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Influence of moisture variability on nutritive contents of herbaceous legumes for utilization in dairy production

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***Target audience:** Dairy farmers, Ruminant animal scientist, Agroclimatologists, climate-change analyst, animal feed scientists*

Abstract

The aim of the experiment was to analyze the seasonal variations on the nutritive composition of two herbaceous legumes; Dolichos rongai (DR) and Commander chicory (CC) across two sub-seasons (early and late rain) planted on the pastureland of Bowen University, Iwo. Leaf samples were collected twice in each month to make six (6) replicates for each legume. Proximate analysis; moisture, ash, crude-fiber (CF), ether-extract (EE), crude-protein (CP) and Nitrogen-free-extract (NFE) and the chemical composition; neutral-detergent-fibre (NDF), acid-detergent-fibre (ADF), acid-detergent-lignin (ADL) and metabolizable-energy (ME) were carried out in the analytical laboratory. Moisture (%) was significantly higher for DR in early-rain (52.06%) and late-rain (39.42%), these values were lower and in contrast for CC which had higher value in late-rain (18.65%) but lower value (7.23%) in the early-rain. Higher value for CP% in CC (4.46%) while DR was 3.15% CP in the early-rain. The CP% values were p <0.05 higher in the early-rain as compared to late-rain. CC had the higher value for ME (2980kcal/kg) values were p <0.05 higher in early-rain as compared to late-rain (1612 kcal/kg), this was in contrast for DR with p <0.05 lower value during the early-rain (1459 kcal/kg) as compared to late-rain (2064 kcal/kg). The analysed values for CF (%) and ash (%) were higher in the late-rain. Summarily, there were variations in nutrient composition of the herbaceous legume in the rainy sub-seasons. Feeding trials is further recommended to validate these findings.

***Keywords**: metabolizable energy, nutrient composition, pasture, proximate analysis, seasonal variation*

Description of Problems

Forages make up 70 -80% of ruminant diet in the tropics and locally-adapted cattle are fed a diet that is based essentially on these pasture forage species comprising both grasses and legumes [1]. Unfortunately, these forage species generally have low nutritive value with large seasonal variations (this is typical of the tropics) in quantity and quality [2]. Apparently, the nutritive value of forages as well as good feed quality contributes about 60% to the proper growth and productivity of dairy animals [3].

Pastureland can be defined as open field cultivated for grazing and feeding of livestock. Pasture species predominate the tropical regions with Nigeria as a tropical country not excluded. They are primary feed sources which serves as forage and the available pasture species used as fodder in the tropical regions for grazing livestock with dairy cattle inclusive (2). These pasture

species include herbaceous legumes and grasses. Legumes are from the large family *Fabaceae (Leguminosae)* which have nodules on the roots having nitrogen fixing bacteria while on the other hand, grasses are of the family *Poaceae*. Common examples of the herbaceous legume species (*Lablab purpureus, Stylosanthes guyanensis, Desmodium unicenatum and Desmodium intortum* (4) and other common forage legumes in Nigeria includes; Centro - *Centrosema pubescens*, Calapo - *Calapogonium mucunoides* and *Pueraria phaseoloides* (5). Others which can be categorized as crosses (*hybrid*) of herbaceous legumes are *Dolichos rongai* and *Commander chicory. Dolichos rongai* with common name *Lab lab bean* is indigenous to Kenya (6). (7) confirmed that this is widely distributed across Africa and other continents as a good dairy forage. *Commander chicory (*similar to *Cichorium intybus)* belongs to the family *Asteraceae*, usually with bright blue flowers (blue daisy) (7).

The supply of nutrients from these pasture species to the grazing animals can be improved by the cultivation of improved seeds of promising tropical pasture species (8). This is so because the nutritive value of forages is affected by the combined effects of genetic, environmental and crop management factors of these cultivated pasture forages (4). The genetic factors include: species and variety of the forage while eenvironmental factors which serves as culture media for the growth of the forage's responses to both biotic and abiotic factors. The abiotic factor such as rainfall is controlled by sub-season. The tropics which is characterized by seasonal changes and in turn greatly affects the nutritive values (the quantity and quality) of these pasture species (9). In the rainy seasons as opposes to the dry season, the moisture content, crude protein and total soluble sugar will increase and the ash content will decrease thereby making the plants to be more succulent and less fibrous with high nutritive value (9).

Herbaceous legumes are a part of these available pasture species used as fodder in the tropical regions, and thus exploring their nutritive characteristics is imperative in the effort to improve dairy productivity. For the purpose of this study, only the two mentioned *hybrid* legumes will be explored. The aim of this study therefore is to investigate the influence of two rainy sub-seasons (early and late rain) on the nutritive contents (proximate analysis and chemical composition) of two *hybrid* legumes (*Dolichos rongai* and *Commander chicory*) for utilization in dairy cattle production.

Materials and Methods

This experiment was designed in randomised complete block design (RCBD) laid out in 2 x 2 factorial arrangement to analyze the seasonal variations on the nutritive composition of two herbaceous legumes; *Dolichos rongai* (DR) and *Commander chicory* (CC) across two sub-seasons; early and late rainy season (April – June and July – September) respectively planted on the pastureland of Bowen University, Iwo, Osun State, Nigeria. Leaf samples were collected twice in each month to make six (6) replicates for each legume across each of the two sub-seasons and the replicate samples were pulled for each month and analyzed in triplicate.

Sample processing and laboratory analysis

The collected leaves were initially sun dried for 8 hours in two days and later oven dried at low temperature of 40^{o}C for 5 hours. The dried leaves were milled into fine

texture individually using a cyclotec sample mill so as to increase the surface area and the milled leaf samples were all packaged and labeled respectively to avoid mix up. The proximate analysis which included the content of; moisture, ash, crude fiber (CF), ether extract (EE), crude protein (CP) as well as the Nitrogen free extract (NFE) all in percentages content (%) and totalling 100%were determined according to (11). The chemical composition; neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) and metabolizable energy (ME) were analyzed according to (10) in the analytical laboratories.

Statistical analysis

Data were subjected to analysis of variance (ANOVA) using SPSS IBM version 25 [12]. The treatment means were separated using Duncan multiple range test (DMRT); when the F tests were significant.

Results and discussion

Tables 1 and 2 revealed the proximate analysis and chemical composition of the herbaceous legumes in the rainy sub-seasons respectively. The measured parameters for moisture (%), CP (%), NFE (%) and ME (kcal/kg) were different *(p <0.05)* between the sub-seasons. Moisture (%) was significantly higher for DR *in* early-rain (52.06%) and lower in late-rain (39.42%), these values were lower and in contrast for CC which had far lower value in late-rain (18.65%) and much lower value (7.23%) in the early-rain. Comparatively, *Dolichos rongai had* far higher moisture content (39% – 52%) in respect with *Commander chicory* having less than 20% (7 – 19%) moisture content.

The dry matter weight of the forage is inversely proportional to the moisture content. Hence the higher the moisture content, the lower will be the dry matter and the more succulent the forage will be for the consumption of ruminant animals. High moisture content of above 50% observed in this study (in DR) is consistent and in line with [13] that observed a moisture content of 56 - 64 % in *Para grass* forages. Conversely, higher moisture content observed in the early rainy season is at *par* with what is observed by [9] that moisture content decreases in the forages and invariably dry matter increases during the late rainy season because the forages reach maturity and becomes more fibrous.

The mineral or ash content is *(p <0.05)* higher (22.59%) in the late rain and 14.17% in the early rainy season in the *Commander chicory*. The lower ash content observed in the *Dolichos rongai* (6.19% and 6.42%) in the early and late rain respectively is within the range of the ash content observed in (12) of 4.19 – 6.63% ash content. The ash content is the inorganic component of the feed which contains both macro (nitrogen (N), phosphorus (P), potash (K), calcium (Ca), sulfur (S), magnesium (Mg) and micro minerals (boron (B), zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), molybdenum (Mo) and chlorine (Cl)). [14] pointed that legumes are rich sources of calcium, phosphorus and crude proteins. Furthermore, [15] supported that reduced feed digestibility is caused by low concentrations of macro and micro minerals nutrients, which have a detrimental impact on rumen microbial activity and development. [15] also pointed out that the combination between locations and seasons has a substantial impact on the micro minerals.

Table 1: Means values of the proximate analysis of the herbaceous legumes in the rainy sub-seasons

Legumes	Rainy Sub-seasons	Moisture (%)	Ash (%)	Crude Fibre (%)	Ether Extract (%)	CP (%)	NFE (%)
DR	Early	52.06±0.62^{a}	6.19±0.40^{c}	8.65±0.33^{b}	6.02±0.17^{a}	3.15±0.17^{b}	23.62±0.82^{d}
	Late	39.42±0.39^{b}	6.42±0.24^{c}	11.38±0.42^{a}	2.30±0.24^{b}	1.32±0.08^{d}	39.16±0.80^{c}
CC	Early	7.23±0.50^{d}	14.17±0.52^{b}	3.24±0.12^{c}	6.85±0.10^{a}	4.46 ±0.05^{a}	64.05±0.21^{a}
	Late	18.65±0.20^{c}	22.59±0.17^{a}	2.88±0.16^{c}	6.90±0.58^{a}	2.49±0.20^{c}	46.49±0.66^{b}

DR- Dolichos rongai, CC- Commander chicory, CP- Crude Protein, NFE- Nitrogen Free Extract
**Note: Means along columns with different superscripts denote significant differences between cultivars (p <0.05)*

Table 2: Means values of the chemical composition of the herbaceous legumes in the rainy sub-seasons

Legumes	Rainy Sub-seasons	NDF (%)	ADF (%)	ADL (%)	ME (kcal/kg)
DR	Early	33.35±1.54^{d}	27.35±1.19^{b}	21.64±0.91^{b}	1459.50±55.77^{d}
	Late	62.37±3.91^{a}	36.99±0.15^{a}	29.59±0.43^{a}	2064.20±27.10^{b}
CC	Early	32.28±1.82^{b}	23.41±1.06^{c}	17.07±0.53^{c}	2980.10±2.98^{a}
	Late	31.66±1.67^{b}	23.28±0.73^{c}	17.27±0.76^{c}	1612.30±24.77^{c}

DR- *Dolichos rongai* ***CC****-Commander chicory* ***NDF-*** *Neutral Detergent Fibre,* ***ADF****-Acid Detergent Fibr* ***ADL*** *-Acid Detergent Lignin,* ***ME****-Metabolisable Energy*
**Note: Means along columns with different superscripts denote significant differences between culti vars (p <0.05) e,*

There was significant difference in the crude fibre content of the DR with lower mean value of 8.65% in the early rain and higher value of 11.38% in the late rainy sub-seasons respectively however there was no significant difference in the crude fibre contents of CC in the early (3.24%) and late (2.88%) rain respectively. Similarly, there was significant difference in the ether extract (crude lipids) content of the DR with the mean value of 6.02% in the early rain and 2.30% in the late rainy sub-seasons respectively however there was no significant difference in the lipid contents of CC in the early (6.85%) and late (6.90%) rain respectively. The significant difference in the crude fibre and lipid contents of DR could be explained that seasons and the age of the plant brought about variability in the mean values of this parameter. The resultant effect is that, as these plants were getting older, the more fibrous it became and inversely, the lower the lipids and the moisture content in DR. However, the seasons and the age did not have a significant effect on the crude fibre and lipids contents of CC. According to [16], the lipid content in diet of ruminant animals may be as low as 5%, what is obtained in this study is higher than this as found in CC as well as DR during the early rain.

For the crude protein % CP, the percentage mean values were higher (*p <0.05)* in the early-rain (3.15% and 4.46%) as compared to late-rain (1.32% and 2.49%) for DR and CC respectively. However, there was higher % CP mean value in the CC (4.46%) while DR was 3.15%CP in the early-rain. According to [15], there were higher CP contents in the forages during the

rainy seasons which drastically reduced as the plant got older towards the dry season. Furthermore, the content of the CP depends on the part of the plant analysed, although only the leaves of the plants were analysed in the study. It was observed by [14] that the leaves had double of the CP contained in the stem hence lower CP may be expected to be in the stem. The ranges of the crude protein percentage in this study were similar to what was obtained in the study by [13] of 3.82 to 5.48% but lower to about 6 – 8% obtained in the studies by (14). It was also pointed by [13] that protein is the most important parameter of nutritional quality of fodders.

There were significant effects of the sub-seasons on the nitrogen-free extract mean values of the two legumes with CC having higher values of 64.05% and 46.49% in the early and late rain respectively. However, the reverse is the case for the DR, with lower but significant % NFE of 23.62% in the early rain and higher value of 39.16% in the late rain. Nitrogen-free Extract (NFE) is the remaining percent of a feed after the percent content of the moisture/water, ash, crude protein, crude lipid and crude fibre is subtracted from 100%. Thus, NFE is the only proximate analysis component that is not determined analytically in the laboratory but rather obtained by calculation. The NFE is consisting of carbohydrates, starches and sugars in feeds; all these are referred to as non-structural or non-fibrous carbohydrates [16].

Neutral detergent fibre (NDF) basically contains the cell wall components of the forage including lignin, cellulose and hemicellulose while Acid detergent fibre (ADF) contains the non-digestible portion of the forage usually the lignin and the cellulose excluding hemicellulose that is NDF minus the hemicellulose is the ADF. The Acid detergent lignin is the ADF excluding the cellulose [16]. For the DR in this study, there were significant effect of the seasons on the mean values for NDF, ADF and ADL but there was not significant effect on these parameters for CC.

In table 2, the metabolizable energy (ME) is the energy expected to the retained and not lost when these forages are consumed by the animal. “It is the energy remaining after urinary loss and gaseous losses arising from the gastrointestinal tract are subtracted from digestible energy” [16]. *Commander chicory* had the higher value for ME (2980kcal/kg) values which was higher *($p < 0.05$)* in early-rain as compared to late-rain (1612 kcal/kg), this was in contrast for DR with lower *($p < 0.05$)* value during the early-rain (1459 kcal/kg) as compared to late-rain (2064 kcal/kg).

Conclusion and Applications

1. Summarily, there were variations in nutritive contents of the herbaceous legume in the defined rainy sub-seasons. These variations might have either positive or negative influence on the milk production of dairy cows in the tropical region.
2. This study is expected to provide dairy farmers with guide on planning and utilization of these feed resources either in combination with other available forages or with the use of supplements for inadequate nutrients in the forages.
3. Feeding trials is further recommended to validate these findings.

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