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EFFECT OF SOIL NUTRIENT CONCENTRATIONS ON THE QUANTITY OF TANNIN AND FLAVONOID DEPOSITED IN *Gmelina arborea* FRUIT LOCATED IN DIFFERENT LOCATIONS

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ABSTRACT

This research was geared towards the study on the effect of soil nutrient concentrations on the quantity of tannin and flavonoid deposited in Gmelina arborea fruit located in Onigambari forest reserve within latitude 7º 23' N and longitude 3º 33' E and environs of Ijebu-Ife which lies within latitude 6º 47' N and longitude 4º 2' E. Soil samples and 50 Gmelina arborea fresh fruits were collected from each location, the pulps and seeds were air dried for 15 days at room temperature to reduce its moisture content, and then grinded into powdery forms before being subjected to Trease and Evans technique to screen for the Tannin and Flavonoid quantity. The results were subjected to both t-test and analysis of variance using Statistical Analysis System (SAS) 9.0 version. Means were separated using Duncan's Multiple Range Test (DMRT) at 5% probability. The seed (0.54 g) and pulp (0.45 g) harvested from Ijebu-Ife have higher concentration of tannin compared with Onigambari seed (0.06 g) and pulp (0.12 g), also flavonoid concentration of seed (0.11 g) and pulp (0.24 g) of Onigambari is lower than that of Ijebu Ife seed (0.35 g) and pulp (0.40 g). The study shows that variations in soil nutrient concentration levels, soil pH and soil textural class of different locations will influence the quantity of Tannin and Flavonoid of Gmelina arborea fruit. The study further revealed that soil nutrient at concentrations levels that are high and tending towards toxicity will reduce deposits of plant phytochemicals which is a quality parameter in plant nutrition.

Key words: *Gmelina arborea*, Tannin, Flavonoid, Soil Nutrient, Plant nutrition.

INTRODUCTION

Gmelina arborea is a tree extensively grown as a fast-growing plant in tropical areas of Africa, Asia and America (Orwa *et al*., 2009). In tropical Africa, the large-scale plantations are found in Senegal, Gambia, Sierra Leone, Côte d'Ivoire, Mali, Burkina Faso, Ghana, Nigeria, Cameroon and Malawi (Adam *et al*., 2016). Gmelina has been assigned top priority for improved utilization and conservation since 1969 (FAO, 2002). This tree is commonly planted as a garden and an avenue tree; growing in villages along agricultural land, village community lands and wastelands (Adam *et al*., 2016).

This tree grows on different localities and prefers moist fertile valleys with 750-5000 mm rainfall (Ecocrop, 2018) and annual temperature of 21-28ºc with maximum temperature at 24-35ºC and minimum temperature at 18-24ºC (Adam *et al*., 2016). The tree attains moderate to large heights of up to 30 m, with a girth of 1.2 to 4 m (Orwa *et al*., 2009). Flowers are often visited and pollinated by bees and birds (Orwa *et al*.,

2009) and the fruit is edible by man and animal (Facciola, 1998).

Gmelina arborea is an advantageous plantation tree and useful for timber production (USDA-ARS, 2016) and also for pulp and paper (Mayowa *et al*., 2016). The wood is often used as firewood and for charcoal (Adam *et al*., 2005). It is cultivated as an ornamental tree in gardens and avenues (Orwa *et al*., 2009). It is also used as biological control for example, in coffee and cocoa plantations to protect the young crops and to suppress noxious grasses (Adam *et al*., 2016). It has the potential to disrupt successional processes in areas where it is invading and out-compete native vegetation (IUCN, 2013). In tropical Asia, they are used in Hindu medicine as in India, the stem bark and roots are used as ingredient to treat a range of ailments (Shenoy and Yoganarasimhan, 2009; Yogesh and Veeranjaneyulu, 2010; Acharya *et al*., 2012). The Leaf sap is taken as a demulcent to treat gonorrhoea and cough, and it is applied to wounds and also for ulcer treatment (Adam *et al*., 2016). The roots are considered to have tonic, stomachic and laxative properties, and the flowers had been used to treat leprosy and blood diseases (Chunekar and Pandey, 1998).

Gmelina arborea has phytochemical compounds that are useful for various purposes as reported by Lawal *et al*. (2016), and these phytochemicals include plant compounds that are beneficial as well as those that are detrimental. It also contains phytonutrients, that is, compounds that have a positive effect on human and animal health (Edward, 2016). However, it has been reported that there can be variations in the quantity of phytochemical components of plants due to environmental factors such as soil composition, temperature, rainfall, and ultraviolet radiation incidence (Kouki and Manetas, 2002; Leonardo *et al*., 2013). Ubani *et al*. (2012) and Elumalero *et al*. (2019) also reported that variation in soils from different locations has an effect on the quantity of phytochemical components. Impact of organic amendment on soils (Maria *et al*., 2010) and seasonal climate change have been reported to affect phytochemicals concentration in plants (Monteiro *et al*., 2006). This background information necessitated a study on the effect of soil nutrient concentrations on the quantity of Tannin and Flavonoid deposited in *Gmelina arborea* fruit located in Onigambari forest reserve and environs of Ijebu-Ife, both in Nigeria as flavonoids acts as anti-allergies and anti-oxidant with Tannin being useful as styptics and internal protection of inflamed surfaces of the mouth and throat, acts as anti-diarrheal and employed as antidote in poisoning by heavy metals, brewing and dye production (Trease and Evans, 2000) which makes them very important both in the pharmaceutical, agricultural and industrial world. Therefore, this study aims to evaluate the soil nutrient concentration from the two locations, determine the quantity of Flavonoid and Tannin from the locations, and assess the effect of soil nutrient concentrations on the quantity of Tannin and Flavonoid present in the two locations.

MATERIALS AND METHODS

Study Area

The study areas are Onigambari Forest Reserve Ibadan, Oyo State and Ijebu-Ife in Ogun State Nigeria. Onigambari Forest Reserve lies within latitude 7^{o} 23’ N and longitude 3^{o} 33’ E, and covers area of 11,618 hectares, between the river Ona on the West and the main road from Ibadan to Ijebu-Ode on the East. It has an average altitude lying between 122 m to 152 m above sea level with an undulating topography and an annual rainfall of 1592.3 mm together with 72 – 86.5% relative humidity and a mean temperature of 22.5^{o}C (Akinyemi, 1998). Ijebu-Ife is situated in Ijebu East, it boarders Ijebu-Mushin and Itele and also shared boundary with Lagos Benin expressway. It lies within latitude 6^{o} 47’ N and longitude 4^{o} 2’ E. It has an average altitude of 67 m above

sea level with an undulating topography and an annual rainfall of 1581 mm together with 81 – 91% relative humidity and a mean temperature of 27.1°C (Olalekan *et al*., 2020).

Data Collection and Analysis

Fifty (50) fresh fruits of *Gmelina arborea* were randomly collected from Ijebu-Ife and Onigambari Forest Reserve. The fruit pulp and seed were air dried for 15 days at room temperature to remove moisture. They were grinded into powdered form, and later subjected to Trease and Evans technique to screen for some selected phytochemical components present in the seeds and fruit pulp. Soil samples from Ijebu-Ife environs and Onigambari locations were randomly collected in triplicate. The soil samples were air-dried, gently crushed and sieved through 2 mm sieve. The following analysis were carried out on each soil sample using standard methods; Soil particle size (Gee and Or, 2002), soil pH (Thomas, 1996), organic matter (Nelson and Sommers, 1996), total nitrogen (Bremmer, 1996), available phosphorus (Kuo, 1996), exchangeable cation (Summer and Miller, 1996), and heavy metals. The results were subjected to both inferential statistics which involves t-test and analysis of variance using Statistical Analysis System (SAS) 9.0 version. Means were separated using Duncan's Multiple Range Test (DMRT) at 5% probability.

Quantitative Phytochemical Analysis

Flavonoids Determination

Colorimetric aluminium chloride method was used for flavonoid determination. 0.5 ml solution of each plant extract in methanol was separately mixed with 0.5 ml of 2% aluminium chloride. After one hour at room temperature, the absorbance was measured at 420NM. A yellow colour indicated the presence of flavonoids. Extract samples were evaluated at a final concentration of 0.1 mg/ml. Total flavonoid content was calculated as quercetin equivalents (mg/g) using the following equation based on the calibration curve: y = 0.0255x, R2 = 0.9812, where y was the absorbance x was the concentration.

$$\text{Flavonoid}\left[\begin{bmatrix} calculate\ of\ saponins\ content \\ amount\ of\ saponins\ \left(\frac{mg}{g}\right) \end{bmatrix}\right] = \frac{weight\ of\ residue}{weigh\ of\ sample}$$

Tannins Determination

The vanillin-HCL reagent was prepared by mixing equal volume of 8% HCL and (1% vanillin in methanol). The reagent was mixed just prior to use. 0.2 g of the grind sample was placed in a small conical flask. Then 10 ml of 1% concentrated HCL in methanol was added. The flask was caped and continuously shaken for 20 minutes and content was further centrifuged at 2500 rpm for 5 minutes. 1.0 ml of the supernant was pipetted into a test tube containing 5ml of vanillin-HCL reagent. Absorbance of 450 Nm was read on spec after 20 minutes of incubation at 30°C. A standard curve was prepared expressing the result using the formula below;

$$\text{Tannins (\%)} = C \times \frac{20}{200} \quad \ldots. 2$$

where: C= Concentration. Correspond to the official density

RESULTS

Table 1 showed soil nutrient concentration and soil physical properties in the study locations. Mean separation carried out for the soil nutrient and soil physical properties for both Ijebu-Ife environ and Onigambari forest reserve showed significant differences except for Total Nitrogen (Total N), Iron (fe), Copper (Cu), Sodium (Na), and Clay. From the soil nutrient and soil physical property that showed significant differences in both locations, Onigambari forest reserve recorded highest values for pH (6.2), Organic carbon (3.45 %), Potassium (1.2 Cmol/kg), Magnesium (4.36 Cmol/kg), Zinc (68 mg/kg), Manganese (60.4 mg/kg) and silt (16.5 %) while Ijebu-Ife only recorded

highest values for Phosphorus (30.84 mg/kg) and Sand (82.5 %).

Table 1: Soil nutrient concentration and physical properties of soil in both Ijebu – Ife environs and Onigambari Forest Reserve.

Soil properties	Ijebu-Ife	Onigambari forest reserve
pH	5.77[b]	6.2[b]
Organic carbon (%)	2.19[b]	3.45[a]
Total N (g/kg)	0.19[a]	0.29[a]
P (mg/kg)	30.84[a]	25.04[b]
K (Cmol/kg)	0[b]	1.2[a]
Mg (Cmo/kg)	1.3[b]	4.3[a]
Ca (Cmol/kg)	2.9[b]	9.3[a]
Fe (mg/kg)	17[a]	16[a]
Zn (mg/kg)	6[b]	68[a]
Mn (mg/kg)	19.8[b]	60.4[a]
Cu (mg/kg)	2[a]	1.1[a]
Na (Cmol/kg)	1.3[a]	1.2[a]
Sand (%)	82.5[a]	70.5[b]
Clay (%)	15[a]	13[a]
Silt (%)	2.5[b]	16.5[a]

Means showing different alphabets on row are significantly different at 0.05% level of significance

The quantity of Flavonoid and Tannin present in the seed and fruit pulp of *Gmelina arborea* obtained from Ijebu-Ife and Onigambari forest reserve is showed in Table 2. Flavonoid and Tannin are present in *Gmelina arborea* seed and fruit pulp as observed from Table 2. Also, the quantity of Flavonoid and Tannin found in *Gmelina arborea* in both locations showed significant differences for seed and fruit pulp. Ijebu-Ife recorded the highest values of Flavonoid (0.35 g), (0.40 g) and Tannin (0.54 g), (0.45 g) for seed and fruit pulp respectively.

Table 2: Quantitative analysis of Flavonoid and Tannin in the seed and fruit pulp of *Gmelina arborea*

Location	Seed		Fruit Pulp	
	Flavonoid (g)	Tannin (g)	Flavonoid (g)	Tannin (g)
Ijebu Ife	0.35[a]	0.54[a]	0.40[a]	0.45[a]
Onigambari forest reserve	0.11[b]	0.06[b]	0.34[b]	0.12[b]

Means showing different alphabets in columns are significantly different at 0.05% level of significance.

DISCUSSION

The study revealed that significant differences were observed between the two locations for pH, Organic carbon, Potassium, Magnesium, Zinc, Manganese, Phosphorus, Sand and Silt. This implies that soil nutrient concentration and soil physical properties are affected by environmental variations which include biotic and abiotic influences. The result obtained is in agreement with the findings of Ronald (2014) who reported that soil nutrient concentration is influenced by many, often interrelated factors which include the parental rock materials, particle

size, humus, water content, pH, aeration, temperature, root surface area, the rhizoflora, and mycorrhizal development.

The pH of the soil also showed significant differences between the two study locations which also affect nutrient concentration as soil pH is one of the most well-known factors affecting mineral solubility and thereby, availability (Ronald, 2014). Plant production of bioactive compounds is not just most strongly affected by genetics and the growing environment, soil fertility plays an important role as well (Barl *et al*., 2002).

The result obtained in the study revealed considerable amount of Flavonoid and Tannin to be present with a significant difference in the values of Flavonoid and Tannin found in both locations for seed and fruit pulp of *Gmelina arborea*. Similar observation was reported by Kouki and Manetas (2002), who submitted that variations in soil components will affect the quantity of phytochemicals that will be available for use. Research investigation of Maria *et al*. (2010) that soil organic content can impact phytochemical components also agrees with the study results.

The higher quantity of phytochemicals (Flavonoid and Tannin) both in the seed and fruit pulp as recorded by Ijebu-Ife compared to that obtained in Onigambari forest reserve can be attributable to environmental influence. This result corroborates the findings of Leonardo *et al*. (2013) who reported environmental factors which include soil to be responsible for differences in phytochemical components. Hence, this highlights the effect of environment on the quantity of phytochemical obtained from the plant fruit.

This high quantity of Flavonoid and Tannin recorded in Ijebu-Ife though the concentration of the pH, Organic Carbon, Phosphorus (P), Potassium (k), Magnesium (Mg), Calcium (Ca), Zinc (Zn) and Manganese (Mn) is significantly lower than Onigambari location can be connected to slightly acidic soil in Onigambari forest reserve. This according to the finding of Ubani *et al*. (2012) has led to excessive concentration of the soil nutrients, resulting in the decrease in concentration of Flavonoid and Tannin as compared to Ijebu-Ife which has a moderately acidic soil.

CONCLUSION AND RECOMMENDATION

The evaluation of the soil nutrient concentration from the two locations of Ijebu Ife and Onigambari has shown that variations or differences in soil nutrient concentration such as Phosphorus (P), the basic cations (Potassium (k), Magnesium (Mg), and Calcium (Ca), metal ions (Zinc (Zn), Manganese (Mn)), soil pH and Organic Carbon will influence the quantity of Flavonoid and Tannin in *Gmelina arborea*. These findings will further assist industries that utilize Flavonoid and Tannin to adequately consider the soil nutrient concentration of the farmlands, plantations or areas where they intend to obtain their raw materials for production so as to optimize the quantity of produce/material desired for their industrial needs. This has further shown that plant quality parameter such as the Phytochemical (Flavonoid and Tannin) is directly influenced by soil nutrient concentration. Hence, adequate attention in terms of evaluation, assessment and management of soil nutrient should be adequately given top priority as this will help improve plant quality parameter vis a vis plant nutrition.

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