RESEARCH ARTICLE Indian Journal of Animal Research, Volume 60 Issue 6: 1074-1079 (June 2026)

Performance of Lactating Yaks based on Feeding Normal *vis-a-vis* Quality Protein Maize

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10.18805/IJAR.B-5484

ABSTRACT

Background: Maize abundantly cultivated in the North Eastern region of India, mainly for human consumption, although it's having good potential to be used as a livestock feed to improve their productive performances. Presently, different improved varieties of maize are cultivating worldwide for use in animal feeds. Studies indicated normal maize is deficient in protein including the most essential amino acids, however, the quality protein maize (QPM), a special maize verity have a balance ratio of leucine to iso-leucine which helps in enhancement of the biological value of the protein in livestock and poultry. The present study was planned to assess the efficacy of normal maize *Vis-a-Vis* QPM on performance of lactating yaks.

Methods: Ten lactating yaks of uniform age, body weight and pariety were randomly divided into two groups of five animals in each and were fed on mixed rations for a period of 112 days. The normal maize part of the concentrates in Ration-1 (R_1) was completely (w/w) replaced with QPM in Ration-R_2 and offered to group T_1 and T_2, respectively. Standard managemental practices were adopted for all the experimental animals. At the end, a digestibility trial of 6 days duration was carried out in all yaks.

Result: The average DMI/100 kg body weight and average daily gain were higher with better feed efficiency in the group T_2 fed diets based on quality protein maize. The nutritive values in terms of digestible crude protein (DCP) and total digestible nutrients (TDN) showed no significant variations between the groups and the values were 5.11±0.52 and 58.15±0.74 and 5.43±0.42 and 59.78±1.11 per cent in T_1 and T_2, respectively. Apparent digestibility of dry matter as well as in all organic matters and their nitrogen balances were comparatively higher (P>0.05) in T_2 group. It was concluded that normal maize can easily be replace with quality protein maize for lactating yaks for better economic returns.

Key words: Digestibility, Lactating yak, Maize, Nutrient balances, Quality protein maize.

INTRODUCTION

Maize (*Zea mays*) grown under the foothills and hilly terrains of North eastern region of India and people used it either for direct consumption or second cycle production for feeding to livestock. The maize grain is the main source of energy in most livestock and poultry diets and plays a potential role as a source of human food. It can contribute up to 30 per cent protein, 60 per cent energy and 90 per cent starch requirements in animal diets (Dado, 1999). Like, other dairy animal yaks for better milk productivity needs to provide a balanced diet as a total mixed ration (TMR) which can overcome the feed shortage of lactating cows by utilizing available feed resources effectively and efficiently (Karunanayaka *et al.,* 2022). Verities of maize namely yellow maize, white maize, quality protein maize are different in their nutritional compositions (Snow *et al.*, 2004; Panda *et al*, 2010). Studies indicated normal maize is deficient in protein including the most essential amino acids lysine and tryptophan (Jia *at el*., 2013; Keretsu *et al.,* 2019). However, the quality protein maize (QPM), a special maize verity have higher content of lysine and tryptophan with lower levels of leucine for maintaining a balance ratio of leucine to iso-leucine which helps in enhancement of the biological value of the protein. It contains almost double the amount of lysine compare to normal maize (Panda *et al*, 2010). Shaktiman is one of such single cross hybrid verity of quality protein maize with its protein content a rounding of 10 per cent. Studies revealed most monogastrics including poultry fed with QPM based diets shows better performances in terms of growth, feed efficiency and economics of feeding (Omage *et al.,* 2009; Panda *et al.,* 2010; Panda *et al.,* 2014; Kaul *et al.,* 2019; Barman *et al.,* 2020). Yak (*Poephagus grunniens*) inhabits in difficult terrains of the foot hills of Himalayas, looses body weights and their milk yields during winter mainly due to inadequate feed/fodder. To counteract the problem supplementation of concentrates especially during winter and seeking possible benefits of QPM, the present study was planned to assess the efficacy of normal maize *vis-a-vis* QPM on performance of lactating yaks.

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How to cite this article: Medhi, D., Paul, V., Singh, T.P., Hussain, M., Jatana, M.S., Bhatt, N. and Sarkar, M. (2026). Performance of Lactating Yaks based on Feeding Normal *vis-A-vis* Quality Protein Maize. *Indian Journal of Animal Research*. **60(6):** 1074-1079. doi: 10.18805/IJAR.B-5484.

Submitted: 29-07-2024 **Accepted:** 11-11-2024 **Online:**10-01-2025

MATERIALS AND METHODS

Location of the study

The study was undertaken at Nyukmadung Yak farm situated at an altitude of 8500 ft. above msl under the ICAR-National Research Centre on Yak, Dirang, Arunachal Pradesh, India. The experimental feeding was conducted for a period of 112 days, followed by a digestibility trial of 6 days during 23rd November 2021 to 20th March, 2022.

Experimental animals and dietary treatments

Ten lactating yaks of uniform age, body weight and pariety were randomly divided into two groups of five animals in each. The ingredients composition of the concentrate mixture was normal maize, wheat bran, ground nut cake, mustard oil cake, mineral mixture and common salt in the proportion of 50, 20, 15, 12, 2 and 1 per cent, respectively in Ration-R_1 and the proportionate amount of the normal maize was quantitatively (w/w) replaced with QPM (Shaktiman variety) in Ration-R_2 and the same was offered to the experimental animal group T_1 and T_2, respectively. At random one dietary treatment was allotted to each group. All the experimental animals were fed individually under stall feeding for 112 days on mixed rations containing both concentrate mixtures and paddy straw as dry roughages in the ratio of 1:2. Green grasses (*Dactylus glomerata)* were offered to the all the experimental animals at the rate of 1.0 kg/animal/day to meet out their Vitamin A requirements. Standard managemental practices were applied for each animal. Fresh drinking water was made available at any time to the experimental animals during the whole experimental period.

Data collection and recording

The fortnightly body weights and daily feed intake of the animals were recorded for calculation of average daily gain and dry matter intake of the experimental animals. A metabolism trial was conducted on all experimental yaks at the end of 112 days of the experimental feeding for a period of six days and the samples of feed, faeces and residue left collected were analyzed for proximate composition according to AOAC (2007). Digestible energy (DE) was calculated as 1.0 kg Total Digestible Nutrient (TDN) being equal to 4.4 Mcal DE and metabolizable energy (ME) was equal to 0.821 times of DE as per Agnew and Yan (2000).

Statistical analysis

The feed intake, average daily gain, milk yield and their composition, feed efficiency and economics of feeding data were subjected to statistical analysis by paired "*t test*" using statistical package Minitab (2003), version 13.20.

RESULTS AND DISCUSSION

The chemical compositions of normal yellow maize, QPM, paddy straw, *Dactylus glomerata* with the experimental rations and that of normal maize and QPM based rations (R_1 and R_2) in terms of their dry matter, organic matter, crude protein, crude fibre, ether extract, total ash, nitrogen free extract contents with their fibre components are presented in Table 1. The findings revealed the values of all components were within the range as reported values of Ghosh and Bandopadhyay (2008); Baruah *et al.* (2012) and Medhi *et al.* (2018). It also indicated that the compositions of concentrates changes with replacement of the normal maize by QPM although their values were within the reported range of earlier workers (Baruah *et al.*, 2012 and Medhi *et al.*, 2016).

The apparent digestibility co-efficient of dry matter as well as different organic nutrients represented in Table 2 and the values were slightly higher (P>0.05) in T_2 group than T_1 fed QPM based diets replacing normal maize and the results were well matched with the findings of Keretsu *et al.,* 2019 in growing mithun calves. The reason might be due to higher lysine and tryptophan content of quality protein maize in comparison to normal maize. Tiwari *et al.* (2013) also revealed higher digestibility of different organic nutrients with QPM based diets in growing pigs. Barman *et al.* (2020) however, observed better digestibility of different organic nutrient in growing pigs with 50 per cent but substantially reduced the values with complete replacement of normal maize with $HQPM^{-1}$ maize. The better digestibility of the nutrients with higher lysine content in the diets interferences in the gut of the animals that's affects amino acid contents of excreta which certainly modified the nutrient digestibility of the animals (Andrew *et al.,* 1979 and Short *et al.,* 1999).

Table 1: Proximate composition of different feed components and the experimental rations.

Parameters	Normal maize	QPM (shaktiman)	Paddy straw	Green fodder *(Dactylus glomerata)*	Concentrate mixture with NM (R_1)	Concentrate mixture with QPM (R_2)
Dry matter	87.66±0.95	89.65±0.89	87.12±2.14	27.8±1.24	87.86±1.47	88.02±1.22
Organic matter	95.79±1.14	97.42±1.27	84.80±2.12	90.2±3.14	90.30±2.34	90.88±2.05
Crude protein	8.31±0.04	9.86±0.08	3.20±0.23	13.4±1.04	17.61±0.65	18.18±0.43
Crude fibre	2.36±0.02	2.52±0.01	32.00±0.34	21.1±1.22	7.10±0.42	6.20±0.33
Ether extract	3.06±0.03	3.26±0.03	1.00±0.08	3.3±1.03	4.38±0.23	4.35±0.09
Total ash	2.21±0.01	2.08±0.01	15.20±0.12	9.8±0.75	9.70±0.41	9.30±0.24
Nitrogen free extract	84.06±1.24	82.28±1.24	48.60±1.24	52.4±2.11	61.22±1.56	59.87±1.07

Means within the same row bearing the same superscript do not differ significantly.

The nutritive values in terms of digestible crude protein (DCP) and total digestible nutrients (TDN) of the experimental rations without or with replacement of normal maize (R_1) through incorporation of quality protein maize (R_2) are presented in Table 3 and the values recorded were 5.11±0.52 and 58.15±0.74 and 5.43±0.42 and 59.78±1.11 per cent in group T1 and T2, respectively. However, statistically the values showed no significant variations between the groups for both DCP and TDN values. The nutritional plan of the experimental yaks in terms of DCP and TDN intake per day as well as per 100 kg body weights also indicated no significant variation between the groups and the findings were in congruence with the findings of Medhi *et al.* (2018) who observed higher nutritive values with high protein diets in growing yak calves.

The average daily gain in body weights of the experimental yaks irrespective of types of maize content in their diets were very less and the reason may be the approach of adult maturity age of all the experimental animals (1st and 2nd pariety). However, the comparatively higher (P>0.05) gain in T_2 (0.186 kg±0.02) against T_1 (0.175 kg±0.07) as reflected in Table 3 might be due to higher protein contents with better amino acid compositions especially the lysine and tryptophan in QPM might be the reason for better growth in T_2 than that of T_1. Similar observations were also recorded by Medhi *et al.* (2018) in growing yak calves. The significant increased growth of growing mithun calves with replacement of normal maize by QPM was also found by Keretsu *et al*. (2019). Ladely *et al.* (1995) also recorded nutritional benefits of high lysine corns in terms of weight gain in ruminants. Feeding the kids with high protein level along with mineral mixure had significantly increased the body weight gain, growth performance, dressing percentage, carcass yield and quality (Muthuramalingam *et al*., 2018). Also, Prakash *et al.* (2023) recorded iimproved feed efficiency and reduced abdominal fat with increased breast muscle in Vanaraja birds during nursery phase fed with QPM based diets.

The daily dry matter intakes of all experimental animals showed no significant differences irrespective of their diet compositions, although the values were slightly higher with QPM (5.400 kg±0.21) compare to NM fed group (5.296 kg ±0.12). Accordingly, the values of per cent mean dry matter intake (DMI/100 kg body weight) also varies (P>0.05) between the groups (Table 3). The efficiencies of feed intakes in the group T_2 fed QPM based diets was found

Table 2: Apparent digestibility of the feed nutrients, nutritive values and plane of nutrition of the experimental yaks fed diets based on normal verses QPM (Mean±SE).

Particulars	T_1	T_2
Digestibility co-efficient (%)		
Dry matter	63.75±1.24	65.12±1.13
Crude protein	63.89±1.07	66.24±0.77
Ether extract	65.78±0.57	67.07±0.75
Crude fibre	62.54±0.52	63.24±0.54
Nitrogen free extract	66.42±1.24	69.45±1.14
N balances (g/day)		
N intake	73.77±2.35	75.12±1.42
Faecal N voided	14.24±0.24	15.42±0.43
Urinary N voided	12.68±0.51	12.63±0.45
N balances	46.85±0.35	47.06±1.04
Energy balances		
DE intake (Mcal/d)	13.55±0.64	14.20±0.27
DE intake (Mcal/100 kg BW/d)	5.59±0.37	5.87±0.25
ME intake (Mcal/d)	11.12±0.34	11.66±0.12
ME intake (Mcal/100 kg BW/d)	4.59±0.17	4.82±0.09
Nutritive values of ration (% DM)		
DCP (%)	5.11±0.52	5.43±0.42
TDN (%)	58.15±0.74	59.78±1.11
Plane of nutrition		
DCP intake		
g/d	270.63±7.24	293.11±5.11
g/100 kg BW/d	111.60±5.01	121.09±0.87
TDN intake		
g/d	3079.62±11.24	3226.92±8.23
g/100 kg BW/d	1270.00±7.21	1333.09±6.24

Means in a row bearing the same superscript do not differ significantly.

Table 3: Growth performances and feed efficiencies of the experimental yaks fed diets based on normal verses QPM (Mean±SE).

Particulars	T_1	T_2
Performances of the experimental yaks		
Initial body weight (Kg)	242.2±5.23	242.4±3.24
Final body weight at the end of 112 days (Kg)	261.8±3.24	263.2±4.51
Total weight gain/loss at 112 days (Kg)	19.6±0.22	20.8±0.24
Average daily gain (g)	0.175±0.07	0.186±0.02
Feed intake		
Voluntary intake (kg/day)	6.062±0.24	6.177±0.15
Total DMI per day (kg)	5.296±0.12	5.400±0.21
Total DM intake, kg/100 kg body weight	2.184±0.02	2.230±0.02
Paddy straw (DM) intake (kg/day)	3.531±0.04	3.600±0.11
Concentrate (DM) intake (kg/day)	1.765±0.05	1.800±0.04
FCR (DMI, kg/kg gain in body weight)	31.787b±0.24	29.470a±0.35

Means in a row bearing the same superscript do not differ significantly.

Table 4: Milk yield, constituents of milk and economics of feeding (Rs./litre milk/day) of the experimental yaks fed diets based Normal verses QPM (Mean±SE).

Particulars	T_1	T_2
Milk yield (g/day)		
Milk yield	906.848±14.24	914.732±13.01
4% FCM yield	1.243±0.012	1.254±0.23
Milk fat	0.053±0.002	0.054±0.002
Milk protein	0.039±0.003	0.038±0.002
Milk total solid	0.152±0.01	0.151±0.03
Milk composition (%)		
Fat	5.87± 0.84	5.86±0.08
Protein	4.27±0.11	4.17±0.12
Total solid	16.72±0.77	16.46±0.32
Total ash	0.89 ±0.11	0.88±0.08
Economics of feeding (Rs./litre of milk)	54.41±1.24	54.88±0.98

Means in a row bearing the same superscript do not differ significantly.

significantly (P<0.05) better (29.47±0.35) than the group T_1 (31.787±0.24) fed diets with normal maize. The findings were well matched with the reported values of higher feed intake and its efficiencies with QPM based concentrates that's have higher lysine contents in different ruminants (Beek and Dado, 1998 and Keretsu *et al.,* 2019). Barman *et al.* 2020 also indicated comparatively better feed efficiency in growing pigs with 50% replacement of normal maize incorporating HQPM-1 in the diets.

The balances of nitrogen in term of g/day and energy in terms Mcal/day for both Digestible Energy (DE) and Metabolizable Energy (ME) values showed no significant variations between the groups (P>0.05), however numerical variations with higher nitrogen and energy balances in T_2 group in compare to T_1 is due to higher nutrient digestibility in this group. The findings are also in congruence with the values reported by Dado (1999); Short *et al.* (1999) and Keretsu *et al.* (2019).

Table 4 representing the milk yield, constituents of milk and economics of feeding in terms of Rs./litre milk/day indicated no effect of the dietary treatments in yak milk yields and its compositions and the slight increased in milk protein contents with QPM fed group might be the consequences of increased protein concentration in the diets. Sutton *et al.* (1996) recorded similar effect in lactating cows based on high protein silages.

The economics on production of the yak milk calculated in terms of rupees per kg of milk yield was found to be Rs. 54.41 and 54.88 in group T_1 and T_2, respectively and it showed no significant variations between the groups indicating no effect of replacement of normal maize with quality protein maize in the diets of lactating yaks.

CONCLUSION

The present study revealed complete substitution of normal maize with quality protein maize in lactating yaks have beneficial effects in term of their growth, feed efficiencies, digestibility and economics of feeding, without any adverse effect on milk yields and its compositions. It was concluded that normal maize can easily be replace with quality protein maize for lactating yaks for better economic returns.

ACKNOWLEDGEMENT

The present study was supported by ICAR-Indian Institute of Maize Research, Ludhiana for providing financial support under NEH grant of the institute and all the authors are thankful to the Director of the institute. The authors are also grateful to the Director, ICAR-National Research Centre on Yak, Dirang, Arunachal Pradesh for providing facilities for undertaking this study.

Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

All animal procedures for experiments were approved by the Committee of Experimental Animal care and handling Techniques were approved by the University of Animal Care Committee.

Conflict of interest

The authors declare that there is no conflict of interest.

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