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Elanchezhiyan M
Department of Animal Nutrition, Veterinary College and Research Institute, TANUVAS, Orathanadu, Tamil Nadu, India

Ayyappan K
Department of Animal Nutrition, Veterinary College and Research Institute, TANUVAS, Orathanadu, Tamil Nadu, India

Ramachandran M
Department of Animal Nutrition, Veterinary College and Research Institute, TANUVAS, Orathanadu, Tamil Nadu, India

Shibi Thomas K
Livestock Farm Complex, Veterinary College and Research Institute, TANUVAS, Orathanadu, Tamil Nadu, India

Saravanan KP
Department of Veterinary and Animal Husbandry Extension Education, Veterinary College and Research Institute, TANUVAS, Orathanadu, Tamil Nadu, India

Srinivasan G
Pulikulam Cattle Research Station, TANUVAS, Manamadurai, Tamil Nadu, India

Corresponding Author:
Ayyappan K
Department of Animal Nutrition, Veterinary College and Research Institute, TANUVAS, Orathanadu, Tamil Nadu, India

Effect of maize (*Zea mays*) cob as roughage source in total mixed ration on *in vitro* fermentation and nutrient digestibility

Elanchezhiyan M, Ayyappan K, Ramachandran M, Shibi Thomas K, Saravanan KP and Srinivasan G

Abstract
The present research work was conducted to study the effect of replacing paddy straw with maize (*Zea mays*) cob in the Total Mixed Ration (TMR). Total Mixed Rations (TMR1 to TMR5) were prepared using maize cob at the level of 0%, 25%, 50%, 75% and 100% replacing paddy straw in the ration containing 12% CP and 60% TDN of 50:50 concentrate to roughage ratio and also ration (TMR6 to TMR10) containing 15% CP and 60% TDN of 40:60 concentrate to roughage ratio. There was significant (p<0.01) differences among the rations in organic matter (OM), crude fibre (CF), nitrogen free extract (NFE), total ash (TA), acid insoluble ash (AIA), neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL), hemicellulose and cellulose contents except crude protein (CP) and ether extract (EE). Among TMR1 to TMR5, *in vitro* gas production study showed significantly (p<0.01) higher total gas (ml/200 mg/48 h), *in vitro* dry matter (IVDMD %) and organic matter digestibility (IVOMD %) in TMR5 and lowest in TMR1 (51.17 vs 36.00; 62.87 vs 57.25 and 64.80 vs 59.93). Among TMR6 to TMR10, *in vitro* gas production study showed significantly (p<0.01) higher total gas (ml/200 mg/48 h), *in vitro* dry matter (IVDMD %) and organic matter digestibility (IVOMD %) in TMR10 and lowest in TMR6 (46.50 vs 32.17; 60.06 vs 53.01; 62.34 vs 55.58). It can be concluded that maize cob could replace paddy straw at 100% level in total mixed ration without affecting nutrient fermentation and digestibility *in vitro*.

Keywords: Dry matter digestibility, gas production, *in vitro* and maize cob

1. Introduction
India has a population of 192.49 million cattle, 109.85 million buffaloes, 74.26 million sheep and 148.8 million goats (20th Livestock Census, 2019) [1]. Most of these livestock are fed with dry roughages and there is shortage of 44% concentrate feed ingredients, 10.95% dry feed and 35.6% green feed in the nation. Demand for dry and green roughage will be 1012 million tonnes and 631 million tonnes, respectively by 2050 (IGFRI Vision, 2050) [19]. To close these gap, green forage production must increase at a rate of 1.69% annually; however, the area under cultivation for fodder represents just 4% of the nation's total cultivated land (8.4 million ha) and has hardly increased in recent years (Dagar, 2017 [13]; Halli *et al*., 2018 [18] and Meena *et al*., 2018 [22]). The lack of fodder production is mainly due to the lack of high quality fodder seed, changing land use patterns, urbanization, diminishing pasture productivity and diverting land for commercial crops among other factors. There are plenty of unconventional feed resources available throughout the country and it should be judiciously utilized to improve production performances of livestock. Maize cobs (*Zea mays*) are byproduct of maize crop after removing the grains from the Maize ear. The world produces over 1070 million metric tons of maize annually, with 26 million metric tons coming from India. Consequently, 1000 kg of maize production can yield 170-190 kg of corn cobs (Singh *et al*., 2018) [33]. India ranked seventh in the world in the amount of production of maize as of December 2019, with an estimated 29 million tonnes produced. Hence, there is a production of 4.68 million tonnes of maize cob in India with present production of maize. Maize cobs, which are abundant in fibre content, have a wide range of agricultural and industrial uses.

In the agricultural sector, they serve as fuel, bedding material for poultry and other animals and even as feed for ruminants, despite their limited nutritional value. These cobs are notably high in cellulose fibre but contain relatively low levels of crude protein making them a potential alternative feed source for ruminants offering cost-effective feeding options (Shashikumar *et al*., 2017) [32].

2. Materials and Methods

Concentrate feed ingredients (maize, soybean meal, ground nut oil cake) were collected from feed mill, Veterinary College and Research Institute, Orathanadu. Feed ingredients were dried to constant weight at 80°C and ground (1mm) in phase I. Two different concentrate mixtures were prepared (CP-20%, TDN-75% & CP-23%, TDN-70%) and stored in air tight container. Fodder sorghum (COFS-29) was collected from fodder unit of Veterinary College and Research Institute, Orathanadu. Paddy straw (Kannanthangudi village, Orathanadu) and Maize cob (Arputhapuram village, Orathanadu) were collected and dried under sun light. Dried samples were ground and passed in 1mm sieve and stored in air tight bags for further analysis. Total mixed ration containing 0%, 25%, 50%, 75% and 100% maize cob replacing paddy straw with different level of crude protein (12% & 15%) and 60% TDN were prepared. The ground feed, fodder samples and total mixed rations (TMR) were analyzed for proximate principles as per the methods described in AOAC, (2016) [7] and fiber components as per the method given by Van Soest *et al*. (1991) [37]. For the *in vitro* gas production studies, separate trials were conducted to estimate the various parameters such as total gas production, *in vitro* dry matter and *in vitro* organic matter degradability. These trials were conducted along with respective blank in triplicate. The incubation of each ingredient was carried out in 100 ml calibrated glass syringes as described by Menke and Steingass (1988) [24]. The substrate (200 mg) was weighed on a plastic boat with removable stem and placed into the bottom of the glass syringe without touching the sides of syringe. The piston was lubricated with petroleum jelly and pushed into the barrel of glass syringe. Each sample was taken in triplicate. The syringes were kept in an incubator at 39±0.5°C up to the incubation period. Syringes were placed in an Automatic water bath shaker with set temperature of 39±0.5°C. The syringes were shaken every two hours up to 48 hours of incubation. Gas production (ml/200 mg substrate) during fermentation was measured after 48 hours**.**

For the determination of apparent dry matter and organic matter degradability, the contents of each syringe were transferred quantitatively into centrifuge tube and centrifuged at 8000 rpm for 20 minutes. The supernatant was carefully separated using pipette without disturbing the pellet. The pellet was transferred quantitatively to a pre-weighed silica crucible and dried in the hot air oven till constant weight. The dry weight of residue was calculated. Dry weight of blank was subtracted from those recorded for the test samples. The residue in each crucible was ashed in muffle furnace at 550°C for 2 hours to determine the organic matter (OM) content.

2.1 Statistical analysis

As per the method of the statistical analysis system (SPSS, version 17 windows) [35], the data collected on various parameters were aggregated and subjected to one-way ANOVA and student "t" test and means were compared, and significance was determined based on suitability at $P<0.05$ and $P<0.01$.

3. Results and Discussion

3.1 Chemical composition of feed ingredients

Chemical composition of paddy straw (PS), maize cob (MC) and fodder sorghum 29 (COFS-29) were analysed and the values are given in the Table 1. Crude protein (CP%), Ether extract (EE%) and crude fibre (CF%) content of MC was similar to the level of PS, however the Nitrogen free extract (NFE%) was higher in maize cob (61.86%) than COFS-29 (54.79%) and paddy straw (44.89%). Total ash (TA%) and acid insoluble ash (AIA%) contents were lower in maize cob than paddy straw. The fibre fractions were analysed for the feed ingredients and the Maize cob contained higher NDF and lower ADF than paddy straw. Hemicellulose and cellulose contents (%) were higher in maize cob than paddy straw and COFS-29. The acid detergent lignin (ADL%) of maize cob was lower than the paddy straw. The average crude protein content of paddy straw was 4.08% which was is comparable with the value reported by Khanday *et al*. (2018) [20] and Ayyappan and Tomar (2006) [10]. The average CP content of maize cob in present study was 4.11% which was corroborated with the value reported by Abubakar *et al*. (2016) [3] and Nagalakshmi and Reddy (2008) [27]. The average CF content of maize cob in the present study was 30.23% which was lower than the value (32.50%) reported by Cetinkaya *et al*. (2020) [11]. The average total ash (TA) content of paddy straw in the present study was 18.94% which was in accordance with findings of Khanday *et al*. (2018) [20] and Wahyono *et al*. (2021) [39]. Total ash content of paddy straw in the present study was higher than the average total ash content of maize cob (2.85%) and the values was similarly related to value reported by Wachirapakorn *et al*. (2016) [38] and Farooq *et al.* (2015) [15]. The average total ash content of COFS-29 was 8.68% and finding was similar to the value (8.69%) reported by Senthilkumar *et al.* (2009) [31]. The average acid insoluble ash (AIA) content of paddy straw was 16.53% and the finding was comparable with report of Murugeswari *et al*. (2017) [25]. The AIA content of paddy straw in the present study was higher (16.53%) than the average AIA content of maize cob (0.43%) and the value was comparable to the report of Ramirez *et al*. (2007) [30]. The average neutral detergent fibre (NDF) content of maize cob was 78.33% which was lower than the value (81.30%) reported by Fasae *et al*. (2014) [16]. NDF content of maize cob in the present study was higher than the average NDF content of paddy straw and it was within the range reported by Ansah *et al*. (2017) [6] who reported the NDF value of different paddy straw variety ranged from 62.2 to 91.3%. The average NDF content of COFS-29 in the present study was 67.64% which was within the range (61.2 to 75.9%) reported by Siwach and Pinki (2018) [34]. The average acid detergent fibre (ADF) content of paddy straw in the present study was 53.36% and the value was similar to the report of Wachirapakorn *et al*. (2016 [38]). The ADF content of paddy straw in the present study was higher than the average ADF content of maize cob (47.82%) which was comparable with the value (47.7%) reported by Wachirapakorn *et al*. (2016) [38]. The average ADF content of COFS-29 in the present study was 50.88% which was within the range (36.1 to 56.3%) reported by Siwach and Pinki (2018) [34]. The average acid detergent lignin (ADL) content of paddy straw in the present study was 14.22% which was similar to the value (14.16%) reported by Abd El-Rahman *et al*. (2014) [2]. ADL content of paddy straw in the present study was higher than the average ADL content of maize cob (5.05%) which was in accordance with the report of Negewo *et al*. (2019) [28]. The hemicellulose and cellulose content of

maize cob in the present study was lower than values reported by Wachirapakorn *et al*. (2016) [38] and Farooq *et al.* (2015) [15], however the contents were higher than paddy straw.

3.2 Chemical composition of Total Mixed Ration

The chemical composition of two concentrate mixtures (CP 20%, TDN 75% and CP 23%, TDN 75%) and Total Mixed Ration on dry matter basis is given in Table 2, 3 & 4. Ten total mixed rations (TMR) were prepared by using 0%, 25%, 50%, 75% and 100% maize cob replacing paddy straw. The crude protein and ether extract contents were not significant (P>0.05) among the rations (TMR 1 to TMR 10). Organic matter content of TMR increased when inclusion level of maize cob was increased (*P*<0.01). Maize cob containing rations showed significantly (*P*<0.01) lower crude fibre content than higher level of paddy straw included rations. Significant (*P*<0.01) difference was found among various TMR in NFE content. TA and AIA content of TMR decreased when inclusion level of maize cob increased (*P*<0.01). NDF, hemicellulose and cellulose content were higher (*P*<0.01) in the maize cob based ration than paddy straw based rations. The rations containing paddy straw showed significantly (*P*<0.01) higher ADF and ADL content than maize cob containing rations. When the inclusion level of maize cob was increased, it resulted in significant difference (*P*<0.01) in NFE, NDF and hemicellulose contents, however the TA, AIA, ADF and ADL contents were decreased. The higher NFE and NDF contents and lower contents of TA, AIA and lignin contents of diets attributed to more acid insoluble ash and lignin contents in the paddy straw. These findings were supported with the reports of Wachirapakorn *et al*. (2016) [38], Shasikumar *et al*. (2017) [32] and Anjum and Afzal (2015) [5].

3.3 *In vitro* gas production, Dry matter and organic matter digestibility of feed ingredients and total mixed rations

Maize cob, paddy straw and total mixed rations were tested for total gas production and dry matter and organic matter digestibility for 48 hours *in vitro* fermentation and the results are given in the Table 5 & 6. *In vitro* gas production (IVGP), dry matter (IVDMD) and organic matter digestibility (IVOMD) of maize cob were higher than paddy straw after 48 hours incubation at 39 ± 0.5 ^{0}C in shaker water bath. *In vitro* gas production of paddy straw at 48 hours of incubation was 31.83 ml (ranged from 30 to 34 ml) which was comparable to the value (34.3 ml) reported by Tang *et al*. (2008) [36]. Total gas production of maize cob was 43.67 ml which was in accordance with the findings of Akinfemi *et al*. (2009) [4]. While comparing the *in vitro* gas production of maize cob with paddy straw, maize cob produced higher cumulative gas volume which was attributed to more cell content and hemicellulose content. These findings were in agreement with the results reported by Chanthakhoun and Wanapat (2012) [12] and Akinfemi *et al*. (2009) [4]. *In vitro* dry matter digestibility (IVDMD) and *in vitro* organic matter digestibility (IVOMD) of maize cob and paddy straw were comparable with the report of Tang *et al*. (2008) [36], Cetinkaya *et al*. (2020) [11] and Akinfemi *et al*. (2009) [4].

The total gas production ranged from 32.17 ml to 51.17 ml and higher volume of gas was recorded from 100% paddy straw replaced maize cob based ration (TMR 5). The least gas production was recorded in 100% paddy straw containing total mixed ration (TMR 6). IVDMD and IVOMD were recorded higher in 100% paddy straw replaced maize cob containing ration than 100% paddy straw containing ration. The total gas production (ml/200 mg), IVDMD % and IVOMD % was increased significantly (*P*<0.01) when the inclusion level of maize cob was increased. TMR with 12% CP and 60% TDN show better results than TMR with 15% CP and 60% TDN. There was a linear increase in gas production, percent IVDMD and IVOMD with increase in replacement level of maize cob and the difference was significant (*P*<0.01). Higher gas production (ml), IVDMD (%) and IVOMD (%) were observed at 100% replacement of paddy straw with maize cob in total mixed rations. These findings were in agreement with results reported by Farooq *et al*. (2015) [15]. The results clearly indicated better utilization of maize cob nutrients as compared to paddy straw *in vitro*. All the nutrient digestibility *in vitro* parameters were improved by increasing the inclusion level of maize cob. As there was no negative impact of paddy straw replacement with maize cob was observed and the use of as sole source of roughage appears to be feasible alternative. The more gas production may be due to high hemicellulose, cellulose and NFE contents of maize cobs attributed to higher fermentation and gas production. When comparing the *in vitro* parameters of TMR1 to TMR5 with TMR6 to TMR10, higher cumulative gas production (ml), IVDMD (%) and IVOMD (%) were noticed in TMR1 to TMR5 ration. The gas production has a significant correlation with dry matter and organic matter digestibility (Lee *et al*., 2003 [21]; Zhao *et al*., 2007 [40]; Deutschmann *et al*., 2017 [14]). The balance between concentrate and forage in the diet plays a significant role in affecting gas production during *in vitro* test (Getachew *et al*., 2002 [17]; Nagadi *et al*., 2000 [26]). TMR1 to TMR5 ration contained roughage to concentrate of 50:50 and TMR6 to TMR10 ration contain roughage to concentrate of 40:60 and the difference in the NDF, ADF and NFE content of these diets improved the *in vitro* nutrient digestibility. These findings were corroborated with finding of (Mendoza *et al*., 2003) [23] who reported inclusion of neutral detergent fibre (NDF) or organic matter (OM) used to predict the apparent digestibility, and also agreement with the results reported by Aregheore (2000) [8] and Arias *et al*. (2003) [9].

4. Conclusion

It can be concluded that maize cob can replace paddy straw at 100% level in total mixed ration without affecting nutrient fermentation and digestibility *in vitro.*

Table 1: Chemical composition (%) of paddy straw, maize cob, CoFS-29 on dry matter basis (Mean ± S.E)

Nutrients	Paddy straw	Maize cob	CoFS-29
Proximate			
Dry matter	89.39±0.05	91.87±0.04	31.10±0.10
Organic matter	81.06±0.11	97.15±0.05	91.32±0.08
Crude protein	4.08±0.05	4.11±0.04	7.40±0.10
Ether extract	0.99±0.09	0.95±0.06	1.06±0.06
Crude fibre	31.10±0.17	30.23±0.12	28.07±0.18
Nitrogen free extract	44.89±0.12	61.86±0.13	54.79±0.02
Total ash	18.94±0.11	2.85±0.05	8.68±0.08

Acid insoluble ash	16.53±0.12	0.43±0.06	5.22±0.06
Fibre fractions			
Neutral detergent fibre	67.64±0.07	78.33± 0.07	65.23±0.08
Acid detergent fibre	53.36±0.06	47.82± 0.08	50.88±0.07
Acid detergent lignin	14.22±0.06	5.05± 0.05	16.34±0.06
Hemicellulose	14.28±0.02	30.51± 0.03	14.35±0.05
Cellulose	39.14±0.01	42.77±0.02	34.54±0.02

Table 2: Chemical composition (%) of different concentrate mixtures on dry matter basis (Mean ± S.E)

Nutrients	Concentrate feed (CP 20% & TDN 75%)	Concentrate feed (CP 23% & TDN 70%)
Maize	54	40
Soybean meal	15	15
Ground nut cake	16	25
Deoiled rice bran	12	17
Salt	1	1
Mineral mixture	2	2
Proximate composition		
Dry matter	88.30±0.01	89.21±0.18
Organic matter	92.59±0.01	91.35±0.17
Crude protein	20.02±0.08	23.17±0.03
Ether extract	1.62±0.06	1.60±0.08
Crude fibre	4.68±0.13	4.46±0.02
Nitrogen free extract	66.27±0.01	62.12±0.01
Total ash	7.41±0.01	8.65±0.17
Acid insoluble ash	1.58±0.03	2.27±0.01

Table 3: Chemical composition (%) of Total Mixed Rations (TMR) with 12% CP and 60% TDN on dry matter basis (Mean ± S.E)

Nutrients	TMR 1	TMR 2	TMR 3	TMR 4	TMR 5	P Value
Paddy straw	40	30	20	10	0	
Maize cob	0	10	20	30	40	
COFS-29	10	10	10	10	10	
Concentrate feed (CP 20% & TDN 75%)	50	50	50	50	50	
Proximate composition						
Dry matter	91.60±0.06	91.86±0.02	91.28±0.05	91.72±0.03	91.52±0.06	0.7521
Organic matter	89.27^{a}±0.17	90.83^{b}±0.08	93.15^{c}±0.09	93.87^{d}±0.05	95.49^{e}±0.21	0.0021
Crude protein	12.12±0.07	12.13±0.07	12.14±0.03	12.16±0.06	12.19±0.05	0.8643
Ether extract	1.24±0.01	1.26±0.05	1.29±0.02	1.28±0.02	1.28±0.02	0.7693
Crude fibre	18.29^{b}±0.10	17.31^{a}±0.05	17.27^{a}±0.06	17.18^{a}±0.10	17.12^{a}±0.03	0.0032
Nitrogen free extract	57.62^{a}±0.10	60.13^{b}±0.02	62.44^{c}±0.03	63.24^{d}±0.02	64.90^{e}±0.02	0.0011
Total ash	10.73^{e}±0.17	9.17^{d}±0.08	6.86^{c}±0.09	6.14^{b}±0.05	4.51^{a}±0.21	0.0001
Acid insoluble ash	8.05^{e}±0.02	6.10^{d}±0.04	4.60^{c}±0.06	3.14^{b}±0.10	1.32^{a}±0.06	0.0000
Fibre fractions						
Neutral detergent fibre	54.94^{a}±0.07	59.37^{b}±0.19	63.89^{c}± 0.06	66.54^{d}±0.07	70.43^{e}±0.06	0.0000
Acid detergent fibre	37.56^{e}±0.05	36.01^{d}±0.07	35.43^{c}±0.07	34.69^{b}±0.07	33.70^{a}±0.07	0.0001
Acid detergent lignin	12.47^{e}±0.04	10.82^{d}±0.04	8.90^{c}±0.04	7.54^{b}±0.03	6.28^{a}±0.05	0.0000
Hemicellulose	17.38^{a}±0.03	23.36^{b}±0.28	28.46^{c}±0.04	31.85^{d}±0.03	36.73^{e}±0.02	0.0000
Cellulose	25.09^{a}±0.02	25.19^{b}±0.12	26.53^{c}±0.02	27.15^{d}±0.02	27.42^{e}±0.03	0.0017

^{a,b,c,d,e} mean values with different superscripts in a row differ significantly (P<0.01)

Table 4: Chemical composition (%) of Total Mixed Rations (TMR) with 15% CP and 60% TDN on dry matter basis (Mean ± S.E)

Nutrients	TMR 6	TMR 7	TMR 8	TMR 9	TMR 10	P Value
Paddy straw	32	24	16	8	0	
Maize cob	0	8	16	24	32	
COFS-29	10	10	10	10	10	
Concentrate feed (CP 23% & TDN 70%)	58	58	58	58	58	
Proximate composition						
Dry matter	91.41 ±0.12	91.27±0.10	91.54±0.07	91.72±0.06	91.46±0.10	0.7861
Organic matter	89.15^{a}±0.35	89.97^{b}±0.01	92.86^{c}±0.07	93.52^{d}±0.08	94.18^{e}±0.09	0.0032
Crude protein	15.18±0.02	15.19±0.09	15.23±0.07	15.25±0.07	15.26±0.08	0.8421
Ether extract	1.34±0.04	1.37±0.06	1.32±0.03	1.33±0.07	1.36±0.08	0.7971
Crude fibre	15.74^{e}±0.12	15.65^{d}±0.16	15.16^{c}±0.02	15.05^{b}±0.09	14.98^{a}±0.06	0.0038
Nitrogen free extract	56.89^{a}±0.01	57.76^{b}±0.02	61.15^{c}±0.02	61.89^{d}±0.01	62.58^{e}±0.02	0.0015
Total ash	10.85^{e}±0.35	10.03^{d}±0.01	7.14^{c}±0.07	6.48^{b}±0.08	5.82^{a}±0.09	0.0001
Acid insoluble ash	7.32^{e}±0.03	5.69^{d}±0.07	4.44^{c}±0.05	3.20^{b}±0.06	1.86^{a}±0.02	0.0000
Fibre fractions						
Neutral detergent fibre	52.83^{a}±0.06	56.50^{b}±0.07	60.61^{c}±0.09	64.33^{d}±0.21	67.32^{e}±0.19	0.0000
Acid detergent fibre	35.31^{e}±0.25	34.29^{d}±0.05	33.42^{c}±0.05	32.80^{b}±0.04	31.71^{a}±0.09	0.0011
Acid detergent lignin	11.91^{e}±0.02	10.41^{d}±0.04	8.75^{c}±0.04	7.32^{b}±0.02	6.08^{a}±0.06	0.0000
Hemicellulose	17.52^{a}±0.30	22.21^{b}±0.03	27.19^{c}±0.10	31.53^{d}±0.21	35.61^{e}±0.24	0.0000
Cellulose	23.40^{a}±0.02	23.88^{b}±0.01	24.67^{c}±0.01	25.48^{d}±0.03	$25.63^{e\pm}$0.02	0.0013

^{a,b,c,d,e} mean values with different superscripts in a row differ significantly (P<0.01)

Table 5: *In vitro* gas production (IVGP), *in vitro* dry matter digestibility (IVDMD %) and *in vitro* organic matter digestibility (IVOMD %) of paddy straw and maize cob (Mean ± S.E)

Feed ingredients	IVGP (ml/48 hrs)	IVDMD (%)	IVOMD (%)
Paddy straw	31.83±0.75	36.76±0.07	38.87±0.14
Maize cob	43.67±0.33	44.36±0.05	46.67± 0.13

Table 6: *In vitro* gas production (IVGP), *in vitro* dry matter digestibility (IVDMD %) and *in vitro* organic matter digestibility (IVOMD %) of TMR 1 to TMR 10 (Mean ± S.E)

Total mixed ration	IVGP (ml/48 hrs)	IVDMD (%)	IVOMD (%)
TMR 1	36.00^{b}±0.51	57.25^{c}±0.06	59.93^{cd}±0.13
TMR 2	40.83^{c}±0.31	58.73^{e}±0.06	61.32^{e}±0.15
TMR 3	43.50^{d}±0.43	60.71^{g}±0.06	62.55^{f}±0.36
TMR 4	48.67^{f}±0.50	61.81^{h}±0.05	64.08^{g}±0.08
TMR 5	51.17^{g}±0.60	62.87^{i}±0.04	64.80^{h}±0.11
TMR 6	32.17^{a}±0.31	53.01^{a}±0.25	55.58^{a}±0.24
TMR 7	37.17^{b}±0.31	54.87^{b}±0.04	57.54^{b}±0.12
TMR 8	41.17^{c}±0.40	57.27^{c}±0.05	59.43^{c}±0.12
TMR 9	44.00^{d}±0.63	58.11^{d}±0.05	60.39^{d}±0.12
TMR 10	46.50^{e}±1.06	60.06^{f}±0.04	62.34^{f}±0.11

^{a,b,c,d,e,f,g,h,i} mean values with different superscripts in a column differ significantly (P<0.01)

5. References

1. 20th Livestock Census, Department of Animal Husbandry and Dairying, Ministry of Fisheries, Animal Husbandry and Dairying; c2019. Govt. of India.
2. Abd El-Rahman HH, Abedo AA, El-Nomeary YAA, Abdel-Magid SS, Mohamed MI. Effect of biological treatments of rice straw on growth performance, digestion and economical efficiency for growing calves. Glob Vet. 2014;13(1):47-54.
3. Abubakar US, Yusuf KM, Safiyanu I, Abdullahi S, Saidu SR, Abdu GT, *et al*. Proximate and mineral composition of corn cob, banana and plantain peels. Int. J Food Sci. Nutr. 2016;1(6):25-27.
4. Akinfemi A, Adu OA, Doherty F. Assessment of the nutritive value of fungi treated maize cob using *in vitro* gas production technique. Livest. Res. Rural Dev. 2009;21(11):188-194.
5. Anjum MI, Afzal M. Influence of substituting wheat straw with corncobs in fattening rations for growth rate and nutrient digestibility in buffalo calves. JAPS: J Anim Plant Sci. 2015;25(5):1216-1221.
6. Ansah T, Dogbe W, Cudjoe S, Iddrisu AAB, Eseoghene AS. Agronomic performance of five rice varieties and nutritive value of the straw from these varieties. West Afr. J Appl. Ecol. 2017;25(1):1-10.
7. AOAC. Official methods of analysis. 20th edition. Arlington, VA: Association of Official Analytical Chemists; c2016.
8. Aregheore EM. Chemical composition and nutritive value of some tropical by-product feedstuffs for small ruminants. *In vivo* and *in vitro* digestibility. Anim. Feed Sci. Technol. 2000;85(1-2):99-109.
9. Arias L, Contreras J, Losada H, Grande D, Soriano R, Vieyra J, *et al*. A note on the chemical composition and *in vitro* digestibility of common vegetables utilised in urban dairy systems of the east of Mexico City. Livest Res Rural Dev. 2003;15(2):21-22.
10. Ayyappan K, Tomar SK. Evaluation of faecal inoculum for estimating digestibility of feedstuffs. Indian J Anim Nutr. 2006;23(1):59-62.
11. Cetinkaya N, Aykanat S, Ayasan T, Celik C. Nutrient contents and *in vitro* digestibility of different parts of corn plant. S Afr. J Anim. Sci. 2020;50(2):302-309.
12. Chanthakhoun V, Wanapat M. The *in vitro* gas production and ruminal fermentation of various feeds using rumen liquor from swamp buffalo and cattle. Asian J Anim. Vet Adv. 2012;7(1):54-60.
13. Dagar JC. Potentials for fodder production in degraded lands. In: Ghosh PK, Mohanta SK, Singh JB, Vijay D, Kumar RV, Yadav VK, Kumar S, editors. Apch. Twd. Fodder secur. India. 2017:333-364.
14. Deutschmann K, Phatsara C, Sorachakula C, Vearasilp T, Phunphiphat W, Cherdthong A, *et al*. *In vitro* gas production and *in vivo* nutrient digestibility and growth performance of Thai indigenous cattle fed fresh and conserved pangola grass. Ital J Anim Sci. 2017;16(3):521-529.
15. Farooq J, Sharma RK, Rastogi A, Barman K. Effect of replacement of wheat straw with maize cobs with or without physico-chemical treatment on degradation of dry matter, truly digestible organic matter and production of microbial biomass of composite ration *in vitro* using goat rumen liquor. J Anim Res. 2015;5(3):501-510.
16. Fasae OA, Adedokun FT, Badmos TM. Effect of forage legume supplementation of maize cobs on the performance of West African dwarf sheep. Slovak J Anim. Sci. 2014;47(3):157-163.
17. Getachew G, Crovetto GM, Fondevila M, Krishnamoorthy U, Singh B, Spanghero M, *et al*. Laboratory variation of 24 hours *in vitro* gas production and estimated metabolizable energy values of ruminant feeds. Anim. Feed Sci. Technol. 2002;102(1-4):169-180.
18. Halli HM, Rathore SS, Manjunatha N, Wasnik VK. Advances in agronomic Management for Ensuring Fodder Security in semi-arid zones of India-A Review. Int. J Curr. Microbiol. Appl. Sci. 2018;7(02):1912-1921.
19. IGFRI Vision 2050. Indian grassland and fodder research institute. Jhansy, Uttar Pradesh, India: IGFRI; 7-23.
20. Khanday ZB, Cauhan P, Dey D, Malik R, Pradhan D, Goyal C, *et al*. A review on fermentation quality of paddy straw silage. J Entomol. Zool. Stud. 2018;6(5):1184-887.
21. Lee SS, Ha JK, Chang MB. Evaluation of Feed Values of Korean Straws Using Pressure Transducer. J Anim. Sci. Technol. 2003;45(2):241-250.
22. Meena LR, Kochewad SA, Kumar V, Malik S, Kumar S, Meena LK, *et al*. Status of fodder production in the

existing farming systems in Muzaffarnagar district of Uttar Pradesh. Range Manag Agrofor. 2018;39(2):313-318.
23. Mendoza-Nazar P, Sandoval-Castro C. *In vitro* gas production and nylon bag rumen degradation as predictors of the *in vivo* apparent digestibility and voluntary intake of tropical hays fed to sheep. J Appl. Anim. Res. 2003;23(1):103-116.
24. Menke KH, Steingass H. Estimation of the energetic feed value obtained from chemical analysis and *in vitro* gas production using rumen fluid. Anim. Res. Dev. 1988;28:7-55.
25. Murugeswari R, Murugan B, Viswanathan K, Babu M. Effect on nutritive value of mechanically and manually harvested paddy Straw. Wkly Sci. Res. J, 2017, 2(34).
26. Nagadi S, Herrero M, Jessop NS. The influence of diet of the donor animal on the initial bacterial concentration of ruminal fluid and *in vitro* gas production degradability parameters. Anim. Feed Sci. Technol. 2000;87(3-4):231-239.
27. Nagalakshmi D, Reddy DN. On farm evaluation of expander-extruder processed complete diet containing maize cobs in Murrah buffaloes. Indian J Vet Res. 2008;17(1):37-43.
28. Negewo T, Melaku S, Asmare B, Tolera A. Effect of graded levels of concentrate supplementation on carcass yield and characteristics of local sheep fed urea treated maize cob as a basal diet. Scientific Papers: Anim. Sci. Biotechnol. 2019;52(1):27-37.
29. Rahman MM, Alam MR, Amin MR, Das NG. Comparative study of the nutritive values of the different varieties of rice straw. Bangladesh J Anim. Sci. 2010;39(1-2):75-82.
30. Ramirez GR, Aguilera-Gonzalez JC, Garcia-Diaz G, Nunez-Gonzalez AM. Effect of urea treatment on chemical composition and digestion of Cenchrus ciliaris and Cynodon dactylon hays and *Zea mays* residues. Cellulose. 2007;38(42.5):39-46.
31. Senthilkumar S, Mercy AD, Murugan M. *In vitro* ruminal digestibility of different varieties of paddy straw. J Sci. Trans Environ Technov. 2009;3(1):20-24.
32. Shashikumar MG, Prabhu TM, Gloridoss RG, Singh KC, Suresh BN, Siddalingamurthy HK, *et al*. Effect of feeding maize (*Zea mays*) husk and cob based complete feed block on feed intake, nutrient utilization and growth in Mandya sheep. Indian J Anim. Nutr. 2017;34(2):135-139.
33. Singh K, Singh J, Kumar S. A sustainable environmental study on corn cob ash subjected to elevated temperature. Curr. World Environ. 2018;13(1):144.
34. Siwach SS, Pinki. Variation in Morphological and Biochemical Characters of Various Forage Sorghum Genotypes (*Sorghum bicolor* L. Moench). Int. J Curr. Microbiol. App Sci. 2018;7(6):481-489.
35. SPSS Statistics version 17.0. Chicago IL: SPSS Inc.
36. Tang SX, Tayo GO, Tan ZL, Sun ZH, Wang M, *et al*. Use of *in vitro* gas production technique to investigate interactions between rice straw, wheat straw, maize stover and alfalfa or clover. Asian-Australas J Anim. Sci. 2008;21(9):1278-1285.
37. Van Soest PV, Robertson JB, Lewis BA. Methods for dietary fibre, neutral detergent fibre, and nonstarch polysaccharides in relation to animal nutrition. J Dairy Sci. 1991;74(10):3583-3597.
38. Wachirapakorn C, Pilachai K, Wanapat M, Pakdee P, Cherdthong A. Effect of ground corn cobs as a fibre source in total mixed ration on feed intake, milk yield and milk composition in tropical lactating crossbred Holstein cows. Anim. Nutr. 2016;2(4):334-338.
39. Wahyono T, Sasongko WT, Sugoro I. Nutrient value and digestibility variation of five rice straw cultivars in Indonesia as ruminant roughage. Adv. Anim. Vet Sci. 2021;9(1):73-81.
40. Zhao GY, Xue Y, Zhang W. Relationship between *in vitro* gas production and dry matter and organic matter digestibility of rations for sheep. J Anim. Feed Sci. 2007;16(2):229-234.

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