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NITROGEN ENRICHMENT OF LITTLE MILLET STRAW USING UREA

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Abstract: The following study has been conducted at Ajeenkya DY Patil University in Pune India. This project's main objective is to improve the nutritional value of little millet straw by using techniques and methods that can be conducted efficiently by farmers. The technique discussed in this research is done through both physical and chemical methods for the little millet straw. The mechanical methods used are chopping, cutting, and grinding of the straw for urea uptake. The chemical methods used are in Kjeldahl's flask. The chemicals used are concentrated sulfuric acid and sodium hydroxide. These two chemicals are used throughout Kjeldahl's method, which constitutes three steps: digestion, distillation, and titration. The results are expected that the treated stock will contain a higher crude protein percentage due to higher nitrogen presence observed through the chemical analysis. The method discussed requires very low labor at all and can be efficiently conducted by a farmer. Higher protein in straw will make it a better feed for the cattle. The only limitation is that Urea has 30% less nitrogen binding efficiency when compared to other nitrogen sources such as anhydrous ammonia, but it is readily available and very well known among farmers.

Index terms: Little millet straw, Urea, Urea treatment, ammonia, enrichment.

I.INTRODUCTION:

1. **Little millet** (*Panicum sumatrense* L.)

It is an associate degree annual herb that grows straight or with bifold blades to a height of 30 cm to 1 m. The leaves of the plant are linear, with the generally furry laminae and membranous furry ligules. The panicles of the plant are from 14-15 cm long with a 2-3.5 mm long beard. The grain is spherical and smooth, 1.8 to 1.9 mm long. Its nutrition composition is 8.7-grams protein, 75.7-gram carbohydrate, 5.3-gram fat, and 1.7-gram mineral per 100 grams.

Little millet originated in south-east Asia, and now grownup in most of the states of India, Dominant states in the production of little millet are Madhya Pradesh, Jharkhand, Uttar Pradesh. Other regions of producing little millet are china, East Asia, Caucasus, Indochina, Malaysia. It will stand up in the drought and wet area. [1]

1.2Urea

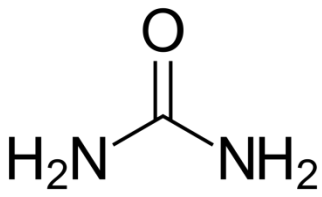

Figure 1: Chemical structure of Urea [2]

Urea is an organic compound with the chemical formula $CO(NH_2)_2$. Urea is the best nitrogen source as it holds about 46.6% nitrogen and protein holds 16% of nitrogen and when converted crude protein value of Urea is 290 gm/100 gm Urea. Urease enzyme developed by rumen microorganism and soil can breakdown urea to ammonia. After Urea's breakdown to ammonia, it provides the nitrogen source that helps ruminant for protein production.

Urea decomposes into ammonia and carbon dioxide by an enzyme called ureases under adequate temperature. The chemical reaction is:

$$CO(NH_2)_2 + H_2O \xrightarrow{urease\ enzyme\ ,\ ambient\ temperature} 2NH_3 + CO_2$$

Figure 2 Urea decomposition [12]

Urea dosage needed to treat little millet straw may vary a lot. Urea's recommended dosage is 4% to 5% of the dry matter, taking into consideration the effect of ammoniation and costs. Unlike anhydrous ammonia, Urea can be easily transported at standard temperature and pressure.

It is harmless to humans. Treating little millet straw with Urea does not need complicated equipment, and the sealing conditions are not as strict as with anhydrous ammonia.[3]

2. Urea Treatment

Urea is readily available in every part of the country, and it is safe to handle, use, and store. In the urea treatment process, ammonia is formed from Urea, and when dissolved in water, it forms alkali called ammonium hydroxide. In the treatment, there is an effect on the cell by dissolving structural carbohydrate hemicellulose, which rises the plant matter in an aqueous solution and reduces the cell's physical strength. This helps to increase protein intake, digestibility, and energy. [3]

3. Characteristics of Urea Treatment –

Urea treatment on little millet straw increases the intake, cellulose, hemicellulose, Neutral detergent fiber, acid

detergent lignin, acid detergent fiber, digestibility, and crude protein content.

Due to the addition of ammonia in urea treatment, there is an increase in crude protein by about 4-5%, increasing the digestibility. Increased digestibility and intake are due to cell wall degradation.

There is an increase of about 2-4 litre in milk yield in the milking cattle due to treated straw.

There are no negative impacts on the fertility or reproductive capacity or health of the animal. Also, in milking cattle, there is no residue of urea treatment straw in milk.

Due to Urea treatment on straw, straw consumption is increased, growth is observed, improvement in health and increase in milk yield and fat count in milking cattle. [3, 4]

II.FACTORS AFFECTING THE PROCESS-

1. Urea concentration

A lower level of Urea dissolved in water may not produce the desired ammonia for treatment; also, the Urea dissolved higher level may not show a beneficial effect. So, the desired amount of the Urea must be added to water accordingly. [3]

2. Water requirement

Water is necessary for treatment as it helps in the hydrolysis of Urea which forms the alkali and acts as the transport mechanism for ammonia to enter the cell wall. For achieving the desired result, an accurate proportion of water and Urea must be added. The final moisture level of the treated straw must be greater than 30%. [3]

3. Methods of spraying

For spraying the solution on straw, sprinklers may be used for uniform contact of the straw and solution of Urea.[3]

4. Compactness of the stack

Compact stack has advantages such as the ammoniation process is at an optimum level, and also there is the low possibility of mould growth which may spoil straw.[3]

5. Duration of treatment

The treatment duration may vary according to the region, as the temperature affects the rate of ammonia produced. Higher the temperature lower the time required for treatment.[3]

6. Type of crop residue used

Initial nutritional quality affects the optimum level of treatment. The lower the initial quality more outstanding is the effect of treatment as if the initial quality is better, there will be a lesser benefit.[3]

III.MATERIAL AND METHODOLOGY

1. Material

Little millet seed, Trustbasket® Organic Vermicompost Fertilizer Manure for Plants, Great indo gardens® UREA 1000 gram Urea NPK 46:0:0 plant Fertilizer,GJ MILLET MART® Organic Little Kutki Seeds for Sowing (1 Kg), groundwater for watering pH-7.20, distilled water, Kjeldahl's Apparatus (KjelTRON™ - Rapid Automatic Nitrogen Estimation System (Nitrogen Analyser), copper sulphate, potassium sulphate, ,conc. sulphuric acid, 40% Sodium hydroxide, 4% Boric acid, Se tablets, Methyl orange, 0.1N Hydrochloric acid, 0.1N sulphuric acid, Erlenmeyer flask, Burette, Digestion tube, SoxTRON™ - Rapid Automatic Fat/oil Solvent Extraction System (Soxhlet), Petroleum ether.

2. Fertilizer

For this project, Trustbasket® Organic Vermicompost Fertilizer is used in order to nutritionally enriched the soil which will in turn help in a better production quality and increase the yield of little millet plant. The product has been purchased from E commerce website, amazon.com, Inc. And the nutritional label as per the manufacturer can be seen in the image below.

NUTRIENTS COMPOSITION	CONTAINS (%)
Organic Carbon	9.8 -13.4
Nitrogen	0.51 - 1.61
Phosphorus	0.19 -1.02
Potassium VERM	0.15-0.73
Calcium COMPOST	1.18-7.61
Magnesium	0.093-0.568
Sodium	0.058-0.158
Zinc	0.0042-0.110
Copper	50.0026-0.0048
Iron	0.2050-1.3313
Manganese	0.0105-0.2038

Table 1 Nutrition label for fertilizer

The direction of used for the fertilizer has been done the way it was recommended, which was to evenly spread two handful of fertilizer over the soil once every 20 days. Since, the growth of plant has been conducted for 38 days, the fertilizer has been spread twice in the duration.

3. Little Millet Seed

For this project, GJ MILLET MART® Organic Little Kutki Seeds for Sowing (1 Kg) is used to obtain little millet straw from mature little millet plant. The product has been purchased from E commerce website, amazon.com, Inc.

Figure 4: GJ MILLET MART® Organic Little Kutki Seeds for Sowing (little millet seed)

4. Growth of little millet plant

The plant had been grown from seed into a sprout to a seedling and then into an adult plant. The indication that the seedling has matured into an adult plant is that the adult plant is able to reproduce and bear seeds. Hence when the little millet plant started to bear seeds, we decided to harvest it.

The plant has been daily watered with groundwater with ph7.20 inside a 9x17 inch claypot. The plant has been grown under normal temperature conditions (high 32°C and low13°C) and only external fertilizer is used additionally which has been mentioned above. The entire 38 growth period of the plant can be seen in figure given below from 12th February 2021 to 5th March 2021

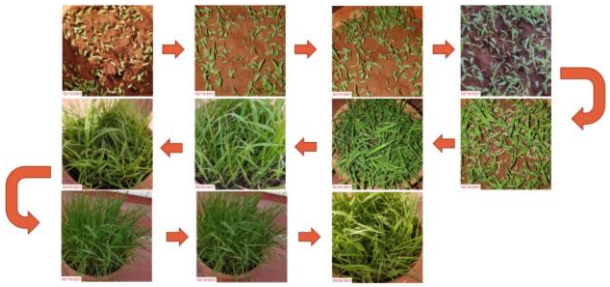

Figure 5: growth of little millet plant

The adult plant is then harvested and seeds are removed to obtain the plant straw. This straw is first used to estimate the moisture content and then further used for the urea enriching treatment.

5. Moisture content estimation

1. First, we have to prepare the sample by chopping the little millet straw into length not more than 1 inch for the ease of handling.
2. Next step is to weigh the container which is to be put inside the microwave so that later we can subtract this weight in order to gain accurate result. The time it will take for the sample to dry will depend on the power of microwave and how evenly the sample is drying and also its moisture content.
3. Now we put a sample into the container, which is then put inside the microwave. High power setting is recommended for the earliest stages of drying.
4. We begin drying through short periods of heating inside the microwave. 1 minute is enough for little millet straw at this stage.
5. Now we take the sample and container out and weigh it. This weight is recorded and then it is again put inside the microwave for the next round of drying. The sample is mixed before so that there is no unevenness while heating.
6. Continue drying the little millet straw for another 30 seconds if the straw was dry enough but if straw was still moist do this for a minute.
7. Precautions must be taken throughout this process as overheating the sample may cause it to burn which can also be avoided by using a lower power setting. Now take the dry sample out and reweigh it.
8. Now repeat steps 4 to 7 until the sample does not reduce to a weight which is one gram lesser than the previously recorded weight.
9. After the drying is successful, note down the dry weight of the sample and then calculate its moisture content.

Figure 6: weight of sample before drying

Figure 7: weight of sample after drying

6. Urea

For this project, Great indo gardens® UREA 1000gram Urea NPK 46:0:0 plant Fertilizer to use it as a nitrogen source for the little millet straw for nitrogen enrichment. The product has been purchased from E commerce website, amazon.com, Inc.

Figure 8: Urea crystals

7. Treatment of straw

I. 100 g of little millet straw is treated with 4 grams of Urea dissolved in 5 ml of water. To this solution, 1% of salt is added as well.

II. This little millet straw is mixed thoroughly, then stored in plastic bags after doing chopped into little particles

III. These straw bags treated with Urea are pressed and sealed to exclude all the air from the bag and then stored under the air-tight condition for up to three weeks at average room temperature.

IV. Now this straw is taken out of the bags and is dried under the sun. [3,15]

Figure 9: weight of urea used

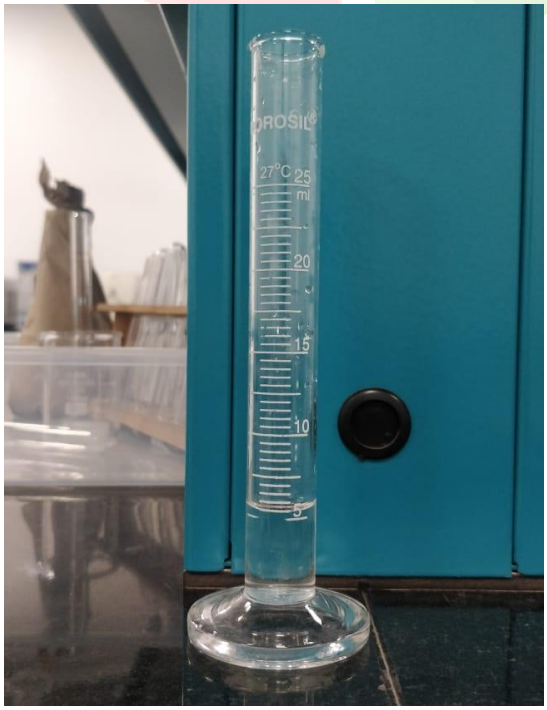

Figure 10: Amount of distilled water used

Figure 11: weight of sample used for enrichment

Figure 12: little millet straw during urea treatment inside airtight bag

8. Chemical analysis of dried millet straw to check the amount of nitrogen without dried faces is done through Kjeldahl's Method.

The following test has been conducted under supervision and assistance of MIT ADT University, Loni Kalbhor, Maharashtra. All the apparatus used are manufactured by Tulin equipments, Chennai.

Figure 14: KjelTRON™ - Rapid Automatic Nitrogen Estimation System (Nitrogen Analyser) – Digestion Unit

Figure 15: KjelTRON™ - Rapid Automatic Nitrogen Estimation System (Nitrogen Analyser) – Distillation Unit

This method was first introduced in 1883 by Johan Kjeldahl to estimate the nitrogen content in various organic and inorganic substances.

The apparatus can be seen in the figure given below. It contains a Kjeldahl flask, Kjeldahl trap, and a condenser.

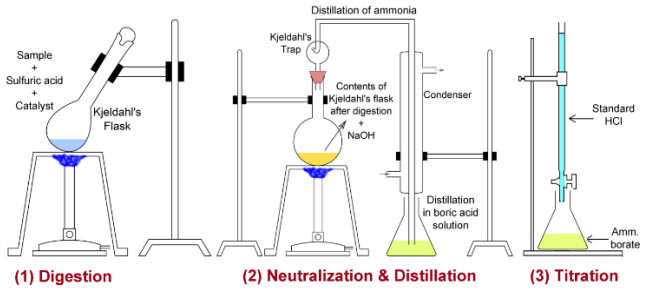

Figure 16. Kjeldahl's flask. [13]

In this process, it can be divided into three steps.

Digestion- the dry sample is heated with sulfuric acid. This results in the breakdown of the sample to oxidation and nitrogen are liberated in the form of ammonium sulfate. This forms a clear and colorless solution. The formula for the same can be seen below.

$$\text{Organic compound} + H_2SO_4 \rightarrow [\text{digest}]\ Cu^{2+} + (NH_4)_2SO_4$$

Figure 17: Kjeldahl's method - digestion.

Distillation- in this step, sodium hydroxide is added to the solution that converts the ammonium salt into ammonia which is liberated as distilled vapors. These papers are then trapped in a unique traffic system of the apparatus with hydrochloric acid and water solution. The formula for the same can be seen below.

$$(NH_4)_2SO_4 + NaOH \xrightarrow{\Delta} Na_2SO_4 + 2H_2O + 2NH_3NH_3 + HCl \rightarrow NH_4Cl$$

Figure 18: Kjeldahl's method - distillation.

Titration- now the amount of nitrogen can be estimated to the amount of ammonia in the sample through back titration. This happens because some HCL is neutralized due to ammonia but the acid left can be then titrated back with a standard solution of a base such as sodium hydroxide. The difference between the initial amount of acid and the amount of acid left after back titration can give us the value of nitrogen or ammonia. The formula can be seen below.

$$B(OH)_2 + H_2O + Na_2CO_3 \rightarrow Na_2HCO_3 + CO_2 + H_2O$$

Figure 19: Kjeldahl's method - titration.

IV. Calculation

1. Calculation of moisture content

- Moisture content in the sample (%) = $\left(\frac{wet\ weight\ of\ the\ sample - dry\ weight\ of\ the\ sample}{wet\ weight\ of\ the\ sample}\right) \times 100$

Figure 20: Formula for calculating moisture content

Figure 21: weight of sample before drying

Figure 22: weight of sample after drying

- Therefore,

Moisture content in the sample (%) $= \left(\frac{20.0824-2.6845}{20.0824}\right) \times 100 =$ 86.632%

2. Nitrogen estimation in the sample

Table 2 nitrogen content

	nitrogen content in untreated sample (mg/plant)	nitrogen content in treated sample (mg/plant)
Test 1	4.16	4.95
Test 2	4.16	4.93
Test 3	4.17	4.95

V.RESULTS

There has been an average 19% increase in nitrogen content of the straw

VI.REFERENCES

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