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Leaf Anatomical Evaluation of Some Minor Legumes and Their Correlated Genetic Implications

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Authors' contributions

This work was carried out in collaboration among all authors. Author JOA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors TPO, EOO, TB and JAI managed the analyses of the study. Authors AII and ADA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Twelve (12) accessions of six (6) species of the minor legumes obtained from National Centre for Genetic Resources and Biotechnology (NACGRAB) Ibadan, Oyo-state, Nigeria; cultivated and nurtured at the teaching and research farm of the Federal University Oye Ekiti, Ekiti State, Nigeria were assessed for genetic variability and diversity analysis through their leaf anatomical features including the cell wall, cell shape and stomata characters. Epidermal peeling, staining, mounting and photo-micrographying procedures in line with established literature were carried out and data analyzed in percentage method. Result through descriptive statistics showed that Stomata prominence among the plants at both surfaces is in order of paracytic, diacytic, animocytic and anomocytic as 50%, 41.7%, 8.3% and 0% respectively. Cells shapes at both surfaces are also in the same proportion; 58.3% for irregular and 41.7% polygonal. Slight difference occurred in the

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proportion of anticlinal wall types at both surfaces. 50% curved, 41.7% slightly straight and 8.3% curved/slightly straight at the adaxial surface but 58.4% curved, 33.3% slightly straight and 8.3% curved/slightly straight at the abaxial surface; having cells with more curved anticlinal wall than at the adaxial surface. The Chi-square and probability values of 8.756 and 0.032; 0.667 and 0.414; 5.1818 were recorded at both the adaxial and abaxial surfaces; for stomata type, cell shape and anticlinal wall type of all the accessions. Generally, the accessions displayed recognizable similarities and differences in their epidermal characters that could be used for genetic extrapolation and taxonomic decision.

Keywords: Stomata; cell shape; anticlinal wall; abaxial;

1. INTRODUCTION

Genetic diversity refers to the heritable variation within and between populations of organism. It has a great importance from the individualistic and population point of view. All the phenotypic features are dependent on the genetic variability of any organisms which also helps to adapt to and evolve in different environmental pressures [1]. A better understanding of genetic diversity will improve our understanding of the taxonomy, origin and evolution of plant species of interest [2]. Much of the large amount of diversity of a species may be found within individual populations, or partitioned among a number of different populations [2].

The goal of conservation genetics is to maintain genetic diversity at many levels and to provide tools for population monitoring and assessment that can be used for conservation planning [3]. Every individual is genetically unique by nature. Conservation efforts and related research are rarely directed towards individuals but genetic variation is always measured in individuals and this can only be estimated for collections of individuals in a population/species. It is possible to identify the genetic diversity from phenotypic variation either by quantitative traits (traits that vary continuously e.g., plant height) or discrete traits such as the stomata type which are all governed by one or few genes [3].

Plants anatomy describes the structure and organization of cells, tissues and organ of plants in relation to their development and function. Plant anatomical structure of the plants is mainly influenced by the genetics or the environmental factors [4,5]. Therefore, the anatomical features give an indication of the phylogeny or relatedness [6]. There are large heritable differences between stomata types; their dimensions, structures and morphology which could be used in diagnosing the relatedness of the species [6].

Legumes are among the three largest families of flowering plants. The flowering plants of greatest importance to world agriculture belong to the family Gramineae (Cereals and grasses) and Leguminosae (Legumes or Beans family). [7] stated that Legumes have often been associated with alleviation of poverty worldwide and consumption of beans is a cheap way of deriving the required nutrients.

Orphan, or underutilized, legumes, are staple food crops in many developing countries but their economic importance in global markets is limited [8]. Orphan crops are a diverse set of minor crops that tend to be regionally important but not traded around the world and as such have received little attention from research networks. However, owing to their lack of economic importance, they have been neglected by both the international scientific community and by industry when compared to commodities such as rice, corn (*Zea mays*), and wheat [9].

Their neglect has been the subject of two reports from [10]. They have generally little economic importance and have not been greatly improved by breeders [8,9]. However, they play a significant role in many developing countries, providing food security and nutrition to consumers, as well as income to resource-poor farmers.

Typical orphan legume crops are (*Vigna unguiculata*), *Cajanus cajan, Mucuna Pruriens* (L.) DC) (Velvet Bean), *Vigna angularis* (L.) Thouars (Rice Bean), *Vigna radiata* (L.) R. Wilczek (Green Gram), *Canavalia ensiformis* (L.) DC) (Sword Bean) *Lablab purpureus* (Var. lignosus) (Lablab Bean) *Psophocarpus tetragonolobus* (L.) DC) (Wing Bean) *Vigna subterranea* (L.) Thouars) (Bambara groundnut) and *Macrotyloma geocarpum* (Harms) (Kersting groundnut) etc.

This paper focused on evaluating data of some anatomical features including stomata type, cell shape and anticlinal wall types of six minor legume species of twelve accessions viz; sword bean (TCg 1and TCg 4), mexican yam bean (TPtu 1 and 5), wing bean (Tpt 12 and 18), jack bean (TCe 1 and 3), kersting groundnut (TKg 6 and 12), pigeon pea (TCc 8127 and 8156) for possible occurrence of genetic diversity.

2. MATERIALS AND METHODS

Twelve (12) accessions of six (6) species of the minor legumes obtained from National Centre for Genetic Resources and Biotechnology (NACGRAB) Ibadan, Oyo-state, Nigeria were cultivated and nurtured at the teaching and research farm of the Federal University Oye Ekiti, Ekiti State, Nigeria.

Epidermal peeling, staining, mounting and photo-micrographying procedures are according to [11].

3. RESULTS

Tables 1 and 2 depict the summary of stomata characteristics, cell shape description and the anticlinal wall types of the twelve accessions of these legumes at both the abaxial and the adaxial surfaces. Stomata distribution and prominence among the plants at both surfaces is in order of paracytic, diacytic, animocytic and anomocytic as 50%, 41.7%, 8.3% and 0% respectively. Cells shapes at both surfaces are also in the same proportion; 58.3% for irregular and 41.7% polygonal. However, there is slight difference in the proportion of anticlinal wall types at both surfaces. 50% curved, 41.7% slightly straight and 8.3% curved/slightly straight at the adaxial surface but 58.4% curved, 33.3% slightly straight and 8.3% curved/slightly straight at the abaxial surface; having cells with more curved anticlinal wall than at the adaxial surface. Generally, the accessions displayed recognizable similarities and differences in their epidermal characters that could be used for genetic extrapolation and taxonomic decision (Table 3).The diagrammatical descriptions of the epidermal features among the plants at the abaxial surface are shown in Fig. 1.

4. DISCUSSION

Taxonomic decision and correlated genetic extrapolation could be deciphered from the result of the epidermal morphology of the plant accessions understudy. Observed vegetative morphology among the species is in line with Edeoga [12] where comparative morphology among different species has been used to establish relationship among some plants. The three major epidermal features (cell wall, cell shape and the stomata character) studied among the taxa revealed variability that could be due to genetic inclination. For instance, all the accessions were having stomata on both surfaces (amphistomatic). Also, possession of curved and slightly straight wall was indicative of irregular cell shape. The influence of “nurture” has been reported to play a key role in determining anticlinal wall type of plant species [13]. Mbagwu et al. [14] has reported the occurrence of more stomata at the abaxial surface than at the adaxial.

Table 1. Summary of stomata type, cell shape and anticlinal wall type of the minor legumes (adaxial surface)

Variables	Characters	Accessions	Percentages	Chi-square value, p-value
Stomata Type	Anomocytic	Nil	0	
	Animocytic	TCc 8217	8.3	
	Paracytic	TCg 4,TCe 1,TCe 3,TKg 6,TKg 12,TCc 8156	50	8.756, 0.032
	Diacytic	TCg 1,TPtu 1,TPtu 5,TPt 12,TPt 18	41.7	
Cell shape	Irregular	TCg 4,TCe 1,TKg 6,TCc 8127,TCc 3, TCc8156,TPtu 1	58.3	0.667, 0.414
	Polygonal	TCg 1,TPtu 5,TPt 12, TPt 18, TKg 12	41.7	
Anticlinal Wall type	Slightly straight	TPtu 5,TCe 1, TCc 8127,TCe 8156	41.7	
	Curved	TCg 1,TPtu 12,TPt 18,TCe 3,TKg 6,TKg 12	50	5.1818, 0.074
	Curved/Slightly straight	TCg 4	8.3	

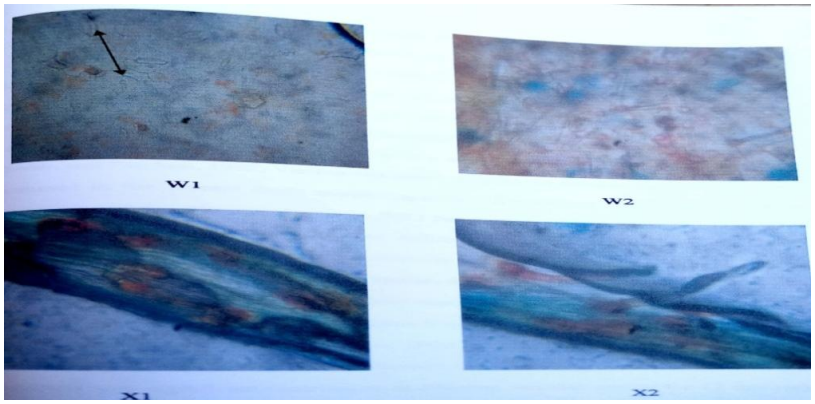
Table 2. Summary of stomata type, cell shape and anticlinal wall type of the minor legumes (abaxial surface)

Variables	Characters	Accessions	Percentages	Chi-square value, p-value
Stomata Type	Anomocytic	Nil	0	
	Animocytic	TCe 8127	8.3	
	Paracytic	TCg 4,TCe 1,TCe 3,TKg 6, TKg 12,TCc 8156	50	8.756, 0.032
	Diacytic	TCg1,TPtu,TPtu 5,TPt 12,TPt 18	41.7	
Cell shape	Irregular	TCg 4,TCe 1,TKg 6,TCc 8127, TCe 8156	41.7	0.667, 0.414
	Polygonal	TCg 1, TPtu 1,TPtu 5,TPt 12,TPt 18,TCe 3, TKG 12.	58.3	
Anticlinal Wall type	Slightly straight	TPtu 5,TCe 1, TCc 8127, TCc 8156	33.3	
	Curved	TCg 1,TPtu 1,TPt12,TPt 18,TCe 3,TKg 6, TKg 12	58.4	6.75, 0.034
	Curved/Slightly straight	TCg 4	8.3	

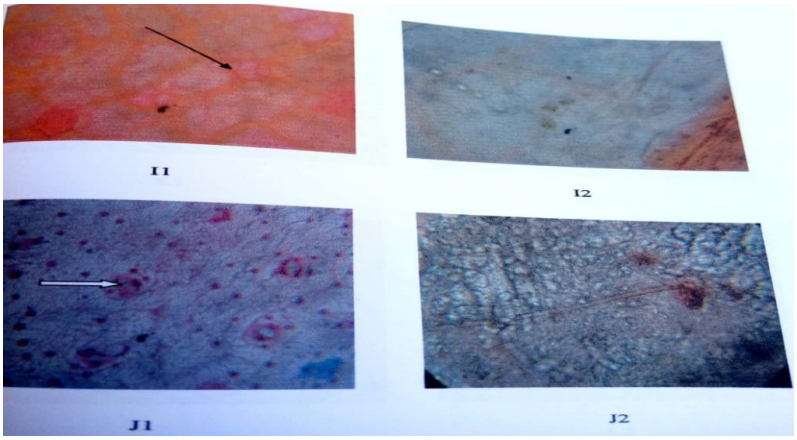
Table 3. Comparison of some epidermal features of the studied plants (abaxial and adaxial surfaces)

TAXA	Characters Codes								
	1	2	3	4	5	6	7	8	9
TCg 1	-	-	-	+	-	+	-	+	-
TCg 4	-	-	+	-	+	-	-	-	+
TPtu 1	-	-	-	+	-	+	-	+	-
TPtu 5	-	-	-	+	-	+	+	-	-
TPt 12	-	-	-	+	-	+	-	+	-
TPt 18	-	-	-	+	-	+	-	+	-
TCe 1	-	-	+	-	+	-	+	-	-
TCe 3	-	-	+	-	-	+	-	+	-
TKg 6	-	-	+	-	-	+	-	+	-
TKg 12	-	-	+	-	-	+	-	+	-
TCc 8127	-	+	-	-	+	-	+	-	-
TCc 8156	_	_	+	_	+	_	+	_	_

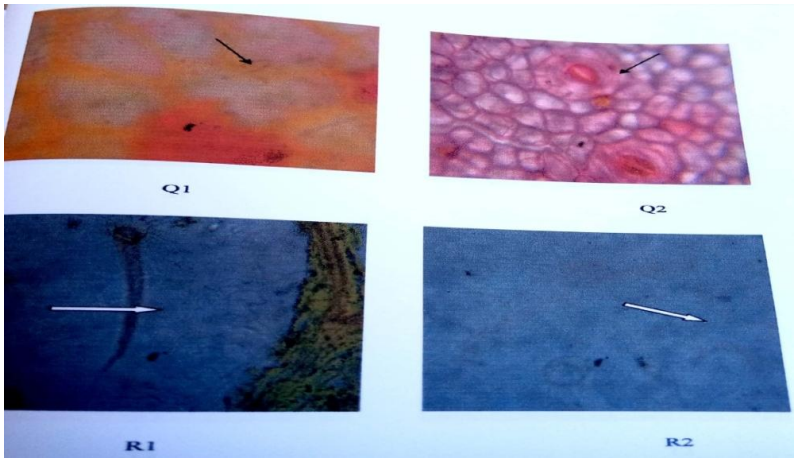
Legend to character codes: 1= Anomocytic stomata, 2= Anisocytic stomata, 3= Paracytic stomata, 4= Diacytic stomata, 5= Irregular cell shape, 6= Polygonal cell shape, 7= Slightly straight anticlinal wall, Curved anticlinal wall, 9= Curved/slightly straight anticlinal wall



W1 = TCg 1 (Diacytic); W2 = TCg 4 (Paracytic); X1 = TPtu 1 (Diacytic); X2 = TPtu 5 (Diacytic)



I1 = Tpt 12 (Diacytic); I2 = Tpt 18 (Diacytic); J1 = TCe 1 (Paracytic); J2 = TCe 3 (Paracytic)



Q1 = TKg 6 (Paracytic); R1 = TCc 8127 (Anomocytic); Q2 = TKg 12 (Paracytic); R2 = TCc 8156 (Paracytic)

Fig. 1. Selected plates showing stomata characters at the abaxial surfaces

5. CONCLUSION

Generally, variability displayed in epidermal features of the studied species and accessions are in agreement with our earlier discovery with minor legumes [11]; consistency of the report of this study with the earlier relevant studies suggested that the distinguishable epidermal characteristics could have genetic implication.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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