*J. Phytol. Res.* **22**(1) : 95-98, 2009

# CHEMICAL COMPOSITION OF LUCERNE (*MEDICAGO SATIVA* L.), IT'S LEAF MEAL AND LEAF PROTEIN CONCENTRATE

**R. D. MADHEKAR and A. M. MUNGIKAR**
Department of Botany, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad-431 004, India.
E-mail: madhekar_ravi@yahoo.co.in

The paper deals with preparation and quality of leaf meal and leaf protein concentrate (LPC) from lucerne (*Medicago sativa* L.). The chemical composition of leaf meal was comparable with LPC, while that of stem portion with pressed crop residue (PCR) when considered for either human or animal nutrition, respectively. It is suggested that leaf meal may be used as a source of protein in animal feeding, while LPC is suitable for human nutrition.

**Keywords :** Leaf meal; Leaf protein concentrate (LPC); Lucerne (*Medicago sativa* L.); Pressed crop residue (PCR).

## Introduction

In developing countries, rapid population growth coupled with limited resources creates serious problems in the steady supply of food and feed[1]. For this purpose, non-conventional protein sources especially from plant origin need to be investigated. They may provide a cheap source of protein along with vitamins and other nutrients in adequate quantities[2-3].The leaves from majority of plants can not be consumed directly because of the presence of fiber and secondary constituents in them[4]. The extraction of protein from them for use in human nutrition, has been recommended. For this purpose, the process of green crop fractionation (GCF) is advocated by Pirie[5]. During GCF, fresh green leaves are macerated to a pulp,which is subsequently pressed. The leaf juice released due to the pressing is then heated to above 90$^0$ C, due to which proteins in juice coagulate to form a curd called leaf protein concentrate (LPC). The LPC is protein- mineral- vitamin rich product suitable in human nutrition as it is free from indigestible fiber[6]. The pressed crop residue (PCR) left behind after extraction of juice from green foliage is suitable in animal nutrition[7]. Lucerne is valuable leguminous fodder and excellent source of protein for poultry. Lucerne foliage has been widely recommended for leaf protein (LP) extraction[8-9]. In addition, the leaf meal from this plant can be used for feedings ruminants[10]. The present investigation was undertaken to compare chemical composition of LPC with leaf meal, and that of PCR with stem portion of lucerne (*Medicago sativa* L.). In addition, extent of losses due to the post harvest delay in the preparation of LPC was also investigated.

## Material and methods

Lucerne (*Medicago sativa* L.) was cultivated in the University Botanical garden and harvested at the preflowering stage early in the morning. A sample of green foliage was pulped[11] and pressed[12]. The juice released due to the pressing was used for the preparation of LPC. The sample of PCR, left behind extraction of juice, was kept in oven for drying.

For the preparation of LPC, 25 ml of water was boiled in beaker and to it 100 ml leaf juice was added slowly with stirring. The heated juice was filtered to isolate LPC which was kept in oven for drying till constant weight. The samples of these two fractionation products were ground to a fine powder and kept aside for the chemical analysis.

The leaf and stem portions of lucerne were separated. They were then dried in oven at 60 ± 5$^0$C till constant weight. The dried samples of leaf (leaf meal) and stem (crop residue) were ground to a fine powder for further analysis. Simultaneously, the green foliage of lucerne was dried in oven and ground to a fine powder for further analysis.

In an another experiment, green foliage of lucerne was harvested early in the morning at 8:00 a. m. and divided into 6 Batches of 1 kg each. The foliages were fractionated after every two hours as described earlier. The amount of juice released and yield of LPC per kg of the foliage was then determined to evaluate the recovery of LPC per unit weight of fresh foliage, and to evaluate changes associated with delay in fractionation after harvesting fresh crop of lucerne. The samples were ground

**Table 1.** Chemical composition of lucerne and its products*.

| | Nitrpgen (N) | Crude Protein (CP) | Crude fiber | Crude fat | Cellulose | Water soluble reducing sugars | Total Ash | ASA | Ca | P | Gross energy Kcal/g DM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Whole plant | 3.63 | 22.50 | 23.8 | 14.86 | 42.05 | 0.94 | 11.1 | 7.85 | 1.13 | 0.13 | 3.58 |
| Leaves | 4.83 | 30.20 | 9.9 | 19.45 | 3.73 | 1.71 | 11.7 | 8.40 | 1.90 | 0.16 | 3.67 |
| LPC | 8.00 | 50.00 | 5.6 | 21.80 | 8.70 | 0.69 | 6.6 | 5.10 | 2.26 | 0.28 | 4.59 |
| Stem | 2.66 | 16.16 | 35.4 | 11.05 | 46.00 | 0.30 | 10.6 | 6.20 | 0.50 | 0.11 | 3.51 |
| PCR | 2.75 | 17.18 | 33.6 | 13.35 | 4.20 | 1.35 | 7.6 | 4.70 | 0.44 | 0.21 | 3.34 |

*all values are expressed as % of dry matter (DM)

**Table 2.** Effect of delay in fractionation of lucerne foliage on the yield of LPC .

| Time | Weight of lucerne foliage (g) | % DM of foliage | N % of DM | Amount of juice extracted (ml) | Yield LPC-DM (g) | Crude protein (% of LPC-DM) |
|---|---|---|---|---|---|---|
| 8.00 a. m. | 1000 | 18.18 | 6.80 | 480 | 24.9 | 46.3 |
| 10.00 a. m. | 960 | 18.75 | 6.72 | 450 | 22.6 | 45.1 |
| 12.00 noon | 905 | 19.72 | 6.72 | 390 | 21.1 | 42.6 |
| 2.00 p.m. | 815 | 20.88 | 6.96 | 325 | 18.5 | 40.1 |
| 4.00 p.m. | 720 | 23.40 | 6.94 | 255 | 17.2 | 35.6 |
| 6.00 p.m. | 690 | 23.18 | 7.18 | 235 | 16.4 | 31.4 |

to a fine powder and taken for analysis.

The nitrogen (N) content was determined by microKjeldahl method[13] and crude protein (CP) was expressed as N x 6.25. A method described by Lees[14] was employed for the estimation of crude fiber. The crude fat content was estimated using soxhlet extrarator with chloroform: methanol (70:30) as a solvent. Cellulose content was estimated following Sadasivam and Manickam[15]. The dry samples were boiled in distilled water, filtered and amount of water soluble reducing sugars was determined in the filtrate by using Folin-wu tubes[16]. Total ash and calcium contents were estimated following the A. O. A. C.[17] methods. The amount of phosphorus was measured following Fiske and Subba Rau[18], as described by Oser[16]. The chromic acid oxidation method of O'shea and Maguire, as described by Mungikar[19], was followed to determine gross energy (GE).

**Results and Disscussion**

The chemical composition of whole plant, dry leaf, stem portions, as well as leaf protein concentrate (LPC) and

pressed crop residue (PCR) is given in Table 1. The leaves contained 4.83 % N on dry matter basis against 2.66 % in the stem portion. Thus, the crude protein content in the leaf and stem portion were 30.20 and 16.16 %, respectively. As expected, crude fiber (CF) content in the leaf was 9.9 % against 35.4 % in the stem portion. The leaves were rich in crude fat, containing 19.45 % against 11.05 % in the stem portions. As with crude fiber, the cellulose content in the leaf portion was low *i. e.* 3.73 % in comparison to 46.0 % in the stem portion. The lucerne plant contains 0.94 % water soluble reducing sugar (WSRS). The sugar content was high in leaf (1.71%) as compared to that in stem portion. The leaves were rich in ash content. The whole plant of lucerne had 1.13 % calcium while 0.13 % phosphorus in its dry matter. The leaf portion was found to be rich in the contents of calcium and phosphorus (1.90 and 0.16 %, respectively) against the values for stem portion. The gross energy was 3.67 Kcal/g of dry leaf meal against 3.51 Kcal/g in stem portion, while 3.58 Kcal/g in the whole plant. A comparison between chemical composition of the dry matter of whole plant, leaf and stem portion indicated that the leaves are more nutritious than the stem portions with higher values for crude protein, crude fat, calcium and phosphorus content, as well as gross energy. The content of crude fiber and cellulose in the stem portion was found to be higher. The difference in the chemical composition of leaf and stem portion was found to be statistically significant. Thus, it can be concluded that, the leaves from green foliage of lucerne is nutritionally rich than remaining part of the plant material. It is advocated that the leaf meal prepared from lucerne can be used in animal nutrition as a nutritious feed rather than whole crop plant.

Table 1 reveals that nutritive value of LPC is superior to that of leaf meal, as it contains 50.0 % crude protein, 2.26 % calcium, 0.28 % phosphorus and 4.59 Kcal/g gross energy. The values of various chemical constituents obtained for PCR and stem portion were comparable, however, in general the stem portion was found to be rich in inorganic constituents over pressed crop residue. The results obtained are in agreement with those reported by Agbede[10]. The nutritive value and simplicity of the preparation of the LPC makes it suitable as a source of protein in food products. The results further suggest that the LPC from lucerne could also be used as protein supplements in non-ruminant feeding. However, under acute shortage of plant protein, leaf meal could be fed to the ruminant animals.

Table 2 gives an account on the data on effect of delay in fractionation of lucerne foliage on the yield of LPC. The weight of 1 kg lucerne immediately after harvesting gradually decreased to 690 g due to evaporation of water and wilting of the foliage. It affected percent dry matter in the foliage which increased gradually from 18.18% at 8.00 a. m. to 23.18% at 6.00 p. m.. The N% of dry matter in the foliage, however, increased from 6.80 to 7.18% due to the loss of water during the period of 10 hours. The amount of juice obtained per kg of green foliage decreased gradually from 480 ml at the beginning to 235 ml in the evening. When prepared in the morning, 1 kg of fresh lucerne yielded 24.9 g dry LPC with 46.3% crude protein. However, when the foliage was fractionated subsequently, there was a gradual decrease in the yield of LPC and its protein content. In the evening, at the end of experiment, the yield of LPC reduced to 16.4 g with 31.4% protein in it.

*Conclusions* - The chemical composition of leaf meal and LPC revealed that, the former is most suitable in animal nutrition as feed grade product while LPC in human and poultry nutrition as a food grade product. In addition, the chemical composition of stem portion of lucerne foliage was in agreement with the pressed crop residue (PCR) suitable for feeding to the ruminant animals under acute shortage of feed grade products. It was also pointed out that while preparing LPC, the green foliage should be, as far as possible, processed for the preparation of LPC immediately after its harvesting. Delay in processing leads to loss of water from the foliage associated with catabolic reactions leading to breakdown of proteins in foliage resulting in decreased yield of LPC with low protein content in it.

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