

EFFECT OF UREA-MOLASSES TREATMENTS ON CHEMICAL COMPOSITION AND *IN-VITRO* DIGESTIBILITY OF RICE STRAW OF DIFFERENT CULTIVARS

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SUMMARY

A study was conducted to assess the chemical composition of different cultivars of rice and to evaluate the effect of urea or urea plus molasses treatment on their nutrient profile. Samples of eight cultivars of rice *viz.* CSR-30, HB-2, Basmati-370, HKR-47, HKR-127, PB-1121, PB-1509 and Taraori, were collected from different parts of Haryana state and treated with 3.5% urea or 3.5% urea plus 3.5% molasses solutions. Chemical analysis of the samples revealed that CSR-30 had slightly higher CP, NFE and OM as compared to other cultivars. Treatment with urea alone or in combination with molasses increased the crude protein content of the rice straw of all cultivar considerably but, the percentage of CP, NFE, OM, IVDMD and IVOMD was reported to be highest in urea or urea plus molasses treated CSR-30. *In-vitro* study revealed that a total mixed ration containing treated rice straw, green fodder and concentrate mixture in the ratio of 35:30:35 had significantly ($p < 0.05$) higher digestibility. Thus, treatment of rice straw either with urea alone or urea plus molasses combination improves the nutritive values of rice straw considerably.

Key word : Rice straw, urea-molasses treatments, CP, NFE, OM, IVDMD and IVOMD

In India, there is a huge gap between the demand and availability of green and dry fodder for livestock animals. Seasonal lean period also worsens the supply of cultivated forage for dairy animal feeding. Thus, the future needs of animal production rely on feeding by-products from food produced for human consumption (Devendra and Leng, 2011; Laconi and Jayanegara, 2015). Rice is one of the main carbohydrate sources consumed by human. India is the second biggest rice producer after China with 118.9 million metric tons of milled rice in 2019-20 (Shahbandeh, 2021) which lead to production of big quantities of by-products such as rice bran, rice hull and rice/paddy straw. Rice straw thus produced can be a readily available and cheap source of fodder for feeding ruminants. But rice straw is low in protein, high in fiber, lignified components and silica (Van Soest, 2006) due to which, burning is one way to dispose of the straw by farmers in India which causes environment pollution. Owing to low digestibility and intake associated with low nitrogen, mineral and vitamin contents, feeding rice straw can't even meet the animal's maintenance nutrients' requirement. Furthermore, rice straw has low digestibility in the rumen (<50%) due to high silica and lignin contents, low rate of passage, and thus reduced dry matter intake

(Aquino *et al.*, 2020). So, pretreatment of rice straw becomes essential to improve its nutritive value for ruminants. Several attempts have been made in past to improve the availability of nutrients from rice straw by physical, chemical and biological treatments like chopping, grinding, alkali treatments, ammoniation or urea treatment, fibrolytic enzymes applications and inoculation with white rot fungal species (Sarnklong *et al.*, 2010). Urea treatment of rice straw has been found to be technically practicable at the farm level. Urea treatment of rice straw has shown to increased straw digestibility by 2-100% than that of the untreated rice with improved productivity of animals (Gunun *et al.*, 2013). Residual urea in the treated straw adds substantial amount of nitrogen for microbial protein synthesis in the rumen (Polyorach and Wanapat, 2015). The aim of the present study was to elucidate the *in-vitro* variability in the nutritive value of rice straws of different cultivars grown in Haryana.

MATERIALS AND METHODS

The samples of rice straw of eight cultivars Haryana *viz.* CSR-30, HB-2, Basmati-370, HKR-47, HKR-127, PB- 1121, Taraori, and PB-1509 were collected from different parts of Haryana state. The

samples of different cultivars were divided into three clusters. First part was untreated, while second part/cluster was treated with 3.5% urea and third cluster of different samples from various rice cultivars were treated with 3.5% urea plus 3.5% molasses. The chemical composition was assessed as per the method of AOAC (2005) and Van Soest *et al.* (1991). *In vitro* dry matter and organic matter digestibility of untreated rice straw, treated rice straw was evaluated by incubating the representative samples with strained rumen liquor in Daisy Incubator (D2303477: Ankom Technology, Macedon, NY, USA) for a period of 24 hours. Further, three total mixed rations (TMRs) were prepared by mixing treated and untreated rice straw

(S) with green fodder (G) and concentrate mixture (C) at the ratio of S:G:C= 40:27:33 (TMR-1), S:G:C= 35:30:35 (TMR-2) and S:G:C= 45:25:30 (TMR-3) giving a forage to concentrate ratio of 67:33, 65:35 and 70:30, respectively. *In-vitro* dry matter and organic matter digestibility of all the three different TMRs was evaluated.

RESULTS AND DISCUSSION

There was non-significant difference in the chemical composition (DM, CP, EE, CF, Ash, NFE, NDF and ADF) of different cultivars of rice grown in Haryana (Table 1). CP content of untreated rice straw

TABLE 1
Chemical composition of different cultivars of rice

Cultivar	Parameters (% DM basis)								
	DM	CP	EE	CF	Ash	NFE	OM	NDF	ADF
Untreated rice straw									
CSR-30	90.40	3.80	1.82	35.57	13.85	50.29	86.15	67.36	48.67
HB- 2	90.56	2.86	2.11	37.45	15.62	48.11	84.38	68.37	48.24
BASMATI-370	91.04	2.88	1.87	36.53	16.10	49.24	83.90	69.23	47.67
HKR 47	89.61	2.72	1.44	33.57	15.43	50.10	84.57	69.10	49.08
HKR 127	90.93	3.20	2.05	38.72	14.59	48.37	85.41	70.03	48.47
PB-1121	89.70	2.92	2.06	37.47	15.20	49.00	84.80	68.80	49.57
TARAORI	90.44	3.08	1.74	36.57	14.80	49.60	85.20	70.08	48.53
PB-1509	89.63	3.03	2.05	37.33	15.42	48.34	84.58	68.98	49.16
Mean	90.29	3.06	1.99	36.65	15.13	49.13	84.87	68.99	48.67
3.5% Urea Treated Rice Straw									
CSR 30	85.27	7.96	1.27	32.74	13.30	55.73	86.70	64.48	47.10
HB 2	85.79	6.88	1.90	34.30	14.98	51.10	85.02	65.99	46.77
BASMATI 370	85.38	7.04	2.20	33.15	15.09	52.60	84.91	65.46	45.79
HKR 47	86.18	7.05	2.19	33.75	14.20	53.50	85.80	65.49	47.10
HKR 127	85.80	6.49	2.15	34.14	13.80	51.44	86.20	66.05	46.81
PB-1121	85.93	6.68	2.67	34.60	16.09	51.65	83.91	64.10	45.70
TARAORI	85.68	7.63	2.20	34.58	14.34	52.46	85.66	65.45	45.85
PB-1509	85.60	7.10	1.80	34.20	14.60	52.29	85.40	63.92	47.15
Mean	85.70	7.10	2.05	33.93	14.55	52.60	85.45	65.12	46.53
3.5% Urea and 3.5% Molasses Treated Rice Straw									
CSR 30	84.72	8.13	1.99	32.05	12.14	56.33	87.86	64.37	45.73
HB 2	85.74	6.86	2.28	33.68	14.20	51.48	85.80	65.43	45.69
BASMATI 370	86.27	7.10	1.89	34.03	15.50	53.58	84.50	65.43	46.50
HKR 47	85.47	7.43	1.67	32.50	15.18	52.75	84.82	65.98	47.87
HKR 127	85.44	6.74	1.80	33.30	14.32	52.20	85.68	64.87	47.05
PB-1121	84.70	6.54	2.10	33.22	15.87	52.49	84.13	65.64	46.48
TARAORI	85.12	6.64	1.75	33.95	15.40	51.98	84.60	64.50	46.26
PB-1509	84.22	6.72	2.23	34.80	14.30	51.80	85.70	63.51	46.26
Mean	85.21	7.02	1.96	33.44	14.61	52.83	85.39	65.34	46.61

*Each value is mean of three observations.

Abbreviation: DM: dry matter, CP: crude protein, EE: ether extract, CF: crude fibre, OM: organic matter, NFE: nitrogen free extract, NDF: neutral detergent fibre and ADF: acid detergent fibre.

was reported to vary from 2.72% (HKR-47) to a maximum of 3.80% (CSR-30). Treatment with urea alone or in combination with molasses treatment increased the crude protein content of the rice straw substantially. CP content was increased from an overall mean value of 3.06% in untreated rice straw to 7.10% in urea treated and 7.02% in urea-molasses treated rice straw. CF was decreased while NFE was increased in the urea as well as urea plus molasses treated rice straws. Similarly, slight reduction in NDF and ADF content was noticed in the treated straws.

In-vitro dry matter degradability (IVDMD) and organic matter degradability (IVOMD) of different straw ranged from 50.00 (PB-1121) to 52.75% (CSR-30), but the values of IVDMD and IVOMD did not differ significantly ($p>0.05$) among untreated straws of different cultivars (Table 2). IVDMD in urea treated straw of CSR-30 was highest followed by HB-2, B-370, HKR-47. IVDMD of PB-1121 and Taraori was significantly ($p<0.05$) lower than CSR30. Similar trend was observed in IVOMD of urea treated straw from different cultivars of rice. The IVDMD and IVOMD in urea-molasses treated straw of rice cultivar CSR-30 was significantly ($p<0.05$) higher as compared to other cultivar's straw except Taraori. Thus, it is apparent that treatment of rice straw with urea or urea plus molasses increases ($p<0.05$) their IVDMD and IVOMD indicating improvement in their nutritive value as a roughage. The mean IVDMD was 51.81, 55.83 and 55.17% in untreated, urea treated and urea- molasses treated rice straw, respectively being significantly ($p<0.05$) higher in treated rice straw as compared to untreated. Similarly, the

IVOMD was significantly ($p<0.05$) higher in urea-molasses treated straw as compared to urea treated and untreated straw.

It was observed that IVDMD and IVOMD were not affected considerably ($p>0.05$) by the type of cultivar of rice used in different TMRs, but the treatment either with urea or urea plus molasses had a significant ($p<0.05$) impact on *in-vitro* digestibility of TMRs (Table 3). The IVDMD and IVOMD was reported to be highest in TMR-1(S:G:C= 35:30:35) followed by TMR-2 (S:G:C= 40:27:33) and TMR-3 (S:G:C= 45:25:30).

The ratio of straw, green fodder and concentrate mixture in different TMRs has significant ($p<0.05$) effect on the mean value of IVDMD and IVOMD (Table 4). A significant effect ($p<0.05$) of treatment was also observed on the mean value of IVDMD and IVOMD different cultivars. The TMR-1, containing straw, green fodder and concentrate mixture at the ratio 35:30:35 has significantly ($p<0.05$) higher degradability of DM and OM as compared to TMR-2 and TMR-3 in untreated, urea treated as well as urea-molasses treated rice straw containing TMRs.

CONCLUSION

From the result of current study, it was inferred that rice straw from variety CSR-30 was better as compared to other in terms of chemical composition, IVDMD and IVOMD. The results also exposed that treatment of rice straw with either urea alone or urea plus molasses improves their nutritive values

TABLE 2
IVDMD and IVOMD in untreated and treated straw of different rice cultivars

Attributes	Untreated straw		Urea treated straw		Urea Molasses treated straw	
	IVDMD	IVOMD	IVDMD	IVOMD	IVDMD	IVOMD
CSR -30	52.75±1.25	56.50±0.96	65.25 ^a ± 1.49	68.75 ^a ±1.25	67.50 ^a ±0.87	72.50 ^a ±1.44
HB -2	51.75±1.11	54.75±0.48	62.50 ^{ab} ±1.19	63.50 ^b ±1.32	63.50 ^b ±0.65	68.75 ^b ±0.63
B-370	51.75±1.55	54.50±0.50	63.00 ^{ab} ±2.20	66.50 ^{ab} ±2.25	63.25 ^b ±1.38	67.50 ^b ±0.65
HKR- 47	52.25±0.95	55.00±0.58	64.75 ^{ab} ±1.42	64.75 ^{ab} ±1.55	62.75 ^b ±1.37	68.00 ^b ±1.35
HKR- 127	51.25±1.49	55.25±0.63	62.25 ^{ab} ±1.49	63.50 ^b ±1.19	63.25 ^b ±1.25	67.50 ^b ±0.87
PB-1121	50.00±0.91	55.50±0.87	60.75 ^b ±0.48	63.75 ^b ±1.03	63.75 ^b ±1.31	67.25 ^b ±1.11
Taraori	51.75±0.48	56.25±1.03	60.50 ^b ±0.87	66.00 ^{ab} ±1.41	67.00 ^a ±1.29	72.25 ^a ±1.11
PB-1509	52.25±1.89	56.00±0.91	63.50 ^{ab} ±1.55	64.00 ^{ab} ±2.12	63.50 ^b ±0.87	68.50 ^b ±1.04
Mean**	51.81 ^a ±0.41	55.53 ^a ±0.25	55.83 ^b ±1.37	57.86 ^a ±1.50	57.17 ^b ±1.44	61.36 ^b ±1.69

*Mean values bearing different superscripts in a column differ significantly ($P<0.05$).

** Values bearing different superscripts in a row for same parameter differ significantly ($P<0.05$).

TABLE 3
IVDMD and IVOMD at different ratio of Straw: Green fodder: concentrate mixture

Attributes	TMR-1		TMR-2		TMR-3	
	IVDMD	IVOMD	IVDMD	IVOMD	IVDMD	IVOMD
Wheat straw	56.94 ^c ±1.43	59.01 ^c ±0.91	55.37 ^c ±0.99	57.36 ^c ±1.22	48.77 ^c ±0.43	51.70 ^c ±1.29
Untreated Rice Straw						
CSR-30	56.19 ^c ±0.63	59.75 ^c ±1.11	55.60 ^c ±0.67	58.10 ^c ±0.71	50.59 ^c ±0.71	52.41 ^c ±1.31
HB-2	56.48 ^c ±0.62	59.25 ^c ±0.85	55.68 ^c ±0.93	56.50 ^c ±1.04	50.94 ^c ±1.25	51.93 ^c ±0.17
B-370	57.05 ^c ±0.52	59.53 ^c ±1.03	55.38 ^c ±0.94	56.25 ^c ±0.96	51.62 ^c ±1.15	52.99 ^c ±0.73
HKR-47	57.27 ^c ±0.60	59.25 ^c ±0.85	54.94 ^c ±0.85	56.05 ^c ±0.58	50.46 ^c ±1.70	51.59 ^c ±1.15
HKR-127	57.74 ^c ±0.93	58.75 ^c ±1.25	56.12 ^c ±1.02	55.50 ^c ±0.65	50.79 ^c ±0.59	51.98 ^c ±1.18
PB-1121	56.94 ^c ±1.08	59.50 ^c ±1.04	56.10 ^c ±0.87	56.25 ^c ±1.11	50.94 ^c ±1.48	51.28 ^c ±0.84
Taraori	57.29 ^c ±0.65	58.03 ^c ±1.41	54.76 ^c ±0.68	57.12 ^c ±1.22	50.52 ^c ±1.25	50.77 ^c ±0.78
PB-1509	56.78 ^c ±1.07	58.10 ^c ±0.40	55.24 ^c ±0.81	56.25 ^c ±0.25	51.05 ^c ±0.68	51.49 ^c ±0.79
Urea Treated Rice Straw						
CSR-30	62.65 ^b ±0.92	64.00 ^b ±0.91	61.93 ^b ±1.16	63.75 ^b ±0.48	56.48 ^b ±0.97	57.73 ^b ±0.56
HB-2	61.53 ^b ±0.83	63.50 ^b ±0.65	61.09 ^b ±1.11	63.07 ^b ±0.58	56.61 ^b ±0.56	56.86 ^b ±0.35
B-370	63.34 ^b ±0.65	65.10 ^b ±1.01	60.77 ^b ±1.19	61.75 ^b ±0.25	56.22 ^b ±0.73	56.67 ^b ±0.50
HKR-47	61.59 ^b ±1.19	64.25 ^b ±0.85	60.78 ^b ±0.27	62.30 ^b ±0.71	56.44 ^b ±0.62	57.66 ^b ±0.48
HKR-127	61.86 ^b ±0.73	63.55 ^b ±0.64	60.81 ^b ±0.79	61.75 ^b ±0.85	56.08 ^b ±0.88	57.73 ^b ±0.51
PB-1121	62.78 ^b ±1.27	63.51 ^b ±0.87	60.25 ^b ±0.41	63.53 ^b ±0.71	56.03 ^b ±0.66	56.68 ^b ±0.82
Taraori	61.01 ^b ±0.64	64.75 ^b ±0.25	61.53 ^b ±0.61	62.59 ^b ±0.96	56.19 ^b ±0.59	57.43 ^b ±0.62
PB-1509	62.93 ^b ±0.42	63.25 ^b ±0.62	60.49 ^b ±1.00	63.25 ^b ±1.03	56.18 ^b ±0.77	57.31 ^b ±0.56
Urea Molasses Treated Rice Straw						
CSR-30	68.12 ^a ±1.30	69.08 ^a ±0.81	66.85 ^a ±0.66	67.75 ^a ±0.75	60.12 ^a ±1.05	62.53 ^a ±0.72
HB-2	67.62 ^a ±0.23	68.75 ^a ±0.63	65.83 ^a ±0.57	67.51 ^a ±0.52	62.78 ^a ±0.73	62.49 ^a ±0.36
B-370	68.04 ^a ±0.82	69.25 ^a ±0.47	65.27 ^a ±1.14	65.75 ^a ±0.62	62.20 ^a ±1.21	62.44 ^a ±0.95
HKR-47	69.35 ^a ±0.95	68.25 ^a ±1.11	65.99 ^a ±0.48	68.25 ^a ±0.47	60.81 ^a ±1.15	62.07 ^a ±0.45
HKR-127	69.85 ^a ±0.45	68.05 ^a ±0.58	66.06 ^a ±0.65	67.75 ^a ±0.75	61.70 ^a ±0.44	60.85 ^a ±1.03
PB-1121	68.09 ^a ±0.84	69.58 ^a ±0.65	66.09 ^a ±0.65	66.25 ^a ±0.75	62.07 ^a ±1.23	62.45 ^a ±0.72
Taraori	69.80 ^a ±0.36	69.25 ^a ±1.10	66.01 ^a ±0.78	67.25 ^a ±1.18	61.67 ^a ±1.44	61.97 ^a ±1.17
PB-1509	68.11 ^a ±1.30	70.51 ^a ±1.55	66.00 ^a ±0.94	66.25 ^a ±0.85	62.64 ^a ±0.61	62.13 ^a ±0.89

*Mean values bearing different superscripts in a column differ significantly (P<0.05).

TABLE 4
Mean value of IVDMD and IVOMD of all the cultivar of rice straw in different TMRs

Rice Straw	TMR-1		TMR-2		TMR-3	
	IVDMD	IVOMD	IVDMD	IVOMD	IVDMD	IVOMD
Untreated	56.96 ^a ±0.76	59.15 ^a ±0.99	55.48 ^a ±0.85	56.50 ^b ±0.82	50.86 ^b ±1.10	51.81 ^c ±0.87
Urea Treated	62.21 ^d ±0.83	63.99 ^d ±0.73	60.96 ^c ±0.82	62.75 ^d ±0.70	56.28 ^f ±0.72	57.26 ^e ±0.55
Urea Molasses Treated	68.62 ^g ±0.78	69.09 ^g ±0.86	66.01 ^h ±0.73	67.10 ^h ±0.74	61.75 ⁱ ±0.98	62.12 ⁱ ±0.79

*Mean Values bearing different superscripts in a row for same parameter differ significantly (P<0.05).

*Mean values bearing different superscripts in a column differ significantly (P<0.05).

considerably. On the basis of *in-vitro* findings, it can be concluded that a total mixed ration containing treated rice straw, green fodder and concentrate mixture in the ratio of 35:30:35 can be best utilized by the animals.

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