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CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF BROCCOLI CROP RESIDUE IN GOATS

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SUMMARY

The broccoli crop residue was analzsed for proximate nutrients, cell wall constituents and mineral and its feeding value was asseseed in goats in the Dept. of Animal Nutrition.The crop residue on DM basis contained 94.22 per cent organic matter, 27.20 per cent crude protein, 5.12 per cent crude fat, 7.99 per cent crude fibre and 53.91 per cent nitrogen free extracts. The crop residue contained 4.47 per cent calcium and 0.45 per cent phosphorus. A feeding trial of 15 days was conducted on five non-lactating Beetal goats (average body weight 24 kg) after which a metabolism trial of seven days duration was also conducted to assess the nutrients digestibility and balance of nutrients. Animals were maintained on fresh chaffed broccoli plant residue as a sole feed. The total dry matter intake of experimental goats was 624.4 ± 39.9 g/day which was worked out to be 2.67 per cent of body weight. Thus, broccoli was highly palatable to the goats but its consumption was limited due to high moisture content. The digestibility coefficients (%) of different proximate nutrients i. e. DM, OM, CP, EE, CF and NFE were 83.7±0.65, 84.04± 0.62, 87.84± 0.53, 87.08± 0.31, 69.64± 0.99 and 83.84± 0.78, respectively. It was found to contain 23.96 per cent DCP and 87.20 per cent TDN. All the animals maintained their body weight and were in positive nitrogen, calcium and phosphorus balance. The results of the study showed that broccoli crop residue was a very nutritious fodder and it could be utilized as a sole feed for small ruminants.

Key words : Broccoli crop residue, Beetal goats, nutrient composition, nutrient balance

India has one of the largest livestock populations in the world and the total livestock population in the country is 512.05 million in which 135.17 million are goats (GOI, 2012). In the developing countries, goats make a very valuable contribution, especially to the poor in the rural areas. One of its notable characteristics is that almost its entire feed requirement is met from crop residues and byproducts; grasses, weeds and tree leaves gathered from cultivated and uncultivated lands; and grazing on common lands and harvested fields. The paucity of quality feeds during lean periods has directed research efforts towards exploring feeding value of fruits and vegetable crop residues. These residues can provide a sizeable contribution towards feed supply for small ruminants. India is the second largest producer of fruits and vegetables in the world and its organized sector generates approximately 1.81 million tonnes of fruit and vegetable wastes. One of promising vegetable crops is broccoli. Broccoli is a cool-season crop and it is rich in minerals, vitamins, and anti-oxidants. India is 2nd largest producer of broccoli and cauliflower with a total production of 7.88 MT (FAOSTAT, 2015). Harvested production of open field broccoli in the European Union (EU) in 2012 was 2249 thousand tonne. While, N content of broccoli was 76-304 kg N/ha (Bakker *et al.*, 2009). Broccoli is a popular vegetable because of its attractive green colour and high nutritional value (Martínez-Villaluenga *et al.*, 2008). Broccoli is an excellent source of many phyto-nutrients such as thiocyanates, indoles and flavonoids besides highly rich in vitamin C. Yi *et al.* (2008) found that broccoli byproducts were possibly a suitable non-conventional feedstuffs to replace concentrates because of their high protein content and low cost. They found little effect on *in vitro* gas production (GP) and ruminal fermentation in ruminant diets after replacing soybean meal with pelletized broccoli residues.Use of such residues from agricultural products as animal feed will not only enhance food security but also contribute to alleviation of environmental problems associated with their disposal. Thus, present work was undertaken to evaluate the chemical composition and feeding value of Broccoli crop residues in goats.

MATERIALS AND METHODS

The experiment was conducted at the animal farm. Five non-lactating female Beetal goats having average body weight of 24 kg were maintained on fresh chaffed broccoli crop residue as a sole feed. All the animals were housed in semi-open sheds having facilities for individual feeding and watering.

Analytical Methods of Proximate Analysis

These analyses show the moisture, crude protein, crude lipids, ash and carbohydrate content of the sample.

Determination of Moisture

Moisture contents in the feed were determined by AOAC (2007). The percentage of the moisture content in the sample was calculated by the following formulae : % of moisture = [Weight of original sample – Weight of dried sample) / Weight of original sample] ×100.

Determination of Ash

Ash content of each feed was estimated by following incineration method (Maynard, 1970). Calculation: % of ash= (weight of ash ÷ weight of sample) × 100

Determination of Crude Protein

Micro Kjeldhal method (Crampton and Harris. 1969; Mitchell, 1972 ; Jacobs, 1973; Pearson *et al*., 1977) as used to determine the crude protein. Calculation: % Nitrogen= (Value of HCl×0.1×0.014/ weight of sample)×100% of Crude Protein = % Nitrogen × Conversion factor (Conversion factor for animal and plant origin was 6.25 & 5.90, respectively).

Determination of Crude lipid Fat is examined with low boiling organic solvent (petroleum ether/ diethyl ether, xylem) by soxhlet extraction and the extract thus obtained weighed after recovery of the solvent. Crude fat was determined through Soxhlet extraction technique (Maynard, 1970; Mitchell, 1972) using hexane (65ºC-70ºC) as the solvent.

Digestibility and Nitrogen Balance Trial

After a feeding trial of 15 days, a digestibility and nitrogen balance trial of seven days duration was conducted. During the trial, the goats were placed in individual metabolic cages (L=1.2 m, W=0.76 m and H= 0.9 m elevated by 0.6 m from the ground) having the provision to collect feces and urine separately. Animals were given 15 days to adjust and during this period voluntary dry matter intake (DMI) was recorded. Thereafter, a five days collection period was given at which the goats were fed 90% of their voluntary DMI. Daily feed offered, orts and faeces voided were measured, sub-sampled, composited and stored at 5°C for subsequent analysis. Urine was collected in plastic bottles containing 50 ml 3 N HCl to prevent nitrogen losses. Daily urine output was measured and immediately analyzed for total nitrogen (AOAC, 2007). Representative samples of feed, orts and feces were analyzed for DM, CP and CF according to AOAC (2007). The samples of feed offered, residue left and feaces were analyzed for proximate nutrients (AOAC, 2007) and cell wall constituents (Goering and Van Soest, 1970).

RESULTS AND DISCUSSION

Broccoli crop residue contained 27.2 per cent crude protein, 5.12 per cent ether extract and 7.99 % crude fibre (Fig.1). Broccoli had high crude protein (27.2 %) and low crude fibre (7.99%) content which made its nutritive value much higher than other traditional fodder crops like berseem which contained 17 per cent crude protein and 25.9 per cent crude fibre. While lucerne contains 18-22 per cent crude protein and 25-35 per cent crude fibre; and oat contain 7-9 per cent Crude protein (NDDB, 2012). Mineral content in broccoli crop residue in terms of calcium and phosphorus noticed was 4.45 and 0.47 per cent, respectively (Table 1). The calcium content in broccoli residue was higher than that of the traditional fodder crops. The values for proximate nutrients observed in present study are higher than those reported earlier (Tewatia *et al*., 2010), which may be due to difference in crop variety, stage of harvesting and proportion of leaves in the crop residue.

The cell wall constituents in terms of NDF, ADF and cellulose content (on dry matter basis) were 24.3 per cent, 21.9 per cent and 18.1 per cent, respectively (Fig. 2). Another Brassica sp. vegetable, cauliflower crop residue was reported (Khan and Atreja, 2001) to contain 22 to 25 percent protein, 3.4-7.1 percent EE and 11.9-13.7 percent CF. Broccoli can replace some of the soyabean and corn in the ration of

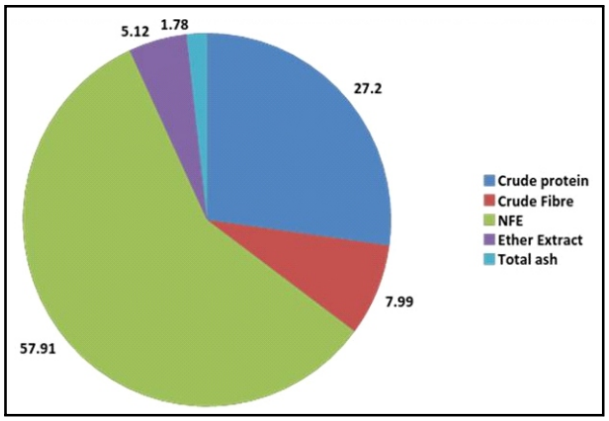

Fig. 1. Proximate nutrients composition of broccoli crop residue (% DM basis).

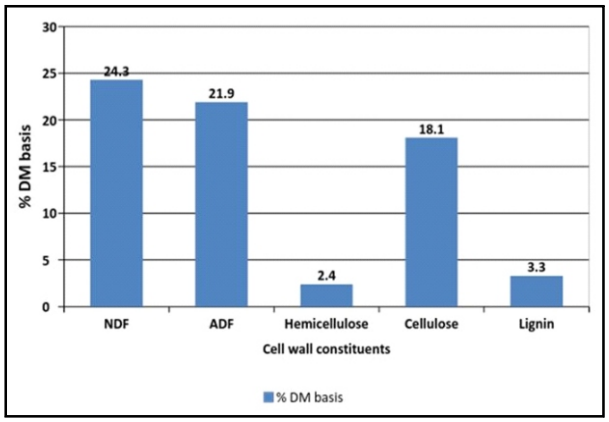

Fig. 2. Cell wall constituents of broccoli crop residue (% DM basis).

TABLE 1
Chemical composition of broccoli crop residue

Parameters	Composition (% DM basis)
Dry matter	12.06
Organic matter	94.22
Crude protein	27.20
Ether extract	5.12
Crude fibre	7.99
NFE	57.91
NDF	24.3
ADF	21.9
Hemicellulose	2.40
Cellulose	18.10
Lignin	3.30
Calcium	4.45
Phosphorus	0.47

TABLE 2
Feed intake, nutrients digestibility and nutritive value in experimental goats fed broccoli crop residue

Parameters	
Dry matter intake	
Total (g/day)	624.4±39.9
% Body weight	2.67±0.10
Nutrients digestibility (%)	
Dry matter	83.72±0.65
Organic matter	84.04±0.62
Crude protein	87.84±0.53
Ether extract	87.08±0.31
Crude fibre	69.64±0.99
NFE	83.84±0.78
Nutritive value (%)	
DCP	23.96 ±0.20
TDN	87.20±0.57

animals as the by-product evaluation of broccoli using Petersen's equations has shown that broccoli has SOYA ratio and CORN ratio of 0.0701 and 0.0325, respectively, while the feed value is $26.99 (Wright and Lackey, 2003). Dry matter intake by the experimental goats was 624.4 g/day, which accounts to 2.67 % of the body weight of the animals (Table 2), indicating that broccoli crop residue was as palatable as any other green fodder like berseem. The digestibility (%) of nutrients viz., dry matter, organic matter, EE and NFE were 83.72 ± 0.65, 84.04 ± 0.62, 87.08 ± 0.31 and 83.38 ± 0.78, respectively (Table 2).

Nutrients intake (%) in terms of DCP and TDN was 23.96 and 87.20.The nutrient requirement for maintenance of these experimental goats worked out to be 37 g DCP and 337 g TDN per day (ICAR, 2013). Nutrients supplied (g/day) by broccoli residue in the present experiment were 150 g DCP and 545 g TDN, which were sufficient to fulfil even the growth requirements (71 g/d DCP and 498 g/d TDN) of goats growing at the rate of 100 g/d (ICAR, 2013). Replacing concentrate with 20 per cent pelletized broccoli byproducts (PBB) had no adverse effects on rumen fermentation, but increased milk production numerically, and increased milk fat content significantly in lactating dairy cows (Yi *et al*., 2015). Cabbage and cauliflower leaves were also reported (Wadhwa *et al*., 2005) as excellent source of nutrients for goats for economizing animal production. The nutrients balance (g/day) in terms of nitrogen, calcium and phosphorus was recorded as 11.70±0.25, 12.94±0.67 and 0.61±0.05, respectively (Table 3). Because broccoli is rich in protein, vitamins and phenolics (Martínez-Villaluenga *et al*., 2008), utilization of pelletized broccoli byproducts (PBB) as a source of concentrates for livestock may be beneficial to both animal production and the environment. Thus, the results of the present study lead us to conclude that broccoli crop residue can successfully sustain the growth of small ruminants especially goats without supplementing concentrate mixture.

TABLE 3
Nutrients balance in Beetal goats fed broccoli crop residue

Nutrients balance (g/day)	
Nitrogen	
Intake	27.99±1.12
Feacal	3.30±0.38
Urinary	12.83±0.68
Balance	11.70±0.25
Nitrogen retained (% of intake)	42.05±0.68
Nitrogen absorbed (% of intake)	57.24±0.94
Calcium	
Intake	34.02±1.73
Feacal	11.88±1.25
Urinary	9.20±0.46
Balance	12.94±0.67
Calcium retained (% of intake)	38.03±1.2
Calcium absorbed (% of intake)	61.31±0.79
Phosphorus	
Intake	2.84±0.22
Feacal	1.34±0.14
Urinary	0.89±0.08
Balance	0.61±0.05
Phosphorus retained (% of intake)	21.47±0.13
Phosphorus absorbed (% of intake)	78.19±0.16

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