22^{cde}	148.39^{b}	135.08^{bcd}	112.44^{e}	135.33^{bcd}	137.76^{bc}	3.66	0.000
DCP (g/ $kgW^{0.75}$)	4.86^{de}	7.00^{a}	5.24^{cd}	6.08^{b}	5.59^{c}	4.66^{e}	5.54^{c}	5.57^{c}	0.13	0.000
TDN (kg)	4.35	4.97	5.52	4.87	4.82	4.32	4.60	4.79	0.10	0.080
TDN (kg/100 kg BW)	1.49^{ef}	1.86^{ab}	1.88^{a}	1.71^{cd}	1.63^{d}	1.46^{f}	1.60^{de}	1.75^{bc}	0.03	0.000
TDN ($g/kgW^{0.75}$)	61.69^{e}	74.96^{b}	78.03^{a}	70.29^{c}	67.55^{d}	60.59^{d}	66.04^{d}	71.32^{c}	1.06	0.000
Digestibility coefficient%										
DM	58.25^{ab}	65.41^{a}	66.46^{a}	66.84^{a}	63.66^{ab}	57.68^{b}	62.99^{ab}	62.13^{ab}	0.822	0.010
OM	59.77^{ab}	66.86^{a}	68.12^{a}	68.36^{a}	65.03^{ab}	59.11^{b}	64.23^{ab}	64.12^{ab}	0.520	0.002
CP	47.57^{abc}	51.44^{a}	45.05^{c}	50.45^{ab}	48.12^{abc}	46.95^{bc}	51.48^{a}	43.94^{c}	0.626	0.002
EE	60.04	64.06	71.10	64.33	69.33	61.28	66.28	66.21	1.290	0.346
CF	50.89	53.81	55.20	49.94	48.39	51.95	52.35	47.02	0.834	0.226
NFE	64.23	62.64	69.25	68.16	66.74	62.95	62.51	64.92	0.661	0.064

Means bearing different superscripts differ significantly at ($P<0.05$)

nutrient intake observed classify the DHM 117 maize variety as highly nutritious fodder. Various other workers also reported the effect of different varieties of different fodders on nutrient digestibility. (Gwayumba *et al.,* 2002) found higher digestibility of protein in Bana variety of napier grass than French Cameroon variety, that may have resulted from the greater protein content (7.2 vs 6.1% CP) in Bana compared to French Cameroon, however DM digestibility was similar in both varieties. The CP and NDF digestibility differed ($P<0.05$) among all four cultivars of sweet potato, with Morooko and K158 having the highest CP and NDF digestibility, respectively (Irungu *et al.,* 2016).

Likewise, Bilal *et al.* (2007) also reported difference in dry matter digestibility (%) as well as NDF digestibility (%) in different varieties of maize, Sadaf, Sultan and Sadaf White *in vitro* and found Sadaf White had better DM and NDF digestibility than other two varieties. Tolera *et al*. (1999) studied the effect of varieties on DM degradability and found that CBF and Birkata had significantly higher ($P < 0.05$) 48 h DM degradability than in Dendane whereas; all the other varieties had intermediate degradability values. The digestibility of five new Brazilian sorghum cultivars (BRS Ponta Negra variety, BRS 655 hybrid, BR 601 hybrid, BRS 506 variety and BRS 610 hybrid) was examined. Among which BRS 506 exhibited the lowest fibre contents and the highest *in vitro* dry matter digestibility (IVDMD) than other cultivars (Neves *et al.,* 2015).

CONCLUSION

From the present study varietal affect was observed in the digestibility and intake of nutrients and the variety DHM 117 have shown higher intake and digestibility at both pre and post-cob stages of the fodder. As the study conducted was of shorter duration and with limited number of animals so, in order to recommend farmers to use a specific maize variety a long term study with larger number of animals is advocated.

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