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Evaluating the chemical composition of COFS 29 fodder harvested at various stage of maturity

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Abstract
Livestock's growth and development are conditioned by the adequate availability of feed and fodder. To address the rising need for green fodder, high yielding, high-quality perennial fodder plantations are urgently needed in India. A popular multi-cut sorghum variety, COFS 29 fodder were harvested six to seven times in a year. However, harvesting intervals have an impact on the quality of the fodder. Understanding the relationship between chemical composition and cutting interval throughout the growing period will help to optimize the cutting intervals between harvests in COFS 29 (multi-cut sorghum fodder variety) fodder verity. In the present experiment, samples were analysed for their chemical composition in fodders harvested at different intervals. Among the five harvesting stages, the first harvest was significantly (p<0.01) higher in dry matter, CF and NDF content and significantly lower in crude protein (CP) and NFE when compared to other harvesting intervals. The ADF, ADL, cellulose and hemicellulose content of the COFS 29 did not differ significantly between the harvesting intervals. After 90 days of plantation, the first harvest looks to be more mature, with a larger percentage of the stem component giving more dry matter with lower con of CP. Harvests made after 45 days aof regrowth are found to be ideal.

Keywords: Harvesting stages, COFS 29, multi-cut, chemical composition

Introduction
The livestock sector has grown at a 8.15 percent over the last five years ending 2019-20 and accounting for about 15 percent of their average monthly income (GoI, Economic Survey, 2021-22) [7], produced 198 million tonnes of whole milk in 2020, which is the highest and 40.41% of the world's milk production (Annual report, 2020) [2]. Livestock's growth and development are conditioned by the adequate availability of feed and fodder. The current green and dry fodder production estimates for 2020 are 590.4 and 467.6 million tonnes, respectively (Annual report, 2019) [3]. As a result, our country's fodder supplies are barely enough to sustain half of the existing cattle population, and leading to a deficit of green and dry fodder of around 260.9 and 62.85MMT, respectively; this deficit will increase further unless suitable strategies are initiated to enhance forage production (Annual report, 2020) [2]. Apart from unavailability, inconsistent quality of fodder is another major constraint in tropical countries, particularly in the summer, affecting ruminant production to a great extent (Jamsawat *et al.*, 2017) [11]. Compared to many affluent nations, India continuously produces livestock at below-optimal levels due to a lack of high-quality green fodder. Cultivating newer types of perennial fodders with higher biomass per unit area is an instant answer to meet the need for the existing livestock green fodder requirement and ensuring that nutrient-rich green fodder may be made available throughout the year (Khaing *et al.*, 2015) [14]. The COFS 29 fodder, a popular multi-cut sorghum variety, being perennial, six to seven harvests can be made in a year and can yield up to 170 t/ ha/yr of green fodder, capable of solving the problem of green fodder demand in India (Fazlullah Khan *et al.*, 2002) [6]. Special features of COFS 29 fodder are profuse tiller (10 -15/plant), large number of leaves, high palatability, high crude protein (8.41%) and less crude fibre (34.0%) (Annual report, 2015) [1]. Apart from this, COFS 29 fodder is becoming more popular and preferred by farmers due to its ability to grow in mid-to-late summer when cool-season perennials have low production.
Forages usually constitute the major portion of the ruminant diet, and high quality, nutritious green fodder is required to exploit the productive potential of dairy animals in our country (Datta, 2013) [5]. The chemical composition and palatability of fodder are the indicators of quality of the fodders.

The composition is influenced by things like harvesting age, soil mineral profile, fertiliser application, and agricultural practises (Muhindo *et al.*, 2018) [16]. The maturity level during harvest is important because it affects the stems/leaves ratio, structural components, and CP content (Wadi *et al.*, 2004; Kassi *et al.*, 2000) [22, 13]. The objective of the current study was to assess the impact of harvesting interval on the chemical composition of COFS 29 fodder, about which there is limited knowledge.

Material and Method

The present experiment was conducted at the Department of Animal Nutrition, Veterinary College, Nandinagar, KVAFSU, Bidar, Karnataka. The experiment included preparation of land and chemical analysis of samples. Land preparation for the crop started with manual removal of weeds, ploughing of the fields, and harrowing the land very well, so that the bed is ready for plantation. To improve the soil productivity, dried cow dung was applied to the soil at a rate of 2 kg/m2 (Roos, 1975). The plantation was done at a spacing of 90 cm between rows x 60 cm between plants. In the plot, weed control was manually done each month throughout the experimental period, and irrigation was given once every 10–15 days. Plot was planted with COFS 29 in the month of February. On the last day of each cutting interval (the 90th day of plantation and four subsequent harvests at the 45th day of re-growth), forage was harvested from the plots. Cutting was done at 10 cm above the ground level. Triplicate samples were collected from the harvested fodder at three different locations. All of the samples were brought right away to the Animal Nutrition Laboratory and dried until constant weight in a hot air oven at 60 °C. After drying the samples, they were pulverised in a tri-hammer mill with a 1 mm mesh screen. Prior to various chemical analyses, the resultant powders were stored in corresponding plastic bags. The pooled samples of fodder were analyzed Dry matter (DM), ash, organic matter (OM), lipid, crude protein (CP) and nitrogen contents were determined according to the methods described by AOAC (2016) [4]. (Van Soest *et al.*, 1991) [21]. Fibre components (NDF, ADF and ADL) were determined according to Van Soest *et al*. (1991) [21].

Statistical analysis

The results were expressed as mean±SE (n=3). Significance was tested by employing analysis of variance (Two way ANOVA).

Result and Discussion

In the current experiment, relatively higher percent of dry matter (DM), crude fibre (CF) and neutral detergent fiber (NDF) was observed in the first harvest when compared to all other harvesting stages (Table 1). This was likely to be due to delayed harvesting (made after 90 days of plantation) (Ravindra *et al.*, 2023) [18]. As the plant ages, dry matter content of plant cells will increase due to the lower water absorption capacity of the plant (Muhindo *et al.*, 2018) [16]. In the third harvesting stage, organic matter (OM) content of COFS 29 was significantly (p<0.01) higher than the first harvesting, however, there was no significant difference among the other harvesting intervals. Relatively, OM and TA (total ash) content of first harvest was lower and higher, respectively in comparison to other all harvesting intervals. This could be due to the known fact that OM and TA content of plants are always inversely proportional to each other and TA content will increase with plant maturity (Muhindo *et al*., 2018) [16].

CP and NFE contents were significantly (p<0.01) lower in the first harvest, but no significant difference (p<0.01) was observed in all other harvesting stages. The lower content of soluble sugars (NFE) and CP in the first harvest could be due to the maturity of the plant. As plants mature, structural components increase and, proportionately, CP and NFE content are diluted in the total dry matter. (Kassi *et al*. 2000; Humphreys, 1991, Susma, 2020) [13, 9, 20]. In the present study, no significance difference in CP and NFE content among the harvesting stages (except first harvesting stage) were likely to be due to the same harvesting interval, which was carried out after 45 days of subsequent re-growth.

Relatively, ether extract (EE) was lower in the first harvest, when compared to all other. This could be due to delayed harvesting in the first cut (Ramya *et al*. 2017) [17]. Previous research has also revealed that as the plant ages, the lipid content decreases (Jagadeesh *et al*., 2017; Muhindo *et al*., 2018). The EE content ranged from 1.76-2.02%, and these variations could be due to many factors within lipid synthesis by the plant (Ramya *et al*. 2017) [17]. Ramya *et al*. (2017) [17] reported similar results of decreasing EE with the increasing maturity for CO(CN)4, CO(BN)5 and COFS 29 fodder with 45, 60 and 75 day harvesting intervals.

In comparison to other harvesting stages, the CF and NDF content were significantly (p<0.01) higher in the first harvest. Similarly, even though, ADF(Acid detergent fibre), ADL (Acid detergent lignin), cellulose and hemicelluose contents did not differ significantly, among the harvesting intervals, numerically higher value was found in the first harvest. Higher values of CF and fibre fractions in the first harvest could be due to the maturity of the plant. According to earlier reports, with the maturity of the plant, structural fibres (NDF, ADF and ADL) content starts increasing along with the DM (Kaitho and Kariuki, 1990; Lounglawan *et al*., 2014; Ramya *et al.*, 2017; Himani *et al.*, 2019, Susma, 2020) [12, 15, 17, 8, 20].

Table 1: Chemical composition (% on DMB) of COFS 29 fodder at different harvesting interval

Composition	COFS 29 (Multi-cut sorghum fodder)					
	1st harvest	2nd harvest	3rd harvest	4th harvest	5th harvest	P
DM	35.84^{a}±0.73	32.69^{b}±0.53	33.83^{ab}±0.10	33.02^{ab}±0.19	33.47^{ab}±0.23	<0.01
OM	89.28^{b}±0.09	90.18^{ab}±0.18	90.63^{a}±0.23	89.99^{ab}±0.22	90.17^{ab}±0.12	<0.01
CP	7.38^{b}±0.11	8.89^{a}±0.07	7.92^{a}±0.05	8.02^{a}±0.08	7.89^{a}±0.19	<0.01
EE	1.76^{b}±0.06	2.02^{a}±0.05	1.81^{ab}±0.09	1.97^{a} ±0.17	1.86±0.32	<0.05
CF	31.04^{a}±0.10	28.08^{c}±0.15	29.84^{b}±0.32	29.22^{b}±0.92	30.08^{ab}±0.29	<0.01
NFE	49.10^{b}±0.05	51.19^{a}±0.31	51.06^{a}±0.36	50.78^{a}±0.51	50.34^{a}±0.47	<0.01
TA	10.72^{a}±0.09	9.82^{b}±0.18	9.37^{b}±0.23	10.01^{b}±0.31	9.83^{b}±0.78	<0.01
AIA	4.97^{ab}±0.08	4.79^{b}±0.16	5.46^{a}±0.13	5.34^{a}±0.17	5.52^{a}±0.46	<0.01
NDF	69.96^{a}±0.26	67.71^{b}±0.22	68.18^{b}±0.32	68.44^{b}±0.92	67.96^{b}±1.14	<0.01
ADF	34.59±0.59	34.09±0.92	35.16±0.19	35.37±0.52	34.77±0.33	NS
ADL	6.91±0.27	6.64±0.13	6.81±0.12	6.53±0.21	6.48±0.23	NS
Cellulose	27.67±0.79	27.45±1.04	28.35±0.30	28.84±1.55	28.39±0.42	NS
Hemicellulose	35.38±0.85	33.62±1.05	33.02±0.28	33.07±1.28	33.19±1.25	NS

Note: Each value is the mean of six observations

: Mean values bearing different superscript in a row differ significantly (p<0.01, p<0.05), and

with at least on common superscript they don't; NS: Non significant (1st harvest- After 90thd of plantation, four subsequent harvests after 45th day of re-growth)

Conclusion

The results of this study show that, compared to subsequent harvests done after 45 days of re-growth, COFS 29 fodder harvested 90 days after planting under irrigation delivers outstanding DM yields but comparatively poor crude protein yields. COFS 29 can produce high-quality fodder if harvested earlier than 90 days after planting. On the other hand, the chemical composition of subsequent harvests made after 45 days of intervals was less affected by harvesting intervals. To establish the ideal age for the first cut after plantation and to confirm whether these preliminary findings are representative in a commercial setting, more study in more extensive field conditions is required.

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