# Chemical Composition And *In Situ* Dry Matter Digestibility of Selected Multi Purpose Trees And Shrubs

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**Target Audience:** Ruminant Nutritionists, Pasture/Forage Crops Scientists, Smallholder Ruminant Farmers

**Abstract**

*Five selected multipurpose trees and shrubs: Allophylus africana, Macaranga barteri, Massularia acuminata, Palisota hirsuta and Costus afer were randomly collected from different locations in their natural habitats. The leaves were plucked, cut into 2cm pieces, bulked, mixed, dried and ground. The stems, each measuring 60cm were divided into three portions: top (0-20cm), middle (20-40cm) and bottom (40-60cm) segments, derinded and treated like the leaves. One half was used for proximate composition and macro-mineral analyses whilst the other half was used for in situ dry matter degradation determination.*

*The ranges in values for CP, CF ash and NFE of leaves of the MPTS were, respectively, 15.59-20.33%, 13.55-18.60%, 4.66-8.12% and 50.22-60.89%. Across all species, CP content decreased from the top to lower portions of the stem fraction whereas CF increased. Mineral contents in leaves tended to be lower than those in the barks of stems. However, mineral deposition increased from the apical to the lowest portions of stems. Rumen degradation after 48h showed that the leaves were more degraded ($P<0.05$) than the stem segments. A. africana, C. afer and P. hirsuta were more degraded ($P<0.05$) than M. barteri and M. accuminata. The results suggest that these five MPTS have good nutritional potentials for small ruminant production.*

Keywords: Multipurpose Trees, Shrubs, Nutrient Composition, Dry Matter Degradation.

## Description of Problem

In Southeastern Nigeria, multipurpose trees and shrubs (MTPS) are cheap sources of feed, which fit into the cut-and-carry traditional system of husbandry by smallholder farmers (1,2). The MPTS are used for stall-feeding as evening meal or as supplements to stover, stalks or straw. Being mostly perennial plants, they remain green long into the dry season and thus provide supplemental feed of high nutrient value during the off-season periods when other forage sources would be of low quality. Nutrient deficiencies in feed quality could be improved or corrected by addition of herbaceous legumes or multipurpose trees to the basal diet. Over 44 indigenous MPTS have been identified (2,3). In recent years, knowledge of the leguminous nature of some of these MPTS has been exploited in their direct cultivation in agro-forestry systems, alley farming, alley grazing and intensive feed gardens (4). Moreover, these trees and shrubs have additional benefits to man as fuel wood and

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timber, increased soil fertility by the leguminous species, wind and water erosion control, house construction, etc. Some of these trees and shrubs are used in ethnoveterinary practices: *Massularia acuminata* is an anti malarial plant; *Uvaria afzelli* stops dysentery and diarrhoea in goats; *Spondas mombin* is used to expel retained placenta in does and ewes whilst *Microdesmis puberula* is used to stop running nose and mitigate stomach upset in goats (2), to mention but a few. However, quantitative information on nutritive value and animal performance on diets containing forage from these MPTS in existing animal agroforestry systems in sub-Saharan Africa is scanty and is only being recently investigated (5,6,7). For quick assessment and initial screening of these trees and shrubs, chemical analyses and *in sacco* degradation methods are often used (8,9). The work reported here was to: (i) compare the proximate composition of the leaf and stem fractions of five selected MPTS, and (ii) determine the *in situ* dry matter digestibility of these fractions.

## Materials and Methods

Five multipurpose trees and shrubs *Allophylus africana* P. Beauv, *Macaranga barteri* Mill Aug., *Massularia acuminata* Cr. Don, *Costus afer* Ker Gawi *and Palisota hirsuta* Thumb Schum were collected from different sites of Port Harcourt Local Government Area, Rivers State, Nigeria, in their natural habitats. The leaves were plucked, finely chopped into 2cm pieces, bulked, thoroughly mixed and sampled. The stems, each 60cm long, were divided into the top (0-20cm), middle (20-40cm) and bottom (40-60cm) portions, respectively, derinded and sampled like the leaves. The leaf and stem portions were dried to constant weight at 60°C for 48h in a forced-air draught oven. The dried samples were divided into two: one-half was milled through a 1mm screen in a laboratory mill (RetchMuhle Dietz) and used for determination of proximate composition and macromineral contents (10). The other half was ground through a 2.5mm sieve in a Wiley hammer mill for determination of *in situ (in sacco)* dry matter degradation. About 3g of each of these samples were then weighed in duplicates into nylon bags (120mm x 90mm with pore size of 40μm). Samples were incubated in batches in the rumen of three mature West African Dwarf bucks fitted with rumen cannulae. The bags tied together with a line twine were placed in the rumen through the cannulae and removed after 48h of incubation. The animals grazed in a *Panicum maximum* (Guinea grass) paddock and offered wheat bran as supplement at 1.5% of body weight twice daily at 0800 and 1600h. Water was provided *ad libitum.* At the end of the incubation period, bags were withdrawn from the rumen, washed under cool tap water until clear and dried to constant weight at 60°C . Data were analyzed as a completely randomized block design, each buck representing a block and treatment means separated by the Duncan's Multiple Range Test as described in (11).

## Results and Discussion

### *Proximate Composition*

The proximate composition of the leaves of the five selected MTPS is shown in Table 1. The ranges in mean values for DM, CP, EE, CF, ash and NFE were 13.76-39.19%, 15.59-20.23%, 1.00-4.44%, 13.55-18.60%, 4.66-8.12% and 50.22-62.30%, respectively. *Costus afer* recorded the highest CP (20.23%) and CF (18.60%) but least in NFE (50.22%). *Palisota hirsuta* was relatively high in ash (8.12%) and NFE (60.59%) but low in CP (15.59%) and EE (1.00%). *Macaranga barteri* and *Allophylus africana* had similar CP values. Except for *C. afer and M. barteri*, content of NFE was high in the other MTPS (>60%). The variations in DM content could be attributed to the stage of growth of the MPTS, which was not considered in this study during collection of the samples. The CP content of the leaves falls within the range (11-20%) reported for non-leguminous browse species by other workers (7,12,13). However, the values obtained here were higher than the average CP of 12.5% for other native browses reported (5,12).

**Table 1. Proximate composition of leaves of five selected MPTS⁺**

| Species | %DM | %CP | %EE | %CF | %Ash | %NFE |
|---|---|---|---|---|---|---|
| *Allophylus africana* | 39.19 | 19.95 | 3.80 | 13.65 | 5.22 | 60.38 |
| *Macaranga barterii* | 36.51 | 19.69 | 4.44 | 17.20 | 5.03 | 53.64 |
| *Massularia acuminata* | 38.56 | 16.95 | 2.54 | 13.55 | 4.66 | 62.30 |
| *Costus afer* | 13.76 | 20.23 | 4.06 | 18.60 | 6.89 | 50.22 |
| *Palisota hirsuta* | 19.61 | 15.59 | 1.00 | 14.40 | 8.12 | 60.59 |

+ = Multipurpose trees and shrubs

Table 2 shows proximate composition of the three segments of the barks of MPTS under study. The CP ranged from 4.37% in *M. acuminata* to 9.18% in *M. barteri*, from 3.82% in *M. acuminata* to 6.01% in *C. afer* and from 2.18% in *P. hirsuta* to 4.92% in *M.barteri* for the top, middle and bottom portions of the barks of all the species, respectively. The trend across all species was a decrease in protein content from the top to the lower portions. This suggests that small ruminants browsing the barks of browse plants up to 40cm from the apex of a stem or branch except *M. accuminata* would have sufficient nitrogen for maintenance even in the dry season. This is because forages with less than 1%N would not meet the minimum dietary protein requirement (14). In contrast, the CF content ranged from 21.10% in *A.africana* to 33.95% in *P.hirsuta*, 24.65% to 35.40% and from 29.05% to 40.65% for the top, middle and lower portions, respectively, for these two MPTS. There was an inverse relationship between CP and CF with advancing stages of maturity as reported elsewhere (15.16). The ash contents of all the stem fractions were lower than the average value of 10.9% for all West African browse plants reported in other studies (1,13). Stage of growth, soil type and location of the species might influence ash content of plant fractions.

**Table 2. Proximate composition of the stem barks from the three segments of five-selected MPTS⁺**

| Species | Part of stem | %DM | %CP | %EE | %CF | %Ash | %NFE |
|---|---|---|---|---|---|---|---|
| *Allophylus africana* | Top | 35.49 | 7.65 | 0.12 | 21.10 | 6.62 | 64.51 |
| | Middle | 38.48 | 4.37 | 0.45 | 24.65 | 7.60 | 62.93 |
| | Bottom | 44.11 | 3.83 | 0.52 | 29.05 | 7.50 | 59.10 |
| *Macaranga barterii* | Top | 27.64 | 9.18 | 0.32 | 29.80 | 9.63 | 51.07 |
| | Middle | 36.13 | 5.47 | 0.43 | 30.02 | 8.43 | 55.66 |
| | Bottom | 38.77 | 4.92 | 0.71 | 31.40 | 5.92 | 57.06 |
| *Massularia acuminata* | Top | 35.14 | 4.37 | 0.43 | 22.45 | 6.27 | 64.48 |
| | Middle | 43.92 | 3.82 | 0.65 | 28.45 | 6.26 | 60-82 |
| | Bottom | 45.09 | 2.18 | 1.14 | 29.45 | 6.18 | 61.05 |
| *Costus afer* | Top | 10.98 | 6.01 | 0.34 | 30.15 | 6.23 | 57.27 |
| | Middle | 13.44 | 6.01 | 0.53 | 30.15 | 7.37 | 55.95 |
| | Bottom | 15.98 | 3.28 | 1.18 | 40.65 | 5.95 | 48.94 |
| *Palisota hirsuta* | Top | 14.24 | 6.56 | 0.53 | 33.95 | 9.45 | 49.51 |
| | Middle | 15.51 | 5.19 | 0.95 | 35.40 | 8.87 | 49.59 |
| | Bottom | 19.97 | 2.18 | 0.84 | 40.65 | 5.00 | 51.43 |

+ = Multipurpose trees and shrubs

The macromineral contents of the edible portions – leaves and barks – of the MPTS are presented in Table 3. Across all species, the mineral contents in the leaves tended to be lower than what obtained in the barks of stems. Also, there was a tendency for the contents to increase from the apical to the lowest portions of stem barks. However, the mean values for Ca and P, 0.87% and 0.15%, respectively, recorded for the leaves of MPTS under study were lower than those earlier reported (5,13). The study showed that K values for the MPTS under study were higher than reported for leguminous browse plants (17) but lower for P and Mg. The variabilities observed might be due to species differences, soil nutrient status, stage of growth or weather conditions (16).

**Table 3. Macro-mineral profile of the leaves and stem bark portions of the five selected MPTS.**

| | | | Mineral composition, % DM** | | | | |
|---|---|---|---|---|---|---|---|
| **Species** | **Portion of plant** | **Ca** | **P** | **K** | **Mg** | **Na** | **Fe** |
| *A. africana* | Leave | 0.87 | 0.14 | 2.87 | 0.14 | 0.65 | 0.08 |
| | Top | 0.87 | 0.16 | 2.85 | 0.14 | 0.71 | 0.02 |
| | Middle | 1.00 | 0.17 | 3.05 | 0.18 | 0.82 | 0.03 |
| | Bottom | 1.25 | 0.20 | 3.10 | 0.18 | 0.93 | 0.05 |
| *M. barterri* | Leave | 0.75 | 0.20 | 4.10 | 0.16 | 0.12 | 0.08 |
| | Top | 0.80 | 0.20 | 4.18 | 0.16 | 0.12 | 0.02 |
| | Middle | 0.82 | 0.22 | 4.25 | 0.20 | 0.18 | 0.04 |
| | Bottom | 0.87 | 0.24 | 4.29 | 0.25 | 0.31 | 0.06 |
| *M. acuminata* | Leave | 0.75 | 0.15 | 2.25 | 0.19 | 0.18 | 0.02 |
| | Top | 0.83 | 0.16 | 2.30 | 0.19 | 0.18 | 0.05 |
| | Middle | 0.84 | 0.16 | 2.39 | 0.20 | 0.25 | 0.05 |
| | Bottom | 1.12 | 0.17 | 2.41 | 0.23 | 0.37 | 0.07 |
| *C. afer* | Leave | 0.87 | 0.17 | 4.81 | 0.16 | 0.12 | 0.05 |
| | Top | 0.86 | 0.11 | 4.87 | 0.17 | 0.12 | 0.05 |
| | Middle | 1.00 | 0.20 | 4.90 | 0.20 | 0.18 | 0.06 |
| | Bottom | 1.25 | 0.23 | 4.94 | 0.23 | 0.31 | 0.08 |
| *P. hirsuta* | Leave | 1.12 | 0.10 | 4.40 | 0.14 | 0.25 | 0.05 |
| | Top | 1.13 | 0.10 | 4.55 | 0.18 | 0.37 | 0.02 |
| | Middle | 1.25 | 0.11 | 4.62 | 0.21 | 0.39 | 0.06 |
| | Bottom | 1.37 | 0.15 | 4.68 | 0.41 | 0.43 | 0.08 |

** Each value is a mean of duplicate samples

### *In situ* dry matter digestibility

The *in situ* dry matter digestibilities of the various edible plants are presented in Table 4. The leaf fractions were generally more degraded ($P<0.05$) than the stem portions. *A.africana, C. afer* and *P. hirsuta* were more ruminally degraded than *M. barteri* and *M. acuminata* in this study. Within the stem portions, digestibility decreased ($P<0.05$) with increasing length of the stem from the top to lower segments. Fibre content is known to affect digestibility. It was higher in the bark portions of the stems than the leaves (Tables 1 and 2). The CF content is high in *C. afer* and *P.hirsuta* but relatively lower for *A. africana.* It is not known from this study why the digestibility was higher in the plant components of these three species than others. This contrasted with an earlier report (15). Perhaps, such factors as the organisation of the cell wall (18), surface availability for attack, cellulose crystallinity and fragility of the cell wall (19) may be implicated in the above differences.

**Table 4. *In situ* dry matter digestibility of plant parts of five selected MPTS**

| Species | % Dry matter digestibility of plant part | | | |
|---|---|---|---|---|
| | Leaves | Top of stem | Middle of stem | Bottom of stem |
| *Allophylus africana* | 74.51[a] | 71.53[a] | 68.76[a] | 61.33[a] |
| *Macaranga barteri* | 69.30[b] | 66.72[b] | 64.25[b] | 58.11[b] |
| *Massularia acuminata* | 68.73[b] | 63.61[b] | 61.24[c] | 56.65[b] |
| *Costus afer* | 73.51[a] | 70.12[a] | 67.33[a] | 65.47[a] |
| *Palisota hirsuta* | 75.26[a] | 68.43[a] | 63.17[c] | 62.53[a] |

[a, b, c] Means with different superscripts within the same column are significant ($P<0.05$).

## Conclusion and Applications

1. The study has characterized the chemical constituents of the edible portions of the MPTS browsed by small ruminants during grazing.
2. *In situ* dry matter digestibility showed that the different plant components were more than 50% degradable.
3. The data obtained in this study suggest that these five MPTS have good nutritional potentials for small ruminant production.

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