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NUTRITIVE AND PROXIMATE ANALYSIS ON FIVE WEEDY GRASSES FOR THEIR POTENTIAL USE AS FODDER

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Abstract

Grasses serve as the primary food source for most of the herbivorous but generally grasses are considered as weeds of open fields. The present study aimed to quantify and compare the mineral and proximate composition from the dry leaf powder of five weedy grasses, namely Apluda mutica, Bothriochloa pertusa, Chloris barbata, Paspalidium flavidum and Stenotaphrum dimidiatum. Among the five weedy grasses, it has been found that Apluda mutica possess high fodder potential because of its highest amount of calcium (53.60 mg/100 g), sodium (123.60 mg/100 g), crude lipid (5.48%) and caloric value (354.84 kcal/100 g) compared to other grasses. Stenotaphrum dimidiatum shows highest crude protein (39.97%) and highest amount of carbohydrate is reported in Paspalidium flavidum (58.87%). A reasonable amount of macro and micro nutrients, total ash, moisture content, crude protein, crude lipid, carbohydrates, crude fibre, and caloric value were also observed in other grasses respectively. The present investigation provides a scientific data for utilisation of the weedy grass as fodder based on the nutritional and biochemical assessments.

***Key words**: fodder, mineral, nutrient, weedy grass, proximate analysis.*

INTRODUCTION

Grasses are mostly C_4 plants which contain most wide-ranging, much required and familiar component of range vegetation particularly in extreme climates of the range areas. Grasses are cosmopolitan in nature, better in taste, fast digestibility and high nutritive value than shrubs and trees (Quraishi, 1999). They can be best choice for fodder purposes due to the above-mentioned properties (Manzoor et al., 2013). Khan et al. (2013) reported that grasses offer a potential alternative forage source for ruminants in tropical countries, especially in slump periods when quantity and quality of fodder are in limited. Wild grasses have a significant role in feeding grazing livestock in pastures, rangelands, plains as well as mountain ecosystems. The health and performance of cattle depends on the availability and concentration of nutrients and mineral elements present in these grasses. Grasses provide feed to about 53% of the total fodder to the ruminants (Ukanwoko & Igwe, 2012).

The increase in demand of fodder species to fill the gap between fodder availability and consumption needs alternative forage resources. The current fodder crops are unable to meet the demand in many tropical and subtropical countries. Traditionally, only a few plants species are used for fodder purposes and almost no data is available about the proximate and mineral analysis of most of the plants (Ukanwoko & Igwe, 2012). The information on mineral and nutrition composition will provide a baseline to uses these species to feed livestock. Amount and quality of nutrients of fodder available to animals are important in determination animals' productivity and growth. 90% of the dry weight (DW) of a diet is composed of carbohydrates, fats and proteins (Hussain & Durrani, 2009).

Worldwide, approximately 11,000 to 13,000 species of grasses have been reported with 800 genera (Mall & Tripathi, 2016). They can highly proliferate in nature and the main reason for their survival and spread is their structure and shape. The grasses in India serve as food source for more than 470 million of livestock. Nearly one-third of Indian grasses considered to have fodder value. Fodder grasses are a rich source of protein and energy for the livestock (Dayanandan, 1994). Due to its adaptive capacity, it can be explored further in economic, ecological and therapeutically aspect. Grasses are generally rich in vitamins and minerals and they also contain secondary metabolites such as alkaloids, tannins, flavonoids, phenols, saponins, cardiac glycosides, steroids and many other phytochemicals (Babu & Savithramma, 2013). Minerals and secondary metabolites are a very important component of any living body. Plants and animals need minerals for their proper growth and development. Plants obtain macro and micro nutrients from water and soil. Humans and herbivores obtain some minerals by consuming the plants. Understanding the nutrients present in the plant samples will help us to indirectly find out the amount of nutrients which will be available to the cattle or other domesticated animals which feed on these fodder grasses (Bradshaw, 1962; Paudel et al., 2019).

A brief description of the grasses based on the following scientific literatures such as Bor (1960), Mayuranathan (1994), Karthikeyan (2005), and Kabeer and Nair (2009) are provided below.

Apluda mutica L. named as Mauritian grass is a perennial belonging to the tribe Andropogoneae. It is commonly seen in the plains. The culms will grow up to 2 m tall; leaf blade is linear to lanceate; spathes are boat shaped; spikelets are sessile, awned or unawned; the lower glume is keeled, upper glume boat shaped; grains are oblong. Flowering and fruiting season are from September to March. It is considered as a good fodder grass and the young shoots are readily eaten by cattle. It also forms the large part of the undergrowth in forests (Figure 1).

Figure 1. Habit of *Apluda mutica*

Bothriochloa pertusa (L.) A. Camus is also called as sour grass belonging to the tribe Andropogoneae found along roadsides, field bunds and on slopes of foot hills. It is a perennial herb with culms up to 80 cm tall; leaf blade is linear; panicles are 8 cm long; inflorescence is a raceme 3 to 8, subdigitate, sessile and pedicelled spikelets; the grains are oblong and flowering and fruiting season is from September to March. This grass also is known for its fodder value (Figure 2).

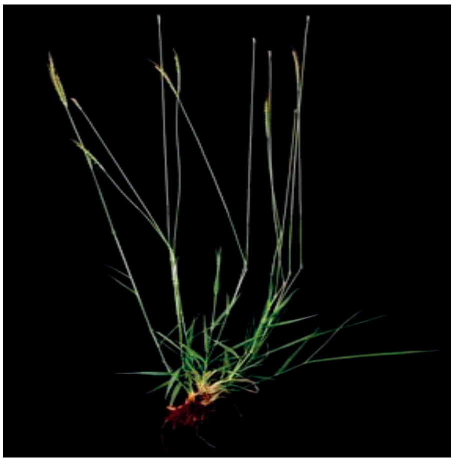

Figure 2. Habit of *Bothriochloa pertusa*

Chloris barbata Sw. is also known as Swollen finger grass belonging to the tribe Cynodonteae. It is commonly seen in disturbed sites, waste areas and in pastures as a weed of open grounds. It is a perennial herb with culms up to 60 cm tall; leaf blade is linear; inflorescene is a spike; spikelets are 2 to 6 mm long, 2-seriate; grains are subtrigonous. Flowering and fruiting season extends throughout the year (Figure 3).

Figure 3. Habit of *Chloris barbata*

Paspalidium flavidum (Retz.) A. Camus is known as yellow water crown grass of the tribe Paniceae. The grass is considered to be an excellent fodder and the grain is collected and eaten in times of scarcity. It is an annual herb with culm up to 50 cm tall; leaf blade is linear to lanceate; inflorescence is a raceme (5 to 10); spikelets are 2.5 to 3 mm long; lower glume is ovate to oblong and the upper glume is ovate and the grains are ovoid. Flowering and fruiting season is between September and January (Figure 4).

Figure 4. Habit of *Paspalidium flavidum*

Stenotaphrum dimidiatum (L.) Brongn is commonly called as buffalo grass belonging to the tribe Paniceae. It is a stoloniferous herb, creeping and forming mats with culm up to 18 to 60 cm long; leaf blade is linear to oblong; inflorescence is a solitary raceme; spikelets (3 to 5), alternately arranged; upper glume is ovate to lanceolate. Flowering and fruiting is from August to December**.** It mostly occurs in natural swards or planted as turf. It plays an important role as pasture or soil conservation ground cover (Figure 5).

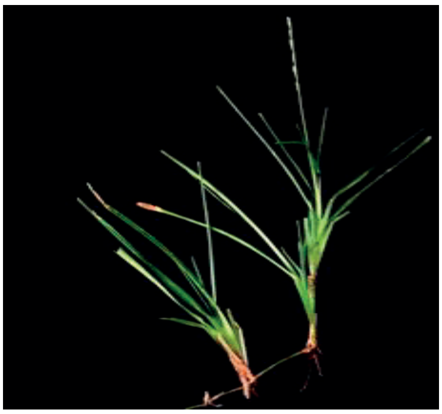

Figure 5. Habit of *Stenotaphrum dimidiatum*

Plants and animals need minerals for their proper growth and development. Plants obtain macro and micro nutrients from water and soil. Humans and herbivores obtain minerals mostly by consuming plants. Analysis of minerals present in the plant sample will indirectly determine the amount of minerals which will be obtained by the cattle or other domesticated animals which feed on these fodder grasses. Bradshaw (1962) have carried out the work using sand culture technique and proposed that a species might resemble one another with their response to one nutrient. The nutritional level of the fodder grass shall change due to some environmental factors such as fire and overgrazing nitrogen content and rainfall and soil condition plays an important role in the distribution of nutritive elements in the plants (Mbatha & Ward, 2010). Wheat grass juice is found to possess richest source of vitamins and essential minerals as calcium, potassium, iron, magnesium, sodium and sulphur used as fodder as well as consumed by humans (Mujoriya & Bodla, 2011). Grasses do have protein content and leaves form a potential *Hominin* dietary resource (Oliver et al., 2018). Khan et al. (2017) have made an assessment of proximate and elemental analysis of six wild weedy grasses and identified them as of potential source of fodder for cattle to meet the fodder crisis. Some of the recent researches on the nutritional and proximate analysis of the selected fodder grasses include Hughes et al. (2015), Sayed et al. (2017), Megersa et al. (2017), and Brown et al. (2018). In general, research work on grasses have been carried out for a very long time and recent studies have incorporated some advanced techniques to find out the nutritive and fodder value of grass. In this study, five weedy grasses were analysed for their nutritive and proximate properties for potential use as local fodder for the livestock and also recommended for cultivation to meet the demand for the fodder shortage due to urbanisation.

MATERIALS AND METHODS

Source of the grass samples

The selected species of five weedy grasses such as *Apluda mutica* L., *Bothriochloea pertusa* (L.) A. Camus, *Chloris barbata* Sw., *Paspalidium flavidum* (Retz.) A. Camus, *Stenotaphrum dimidiatum* (L.)

Brongn were identified and collected from different sites in and around Tambaram, Chennai, India during 10-15 November 2019. The collected grass samples were authenticated at the Centre for Floristic Research and Herbarium, Department of Botany, Madras Christian College (Autonomous) using standard literatures (Karthikeyan, 2005; Kabeer and Nair, 2009).

Preparation of grass samples for mineral and proximate analysis

The leaves of selected fodder grasses were rinsed thoroughly in running water, shade-dried for about two weeks, pulverised, sieved into fine powder and stored in airtight container. The mineral and proximate analysis were carried out in dried powdered leaf samples separately.

Mineral analysis

Dry ash of the powdered leaf samples was digested 100 ml of 1 M Hydrochloric acid and five macro minerals such as calcium, iron, magnesium, sodium and phosphorus and two micro minerals such as selenium and zinc were determined using atomic absorption spectro-photometer (AAS) and flame photometer (FPM). The results for mineral contents were expressed as mg/100 g DW (AOAC, 2003).

Proximate analysis

Proximate analysis was carried out for the estimation of total ash, moisture, crude protein, crude fat, crude fibre and carbohydrate in the powdered leaf samples and the results were determined by using standard methods.

Total ash

The powdered sample was heated in silica crucible in a low flame followed by heating in a muffle furnace for about 3 to 5 h at 550°C, cooled and weighed for determining the ash content (AOAC, 2003).

Moisture content

It was determined by keeping the sample in an air oven at 110°C and weighed (AOAC, 2003). The percentage of moisture content was calculated as follows:

Percentage of moisture content = 1 – weight of dry sample/weight of wet sample × 100.

Crude protein

The crude protein content was analysed by adopting micro-Kjeldahl method. 2 g of the dried sample was taken in a Kjeldahl flask and 30 ml conc. H_2SO_4 was added followed by the addition of 10 g potassium sulphate and 1 g copper sulphate. The solution was heated till the frothing had ceased. When the solution became colourless or clear, it was heated for another hour, allowed to cool, diluted with distilled water and transferred to an 800 ml Kjeldahl flask, washing the digestion flask. Zinc and 100 ml of 40% caustic soda were added and then 25 ml of 0.1 N sulphuric acid was taken in the receiving flask and distilled. It was tested for completion of reaction and titrated against 0.1 N caustic soda solution using methyl red indicator for estimation of Kjeldahl nitrogen, from which protein content is determined (Indrayan et al., 2005).

Crude lipid

2 g of moisture-free sample was extracted with petrol in a Soxhlet extractor and heated in the flask on a sand-bath for about 6 h till a drop taken from the drippings left no greasy stain on the filter paper. Boiled with petrol and the residual petrol was filtered with Whatman no. 40 filter paper and the filtrate was evaporated in a pre-weighed beaker and increase in weight of beaker gave crude lipid (Indrayan et al., 2005).

Crude fibre

2 g of moisture and fat-free material of sample was treated with 200 ml of 1.25% H_2SO_4. Washed, filtered and after the residue was treated with 1.25% NaOH. Again it was filtered, washed with hot water and then 1% HNO_3 and again with hot water. The residue was ignited and the ash weighed. Crude fibre content was determined by measuring loss in weight (Indrayan et al., 2005).

Carbohydrate

The total carbohydrate content (%) in the samples was calculated by difference method (Ooi et al., 2012). The percentage of carbohy-drate was calculated as follows: Percentage of carbohydrate = 100 – (percentage of ash + percentage of moisture + percentage of fat + percentage of protein).

Caloric value

The caloric value (nutritive value) was calculated by sum of the percentages of protein and carbohydrates multiplied by a factor of 4 (kcal/g) and total lipids multiplied by a factor of 9 (kcal/g) (Ooi et al., 2012).

Statistical analysis

Mean and standard error of mean were calculated in triplicates for all determinations using SPSS version 15.0.

RESULTS AND DISCUSSIONS

Grasses are generally used for fodder purpose but nutritional and medicinal value of most of the fodder grasses is unknown. It is quite important to understand the nutritional and biochemical properties of fodder grasses to utilise them as a potential fodder. The present study made an attempt to study the nutritive, proximate analysis of selected grasses such as *Apluda mutica*, *Bothriochloa pertusa*, *Chloris barbata*, *Paspalidium flavidum* and *Stenotaphrum dimidiatum*.

Mineral analysis

In the present study, some of the macro minerals, such as calcium, iron, magnesium, sodium and phosphorous, were estimated in the selected grass samples, and the amount of macro minerals present in leaf samples on DW basis is represented in Table 1. Calcium is an important mineral nutrient for plants. It is involved in holding together the cell wall of plants.

Table 1. Estimation of macro and micro minerals of the selected weedy grasses

Botanical name	Macro minerals					Micro minerals	
	Calcium (mg/100 g)	Iron (mg/100 g)	Magnesium (mg/100 g)	Sodium (mg/100 g)	Phosphorus (mg/100 g)	Selenium (mg/100 g)	Zinc (mg/100 g)
Apluda mutica	53.60 ± 0.12	2.65 ± 0.01	23.80 ± 0.08	123.60 ± 0.12	31.50 ± 0.12	1.47 ± 0.01	13.70 ± 0.16
Bothriochloa pertusa	34.30 ± 0.08	3.13 ± 0.01	10.50 ± 0.20	34.80 ± 0.08	11.50 ± 0.16	1.36 ± 0.01	10.7 ± 0.08
Chloris barbata	12.70 ± 0.12	2.55 ± 0.01	15.40 ± 0.12	34.60 ± 0.12	10.50 ± 0.16	1.35 ± 0.01	4.57 ± 0.01
Paspalidium flavidum	28.40 ± 0.08	4.39 ± 0.01	18.60 ± 0.12	30.70 ± 0.16	12.50 ± 0.12	4.34 ± 0.01	20.18 ± 0.08
Stenotaphrum dimidiatum	20.20 ± 0.12	4.56 ± 0.01	9.47 ± 0.01	23.60 ± 0.16	8.47 ± 0.01	2.34 ± 0.01	5.87 ± 0.01

Values are represented as mean ± standard deviation (n = 3) of three determinations on dry weight (DW) basis.

Calcium is taken up by roots from the soil solution and delivered to the shoot via the xylem (White & Broadley, 2003). It plays an important role in activating certain enzymes such as Ca^{2+} ATPases (Sze et al., 2000). These enzymes send some signals to coordinate certain cellular activities and it helps to face environmental challenges (Sanders et al., 2002; White, 2000). Magnesium is one of the essential mineral nutrients required by plants because it contains various physiological functions such as phloem loading and transport of photoassimilates into roots, shoot tips and seeds (Cakmak et al., 1994; Hermans et al., 2005). It also involved in the process of photosynthesis, enzyme activation, formation and utilisation of ATP. Hence, the formation of root and seed gets affected because of low supply of Mg in soil (Cakmak & Kirkby, 2008; Hermans et al., 2005). The data revealed that *A. mutica* contains the highest amount of the rest of the macro minerals that include calcium (53.60 mg/100 g), magnesium (23.80 mg/100 g), sodium (123.60 mg/100 g) and phosphorous (31.50 mg/100 g). Na^+ is useful to many species at lower levels of supply, but in certain C_4 species, it is very essential and accumulates to significant levels in plant organelles as same of K^+ (Gattward et al., 2012; Schulze et al., 2012), there are several pathways for its entry across root plasma membranes. Phosphorus play a major role in establishing root growth, seed germination and plant growth. In lack of phosphorus, grass would arrive stunted during the early stages of development. It acts as energy transfer of plants and also is an important component in the building blocks of DNA (Maathuis & Diatloff, 2013). The lowest amount of calcium was present in *C. barbata* (12.70 mg/100 g), and the lowest amount of magnesium (9.47 mg/100 g), sodium (23.60 mg/100 g) and phosphorus (8.47 mg/100 g) was observed in *S. dimidiatum*. Sherasia et al. (2016) studied nutritional content of few fodder plant and similar to our study, they also reported Ca, P, Cu, Zn and Mn content from various feed resources including straws of *Sorghum bicolor*, *Triticum aestivum* and *Pennisetum glaucum*. Sahoo et al. (2014) reported nutritional analysis of 13 marginal land grasses and results states that grasses were rich source of Ca and moderate source of other elements.

Iron is essential for some metabolic activities such as photosynthesis, DNA synthesis, and respiration. The highest amount of iron was found in *S. dimidiatum* (4.56 mg/100 g), whereas the lowest amount of iron was present in *C. barbata* (2.55 mg/100 g). It is involved in many biochemical pathways especially electron transport chain. Ishimaru et al. (2011) reported that graminaceous plants depend on an Fe^{+3} chelation system at the time of secretion of mugineic acid family phytosiderophores. Mugineic acids are secreted to the rhizosphere via TOM1, and then they chelate Fe^{+3}. The amount of micro minerals, such as selenium and zinc, was estimated in the weedy grass samples and is described in Table 1. Although essentiality of Se to plants is in less, however, many workers have reported beneficial effect of Se in different plants (Cartes et al., 2010; Hasanuzzaman & Fujita, 2011; Pandey & Gupta, 2015). Some studies have described that Se at low levels protect the plants from variety of abiotic stresses containing cold (Chu et al., 2010), dryness (Hasanuzzaman & Fujita, 2011), desiccation (Pukacka et al., 2011), and metal stress (Kumar et al., 2012; Pandey & Gupta, 2015). The same selected samples were used and found that the highest amount of the micro minerals, selenium (4.34 mg/100 g) and zinc (20.18 mg/100 g), was present in *P. flavidum*, whereas the lowest amount of selenium (1.35 mg/100 g) and zinc (4.57 mg/100 g) was found in *C. barbata*. Zinc is an important micronutritent for plant growth and development. Zinc is involved in various processes such as growth hormone production and internode elongation. It is also help the plant to produce chlorophyll content. In addition, zinc has a structural role in enzymes (John et al., 2013).

Mujoriya and Bodla (2011) have studied the nutritional value of young grass blade of wheat plant. They have concluded in their research by proving that wheat grass is not only has high nutritive values but also has good medicinal properties such as the anticancer property. Khan et al. (2007) reported Fe, Cu, Zn, Mn and Se content of four different grasses including Bermuda grass, Bahia grass, Star grass and Guinea grass of different seasons. They concluded that there was not a significant variation in micro-nutrient status of the grasses due to seasonal changes. Similarly, seasonal changes of mineral content of grasses was studied by Kappel et al. (1985).

Proximate analysis

The proximate analysis includes the estimation of the total ash, moisture, crude protein, crude lipid, crude fibre and carbohydrates and caloric value of weedy grass samples (Table 2). It was observed that *C. barbata* has the higher quantity of total ash (16.74%), moisture content (10.38%) and caloric value (354 kcal/100 g). The low quantity of total ash was found in *B. pertusa* (11.31%), the less amount of moisture content was present in *A. mutica* (6.08 ± 0.08%), and the less caloric value was observed in *P. flavidum* (186.7 kcal/100 g). Kumar et al. (2015) reported CP, EE and total ash content of leguminous and non-leguminous green fodder. In another study, Sultan et al. (2008) analysed dry matter, organic matter, ash and crude protein content from 12 marginal land grasses. The results indicates that *S. dimidiatum* has the higher amount of crude protein (39.97%) and *P. flavidum* has the lower amount of crude protein (20.84%). The higher amount of crude lipid was present in *A. mutica* (5.48%) and the less amount of crude lipid was found in *C. barbata* (1.35%) and *S. dimidiatum* (1.35%). The higher amount of crude fibre was present in *C. barbata* (6.36%) and the less amount of crude fibre was present in *P. flavidum* (5.09%). The less amount of carbohydrate was present in *S. dimidiatum* (35.97%) and higher value reported in *P. flavidum* (58.87%). Babu and Savithramma (2013) reported the nutrient content of 20 grass species from Poaceae family. They concluded that grasses contain high nutritive value can be chosen for feeding the livestock. Dayanandan (1994) has studied the nutritive value of some of the selected fodder grasses. In his study, he has compared the nutritional value of nine species of native fodder grass. Among these nine species, *A. mutica* and *B. pertusa* were used in the present study also. There are differences in the values of protein, fibre and moisture content, it can be due to some ecological factors that impact the nutritional content of the plants.

Table 2. Proximate composition of the selected weedy grasses

Botanical name	Total ash (%)	Moisture (%)	Crude protein (%)	Crude lipid (%)	Carbohydrate (%)	Crude fibre (%)	Caloric value (kcal/100 g)
Apluda mutica	12.06 ± 0.82	6.08 ± 0.08	30.64 ± 0.01	5.48 ± 0.08	45.74 ± 0.04	5.42 ± 0.04	354.84 ± 0.82
Bothriochloa pertusa	11.31 ± 0.81	8.50 ± 0.54	29.96 ± 0.01	1.98 ± 0.08	48.25 ± 0.04	5.68 ± 0.01	330.66 ± 2.75
Chloris barbata	16.74 ± 0.85	10.38 ± 0.54	32.97 ± 0.01	1.35 ± 0.08	38.56 ± 0.81	6.36 ± 0.01	298.27 ± 0.97
Paspalidium flavidum	12.60 ± 0.81	6.09 ± 0.01	20.84 ± 0.01	1.60 ± 0.07	58.87 ± 1.73	5.09 ± 0.08	333.24 ± 0.08
Stenotaphrum dimidiatum	14.62 ± 0.81	8.09 ± 0.08	39.97 ± 0.08	1.35 ± 0.07	35.97 ± 0.01	5.26 ± 0.01	315.41 ± 2.75

Values are represented as mean ± standard deviation (n = 3) of three determinations on dry weight (DW) basis.

Paine et al. (2017) have proved that grasses do have protein content and the grasses can be broadly divided into high- and low-level protein containing grass and thereby they concluded their result by considering grass leaves as a potential “hominin” dietary resource. Mbatha and Ward (2010) also studied that various impacts on the nutritional level of the fodder grass because of some environmental factors such as fire and overgrazing nitrogen content. They have explained that rainfall and soil condition plays an important role in the distribution of nutritive elements in the plants. Therefore, this might the one of the reason for variation in the readings. The other reason for different nutritional values can be due to seasonal changes as studied by Megersa et al. (2017). As per Hughes et al. (2015), the variation of nutritional content can also be due to the reason that the leaves have different nutritional values at different stages of growth.

CONCLUSIONS

The decline of the grasslands and demand for the fodder grass is increasing tremendously and also fodder with low nutrients directly affects the growth and productivity of livestock.

The present investigation suggest that selected weedy grasses possess good source of minerals and nutrients and caloric value. Hence, they can be utilised as a potential source of fodder by recommending for cultivation. Further studies on the distribution of phytochemicals in these grasses would help to improve the health status of the grazing animals.

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