ORIGINAL ARTICLE

BIOCHEMICAL INDICES OF *COSTUS AFER* KER GAWL AND SOIL QUALITY IN THE HILLY AREA OF YENAGOA, BAYELSA STATE, NIGERIA

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ABSTRACT

Background: *Costus afer* grows on different soil terrains such as elevated and regular soil terrain, which may influence the biochemical composition of this important medicinal plant. **Objectives:** This study was designed to evaluate the mineral nutrients and proximate contents of *Costus afer* as well as the soil quality of the hilly area of the study area. **Methods:** A plot of about 30m x 30m was selected on a dried hilly area of Yenagoa, alongside a regular terrain. Leaf samples of *Costus afer* were collected within the marked plot from a hilly area with a total of 5 points, and a corresponding 5 points for the regular terrain. At each location, soil sample (0-20cm) was collected for physico-chemical properties of the experimental soil. Leaf and soil samples were analysed using standard methods. **Results:** There were marked variations ($P<0.05$) in mineral nutrient and proximate contents in leaf samples of *Costus afer from* the hilly and regular terrain of the study area. The mineral nutrient contents as well as the proximate composition of the regular soil were relatively higher than those of the hilly soil. **Conclusions:** This study indicates the topographic terrain of the study area has a major influence on the nutrient status and the proximate composition of *Costus afer,* hence, could play a crucial role in plant growth and development.

Keywords: *Topography, soil quality, mineral nutrient, proximate, Yenagoa.*

1. INTRODUCTION

Costus afer Ker-Gawl belongs to the family Zingiberaceae, and is usually described as a tall, herbaceous and unbranched tropical perennial plant with creeping rhizome [1]. It is commonly known as ginger lily or bush cane, and widely found in the forest belt in different parts of Africa including Nigeria [2]. In West Africa, it is often found in moist or shady forest and river banks, but usually domesticated in home garden for medicinal purposes [3]. The stem, seeds, leaves and rhizomes have been shown to contain several bioactive substances, hence are utilized as a remedy for cough, inflammation, arthritis, as laxative, aparient, purgative, diuretic, rheumatism, amoebic dysentery, leprosy, venereal diseases, malaria, worms, hemorrhoids and treatment of several other diseases [2-4,5,6].

Soil is the outermost layer of the surface of the earth in which plants grow, and composed of eroded rock, mineral nutrients, decaying plant and animal matter, water and air. Most plants are anchored to the soil through their roots, with which they absorb water and nutrients, hence, variation in the physical, chemical, and biological properties of the soil has distinct effects on plant growth and development, depending on natural adaptation [7,8,9,10]. Topography includes the physical features of the earth such as the land elevation, slope, terrain, mountain ranges and bodies of water. The steepness of a slope affects plant growth due to variation in incidence of solar radiation, wind velocity and soil type, thus a steep slope can lead to rapid surface runoff and soil erosion, thereby resulting in soil degradation [11, 12-10].

Temperature effect is an overriding factor when examining the elevation of land with respect to the level of the sea surface with a resulting influence on plant growth and development [13,14]. Topography exerts a major influence on soil development such that soils in the valley tend to be deeper, darker, and contain more horizons, due to increased material deposition from hillside erosion, material accumulation from downward leaching from the tops of hills, and the collection of greater quantities of water in the low lying areas while soils on the tops of hills tend to be deep, but lighter in color, due to downward leaching losses. Soils in the valleys tend to be deeper, darker, and contain more horizons [7-9, 10-13]. Bayelsa State is a lowland area characterized by irregular terrains as well as tidal flats and coastal beaches, beach ridges and flood plains. The State has a riverine and estuarine setting with many of its communities completely surrounded by water, and lies in the heaviest rainfall area of Nigeria, with heavy rain fall and short dry season [15-16].
Therefore, the major objective of this study was to examine the effects of soil topography on the mineral and proximate contents of *Costus afer* in Yenagoa, Bayelsa State, Nigeria.

2. MATERIALS AND METHODS

2.1 Study area

A plot of about 30m x 30m was selected on a dried hilly area of Yenagoa, alongside a regular terrain. The research area is in the tropical climatic zone of Nigeria with a mean maximum monthly temperature ranging from 26°C to 31°C. It is characterized by marshy terrain, eroded ridges and different sized hill slopes. The state is geographically located within latitude 4Â°15′ North and latitude 5Â°23′ south. It is also within longitudes 5Â°22′ West and 6Â°45′ East [15-16]. The elevation of the study area ranged from 25m to 3m with an average of 13m [17].

2.2 Data collection

Leaf samples of *Costus afer* were collected within the marked plot of about 30m x 30m from a hilly area with a total of 5 points, and a corresponding 5 points for the regular terrain. At each location, soil sample (0-20cm) was collected for physico-chemical properties of the experimental soil.

2.3 Analysis of soil samples

Soil samples (0-15cm depth) collected from the study site, Yenagoa were analysed using standard methods for physico-chemical properties [18].

2.4 Proximate composition

Leaf samples of *Costus afer were* washed several times with water and rinsed with distilled water. They were placed in polybags. They were dried in an oven maintained at 60° C to a constant weight, macerated to powder, and stored in sample bottles for analysis. The proximate compositions (moisture, lipid, crude protein, crude fibre, ash, carbohydrate) of plant material were determined using standard method [18].

2.5 Statistical analysis

Standard errors of the mean values were calculated and data were subjected to an analysis of the variance (ANOVA) test to compare the means [19] the difference is significant when the P-value is ($P < 0.05$).

3. RESULTS

The physico-chemical properties of the experimental soils (regular and hilly soils) are shown in Table 1. The pH of the regular soil was 5.30 while that of the hilly soil was 4.70. The content of nitrogen in the regular soil (0.27%) was significantly ($P < 0.05$) higher than that of the hilly soil (0.13%). Similarly, the phosphorus (8.36mg/kg), calcium (4.12 mg/kg), magnesium (2.32 mg/kg), sodium (0.28 mg/kg), and potassium (2.14 mg/kg) contents of the regular soil were significantly ($P < 0.05$) higher than those of the hilly soil (P-3.27mg/kg, Ca-1.78 mg/kg, mg-1.21mg/kg, Na-0.22mg/kg and K-1.36mg/kg). The hydrogen (0.79mg/kg) and aluminium (0.87 mg/kg) contents of the hilly soil were significantly ($P < 0.05$) higher than those of the regular soil (H-0.43 mg/kg, and Al- 0.36mg/kg) (Table 1).

Table 1: The table presents the physico-chemical properties of experimental soils.

Soil parameters	Regular soil	Hilly soil
pH	5.30±0.21	4.70±0.33
N (%)	0.27±0.03	0.13±0.02
P(mg/kg)	8.36±0.67	3.27±0.20
Ca (mg/kg)	4.02±0.32	1.78±0.19
Mg (mg/kg)	2.32±0.54	1.21±0.28
Na (mg/kg)	0.28±0.07	0.22±0.06
K (mg/kg)	2.14±0.51	1.36±0.23
H(mg/kg)	0.43±0.22	0.79±0.13
Al (mg/kg)	0.36±0.04	0.87±0.06

Mean ± standard error from 5 replicates.

The mineral nutrient contents in leaves of *Costus afer* obtained from the experimental soils (regular and hilly soils) are presented in Table 2. The trend of mineral nutrients in the regular soil was in descending order of sodium, calcium, potassium, magnesium, nitrogen, phosphorus, zinc, iron, copper, manganese and lead, while that of the hilly soil was in the descending order of calcium, sodium, magnesium, potassium, nitrogen, phosphorus, iron, zinc, manganese, copper and lead (Table 2). The moisture (30.02%), ash (13.55%), crude protein (14.21%) and carbohydrate (23.71%) contents in leaves of *C. afer* at the regular soil were comparatively higher than those of the hilly soil (moisture- 26.34%, ash-10.02%, crude protein-12.10%, carbohydrate-22.42%) (Table 3). Conversely, the crude fat (4.42%) and crude fiber

(24.70%) contents in leaves of *C. afer* at the hilly soil were relatively higher than those of the regular soil (crude fat-3.48%, crude fiber-15.03%) (Table 3).

Table 2: The table presents the mineral nutrients contents in Leaves of Costus afer from the experimental soils.

Mineral nurients	Regular soil	Hilly soil
Ca (mg/kg)	20.21±0.34	14.42±0.46
Mg (mg/kg)	10.30±0.52	6.34±0.61
Na (mg/kg)	23.14±0.48	10.27±0.70
K (mg/kg)	14.20±0.50	4.42±0.33
N (%)	3.07±0.27	1.21±0.10
P (mg/kg)	0.82±0.04	0.36±0.08
Fe (mg/kg)	0.39±0.12	0.31±0.04
Mn (mg/kg)	0.04±0.02	0.03±0.02
Cu (mg/kg)	0.05±0.03	0.02±0.01
Zn (mg/kg)	0.70±0.16	0.22±0.10
Pb (mg/kg)	0.004±0.00	0.002±0.00

Mean ± standard error from 5 replicates.

Table 3: The table presents the proximate composition of Leaves of Costus afer from the experimental soils.

Proximate	Regular soil	Hilly soil
Moisture (%)	30.02±0.40	26.34±0.32
Ash (%)	13.55±0.24	10.02±0.29
Crude Fat (%)	3.48±0.13	4.42±0.28
Crude Fiber (%)	15.03±0.41	24.70±0.19
Crude protein (%)	14.21±0.70	12.10±0.24
Carbohydrate (%)	23.71±0.32	22.42±0.58

Mean ± standard error from 5 replicates.

4. DISCUSSION

This study clearly revealed that the topographic terrain of the study area has a significant influence on the mineral nutrients status as well as the proximate composition of *Costus afer.* The mineral nutrient contents as well as the proximate composition of the regular soil were relatively higher than those of the hilly soil. This variation is basically attributed to the topographic influence on soil physical and chemical composition. Topography has been reported to be one of the primary terrain attributes which constitute the most relevant soil forming factors [20]. The different types of parent material, vegetation, topography, climate, fertilizer application, and land use types have been identified as factors that influence the levels of available micronutrients in topsoil [21]. Soil properties have been reported to greatly affect available micronutrients distribution, soil organic matter, pH, moisture regime and available phosphorus [22, 23]. Topographic factors can pose a significant influence on soil nutrients distribution by either directly affecting micronutrient contents or indirectly influencing soil chemical properties [24, 25].

In general, altitude has been reported as one of the limiting factors that influence plant species growth and dispersion with its variation leading to different vegetative forms and forest types [11-26]. Elevation of land has primary influence on moisture contents of the slopes, variation in sunlight and wind blow, soil moisture, fertility and depth, hence, on plants growth and dispersion, although, these effects are significant in areas with low moisture and rainfall levels [12]. Soil drainage and depth are considered as overriding factors in a sloppy area with overall effects on plants dispersal, diversity, richness and growth [8]. Similarly, the degree of land elevation, and stoniness of the land have been reported to have a major influence on plant dispersal and growth relative to soil chemical content and human-induced factors, particularly, due to their effects on moisture [14]. Terrain attributes have also been demonstrated to be closely related to soil fertility and plant growth in cultivated land [9], as well as key factors for analyzing species richness and beta diversity in a close-by nature conservation area with comparable geomorphology [27]. Topography has also been considered to be a major controlling factor for variability in soil nutrient and water availability under natural conditions [28, 29], and its role on soil fertility for plant growth has been demonstrated using climatic, altitudinal and topography transects [30,31,32]. Therefore, topography influences the spatial distribution of soil fertility in terms of soil organic carbon, soil pH, cation exchange capacity and nutrients [33], hence, its effects on plant growth and development.

5. CONCLUSION

In this study, the mineral nutrient contents as well as the proximate composition of the regular soil were comparatively higher than those of the hilly soil. Therefore, the topographic terrain of the study area has a major influence on the nutrient status and the proximate composition of *Costus afer*. This clearly indicates that topography plays a crucial role in plant growth and development.

6. REFERENCES

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