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Full Length Research Article

Interaction Effect of Season, Habitat and Leaf Age on Proximate Composition of *Senna occidentalis* and *Senna obtusifolia* Leaves Grown in Fadama and Upland Locations in Sokoto, Nigeria

*[1]U. Tambari, [2]B. L. Aliero, [2]S. Muhammad and [3]L.G. Hassan
[1]Department of Biology, School of Sciences, Shehu Shagari College of Education, Sokoto, Nigeria
[2]Department of Biological Sciences, Faculty of Science, Usmanu Danfodiyo University, Nigeria
[3]Department of Pure and Applied Chemistry, Faculty of Science, Usmanu Danfodiyo University, Sokoto, Nigeria
[*Correspondence Address: utambari@gmail.com; ☎: +2348053014730]

ABSTRACT: This study was aimed to assess the effect of season, habitat and leaf age on proximate composition of leaves of *Senna occidentalis* L. and *S. obtusifolia* L. Leaves samples were collected from stands of Fadama Research Farm and Upland (Biological garden) at Permanent Site, Usmanu Danfodiyo University Sokoto and analyzed for nutrient contents using oven drying, muffle furnace ashing, soxhlet extraction, distillation and ashing, micro Kjeldahl method, and difference (NFE) methods. Data was subjected to ANOVA and LSD at 0.05% for means separation. The results for interaction effect were all statistically significant ($P<0.05$) in the leaves of the two Senna species and were influenced variedly by the treatment factors. Specifically, rainy subseason, fadama and upland habitats, young and matured leaves treatments favoured most of the nutrient contents (e.g. moisture, ash, crude fibre and NFE) in the following ranges : Moisture (31.37 - 81.07%), Ash (3..50 - 80.00%), Crude Fibre (1.00 – 12.50%), Ether Extract (1.07–5.47 %), Crude Protein (7.13 – 18.94 %) and NFE (60.49 - 83.66%). This indicates that season, habitat and leaf age are important factors affecting plant growth and development. The results suggest that the species may be sources of the nutrients studied and could enrich the dietary intake of individuals.
Keywords: Interaction effect, Season, Habitat, Leaf age, Proximate composition, *Senna.*

INTRODUCTION

Due to increasing population and economic crises in most developing nations, for example in Nigeria, food insecurity has been a serious threat to growth, development and survival (Hassan *et al.*, 2007), hence partly the focus on non- conventional wild plants for supply of nutrients. Bulus *et al.* (2007) assert that most people are now incorporating the non-conventional (wild) food plants in their diets, to provide not only nutrients but also traditional treatment for various ailments. Tukan *et al.* (1998) reported that over the last two decades, studies have revealed that wild or semi-wild plants are nutritionally important because of higher vitamins, minerals, essential fatty acids and fibre contents. Some of the plants also enhance taste and colour in diets (Bianco *et al.*, 1998). From the study of Smith *et al.* (1996) on wild and cultivated plants from regions in Burkina Faso and Niger Republics, the edible wild plants were often the highest in mineral contents particularly in zinc. High protein content was also reported in some wild vegetables in Botswana (Flyman and Afolayan, 2007).

Septic weed or Coffee Senna (*Senna occidentalis* L.) and *Senna obtusifolia* L. (Sickle-Senna or Sickle-Pod) are parts of the numerous important wild plant species growing in the savanna region of Nigeria functioning as primary producers in the ecosystem. Their leaves, especially when young, are cooked and eaten as vegetables by majority of the rural communities in the zone. The flowers, fruits and seeds are also parts of the food and sometimes used as medicine for human consumption. These species are also used as fodder for animals. In addition, they provide shade and contribute to the supply of nutrients to the soil to increase soil fertility. The roots, stems and leaves are equally subjected to medicinal uses and the dry stalks as fuel wood in addition to provision of habitat to micro fauna and supply of other tangible products to human population. Evans (1982) reported that almost every part of any plant (root, stem, leaf, bark, flower, fruit and seed) is known to have some uses.

Literature search revealed that these species of plants under study have not been domesticated, but grow in the wild as weeds. *S. obtusifolia* L. is among the leafy vegetables that contribute to the rural women economic income in some parts of the study area (Bello *et al.,* 2008). The contributions of the leaves as dietary food vegetables to the populace in the study area has made these species under study very popular in the local communities of Sudan savanna, north-western, Nigeria. Hassan *et al*, (2002) have reported the following values with respect to proximate composition and mineral contents of *C. occidentalis* leaves: 82.30% moisture content, 10.00% ash, 1.70% crude fibre, 0.80% crude lipid, 1.74% crude protein, 3.46% NFE, 0.68mg/kg Ca, 0.15mg/kg Fe, 0.58mg/kg Mg, 2.25mg/kg K, 0.25mg/kg P, 0.50mg/kg Na and 0.05mg/kg Zn. They further stated that all the fourteen (14) elements known are essential. But the seven (7) determined elements in the study are the most important and the values obtained were within the ranges of their daily allowance and in conformity with findings of other similar plants of similar habitat in Sokoto and Northern Nigeria. Similarly, Umar *et al.* (2014) reported that interaction between leaf age and habitat had not significantly effect on the concentration of most nutrient elements studied but ash, crude fibre and K were significantly higher in young, fadama and upland treatments; ether extract was higher in matured, fadama and upland treatments; and Ca was higher in young and matured; and upland treatments. They concluded that leaf age and habitat are two independent factors that had independently and mutually influenced the concentration of some nutrient elements in the leaves of *C. tora* that has essential roles to play in health. The not yet quantified or unscientifically validated contribution of the leaves of these plants as dietary food vegetables to the populace in the study area has made these species very popular in the local communities.

This study was undertaken with a view to suggest scientific reasons for cultivating the species to ensure their sustainability by raising seedlings in both fadama and upland habitats and determine their foliar chemical compositions to reveal their nutritional potentials in the study area for socio-economic development. The study therefore, determined nutrients based on interaction effect of season, habitat and leaf age on the proximate compositions of the leaves of *S. occidentalis* L. and *S. obtusifolia* L. grown in fadama and upland locations of Sokoto, Nigeria.

MATERIALS AND METHODS

The Study Area

The study was conducted at the Permanent Site, Usmanu Danfodiyo University, Sokoto (05^0 10E - 05^0 12^1E, 13^0 04 0N – 13^0 06 40N) at 308 m above sea level. The climate is distinguishable into rainy season (May - October) and dry season (November - April), with a relatively cool Harmattan period (November - February) (NMA, 2009, and SARDA, 2009). The pattern of rainfall distribution ranges from 553.43 – 628. 94 mm but relative humidity is about 16 - 55.5% (NMA, 2009; SARDA, 2009). The average temperature ranges from 16.3°C during harmattan season to 44.7°C in the hot season (SARDA, 2009, and NMA, 2009). The fadama land of the area is clayey, hydromorphic, most productive, ecologically sensitive, most highly cultivated, both in the wet and dry season. It is low-lying relatively flat area occurring in streamless depression or adjacent to stream or rivers. The upland soils of the area are predominantly sandy (>90% sand). The surface texture of the soil is fine sand changing in some cases to loamy sand in the subsoil. Colours are usually dark to dark-red in the surface horizons and reddish brown in the subsoils or in the entire profile. The land is therefore very fragile and susceptible to serious soil erosion during both wet and dry season (Noma and Yakubu, 2002; Adeyeye, 2005; Yakubu *et al.,* 2008).

Treatments and Experimental Design

The treatments for this study were the stands of the study plant species: *S. occidentalis* and *S. obtusifolia* including the experimental sites: fadama and upland areas. It also consist of season (early and late: rainy and dry), and leaf-age (young (0-5days), and mature (>5 days). The experiment was laid in a completely randomized block design (CRBD) with repeated measure. Each of the study plant species had three blocks (beds) as replications respectively at each of the experimental sites (Fadama Research Farm and Biological Garden, permanent site of Usmanu Danfodiyo University Sokoto, Nigeria). The design allows for interaction study based on the treatment components of the study as reflected in result tables.

Sample Collection

Samples of fresh leaves were collected from the study species (*S. occidentalis and S. obtusifolia*) right from their seedling stage to their full stage of maturity based on days after sowing (DAS) at harmattan, dry and rainy subseasons of the year. Eight (8) innermost plants were sampled from the two (2) inner rows excluding the border line rows of each of the beds, making a total of twenty four (24) plants per 3 beds sampled for each plant species from fadama and upland locations. The leaf sample collection was done by handpicking tender young (0-5 days) and matured (>5days) green leaves and put in their respective bags for phytochemical analysis according to Evans (982).

Preparation of Sample

The samples were separately collected as young and matured leaves according to location/habitat of the plant (i.e. fadama and upland) for each of the plant species and were thoroughly mixed together in the laboratory before oven drying. The procedures adopted were as described by Krishna and Ranjhan (1980); Evans (1982); and Udo and Ogunwale (1986). The dried samples of each group were then pulverized separately using mortar and pestle and sieved in 0.5mm size mesh and stored for chemical analysis at each growing subseason.

Chemical Analyses

Two grammes (2g) of the powdered sample were used in the proximate analysis (Udo and Ogunwale, 1986}. The determination of each parameter was replicated thrice. The parameters determined were moisture (oven drying); ash (Muffle Furnace Ashing); ether-extract (Soxhlet extraction) and crude-fibre (distillation and ashing). The procedures were as described by Thiammaih (1999). Crude-protein was determined by Microkjeldahl Method; and nitrogen-free extract (NFE) was determined by difference as described by Udo and Ogunwale (1986).

Data Analysis

Data collected from this study were subjected to analysis of variance (ANOVA). Significant (P<0.05) differences were analyzed using the least significant difference (LSD) to separate the means.

RESULTS AND DISCUSSION

Moisture Contents

There was significant (P<0.05) difference in the moisture values obtained (Tables 1 and 2) for the interaction effect of growing season, habitat and leaf age with the highest moisture content obtained (81.07 %) during rainy sub-season, at upland and matured leaves treatment in *S. occidentalis* than all the other treatments. Similarly, late rainy growing subseason at fadama and matured leaf treatment gave the highest moisture content (80.50 %) in *S. obtusifolia* than all the other treatments. The moisture contents (33.20 – 81.07 % and 31.37 – 80.50 %) for *S. occidentalis* and *S. obtusifolia* respectively were below those reported by Hassan *et al.* (2002) in *C. occidentalis* (82.30 %); and Adegbola (1985) in fresh leaves (88.00 %) for leafy vegetables. These findings were in agreement with reports of De Leeuw (1979) and Evans (1982) that differences in nutrient composition found in plant species are due to changes caused by some factors e.g. temperature, rainfall, relative humidity, season, time of day, climate, genetic factors and stage of growth of the leaf or plant, plant age, position of leaves in the crown, habitat of the plant and natural differences that exist between plants. This finding of significant (P<0.05) effect on moisture content for interaction in this study was advancement over similar report made by Umar (2007) on interaction effect of season and stage of leaf development on moisture contents of four tree species but no significant effect was observed.

Ash Contents

The values of ash obtained in *S. occidentalis* (3.50 – 12.47 %) and in *S. obtusifolia* (5.13 – 80. 00 %) (Tables 1 and 2) were lower and higher than those reported by Hassan *et al.* (2002) in *C. occidentalis* leaves (10.00 %); and those of Umar (2007) respectively for interaction effect of season and stage of leaf development in four tree species (5.97 - 13.88 %). Similar finding was reported by Silmary *et al.* (2004) that nutrient concentration in the soil had more influence than composition of the foliage for the variation in the nutrient concentration of individual plant caused by differences in the plant's habitat or environment.

Crude - Fibre Contents

The significant (P<0.05) difference observed in the values of crude fibre ((Tables 1 and 2: 1.00 – 4.07 % and 1.43 – 12.50 % in the leaves of *S. occidentalis* L. and *S. obtusifolia* L.) for interaction effect, were within the range when compared with those reported by Ross *et al.* (1985) for most leafy vegetables (0.70 % - 12.0 %). This finding is in agreement with report of De Leeuw (1979) that the nutrients values of plant is individually and collectively affected by various factors such as edaphic, climatic and genetic factors and varies from time to time and location to location. Gent (2002) reported that differences in leaf nutrient concentration due to season often occurred in early rainfall. This finding implies that more of this nutrient content could be obtained from *S. obtusifolia* than from *S. occidentalis* during early rainy sub-season from fadama and young leaves of the stands of the study species.

Table 1: Proximate Composition of *Senna occidentalis* Leaves as Influenced by Season, Habitat and Leaf Age.

Treatments	Moisture (%)	Ash (%)	Crude fibre (%)	Ether Extract (%)	Crude protein (%)	N FE (%)
Dry Fadama Young	61.07[i]	8.03[d]	2.53[c]	3.53[c]	11.02[g]	74.90[c]
Dry Fadama Matured	77.83[d]	8.43[d]	2.93[c]	5.13[a]	11.68[h]	71.81[d]
Dry Upland Young	73.37[c]	8.03[d]	2.47[d]	4.03[b]	18.28[a]	67.21[e]
Dry Upland Matured	73.47[g]	8.00[d]	2.50[cd]	5.47[a]	10.11[j]	73.91[c]
Early Rainy Fadama Young	55.37[j]	12.47[a]	4.03[a]	2.03[e]	16.50[c]	64.97[e]
Early Rainy Fadama Matured	33.20[m]	12.07[a]	4.07[a]	2.47[e]	15.38[d]	66.29[e]
Early Rainy Upland Young	46.07[l]	11.00[b]	3.50[b]	2.03[e]	17.95[b]	67.72[e]
Early Rainy Upland Matured	54.37[k]	10.13[c]	3.00[b]	3.47[d]	15.25[d]	65.62[e]
Late Rainy Fadama Young	78.50[c]	7.47[e]	2.13[d]	3.03[d]	14.41[g]	74.98[c]
Late Rainy Fadama Matured	80.03[b]	3.50[h]	1.00[f]	1.07[g]	10.76[i]	83.66[a]
Late Rainy upland Young	78.47[c]	7.00[e]	3.03[b]	2.50[de]	13.66[e]	60.49[f]
Late Rainy Upland Matured	81.07[a]	4.53[g]	1.50[e]	1.40[fg]	11.48[h]	80.99[a]
Harmattan Fadama Young	77.07[e]	6.07[f]	1.50[e]	2.47[e]	12.80[f]	77.35[b]
Harmattan Fadama Matured	73.37[g]	8.37[d]	2.03[d]	3.40[d]	12.21[g]	74.13[c]
Harmattan Upland Young	74.47[f]	7.07[e]	2.00[d]	2.10[e]	12.80[f]	76.05[b]
Harmattan Upland Matured	72.13[h]	10.07[c]	2.50[cd]	3.50[cd]	12.21[g]	71.72[a]
Standard Error Mean	0.16	0.04	0.03	6.28	0.15	0.75
Significant (5%)	S	S	S	S	S	S

Within a treatment group, means in a column with the same letter(s) are not significantly different using least significant difference (LSD) at 5% level Using SAS (2003). SEM=Standard Error Mean; S=, NS= Non – Significant; NFE: Nitrogen Free Extract.

Ether Extract Contents

Result of Tables 1 and 2 reported for Ether Extract in the range of values: 1.07 – 5.47 % and 1.47 – 5.47 % for the leaves of *S. occidentalis* L. and *S. obtusifolia* L. were lower and others higher than the values reported by Hassan *et al.* (2002) in *C. occidentalis* (1.70 %); and in four tree species (3.27 % - 12.23 %) reported by Umar (2007) for interaction effect of season and stage of leaf development. These findings are in agreement with report of Abel *et al.* (1987) that browse plants are good sources of lipids especially during the dry season and good enough for survival despite their relatively good protein content, their quality is usually not sufficient for optimum productivity. This finding implies that the matured leaves obtained from fadama habitat during dry sub-season tend to produce more ether extract than the other treatments.

Crude Protein Contents

Interaction between season, habitat and leaf age significantly (P<0.05) effect the crude protein content in the leaves of the study species (Tables 1 and 2) with the highest content obtained during dry sub-season, upland habitat and young leaf treatments (18.28 % in *S. occidentalis* and 18.94 % in *S. obtusifolia)* than all the other treatments obtained in the study. The values obtained (10.11 – 18.28 % in *S. occidentalis* and 7.13 – 18. 94 % in *S. obtusifolia*: Tables 1 and 2) were within the range and some higher than those reported by Umar (2007) for interaction effect of season and leaf age in four plant species (3.47 % - 12.88 %). These observations agreed with the report of Crowder and Chhleda (1982) that higher protein content occurs in plants in the early growing season (dry season in this case) when moisture content is also high and fibre and lignin contents were low but good enough for survival.

Nitrogen - Free Extract (NFE) Contents

Interaction between season, habitat and leaf age had significant (P<0.05) effect on the content of NFE in *S. occidentalis* (Table 1) and *S. obtusifolia* (Table 2) with the highest values obtained during late rainy sub-season, at upland and fadama habitat, in matured leaves treatments (83.66 % and 80.99 %) than all the other treatments in *S. occidentalis*, while highest content were also observed during the late rainy and harmattan sub-seasons, fadama and upland habitats, young and matured leaves treatments (80.47 %, 80.00 %, 78.20 %, 77.81 % and 77.60 %) than all the other treatments in *S. obtusifolia.* But the values obtained (60.49 – 83.66 % and 66.03 – 80.47 % in the leaves of *S. occidentalis* L. and *S. obtusifolia* L.) were commensurate with those reported by Umar (2007) in interaction effect of season and leaf age of four tree species (49.89 - 78.84%). This observation agreed with report of Silmary *et al.* (2004) that variation in the nutrient concentration of individual plants may be caused by differences in habitat or environment. Harper (1989) commented that among the reasons for nutrient variations in plants was that the younger leaves were born in more exposed positions and the older (matured) ones were more likely to be shaded by the young for competition for available light, temperature and other climatic factors that influence nutrient concentration and growth.

Table 2: Proximate Composition of *Senna obtusifolia* Leaves as Influenced by Season, Habitat and Leaf Age

Treatments	Moisture (%)	Ash (%)	Crude fibre (%)	Ether Extract (%)	Crude protein (%)	N FE (%)
Dry Fadama Young	79.13^{cd}	8.00^{f}	2.50^{de}	2.97^{c}	13.41^{d}	73.12^{b}
Dry Fadama Matured	80.43^{b}	8.47^{f}	2.03^{e}	5.03^{a}	13.33^{d}	71.16^{c}
Dry Upland Young	64.10^{i}	9.03^{e}	2.03^{e}	3.47^{b}	18.94^{a}	66.55^{d}
Dry Upland Matured	79.00^{d}	9.47^{e}	1.43^{g}	5.47^{a}	12.74^{e}	71.37^{bc}
Early Rainy Fadama Young	60.43^{k}	11.00^{d}	12.50^{a}	1.47^{f}	15.77^{c}	68.10^{d}
Early Rainy Fadama Matured	31.37^{m}	9.47^{e}	2.97^{d}	3.13^{b}	17.75^{b}	69.19^{c}
Early Rainy Upland Young	61.43^{j}	12.07^{c}	4.03^{b}	2.53^{c}	13.41^{d}	68.62^{cd}
Early Rainy Upland Matured	38.07^{c}	11.03^{d}	3.47^{c}	3.03^{b}	11.88^{g}	74.54^{b}
Late Rainy Fadama Young	79.50^{c}	80.00^{a}	2.50^{de}	2.50^{cd}	8.78^{k}	78.20^{a}
Late Rainy Fadama Matured	80.50^{a}	5.13^{i}	1.50^{f}	1.50^{e}	11.42^{h}	80.47^{a}
Late Rainy upland Young	78.50^{e}	8.50^{f}	2.50^{de}	2.43^{d}	10.11^{k}	77.81^{a}
Late Rainy Upland Matured	79.47^{c}	6.07^{h}	2.00^{e}	1.50^{e}	7.13^{i}	66.03^{d}
Harmattan Fadama Young	78.47^{e}	65.50^{b}	1.53^{f}	2.13^{d}	10.36^{j}	80.00^{a}
Harmattan Fadama Matured	74.50^{g}	8.03^{f}	2.07^{e}	3.07^{b}	12.54^{f}	74.98^{b}
Harmattan Upland Young	77.23^{f}	7.50^{g}	2.03^{e}	2.50^{cd}	10.36	77.60^{a}
Harmattan Upland Matured	73.23^{h}	9.43^{e}	2.37^{e}	3.43^{b}	12.54^{f}	72.23^{b}
Standard Error Mean	0.04	0.02	0.03	0.03	0.06	1.23
Significant (5%)	S	S	S	S	S	S

Within a treatment group, means in a column with the same letter(s) are not significantly different using least significant difference (LSD) at 5% level Using SAS (2003). SEM=Standard Error Mean; S=, NS= Non – Significant; NFE: Nitrogen Free Extract.

CONCLUSION

Nutrients contents of the two plants studied were variedly influenced by the treatment factors such as rainy season, fadama and upland habitats, young and matured leaves. Treatments favoured most of the nutrient contents. Similarly, Ether Extract and Crude Protein in the leaves were higher during dry season, at upland location, in young and matured leaves treatments. Furthermore, season, habitat and leaf-age are three important factors affecting plant growth and developments.

Recommendations

For further study, similar research should be conducted on other similar parameters and species to bring out more of their nutritional potentials and their full utilization by the users.

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