Evaluation of Protein Content In Some Fodder Crops

Shazia Rehman[1], Sabahat Nizam[2],SaimaRubab[3] ,Saraj Bahadur[4] and Xia Wei[5*]

[1]College of Tropical Crops, Hainan University, Haikou, 570228, P.R China
[2]Department of Botany, Lahore College For Women University, Lahore, Pakistan
[3]Department of Pharmacognosy, Lahore Pharmacy College, A Project of Lahore Medical and Dental college, Pakistan
[4]College of Forestry, Hainan University, Haikou, 570228, China
[5]Hainan Yazhou Bay seed laboratory, Sanya 572025, China

Corresponding author: Xia Wei
Email adress: saizjxiawei@126.com

Abstract

Livestock is a vital component of global agricultural production, and grass-based livestock production has become increasingly popular due to the protein-rich diets required by the growing population. In this study, the nutritional composition of four different fodder crops (maize, berseem, oat, and lucern) was analyzed in terms of ash, fiber, fat, and protein content. The Research work was completed in the FBRC lab of PCSIR Lahore. In this study, four fodder crops, Maize (*Zea maize* L.), Berseem (*Trifoliumalexandrinum* L.), Oats (*Avena sativa* L.), and Lucerne (*Medicago sativa* L.), were utilized as experimental plants and their proximate nutrition composition and protein levels were examined. The four fodder proximate nutritional compositions i.e. Maize 2.277% Ash, 1.367% Fat, 9.708% Fiber, Oat 2.821% Ash, 1.946% Fat, 12.35% Fiber, Berseem 1.1302% Ash, 1.225% Fat, 4.867% Fiber, Lucern 1.642% Ash, 1.173% Fat, 5.883% Fiber. The highest value of protein was present in Lucern 8.038% followed by 5.16%, 4.14%, and 3.103% in Maize, Oat, and Berseem respectively.While Oats and Wheat had a higher fiber composition respectively.Based upon the higher availability of crude protein Lucerne (*Medicago sativa L.*) could be used as a supplement in ruminant animal feed. Farmers should grow Lucern and Maize in more areas to meet the protein needs of ruminants.

Keywords

Ruminant; fodder crops; crude protein; nutritional analysis

1. INRODUCTION

Most important in ruminant production systems is the provision of adequate nutrition. Inadequate quantities and qualities of feed are mostly responsible for the low animal output. Ruminant animals obtain all of their necessary nutrients and energy only from plants (Herrero *et al*., 2013). In the face of rising rivalry between humans and their livestock for food, ruminants fattened on grain supplements may achieve 75%

of their dietary needs from pasture alone (Rashid *et al*., 2007; Blair, 2021). Pakistan's livestock feed pool lacked 21 % of its total dry matter (DM) and 33 % of its crude protein needs. There aren't enough green fodders, especially in the hottest months (June and July) and the coldest months (December and January), so most of the animals aren't getting enough to eat (Ahmad *et al*., 2009; Khan *et al*., 2020). Ruminants get roughly 95 percent of their nutrient requirements from grass in places where grain feeding is not popular. The feeding value of any forage is determined by the species' properties, such as its availability, accessibility, and nutrient content (Fasae *et al*., 2010; Suttle, 2022;). The feeding value of forages in ruminant production is determined by the balance between available nutrients and the number of nutrients consumed by the animal (Detmann *et al*., 2014). A consistent source of income for both full-time and part-time farmers in underdeveloped nations is small ruminant farming. It aids in the provision of high-quality protein to a large number of people in both rural and urban sites (Bangulzai *et al*., 2016).

A lack of feed with a high nutritional value throughout the year is, however, one of the most significant technical barriers to enhanced ruminant output. Improving livestock requires optimal utilization of available feed supplies (Laconi and Jayanegara, 2015; Wilkinson and Rinne, 2018). Even in developed locations where grains are regularly fed to ruminants, forage provides 75% of the total nutrients. In places where grain feeding is rare, ruminants acquire 95% of their nourishment from roughage (Hernández and Guthery, 2012). Productivity among range animals is directly proportional to the amount and quality of vegetation. Livestock dietary requirements vary depending on factors such as age, physiological function, , gestation, maintenance of growth, fattening, and geographic location (Leroy *et al*., 2022). Most Pakistani rangelands have enough forage but are unpalatable due to overstocking (Hussain and Durrani, 2007; Gurung, 2020). Protein is a fundamental component of all living cells because it makes enzymes, hormones, and antibodies. Animals need protein for growth and tissue repair. All nitrogenous compounds in forage feed are reliable sources of crude protein (Bahadur, 2011; Hertzler *et al*., 2020). Irrigated lands provide 80-90% of the nutrients animals need through their feed crops. The productivity of animals will not increase unless fodder is prioritized as a core crop (Anikwe, 2011). According to Kearney (2010), the increase in milk production has resulted due to greater availability of green fodder in the recent past.

The world's third most valuable grain crop is maize (Dahmardeh *et al*., 2009; Neupane *et al*., 2022). It is a C4 plant commonly known as corn (Shafique *et al*., 2014). It covers about 118 million hectares of agricultural land in the world (Ahmed *et al.,* 2007; Singh *et al*., 2022). It is a staple crop in Pakistan and is used for food, animal feed, and animal fodder. Both humans and animals depend on it as a main source of nutrition. Its forage is used by nearly every type of livestock (Iqbal *et al*., 2015). Its grain is the primary component of livestock and poultry feed, and it can also be used for hay and silage. Animals enjoy it because of its delicious texture and aroma (Akram and Goheer, 2006; Abebe and Alemayehu, 2022). Pakistan's land and weather are ideal for growing maize, but the country's yields per hectare are poor (Ayub *et al*., 2002). Low maize fodder yield is caused by many factors, but fertilizer application can increase per-unit-area yield (Curtis and Halford, 2014). Maize's fodder output and quality, notably

its protein content, benefit from nitrogen fertilization. The application of nitrogen to maize increases its nutritional value, as documented byMaqsood and Shehzad (2013), by increasing its crude protein and decreasing its ash and fiber levels.

Trifoliumalexandrium is a popular fodder for milch animals. It provides superior and cheap nutrition for prolonged periods to the cattle and helps enhance milk production (Karar*et al*., 2017).To add to this, it is legume fodder and therefore adds nutrients essential to maintaining soil fertility and productivity (Kebede, 2020).The fodder has remarkable adaptability and can be successfully grown under sub-tropical and tropical agroecological conditions. Its germination requires a temperature range of 25-30 ºC while a temperature between 15 to 20ºC is considered best for vegetative growth. On the other, flowering needs a bit higher temperature of 35 to 40ºC (Tyagi *et al*., 2018). Mandal *et al*. (2009) studied to evaluate the nutritive value of Berseem at higher ages using Garole sheep as experimental material. As the CF% of the fodder was somewhat higher (19.7%) due to its maturity, the experimental animals showed a tendency in lowering body weight (7.21kg ±o.27) at the end of the experiment.

Avena sativa ranks fifth in terms of world production of cereals and is widely used as a companion crop for under-sowing forage legumes(Verma *et al*., 2017). In Pakistan, it is important winter fodder, in both irrigated and rainfed areas It can be cultivated as pasture for cattle, as a green fertilizer for the soil and for grain production (Pedo *et al*., 1999; Khan *et al*., 2021; Bahadur et al., 2020; Ashfaq *et al*., 2019). Oat grain has always been an important form of livestock feed and a good source of protein, fiber, and minerals. In many parts of the world, oats are grown for use as grain as well as for forage and fodder, straw for bedding, hay, haylage, silage and chaff (Strychar *et al*., 2011; Poutanen*et al*., 2022).Despite the extensive worldwide use of oats for forage and fodder uses, very little of the world's research plant improvement resources are devoted to the development of the oat crop specifically for fodder uses (Bacchi *et al*., 2021). Fodder oats, mainly *Avena sativa L.* have since the 1950s and 1960s grown to become major forage and fodder crops along the Himalayan Hindu Kush range from Afghanistan to Myanmar. Increasingly, cereal fodder crops are being used to encourage and facilitate moves toward zero grazing and tethered animals to spell over-grazed land at all altitudes (Stevens *et al*., 2004;Ahmed *et al*., 2014).

*Medicago sativa*is a high-producing, nutritious legume that is well-adapted to a range of climates throughout the world (Angmo *et al*., 2022). Lucerne may be grown as a pasture for year-round and special-purpose grazing, or for hay, silage, green fodder, pellets, cubes, seed production, sprouts, or protein fractionation (Bouton, 2012). Whether grazed or used as fodder, lucerne has a high nutritive value relative to other fodder at comparable growth stages: it is high in protein, metabolizable energy, vitamins and minerals, all of which can increase animal production (Radoviae *et al*., 2009). When sown as a pasture phase, it can improve soil nitrogen levels and control crop weeds such as wild oats and some summer-growing weeds (Burnett *et al*., 2018). Lucerne can also be used as a special-purpose pasture to finish prime lambs and beef cattle in late spring and summer when other pasture species are low in protein and may have

dried off (Mcdonald *et al*., 2003).

Keeping in view of nutritional status of the present work is concerned with the evaluation of rich protein fodder crops available for livestock by using Kjeldahl method.The aims of this research are to analysis the protein content value of fodder for livestock.We will also analyse the ash, fat and fiber concentration in the selected fodder crops.To evaluate innovative, cost-effective and resource-efficient fodder crops that are high in protein to reduce the gap between supply and demand of quality livestock feed around the year.

2. MATERIALS AND METHODS

2.1. Collection and preservation

Study work was completed at the Food and Biotechnology Research Centre Lab (FBRC) of the Science and Industrial Research Council of Pakistan (PCSIR) in Ferozpur Road, Lahore, Pakistan.In this study, different fodder leaves were taken from five different localities of Lahore. Five samples of each fodder viz. Maize, Berseem, Oat, Lucerne leaves taken from the road shops of Sherakot, Bund road, Sagian road, Jamal town, Kot Abdul Malik road and sheikhupura Lahore. All the collected samples were transported in air-tight polythene bags from the market to the lab. All the samples were stored in the refrigerator. So that it could be used for further studies.

Fig. 1A

Fig. 1B

Fig. 1C

Fig. 1D

Fig. 1(A-D): Maize fodder, Berseem fodder, Lucern Fodder and Oat fodder.

2.2. Proximate analysis

Following proximate nutritional analysis was executed, which includes; ash percentage**,** fat and protein. By Digital Muffle Furnace sigma 2/ 1500 (England) according to AOAC, 2012.The crucibles removed from the oven in moisture test were used further, now charred the dehydrated sample and put into a muffle furnace at 550ºC for 4-6 hours. Remove the crucibles from the furnace when white-colored material appeared in the crucibles, that material is called ash. Put the crucibles in a desiccator for 10-15 minutes and then weighed them again.

$$\text{Ash \%} = \frac{\text{Wt. after ash} - \text{Wt. of empty crucible}}{\text{Wt. of sample}}$$

2.4. Analysis of Fat

By Soxhlet Cat No: 0500 according to AOAC, 2012.Fats were estimated by the hot extraction method. Weigh the empty thimble first. 2g sample was taken in the thimble and placed in the oven for 1 hour so that extra moisture should be removed. Now weigh it again. Place the thimbles in the Soxhlet apparatus for 4-16 hours. n- Hexane was poured into the Soxhlet apparatus. n- Hexane is an extraction solvent. The thimble was removed and firstly air dried and then dried in an oven for 1 hour. After 1 hour put the thimbles in a desiccator and weighed them again. Now the sample got was defatted.

$$\text{Fat\%} = \frac{\text{Wt. of sample +Th (before extraction)} - \text{Wt. of sample Th (after extraction)}}{\text{Wt. of sample}}$$

2.5. Determination of Fiber

According to AOAC (2012), using the Electro mantle. We weighed out 1g of leaves and reflux the fiber apparatus flask containing 1.25 ml of 1.25% H2SO4 for 30 minutes. Set the stove to high and wait. As at the time the bubbling began, the reflux process was started. Put the contents through a filter made of silk that has been cleaned in hot water. We can find the point where it went neutral. This is the residue that we just took out of the flask while it was refluxing. Bring in 100 cc of NaOH (1.25%). Once more for half an hour, it was reflux. After that, the sample was weighed, placed on a sheet of watt-man filter paper, washed with hot water, and finally cleaned with alcohol. After air drying, it was placed in a crucible and baked at 130 °C for 1:30 hours. The crucible should next be heated in a furnace for four to six hours at 550 degrees Celsius. After the ashing was complete, the crucibles were removed and weighed.

Wt. of sample = dehydrate sample – empty crucible wt. –filter paper

Wt. of ash = weight of ash after furnace – empty crucible wt.

$$\text{Fiber \%} = \frac{\text{Wt. of sample} - \text{Wt. of ash}}{\text{Initial wt. of sample}} \times 100$$

2.6. Determination of crude Protein

There were three main steps involved in protein estimation i.e. digestion, distillation and titration.For crude protein determination, Kjeldahl's method was used as indicated (AACC, 2000).

Nitrogen % = {Sample titre - Blank titre} * Normality of HCL*14*Volume made up of the digest*100 / Aliquot of the digest taken*weight of the sample taken*1000

Protein% = Nitrogen % × 6.25

3. RESULTS AND DISCUSSION

Livestock is a major component of global agricultural production systems. The protein-rich diets of the burgeoning population gave impetus to grass-based livestock production. The nutritional composition of different fodder crops was analyzed and we have found the ash, fiber, fat and protein different concentrations in maize, berseem, Lucern and oat in the forage crop.

3a. Maize

In terms of its nutrient profile, maize is generally balanced and provides an excellent source of energy. When compared to other fodder crops, such as lucern and berseem, the nutritional profile of forage maize is significantly higher. It was discovered that the concentration of ash in fodder crop is a good indicator of the mineral matter composition of the crop. The ash content of maize was measured to have a significantly high value of 2.277%. Additionally, a significant concentration of fat and fiber was discovered, with respective values of 1.36 and 9.708% (Table 1). The examination of maize's protein content was also carried out, and it revealed a significantly high concentration of 5.16% (Figure 2). In comparison to berseem, maize exhibited a considerably elevated level of ash content, which was recorded at 1.130%. However, unlike Lucern, maize is a moderately well-balanced source of nutrients that offers a substantial amount of energy. The nutritional composition of forage maize surpasses that of other fodder crops such as berseem and lucern. Additionally, the fat and fiber content of maize was detected to be low, with 1.225% and 4.867%, respectively (Table 1). The study on protein content revealed that maize had the lowest level of protein matter (3.103%), which was less favorable than both oat and maize fodder (figure 2). Not withstanding, maize had a fairly balanced nutrient profile, providing a high energy source, and with the second high protein content among the four crops.

3b. Oat

Overall, oats have a satisfactory nutritional profile, with higher levels of lipids than other cereals. This makes it an excellent source of energy and unsaturated fatty acids. The fat content of oats ranges from 5.0% to 9.0%, making it advantageous for animal feed due to its high lipid content and excellent fatty acid composition. Ash content analysis showed that oats contain 2.821%, while the fat and fiber contents are 1.946% and 12.35%, respectively. Furthermore, oats have a high protein value, second only to lucerne and maize.

3c. Lucern

The proportion of fat that was contained in lucern was 1.642%, which was quite a bit lower than the proportion of fat that was found in the other fodder crops. In comparison to the berseem crop, the lucern had a fat percentage that was 1.173% lower than the standard, and its fiber content was 5.883% lower than the normal as well (Table 2). On the other hand, the lucern fodder had the highest and most significant protein value, which clocked in at 8.038% (Figure 2). while has a lower fat contents than the other crops.

3d. Berseem

In comparison to lucern and maize, the concentration of ash in berseem was found to be 1.1302%, which is significantly a lower value. On the other hand, a much lower concentration of fat and fiber was discovered in the berseem when

compared to the concentrations reported in other fodder crops, specifically 1.225% and 4.867% of fat and fiber respectively (Table 1 and figure 2).Berseem had the lowest protein content, while oats had a higher fat content and a good fatty acid composition.

The approximate nutritional analyses of all the fodder samples were done and their values were represented with the help of a graph. These graphs were presented below for all four fodders one after the other.

Table 1. The proximate nutritional value of maize has been analyzed the values were shown in the table.

Contents	**Mean and SD**
Maize	
Ash	2.277% ±0.015
Fat	1.367% ±0.012
Fiber	9.708% ±0.056
Berseem	
Ash	1.302% ± 0.002
Fat	1.225%±0.006
Fiber	4.867% ±0.044
Oat	
Ash	2.821% ±0.047
Fat	1.946% ±0.0005
Fiber	12.356% ±0.055
Lucern	
Ash	1.642%±0.003
Fat	1.173%± 0.002
Fiber	5.883%±0.003

The mean values were calculated by applying standard deviation(SD).

3.1. Crude Protein content of Fodder Crops

The protein content of all fodders has been evaluated by Kjeldahl method and their values asshown in the table then represented by a graph with the help of MS Excel.

Table 2. The protein content of Fodder Crops

Fodder Crops	Protein(%) and SD
Maize	5.16 ±0.03
Oat	4.14 ±0.026
Berseem	3.103 ±0.0015
Lucern	8.038 ±0.004

The mean values were calculated by applying standard deviation

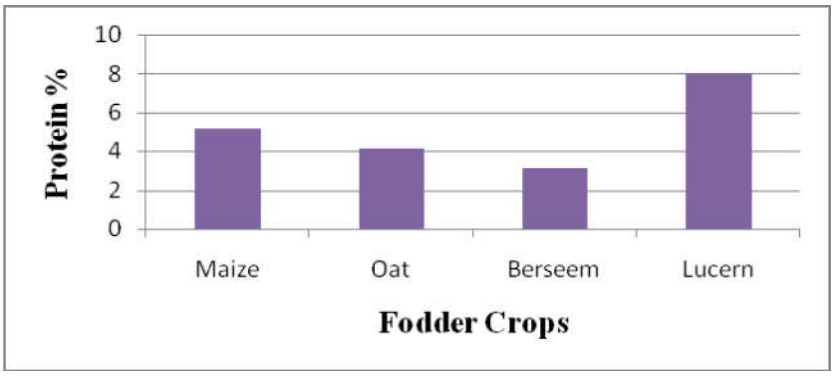

Fig. 2: Graphical representation of protein content of fodder crops

Fodder crops are the main and cheapest source of feed for livestock. A regular supply of adequate and nutritious fodder is essential for the promotion and development of livestock. Nutrition is the most important consideration in ruminant production systems.

Inadequate quantity and quality of feed supplies are primarily responsible for the poor productivity of livestock. Fodder contains about 75% of the nutrients. The proximate nutritional analysis and Protein content was evaluated of four fodder crops viz. Maize (*Zea maize* L.), Berseem (*Trifoliumalexandrinum* L.), Oats (*Avena sativa* L.),Lucerne (*Medicago sativa* L.),The protein content (%) values ranged from as low as 3.103 in Berseem (T. *alexandrinum*L.) to as high as 8.038 in Lucerne (*M. sativa* L.). Earlier reports (El-Shatnawi and Mohawesh, 2000) submitted that ruminants involve 7 to 9% CP for save and 10 to 12% for lactation. As Lucern has high protein content it can be used for ruminant maintenance. In accordance with (Yatoo*et al*., 2016) Lucern has high protein content. While protein content of Oats (*A. sativa* L.) was 4.14% which is lower and related to the work of (Yatoo*et al*., 2016) and Maize (*Z. maize* L.) was 5.16% respectively. This lies in ranges that are good

for ruminant digestibility. The key drivers of animal production remain the overall crop DM yield and crop utilization. (Judson and Edwards, 2008).The crude protein contents of different fodders indicated wide variations with other results. (Anusheela and John, 2017) evaluated Maize CP contents that were 9-11% not parallel with the present result. Agronomic aspects such as the application of different levels of nitrogen fertilizers, harvesting period, ensiling, field drying and storage could result in these variations.

The fiber content was as low as 4.867% in Berseem (*T. alexandrinum*L.) to as high as 12.35% in Oats (*A. sativa* L.). While Lucerne (*M. sativa* L.) had 5.883% and Maize (*Z. maize* L.) had 9.708%. The Fat content varied between 1.367% (Maize), 1.225 %(Berseem), 1.946 % (Oat), and 1.173%(Lucern). The Ash content of Maize (2.277%), was related to the result of (Enyisi*et al*., 2014) Oat (2.821%), Berseem (1.302%) &Lucern 1.642%. Fodder tree leaves were also used as feed for ruminants where fodder crops were not sufficient to meet the demand of ruminants' production system. In the developing world, the current condition of animal protein deficiency is caused by a lack of forage. Fodder trees and shrubs have long been used in livestock feeding (Khan *et al*., 2014).The total protein content of legumes is high, and the rumen-degradable protein content is even higher. Furthermore, legumes have a higher(73.2 %) nutrientutilization rate than cereal fodders(57.8%). Protein content in Lucerne was reported by (Kaithwas*et al*., 2011) to be similar to the current findings.

Lucerne is a multi-cut forage crop that is known as the "Queen of Fodder Crops," and it is grown for producing high-protein and energy-rich green fodder during the winter season reported by Singh *et al*., (2019). Due to its contribution to sustainable agriculture and its high productivity of feed proteins per unit area, Lucerne (*Medicago sativa* L.) has the potential to become an even more important crop in temperate regions (Annicchiarico *et al*., 2010). Lucerne, a perennial fodder tree that produces protein-rich fodder is an excellent choice for your livestock's dietary needs. The crude protein in tree lucerne ranges from 23.0 to 28.0 %, which can be metabolized into a form that benefits human health when consumed in the form of eggs, milk, white meat, or red meat (Rajan*et al*., 2019).The content of crude protein (CP) in the leaves of the fodder tree varied from 15.20 to 25.43% for *Pterocarpussantalinoides* and *Moringaoleifera* leaves, respectively, while CP in the foliage of shrubs ranged from 21.63 and 26.67% for *Stylosanthesscabra*, and *Lablab purpureus*, respectively (Parsana *et al*., 2013). These folders can be fed as supplements and can alleviate feed shortages experienced by ruminants in the dry season.

Medicago sativa, the herbaceous perennial legume, provides significant advantages over cultivating oats alone on fallow fields, as reported by a study by Angmo *et al*. (2022). In comparison to the other examined legumes, alfalfa was judged to be the superior feed crop due to its exceptional, highly adaptable agronomic features. It has been found that due to the presence of nitrogen-fixing bacteria in their roots, leguminous forages can make use of the nitrogen in their natural environment, making them a richer protein source (Iqbal *et al*., 2015). Fat concentration is one of the important quality traits that determine the gross energy of various forages and feeds, as fat yields over 9 Kcal/g

while proteins and carbohydrates yield about 5 Kcal/g (Idris *et al*., 2019). In the present study, oat had significantly higher fat concentrations than other cropping systems. Manoj *et al,* 2021 reported improved fat content by 3.3% in maize + cowpea fodder than in maize fodder alone. Niu *et al*. (2010) found that compared to a mixed crop, Lucerne has 1.8 times the concentration of CP. Legumes regularly surpassed the other nine species in terms of fodder quality, with a higher content of crude protein (Zhang *et al*., 2018). New research on nutritional assessment of fodder crops has shown that experimental crops, i.e. Maize, Berseem, Berseem, Oat, and Lucern were good in nutritional status and should grow abundantly to meet the demand of ruminant animals (Malik *et al*., 2021). Lucern and Maize can be used for extremely protein-demanding livestock, such as nursing cows and convalescents, as a feed source. Moreover, other economically and nutritionally important plants such *Vignaradiata* (Javer *et al*., 2021) and medicinally important plant (Bahadur *et al*., 2022a; 2022b; 2022d; 2022e; 2023; Ullah *et al*., 2021; Sharif *et al.*, 2022) should be screened out for its potentail active constituetns.

4.CONCLUSION

Fodder crops have often played a vital role in livestock feeding. Crops are usually recognized as an important component of animal feeding, most especially as protein suppliers. The intake of these fodders can be improved with concentrate supplementation which improves the production performance of the ruminant animals. Based upon the higher availability of crude protein Lucerne (*Medicago sativa*) preferably use as a supplement in ruminant animal feed, although oats and wheat differed in their fiber content, with oats having a higher fiber composition compared to wheat. Forages rich in protein that have a good amino acid composition and easily digested are essential for efficient animal husbandry since they are the cheapest and most accessible source of these desirable traits. Fodder crops are a crucial and economical source of animal feed, and this study provides valuable information for selecting the most appropriate crop for livestock feeding.

Conflict of interest

We all authors have no conflict of interest to declare.

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