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NUTRITIONAL AND MINERAL COMPOSITION OF DIFFERENT VARIETIES OF NORMAL AND HIGH QUALITY PROTEIN MAIZE FODDER AT POST- COB STAGE

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Abstract: Present findings provide valuable information on the nutritional characteristics of different varieties of normal and high quality protein maize fodder at its post-cob stage. The four normal maize (HTHM 5101, DHM 117, HM 5 and Shaktiman /900 M Gold) and three high quality protein maize (HQPM 5, HQPM 7, HQPM 9/ Vivek) varieties were sown in different plots under identical agronomy practices and environment. The representative samples were obtained after 70-80 days of sowing when the cobs are grown. The processed samples of different varieties of maize fodder at post-cob stages were analyzed for chemical and minerals composition. The findings concluded that the different genotypes of maize fodder differ substantially in their chemical and mineral compositions.
Keywords: Chemical composition, High Quality Protein Maize, maize fodder, post-cob,

Introduction

Maize (*Zea mays L.*) 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). Nearly 23% of the maize produced in India, is used for human food, while approximately 63% is utilized for poultry and animal feed (Yadav et al, 2014). Maize possesses most of the characteristics of an ideal type of fodder and forage plant. It is one of most nutritious non-legume green fodder. The high acceptability of maize as fodder can be judged from the fact that it is free from any anti-nutritional components and is quick growing, yields high biomass, and is highly palatable. However, in spite of several important uses, the normal maize genotypes are inherently deficient in two essential amino acids, viz., lysine and tryptophan leading to amino acid balance and low biological value of traditional maize genotypes. To

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overcome this problem, the researchers through breeding and selection discovered new mutants that could alter the amino acid profile of maize endosperm protein, which resulted in the development of quality protein maize (QPM). QPM has higher nutritional and biological value and is essentially interchangeable with regular maize in cultivation and kernel phenotype (Vasal, 2000). It is no different from that of regular maize in terms of quantity of energy and protein, but differs in protein quality because it contains almost double amount of lysine and tryptophan in comparison to regular maize (Panda et al, 2014). The other nutritional benefits of QPM include higher niacin availability due to higher tryptophan and lower leucine content, higher calcium and carbohydrate (Graham et al, 1980) and carotene utilization (De Bosque et al, 1988). Various researchers concluded the high efficacy of feeding QPM grains in pig and poultry production. But regarding the nutritional characteristics of maize fodder of normal and QPM varieties at post cob stage, studies are limited. The fodder is harvested after the cobs are produced nearly after 70-80 days of sowing. At this stage, the fodder is still green and fresh which is nutritious and palatable for livestock than dry maize stovers. Hence, in the present study nutritional composition of different varieties of normal and QPM at post cob fodder was undertaken aiming at exploiting and promoting its efficient utilization in feeding the ruminants species.

Material and Methods

For studying the nutritional composition of post cob maize fodder of different varieties the seeds of selected varieties viz. four normal (HTHM 5101, DHM 117, HM 5 and Shaktiman/900M Gold) and three QPM varieties (HQPM 5, HQPM 7, HQPM 9/ Vivek) were obtained from International Maize and Wheat Centre, New Delhi. They were sown in in lines (20- 30cm apart) by zero tillage method in different plots of Instructional Livestock Farm Complex, DUVASU, Mathura. All the fodder varieties were cultivated under similar agronomic practices and climatic conditions. After about 75-80 days of sowing the cobs are produced and the post-cob fodder was obtained. The representative samples of post-cob stage of fodder from different varieties of maize were brought to laboratory. The samples were prepared for analysis by drying to constant weight in hot air oven at 80°C temperature and then grinded in the laboratory Wiley mill-using sieve of 2 mm diameter. The dried and grinded samples were stored in clean, well-labeled airtight containers for further analysis. The processed samples of different varieties of post-cob stages maize fodder were analyzed for proximate compositionas per the standard methods described by the Association of Official Analytical Chemists(AOAC, 1995), fiber fractions (Van Soestet al, 1991) and minerals. The estimation of Calcium (Ca), Sodium (Na) and Potassium (K) was done by microprocessor flame photometer model 1385/1382 from (Esico) using their respective standards, while phosphorous was determined by as per the protocol of (AOAC, 1995).

The micro minerals i.e. Cu, Zn, Fe and Mn were estimated by using Perkin Elmer Analyst 400 Atomic Absorption Spectrophotometer equipped with air-acetylene flame. The preparation of feed samples for mineral analysis was carried out after acid digestion of 5.0 g of the grounded sample with adequate amount of tri acid mixture (nitric acid, sulphuric and perchloric acid in 3:1:1 ratio) until a clear solution was obtained. The digest was allowed to cool and then transferred into a 100 mL volumetric flask and made up to mark with de-ionized water. The data obtained are reported as mean± standard error for three replicates using Microsoft excel software.

Result and Discussion

The Proximate composition and fibre fractions (% DM basis) of different varieties of normal and QPM fodder at post-cob stage is presented in Table 1 and 2 respectively. The Organic Matter (%) ranged from 91.00±0.0.79 (DHM 117) to 94.97±0.57 (HQPM 5). A variation in protein concentration (6.19 to 8.39 %) was found in different varieties of maize fodder at post cob stage. The highest concentration of protein (8.39%) was found in variety HTHM 5101and lowest in HQPM 7 (6.19 %). The variation observed in the crude protein content might be due to the different varieties of maize fodder. Studies carried by other workers are in agreement with the present findings. Balint et al. (1977), Ameret al, (1986) and Awanet al, (2001) also reported significant differences among the maize cultivars for crude protein content. The protein content of the post cob maize fodder was found lower than the maize green fodder but was higher than the maize stovers which shows that the fodder is nutritious and palatable and has potential to the requirement of livestock feeding on it. Good quality fodder requires a CP content above 4% (Wang, 2009). However, the HQPM varieties did not show higher content of crude protein than normal varieties. Similar to present findings, Rather et al, (2011) also found lower protein % in HQPM 1 than the C-15 variety. Mbuya et al, (2011) also concluded that the QPM genotypes have similar level of protein content but have better amino acid balance compared to normal maize. According to Akumoa –Boateng (2002) and Nuss and Tanumihardjo, (2011) the crude protein of QPM is not higher than that of common maize, however, it is better in terms of amino acids composition. The values of Ether Extract (%) ranged between 0.89% (HQPM 9) to 2.07 (HTHM 5101). Ayubet al, (1998) also reported significant differences among the maize cultivars (Sadaf, Sultan, Sarhad

White and Golden) for ether extractable fat. The Crude fibre (%) content differ among different varieties varied between 31.65 to 40.06 % which depicts that the fodder is fully matured because as plant grows, there is the need for fibrous tissue and therefore the content of structural carbohydrate increases. The concentration of protein decreases and the fibre content increases as the plant matures (Olaniteet al, 2010). The variation observed in different proximate parameters in composition of different varieties of maize fodder might be due to difference in genetic makeup of the varieties. These varieties have different maturity time and growth rate but were harvested at similar time that might have affected their nutritional composition. Literature evidences reveal the existence of genetic differences in chemical composition and the findings of the present study are also in line with Dattet al, (2006) who also observed the variation in OM, CP, EE, CF, Total ash and NFE content of ten different cultivars of maize including some varieties and their crosses. Similarly, studies conducted by Tolera et al, (1999) have also shown evidence of significant ($P<0.05$) varietal differences in chemical composition of maize.

The fibre fractions (%) viz. Neutral Detergent Fibre, Acid Detergent Fibre, Cellulose, hemicellulose and Acid Detergent Lignin varied among different varieties of maize fodder at post cob stage. The findings of the current study were in agreement with the studies of Geletiet al, (2011) and Tolera et al, (1999) who observed significant varietal effects of maize fodder for NDF ($P<0.01$), ADF ($P<0.05$) and ADL ($P<0.05$) fractions. The fibre contents in this study are close to the findings of (Veribicet al, 1995). However, results were in contrast to the work of Dattet al, (2006) who noticed lower values of NDF (53.10-64.53 %), ADF (30.23-41.94%), Hemicellulose (17.49-25.91 %), cellulose (22.29-33.69%), lignin (2.92-4.73 %) of ten cultivars of maize. Differences in comparison with other literature may be due to variety selected, cultivation practices, stage of harvest, soil, climatic conditions and proportion of morphological fraction (Tang et al, 2006). In the present study agronomic practices, climatic conditions and time of harvesting of fodder were kept identical for all varieties under test. Therefore, it can be predicted that the cause for variation might be due to genetic makeup of the variety, which might have affected the nutrient uptake from the soil and hence the nutritional composition.

Mineral composition of different varieties of maize fodder at post-cob stage

The mineral composition of different varieties of maize fodder at post-cob stage is presented in Table 3. The range of Calcium (%) reported in different maize varieties varied from 0.64 to 1.11. The Phosphorus (%) of ranged from 0.03 to 0.07. However, Singh (1976) reported Ca and P content (%) of two maize varieties Ganga-5 (0.65, 0.14) and Vijay (0.47, 0.15), the difference observed might be due to different cultivars and environmental conditions. The concentration ranges of the micro-minerals Cu, Fe, Mn, and Zn were 7.12-8.76 ppm, 404.28-678.60ppm, 25.92-72.54ppm and 27.12-58.20ppm respectively. Calcium, Copper, zinc and iron were present in appreciable quantities in all the varieties of maize fodder at post cob stage. The main factors affecting the mineral composition of forages are species, variety, stage of maturity, soil and environmental factors, morphological fraction and use of fertilizers etc. Hence, the variation in mineral composition of different varieties of maize fodder in the study is attributed to variety and different genetic makeup since all other factors were similar to all the varieties during cultivation. Sen and Ray (1964) studied the Ca and P levels in some tropical grasses at different stages of maturity and reported a great diversity in the pattern revealed by different elements in different plant species at various stages of maturity, that might be due to variation in mineral composition of different plant parts, the ratio of which changes radically as the plant matures. Azimet al, (1989) also observed the variation in Na, K, Ca and P content of different fractions of the plant. Hussaini et al, (2008) showed that nitrogen fertilizer application up to 60kg/ha significantly increased the concentration of N, P, Ca and Mg in maize grain. Numerous studies investigated the important factors on accumulating minerals. Zhang et al, (2010) evaluated the effects of genotype and environment on mineral compositions of wheat grains grown in different locations, and found a large variation for all mineral elements. Peterson et al, (1983) also reported significant variation in mineral concentration by genotypes and concluded that the genotype effect was much larger than environment factors.

Conclusions

The present study confirmed that different genotypes of maize fodder differ substantially in their chemical composition. With the advancing age/stage and maturity the dry matter content and the various cell wall constituents increased. As because the fodder was grown under well-standardized conditions, effect of location and agronomy may have on chemical composition still need to be investigated. To evaluate the relevance of the variability animal trials are further recommended.

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

Variety	Organic Matter	Crude Protein	Ether Extract	Crude Fibre	Total Ash	Nitrogen Free Extract
HTHM 5101	92.86±0.56	8.39±0.79	2.07±0.39	32.76±1.24	7.14±0.90	49.64±1.66
DHM 117	91.00±0.79	6.56±0.59	1.93±0.16	32.00±1.10	9.00±1.00	50.51±1.23
HM 5	92.04±0.85	7.09±0.52	1.72±0.28	40.06±1.32	7.96±0.53	43.17±1.08
SHAKTIMAN	92.8±0.91	7.80±0.50	1.39±0.31	31.65±1.23	7.20±0.62	51.96±1.19
HQPM 5	93.69±0.57	6.29±0.53	1.57±0.25	33.33±1.18	6.31±0.57	52.5±1.34
HQPM 7	91.92±0.94	6.19±0.75	1.89±0.16	34.66±1.19	8.08±0.53	49.18±1.41
HQPM 9	92.44±0.83	7.35±0.67	0.89±0.22	37.66±0.93	7.56±0.72	46.54±2.58

Table 2: Fibre fractions (% DM basis) of different varieties of maize fodder at post-cob stage

Variety	NDF	ADF	Hemicellulose	Cellulose	ADL
HTHM 5101	77.65±1.48	48.35±2.75	29.30±1.46	39.93±1.02	8.42±0.94
DHM 117	71.01±2.16	42.26±1.56	28.75±1.68	33.45±1.13	8.81±0.40
HM 5	72.81±2.29	43.42±2.19	29.39±2.06	34.80±1.40	8.62±0.64
SHAKTIMAN	73.36±2.00	44.43±2.90	28.93±1.53	35.50±1.66	8.93±0.58
HQPM 5	77.25±1.62	47.93±2.12	29.32±1.89	38.95±1.41	8.98±0.68
HQPM 7	76.25±2.81	47.20±2.10	29.05±1.98	38.67±1.98	8.53±0.71
HQPM 9	72.29±3.37	42.67±1.29	29.62±1.63	34.85±1.06	7.82±0.55

Table: 3: Mineral Composition of different varieties of maize fodder at post-cob stage

Variety	Ca (%)	P (%)	Na (%)	K (%)	Cu (ppm)	Zn (ppm)	Mn (ppm)	Fe (ppm)
HTHM 5101	0.64±0.09	0.03±0.01	0.95±0.10	0.75±0.15	7.12±0.62	27.12±2.84	25.92±2.32	404.28±14.40
DHM 117	0.97±0.07	0.05±0.01	0.86±0.12	0.54±0.14	8.44±0.69	33.36±1.12	47.16±2.12	571.08±19.05
HM 5	0.86± 0.09	0.05±0.01	0.94±0.13	1.14±0.11	7.68±0.85	58.20±2.01	52.02±2.56	553.68±24.29
SHAKTI MAN	1.05±0.09	0.07±0.01	0.92±0.11	0.98±0.11	7.32±0.75	39.24±2.24	40.92±3.72	662.40±24.24
HQPM 5	1.11±0.06	0.04±0.01	0.81±0.11	1.14±0.09	8.18±0.83	28.50±2.75	30.78±1.48	426.60±16.83
HQPM 7	0.98±0.10	0.03±0.01	0.97±0.06	1.18±0.12	8.46±0.44	38.28±1.85	43.08±2.83	506.82±13.42
HQPM 9	1.08±0.09	0.06±0.01	0.86±0.14	1.07±0.11	8.76±0.42	43.50±2.65	72.54±2.29	678.60±24.62