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Chemosystematics Studies on Six Varieties of *Mangifera indica* L.

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Abstract

Taxonomic investigation was carried out on six (6) varieties of *Mangifera indica* (Julie, Broken, Peter, Kerosene, Opioro and Big fibre) using chemosystematics evidence. Extracts obtained from the leaf of each variety were phyto-chemically screened and quantified. Gravimetric and spectroscopic approaches were adopted in the quantification of active principles common to all the six varieties. Binary matrices computed from qualitative assessment were analysed to yield a dendrogram using the Average Linkage Method. Quantitative values were subjected to appropriate descriptive and inferential statistical analysis. All varieties possessed alkaloid except Big-fibre. Peter and Kerosene varieties lacked saponin, an active principle present in other varieties. Anthraquinone was present in all except in Julie and Opioro. Five out of the six varieties lacked phlobatannin. All varieties had tannin, steroid, flavonoid and reducing sugar. Tannin was lowest in Big-fibre (0.43%) but highest in Opioro (2.41%). Steroid ranged from 3.8% in Opioro to 9.0% in Julie with a standard deviation of 1.84. Julie variety recording the lowest composition in flavonoid (0.01%) and reducing sugar (0.04%) components was notable. Comparison of the mean values of phytochemicals has shown a statistically significant difference ($p = 0.0005$) with a large F-value (18.244). Using the LSD mean separation, steroid was the most remarkable phytochemical contributing to the significant differences. Dendrogram revealed very close relationship between Julie and Opioro varieties. The remaining four were divergent and distinct although Broken and Peter varieties arose from the same ancestral lineage with Julie and Opioro. However, Big-fibre and Kerosene varieties were clearly different from rest belonging to a different phylogenetic ancestor. With these remarkable differences, they ought to be given special taxonomic and systematic review for appropriate nomenclatural assignment. The six varieties of *Mangifera indica* investigated are thus clearly partitioned and therefore recommended to be circumscribed. This approach is maiden, and considered innovative as it is employed in this study for the first time in the taxonomy of *Mangifera*.

Keywords

Chemosystematics, *Mangifera indica*, Varieties, Phytochemicals, Taxonomy, Circumscription

1. Introduction

A very important application of phytochemical studies apart from drug discovery is the aspect of plant taxonomy [1]. This is based on the principle of classifying and circumscribing taxa using similarities and differences in their bioactive ingredients as a branch of chemotaxonomy [2]. *Mangifera indica* (Family Anacardiaceae) popularly called mango tree has over 180 different cultivars [3] [4]. It is a perennial fruit tree which has witnessed much divergence along the course of evolution. Thus, it is a successful key stone fruit tree in most parts of Africa, especially in Nigeria where different varieties exist [5]. They are identified using vegetative and reproductive structures [5] [6]. The fruit produced by each variety is diagnostic with characteristic features such as shape, size, fibre, aroma and texture. In plant studies, diversity and existence of huge varieties of a particular species often pose enormous taxonomic challenges [5] [7] [8] [9]. The use of common names in plant identification is generally misleading, confusing and taxonomically unacceptable [3] [10] [11]. Chemosystematic audit is necessary in plant taxonomy to confirm outcomes of other evidences such as gross morphology, anatomy, cytology and palynology [2].

[5] successfully carried out a taxonomic audit of *Mangifera indica* in Nigeria using microanatomical evidences. The authors suggested specific nomenclatural assignments to divergent varieties in their publication. It is therefore evident that detailed taxonomic investigation could bring orderliness to the enormous diversity of the species for proper nomenclature and identity [5]. Advances in analytic techniques such as chromatography, spectroscopy and gravimetry have made it possible to elucidate the bioactive compounds present in plants for qualitative and quantitative assessment for diverse applications [12] [13] [14] [15]. Chemical constituents such as flavonoids, tannins, steroids, glycosides and anthraquinones among others, are highly distinguishing and specific [12] [16] [17]. These bioactive principles are true reflections of the genetic information and thus provide unique information that forms the basis of separating taxa [17]. It is therefore crucial to further elucidate the relatedness and divergence among the different varieties of *Mangifera indica* in the North Central part of Nigeria. The overall aim of this study was to classify, delimitate and circumscribe the varying cultivars and determine their phylogenetic relationships using the chemical components they possess.

2. Materials and Methods

Leaves of six (6) varieties of *Mangifera indica* (Julie, Broken, Peter, Kerosene, Opioro and Big fibre) were collected from different Local Government Areas in

Benue State, Nigeria. Proper identification was ensured by the collectors through whole plant morphologies and their unique vegetative and reproductive characteristics. Qualitative determination of the phytochemicals present in the leaf extracts was based on standard protocols [12] [14]. Gravimetric and spectroscopic approaches were adopted for the quantification of active principles common to all the six varieties [14] [15]. Mean values were computed and subjected to appropriate descriptive and inferential statistical analysis on the SPSS software (20.0 versions). Binary matrices were computed from qualitative results using 0 and 1 for absence and presence of active principle respectively. Dendrogram was constructed from the matrices using the Average Linkage Method to classify the six varieties.

3. Results and Discussion

Qualitative investigation has revealed differences and similarities in the active principles of the six varieties studied (**Table 1**). All varieties possessed alkaloid except Big-fibre. Peter and Kerosene varieties lacked saponin, an active principle present in other varieties. Anthraquinone was present in all except in Julie and Opioro varieties. Five out of the six varieties lacked phlobatannin. All had tannin, steroid, flavonoid and reducing sugar. This pattern typically marks points of genetic convergence in the course of evolution [10] [17] [18]. However, variation observed in the type of phytochemical reflects divergence of genetic components culminating in distinct biochemical pathways [2] [10]. The observed variation in the quantitative approach was remarkable (**Table 2** and **Figure 1**). Tannin was

Table 1. Binary matrix of qualitative assessment.

	Broken	Peter	Julie	Bigfibre	Opioro	Kerosene
Alkaloid	0	0	0	1	0	1
Saponin	1	0	1	1	1	0
Tannin	1	1	1	1	1	1
Reducingsugar	1	1	1	1	1	1
Phlobatannin	0	0	0	0	0	1
Anthraquinone	1	1	0	1	0	1
Steroid	1	1	1	1	1	1
Glycoside	0	1	0	0	1	0
Flavonoid	1	1	1	1	1	1

Key: 0 = absence 1 = presence.

Table 2. Percentage composition of intersected active principles.

	Broken	Peter	Julie	Bigfibre	Opioro	Kerosene
% Tanin	1.73	1.61	1.37	0.43	2.41	2.11
% Steroid	5.0	4.4	9.0	6.2	3.8	5.92
% Flavonoid	3.3	2.71	0.01	0.05	1.43	0.26
%Reducing sugar	0.83	1.62	0.04	2.16	0.09	0.55

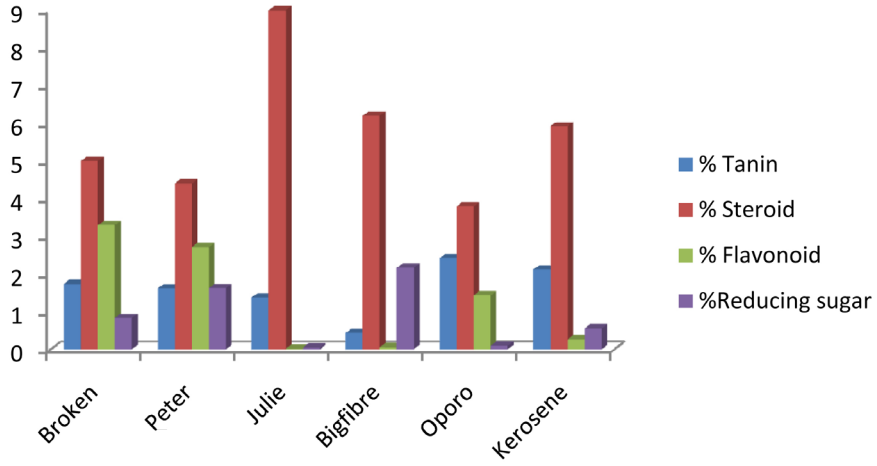

Figure 1. Relative proportions of quantified phytochemicals.

lowest in Bigfibre (0.43%) but highest in Opioro (2.41%). Steroid ranged from 3.8% in Opioro to 9.0% in Julie variety with a standard deviation of 1.84. With 95% confidence interval of the mean, repeating the experiments several times would yield a wide variation in the steroid ranging from 3.79 to 7.65 (**Table 3**). Julie variety also recording the lowest composition in flavonoid (0.01%) and reducing sugar (0.04%) component was also notable. Comparison of the mean values of phytochemicals among the six varieties studied has shown a statistically significant difference ($p = 0.0005$) with a large F-value (18.244) (**Table 4**). The LSD (least significance difference) method of mean separation showed that steroid was the most remarkable phytochemical contributing to the significant differences (**Table 5**).

Dendrogramhas revealed very close relationship between Julie and Opioro varieties (**Figure 2**). The remaining four were divergent although Broken and Peter arose from the same ancestral lineage with Julie and Opioro. However, Bigfibre and Kerosene varieties were clearly different from rest belonging to different ancestral origin. With these remarkable differences, they ought to be given special taxonomic and systematic review for appropriate nomenclatural assignment. This study has successfully employed the use of chemosystematic evidentiary character in the varietal description, delimitation and circumscription of the six varieties of *Mangifera indica* studied. The present finding is a confirmation to previous taxonomic investigation on *Mangifera indica* using microanatomical evidences as reported by [5]. In their findings, Julie and Opioro varieties were also closely related in the dendrogram while Bigfibre was unique for having the highest stomatal index. The two detailed taxonomic reports so far are complementary and confirmatory using different evidences. It has been proven that phytochemical analysis could be reliably employed in solving taxonomic problems apart from its medicinal applications. This view also agrees with the findings of [17] where only foliar flavonoid composition was employed in the chemotaxonomic studies of Japanese *Citrus* species.

Further taxonomic investigation may be required on larger number of *Mangifera indica* varieties using genomic tools such as molecular marker approach.

Table 3. Descriptive statistics.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	6	1.6100	0.68621	0.28014	0.8899	2.3301	0.43	2.41
2	6	5.7200	1.84261	0.75224	3.7863	7.6537	3.80	9.00
3	6	1.2933	1.43617	0.58631	−0.2138	2.8005	0.01	3.30
4	6	0.8817	0.85171	0.34771	−0.0122	1.7755	0.04	2.16
Total	24	2.3763	2.32488	0.47456	1.3945	3.3580	0.01	9.00

Key: 1 = Tannin 2 = Steroid 3 = Flavonoid 4 = Reducing sugar.

Table 4. Analysis of variance.

Phytochemicals	Sum of Squares	Df	Mean Square	**F**	**Sig.**
Between Groups	91.046	3	30.349	**18.244**	**0.000**
Within Groups	33.270	20	1.664		
Total	124.316	23			

Table 5. Multiple mean separation using the least significance difference (LSD).

(I) Phytochemicals			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD Key: 1 = Tannin 2 = Steroid 3 = Flavonoid 4 = Reducing sugar	**1**	**2**	**−4.11000***	0.74465	**0.000**	−5.6633	−2.5567
		3	0.31667	0.74465	0.675	−1.2367	1.8700
		4	0.72833	0.74465	0.340	−0.8250	2.2817
	2	**1**	**4.11000***	0.74465	**0.000**	2.5567	5.6633
		3	**4.42667***	0.74465	**0.000**	2.8733	5.9800
		4	**4.83833***	0.74465	**0.000**	3.2850	6.3917
	3	1	−0.31667	0.74465	0.675	−1.8700	1.2367
		2	**−4.42667***	0.74465	**0.000**	−5.9800	−2.8733
		4	0.41167	0.74465	0.587	−1.1417	1.9650
	4	1	−0.72833	0.74465	0.340	−2.2817	0.8250
		2	**−4.83833***	0.74465	**0.000**	−6.3917	−3.2850
		3	−0.41167	0.74465	0.587	−1.9650	1.1417

*The mean difference is significant at the 0.05 level.

Since variation in plant chemical constituents is a reflection of their coded genetic information, the present report is therefore reliable, innovative and technically robust. This is because the outcome has successfully partitioned and circumscribed the six varieties of mango studied for appropriate nomenclatural

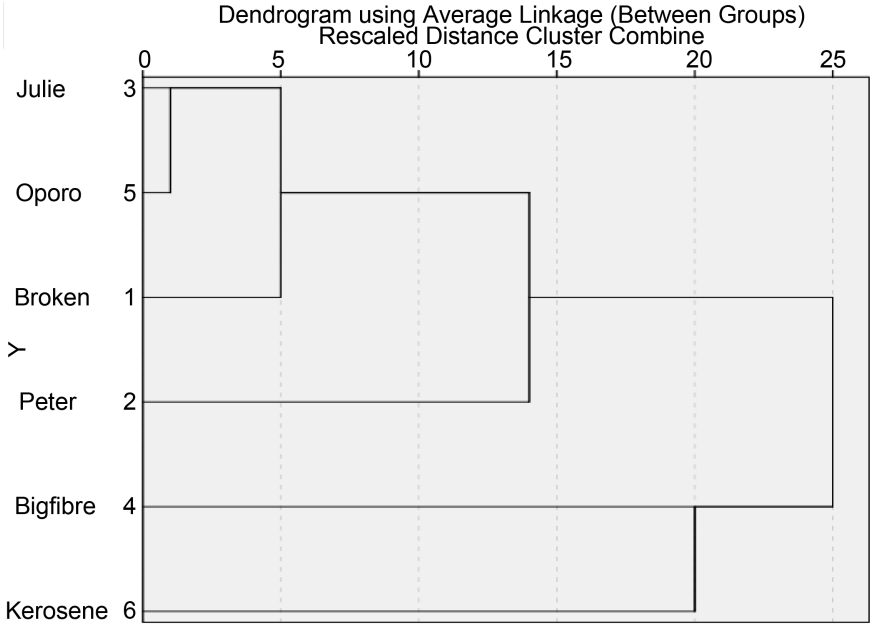

Figure 2. Dendrogram of six varieties of *M. indica.*

assignment.

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