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

Adire Chandrakanth[1*], Yeleti Shyam Babu [2], D.D. Veera Hanuman[3]
[*]Corresponding author- M.V. Sc, Department of Livestock Production Management, College of Veterinary science, rajendranagar, Hyderabad, 500030
M.V. Sc, Department of Livestock Production Management, College of Veterinary science, rajendranagar, Hyderabad, 500030
Ph. D Scholar, Department of Veterinary Pharmacology and Toxicology, College of Veterinary science, rajendranagar, Hyderabad, 500030
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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 CO_2 concentration due to human activities (IPCC, 2014a). Rising atmospheric carbon dioxide (CO_2) 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 CO_2 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 CO_2 concentration are expected to have cascading effects on numerous aspects of plant biochemistry, since plant productivity is strongly tied to atmospheric CO_2 through photosynthesis (Dietterich *et al*., 2015).

In general, C3 plants are more responsive to elevated CO_2, 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 CO_2-grown plants reflects higher photosynthetic carbon assimilation (Cure and Acock, 1986).

There is limited information available on the influence of rising CO_2 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 CO_2 and temperature, by cultivating groundnut crop in carbon dioxide and temperature gradient chambers (CTGC).

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 ± 0.5ºC 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 ± 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 di-acid digestion and Inductively Coupled Plasma-optical emission spectrometry (ICP-OES) method.

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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 2×2×2×2 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 eCO_2 + 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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