Advances in Science and Technology, Vol. 3, No.1, March / April 2009, pp56-62.

Anatomical Study of Some Varieties of *Arachis Hypogaea* Linn In Nigeria

D.O. Aworinde[1*] and A.A. Jayeola[2]
[1]Department of Biological Sciences, University of Agriculture, Abeokuta, Ogun State, Nigeria. [2]Department of Botany and Microbiology, University of Ibadan, Ibadan, Oyo State, Nigeria.
(Submitted: June 25, 2008; Accepted: March 18, 2009)

Abstract

Fourteen varieties of *Arachis hypogaea* Linn., consisting commercial and hybridal lines were studied in search of useful and stable characters for their identification. Shells, testae and cotyledons were examined by light microscope. Lignification of the epidermal cells, distribution of tracheary elements, shapes and arrangement of endodermal cells, occurrence of inclusions are all diagnostic characters. Testae occurred in one layer in some species while it composed more than one layers in some others. Tracheary elements vary from annular in some species but helical in other. Our knowledge of the structure of *A. hypogaea* could provide a sound basis of identification using simple samples rather than whole plant.

Keywords: Anatomical characters, *Arachis hypogaea*, Hybridal, Endosperm, Identification.

1.0 Introduction

Arachis hypogaea L. belongs to the family Fabaceae and sub family Papilionaceae (Hutchison and Dalziel 1958). Different cultures have different names by which the crop is known. There are about twenty-two Arachis species that are known (Ramanatha Rao 1988).The followings are the valid Arachis epithet with citation: *Arachis batizioco* Krap .et. Greg., *Arachis villosa* Beuth, *A. diogoi* Holine, *A. helodes* Mart et. Greg, *A. hypogaea* Linn, *A. nambyquarae* Hoehne, *A. monticola* Krap et. Rig., *A. tuberose* Beuth, *A. guranitca* chod et. Hassl *A. paraguariensis* chod et Hassl, *A. benthanii* Handro, *A. burkatii* Handro, *A. glabrata* Beuth, *A. hagenbeckii* Harms, *A. prostrate* Benth, *A. marginata* Gard, *A. villosulicarpa* Hoshae, *A. Lutescens* Krap et Rig and *A. pusilla* Benth. As in the case of interspecific taxonomy of the genus Arachis, subspecific classification of *Arachis hypogaea* has been considered by various researchers. According to Ramanatha Rao, (1987; 1988,) most of the earlier classification or characterization were based on growth pattern and location of reproductive branches. The morphological description and developmental aspects of *Arachis hypogaea* confused for a long time because of the geocarpic fruit, the complex branching pattern and the highly condensed nature of the reproductive axis (inflorescence) have been mainly responsible for such a confusion (Richter 1989).

Many of the earlier researchers were unable to associate the underground fruit to the aerial flower of the plant. Margraff (1948), illustrated the fruits as growing on the roots. Smith (1950), published for the first time a clear and correct account of the aerial flowers and subterranean fruits of *Arachis hypogaea*. The fruit of *Arachis hypogaea* (groundnut) is referred to as a pod which is a slightly modified lomentiform indehiscent carpal. The cultivar differences in the proportion of pegs penetrate the soil developing into pods were found to be significant (Seshadri 1962). The mature pod normally contains one to four seeds. Occasionally five or even six seeds per pod have been recorded. According to Smartt (1976), single-seeded pods may be produced when all the ovules except the proximal abort and the size may range up to 8.0cm × 2.6cm. Mitra (1985) worked extensively on morphological variability of some fruits and found out that the fruit of groundnut consists of valves structurally dehiscent but functionally indehiscent. Under pressure, pods split along the longitudinal suture. The number of seeds per pod is basically cultival-specific, though it is influenced to some extent by season and other factors (Seshadri 1962).

Anatomical characters were regarded to be an extension of, and supplement to those morphological

* Corresponding author's e-mail: davidaworinde@yahoo.com

characters on which scientific classification is based (Metcalfe and Chalk 1983). Anatomy sometimes proves very useful or helpful in individual identification especially materials that are not accompanied by flora parts or fruits (Yue *et al*. 1999).

2.0 Materials And Methods

Groundnut specimens were collected from different parts of the country. The specimens consist of 7 hybridal lines and 7 commercial or local lines. The places of collection fall within the western part of Guinea and Sudan Savanna belts of Nigeria where groundnut are mostly cultivated. They include Ajaawa, Oyo, Efon-Alaaye, Gbajibo, Mokwa, Bida and Kaffin-koro.

The soils are nutritionally richer because of lower rainfall than those of forest region. They receive about 1600mm to 1700mm rainfall per annum. The organic content in the surface is low and total content is less than 0.1% available. Phosphorus is also low, less than 10ppm, but the soils are generally capable of cation and generally moderate in exchangeable ions (Vieira 1999). The anatomical sectioning was carried out in Maize Pathology Laboratory at International Institute of Tropical Agriculture (IITA).In order to produce the internal structure of the varieties, transverse sections through the centres of the cells, testae and cotyledons were made following Fernandes, (1999).Materials were fixed in FAA for 24hrs followed by dehydration in series of ethanol (30% - 90%). Infiltration was done with the use of paraffin wax using tertiary butyl alcohol (TBA) as base for 24 - 72hrs at 55-60°C. Infiltrated specimens were then transferred into the embedding liquid, trimming of the relatively hard polymerized blocks was done with the aid of disposable knives. Transverse sections (10µm) thick were made with a rotary microtome, staining was done with safranin for 15mins subsequently rinse in distilled water and differentiated in ethanol series (30- 90%). Specimens were counterstained in Fast green for 5seconds, transferred into xylene, cleared in clove oil and mounted in DPX. Examination of prepared slides was done using giant microscope LEICA attached to the computer. Anatomical descriptions followed the conventions established in Kaul *et al* (1999).

Table 1: Showing Local (C.L) and Hybridal (H.L.) Varieties.

Varieties	Assigned Code
Kaffin-koro Local	C.L1
Gbajigbo Local	C.L.2
Oyo Local	C.L 3
Efon- Alaaye Local	C.L 4
Ajaawa Local	C.L5
Bida Local	C.L 6
Mokwa Local	C.L 7
ICGV-SM 93525	H.L 8
ICGV-SM 94583	H.L 9
UGA 7	H.L 10
ICG-IS 96846	H.L 11
ICGV-SM 95316	H.L 12
ICG-IS 95631	H.L 13
ICG-IS 96894	H.L 14

3.0 Result

The anatomical features of seeds of *Arachis hypogaea* varieties were shown in plates 1-14 with special reference to the cells, testae and cotyledons. Dehiscent fruit walls commonly occur in fruits containing several seeds like groundnut (Hammons 1972). The fruit of *Arachis hypogaea* is structurally dehiscent but functionally indehiscent (Mitra 1985). The outermost exocarp consists of epidermal cells covered with cuticle, one or more layers of epidermal cells, partly compressed and highly lignified. While the mesocarp and endocarp consist of parenchymatous cells and cross cells elongated transversely to the long axis and having thick lignified walls (Smartt 1999).

As shown in Figures CL 1, CL 2, CL 4, CL 5, CL 7, HL 9, HL 11 and HL 14, the epidermal cells distinctly lignified. Parenchyma cells are thin-walled and slightly lignified. The inner most sclerenchyma cells are heavily lignified. Sclerenchyma cells shown in plates CL 4 and HL 14 are slightly lignified while those shown in plates CL 3, CL 5, HL 9, HL 11 and HL 14 are heavily lignified. Their parenchyma cells are irregular in shape and are of various sizes. Figures CL 1 to HL 14 showed that each mature seed coat (testa) is made up of more than two distinct layers,

the outermost layer consists uniseriate outer palisade cells which are columnar in shape. The middle is made up of parenchymatous cells containing starch grains and richly supplied with tracheary elements; the innermost layer consists of a single layer of isodiametric cells. Figures CL 1, CL 3, CL 4 and CL 7, the testae are differentiated into three multivariate layers; the outer is not heavily lignified but permeated by large intercellular spaces, the middle which is multiseriate, wavy, lignified and richly supplied with tracheary elements. The inner layer is also heavily lignified with a uniseriate layer of cells. Figures CL 2, CL 6, HL 8, HL 11, HL 13 and HL 14 showed lignified outer layers of cells, the middle layer is heavily lignified and housed numerous annular tracheary elements while the inner layer of cells is uniseriate and heavily lignified. Figures HL9 and HL14 showed testae which are differentiated into three distinct layers of cells. The outer and middle layers are lignified and harboured numerous spirally arranged tracheary elements while the inner layer showed slight lignification.

Figures CL 1, CL 7, HL 11 and HL 13 contained endospermal cells with thin cuticular layer covering the uniseriate layer of epidermal cells. Most of the cells are round in shape and contain copious food reserves which are evenly distributed among them. Figures CL 2, CL 3, CL 6, HL 10, HL 12 and HL 14 showed mature endospermal cells and region of cells differentiation. The endospermal cells in Figures CL 5 and HL 13 are smaller, interlocked and closely packed, irregular in shape, deeply stained and contain copious food reserve. Figures CL 6, HL 9 and HL 14 depict the distinct uniseriate layer of epidermal cells surrounded by thin layer of cuticle. The endospermal cells consist considerably very low food reserves which are unevenly distributed among the cells. Most of the cells in these varieties are empty, thick-walled and of various sizes and shape. They contain angular collenchymatous cells.

4.0 Discussion

Identification and classification of *Arachis hypogaea* using morphological features as posed a great difficulty in research over the years. Pod size, constriction and reticulation, pod length and breadth, number of seeds per pod, presence or absence of

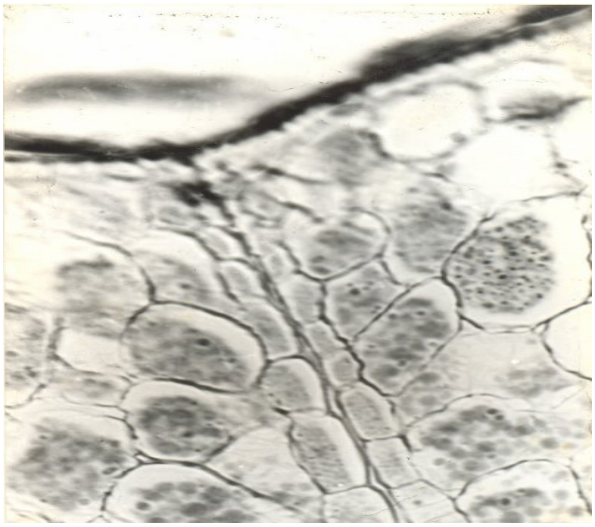

Figure CL 1

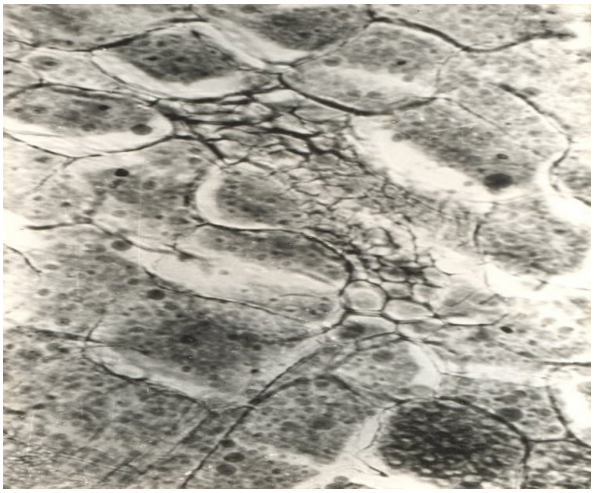

Figure CL 2

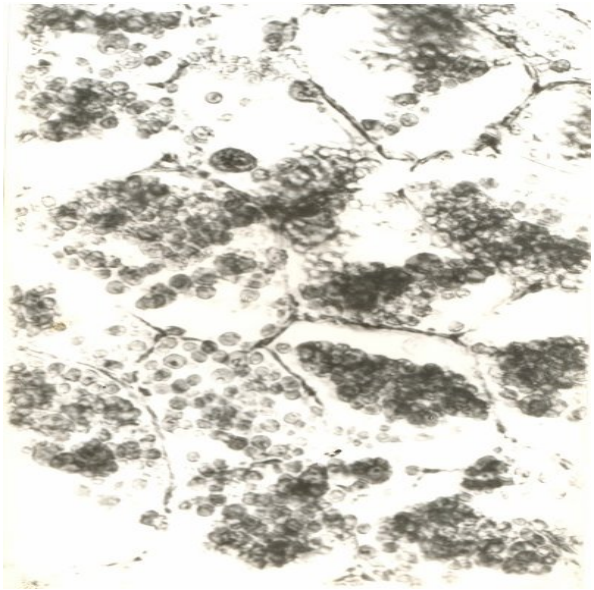

Figure CL 3

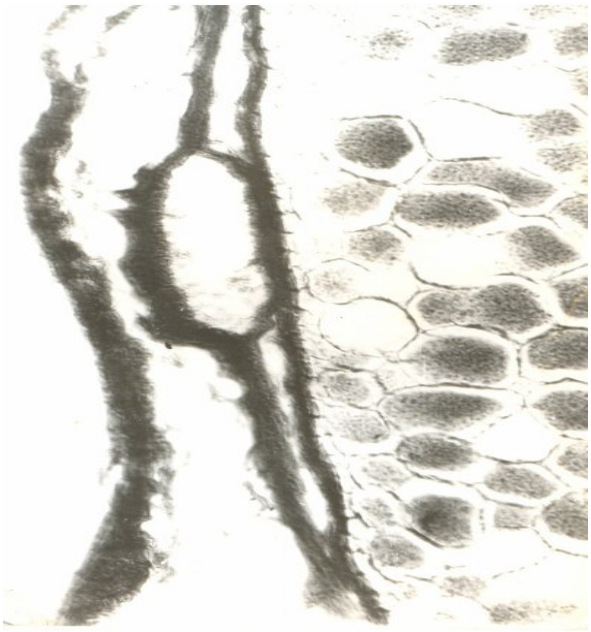

Figure CL 4

Figure CL 7

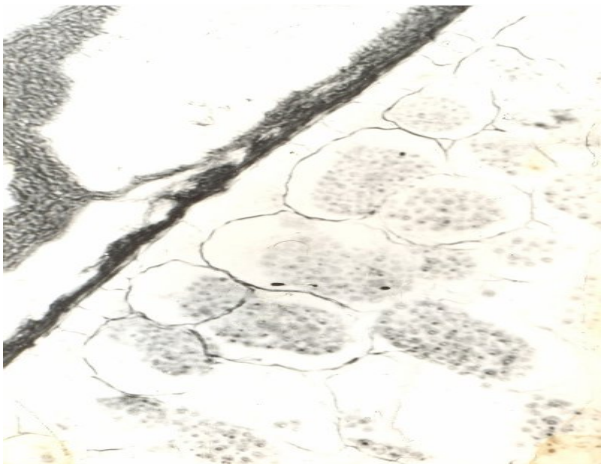

Figure CL 5

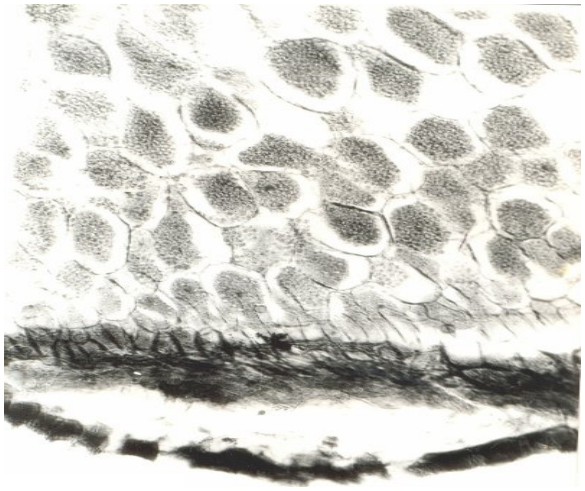

Figure HL 8

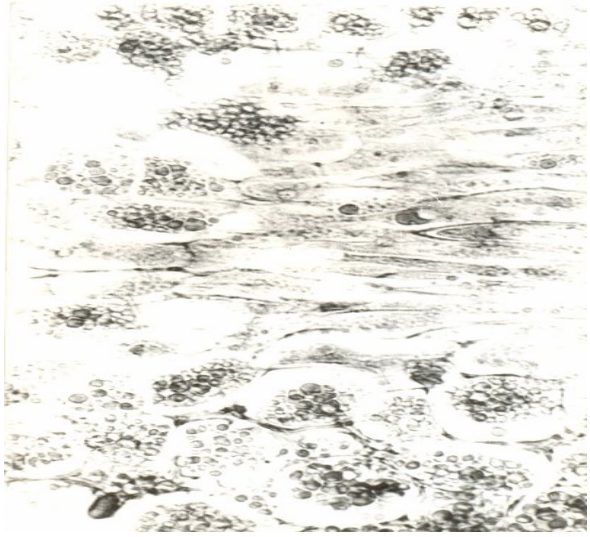

Figure CL 6

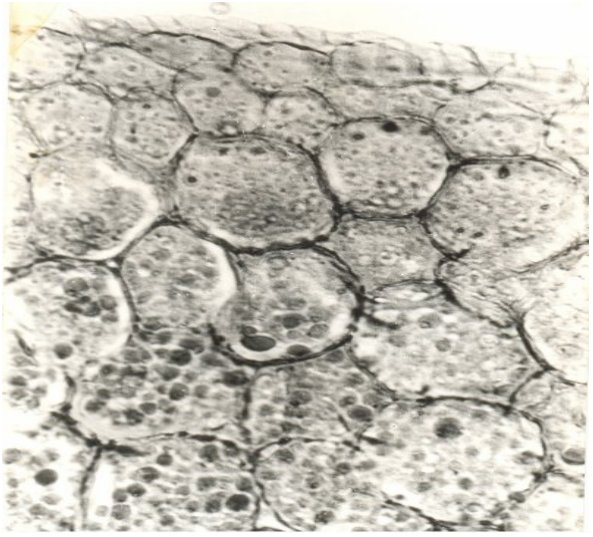

Figure HL 9

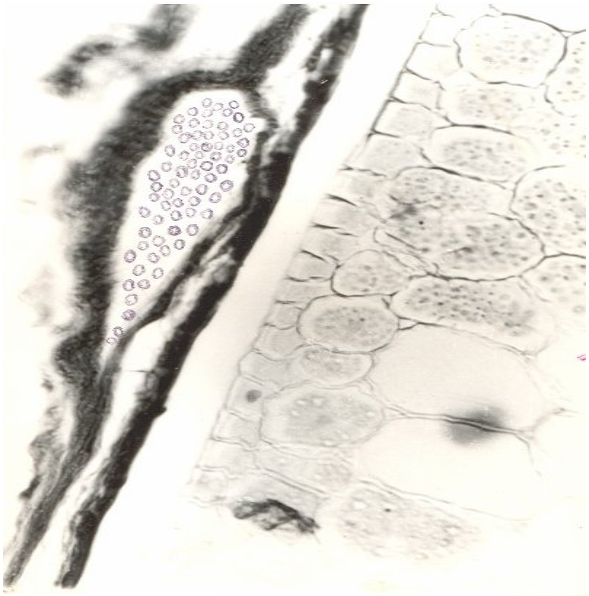

Figure HL 10

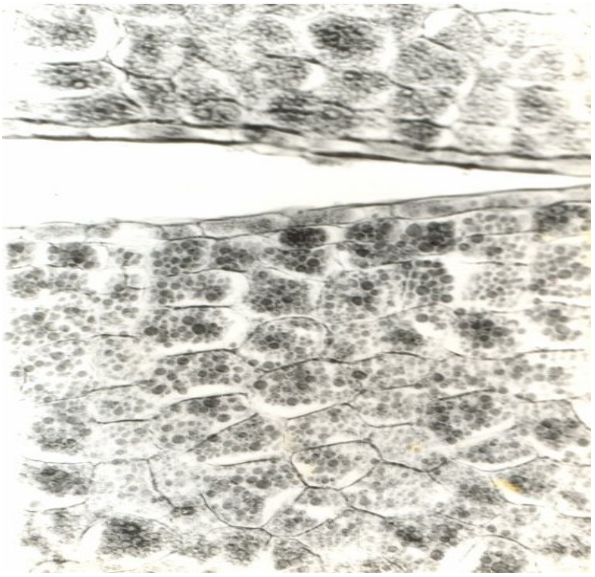

Figure HL 13

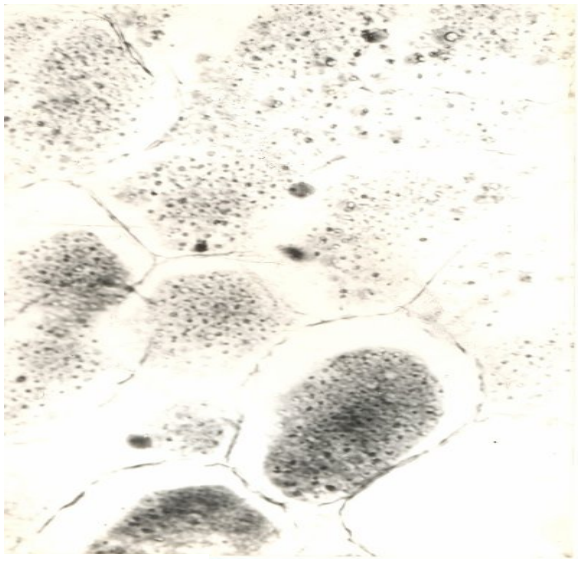

Figure HL 11

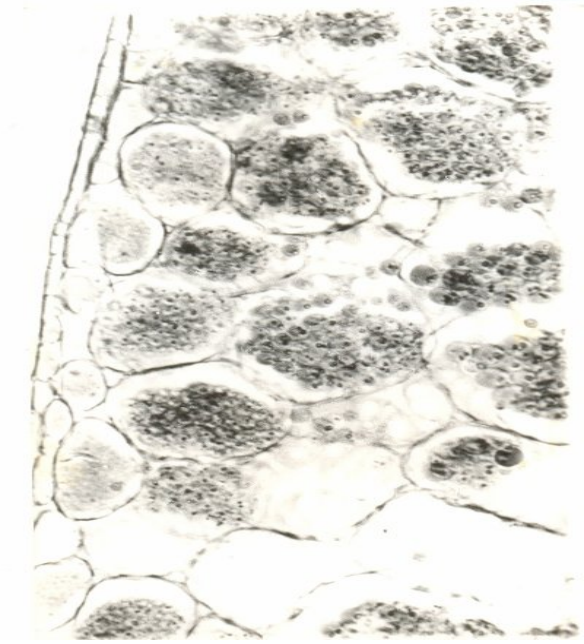

Figure HL 14

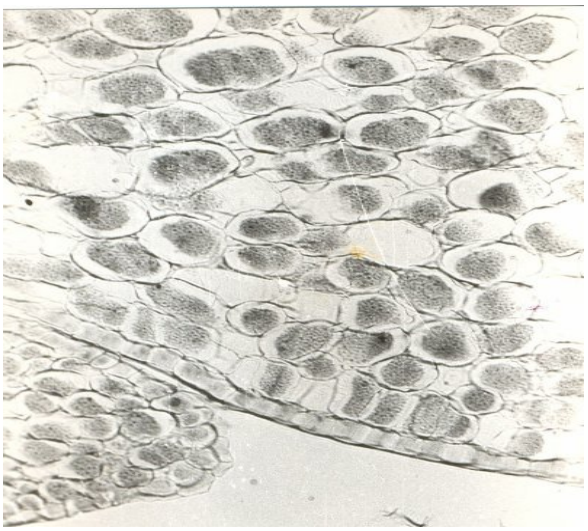

Figure HL 12

Photomicrographs showing the Transverse Section of fruits of some varieties of *Arachis hypogaea* L. in Nigeria. Figure CL1: Kaffin-koro Local; Figure CL 2: Gbajigbo Local; Figure CL 3: Oyo Local; Figure CL 4: Efon- Alaaye Local; Figure CL 5: Ajaawa Local; Figure CL 6: Bida Local; Figure CL 7: Mokwa Local; Figure HL 8: ICGV-SM 93525; Figure HL 9: ICGV-SM 94583; Figure HL 10: UGA 7; Figure HL 11: ICG-IS 96846; Figure HL12: ICGV-SM 95316; Figure HL 13: ICG-IS 95631; Figure HL 14: ICG-IS 96894

beak are the possible areas whereby groundnut varieties have shown marked variability and similarity. Therefore these parameters are useful in the characterization of groundnut varieties. John *et al.*, (1954); Mohammad *et al*., (1973b) classified groundnut into five groups based on pod length and breadth. Variations exist in the cellular organization of the epidermis, hypodermis, endosperm and internal structural details in all the groundnut varieties investigated. Stace (1965) suggested that since the internal parts of plants are not easily affected by the environment, they are useful in the taxonomic delimitation of taxa. Consequently, groundnut varieties could be best identified using anatomical parameters in their shells, testae and cotyledon. Lignification of tissues in shells of groundnut varieties is not even, there is heavy lignification in HL 13 and HL 14 are could be distinguished from CL 2 and CL 4 on this basis. Seed coat consists of multilayered tissues in all the varieties. The shape and arrangement of endospermal cells do not differentiate the hybridal line from commercial line because differences exist within and between both. However, marked difference is evident in the distribution of food reserves in both commercial and hybridal lines. Most commercial lines have copious food reserve in their endospermal cells, so also hybridal line HL 11, HL 13 and HL 14. This anatomical character shows that HL 11, HL 13 and HL 14 are true hybrid of the local varieties. This report is in line with the work of Yoneyama, (1990) he used the cultivated species of *Ricinus communis* to trace the wild species. Meanwhile, the hybridal line HL 11 and HL 13 together with commercial line CL 6 are distinctive in their lowest quantity of food reserves. This suggests that genetic mutation might have occurred in cause of hybridization. From the available literature, anatomical study on groundnut varieties is scanty and not comprehensively documented. However, Wynne, *et. al.*, (1983) studied only the surfaces of seeds of some genus in leguminosae. The anatomical information is very important in formulating research programs in the disciplines of Plant breeding, Agronomy, Pathology, Entomology and Physiology. This work is able to provide some useful information on the anatomical characters of groundnut fruit.

Large gap still exist in our knowledge of the genus *Arachis* as a whole, this calls for more investigation and researches. Further anatomical studies of some varieties of groundnut needed to be carried out as this may not only have taxonomic significant but also help to identify any useful association of morphological character with anatomical features. Such comprehensive studies of the genus as a whole which is presently lacking will be useful in gaining a better understanding of how wild species could be used to improve the commercial or local groundnut crop.

References

Fernandes, E.M., and Rosolem, C.A. 1999, "Groundnut yield as affected by liming and Drying method," Pesquisa Agropecuaria Brasileira, **34**, 11- 20.

Hammons, R.O. 1978, "Krinkle, a dominant leaf marker in the peanut *Arachis hypogaea* Linn," Crop Science, **4**, 22-24.

Hutchison and Dalziel, 1958 "Monographic study of Arachis in Western North America," *Rhodora* ***43***, 289-325.

John, C.M. and Seshadri, C.R. 1954, "Varieties and forms of groundnut *Arachis hypogaea* Linn., their classification and economic characters, Indian Jour. of Agricultural Science, **24**, 159-193.

Kaul, J.N. 1999 "Response of groundnut (*Arachis hypogaea*) genotypes of planting Geometry under sub- tropical conditions" Indian Journal of Agricultural Sciences **69**, 458-460.

Margraff, C.M. 1948, "An atomy in groundnut" (ed. P.S. Reddy), Indian Council of Agricultural Research, New Delhi, Pp.65-76.

Metcalfe, C.R. and Chalk, L.C. 1983, "Anatomy of the Dicotyledons 2 nd ed. Vol. 1 and 11 Clarendon Press, Oxford.

Mitra, J. 1985, "The peanut *Arachis hypogaea*, its history, histology and utility. Penn University Botany Lab. Contributions, **4**, 301-338.

Mohammad, 1973 "Studies in the genus *Arachis* 111 Polyembryony in the groundnut *Arachis hypogaea* Linn.," Indian Oilseeds Journal, **2**,74.

Ramanatha Rao, V. 1987, "Origin Distribution and taxonomy of Arachis hypogaea and Sources of resistance to groundnut rust (Puccina arachidis Speg.)", In: Groundnut rust disease, Patancheru Indian, Pp. 3-15.

Ramanatha Rao, V. 1988, "Botany, In: Groundnut (ed.P.S.Reddy)" Indian Council or Agricultural Research, New Delhi, Pp.24 – 64.

Richter, A. 1989, "Anatomy,embryology and ecology of Arachis hypogaea *Botanical Gazette*,

78, 289-310.

Seshadri, C.R. 1962, "A mutant form of groundnut Madras Agricultural Journal, **43**, 199 – 200.

Smartt, J. 1976, "Groundnut varieties of northern Rhodesia and their classification, Empire Journal of Experimental Agriculture", **29**, 153-158.

Smith, B.W. 1950, "Arachis hypogaea L. Aerial flower and subterranean fruit," American Journal of Botany, **41**, 607- 616.

Stace, C. A. 1965, "Cuticular studies as an aid to plant taxonomy" Brit. Nat. Hist. Bull. Bot., **4,** 3-78.

Vieiria, R.F. and Summer, D.R.1999, "Application of fungicides to foliage through over-head sprinkler irrigation- a review. Pesticide Science, **55**, 412-422.

Wynne, J.C., Elkan, G.H., Isleib, T.G., and Schneeweis, T.J. 1983, Effect of host plant, Rhizobium strain and host strain interaction on symbiotic variability in peanut, Peanut Science, **10**, 110-114.

Yoneyama, T., Nambiar, P.T.C., Lee, K.K., Sreenivasa Rao, B., and Williams, J. H. 1990, "Nitrogen accumulation in three legumes and two cereals with Emphasis on estimation N_2 fixation in the legumes by the natural ^{15}NAbundance technique, Biology and Fertility of soils, **9**, 25-30.

Yue, C.P., Mao, Z. Q., Zhu, Q., Yue, B. S.., and Jia, J. 1999, "The effect of a compound Organic and inorganic fertilizer on the yield of groundnuts," Journal of Henan Agricultural Sciences, **6**, 25-26.