

A Monthly e Magazine
ISSN:2583-2212

Popular Article

Sept, 2023; 3(09), 2374-2377

Methodology To Study the Effect of Elevated Atmospheric Temperature and Carbon Dioxide Concentrations on the Quality of Groundnut Haulms as Livestock Feed

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Introduction

Climate change has become the main focus of social and scientific attention. It is one of the most critical threats facing the world today, with predicted increases in global mean temperature, length and severity of drought events, and atmospheric CO₂ concentration due to human activities (IPCC, 2014a). Rising atmospheric carbon dioxide (CO₂) concentrations along with increased ambient temperature are going to impact severely the food production systems including animal origin.

Greenhouse gases are the primary cause of rising temperatures in the atmosphere. The CO₂ level has risen at a pace of 1.9 ppm per year over the last twelve years and is expected to exceed 570 ppm by the middle of this century (IPCC, 2014b). As a result, the global surface temperature is expected to rise by 3-4.5°C (IPCC, 2014). Such increases in CO₂ concentration are expected to have cascading effects on numerous aspects of plant biochemistry, since plant productivity is strongly tied to atmospheric CO₂ through photosynthesis (Dietterich *et al.*, 2015).

In general, C3 plants are more responsive to elevated CO₂, which leads to greater main shoot length, elongation of branches, individual leaf area per plant, and dry mass. It is understood that the accumulation of sugars and starch in the leaves of elevated CO₂-grown plants reflects higher photosynthetic carbon assimilation (Cure and Acock, 1986).

There is limited information available on the influence of rising CO₂ levels and temperatures on the quality of groundnut haulms used as animal feed under the climate change scenario. Hence, an attempt has been made to investigate the effects of climate change, i.e., increased CO₂ and temperature, by cultivating groundnut crop in carbon dioxide and temperature gradient chambers (CTGC).

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Methodology

Groundnut crop was grown with recommended package of practices in Carbon dioxide and Temperature Gradient Chamber (CTGC) at four different environmental conditions.

- a) Chamber with ambient temperature and carbon dioxide i.e., 27 ± 0.5 °C temp and 380 ± 25 ppm CO₂ (T1; Control).
- b) Chamber with elevated temperature of 5 ± 0.5 °C more than control referred as eTemp (T2).
- c) Chamber with elevated CO2 concentration of 550 ± 50 ppm referred as eCO2 (T3).
- d) Chamber with elevated CO2 concentration of 550 ± 50 ppm with elevated temperature of 5 ± 50 0.5°C, over control referred as eCO2 + eTemp (T4).

At harvest stage, representative groundnut plants from each chamber were collected and haulms were separated and screened by chemical composition, energy content, mineral content, in vitro dry matter digestibility, in vitro gas production technique and digestibility of nutrients through a digestibility trial in Nellore Ram lambs.

1. Proximate Composition

The proximate analysis of groundnut haulms samples was performed as per the procedures described (AOAC, 1995). It includes the following:

- 1. Dry Matter (DM)
- 2. Total Ash
- 3. Organic Matter (OM)
- 4. Crude fibre (CF)
- 5. Crude Protein (CP)
- 6. Ether Extract (EE)
- 7. Nitrogen Free Extract (NFE)

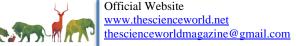
2. Fibre Fractions Analysis

Fiber fractions in groundnut haulms samples were performed as per the method described by Van Soest et al. (1995). It includes the following:

- 1. Neutral Detergent Fibre (NDF)
- 2. Acid Detergent Fibre (ADF)
- 3. Hemicellulose
- 4. Cellulose
- **5.** Acid Detergent Lignin (ADL)

3. Minerals Concentration

Minerals like Copper (Cu), Iron (Fe), Zinc (Zn) and Manganese (Mn) were estimated using diacid digestion and Inductively Coupled Plasma-optical emission spectrometry (ICP-OES) method.



6. In Vitro Dry Matter Digestibility (IVDMD)

In vitro DM digestibility of samples was determined by Tilley and Terry (1963) method using the instrument *Daisy incubator* by Ankom Technology.

4. Digestible Energy (DE)

DM digestibility values are used to estimate digestible energy (DE, MJ kg⁻¹) using the regression equation suggested by Fonnesbeck *et al.* (1984).

5. Metabolizable Energy (ME)

DE values are converted to ME using the formula reported by Khalil et al. (1986).

7. In Vitro Gas Production (IVGP)

In vitro gas samples were analysed using gas chromatograph (450-GC, BRUKER Daltonics, Bremen, Germany) with a stainless-steel column (80/100 mesh Porapak Q column) and a C-R3A integrator.

8. Digestibility trial

A digestibility trial with $2\times2\times2\times2$ Latin square design was conducted in Nellore ram lambs (8 No.s) with each group consists of 2 animals. 1^{st} group served as control and the other 3 groups are the treatment groups where in the pooled groundnut haulms from each treatment was used for feeding the experimental animals.

Conclusion

The study indicated that the nutritive value of groundnut haulms in terms of CP and DE/ME would decrease under eTemp and eCO₂ + eTemp environmental conditions. Further, cultivation of groundnut crop at elevated temperature and carbon dioxide levels would result in lower digestibility in small ruminants.

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