Full Length Article

EFFECT OF MAIZE (*ZEA MAYS*) COB BASED TOTAL MIXED RATION IN GROWING CALVES

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ABSTRACT

The present study was conducted to study the effect of maize (Zea mays) cob on replacing paddy straw in the Total Mixed Ration (TMR). Twelve cross bred calves of about 5 to 8 months of age with body weight ranging from 41 to 79 kg were divided into two groups of six each in completely randomized design. Five complete diets were prepared (TMR1 to TMR5) using maize cobs at the level of 0%, 25%, 50%, 75% and 100% replacement of paddy straw in the diets containing 12 % CP and 60 % TDN of 50:50 concentrate to roughage ratio. There was significant (P<0.01) differences among the diets in OM, CF, NFE, TA, AIA, NDF, ADF, Lignin, Hemicellulose and Cellulose contents. In vitro rumen fermentation study showed significantly (P<0.01) higher total gas (ml/200 mg/48 h), in vitro dry matter and organic matter degradability in maize cob based ration than paddy straw contained ration (51.17 vs 36.00; 62.87 vs 57.25; 64.80 vs 59.93). Paddy straw (100%) based diet as control ration and maize cob (100 % replacement of paddy straw) based diet as treatment ration fed to growing calves for sixty days in growth trial. A seven day digestion trial was conducted in the middle of the experiment. The digestibility (%) of DM, OM, CP, EE, CF and NFE were significantly (P<0.01) higher in the maize cob based diet fed group than paddy straw based diet fed group. The average body weight gain (kg) and FCR (kg DMI/ kg gain) were significantly (P<0.05) higher in maize cob fed animals (19.47; 6.10) than paddy straw fed animals (16.02; 7.34). The feed cost per unit of weight gain in calves fed paddy straw based diet was numerically higher (30.78 %) than calves fed on maize cob based ration. It could be concluded that maize cob based ration could replace paddy straw at 100 % level in total mixed ration without affecting feed intake and nutrient digestibility and may also improve the body weight gain and reduce feed cost in growing calves.

Key words: Digestibility, Growing calves, Growth performances, *In vitro*, Maize cob, Paddy straw, Total Mixed Ration

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INTRODUCTION

According to the 20thLivestock census, of the total animal population of 535.82 million around 302.82 million bovines consist of various species, including cattle, buffalo, mithun and yak, which reflects a 4.6% increase in population compared to the 2012 census (20th Livestock Census, 2019). India is home to a significant portion of the global bovine population, with 14.7% and 57.3% of the world's cattle and buffaloes, respectively. In India, most of the livestock are fed with dry roughages and faces net shortage of 44% concentrate feed ingredients, 10.95% dry fodder, and 35.6% green fodder in the nation (IGFRI Vision, 2050). The lack of fodder 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. Plenty of unconventional feed resources available throughout the country. They should be judiciously utilized to improve the production performances of livestock. Maize cobs (*Zea mays*) are byproduct of maize crop after removing the grains from the Maize ear. About 170 to 190 kg of cobs is obtained from the1000 kg of maize shelled (Singh *et al*., 2018). According to the Second Advance Estimates of the Ministry of Agriculture and Farmers Welfare for 2022-23, the area dedicated to maize cultivation in India has expanded to 9.8 million hectares, resulting in a total production of 33.62 million tonnes. Several states have emerged as leading contributors to the country's overall maize production. These states include Karnataka, Madhya Pradesh, Maharashtra, Bihar, Telangana and Andhra Pradesh. In Tamil Nadu, maize cultivation is carried out across 4 lakh hectares, leading to a production output of 25.64 lakh tonnes during the year 2020-21 (TNAU, 2023). Hence, there is a scope of production of 4.68 million tonnes of maize cob in India with the present production of maize. Maize cobs, which are abundant in fibrous 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 hemicellulose and cellulose but contain relatively low levels of crude protein, making them a potential alternative feed source for ruminants (Shashikumar *et al*., 2017). This substantial quantity of maize cobs has the potential to serve as an alternative roughage source for ruminants and also as cost-effective feeding options. Keeping these facts in view, the present study was planned to identify the inclusion level of maize cob to replace paddy straw in total mixed ration using *in vitro* experiments and to assess the digestibility of nutrients and economics of maize cob based total mixed ration in growing calves.

METERIALS AND METHODS

This study was conducted at Veterinary College and Research Institute, Orathanadu, Thanjavur district. Concentrate feed ingredients were collected from feed mill, and Maize cob and paddy straw were collected from nearby village (Arputhapuram,

Thanjavur) 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 cobs replacing paddy straw with 12 % crude protein and 60% TDN were prepared. The ground feed samples and total mixed rations (TMR) were analyzed for different proximate constituents as per the methods described in AOAC (1999) and fiber components as per the method given by Van Soest *et al*. (1991).

In vitro gas production, dry matter degradability (IVDMD) and organic matter degradability (IVOMD) of diets were carried out in 100 ml calibrated glass syringes as described by Menke and Steingass (1988). Feed samples (200 mg) were taken in triplicate in the glass syringes and strained rumen liquor (30 ml) collected from the cattle using stomach tube and mixed with rumen buffer medium (1:3) were infused into syringes under anaerobic conditions. The syringes were kept in an automatic water bath cum shaker incubator at 39 ± 0.5°C for 48 hour incubation. Total gas production and dry matter degradability were measured after 48 hour fermentation. 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 12000 g for 20 minutes at 4°C. 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 and the dry weight of residue was calculated. The dry weight of the blank was subtracted from those recorded for the test samples. The residue in each crucible was ashed in a muffle furnace at 550°C for 2 hours to determine the organic matter (OM) content.

Twelve crossbred Jersey female calves, 5-8 months of age, were selected from the cattle yard of Veterinary College Research Institute, Orathanadu, Thanjavur and distributed randomly into two groups according to their body weight. The average body weight of calves fed with Paddy straw based diets (Control) and Maize cob based diet (Treatment) were 59.00 ± 5.25 kg and 60.28 ± 4.05 kg, respectively. The calves were housed in well-ventilated stall having facilities for individual feeding. Calves were dewormed using albendazole @ 10 mg/kg body weight before starting the experimental feeding.

Total mixed rations (0% inclusion level of maize cob for the control group and 100% inclusion on maize cob instead of paddy straw for the treatment group) having 12% CP and 60% TDN selected based on IVDMD and IVOMD. These isocaloric and isonitrogenous rations were fed to growing crossbred calves at the rate of 3.5 % BW for 60 days. Drinking water was offered free choice throughout the day. The animals were weighed before feeding and watering in the morning on three consecutive days at the start of experimental feeding and thereafter at fortnightly intervals during the experimental period of 60 days. Dry matter intake was recorded twice a week by subtracting the residual dry matter from the

quantity of dry matter offered. Growth rate was calculated based on increase in body weight at fortnightly intervals and feed conversion efficiency was also calculated from dry matter intake to live weight gain. A digestion trial was conducted in the middle of experimental period with 7 days collection period to determine the nutrient digestibility. Animals were weighed before and after the trial consecutively for three days. Fresh drinking water provided free choice throughout the day. Feed and their respective residues were collected in separate polythene bags daily for dry matter estimation. Faeces voided during 24 hours was collected and weighed at 8.00 AM daily. After thorough mixing, an aliquot was taken in duplicate for dry matter estimation. Another aliquot (1%) was mixed thoroughly with 5 ml of 25% H_2SO_4 and stored in air tight plastic container for total Nitrogen estimation. Dried dung samples were ground to pass through 1 mm sieve size and analyzed for proximate principles as per standard procedure AOAC (1999). Digestibility of nutrients was calculated for the diets provided to the growing calves. The economics were calculated by adopting the following ingredient cost (cost/kg) concentrate feed, CoFS-29 green fodder, paddy straw and maize cob, Rs.34 per kg, Rs.1 per kg, Rs.5 per kg and Rs.1, respectively.

As per the method of the statistical analysis system (SPSS, version 2008), the data gathered on various parameters were aggregated and subjected to one-way ANOVA statistical analysis and student "t" test and means were compared, and significance was determined based on suitability at $P < 0.05$ and $P < 0.01$.

RESULTS AND DISCUSION

Ingredients level and chemical composition (%) of total mixed rations are given in Table 1 & 2. Maize Cob (MC) showed higher Crude Protein (CP), Nitrogen free extract (NFE), Hemi cellulose and cellulose than the Paddy Straw (PS). The lignin content of paddy straw was higher than the maize cob. Chemical composition of paddy straw was in accordance with findings of Singh *et al.* (2022) and Ayyappan and Tomar (2006). The proximate and fiber fractions of maize cob was comparable with finding of Wachirapakorn *et al*. (2016); Anjum and Afzal, (2015) and Nagalakshmi and Reddy, (2008). Chemical and fiber composition of TMR1 to TMR5 in present study revealed, when the maize cob inclusion level increased to replace the paddy straw there was no significance difference ($P > 0.05$) in dry matter, crude protein and ether extract. As the inclusion level of maize cob increased, OM, NFE, NDF and hemicellulose contents were significantly ($P < 0.01$) increased while TA, AIA, ADF, ADL percent level decreased. These findings are related with the report of Wachirapakorn *et al*. (2016), Shasikumar *et al*. (2017) and Anjum and Afzal (2015).

The complete diets were formulated using maize cob replacing paddy straw and rations were tested for total gas production, IVDMD and IVOMD and values are given in Table 3. Total gas production (ml), IVDMD % and IVOMD % of TMR1 to TMR5 ranged

from 36.0 to 51.17, 57.25 to 62.87 and 59.93 to 64.80, respectively. There was a linear increase in total gas production, percent IVDMD and IVOMD with increase in level of maize cob and the difference was significant (P<0.01). Highest gas production, IVDMD and IVOMD were observed at 100 % replacement of paddy straw with maize cob in complete diets. These findings were in agreement with results reported by Farooq *et al.* (2015). The results revealed better utilization of maize cob during *in vitro* fermentation as compared to paddy straw. All the digestible parameters were improved by increasing inclusion level of maize cob. As there was no negative impact of paddy straw replacement with maize cob, the use of the maize cob as sole source of roughage appears to be a feasible alternative. Total gas production from maize cob based rations was significantly (P<0.01) higher than paddy straw based rations. These results were comparable with finding of Farooq *et al*. (2015) who reported 29.50 ml of gas production from 200 mg substrate containing maize cobs incubated for 24 hours only. The more gas production may be due to high hemicellulose, cellulose and NFE contents of maize cobs attributed to higher fermentation and gas production. The negative relationship found between lignin content of the crop residues and digestibility emphasised to improve the poor quality roughages mainly available as feed resources for the ruminants should be processed to improve their nutritive values.

Effect of maize cob based ration on feed intake, digestibility and economics of feeding in growing calves are given in the Table 4. The average body weight of growing calves at the start of experiment was 59.00 ± 5.25 kg in group fed with paddy straw based diet and 60.28 ± 4.05 kg in group fed with maize cob based diet and there was no significant (P>0.05) difference observed. The average dry matter intake of calves fed on maize cob and paddy straw contained diets was not significant (P<0.05). The level of dry matter intake was quite adequate in both the groups to meet the requirement of growing calves (ICAR 2013). The present study findings are corroborated with report of Anjum and Afzal (2015) and Azim *et al*. (2000) who reported no significant (P>0.05) differences in dry matter intake but found significant (P<0.05) differences in body weight gain and FCR in buffalo heifer. Similar results were documented previously by Kerley *et al*. (1985) who reported that diets containing maize cob had no negative effect on growth performances in growing lambs. Similarly, Sachin *et al*. (2023), Kavya *et al*. (2018), Pradeep (2015) and Senani *et al*. (2013) also reported positive effect on growth performances in lambs fed on maize cob based diets and the finding of the current study was in accordance with those reports.

Feeding maize cob based ration increased body weight gain (21%) in growing calves when compared to feeding of paddy straw based ration. The result was in accordance with report of Anjum and Afzal (2015), who observed increased body weight gain on growing buffalo calves from maize cob based rations. However, Senani *et al*. (2013) reported no significant effect on body weight

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

(*n=4)

Table 2. Ingredient level (%) and Chemical composition of diets (% DM basis)

Ingredients	TMR 1	TMR 2	TMR 3	TMR 4	TMR 5
Paddy straw	40	30	20	10	0
Maize Cob	0	10	20	30	40
Fodder Sorghum (CoFS 29)	10	10	10	10	10
Yellow maize	27	27	27	27	27

Soyabean meal	7.5	7.5	7.5	7.5	7.5
Groundnut meal	8	8	8	8	8
Deoiled Rice Bran	6	6	6	6	6
Mineral mixture	1	1	1	1	1
Salt	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100
Proximate composition					
DM	91.60 ± 0.06	91.86 ± 0.02	91.28 ± 0.05	91.72 ± 0.03	91.52 ± 0.06
OM	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
CP	12.12 ± 0.07	12.13 ± 0.07	12.14 ± 0.03	12.16 ± 0.06	12.19 ± 0.05
EE	1.24 ± 0.01	1.26 ± 0.05	1.29 ± 0.02	1.28 ± 0.02	1.28 ± 0.02
CF	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
NFE	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
TA	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
AIA	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
Fiber fractions					
NDF	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
ADF	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
ADL	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
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
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

(*n=6), Figures with different superscripts in a same row differ significantly (P<0.01)

Table 3. Effect of replacing paddy straw with maize cob on *in vitro* gas production, dry matter degradability and organic matter degradability of different TMR diets

Feed ingredients	IVGP (ml/48 hrs)	IVDMD (%)	IVOMD (%)
TMR 1	$36.00^{a} \pm 0.51$	$57.25^{a} \pm 0.06$	$59.93^{a} \pm 0.13$
TMR 2	$40.83^{b} \pm 0.31$	$58.73^{b} \pm 0.06$	$61.32^{b} \pm 0.15$
TMR 3	$43.50^{c} \pm 0.43$	$60.71^{c} \pm 0.06$	$62.55^{c} \pm 0.36$
TMR 4	$48.67^{d} \pm 0.50$	$61.81^{d} \pm 0.05$	$64.08^{d} \pm 0.08$
TMR 5	$51.17^{e} \pm 0.60$	$62.87^{e} \pm 0.04$	$64.80^{e} \pm 0.11$

(*n=6), Figures with different superscripts in a same column differ significantly (P<0.01)

Table 4. Effect of Maize cob based TMR on feed intake and digestibility (%) of nutrients in growing calves (Mean* ± S.E)

Particular	Control group	Treatment group	P
Initial BW (kg)	59.00 ± 5.25	60.28 ± 4.05	0.8503
Final BW (kg)	75.02 ± 6.09	79.75 ± 4.72	0.5528
BW gain (kg)	$16.02^{a} \pm 1.07$	$19.47^{b} \pm 0.74$	0.0237
Total DMI (kg)	117.60± 10.05	118.80± 7.65	0.9262
TDMI (kg/d)	1.94 ± 0.02	1.94 ± 0.01	0.5790
ADG (g/d)	$267.00^{a} \pm 17.75$	$324.33^{b} \pm 12.21$	0.0239
Digestibility coefficient			
DM	$61.53^{a} \pm 0.10$	$64.11^{b} \pm 0.07$	0.0000
OM	$65.19^{a} \pm 0.07$	$66.29^{b} \pm 0.04$	0.0000
CP	$71.79^{a} \pm 0.16$	$72.97^{b} \pm 0.11$	0.0001
EE	$69.75^{a} \pm 0.18$	$71.59^{b} \pm 0.07$	0.0001
CF	$50.98^{a} \pm 0.18$	$52.95^{b} \pm 0.11$	0.0000
NFE	$66.13^{a} \pm 0.05$	$68.45^{b} \pm 0.07$	0.0001

Nutritive value			
DCP (%)	$8.70^{a} \pm 0.02$	$8.90^{b} \pm 0.01$	0.000
TDN (%)	$59.16^{a} \pm 0.03$	$64.44^{b} \pm 0.04$	0.000
DCPI (kg)	$0.168^{a} \pm 0.0005$	$0.173^{b} \pm 0.0002$	0.000
TDN intake (kg/d)	$1.15^{a} \pm 0.001$	$1.25^{b} \pm 0.001$	0.000
FCR (kg DMI/kg gain)	$7.34^{b} \pm 0.37$	$6.10^{a} \pm 0.18$	0.0132
FCE (kg gain/kg DMI)	$0.136^{a} \pm 0.009$	$0.164^{b} \pm 0.006$	0.0299
Total feeding cost for 60 days (Rs.)/ calf	Rs. 2525	Rs. 2347	
Total feeding cost (Rs.)/ day/calf	Rs. 42.08	Rs. 39.11	
Over all total cost for 1 kg gain	Rs. 157.60	Rs. 120.50	

(*n=6), Figures with different superscripts in a same row differ significantly (P<0.01)

gain but maize cob could replace ragi straw in the ration fed to Bandur lambs without any adverse effect.

Nutrient digestibility of crude protein, crude fiber, ether extract, NFE and dry matter were significantly (P<0.01) higher in maize cob based ration than paddy straw contained ration. This might be due to higher hemicellulose, cellulose and lower lignin in maize cob based ration. These results were corroborated with findings of Anjum and Afzal (2015) and Azim *et al*. (2000) who reported higher nutrient digestibility in the maize cob based diets in growing calves.

The cost of live weight gain is mainly relying on cost of feed and efficiency of feed utilization by the animals. The feed cost per unit of weight gain in calves fed paddy straw based diet was numerically 30.78 % higher than calves fed on maize cob based ration. The higher feed cost incurred per unit of weight gain was observed in paddy straw based diet (Rs. 157.60) than calves fed with maize cob based diet (Rs. 120.50). The results suggested that the maize cob can beneficially substitute paddy straw in growing calves in terms of better growth rate, feed efficiency, nutrient digestibility and cost effective alternate for profitable calf rearing.

CONCLUSION

From the study it can be concluded that the paddy straw can be completely replaced with maize cob in total mixed rations without affecting dry matter intake, nutrient

digestibility, body weight gain, and feed cost in growing calves.

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