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Relative Appraisal Among Different Sugarcane Varieties for Quality of Sugarcane Tops Silage as Non-Conventional Feed Resource

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ABSTRACT

The study included evaluation of nutritive quality of tops of four sugarcane varieties (Co 118, CoJ 88, CoPb 93 and CoPb92), berseem (BL-10) and silage made from them. Four types of silage were prepared by mixing sugarcane tops of each variety with barseem in a fixed proportion of 60:40 sugarcane and barseem, respectively. Mixture of tops of sugarcane varieties Co 118, CoJ 88, CoPb 92 and CoPb 93 with barseem variety BL 10 was referred as silage-I, silage-II, silage-III and silage IV, respectively. Tops of each sugarcane variety, berseem and silages were evaluated for their nutritional composition. Variety CoJ 88 contain highest dry matter content (30.1%) whereas variety Co118 contain highest percent crude protein (5.05%) among all varieties. The acid detergent fiber (38.8%) and ADL(5.0%) were lowest in variety CoPb92. Silage I had highest CP (8.30%), NDF(66.6%),ADF(35.3%) and ADL(4.20%) levels whereas silage III had significantly lower CP, NDF, ADF and ADL. Predicted palatability/intake and energy quality parameters indicated that DMI (1.80%), DDM(61.4%), TDN (63.1%), RFV (85.8%), RFQ (2.03%) and NEL(1.43Mcal/Kg)values were highest for silage III. Fermentation quality parameters like acetic acid content (2.89%) and TVFA (5.17) of CoPb 92 were optimum . It was concluded that among all four varieties, CoPb 92 mixed with berseem (BL-10) in 60:40 ratio gives the most appropriate quality of silage.

Key words: Palatability, Quality,Silage, Sugarcane tops

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INTRODUCTION

Silage is very important component of fodder based livestock production system. Under Indian conditions owing to high concentration of soluble sugars and starch, maize is the most suitable crop for silage preparation but due to decline in area under fodder production in India.Green fodder availability inIndia is deficit by 35.6% which may increase to 67% in future (Vision, 2050). Fodder deficit data indicates the dire need to explore alternate forage resources. Utilization of agricultural residues as non-conventional feed resources for dairy animals is a promising option for profitable and sustainable integrated crop-livestock system (Go´mez-Va´zqueze et al., 2011; Makkar, 2016; Santos et al., 2020; Seidavi et al., 2020). Sugarcane tops are one such by-product of sugarcane harvesting, comprising green leaves, the leaf bundle sheath and some immature cane. India is the largest producer of sugarcane in the world andproduces about 40-50 million tons tops and leaves annually (Solomon, 2011). Sugarcane tops have been in use as an alternate fodder resource among farmers in Punjab. It contains optimum level of water soluble carbohydrates (82.5-155 g/kg DM), that makes it a prospective alternative for making silage. But, lowdry matter digestibility (54%), low protein content of 5.5% and crude protein digestibility (39%) of sugarcane tops needs to be supplemented with a protein source (McKenzie and Griffith, 2007). Furthermore, its nutritive value may also vary according to its variety, pre harvesting methods, stalk

cutting point, plant maturity and the leaves content (McKenzie and Griffith, 2007) that may affect the quality of silage.

MATERIALS AND METHODS

Silage and quality analysis

The study included evaluation of nutritive quality of tops of four sugarcane varieties (Co 118, CoJ 88, CoPb 93 and CoPb 92), berseem (BL-10) and silage made from them.

Sugarcane tops and berseem samples were collected at Regional Research Station, Kapurthala, Punjab, India, and were processed for chemical analysis and evaluation of their ensiling potential. Four types of silage were prepared by mixing sugarcane tops of each variety and berseem as follows:

Silage-I: Co 118 sugarcane tops and berseem (BL-10) in ratio of 60:40

Silage-II: CoJ 88 sugarcane tops and berseem (BL-10) in ratio of 60:40

Silage-III: CoPb 93 sugarcane tops and berseem (BL-10) in ratio of 60:40

Silage-IV: CoPb 92 sugarcane tops and berseem (BL-10) in ratio of 60:40.

Forages were chopped (2–4 cm) ensiled for 45 days in low-density polypropylene tube.Each variety of sugarcane and berseem (before ensiling and after ensiling)were dried in hot air oven at 60 °C for 48 hours to determine dry matter (DM). All samples were ground and analyzed for proximate analysis and cell wall constituents. Crude protein (CP), ether extract (EE), total ash, organic matter (OM), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were estimated as per (AOAC, 2005) and Van Soest et al. (1991) and cellulose was assessed by the method of (Crampton and Maynard, 1938).

Nutritive quality of silage I, II, III and IV were evaluated by taking 25 g of sample from each bag and processed with 225 mL distilled water (DW). The extract was used to estimate pH (by using portable pH meter), lactic acid (Barker and Summerson, 1941), volatile fatty acids (by using gas liquid chromatography Michro-9100, Netel Chromatograph, India; Cottyn and Boucque,1968) and ammonical-N (AOAC, 2005). The parameters like total digestible nutrient (TDN), net energy for lactation (NEl), dry matter intake percent body weight (DMI % BW), relative feed value (RFV) and relative feed quality (RFQ) were calculated by using equations given by Lardy (2018).

DMI (% BW) = 120 / (% NDF) ; Digestible dry matter (DDM) = 88.9 - (0.779 ×% ADF)

RFV = (% DDM ×% DMI) / 1.29 ; RFQ = (TDN × intake) / (16.8 + 39.2)

TDN = 87.84 - (0.79×% ADF) ; NEl (Mcal/kg) = 0.0245 × TDN - 0.12

Statistical Analysis

Data pertaining to chemical composition of each variety were analyzed using one-way analysis of variance (ANOVA). Data generated for silage chemical composition and quality were analyzed by using full factorial design with fixed factors variety (Co 118, CoJ 88, CoPb 93 and CoPb 92). All statistical procedure was done using SPSS (2007) and Tukey's b test.

RESULTS AND DISCUSSION

Nutritive value of silage

Comparison of proximate parameters and cell wall components for all the forages and their depicted variation with respect to varietal differences are summarized in Table 1. Among all varieties, CoJ 88 contained significantly higher dry matter content (30.1%), whereas varieties CoPb 92, CoPb 93and Co 118 contained 26.0%, 25.4% and 24.8% dry matter content, respectively. Dry matter content of variety CoJ 88 was 15.8 %, 18.5% and 21.4% higher than varieties CoPb92,CoPb 93 and Co 118, respectively. Variety CoPb93 (4.35%) tested lowest in crude protein content as compared to variety Co 118 (5.05%), CoJ 88 (4.98%) and CoPb 92 (5.0%). However, varieties Co 118, CoJ 88 and CoPb 92 were statistically similar in crude protein content. Ether extract level of variety CoJ

88 (2.0%) and CoPb 92 (1.89%) were statistically equivalent but was significantly higher than variety Co 118 and CoPb 92 that contained 1.7% and 1.5% ether extract, respectively.

Table 1.Nutrient composition of sugarcane tops and berseem on DM basis

Parameters	Sugarcane tops						
(%)	Co 118	CoJ 88	CoPb 93	CoPb 92	SEM	P- value	Berseem
DM	24.8^{a}	30.1^{c}	25.4^{ab}	26.0^{b}	0.110	0.000	10.8
CP	5.05^{b}	4.98^{b}	4.35^{a}	5.0^{b}	0.070	0.021	18.1
EE	1.7^{ab}	2.0^{b}	1.5^{a}	1.89^{b}	0.040	0.023	2.85
NDF	68.6^{a}	71.8^{b}	72.9^{b}	69.0^{a}	0.187	0.008	45.5
ADF	39.9^{b}	41.2^{c}	42.9^{d}	38.8^{a}	0.089	0.004	31.25
ADL	7.00^{b}	6.55^{b}	7.80^{b}	5.00^{a}	0.160	0.008	5.65
Cellulose	32.9^{a}	34.6^{c}	35.7^{c}	33.8^{b}	0.083	0.005	25.6
Ash	6.20^{b}	5.20^{a}	6.80^{c}	6.92^{d}	0.010	0.000	14.3
OM	93.8^{c}	94.8^{d}	93.2^{b}	93.1^{a}	0.010	0.000	85.7

Fiber analysis of different varieties of sugarcane depicted that ADF (38.8%) and ADL(5.0%) levels were lowest in CoPb 92. Percentage of structural carbohydrates, NDF in variety CoJ 88 (71.8%) and variety CoPb 93 (72.9%) were statistically equivalent but higher than that of Co 118 (68.6%) and CoPb 92 (69.0%). Acid detergent fiber (ADF) content was statistically highest in CoPb 93 (42.9%) as compared to CoPb 92 (38.8%), Co 118 (39.9%) and CoJ 88 (41.2%). Acid detergent lignin percentage was lowest in CoPb 92 (5.0%) while other three varieties were statistically at par with each other in lignin content viz. CoPb 93 (7.8%), Co 118 (7.0%) and CoJ 88 (6.55%). Consequent upon the NDF, ADF and ADL levels, percentage of cellulose was lowest in Co 118 (32.9%) while CoJ 88 and CoPb 93 had highest and equivalent cellulose content 34.6% and 33.8%, respectively.

Mineral content of all four varieties varied significantly and was highest in CoPb 92 (6.92%) and lowest in CoJ88 (5.20%). Consequently organic matter was lowest in CoPb 92 (90.4%) and highest in CoJ88 (94.8%). Berseem fodder had optimal nutritional composition with respect to CP(18.1%), EE(2.85%), NDF (45.5%), ADF (31.25%), ADL (5.65%) and Cellulose (25.6%).

Table 2. Effect of variety on nutrient composition of different sugarcane tops silages (% DM basis)

Parameters	Sugarcane tops					
(%)	Co 118	CoJ 88	CoPb 93	CoPb 92	SEM	P-value
DM	18.1^{a}	21.0^{c}	19.4^{b}	18.2^{a}	0.063	0.000
CP	8.30^{c}	8.05^{b}	7.45^{a}	7.85^{ab}	0.048	0.014
EE	1.80	2.40	1.60	2.25	0.110	0.164
NDF	67.5^{ab}	68.6^{bc}	68.9^{c}	66.6^{a}	0.117	0.007
ADF	40.1^{b}	40.6^{b}	43.0^{c}	35.3^{a}	0.175	0.000
ADL	6.75^{b}	6.00^{b}	6.25^{b}	4.20^{a}	0.105	0.004
Cellulose	33.4^{b}	34.6^{b}	36.7^{c}	31.1^{a}	0.156	0.001
HC	27.4^{ab}	28.1^{b}	25.9^{a}	31.3^{c}	0.172	0.002
Ash	9.75^{b}	7.12^{a}	9.10^{b}	9.57^{b}	0.073	0.001
OM	90.3^{a}	92.9^{b}	90.9^{a}	90.4^{a}	0.003	0.001

The data in Table 2 depicts comparison and variation of nutritional value of silage made from different varieties of sugarcane mixed with berseem fodder. Silages prepared from tops of variety CoJ 88 and barseem had highest dry matter content(21.0%)whereas silage prepared from variety Co 118 tested lower dry matter content (18.1%) among all prepared silages. Silage made from variety CoPb 93 contains 19.4% DM content. The dry matter content values of silages of varieties CoPb 92 (18.2%) and Co 118 was also statistically similar.CP level in silage made from Co 118 was highest (8.30%) while silage prepared from variety CoPb 93 had the lowest (7.45%). The crude protein content in silage of variety CoJ 8and CoPb 92 was 8.05% and 7.85% respectively.

Non-significant differences were observed in ether extract of fresh forages and silages prepared from all four varieties of sugarcane. The ether extract of variety Co 118, CoJ 88, Co Pb 92, Co Pb 93 was 1.80%, 2.40%, 1.60% and 2.25 %, respectively.Neutral detergent fiber percentage in silage of CoPb 92 was significantly lowest (66.6%) and it was highest in silage of CoPb 93 (68.9%) whereas per cent NDF values in silage of variety Co 118 and CoJ 88 were 67.5 and 68.6 respectively.A lower NDF content is desirable to maximize forage and dry matter intake (corn silage.com) suggesting silage made from CoPb 92 as the most appropriate silage among the silage prepared from varieties Co 118, Co Pb 93 and CoJ 88. Acid detergent fiber (ADF) content of silage prepared from Co 118 and CoJ 88 was statistically at par with each other (40.1 and 40.6%) and their ADF values were between highest ADF of CoPb 93 silage (43.0%) and lowest ADF of CoPb 92 (35.3%). Lowest neutral detergent fiber and ADF values result indicate highest digestibility and energy content of silage (corn silage.com) made from CoPb 92.

Corresponding to ADL percentage in fresh forage ADL content of CoPb 92 silage was lowest (4.20%) whereas the silage prepared from other varieties Co 118,CoJ 88 and CoPb 93 contained lignin content of 6.75%, 6.00% and 6.25%, respectively which were statistically similar among each other. Silage preparation resulted into slight reduction in cellulose in all varieties by 0.18-3.05% except variety CoPb 93 where it increased by 1.1%. Overall cellulose level was lowest in silage made from CoPb 92 (31.1%) and highest in CoPb93 (36.7%). Variety Co 118 contained 33.4% cellulose and variety CoJ 88 contained 34.6% equivalent cellulose content. Hemicellulose content of CoPb93 tested lowest (25.9%) and variety CoPb 92 tested highest in hemicellulose content (31.3%). In spite of significant variations among them, all varieties of sugarcane satisfied the nutritional parameters of silage.

Mineral content of silage prepared with varieties Co118, CoPb 93 and CoPb 92 had statistically equivalent mineral content of 9.75, 9.10, 9.57 per cent, respectively but were significantly higher than the silage of variety CoJ 88 which contained 7.12% mineral content. Consequently, organic matter content of CoJ 88 (92.9%) was significantly high while all other three types of silage had equivalent OM content i.e. 90.3, 90.9 and 90.4 % for Co118, CoPb 93 and CoPb 92, respectively.

Table 3. Effect of sugarcane variety on Intake and quality parameters of different sugarcane tops silages (% DM basis)

Parameters	Sugarcane tops					
(%)	Co 118	CoJ 88	CoPb 93	CoPb 92	SEM	P-value
DMI (%,BW).	1.78^{bc}	1.75^{ab}	1.74^{a}	1.80^{c}	0.003	0.007
DDM(%)	57.7^{b}	57.3^{b}	55.4^{a}	61.4^{c}	0.137	0.000
TDN(%)	59.7^{b}	59.4^{b}	57.7^{a}	63.1^{c}	0.123	0.000
RFV	79.5^{b}	77.7^{b}	74.8^{a}	85.8^{c}	0.239	0.001
RFQ	1.89^{bc}	1.86^{ab}	1.79^{a}	2.03^{de}	0.006	0.001
NEl, M cal/kg	1.34^{b}	1.34^{b}	1.29^{a}	1.43^{c}	0.003	0.000

Intake, DMD, TDN and NEl content of silage energy are the major factor affecting the animal performance (Moore et al., 1999). Palatability/intake and energy quality parameters (Table 3) depicted that predicted DMI (1.80%), DDM (61.4%), TDN (63.1%), RFV(85.8%), RFQ (2.03%) and NEL(1.43Mcal/Kg)values were highest for silage made from CoPb 92 and lowest for CoPb 93. Variety CoPb 92 had lowest levels of NDF and ADF accounting for its higher intake higher TDN and NEL energy. Lowest ADF of silage made from CoPb 92 (35.3%) could also be responsible for highest digestibility and energy content of silage that could support the production efficiency of lactating animals in better way as compared to other silages under study. In the present study, the values of RFV varied between 74.14-85.8, which were almost in the range reported for other sources like maize and wheat fodders Hundal et al.(2020).Furthermore, higher RFV and RFQ values for silage made from CoPb 92 indicate it as optimum source of energy and protein when fed solely(Moore and Undersander, 2002).Low DMD, energy and protein values of silage made from CoPb 93 are due to high NDF and ADF values of silage.

Table 4. Effect of variety on pH, Ammonical-N and various acids of different sugarcane tops silages (% DM basis)

Parameters	Sugarcane tops					
(%)	Co 118	CoJ 88	CoPb 93	CoPb 92	SEM	P-value
pH	4.47^{bc}	4.21^{a}	4.39^{b}	4.56^{c}	0.014	0.004
Ammonical-N (% of TN)	8.74^{b}	5.36^{a}	5.67^{a}	9.19^{b}	0.210	0.002
Lactic acid (% DM)	6.31^{d}	3.76^{a}	4.95^{b}	5.89^{c}	0.014	0.000
Acetic acid (% DM)	1.46^{a}	1.77^{ab}	2.18^{b}	2.89^{d}	0.064	0.006
Propionic acid (% DM)	0.69	0.77	0.95	0.92	0.030	0.099
BCFA	1.40	1.39	1.41	1.36	0.014	0.614
TVFA	3.55^{a}	3.93^{a}	4.55^{ab}	5.17^{b}	0.105	0.020

Different varieties of sugarcane had significant effect on level of quality parameters like pH, ammonical nitrogen/TN, lactic acid, acetic acid, and TVFA. Data in Table 4 depicts that pH of silage made from mixture of different varieties of sugarcane tops and berseem varied between 4.21 (CoJ 88) to 4.56(CoPb 92). Varity Co118 had highest CP level (5.35%) accounting for higher buffering and relatively higher pH 4.47of silage. Owing to their pH values silage made from CoJ 88 (4.21) and CoPb 93(4.39) may be rated as good quality silage and rest as average in quality (Jianxin and Jun, 2020).Ammonical nitrogen/TN level of silages varied between 5.36 (CoJ 88) -9.19 (CoPb 92) and Co 118 (8.74 %) also had the level statistically equivalent to CoPb 92 (9.19%). On the basis of ammonical nitrogen/TN content all four types can be rated as good quality silagewith best the silage made from CoJ88 (5.36%).

Fermentation of water soluble sugars led to production of lactic acid (Borreani et al., 2018) which varied between 3.76 (CoJ 88) to 6.31% (Co 118).The content of lactic acid was within the range of good quality silage as described by McDonald et al. (1991). In spite of higher CP of Co 118 and higher pH of its silage in comparison with other varieties, highest lactic acid content revealed not only good quality fermentation but also well preserved stable silage made from Co118. Acetic acid content of silage immensely affects its stability. Hundal et al.(2020) reported 0.90-1.52% acetic acid (on DM basis) in silage made from maize hybrids. In present study the acetic acid content of all the silages also fell within the similar normal range of 1-3% (Kung

and Randy, 2001).Acetic acid level varied between 1.46 (Co118) and 2.89% (CoPb 92) depicting acceptable quality silage for all four varieties (Ward, 2001).TVFA level in CoPb92 (5.17) was significantly higher than co118 and Co88 but comparable to Cop93 . BCFA level were equivalent for all four types of silage.

CONCLUSION

Lowest NDF and ADF values in silage made from CoPb 92 indicated its highest digestibility and energy content. This was well supported by highest predicted values of DMI, DDM, TDN, RFV, RFC, RFQ, NEL and acetic acid and TVFA content of the silage made from CoPb 92.Other parameters like pH, Ammonical-N (% of TN),Lactic Acid (% DM), Propionic acid and BCFA levels of silage made from CoPb 92 were also at optimum level. Silage made from sugarcane variety CoPb 92 after mixing with berseem had the most appropriate quality for feeding to the animals as compared to other three varieties.

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