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# Nutrient Digestibility and Cost Effectiveness of Maize Stovers and Maize Cobs as Replacement of Wheat Straw in Total Mixed Ration and their Effect on Growth Performance in Nili-Ravi Buffalo Calves

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**MIA conducted the experiment, collected data, performed the statistical analysis and wrote the manuscript. SJ helped in experimental feed preparation. AWY helped in chemical analysis. FA and JI supervised the experimental animals and assisted in manuscript drafting.**

**Key words**
**Growth performance, Nutrient digestibility, Maize stovers, Maize cobs, Nili-Ravi buffalo calves, Wheat straw**

## ABSTRACT

To examine the utilization of maize stovers (MS) and maize cobs (MC) as replacement of wheat straw (WS) in Total Mixed Ration (TMR) for buffalo calves, 18 calves (aged 14±2 months weighing 189±15 kg) were randomly divided into six equal groups. Six TMRs [iso-nutritious with 12% CP and 68% TDN] having crop residues MS, MC and WS each supplemented with 75% and 65% concentrate (C) were formulated as: $T_1$) MS to C ratio of 25:75%, $T_2$) MS to C ratio of 35:65%, $T_3$) MC to C ratio of 25:75%, $T_4$) MC to C ratio of 35:65%, $T_5$) WS to C ratio of 25:75% and $T_6$) WS to C ratio of 35:65%. These TMRs were offered *ad libitum* along-with 5 kg green fodder to each calf for 100 days. Daily feed intake, body weight gain and nutrient digestibility during last 5-days were recorded of individual animals. The calves fed TMR with 25% MC attained significantly higher weight gain (830 g/d, P<0.05), followed by the calves fed TMR with 35% MC (760 g/d) whereas, those fed TMR with 35% MS got lowest weight gain (687 g/d). Similarly, better feed conversion ratio (6.63) was observed in calves fed 25% MC based TMR while poor (7.90) FCR was observed in TMR with 35% WS. Intake of calves for dry matter (DM), crude protein (CP), neutral detergent fibre (NDF) and acid detergent fibre (ADF), among all the groups was similar, however, except ADF, digestibility of DM, CP and NDF was significantly (P<0.05) higher in calves fed TMR with 25% MC and lower in those fed 35% WS based TMR. Cost of feed per kg gain was lowest (Rs 128) in calves fed TMR with 35% MC and it was highest (Rs. 167) in both TMRs with 25% WS and 35% WS, respectively. In conclusion, TMR with 35% MC is better in terms of feed cost per kg gain in buffalo calves compared to other rations used in this study.



## INTRODUCTION

In Pakistan, nutritional requirement of livestock is currently not fulfilled in terms of dry matter (19.4%), crude protein (37.2%) and metabolizable energy (38.0%). Crop residues are predominant ruminants feed contributing 58.8% followed by fodder contributing 23.8%, grazing contributing 9.2% and concentrates contributing 8.2% (Habib *et al*., 2016). Among crop residues, wheat straw (WS) is mostly used from 25 to 50% as a source of dry roughage in ruminants feeds round the year (Sarwar *et al*., 2002; Khan *et al*., 2006) depending on availability of feed resources and animal productivity. Due to use of combined wheat harvester in the recent past, there is huge loss of WS in the field (Mirza *et al*., 2008) which is resulting in high prices of WS (>25 PKRs/kg of ground wheat straw) and making it difficult for farmers to use it in ruminants' feed, particularly during winter. The scarcity of green fodder and escalating prices of concentrate and WS has motivated nutritionists for exploration of non-conventional crop residues to be utilized in livestock feeding. Crop residues are a way to reduce feeding costs by improving the nutritional profile and efficient utilization in animal feeds (Saha *et al*., 2002) with proper roughage to concentrate ratio. Sruamsiri *et al*. (2007) suggested that cereal straws and crop residues in combination with locally available protein and energy rich sources are essential to improve roughage utilization in ruminants for better quality meat production. Maize

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stovers (MS) and maize cobs (MC) are main crop residues characterized by abundance, low cost, less competitive usage, and great potential for feed utilization. The total annual maize grains yield in the country is 5.7 million tons, accompanied by 22.8 million tons production of MS and MC (GOP, 2018) that are mostly considered a waste and are burnt usually. Konka *et al*. (2015) suggested that MS are superior than red gram straw or black gram straw in terms of *in vitro* digestibility (DM, CP, NDF and ADF), *in vitro* total VFA production and cost of formulation for buffalo bulls when used in combination with concentrate as a complete ration (as 60:40% ratio of roughage to concentrate).

Though, MS and MC are a good source of energy for ruminants but the availability of this energy to animals is generally limited because of its physical nature which generally reduces voluntary intake, the chemical association between lignin and cell wall carbohydrates and the physical limitation of the cell wall components for microbial fermentation (Wattanaklang *et al*., 2016). Maize stovers may be the best as livestock feed among cereal stovers and most straws due to high CP (6%) content. Previous researchers (Anjum and Afzal, 2015) have reported that availability of MS and MC is more compared to other roughages for animal survival during shortfall of feed supply. MS and MC could be a valuable addition in ruminant feeding systems (dairy, beef and heifers) as it has highest feeding value of all cereal straws (Kuchenmeister, 2020). The objective of current study was to compare nutritional value of MS, MC and WS supplemented with concentrate and effects on voluntary feed intake, growth performance, nutrient digestibility, and economic benefits in buffalo calves.

## MATERIALS AND METHODS

*Crop residues analysis*

Three types of crop residues such as MS, MC and WS were collected (about 2.5 tons each) from National Agricultural Research Centre (NARC), Islamabad-Pakistan and stored in the warehouse. The MS were chopped to 3-5 cm particle size using tractor driven chopper (Agritech Industries (Pvt.) Ltd., Multan, Pakistan), whereas MC and WS were grounded to 0.7-0.9 cm particle size using hammer grinder mill. The representative samples of MS, MC and WS were analyzed for proximate composition at Animal Nutrition Laboratory, NARC according to method by AOAC (1990), and cell wall constituents following the method by Van Soest *et al*. (1991).

*Preparation of rations and experimental design*

Three crop residues, MS, MC and WS were mixed with two levels (75% and 65%) of concentrate to uniformly prepare six treatments as total mixed rations (Table I). All TMRs were formulated as per NRC (2001) protocol by adopting the large dairy breeds calf's nutrient requirement for growth rate of 0.6 kg/day (CP =12% and TDN= 68%) in a 3×2 factorial arrangements. Factor A was three types of crop residues: MS, MC and WS. Factor B was two levels (75 and 65%) of concentrate (C), respectively. The dietary treatments ($T_1$ to $T_6$) were designated as follow: $T_1$, Maize stovers 25% + Concentrate 75%; $T_2$, Maize stovers 35% + Concentrate 65%; $T_3$, Maize cobs 25% + Concentrate 75%; $T_4$, Maize cobs 35% + Concentrate 65%; $T_5$, Wheat straw 25% + Concentrate 75%; and $T_6$, Wheat straw 35% + Concentrate 65%

**Table I. Ingredients and chemical composition of maize stovers (MS), maize cobs (MC) and wheat straw (WS) based total mixed rations with two roughage to concentrate ratios.**

| Ingredients | MS concentrate | | MC concentrate | | WS concentrate | |
|---|---|---|---|---|---|---|
| | 25:75 | 35:65 | 25:75 | 35:65 | 25:75 | 35:65 |
| **Crop residues (kg)** | | | | | | |
| Maize stovers | 25 | 35 | - | - | - | - |
| Maize cobs | - | - | 25 | 35 | - | - |
| Wheat straw | - | - | - | - | 25 | 35 |
| **Concentrate (kg)** | | | | | | |
| Cottonseed meal | 2 | 2 | 2 | 2.5 | 2 | 2.5 |
| Rapeseed cake | 5 | 5 | 5 | 5 | 5 | 5 |
| Maize gluten feed 30% | 12 | 17 | 13 | 17 | 14.5 | 18 |
| Maize grains | 15 | 18 | 15 | 18 | 15 | 18 |
| Rice polishing | 11.5 | 8 | 11.5 | 8 | 10 | 8 |
| Wheat bran | 18 | 3.5 | 18 | 4 | 18 | 3 |
| Cane molasses | 9 | 9 | 8 | 8 | 8 | 8 |
| Di-calcium phosphate | 1 | 1 | 1 | 1 | 1 | 1 |
| Limestone | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Common salt | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Mineral pre-mix | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |
| **Overall chemical composition (DM, %)** | | | | | | |
| DM | 87.5 | 86.5 | 86.4 | 87.2 | 87.1 | 87.3 |
| CP | 12.1 | 11.9 | 12.1 | 12.0 | 12.0 | 11.9 |
| EE | 5.1 | 4.3 | 5.3 | 3.7 | 3.8 | 3.5 |
| CF | 11.6 | 13.1 | 11.3 | 12.2 | 18.1 | 19.8 |
| Total ash | 10.0 | 9.8 | 9.0 | 9.3 | 9.4 | 9.6 |
| ADF | 21.5 | 24.6 | 22.3 | 25.5 | 23.8 | 26.7 |
| NDF | 54.7 | 52.8 | 59.5 | 55.8 | 56.0 | 57.8 |

*Total mixed rations comprising two (25% and 35%) inclusion levels of each maize stover (MS), maize cobs (MC) and wheat straw (WS) and designated as MS25%, MS35%, MC25%, MC35%, WS25% and WS35%, respectively.

*Animals and feeding management*

For this experiment, 18 buffalo calves having 14±2 month's age and 189±15 kg initial body weight were taken from Livestock Research Station, NARC. These calves were randomly divided into 6 equal groups with three calves in each following completely randomized design. After deworming, vaccination, and acclimatization to new feed for 10 days, these calves were housed in individual tie stalls with cemented floor shed. The shed was cleaned and washed with fresh water daily to maintain hygienic environment. These calves were offered total mixed rations *ad libitum* at 0900 h and 5 kg green fodder (maize and mott grass) at 1600 h for 100 days (October, 2017 to January, 2018). Fresh drinking water was offered to the calves 2-3 times a day. Data on daily feed intake and body weight gain were recorded for each animal separately. During last week of the experiment, *in vivo* digestibility study was conducted for five days and feed, orts and feces samples were collected daily, composited separately for each animal and stored in refrigerator at 4°C for chemical analysis.

*Feed cost per kilogram gain*

The cost efficiency expression is a ratio between output to input calculated by using feed price, calves body weight, and growth rate as the formula given by Xie *et al*. (2012).

Output/input = (ADG × MPBW)/ (DMI × MPF)

where ADG is the average daily gain (kg/head), MPBW is the average market price of body weight (Rs/kg), DMI is the daily dry matter intake (kg/head), and MPF is the market price of feeds.

*Statistical analysis*

The data were statistically analyzed with the standard procedure of analysis of variance according to Completely Randomized Design as described by Steel *et al*. (1997) using Minitab 15 software. The data regarding feed intake, body weight, weight gain and digestibility parameters were given as means ± SE. Means were compared by Duncan's Multiple Rang Test at 5% level of probability.

## RESULTS AND DISCUSSION

*Chemical composition of crop residues*

The chemical composition of MS, MC and WS is shown in Table II. The dry matter (DM), crude protein (CP) and ether extract (EE) contents of MC were slightly higher compared to those of MS and WS but the difference was non-significant (P>0.05). The values of neutral detergent fibre (NDF) and acid detergent fibre (ADF) in MS, MC and WS were 75.5, 79.9, 76.0% and 54.5, 47.4 and 50.1%, respectively. The NDF content of MC was significantly higher and ADF content was significantly lower compared to those of MS and WS. However, acid detergent lignin (ADL) and total ash (TA) contents were highest in WS followed by MS and MC. The results of current study were supported by previous studies that have reported chemical composition of MC and WS as 2.42% and 2.21% CP, 7.67% and 9.82% lignin content (Azim *et al*., 2000) and 48% and 45% total digestible nutrients (Lardy and Anderson, 2003), respectively.

*Growth performance*

Effects of three types of crop residues (MS, MC and WS) with two different levels of concentrate (75% and 65%) on total DM intake, DM intake on % BW, ADG and FCR in buffalo calves are presented in Table III. Type of crop residues had significant (P<0.05) effect on ADG and FCR. The highest (P<0.05) ADG and better FCR were observed in buffalo calves fed on MC compared to those fed on MS and WS based rations, however, the difference between maize stovers and wheat straw was non-significant (P>0.05). Total DM intake and DM intake on % BW were not influenced (P>0.05) by the types of crop residues as well as levels of concentrate among the buffalo groups. The current findings are in accordance with previous work byAnjum and Afzal (2015) and Azim *et al*. (2000) which reported that WS replaced by ground corncobs in total mixed rations had no negative effects on DM intake but found better (P<0.05) in weight gain and FCR in growing buffalo calves. Furthermore, Urio and Katogile (1987) stated that rations having 30% corncobs and maize stovers had no adverse effect on growth performance and milk yield in dairy animals. Results of the current study indicated that weight gain in buffalo calves increased as the concentrate proportion in total mixed rations was increased.

Interactions between three types of crop residues and two levels of concentrate had non-significant (P>0.05) effect on DM intake, DM intake on % BW among the buffalo calves. This indicates that MC, MS and WS each either supplemented with 75 and 65% levels of concentrate based TMRs had no adverse effects on palatability in buffalo calves. However, there was significant (P<0.05) difference in ADG and FCR among the buffalo calves. The highest (P<0.05) ADG and better FCR were observed in calves fed TMR with 25% maize cobs compared to all other rations. The second highest (P<0.05) growth rate was obtained on both TMRs having 35% maize cobs and 25% wheat straw than the rest of TMRs which had non-significant (P>0.05) difference between them. This indicates that TMRs at 25% and 35% inclusion levels of MC are better than rest of all TMRs except 25% wheat

straw-based ration. Current results are in accordance with Wachirapakorn *et al*. (2016) who found significantly improved nutrient intake and milk yield in lactating dairy crossbred cows fed TMR containing 40% ground corn cobs as the whole roughage source.

**Table II. Chemical composition (DM, %) of three type of crop residues.**

| Crop residues | Chemical composition (DM, %)* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | DM | CP | EE | CF | NDF | ADF | ADL | TA |
| Maize stovers | 88.6 | 2.5 | 1.1 | 36.5 | 75.5 | 54.5 | 8.5 | 6.5 |
| Maize cobs | 89.6 | 3.6 | 1.5 | 34.9 | 79.9 | 47.4 | 7.5 | 4.9 |
| Wheat straw | 87.2 | 2.4 | 0.3 | 41.4 | 76.0 | 50.1 | 10.9 | 8.2 |

*Abbreviations stands for DM, dry matter; CP, crude protein; EE, ether extract; CF, crude fibre; NDF, neutral detergent fibre; ADF, acid detergent fibre; ADL, acid detergent lignin and TA, total ash.

Better (P<0.05) feed conversion ratio was noted on TMRs having 25% and 35% inclusion levels of MC while poor FCR was observed in TMRs having 25% MS and 35% WS. However, FCR in other calves groups did not differ from each other. Buffalo calves got poor weight gain and FCR on TMRs having 25% MS and 35% WS may be due to higher ADL contents (Table II). It is general observation that at harvesting of maize grains, the plant becomes over matured resulting hardy stem and shedding of more leaves during harvesting, transportation and chopping causing increased in lignin content.

*Digestion coefficient of nutrients*

Table IV shows that during *in vivo* digestibility, intake of calves for DM, CP and NDF among all the groups was similar except ADF. The ADF intake was maximum in calves fed TMRs having 25% or 35% WS. Except CP, digestibility of DM, NDF and ADF was significantly (P<0.05) higher in TMR with 25% MC and lowest in those fed TMR with 35% WS. Digestibility of DM, NDF and ADF increased with higher level of concentrate in total mixed ration regardless of types of crop residues. Higher nutrients digestibility at higher concentrate level may be due to more readily available energy for microflora for growth and production compared to lower concentrate level (75% vs. 65%). The current findings are in accordance with previous work of Wanapat and Wachirapakorn (1990) who reported improved digestibility of DM, organic matter (OM) and CP by increasing levels of concentrate in total mixed ration regardless of type of straw.

*Economic benefit analysis*

Feed cost per kg weight gain of buffalo calves fed three types of crop residues; MS, MC and WS supplemented with two levels of concentrate is shown in Table V. In this study, the price of 1kg maize fodder on DM basis was PKRs. 10 while price of TMRs consisting of 25% MS,

**Table III. Growth performance of buffalo calves fed maize stovers, maize cobs and wheat straw based total mixed ration with two roughage to concentrate ratios.**

| Treatments | Total DMI (kg/h/d) | DMI (% BW) | Total BWG (kg/h) | Daily BWG (kg/h) | FCR (kg/kg) |
|---|---|---|---|---|---|
| **Types of crop residues** | | | | | |
| Maize stovers (MS) | 5.40±0.12 | 2.43±0.18 | 70±0.03$^{b}$ | 0.70±0.03$^{b}$ | 7.72±0.18$^{a}$ |
| Maize cobs (MC) | 5.33±0.14 | 2.33±0.18 | 79±0.03$^{a}$ | 0.79±0.03$^{a}$ | 6.71±0.15$^{b}$ |
| Wheat straw (WS) | 5.52±0.15 | 2.46±0.18 | 72±0.04$^{b}$ | 0.72±0.04$^{b}$ | 7.69±0.19$^{a}$ |
| **Level of concentrate (C)** | | | | | |
| 75% | 5.53±0.15 | 2.45±0.18 | 76±0.04 | 0.76 ±0.04 | 7.28±0.18 |
| 65% | 5.30±0.14 | 2.36±0.18 | 71±0.03 | 0.71 ±0.03 | 7.45±0.18 |
| **Interaction (Types of crop residues × Level of concentrate)** | | | | | |
| MS to C ratio of 25:75% | 5.50±0.14 | 2.49±0.18 | 71±0.04$^{c}$ | 0.71±0.04$^{c}$ | 7.75 ±0.19$^{a}$ |
| MS to C ratio of 35:65% | 5.30±0.12 | 2.38±0.18 | 69±0.02$^{c}$ | 0.69±0.02$^{c}$ | 7.68±0.17$^{ab}$ |
| MC to C ratio of 25:75% | 5.50±0.14 | 2.39±0.18 | 83±0.03$^{a}$ | 0.83±0.03$^{a}$ | 7.63±0.15$^{b}$ |
| MC to C ratio of 35:65% | 5.15±0.12 | 2.27±0.18 | 76±0.03$^{b}$ | 0.76±0.03$^{b}$ | 7.78±0.15$^{b}$ |
| WS to C ratio of 25:75% | 5.60±0.15 | 2.47±0.18 | 75±0.04$^{b}$ | 0.75±0.04$^{b}$ | 7.47±0.17$^{ab}$ |
| WS to C ratio of 35:65% | 5.45±0.14 | 2.44±0.18 | 69±0.03$^{c}$ | 0.69±0.03$^{c}$ | 7.90±0.19$^{a}$ |

Means ±SEM in a row with different superscripts differ significantly (p<0.05). Values of each parameter are means of 3 observations.

**Table IV. Nutrients intake and digestibility in buffalo calves fed maize stovers, maize cobs and wheat straw based total mixed ration with two roughage to concentrate ratios.**

| Parameters | MS: Concentrate | | MC: Concentrate | | WS: Concentrate | |
|---|---|---|---|---|---|---|
| | 25:75 | 35:65 | 25:75 | 35:65 | 25:75 | 35:65 |
| **Average intake (kg/h/day)** | | | | | | |
| Dry matter | 5.50 ±0.14 | 5.30 ±0.12 | 5.50 ±0.14 | 5.15 ±0.12 | 5.60 ±0.15 | 5.45 ±0.14 |
| Crude protein | 0.57 ±0.01 | 0.53 ±0.01 | 0.57 ±0.02 | 0.52 ±0.01 | 0.57 ±0.01 | 0.55 ±0.02 |
| Neutral detergent fibre | 2.47±0.04 | 2.52±0.05 | 2.28±0.04 | 2.26±0.04 | 2.66±0.06 | 2.66±0.05 |
| Acid detergent fibre | 1.04 ±0.02$^{b}$ | 1.28 ±0.03$^{ab}$ | 0.93 ±0.01$^{b}$ | 1.01 ±0.02$^{b}$ | 1.44±0.03$^{a}$ | 1.40 ±0.03$^{a}$ |
| **Nutrients digestibility (%)** | | | | | | |
| Dry matter | 62.88±1.34$^{b}$ | 60.23±1.14$^{c}$ | 65.48±1.74$^{a}$ | 63.52±1.54$^{b}$ | 61.12±1.39$^{c}$ | 60.12±1.24$^{c}$ |
| Crude protein | 63.80±1.84 | 62.13±1.64 | 66.18±2.17 | 64.16±2.04 | 61.81±1.53 | 61.81±1.74 |
| Neutral detergent fibre | 63.55 ±1.64$^{b}$ | 62.66 ±1.51$^{bc}$ | 66.97 ±1.87$^{a}$ | 65.00±1.60$^{ab}$ | 61.33±1.54$^{c}$ | 62.33 ±1.61$^{bc}$ |
| Acid detergent fibre | 58.12±1.66$^{b}$ | 59.55±1.74$^{b}$ | 63.66±1.89$^{a}$ | 63.10±1.84$^{a}$ | 58.15±1.69$^{c}$ | 57.58±1.51$^{c}$ |

*Total mixed rations comprising two (25% and 35%) inclusion levels of each maize stover (MS), maize cobs (MC) and wheat straw (WS) and designated as MS25%, MS35%, MC25%, MC35%, WS25% and WS35%, respectively. These TMR were offered *ad-libitum* while the fixed quantity (5 kg/head/day) of green fodder was provided for 100 days. n=3 buffalo calves per treatment

**Table V. Economic analysis of buffalo calves fed maize stovers, maize cobs and wheat straw based total mixed ration with two roughage to concentrate ratios.**

| Performance | MS: Concentrate | | MC: Concentrate | | WS: Concentrate | |
|---|---|---|---|---|---|---|
| | **25:75** | **35:65** | **25:75** | **35:65** | **25:75** | **35:65** |
| **DM intake (kg/head/day)*** | | | | | | |
| Total mixed ration | 4.25 | 4.05 | 4.25 | 3.90 | 4.35 | 4.20 |
| Maize fodder | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 |
| Total | 5.75 | 5.55 | 5.50 | 5.40 | 5.85 | 5.70 |
| **Cost of feed (Rs/head/day)**** | | | | | | |
| Total mixed ration | 100.50 | 86.22 | 101.70 | 84.55 | 112.62 | 102.60 |
| Maize fodder | 12.50 | 12.50 | 12.50 | 12.50 | 12.50 | 12.50 |
| Total cost | 113.00 | 98.72 | 114.20 | 97.05 | 125.12 | 115.11 |
| Average daily gain (kg) | 0.71 | 0.69 | 0.83 | 0.76 | 0.75 | 0.69 |
| Feed cost/kg gain (Rs) | 159 | 143 | 138 | 128 | 167 | 167 |

*Total mixed rations comprising two (25% and 35%) inclusion levels of each maize stover (MS), maize cobs (MC) and wheat straw (WS) and designated as MS25%, MS35%, MC25%, MC35%, WS25% and WS35%, respectively. **On dry matter basis price of one-kilogram green maize fodder was Rs. 10 while total mixed rations having $MS_{25}$, $MS_{35}$, $MC_{25}$, $MC_{35}$, $WS_{25}$ and $WS_{35}$ was Rs. 23.65, 21.29, 23.93, 21.68, 25.89 and 24.43, respectively. n=3 buffalo calves per treatment.

35% MS, 25% MC, 35% MC, 25% WS and 35% WS was PKRs. 23.65, 21.29, 23.93, 21.68, 25.89 and 24.43, respectively. The price of 1kg live weight of animal was assumed to be PKRs. 175.

Although buffalo calves fed TMR with 25% MC obtained maximum weight gain (830 g/d). However, the feed cost per kg gain (PKRs. 138) was higher than those fed 35% MC based TMR (PKRs. 128). The reason for higher cost per kg live weight gain in buffalo calves fed 25% MC based TMR in comparison to 35% MC based TMR could be due to higher incorporation level of concentrate in the TMR. Similar pattern of feed cost per kg gain with other rations was observed. The previous researcher Shi *et al*. (2014) reported that profit returns were mainly depending on efficiency of feed utilization by animals and feed cost. Xie *et al*. (2012) and Mirza *et al*. (2008) suggested that economic returns can be obtained by comparing the cost of the supplements and basal feed with the value of the live body weight produced.

## CONCLUSION

Maize cobs are better when compared with maize stovers and wheat straw in total mixed ration for optimum weight gain, better feed conversion ratio, efficient nutrient utilization, and economic benefit in buffalo calves. Whereas, both maize stovers and wheat straw are comparable with each other for same parameters except economic benefit (less feed cost per kg gain of maize stovers than wheat straw). Furthermore, maize stovers, maize cobs and wheat straw in total mixed ration up to 35% inclusion level had no adverse effect on palatability in buffalo calves.

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*Statement of conflict of interest*

The authors have no conflict of interest.

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