International Journal of Zoology and Applied Biosciences **ISSN: 2455-9571**
Volume 7, Issue 5, pp: 1- 6, 2022
https://doi.org/10.55126/ijzab.2022.v07.i05.001
http://www.ijzab.com

Research Article

EFFECT OF FIBRE FRACTIONS OF *AILANTHUS EXCELSA* ROXB. ON *IN-VITRO* DRY MATTER DIGESTIBILITY(IVDMD) AND METABOLISABLE ENERGY

Sumathi R, Brindha B, Suresh Babu D, Murugesan S and Senthilkumar N*

Chemistry and Bioprospecting Division, Institute of Forest Genetics and Tree Breeding, Coimbatore.

Article History: Received 15th June 2022; Accepted 22nd August 2022; Published 11th September 2022

ABSTRACT

Forages usually constitute the major portion of the ruminant feeds in our country. Availability of feed containing imbalanced chemical composition and metabolisable energy is major handicap in ruminant production the world over. The present study aimed to evaluate the fibre fractions of *Ailanthus excels* Roxb. fast growing multipurpose indigenous tree species used as cattle fodder as the leaves are rated as highly palatable and nourishing with high percentage of crude protein. The fiber fractions i.e. Neutral Detergent Fibre (NDF), Acid Detergent Fiber (ADF), Acid Detergent Lignin (ADL) values were measured for *Ailanthus excels* Roxb. leaves and observed that AD Fvaried from 0.91% to 74 %and the average was recorded as 48.93 ± 8.36 %, NDF ranged from 28.49 % to 94.77 % with an average of 5.6± 0.97 % and recorded the minimum of 0.2% to the maximum of 17.5 % of ADL value. Low or high NDF value indicate the dry matter digestibility and dry matter intake that will result in a decrease or increase in livestock consumption. Hemicellulose and cellulose, the slowly digestible fibre materials present in the cell wall ranged from 1.72 to 82.5 % and 0.45 to 96.72 % respectively. The digestibility of the *A.excelsa* leaves was tested for 24 hrs and 48 hrs were observed that almost all accessions showed digestibility greater than 50%.Metabolizable energy (ME) and Total Digestible Nutrients (TDN) are the other two energy requirement of cattle other than IVDMD and ME observed to be more than 8.23(MJ/Kg DM) for all the accessions and TDN value more than 40 %. Though fodder is nutrient treasure, the IVDMD decides the nutrient intake by the cattle. With the desirable fibre fraction and promising IVDMD and metabolizable energy values of *A. excel* accessions can be an alternate tree fodder for cattle during lean period.

Keywords: *Ailanthus excelsa*, Hemicellulose, IVDMD, Cattle feed, Metabolizable energy, Livestock, Ruminant.

INTRODUCTION

Livestock offers enormous opportunities to improve people's livelihoods and nation's gross domestic product. India has vast livestock resources which plays a vital role in Indian economy. It ensures the income of millions of landless and small farm households especially securing livelihood of economically poor communities from sales of various products and acts as a form of insurance against crisis times. It provides livelihood to two-third of rural community also employment to about 8.8% of the population in India. Over the last three decades, livestock populations have risen by 31% while the extent of permanent pasture land available for grazing has declined by 26% even though two-thirds of India's wildlife reserves are grazed by livestock. Several states of India have been facing problems to sustain large livestock population due to inadequate fodder. India has a great livestock wealth, and a substantial fodder requirement of livestock is met through a variety of grazing lands namely, forests, miscellaneous tree crops, groves and culturable waste lands. In a wide range of farming systems, fodder trees are important feed sources for livestock. However, changing land use patterns, urbanization and other factors have now reduced the availability of land for livestock production and therefore, supply of feed and fodder for livestock production needs to be carefully evaluated. During unfavorable season, one potential way for increasing the quality and availability of feeds for smallholder ruminant animals may be through the

*Corresponding Author: Dr. N. Senthilkumar, Chemistry and Bioprospecting Division, Institute of Forest Genetics and Tree Breeding, Coimbatore., Email: senthilnk@icfre.org

use of multipurpose trees and shrub legumes. Use of such indigenous multipurpose fodder trees would be considered as good alternative to curb the problem of feed availability to cattle. For longer period the trees, shrubs and herbs are used as fodder for browsing and grazing animals, particularly in the areas of poor quality pastures due to their nutrition capacity.

Ailanthus excels Roxb.(Simaroubaceae) is one such promising multi-purpose tree species, as an important source of dietary nutrients, alleviate the fodder scarcity and thereby significantly boost the livestock production. The proximate analysis of the leaves of *A.excelsa* provides a potential nutrient rich source for cattle. The anti-metabolites nitrite and most dangerous fungal toxin Aflatoxin was found in non-traceable quantity, thereby the toxicity of the leaf of *A.excelsa* was ruled out. Hence, *A.excelsa* leaves enriched with nutrients, especially with high protein content can be recommended as an efficient fodder for ruminants/cattle (Sumathi*et al*., 2017). Cell wall constituents are good indicators of fiber contents in forages and for predicting nutritional worth of fibrous feed resources. *In-vitro* NDF digestibility dependent on cell wall constituents, especially NDF, ADF and lignin and gives us more accurate estimates of total digestible nutrients (TDN), net energy (NE), and feed intake potential. In general, increased NDF digestibility will result in higher digestible energy and forage intakes. One unit increase of NDF digestibility is associated with 0.37 lb increase in dry matter intake and 0.51 lb increase in milk yield. To overcome the need for an alternate feed enriched with nutrients and essentials components, the thrust arise to search for potential treefodder to feed the livestock, when availability of pasture and vegetation cover is low in the fields. With this the present study aimed to evaluate the cell wall constituents, in vitro dry matter digestibility and the energy matters to identify the potential source of *A.excelsa* as efficient cattle feed.

MATERIALS AND METHODS

Analysis of Fibre Fractions-Cell wall constitutions

Determination of neutral detergent fibre (NDF)

Weighed 1g of sample and added into a conical flask of the refluxing apparatus. 100 ml neutral detergent solution, 2 ml of decalin and 0.5 g sodium sulphite was added and refluxed for 60 minutes, time starting from the onset of boiling. Filtered off the reagent, washed thrice with hot distilled water under vacuum, removed and then washed the crucible with hot water. Washed twice with acetone in same manner and dried using suction pump. The crucible along with sample was dried at 100ºC for 8 hrs and weighed it. The yield is reported as recovered NDF as percent of cell wall constituents (Goering and Van Soest, 1970).

Estimated cell soluble material by subtracting this value from 100: Calculation

(NDF %) = (wt. of crucible + cell wall constituents) – (wt. of crucible)

-------------------------------------- X 100

Wt. of dry sample

Cell contents (%) = 100 – cell wall constituents

Determination of Acid detergent fibre and Acid detergent Lignin (ADF& ADL)

1 g of powdered dry sample was weighed in a beaker and added 100 ml acid detergent solution and 2 ml decalin and refluxed for 60 minutes from onset of boiling. Filtered the residue in a weighed crucible. Washed with hot distilled water 3-4 times followed by acetone until it colour faded away and dried using vacuum. Cooled, 72% H_2SO_4 was added to the obtained residue and allowed the acid to drain away. Later the residue was washed with cold distilled water to remove the acid content then it was vacuum dried and ignited in muffle furnace for 6 hrs at 540°C and cooled using desiccator and weighed.

Calculation

Wt. of crucible with ADF residue – Wt. of empty crucible

% ADF = -- X 100

Wt. of substance

Wt. of crucible and lignin – Wt. of crucible and ash

% ADL = ------------------------------ X 100

Wt. of sample on dry matter basis

Cellulose and Hemicellulose (Rinne*et al*., 1997)

Hemicellulose was calculated as NDF – ADF and cellulose as ADF – ADL

In vitro Dry Matter Digestibility (IVDMD)

2g of plant sample was incubated under anaerobic condition with rumen micro organism for 48 hrs at 39°C followed by acid pepsin digestion for another 24 hrs at 39°C. After the completion of the process the residual plant material was collected and oven dried at 105°C for 12 hrs and obtained the plant material was weighed and calculated to find the digestive capacity of *A. excelsa.*

1- Wt. of dry plant residue – Wt of dry residue from blank

Percentage (%) IVDMD = -------------------- X 100

Dry wt. of original sample

RESULTS AND DISCUSSION

Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and Acid Detergent Lignin (ADL) measures the structural components in plant cells like hemicellulose, cellulose, lignin and pectin. They are the most common measure of fibre used for animal feed analysis and good indicator of forage used as animal feed for livestock. Neutral Detergent Fiber NDF comprehensively measures almost total fiber that is the combination of cellulose, hemicellulose and lignin in forage and ADF is a measure of the plant components in forage. The levels of ADF and NDF are acute since they influence animal productivity and digestion. They are the least digestible by livestock, including cellulose and lignin.NDF is a good indicator of the bulkiness of forage and used to predict the amount of forage intake by the animal which increased the rate of passage of digesta and intestinal bulk (Mertens, 2009). NDF value is inversely proportional to dry matter intake in the animal and as forage matures the digestibility decline more than 40 percentage units. High NDF based diet may have an adverse effect on feed intake of livestock and it varies widely in its digestibility in the rumen. NDF of *A. excelsa* leaf ranged from 28.49 % to 94.77 %. Low or high NDF value indicate the dry matter digestibility and dry matter intake that will result in a decrease or increase in livestock consumption. NDF is one of the common measure of fibre used for animal feed analysis. Chitra and Balasubramanian (2016) reported that the NDF values of Albizia tree leaves varied from 33.72 - 44.25 percent and they recorded the highest and NDF value in *Albizi aprocera* followed by *Albizia lebbeck*, *Albiziagua chapele*, *Albizia saman* and *Albizia falcatariae*.

ADF value measured for *A.excelsa* leaves varied from 0.91% to 97.62 %and the average was recorded as 48.93 ± 8.36 % and the average ADL value was observed to be 5.6± 0.97 % and recorded the minimum of 0.2% to the maximum of 17.5% of ADL value. ADF has adverse effect on digestibility and hence, high ADF concentrations lower the energy of the forage. John (2005) reported that the feed is highly digestible with lower ADF and lower NDF leads to higher intakes. The ADF and NDF were highest with values of 41.00 and 77.10 respectively in the wild grass, which lower the dry matter digestibility and dry matter intake that resulted in a decrease in livestock consumption (Belyea *et al.*, 1993). The same was reported by Amiri *et al*. (2012) in Australian Napier that the presence of lower ADF and NDF values of about 31.95 and 60.84 per cent respectively indicated that less fiber content enhances more digestibility for livestock. ADF and ADL content of foliages varied from 23.25 – 34.87% and 8.25–11.70% respectively in five Albizia tree species namely *Albizia lebbeck*, *Albizia saman*, *Albizia falcatariae*, *Albizia procera* and *Albizia guachapele* comparatively ADF value is lesser and ADL value greater than what recorded in *A.excelsa* (Chitra and Balasubramanian, 2016).Khanal and Subba (2001) stated that high ADL content limits the voluntary intake of feed, digestibility, and nutrient utilization of ruminant animals.

Cellulose and Hemicellulose are the slowly digestible fibre materials present in the cell wall. Hemicellulose, cellulose, and lignin are included in neutral detergent fibre while cellulose and lignin are included in acid detergent fibre. Animals depend on microbial fermentation to reduce these compounds into the compounds which they can use and leaves contain less cellulose and hemicellulose than stem. Higher animals lack the enzymes/chemicals required to hydrolyze hemicellulose and cellulose. *A.excelsa* leaves reported to have hemicellulose ranging from 1.72 to 82.5 % and cellulose ranging from 0.45 to 96.72 %. Hemicellulose content of foliages varied from 7.92–11.91% in *Albizia lebbeck*, *Albizia saman*, *Albizia falcatariae*, *Albizia procera* and *Albizia guachapele* (Chitra and Balasubramanian, 2016).

Table 1. Cell wall constituents of *A. excelsa* leaves**.**

S.No.	Accession No.	ADL %	ADF %	NDF %	Hemicellulose %	Cellulose %
1.	1	0.5±0.07	25.00±0.60	36.12±0.70	11.12±0.29	24.5±0.65
2.	2	1.0±0.19	24.1±0.90	41.48±1.04	17.38±0.46	23.1±0.54
3.	3	8.8±0.04	27.4±1.80	34.56±0.74	7.16±0.42	18.6±0.82
4.	89	1.3±0.12	21.01±1.95	34.25±1.37	13.24±0.46	19.71±0.75
5.	32	0.9±0.11	26.19±1.00	37.1±0.57	10.91±0.74	25.29±0.65
6.	33	1.0±0.08	15.76±1.26	50.52±1.37	34.76±0.68	14.76±0.60
7.	5	1.4±0.09	25.41±0.30	42.31±0.35	16.90±0.48	24.01±0.87
8.	6	0.8±0.09	22.89±0.40	30.6±0.53	7.71±0.28	22.09±0.63
9.	7	2.8±0.1	22.42±0.80	46.87±1.45	24.45±0.53	19.62±0.80
10.	8	1.2±0.22	22.40±0.85	59.31±0.11	36.91±0.51	21.2±1.22
11.	9	5.6±0.09	27.82±2.40	61.35±0.62	33.53±0.32	22.22±0.50
12.	10	0.9±0.08	15.34±0.52	56.47±0.68	41.13±0.60	14.44±0.77
13.	11	0.3±0.02	19.45±1.22	65.12±0.39	45.67±0.55	19.15±0.53
14.	12	1.0±0.08	22.42±0.46	52.09±1.16	29.67±0.62	21.42±0.77
15.	200	14.9±0.75	17.92±1.33	42.92±1.03	25.00±0.45	3.02±0.56
16.	13	3.4±0.20	23.10±0.28	46.68±0.66	23.58±0.40	19.7±0.98
17.	120	11.2±0.40	15.13±1.07	67.77±0.37	52.64±0.46	3.93±0.61
18.	14	0.7±0.20	24.07±0.32	65.13±0.89	41.06±0.36	23.37±0.76

19.	15	0.6±0.38	21.94±0.95	52.09±1.33	30.15±0.40	21.34±0.58
20.	16	1.0±0.92	26.21±0.35	59.82±0.8	33.61±0.37	25.21±0.82
21.	17	0.2±0.09	25.17±0.69	42.92±0.72	17.75±0.73	24.97±0.81
22.	18	0.3±0.18	0.20±0.30	36.00±0.66	3.42±0.37	2.1±0.59
23.	19	0.7±0.17	26.32±0.87	46.68±0.66	20.36±0.58	25.62±0.77
24.	20	0.3±0.18	28.76±0.66	42.97±0.99	14.21±0.65	28.46±0.90
25.	21	0.9±0.27	17.57±0.92	44.42±0.60	26.85±0.87	16.67±1.25
26.	23	1.6±0.28	11.74±1.32	59.43±0.87	47.69±0.90	10.14±0.95
27.	24	0.8±0.12	24.70±0.50	48.27±0.76	23.57±0.58	23.9±0.68
28.	25	0.9±0.25	21.569±0.86	66.49±0.79	44.92±0.94	20.70±0.75
29.	26	0.7±0.22	25.07±0.85	28.49±0.51	3.42±0.56	24.37±0.80
30.	27	3.7±0.50	15.86±1.07	41.63±1.13	25.77±0.91	12.16±0.86
31.	29	0.7±0.13	30.50±1.08	37.47±0.60	6.97±0.77	29.8±0.68
32.	30	0.8±0.12	31.49±0.80	38.24±0.59	6.75±0.57	30.69±0.73
33.	31	1.9±0.42	30.41±0.78	84.94±0.94	54.53±0.41	28.51±1.09
34.	34	1.1±0.20	30.24±0.98	64.34±0.90	34.10±0.68	29.14±0.84
35.	35	1.2±0.08	47.85±0.52	66.28±1.04	18.43±0.43	46.65±0.59
36.	36	1.7±0.16	26.68±0.87	60.94±1.19	34.26±0.58	24.98±0.56
37.	37	1.5±0.18	26.80±0.38	79.53±0.79	52.73±0.65	25.3±1.12
38.	38	1.4±0.16	42.13±0.60	47.90±0.75	5.77±0.54	40.73±0.51
39.	39	6.4±0.22	23.93±1.51	64.44±1.04	40.51±0.73	17.53±0.80
40.	40	1.5±0.22	23.98±0.40	48.81±0.83	24.83±0.59	22.48±0.94
41.	41	1.8±0.18	39.01±0.25	54.13±0.37	15.12±0.40	37.21±0.79
42.	44	1.4±0.22	50.19±0.43	47.00±0.68	3.19±0.55	48.79±0.67
43.	46	1.8±0.38	26.32±0.87	75.56±0.84	49.24±0.65	24.52±1.13
44.	47	1.1±0.30	27.18±0.95	90.48±0.84	63.3±0.74	26.08±0.71
45.	48	1.2±0.17	36.88±0.69	59.41±1.12	22.53±0.45	35.68±0.96
46.	54	1.4±0.18	22.97±0.90	39.74±0.96	16.77±0.52	21.57±0.66
47.	60	1.5±0.12	14.32±0.50	56.86±0.82	42.54±0.58	12.82±0.60
48.	63	1.3±0.10	1.75±0.60	44.78±1.05	43.03±0.59	0.45±0.10
49.	76	2.1±0.15	1.00±0.10	49.36±1.53	48.36±1.06	1.10±0.12
50.	80	2.5±0.22	8.30±0.48	56.05±0.81	47.75±0.92	5.80±0.79
51.	84	1.8±0.30	0.91±0.13	46.07±1.16	45.16±1.07	0.89±0.17
52.	85	1.5±0.07	7.46±0.54	49.66±0.70	42.20±0.78	5.96±0.76
53.	86	1.6±0.28	19.46±0.40	48.94±0.80	29.48±0.80	17.86±1.44
54.	87	1.2±0.08	87.01±0.45	62.56±0.65	24.45±1.20	85.81±0.53
55.	88	0.3±0.13	88.19±0.56	55.12±1.33	33.07±0.92	87.89±0.53
56.	91	0.3±0.05	63.60±0.38	46.35±0.94	17.25±0.57	63.3±0.98
57.	92	1.2±0.12	90.20±1.20	73.12±0.74	17.08±0.74	89.00±0.77
58.	93	2.4±0.18	82.00±0.62	94.77±0.66	12.77±0.65	79.60±0.82
59.	94	0.5±0.08	2.60±0.11	85.10±0.74	82.5±1.15	2.10±0.48
60.	95	0.9±0.12	97.62±1.13	45.61±0.74	52.01±0.97	96.72±0.67
61.	96	1.0±0.32	82.5±0.48	49.67±0.85	32.83±0.73	81.5±0.86
62.	97	2.4±0.20	96.94±0.81	67.19±0.80	29.75±0.67	94.54±0.85
63.	98	1.4±0.16	74.36±0.53	48.86±0.84	25.50±0.43	72.96±0.83
64.	102	17.5±1.00	83.12±0.66	81.4±0.96	1.72±0.67	65.62±1.07

The *in-vitro* dry matter digestibility (IVDMD) has been extensively used to analyse ruminant feedstuffs and to evaluate its nutritional property. It is the most accurate method available for predicting digestibility data for ruminants and the method used to measure *in vivo* nutrient digestibility of feed ingredients, In the present study IVDMD analysis was made for *A.excelsa* accessions for both the summer and winter seasons and its digestibility was tested for 24 hrs and 48 hrs and observed that it ranged between 47.17% and 68.14% and almost all accessions showed digestibility greater than 50%. IVDMD of all the accessions were found promising irrespective of the high fibre content and cell wall constituents which affects the digestibility of the forage. Datta*et al*. (2009) studied the *in-vitro* dry matter digestibility(IVDMD)of the leaves of 12 species viz. *Acacia auriculiformis, Albizzia procera, Dalbergia sissoo, Gliricidia maculata, Leucaena leucocephala, Samanea saman, Azadirachta indica, Eucalyptus hybrida, Gmelina arborea, Michelia champaca, Morus alba, Tectona grandis* and observed that *Leucaena leucocephala* found to have highest level of IVDMD (65.20%/67.66%) than others. Solorio-Sánchez *et al*. (2000) reported that the IVDMD of the leaves of eight tropical fodder trees viz. *Gliricidia sepium, Albizia lebbeck, Sesbania grandiflora, Brosimum alicastrum, Leucaena leucocephala, Piscidia piscipula, Bursera simaruba, Guazuma ulmifolia* ranged from 74.3 to 38% and highest IVDMD (74.3%) in *G.sepium* foliage and lowest (37.9%) in *G.ulmifolia*. Although *D.abssinica* showed lowest CP content, in-vitro digestibility was high probably due to its relatively lower content of the fiber fractions, in general fiber and digestibility are negatively correlated (McDonald *et al*., 2002). Lignin is a principal factor limiting digestibility (Van Soest, 1994). In addition, low protein and high fibre contents have negative effects on digestibility (Minson, 1982).

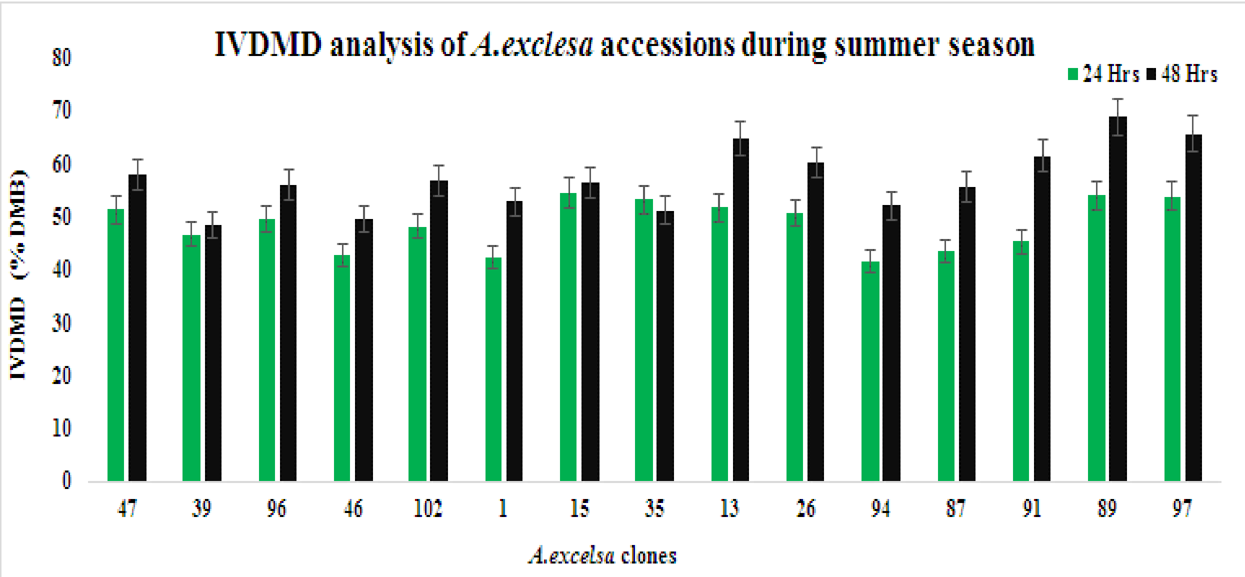

Figure 1. IVDMD analysis of *A.excelsa* leaves collected during summer season.

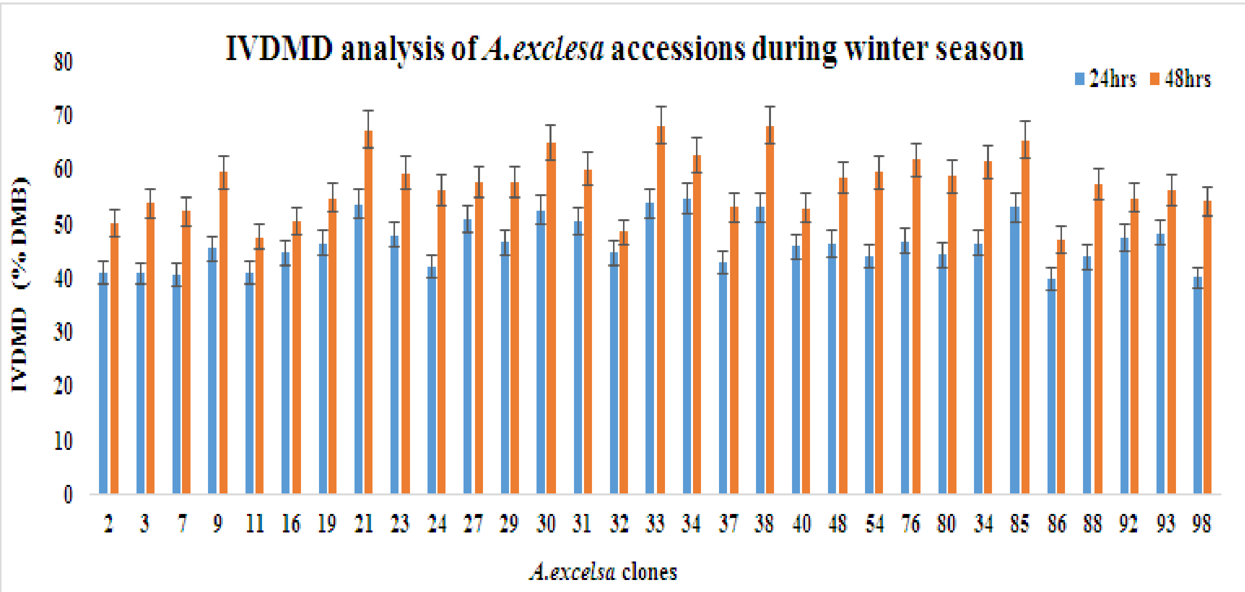

Figure 2. IVDMD analysis of *A.excelsa* leaves collected during winter season.

Metabolizable energy (ME) and Total Digestible Nutrients (TDN) are the other two energy requirement of cattle other than IVDMD.ME observed to be more than 8.23(MJ/Kg DM) for all the accessions (7.5 MJ/Kg DM - recommended for animal feed) and all the accessions recorded to have ME value more than the recommended value for animal feed. Accessions were found to have TDN value more than 40 %. Metabolisable energy calculated for leaf samples of all accessions of *A.excelsa* collected during winter season ranged from 7.22 to 10.43(MJ/Kg DM) and Total Digestible nutrients ranged from 42.45 to 61.33 %. Datta*et al*., (2009) measured the Metabolizable energy of the leaves of 12 species viz., .*Acacia auriculiformis*, *Albizzia procera*, *Dalbergia sissoo*, *Gliricidia maculata*, *Leucaena leucocephala*, *Samanea saman*, *Azadirachta indica*, *Eucalyptus hybrida*, *Gmelina arborea*, *Michelia champaca*, *Morus alba*, and *Tectonagrandis*andME (7.95 $MJ \cdot kg^{-1}$ DM) can be recommended as good quality fodder while *G.maculata*, *M.alba*, *T.indica*, *D.sissoo* and *S.saman* were found to have medium type and rest of poor quality. Total digestible nutrients and metabolizable energy decreased with increasing maturity (Kim and Jang, 1987). IVDMD of all the accessions were found promising in both the seasons irrespective of the high fibre contents and cell wall constituents which affects the digestibility of the forage.

CONCLUSION

Livestock is an important source of livelihood of millions of landless and small land holders especially securing livelihood of economically poor communities. IVDMD analysis and digestibility tested for 24 hrs and 48 hrs observed that almost all accessions showed digestibility greater than 50% and Metabolizable energy (ME) and Total Digestible Nutrients (TDN) which are the other two energy requirements of cattle other than IVDMD. Invariably the IVDMD of all the accessions were found promising in both the seasons irrespective of the high fibre content and cell wall constituents which affect the digestibility of the forage.With promising digestibility *A.excelsa* can be used as cattle feed during lean period.

ACKNOWLEDGMENT

The authors express sincere thanks to the head of the Chemistry and Bioprospecting Division, Institute of Forest Genetics and Tree Breeding, for the facilities provided to carry out this research work.

REFERENCES

Sumathi P, Govindaraj M, Govintharaj P (2017). Identifying Promising Pearl Millet Hybrids Using AMMI and Clustering Models. *International Journal of Current Microbiology and Applied Sciences*, 6(2), 1348- 1359.

Sumathi, T.; Chawla, S.L.; Patil, S. and Palagani, N. (2017). Effect of growing media and primary nutrients on postharvest life of cut flowers of anthurium var. *Tropical Journal of Ornamental Horticulture*, 20 (1 & 2), 75-79.

Goering, H.K., Van Soest, P.J., 1970. Forage fibre analyses (apparatus, reagents, procedures, and some applications). Agriculture Handbook No. 379, Agric. Res. Serv., USDA, Washington, DC, USA, 20 pp.

Rinne, M., Huhtanen, P. & Jaakkola, S., (1997). Grass maturity effects on cattle fed silage-based diets. 2. Cell wall digestibility, digestion and passage kinetics. *Animal Feed Science Technology*. 67, 19-35.

Mertens D. R. (2009). Impact of NDF Content and Digestibility on Dairy Cow Performance. *WCDS Advances in Dairy Technology*, 21, 191-201.

Chitra, P. and A. A. Balasubramanian (2016). Study on chemical composition and nutritive value of Albizia tree leaves as a livestock feed. *International Journal of Science, Environment and Technology*, 5(6), 4638-4642.

Belyea, R.L., Steevens, B., Garner, G., Whittier, J.C. and Sewell, H. (1993).Using NDFand ADF to balance diets. Agri-cultural publication, G. 3161.

AmiriF and Mohamed Shariff A.R.B (2012).Comparison of nutritive values of grasses and legume speciesusing forage quality index. *Songklanakarin Journal Science and Technology*, 34 (5), 577-586,

Khanal RC and DB Subba. (2001). Nutritional evaluation of leaves from some major fodder trees cultivated in the hills of Nepal. *Animal Feed Science Technology* , 92, 17-32.

Solorio-Sánchez, F., Armendariz-Yañez, I., Ku Vera, J. (2000). Chemical composition andin vitro dry matter digestibility of some fodder trees from South-east Mexico. LivestockResearch for Rural Development 12, 4.

McDonald, P., Henderson, N., Heron, S (2002). Biochemistry of Silage. Chalcombe Publications, Marlow, UK

Van Soest P.J. (1994). Nutritional Ecology of the Ruminant. Cornell University, USA. 476 pp.

Minson, D. J. (1982). Effects of chemical and physical composition of herbage eaten on intake. In: Nutritional Limits to Animal Production from Pastures (Hacker, J. B. ed.), CAB International, Farnham Royal, U.K pp. 167–182.

Kim, D. J. and J. H. Jang, (1987). Study on the fibre characteristics, cell wall nitrogen and dry matter digestibility in the wild legume shrubs, *Korean Journal of Animal Science*, 29(9), 399-407.