

**Morphological Characterization of Cashew
(*Anacardium occidentale* L.) Fruits at the Western
Philippines University (WPU) Cashew Plantation**

Romeo R. Lerom
College of Arts & Sciences
Western Philippines University
Aborlan, Palawan,
romeolerom@yahoo.com

ABSTRACT

The cashew plantation of Western Philippines University (WPU) started in 1975. Preliminary characterization of the cashew fruit was conducted based on the International Board of Plant Genetic Resources (IBPGR) Descriptors for Cashew to assess the extent of genetic diversity present within the collection.

The results of the preliminary morphological characterization of 21 cashew fruit trees present in the WPU cashew plantation were presented in a dendrogram. Results revealed that the morphological characterization of the 21 cashew fruit trees differed in terms of apple weight, length, width, shape, color and total amount of soluble solids as well as in the nut and kernel dimensions.

Keywords: *cashew characterization, Anacardium occidentale, WPU*

INTRODUCTION

Cashew is one of the major valued crops with high economic potential. The sap from the bark incision can be used to make indelible ink. Young leaves may be used for salads and condiments. The ripe fruit is eaten raw as dessert. The juice extracted from the fruit may be made into wine and vinegar. Fluid from the fruit shell is used in preserving woodworks and books against termites. The kernel is roasted and eaten and is also used in making candies, cakes and ice cream.

Cashew plantation establishment at the Western Philippines University (WPU), formerly State Polytechnic College of Palawan (SPCP), started in 1975. However, this crop has not been well-studied with regard to its morphological characteristics. It is very important to study the morphological characteristics of the cashew collections to determine its diversity and as basis for further study.

Tabinga and Gagni (1984) reported that systematic classification to varieties is not yet available. This fact is true even up to the present. The

limitations on the lack of quality and high yielding planting materials are still a problem in cashew up to now. Limited or no characterization studies using the International Board for Plant Genetic Resources (IBPGR) Descriptors for Cashew had been conducted in Palawan.

Thus, this study was conducted to fill that gap. It specifically characterized the different cashew varieties at WPU cashew plantation with the hope of identifying high quality varieties with better economic yield. Further, efficient morphological characterization of cashew varieties would help elevate the cashew industry not only in Palawan, Rizal and Zambales but in other provinces as well.

METHODOLOGY

Fruit Collection

Twenty one cashew trees were selected for characterization of fruit and nut at the WPU campus cashew field establishment located at the following areas: cashew plantation (CP₁): N 09°26'50", E 118°33'24", (CP₂): N 09°26'51", E 118°33'27", (CP₃) N 09°26'26.2", E 118°33'38.7" and (CP₄) N 09°26'24.3" E 118°33'36.8". Ten cashew apples and nuts were collected from each chosen tree.

Characterization

The International Board for Plant Genetic Resources (IBPGR, 1986) Descriptors for Cashew was used for the morphological characterization of the cashew apple, nuts and kernel traits. The following character traits were used: for cashew apple; weight, length, width, shape of apple base (Shp), ease of peeling (EOP), color (Clr), cashew apple apex (Apx), ridges on cashew apple (Rdg), cavity at apex of cashew apple (Cav); for flesh of apple: total soluble solids (TSS), color (CLR), softness (Sft), and odor (Odr); for nut and kernel dimension: weight (Wgt), length (Len), width (Wid), and thickness (Thi).

Measurement

The weight and dimension of cashew apple, nut and kernel were measured using analytical balance and Vernier caliper, respectively.

Data Analysis

The data were analyzed using the STATISTICA (1994) program.

RESULTS AND DISCUSSION

From a total of 625 trees, the fruits of 21 cashew trees at WPU campus were morphologically characterized. Results revealed different variety/strains of cashew. The morphological characteristics of cashew apple are presented in Table 1. The weight (Wgt) of apple ranged from 29.4 g to 114.0 g with trees number 20 and 17 having the lowest and highest weight of apple (Plate 1 & 2), respectively.

Table 1. Morphological characteristics of cashew apple of the 21 trees characterized

TREE	CASHEW APPLE									CASHEW FLESH			
	Wgt	Len	Wid	EOP	Shp	CLR	Rdg	Apx	Cav	TSS	Clr	Sft	Odr
1	77.8	51.3	22.8	3	3	1	2	1	3	7.0	2	7	7
2	49.0	55.2	24.7	7	2	2	2	1	7	10.0	2	7	7
3	95.4	69.6	23.1	7	2	1	0	1	7	8.0	2	7	7
4	80.2	84.5	23.5	3	4	3	0	2	7	7.0	3	7	7
5	41.0	54.1	21.0	7	2	2	0	1	3	8.0	2	5	7
6	90.6	70.7	23.2	7	1	3	1	1	7	8.0	3	5	7
7	41.0	52.0	22.7	7	2	3	2	1	2	5.0	3	7	7
8	104.0	81.3	28.0	7	2	1	2	1	3	9.0	1	7	7
9	96.9	72.7	49.5	3	2	2	0	2	3	9.0	2	7	7
10	64.5	57.6	44.3	3	2	2	2	1	3	6.0	3	5	7
11	55.4	57.6	37.8	3	2	2	0	1	3	7.0	2	7	7
12	67.8	58.4	45.0	3	2	1	2	1	3	8.0	2	7	7
13	73.0	55.0	50.1	3	3	1	2	1	3	9.0	1	7	7
14	84.6	62.9	48.8	3	2	2	2	2	3	8.0	2	7	7
15	66.8	62.2	37.8	3	2	1	2	2	3	7.0	3	7	7
16	97.9	82.1	50.2	3	2	3	2	2	3	8.6	4	7	3
17	114.0	87.6	52.6	3	2	3	2	2	3	9.6	4	7	3
18	31.7	48.2	33.9	3	2	2	2	1	3	14.0	2	7	7
19	32.4	49.3	34.9	3	2	1	0	2	0	13.8	3	7	7
20	29.4	47.6	34.9	3	2	3	2	2	3	11.8	3	7	7
21	80.4	79.9	46.9	3	2	3	2	2	3	7.8	4	7	3

The longest (Len) apple came from tree 17 with 87.6 mm and the shortest was from tree number 20 with 47.6 mm. The widest (Wid) cashew apple was from tree number 9 with 49.5 mm and the narrowest from tree number 5 with 21.0 mm. The ease of peeling (EOP) is the same with tree numbers 1, 4 and 9-14 which are easily peeled while tree numbers 2-3 and 5-8 (Plate. 3) were difficult to peel. The color (Clr) of apple is yellow for tree numbers 1, 3, 8, 12-13, 15 and 19 (Plate 4). On the other hand, red apple color can be seen in the tree numbers 2, 5, 9-11, 14, and 18 (Plate 5) while apples from tree numbers 4, 6-7, 16-17, and 20-21 are orange (Plate 6). The shape of apple is variable from cylindrical, round (Plate 7) to conical (Plate 8).

The shape of apple base (Shp) is angular for tree numbers 5 and 12 while rounded on tree numbers 2-3, 8, 10-11, 13, and 15. Flattened shape of apple base is found on tree numbers 4, 6-7 and 16-17 (Plate 9). On the other hand, the shape of the apple base from tree numbers 7, 14 and 18-20 are obliquely flattened.

The ridge on cashew apple (Rdg) is absent in tree numbers 2-5, 9, 11 and 19. On the other hand, tree numbers 1-2, 7-8, 10, 12-18 and 20-21 are entire while tree number 6 have broken ridges on cashew apple (Plate 10). This indicates that the cashew apple have differences in terms of the presence or absence of ridges.

The cashew apple apex (Apx) is level on tree numbers 1-3, 5-8, 10-13 and 18 while the rest are oblique (Plate 11). On the other hand, the cavity of cashew apple (Cav) is absent in tree number 19 and shallow in tree numbers 1, 5, and 8-18 and 20-21. Deep cavity at the apex of cashew apple was also observed on tree numbers 2-4 and 6 (Plate 12). The total soluble solid (TSS) in tree number 18 is highest with 14° brix and lowest on tree number 7 with 5° brix. It has been shown that various cashew apples from different trees have different TSS. This implies that cashew have different TSS and therefore belong to different varieties.

The flesh color (Clr) is white in tree numbers 8 and 13 while tree numbers 1-3, 5, 9, 11-12, 14 and 18 have cream color. On the other hand, the color is yellow in tree numbers 4, 6-7, 10, 15, and 19-20 and orange in tree numbers 16-17 and 21.

The flesh softness (Sft) is high in tree numbers 1-4, 7-9, and 11-21 while intermediate in tree numbers 5-6, and 10. Odor (Odr) is almost uniform except in tree numbers 16-17 and 21 with weak odor while the rest have strong odor.

The dimension of nut shown in Table 2 revealed that the nut weight (Wgt) ranged from 3.6 g to 16 g (Plate 2) with tree numbers 19 and 17 as the lowest and highest respectively. The longest (Len) nut is found on tree number 21 with 45.3 mm and the shortest was in tree number 19 with 25.8 mm. The widest (Wid) nut is in tree number 21 with 33.5 mm and the narrowest is in tree number 18 with 19.5 mm. The thickest (Thi) nut was observed in tree number 21 with 25 mm and thinnest was in tree number 5 with 12.6 mm.

The dimension of the cashew kernel as shown in Table 2 revealed that the kernel weight (Wgt) ranged from 1.4 g to 5.5 g with tree numbers 14 and 16 as the highest and lowest, respectively. The highest length (Len) of kernel was observed in tree number 21 with 33.3 mm and the shortest was found on tree number 19 with 20.2 mm. The widest (Wid) kernel is tree number 16 with 22.6 mm and the narrowest is tree number 18 with 14.1 mm. The thickest (Thi) nut was observed in tree number 16 with 15.3 mm and thinnest was in tree number 20 with 8.8 mm.

Table 2. Morphological characteristics of cashew nut and kernel of the 21 trees characterized.

TREE	NUT				KERNEL			
	Wgt	Len	Wid	Thi	Wgt	Len	Wid	Thi
1	5.6	29.7	22.8	14.9	1.6	23.4	15.5	9.2
2	5.2	32.5	24.7	14.1	2.0	24.3	15.7	9.1
3	5.4	30.5	23.1	15.0	2.0	24.5	16.1	9.3
4	6.0	31.8	23.7	16.0	2.6	24.5	17.2	11.7
5	4.0	28.5	20.4	12.6	1.8	21.4	14.5	9.5
6	5.8	30.7	23.4	16.8	2.0	23.4	16.3	11.3
7	4.8	32.0	22.5	15.0	1.8	25.4	16.8	11.0
8	7.8	36.5	27.8	17.1	3.0	28.7	18.0	11.1
9	5.8	31.9	23.0	15.4	2.0	24.2	15.4	10.2
10	5.6	31.5	23.3	15.2	1.8	24.6	14.3	9.3
11	5.8	30.3	23.7	16.6	2.4	23.5	17.4	11.5
12	6.8	32.7	24.1	16.6	2.4	26.4	17.4	10.6
13	7.6	34.7	26.3	17.8	2.6	27.4	17.3	11.8
14	4.6	32.7	24.0	15.6	1.4	24.0	15.3	9.1
15	7.4	31.5	25.1	16.9	2.4	24.1	19.0	11.8
16	15.0	42.9	31.3	24.4	5.5	25.3	22.6	15.3
17	16.0	44.4	32.0	23.6	5.0	32.5	22.9	15.2
18	4.8	27.3	19.5	16.7	1.75	21.7	14.1	12.1
19	3.6	25.8	20.7	15.7	1.56	20.2	15.2	9.8
20	4.6	29.2	22.4	14.6	1.71	22.4	16.3	8.8
21	15.2	45.3	33.5	25.0	5.00	33.3	22.4	12.1

Cluster Analysis Using Dendrogram of Cashew Varieties/Strains

Associations among 21 cashew varieties/strains as revealed by UPGMA cluster analysis are presented in Figure 1. Genetic distance estimates based on morphological character traits were used for cluster analysis in order to present the relationships as a dendrogram.

The dendrogram revealed that cashew trees could be classified into 2 main clusters at linkage distance of 50. The first cluster consisted of 15 trees accounting to 71.43 % of the total trees characterized. The second cluster consisted of 6 cashew trees comprising 28.57% of the total trees characterized.

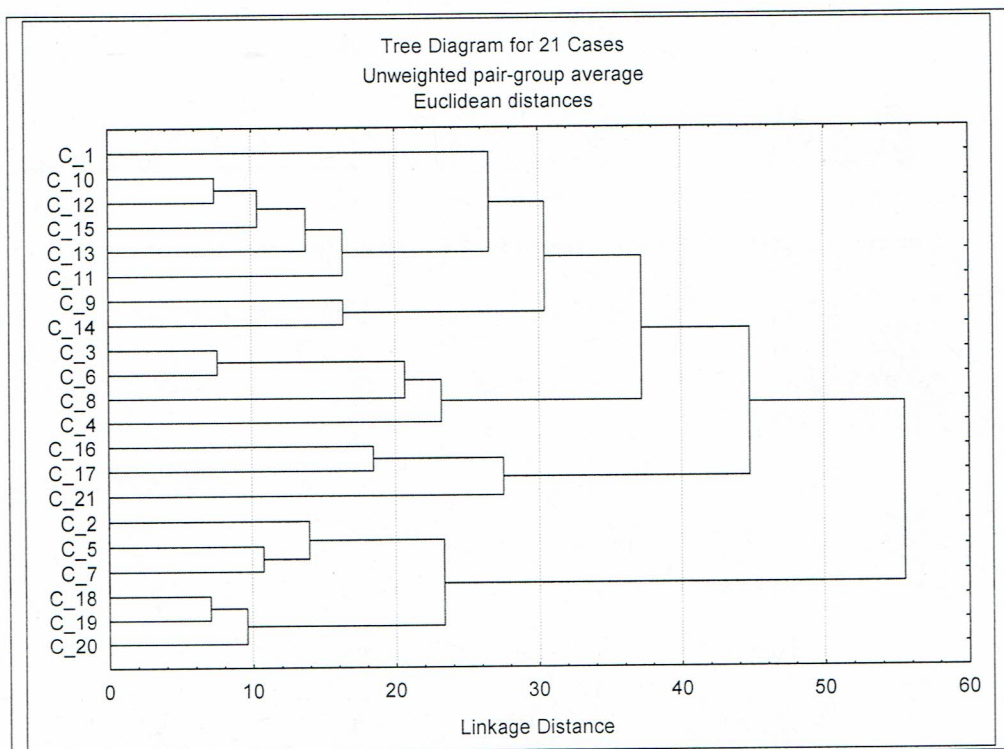
The composition of the subgroups in cluster 1 is heterogeneous at linkage distance of 30, where 4 subgroups can be formed. On the other hand, at linkage distance 20, 7 subgroups can be formed. Cluster 1 is characterized by heavier apple weight, longer length of apple, wider width of cashew apple, ease of peeling varied from easy to difficult, shape of apple is variable from cylindrical, conical to round and pyriform. The apple color is also variable from red, orange to yellow.

The ridges on cashew apple were also variable. Some were absent, broken and entire. The cashew apple apex is either level or oblique. While cavity at apex of cashew apple is either shallow or deep. The total soluble solids is lower, flesh color is variable from white, cream, yellow and orange. Flesh softness is either intermediate or high while flesh odor is either weak or strong.

The dimension is heavier weight, longer length, wider width, and thicker thickness for either nut or kernel.

The second cluster is characterized by lighter apple weight, shorter length of apple, narrower width of apple; ease of peeling varied from easy to difficult, shape of apple is conical. The apple color is also variable from red, orange to yellow. The ridges on cashew apple were either absent or entire. The cashew apple apex is either level or oblique. While the cavity at apex of cashew apple is variable from absent, to shallow or deep. The total soluble solids is high, flesh color is either cream or yellow. As to flesh softness, majority is high and only one is intermediate while flesh odor is strong.

The dimension is lighter weight, shorter length, narrower width, thinner thickness for either nut or kernel.



* Numbers correspond to the numbering of cashew trees in Tables 1 & 2.

Figure 1. Dendrogram.

SUMMARY AND CONCLUSIONS

The study showed variability of the 21 cashew trees characterized from the WPU field establishment in terms of the morphological characteristics. Differences were observed in apple weight, length, width, color of apple, shape of apple, ease of peeling the apple, shape of apple base, ridges on cashew apple, cavity at apex of cashew apple, cashew apple apex, flesh color. The total amount of soluble solids is variable but high at the second cluster, while the nut and kernel dimensions were also variable.

The morphological characteristics provide us with initial information on the diversity of cashew present in Palawan. Some varieties/strains were distinctively heavier in apple weight, heavier nut and kernel weight. The color of apple, apple shape, the flesh softness of apple are also varied with better quality.

From these, the genetic diversity can be assessed which are essential for making cashew products like cashew prunes, and candies. Furthermore, one could distinctively select cashew with good kernel quality and large sizes for roasted cashew nuts/kernel.

RECOMMENDATIONS

1. Collection, characterization and evaluation of promising cashew varieties in research stations and farmers field at varied environmental conditions must be conducted.
2. Conduct test studies on the performance of identified promising cashew strains/variety.
3. Confirm the morphological characterization through molecular analysis for classification purposes.
4. Breeding of promising variety of cashew is highly recommended.

LITERATURE CITED

- International Board for Plant Genetic Resources (IBPGR) 1986. Descriptors for Cashew. IBPGR Secretariat, Rome. 31 pp.
- Tabinga, G.A. and A.O. Gagni 1984. Cashew Production in the Philippines. Department of Development Communication. UPLB College, Laguna. 35 pp.

Acknowledgment

I am grateful to Mr. Roland D. Hipol for the analysis of the data and to Dr. Noel L. Gauran for his support and to his staff Mrs. Maribel B. Peneyra for encoding the data.

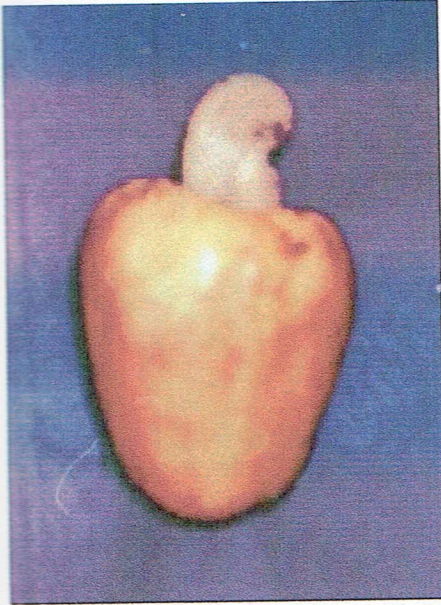


Plate 5. Red color apple.

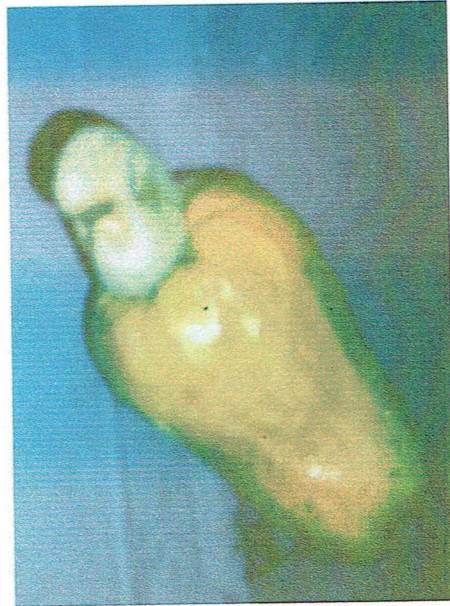


Plate 6. Orange color apple.

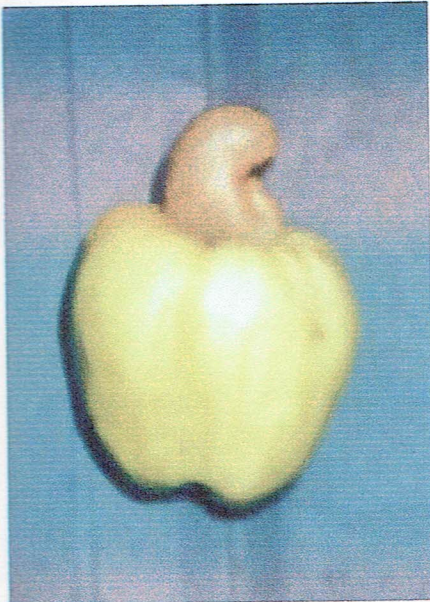


Plate 7. Round shape apple.

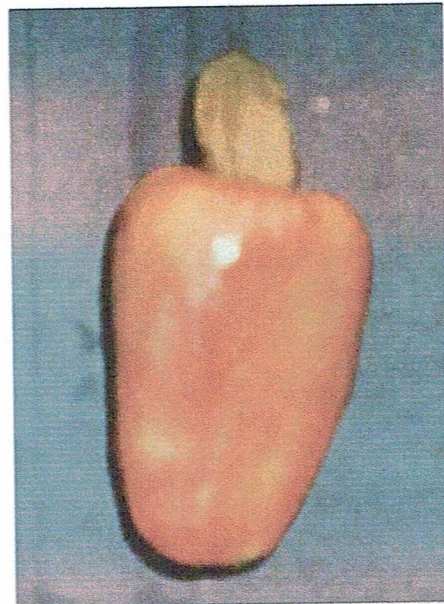


Plate 8. Conical shape apple.



Plate 1. Newly developed apple on tree with highest weight of apple.



Plate 2. Newly developed apple on tree with highest weight of apple & nut.

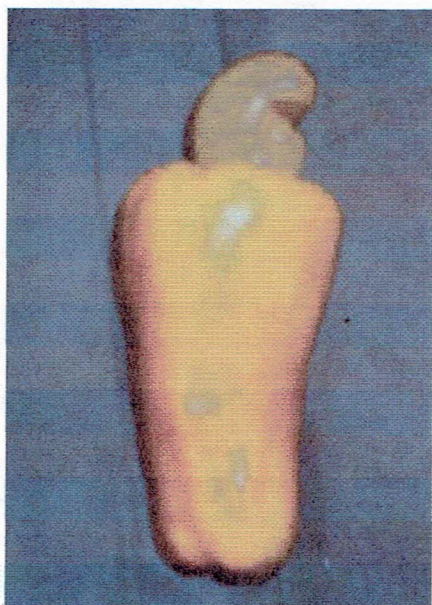


Plate 3. Cashew apple difficult to peel.

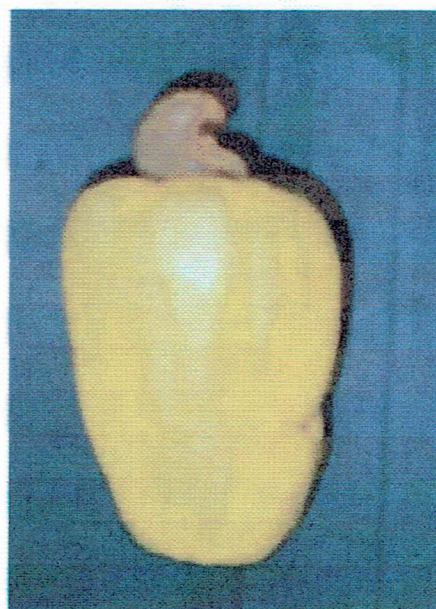


Plate 4. Yellow color apple.

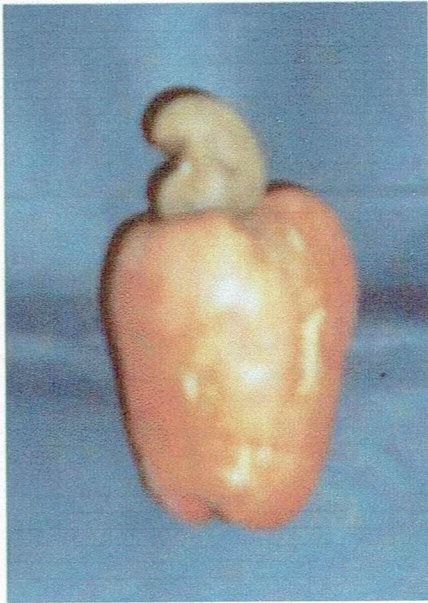


Plate 9. Flattened shape of apple base.

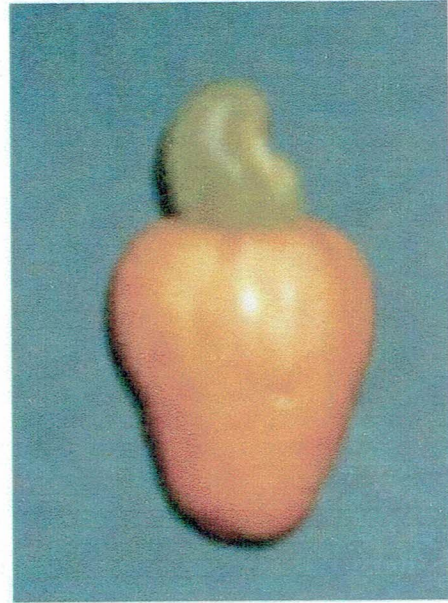


Plate 10. Broken ridges on cashew apple.



Plate 11 Oblique cashew apple base.

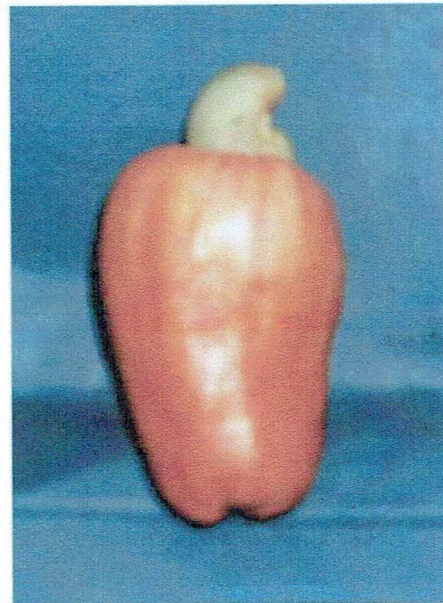


Plate 12. Deep cavity at the apex of cashew apple.