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EFFECTS OF CONCENTRATE MIXTURE LEVEL ON NUTRIENT DIGESTIBILITY, GROWTH, PRODUCTION AND REPRODUCTION PERFORMANCE OF JAMUNAPARI GOAT UNDER SEMI INTENSIVE CONDITION

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Twenty female Jamunapari goats of live weight of 10.5 ± 1.2 kg at 08± 0.56 months of age were used for 240 days feeding trial. Goats were assigned to four dietary treatments in a completely randomized design with five (05) goats in each group. All animals were supplied ad libitum green grass and water. They were supplied 150, 200, 250, 300 gm concentrate mixture per day with roughage for group T_1, T_2, T_3, and T_4 respectively. Total dry matter (TDM) intake (413.2, 456.67, 489.2 and 495.7g/day) in groups T_1, T_2, T_3, and T_4, respectively, was significantly ($p \leq 0.01$) influenced by the level of concentrate in the diet. Average total digestible crude protein (DCP) intake (3.1, 3.5, 3.9, 4.0 g/kg body weight and average total digestible nutrient (TDN) intake 21.1, 22.3, 24.7, 25.1 g/kg body weight was significantly ($p \leq 0.01$) higher in group T_4 and lower in group T_1. The nutrient intake and digestibility were also significantly higher ($p \leq 0.01$) in T_4 group. The percent digestibility of dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE) and nitrogen free extract (NFE) were 70.1, 75.99, 73.50, 67.24, 62.13 and 49.60%, 73.14, 76.97,76.84, 68.32, 64.04 and 53.25%, 75.45,78.44,78.67,70.43,68.43 and 59.77%, 79.56, 80.16,81.69,72.45,70.82 and 63.09% in T_1, T_2, T_3 and T_4 group, respectively. Reproductive performances, birth weight of kids and litter size did not differ significantly between groups, but had significant effect on feed digestibility and milk production. Daily 300 gm concentrate mixture along with roughage is necessary for better growth, production and reproduction performance of Jamunapari doe in semi-intensive system.

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INTRODUCTION

The goat is a multi-functional animal and contributes an important role in the livelihood of a large proportion of small farmers, particularly women, landless and marginal farmers (Choudhury et al*.,* 2012). The livestock resources of Bangladesh are mainly based on cattle, goats, sheep, buffalo, and poultry. About 21.6 million (FAO, 2010; BER, 2012) and 25.7 million (BBS, 2016) (BBS, May 2016) goat heads are distributed throughout the country. Livestock is an integral component of agriculture and makes multifaceted contributions to the growth and development of the agricultural sectors of Bangladesh. However, the growth of livestock production is the second-highest among all other sub-sector of agriculture in Bangladesh (BER, 2012). The total livestock population in Bangladesh is composed of 25.93 million goats, 23.94 million cattle, 1.48 million buffaloes, and 3.4 million sheep (DLS, 2017). Among the livestock sector, goats are a very important species of livestock because of their short generation intervals and high prolificacy rate.

The production and consumption of livestock products are still much lower in consumption with other countries. According to the report, the requirement of animal protein per head per day is 120 gm. However, the availability is only 22.0 gm. (DLS, 2011), and the deficit of meat is more than 80% in 2010. To satisfy the animal protein requirement, goat farming can play an important role without religious obstacles to consume goat meat. Goat is one of the most important amongst the domestic species in the tropics, performing a variety of functions and, in comparison to other ruminants, displays a unique ability to adapt and maintain themselves in harsh environments. Goats play an important role in the livelihoods of smallholder farmers in Bangladesh as they serve as assets that can be easily liquidated to provide cash in times of need (Akhter et al*.,* 2006).

Jamunapari goat has a distinguish characteristic long ear and Roman nose. Their origin place is chakarnagar tahsil of Etawah district. It is the tallest goat breed and reared for milk and meat purpose. It is recognized by the Indian Council of Agricultural Research (Report, 2003). On the basis of above observations, it can be concluded that Jamunapari goat is tall sized, dual purpose goat and well adapted to the environmental conditions of the region such as heat, cold, humidity, water scarcity and seasonal fluctuation in feed availability in terms of quality and quantity as well as disease outbreaks. It shows excellent feed conversion efficiency under extreme conditions. High milk production and high dressing percentage is preferred by local farmers (Rawat et al., 2015). Bucks of exotic breeds are being imported by the private sector from India and used for cross breeding, especially in western Bangladesh. The Jamunapari is well adapted to the unique ravines of this area with its dense bush. The Jamnapari is the best dairy goat in India (Rout et al., 1999). The number of this breed in Bangladesh is not known, but most are found in Chuadanga, Meherpur, Kushtia, Jhenidah, Pabna, Jessore districts, and scattered found Chittagong and Cox's Bazar (Faruque and Khandoker, 2007). Goat's milk is highly nutritious. Goats that produced twins yielded more milk and had longer lactation (Carnicellaet et al*.,* 2008).

In winter season, Jamunapari goats vigorously browse feeds and spend almost 95% of their time, however, in hot summer season, browsing gradually decreases up to 55% of their time. Besides, grazing various fields which is the main source of feeds for Jamunapari goats, a farmer should supply extra nutrition to the goat, such as concentrate mixture (Tiwari et al., 2016). It was also reported that most of the farmers are not aware of scientific feeding practice in Jamunapari goat rearing (Tiwari et al., 2016). Therefore, it is of great significance to assess the effects of different concentrate mixture on different performances of Jamunapari goats under semi-intensive rearing system. Considering these, the present study was undertaken to determine the effects of concentrate mixture level on nutrient digestibility, growth, production and reproduction performance of Jamunapari goat under semi intensive condition which will certainly be helpful for sustainable Jamunapari goat rearing approach.

MATERIALS AND METHODS

The study was carried out for 240 days feeding trial. The selected 20 goats were ear-tagged and maintained under semi-intensive conditions. The live weight of the goat was10.5 ± 1.2 kg at 08 ± 0.56 months of age. Four dietary treatments were used in a completely randomized design with five (05) goats in each group. Animals were allowed to graze for 3-4 hours and 150g, 200g, 250g, and 300g concentrate mixture/day for group T1, T2, T3, and T4 group each morning and evening. Total concentrate feed was divided into two portions, and animals were supplied half in the morning, and a half was supplied in the late afternoon. The feed was offered individually in a plastic bowl. Adlibitum fresh drinking water was provided to each group. The composition of the 100kg concentrate mixture was 25 kg wheat bran, 25 kg rice bran, 15 kg crushed maize, 15 kg soybean meal, 19 kg mustard oil cake, 0.1 kg vitamin-mineral premix, and 1kg salt. The

chemical composition of the concentrate mixture was 18% CP and 13MJ ME /kg dry matter (DM). All goats were housed in a tin shed with having cement floor and cemented wall raised above the ground with sufficient space to keep them comfortable. Kids were kept with their mothers. Wheat bran, rice bran, crushed maize, soybean meal, and mustard oil cake were purchased from the local market. Chemical analysis of the feed sample was done in the Animal Nutrition Laboratory following the methods of (AOAC, 1990).

Two goats from each group were randomly selected for the digestibility trial. For five consecutive days, the diet samples were collected through the hand pickling method, while the fecal samples were collected from the rectum at 08.00 hr. Subsequently, samples were properly mixed and pooled for five days' collection period for individual goats. The IVDMD of all the diet samples was estimated by the method of (Tilley and Terry, 1963). The fecal outgo was estimated by the following formula, and subsequently, the digestibility was calculated. The faecal outgo (g DM/day) =Intake (g DM/day) × (100- IVDMD)

The metabolizable energy (ME) intake was calculated as MEI=OMI (g)×19×0.82 (ARC, 1980). The weight of animals was taken after 15 days of the whole study period. Digital weighing balance was used for measuring weight. The birth weight of kids was measured within one hour after birth. Data on reproductive performance, including the number of services per pregnancy, gestation length, litter size, birth weight of kids, postpartum ewe weight, and placenta weight, were recorded. Data were compiled, tabulated, and analyzed using a statistical package for social sciences (SPSS 11.5). The least significant difference (LSD) tests were performed for comparison with SPSS (version 11.5).

RESULTS AND DISCUSSION

Chemical composition of feed

Table 1 shows the proximate composition of the feed ingredients used in different diets (% on a dry matter basis). Protein, fat, fiber and ash content of wheat bran and rice bran is 12%, 5.4%, 14.0%, 6.0% and 11.7%, 18%,8.6%, 8.5%, respectively. Hanis-Syazwani et al. (2018) and Sehgalet et al. (2018) mentioned the crude protein, ether extract, ash, and crude fiber content of maize bran is 9.2%, 2.3%, 9.7%, and 28.2%, respectively. Mustard oilcake contains91.42% dry matter, 30.12% crude protein, 5.98% crude fiber, 9.29% ether extract, 6.73% ash, and 37.39% NFE (Sharma, 2013). Joch et al. (2019) observed the dry matter, crude protein, ether extract, and ash content of Soybean meal is 87.4%, 49.6%, 2.2%, and 7.7%, respectively.

The dry matter content of Napier, German grass is 24.3%, 23.9%, and crude protein content is 8.7% and 8.3% (Misbah, 2007). Mahfuz (2017) found that German grass contains 15.9% dry matter and 8.5% crude protein. Our findings are more or less similar with the above findings.

Table 1. Chemical composition of feed

Feed	DM	g/100g DM				
		CP	CF	EE	TA	NFE
Wheat bran	87.0±1.8	15.3±1.2	12.2±0.5	3.6±1.1	4.8±1.2	64.1±1.2
Rice bran	89.4± 1.2	11.3±1.5	17.2±0.6	13.5±1.3	11.8±1.1	46.2±1.2
Crushed Maize	87.3±2.6	10.7±1.2	14.6±0.7	5.1±0.9	4.9±1.5	64.7±1.2
Mustard oil cake	89.0±3.3	33.7±1.6	4.7±0.7	8.9±0.8	7.8±1.7	44.9±1.5
Soybean meal	87.4±3.2	49.3±1.1	5.8±0.6	2.1±0.9	6.8±1.3	36.0±1.1
Napier grass	24.8±5.1	8.9±1.7	37.2±0.8	1.8±1.1	14.2±1.8	37.9±0.9
German grass	17.9±3.6	9.8±1.6	34.2±0.4	3.4±0.8	10.3±1.4	42.3±1.4
Roadside grass	21.1±4.1	10.9±1.4	21.4±0.8	2.3±1.5	8.9±1.1	56.5±1.1

Legends: DM= Dry matter, CP= Crude protein, CF= Crude fiber, EE= Ether Extract, TA= Total ash, NFE= Nitrogen free extract

Intake and digestibility of feed

Concentrate mixture significantly ($p<0.01$) increased dry matter (DM) intake (413.2, 456.67, 489.2 and 495.7 g/day, respectively, in groups (Table 2). Average digestible crude protein (DCP) intake (3.1, 3.5, 3.9, and 4.2g/kg BW) was significantly higher in the T4 group than in group T1. Total dry matter (DM) and crude protein (CP) intake was significantly

(p<0.01) influenced by the level of concentrate in the diet (Sultana et al., 2012). The present findings correspond well with this observation. Srivastava and Sharma (1998) mentioned the DM, OM, CP, CF, EE and NFE digestibility of Jamunapari goat is 71.9%, 75.5%, 74.3%, 68.0%, 65.5% and 74.0% which is almost similar with our findings. Concentrate mixture supplementation improves nutrient digestibility (Mc Donald et al., 1988).

Nutrient digestibility significantly (p<0.01) improved by different concentrate supplementation in diet (Chaturvedi et al., 2003). In our findings, the digestibility percent of DM, OM, CP, CF, EE and NFE was significantly (p<0.01) improved by the increased level of concentrate mixture in the diet.

Table 2. Intake and digestibility of feed

Parameter	T1	T2	T3	T4	SED	Level of significance
1st Body weight (kg)	10.5	10.6	10.4	10.7	0.2	NS
Final body weight kg	16.7	17.8	18.1	19.0	0.5	NS
Live weight gain kg	6.2	7.2	7.7	8.3	0.5	NS
Daily weight gain g/d	39.34^{d}	40.2^{c}	43.1^{b}	45.6^{a}	0.4	**
DMI (g/day)	413.2^{d}	456.67^{c}	489.2^{b}	495.7^{a}	0.6	**
DMI kg/100kg BW	3.30^{d}	3.43^{b}	3.48^{b}	3.52^{a}	0.1	**
Av DCP intake g/kg BW	3.1^{c}	3.5^{b}	3.9^{b}	4.2^{a}	0.3	**
AV TDN intake g/kg BW	21.1^{d}	22.3^{c}	24.7^{b}	25.1^{a}	0.4	**
Nutrient digestibility (%)						
Dry matter	70.1^{d}	73.14^{c}	75.45^{b}	79.56^{a}	1.61	**
Organic matter	75.99^{d}	76.97^{c}	78.44^{b}	80.16^{a}	1.83	**
Crude protein	73.50^{d}	76.84^{c}	78.67^{b}	81.69^{a}	2.01	**
Crude fiber	67.24^{d}	68.32^{c}	69.43^{b}	71.45^{a}	0.91	**
Ether extract	62.13^{d}	64.04^{c}	68.43^{b}	70.82^{a}	1.60	**
Nitrogen free extract	69.60^{d}	71.25^{d}	73.77^{b}	76.09^{a}	0.8	**

Growth performance of goat

Table -3 shows the growth performance of kids with different concentrate levels. The growth rate did not differ significantly from the diet, which supports the findings of (Sultana et al., 2012). They observed that the growth rate did not vary significantly by the level of concentrate mixture. Concentrate supplementation increased feed intake of does, live weight gain of kids in the first month, and milk yield of does. Hassan et al. (2010) reported that Jamunapari weighed about 1.6 kg at birth, 7.9 kg at three months, and 21.4 kg at 12 months which are almost similar to our findings.

Patnaik and Nayak (1988) found the birth weight was 2.3kg and after three months 9.4kg, which is slightly higher than our observations. Kabir et al. (2002b) found a higher daily growth rate (62.4g/day) in kids which received the high protein diet (16% CP) than those fed the low protein diet (10% CP; 45.4g/day). Kochapakdee et al. (1994) reported that the Thai female growing goats received concentrate diet (0.75% BW) gained 36g/day while goats on control diet (grazing only) gained 14 g/day. Bhuiyan et al. (1996) suggested that a higher level of concentrate supplementation increased the daily live weight gain of kids. Similarly, Sharma and Ogra (1990) stated that supplementation of concentrate feed significantly (p<0.05) improved total DM intake, growth rate, and FCR of kids. The semi-intensive group will achieve higher weight gains when compared to the extensive group due to the provision of concentrate feed along with 4 hours of grazing and lesser time exposure to environmental stress. The extensive group will achieve comparatively lower weight gains than other rearing systems. Higher body weight gains for the lambs reared under semi-intensive and intensive system of feeding when compared to the extensive system (Porwal et al., 2005). Carvalho et al. (2007) observed the more quantity of roughage and less concentrate feed in the diets lowers the live weight gain.

Table 3. Growth performance of kids

Body weight (kg)	T1	T2	T3	T4	Level of significance
Birth weight	1.4±1.6	1.6±1.2	1.5±1.5	1.3±1.8	NS
30 days	2.3±1.2	2.6±1.5	3.1±1.1	3.8±1.4	NS
45 days	4.0±1.7	4.3±1.2	4.7±1.3	4.9±1.1	NS
60 days	5.0±2.3	5.1±2.8	5.5±2.1	5.3±2.6	NS
75 days	5.6±1.1	5.9±1.6	6.2±1.9	6.8±1.0	NS
90 days	7.4±2.8	7.7±2.5	7.9±2.6	8.1 ±2.9	NS
105 days	8.2±0.5	8.6±1.1	8.9±1.4	9.0±1.6	NS
120 days	9.2±3.5	9.6±3.2	9.9±3.0	10.2±3.8	NS

NS, non-significant at 5% level of probability

Production performances of goat

Milk yield increased significantly ($p<0.01$) with the increased level of concentrate mixture (Table- 4). Average milk yields were 524.3, 530.82, 547.27, and 558.15 ml/day for groups T1, T2, T3, and T4, respectively, which support the findings of (Sultana et al., 2012). They observed that increased level of concentrate supplementation significantly ($p<0.01$) improve milk yields. Chowdhury et al. (2002) found that the average milk yield of Black Bengal does was 334g/day when fed (200-300) g concentrate per day. Milk production was not significantly affected by the forage-to-concentrate ratio (75: 25, 60: 40, and 45: 55) but tended to increase with an increase in concentrate feeding (Kawas et al., 1991). Giger-Reverdin and Sauvant (1991) suggested that milk composition and yield are influenced by the type of forage but not by the type of concentrate.

Table 4. Milk production of Jamunapari doe

Months	Milk production (ml/day)				Level of significance
	T1	T2	T3	T4	
1st month	573.6 ± 51.6	585.6 ± 41.6	610.6 ± 61.6	623.6 ± 78.6	**
2nd month	606.6 ± 19.1	621.10±24.1	635.12±18.1	641.02±26.5	**
3rd month	581.3 ±24.3	591.11±31.5	601.23± 26.4	612.11±32.5	**
4th month	485.3 ± 17.6	502.15± 25.3	525.24± 21.2	540.29±24.8	**
5th month	304.4 ± 19.2	354.14± 26.3	364.16±15.6	373.34±20.5	**
Average	524.3 ± 26.36	530.82±29.76	547.27±28.58	558.15±36.58	**

Reproductive performance of goat

Table-5 represents the reproductive characteristics of the doe with different concentrate levels under semi-intensive conditions. The reproductive character did not differ significantly between groups by the level of concentrate in the diet, which is similar to the findings of (Sultana et al., 2012). Hassan et al. (2010) observed the age of 1st kidding and 1st heat of Jamunapari doe is 548.6 days and 354.7days. Gestation length is 152.8 days, and the number of services per pregnancy is 1.3, which is almost similar to our present findings. Rout *et al.,* 1999 reported kidding interval was 229.3 days, which is similar to this finding. Due to long lactation, the kidding interval of 210.6 days was longer than in Black Bengal goats 179 days as reported by Hassan *et al.,* 2007. Under farming conditions in India, Rout et al. (1999) reported that the age at first kidding was 737.0 days which is much higher than our findings. The Jamunapari goats attained sexual maturity earlier in Bangladesh. Rout et al. (1999) reported kidding interval was 229.3 days, which is slightly higher than the present findings.

Table 5. Reproductive performance of Jamunapari doe

Parameter	T1	T2	T3	T4	Level of significance
Age of 1st kidding (days)	545.41±0.2	551.25±0.3	548.60±0.2	550.21±0.3	NS
Gestation length (days)	157.34±8.4	154.28±7.2	149.51±6.1	158.28±7.1	NS
Age at1st heat (days)	358±1.4	357±1.8	349±1.4	347±1.7	NS
Birth weight of kids (kg)	1.4±0.03	1.7±0.07	1.5±0.09	1.6±0.07	NS
Litter size	1.2±0.1	1.3±0.3	1.4±0.1	1.2±0.1	NS
kidding interval (days)	212.5±3.0	216±3.01	215±3.0	218±3.05	NS
No. of service per pregnancy	1.32±0.6	1.31±0.4	1.30±0.3	1.34±0.2	NS
Weight of placenta (g)	341.4±12.3	345.21±15.6	343.14±11.5	342.5±13.7	NS

NS= Non significant

CONCLUSION

Only green grass does not fulfill the nutrient requirements. Concentrate supplementation linearly improves the intake, digestibility of nutrients, and milk production of Jamunapari goat. Feeding of concentrate mixture also increased live weight gains of kids. The daily supplementation of concentrate mixture to goat with roughage feeding and supplying fresh drinking water recommended for optimizing growth performance of Jamunapari goat under semi-intensive rearing system in Bangladesh.

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CONFLICT OF INTEREST

There is no conflict of interest in this study.

REFERENCES

1. AOAC, 1990. Official methods of analysis, 15th (edn). Association of Official Analytical Chemists, Washington D C.
2. ARC, 1980. The Nutrient Requirements of Ruminant Livestock. Agriculture Research Council Supplement (1) pp. 78–80. Slough, U K: Commonwealth Agriculture Bureaux.
3. Akhter S, SS Husain, SA Chowdhury, MM Munzur and & GK Dev, 2006. Estimation of variance components and prediction of breeding value for some economically important traits of Black Bengal goat. Bangladesh Journal of Animal Science, 35: 20-26.
4. BER, 2012. Bangladesh Economic Review, Finance Division, Ministry of Finance, Government of the Peoples' Republic of Bangladesh.
5. BBS, 2016. Bangladesh Bureau of statistics, Ministry of Planning, Government of the Peoples' Republic of Bangladesh.
6. Bhuiyan R, KK Baruah and PC Das, 1996. Growth Response and Carcass Characteristics of Crossbred Kids Fed Ration Having Different Concentrate to Roughage Rations. Indian Journal of Animal Nutrition, 13:167-169.
7. Choudhury MP, SC Sarker, F Islam, A Ali, AKFH Bhuiyan, MNM Ibrahim and AM Okeyo, 2012. Morphometry and performance of Black Bengal goats at the rural community level in Bangladesh. Bangladesh Journal of Animal Sciences, 41(2), pp. 83-89.

8. Carnicella D, MD Maria, CC Ayres, V Laudadio and C Dario, 2008: The effect of diet, parity, year and number of kids on milk yield and milk composition in Maltese goat. Small Ruminant Research, 77: 71-74.
9. Chaturvedi OH, R Bhatta, A Santra, AS Mishra and JS Mann, 2003. Effect of supplementary feeding of concentrate on nutrient utilization and production performance of ewes grazing on community rangeland during late gestation and early lactation. Asian-australasian Journal of Animal Sciences, 16(7), pp. 983-987.
10. Chowdhury SA, MSA Bhuiyan and S Faruk, 2002. Rearing Black Bengal goat under semi-intensive management 1. Physiological and reproductive performances. Asian-Australasian Journal of Animal Sciences, 15(4), pp. 477-484.
11. Carvalho S, MA Brochier, J Pivato, A Vergueiro, RC Teixeira and R Kieling, 2007. Performance and economic evaluation of the feeding of feedlot lambs with diets with different roughage: concentrate ratios. Ciencia Rural, 37(5), pp.1411-1417.
12. DLS, 2017. Department of Livestock Service, Annual report on livestock in Bangladesh, Division of Livestock Statistics, Directorate of Livestock Services, Ministry of Livestock and Fisheries, Government of Peoples' Republic of Bangladesh, Dhaka.
13. DLS, 2011. Department of Livestock Services. Ministry of Fisheries and Livestock. Government of the Peoples' Republic of Bangladesh.
14. FAO, 2010 Food and agriculture organization of the United Nations statistical databases. See http://faostat.fao.org/.
15. Faruque MO and MAMY Khandoker, 2007: Recent advances of goat genotyping in Bangladesh. In: Workshop on recent advances of livestock genotyping in Bangladesh. Genotyping of goats and buffaloes for breed and type determination. 10 May, Dhaka, Bangladesh, pp. 28-40.
16. Giger-Reverdin S and D Sauvant, 1991. Evaluation and utilization of concentrates in goats. In *Goat nutrition* (pp. 172-183). EAAP, Wageningen.
17. Hanis-Syazwani M, IF Bolarinwa, O Lasekan and K Muhammad, 2018. Influence of starter culture on the physicochemical properties of rice bran sourdough and physical quality of sourdough bread. Food Research, 2(4), pp. 340-349.
18. Hassan MM, SN Mahmud, SA Islam and OF Miazi, 2007. A comparative study on reproductive performance and productivity of the Black Bengal and Crossbred goat at Atrai, Bangladesh. University Journal of Zoology, Rajshahi University, 26, pp. 55-57.
19. Hassan MR, MAI Talukder and S Sultana, 2010. Evaluation of the production characteristics of the Jamunapari goat and its adaptability to farm conditions in Bangladesh. Bangladesh Veterinarian, 27(1), pp. 26-35.
20. Joch M, V Kudrna, J Hakl, M Božik, P Homolka, J Illek, Y Tyrolová and A Výborná, 2019. In vitro and in vivo potential of a blend of essential oil compounds to improve rumen fermentation and performance of dairy cows. Animal Feed Science and Technology, 251, pp. 176-186.
21. Kawas JR, J Lopes, DL Danelon and CD Lu, 1991. Influence of forage-to-concentrate ratios on intake, digestibility, chewing and milk production of dairy goats. Small Ruminant Research, 4(1), pp. 11-18.
22. Kabir F, M Sahjalal, SA Chowdhury, J Alam and MR Islam, 2002b: Effect of protein supplementation to grazing on growth and reproductive performance in female goats and sheep. Pakistan Journal of Biological Science, 5:719-721.
23. Kochapakdee S, W Pralomkarn, S Saithanoo, A Lawpetchara and BW Norton, 1994. Grazing management studies with Thai Goats II. Reproductive performances of different genotypes of does grazing improved pasture with or without concentrate supplementation. Asian-Australasian Journal of Animal Sciences, 7(4), pp. 563-570.
24. Misbah UA, 2007. Study on the productive and reproductive performance of Black Bengal goat under improved management and feeding "pusti" (Doctoral dissertation, MS Thesis, Department of Animal Nutrition, Faculty of Animal Husbandry, Bangladesh Agricultural University, Mymensingh, Bangladesh).
25. Mahfuz SU, MS Islam, MR Chowdhury, S Islam, MK Hasan and MN Uddin, 2017. Influence of concentrate supplementation on production and reproduction performance of female Black Bengal goat. Indian Journal of Animal Research, 52(5), pp. 735-39.
26. Mc Donald P, RA Edwards and JFD Greenhalgh, 1988. Animal Nutrition. 5th (Edn). Longman Scientific and Technical, Group UK Limited, Longman House, Burnt Mill, Harlow, Essex CM20 2JE, England.
27. Patnaik RK and S Nayak, 1988. Growth rate and survivability patterns in Black Bengal, Ganjam and Jamunapari breeds of goats under farm conditions in Orissa. Indian Journal of Animal Sciences, 58:1442-1445.
28. Porwal K, SA Karim, A Agrawal and VK Singh, 2005. Blood biochemical profile of lambs maintained under different system of feeding management. The Indian Journal of Small Ruminants, 11(2), pp. 166-171.
29. Report, Final Report. Network Project on Survey, Evaluation and Characterization of jamunapari goat, 2003.
30. Rawat SK, R Gupta, SC Singh and S Dwivedi, 2015. Growth rate and survivability patterns in Jamunapari breeds of goats under farm conditions in Mahoba district of Bundelkhand region. Economic affairs, 60(1), pp. 165-169.

31. Rout PK, A Mandal, R Roy and LB Singh, 1999. Improvement and conservation of Jamunapari goats in their home tract. India Ministry of Agriculture Report, New Dehli.
32. Sehgal JP, A Dey and S Kant, 2018. Developing feeding module for increasing milk production in Murrah buffaloes (Bubalusbubalis). Buffalo Bulletin, 37(1), pp. 45-50.
33. Sharma NK, 2013. Chemical composition of oilseed cakes and deoiled cakes in Nepal. Online Journal of Animal and Feed Research (OJAFR), 3(1), pp. 74-76.
34. Sultana S, MJ Khan, MR Hassan and MAMY Khondoker, 2012. Effects of concentrate supplementation on growth, reproduction and milk yield of Black Bengal goats (Capra hircus). Bangladesh Veterinarian, 29(1), pp. 7-16.
35. Srivastava SNL and K Sharma, 1998. Feed intake, nutrient utilization and growth rate of Jamunapari goats fed sundried Leucaenaleucocephala. Asian-Australasian Journal of Animal Sciences, 11(4), pp. 337-343.
36. Sharma K and JL Ogra, 1990. Growth rate and feed conversion efficiency of Barbari kids fed khejri (Prosopis cineraria) leaves with different levels of concentrate. Indian Veterinary Journal, 67(3), pp. 252-254.
37. Tilley JMA and DR Terry, 1963. A two-stage technique for the in vitro digestion of forage crops. Grass and Forage Science, 18(2), pp. 104-111.
38. Tiwari R, D Katheria and A Singh, 2016. Feeding management of Jamunapari goats in the ravine region of Uttar Pradesh. Indian Journal of Small Ruminants (The), 22(2), pp. 272-274.