

The Physical Properties of *Ube* (*Dacryodes edulis*) at Different Stages of Fruit Development

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Abstract: Industrial processing is the major reason for the promotion of *ube* (*Dacryodes edulis*) since it is a multipurpose fruit tree. However no commercial products has been made from it due to lack of information on the properties of the fruit. The fruit flesh is greatly appreciated by local people who eat it after boiling or roasting. This study examined the physical properties of *ube* (African pear) during fruit development. The results showed that the development of the fruit differed significantly ($p < 0.05$) on all the physical properties. These properties did not differ significantly at the 17th to 21st week after fruit set except in the colour indicating ripening. Thus establishing the fact the fruit has reached optimum maturity and ready for harvest. The fruit width showed two different measurements from the opposite sides due to the rectangular/oblong shape instead of the perfect circle previously thought by some earlier researchers. The fruits with larger pulp/seed ratios had smaller seed weight in relation to fruit-size since a larger air space was enclosed between the fruit pulp and the seed.

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1.0 Introduction

African pear (*Dacryodes edulis*) which belongs to the family of Burseraceae, is known as *Safou* in French, *ube* in Ibo, *elemi* (Yoruba), *eben* (Efik) and *orumu* (Benin) (Kengue et al., 2002; Nwokeji et al., 2005). They grow in a wide variety of climate, soil type and are widely distributed in Africa. They are found in Cabinda, Cameroon, Congo (Brazzaville), Congo (Kinshasa), Gabon, Ghana, Equatorial, Guinea, Nigeria and Sao Tome, (Onana, 2008). In south-east Nigeria, the trees are grown around homesteads and flowering takes place from January to April. The major fruiting season is between May and October (Emebiri and Nwufu, 1990; Kengue and Nyagatchou, 1990). In both rural and urban areas of Cameroon, the fruits are boiled or roasted and then eaten with cassava or maize (Kengue, 1995; Tchata, 1996).

Fruits are ellipsoidal and their size varies approximately from 4 to 9cm long and from 2 to 5cm wide (Omoti and Okiy, 1987). As a percentage of dry matter, the pulp contains 31.9% oil, 25.9% proteins and 17.9% fibre (Omoti and Okiy, 1987; Ajiwe et al., 1997). They could be an important source of pulp oil, seed oil and even whole fruit oil (Awono et al., 2002). The ube oil should take their place in the food industry, the pharmaceutical and the cosmetics industry (soap, perfume, creams) as well as in other branches of industry where fat raw materials are needed. The cake remaining after the production of pulp oil may be useful in the food industry (bakery, baby foods).

Information on the consumption and composition of *ube* is far from complete. As the fruit becomes more popular and is increasingly commercialized, such information is indispensable for proper valorization of the fruit. Also, because of the high perishability of the *ube* fruit, high percentages of fruit losses are incurred annually.

For the fact that *ube* like most other indigenous African tropical fruit trees species (TFTS) has a multipurpose value and industrial potentials, the study is to provide information useful to food processors and agriculturist in optimizing the economic and nutritional potentials of the fruit. It will also provide information necessary in the classification of the fruit and also data necessary in determining the appropriate harvesting period of the fruit; The research will also provide the information necessary in equipment design for *ube* processing.

Therefore, the objective of this study is to determine the changes that take place on the physical properties of the fruit during development.

2.0 Materials and Methods

The *ube* fruits were obtained from three different trees labeled 1, 2 and 3 which were located in Umuahia, Abia state, Nigeria.

2.1 Sample Collection and Preparation

Forty fruits (40) fruits were collected randomly from each fruit tree at bi-weekly intervals starting from the fifth week after fruit set until senescence. The

collected fruits were cleaned with a moist soft cotton-wool then subjected to the physical determinations.

2.2 Physical Characteristics.

The physical characteristics which were studied in triplicates include; fruit length, width, pulp thickness which were measured with venier calipers (Silou, 1996). Also, fruit weight, pulp weight, seed weight were determined with electronic mettler balance while fruit density, volume by Silou (1996) as well as the percentage pulp, percentage seed, pulp/seed ratios by calculation (Omoti and Okiy, 1987). Also, the colour changes of the fruit were observed by visual evaluation. Different codes were allocated to the fruits based on their colours. The highest code being six (bluish-black) and the lowest, one for pink.

2.2.1 Mass of the entire fruit and the Mass of pulp:

Using an electronic mettler balance, the entire fruit was weighed to obtain the total mass (Mt). After withdrawal of the seed, the pulp was weighed to obtain pulp mass (Mp). (Here pulp means exo-, meso- and endocarp). Also, volume of the fruit was measured by water displacement in a measuring cylinder (Silou, 1996).

2.3 Statistical Analysis

The analysis of variance (ANOVA) of the data obtained from the study and separation of means using Least significant difference Test (LSD) were computed using statistical package for social sciences (SPSS) version 13. Significant difference was judged at $p < 0.05$. The observed colour changes during the fruit development were given codes and represented graphically.

3.0 Results and Discussions

3.1 Changes observed in the physical properties of *ube* fruit during development and ripening.

The fruit length increased significantly ($p < 0.05$) from the fifth week till the ninth week and remained steady till harvest maturity (Table 1.0). The slight changes within the 11th to 21st week showed the period of slow structural development within the fruit. The fruit length values ranged from 5.13cm to 5.43cm at the (17th – 21st week) which corresponded with the period of the bluish black colour development in the fruit (figure 1) which indicates ripening. Similar results at this period were reported by other researchers (Omoti and Okiy, 1987; Kengue, 2001; Onuegbu and Ihediohanma 2008; Waruhiu et al., 2004 and Anegebeh et al., 2005). In contrast, these values were lower than the values (5.52- 8.17cm; 5.7- 6.1cm) reported by the authors (Fonteh et al., 2005 and Kinkela et al., 2006). The variations could be attributed to the differences

climatic conditions and the variety of the fruit (Askar *et al.*, 1972).

The width significantly increased ($p < 0.05$) from the 5th week to the 7th week after fruit set and had only slight changes at the (9th- 21st week) as the fruit developed to harvest maturity (Table 1.0).

The fruit width measurement revealed two different values from adjacent sides due to the rectangular/oblong shape of the fruit instead of the perfect circle previously reported by some earlier researchers (Omoti and Okiy, 1987). Width A and B had values of 0.48- 3.01cm and 0.42- 2.82cm respectively. The trend was virtually consistent indicating width A as the wider side and width B as the smaller side. Onuegbu and Ihediohanma (2008) reported a similar trend. This observation could be relevant in equipment design for industrial utilization of the fruit. The width A and B values (2.91- 3.01cm and 2.84- 2.82cm) at the (17th -21st week) respectively, agreed with those reported by the several researchers (Kengue, 2001; Onuegbu and Ihediohanma 2008; Waruhiu et al., 2004 and Anegebeh et al., 2005). In contrast, they were lower than the values (3.4- 3.9cm reported by the authors (Kinkela et al., 2006). The stage of development at the time of harvest and the geographical growth conditions of the fruit may have resulted to the differences.

The fruit weight rapidly increased from the 5th to 9th week (5.77g to 18.66g). This indicates the period of the fruit cell development with accumulation of cell (nutrient) constituents (Bezard *et al.*, 1991). However only slight changes were observed within the (13th – 21st week) as the fruit approached full maturity and harvest, with values ranging from 22.60g to 24.75g (Table 1.0). These results agree with those reported by previous researchers, (Onuegbu and Ihediohanma 2008; Waruhiu et al., 2004 and Anegebeh et al., 2005). However, they were lower than the range of values (37.4- 48.8g and 53.28- 95.82g) reported by other authors (Mbofung et al., 2002 and Fonteh et al., 2005). The variation could be attributed to differences in growth condition of the fruits (Kengue, 2001 and Waruhiu et al., 2004). The fruit volume differed significantly ($p < 0.05$) from the 5th to the 11th week with values ranging from 4.33 to 21.11ml but only had slight changes within the (11th- 21st week) of the fruit development with values ranging from 24.44ml to 27.67ml. These agreed with the already observed trend in the fruit.

Pulp weight rapidly increased from the 5th week to the 9th week but showed only slight changes within the (11th- 21st week) as the fruit approached maturity (Table 1.0). The results ranged from 5.48g to 17.70g. The cell development with the accumulation of nutrients may have contributed to it. The pulp weight values of

17.42- 17.70g were recorded at the 17th- 21st week as shown on Table1. This agrees with results reported by previous authors (Onuegbu and Ihediohanma, 2008; Waruhiu et al., 2004 and Anegbah et al., 2005). Kapseu and Tcheingang (1991); Mbofung et al. (2002) and Fonteh et al. (2005) reported a higher values (25.5- 65.71g). The growing conditions of the fruits and the state of development at the time of harvest might have influence these

variations (Waruhiu et al., 2004). The seed weight on the other hand gradually increased from 0.22 to 7.00g from the 5th week to the 21st week. The seed weight values (5.28- 7.00g) at the (17th- 21st week) respectively was observed during the same period of significant external colour change (bluish-black) as in figure1. This agreed with the observations reported by earlier researchers (Onuegbu and Ihediohanma, 2008; Anegbah et al., 2005).

Table 1. Physical properties of ube fruit at different stages of development

Development Stage (week)	Fruit length (cm)	Width A (cm)	Width B (cm)	Single fruit wt (g)	Single fruit vol (ml)	Pulp wt Mp (g)	Seed wt (g)	% pulp	% Seed	Pulp/Seed ratio	Pulp thickness (cm)	Fruit density (g/cm ³)
Wk 5	2.16 ^c	0.48 ^c	0.42 ^e	5.77 ^c	4.33 ^c	5.48 ^d	0.22 ^d	95.47 ^a	3.74 ^d	32.02 ^a	0.14 ^f	1.36 ^a
Wk 7	3.66 ^b	0.92 ^d	0.86 ^d	9.68 ^e	8.56 ^c	9.02 ^c	0.52 ^{cd}	92.22 ^{ab}	5.22 ^d	26.08 ^{abc}	0.27 ^e	1.15 ^b
Wk 9	5.05 ^a	2.42 ^c	2.37 ^c	15.87 ^d	17.22 ^b	13.72 ^b	2.11 ^{bc}	86.47 ^{bc}	13.1 ^{6c}	11.47 ^{cd}	0.46 ^a	0.96 ^c
Wk 11	4.96 ^a	2.57 ^c	2.52 ^c	18.22 ^{cd}	21.11 ^{ab}	14.98 ^{ab}	3.21 ^b	84.56 ^c	15.09 ^c	16.05 ^{bcd}	0.36 ^d	0.86 ^{cd}
Wk 13	5.24 ^a	2.82 ^b	2.77 ^b	18.86 ^{bcd}	24.44 ^a	16.46 ^{ab}	3.45 ^b	85.30 ^c	14.44 ^c	28.1 ^{6ab}	0.45 ^{ab}	0.81 ^d
Wk 15	5.29 ^a	3.00 ^{ab}	2.93 ^{ab}	22.60 ^{abc}	27.56 ^a	16.98 ^a	5.56 ^a	77.07 ^{de}	22.59 ^{ab}	6.48 ^d	0.40 ^{bcd}	0.89 ^{cd}
Wk 17	5.13 ^a	2.91 ^{ab}	2.84 ^{ab}	22.70 ^{abc}	27.00 ^a	17.42 ^a	5.28 ^a	81.25 ^{cd}	18.82 ^{bc}	15.17 ^{bcd}	0.43 ^{abc}	0.95 ^{ed}
Wk 19	5.43 ^a	3.04 ^a	2.99 ^a	23.43 ^{ab}	27.72 ^a	17.10 ^a	6.30 ^a	74.90 ^e	24.78 ^{ab}	12.55 ^{bcd}	0.37 ^{cd}	0.89 ^{cd}
Wk 21	5.43 ^a	3.01 ^a	2.82 ^{ab}	24.75 ^a	27.67 ^a	17.70 ^a	7.00 ^a	72.86 ^e	27.12 ^a	6.69 ^d	0.38 ^{cd}	0.94 ^{cd}

abc* Means with similar superscripts in the same column are not significantly different (p>0.05)

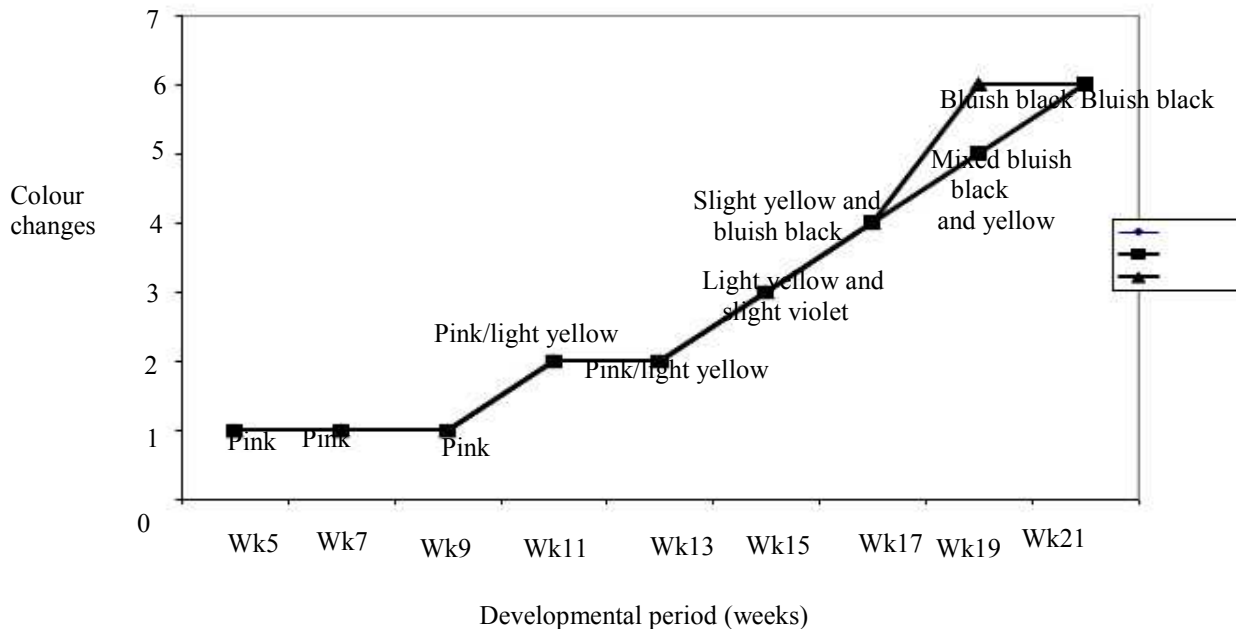


Figure 1. Colour changes observed during the fruit Development of *ube*.

The percentage pulp decreased while the percentage seed increased significantly ($p < 0.05$) with the fruit development. The mean values decreased from 95.4 to 72.86% for percentage pulp and increased from 3.74 - 27.12% for percentage seed were from the 5th week to the 21st week. It is important to note that certain fruits from Tree 3 had virtually little or no seed and this could contribute to the high values of the percentage pulp. The results were similar to the observations made by the researchers as a normal occurrence among some *ube* fruit varieties. (Onuegbu and Ihediohanma, 2008; Fonteh et al., 2005).

The pulp/seed ratio also decreased from the fifth week value of 32.03 to 6.69 at the 21st week. The values (15.17- 6.69) at the (17th- 21st week) are similar to the observations made by Anegebe et al. (2005). These values suggest that the pulp increased faster at the early stages of fruit development, while the seed increased more towards the end of the developmental period. The pulp thickness increased from the fifth week after fruit set till harvest maturity with values ranged from 0.14 to 0.38cm. The pulp is the edible portion of the fruit. Therefore its weight, thickness and proportion in the fruit are of utmost importance to the consumer as well as the fruit processor. Fruits with thicker pulps are usually preferred.

The fruit density also varied with the fruit development (1.36- 0.94g/ml) from the 5th week to the 21st week, as shown in Table 1.0. It was observed that mature fruits with larger pulp/seed ratios had smaller seed weight in relation to fruit size. Usually a larger air space was enclosed between the fruit pulp and the seed. This resulted to the low density values for such fruits and they floated on water. This explains why some of the fruits may float on water while others did not. The fruit colour changed from pink to bluish-black as shown in figure 1. This colour change in the fruit is gradual starting (around the 15th week) from the part of the fruit closest to the fruit stalk and slowly covering the whole fruit at the 19th to 21st week. This also agreed with observations reported by Onuegbu and Ihediohanma (2008).

4.0 Conclusion

The results of this study showed that the fruit development had an effect on the physical properties of the African pear fruits. The results point to the fact that the fruit matures at the 17th -21st week after fruit set. This period could be regarded as the physiological mature stage of the fruits that would present the optimum values of the properties. This information is of help the harvesters in order to reduce the collection of unripe fruits or over-ripe fruits that dropped naturally due to senescence, which may result to contamination, pest and disease attacks. The results will therefore enable farmers and processors to predict the appropriate time of harvest for optimum utilization of the fruit.

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