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. Lack of information on the properties of the fruit has led to no processed products from it as the fruit flesh is greatly appreciated by local people who eat it after boiling or roasting. This study examined the physical properties of African pear during fruit development. The results showed that the development of the fruit differed significantly ($p < 0.05$) on all the physical properties. But the 17th- 21st week after fruit set, established the fact of previous reports made at the time of harvest as the physiological mature stage of the fruits to showcase the optimum values of the properties. 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, Equitorial, 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 Nwufo, 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; Tchatat, 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 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 determination.

2.2 Physical Characteristics.

The studied physical characteristics carried out in triplicates are the; 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 (M_t). After withdrawal of the seed, the pulp was weighed to obtain pulp mass (M_p). (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 Anegbeh *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 Anegbeh *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 to18.66g). This indicates the period of the fruit cell development with accumulation of cell (nutrient) constituents (Bezard *et al.*, 1991). However only slight change 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 Anegbeh *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. This agreed with the already observed changes in the fruit weight.

Pulp weight rapidly increased from the 5th week to the 9th week but showed slight changes within the (11th- 21st week) as the fruit approached maturity (Table 1.0). The results ranged from 5.48- 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 17^{th}- 21^{st} week as shown in Table1. This agrees with results reported by the authors (Onuegbu and Ihediohanma, 2008; Waruhiu *et al.*, 2004 and Anegbeh *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 could influence the variations (Waruhiu *et al.*, 2004). The seed weight on the other hand gradually increased from 0.22 to 7.00g from the 5^{th} week to the 21^{st} week. The seed weight values (5.28- 7.00g) at the (17^{th}- 21^{st} week) respectively was observed during the same period of significant external colour change (bluish-black) as in figure1. This agreed with the results reported by earlier researchers (Onuegbu and Ihediohanma, 2008; Anegbeh *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 Mt (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^e	0.42^e	5.77^e	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}	13.16^c	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	28.16^{ab}	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^{cd}
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}

Table 1 Developmental effect on the Physical properties of Ube fruit

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

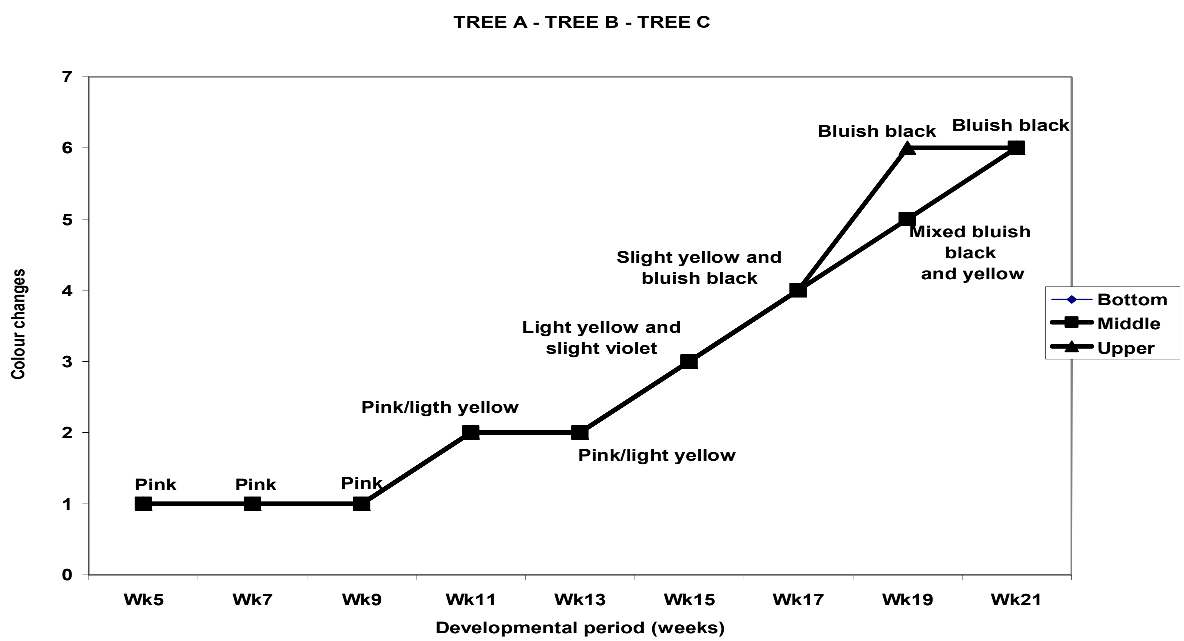

Figure 1. Colour changes observed during the fruit Development of Ube.

The percentage pulp decreased while the percentage seed increased significantly ($p<0.05$) with the fruit development. The mean values of 95.47- 72.86% for percentage pulp and 3.74 - 27.12% for percentage seed were observed 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 Anegbeh *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 figure1. This colour change in the fruit is normally gradual starting (around the 15thweek) 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 several 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. Also, help the harvesters to reduce the collection of unripe fruits or over-ripe fruits that dropped naturally due to senescence, which results to contamination, pest and disease attacks. The results will enable famers and processors to predict the appropriate time of harvest for optimum utilization of the fruit.

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References

[1] Ajiwe,V.I.E., Okeke, C.A., Nnabuike, B; Ogunleye, G.A and Elebo, E. Application of oils extracted from African star apple *(Chrysophyllum africanum)*, horse eye bean *(Mucuna sloanei)* and African pear *(Dacryodes edulis)* seeds. *Bioresource Technology* 1997:**59** (2-3): 259- 261.

[2] Anegbeh, P.O; Ukafor, V; Usoro, C; Tchoundjeu, Z; Leakey, R.R.B and Schreckenberg, K Domestication of *Dacryodes edulis*: Phenotypic variation of fruit traits from 100 trees in south-east Nigeria. *New forests* 2005 **29** (2):149-160. <www.icraf.org/ar2005/other_01.asp>Accessed 27th October, 2007.

[3] Askar, A; Rubach, K and Schormuller, J. The importance of amino- acids in frui behaviour of amino acid during ripening of bananas. *Gordian* 1972:73, 12-16.

[4] Awono, A; Ndoye, O; Schreckenberg, K; Tabuna, H; Isseri, F and Temple, L Production and marketing of Safou (*Dacryodes edulis)* in Cameroon and internationally: Market development issues. *Forest, Trees and livelihoods* 2002:**12** ($^1/_2$): 125- 147.

[5] Bezard, J; Silou, T; Sempore, G and Kiakouama, S. Study of *Dacryodes edulis*-Variation of the Composition of the glyceridic fraction for Safou Pulp (pear tree) during ripening. *Revue francaise de Corps Gras*1991:**38** (7- 8): 233-241.

[6] Emebiri, L.C. and Nwufo, M.I. Effects of fruits types and storage treatment on the biodeterioration of African pear (*Dacryodes edulis)* (G. Don) H.J. Lam). *International Biodeterioration* 1990 :**26**(1):43-50.

[7] Fonteh, F.A; Niba, T.A and Tchoumboue, J. Some physico-chemical properties of the African pear and Black olive from different agro-ecological zones of Cameroon. *Fruits*

2005:**60**(2):107-113< www.fruits-journal.org/articles/fruits/abs/2005/02/i5012/i5012.html>Accessed 20th August, 2007.

[8] Kengue, J. Le Safoutier (*Dacryodes edulis* (G.Don) H.J. Lam). *Le flamboyant* 1995 :33:4-7.

[9] Kengue, J *Safou extension manual international centre for underutilized crops*, Academic Publishers Southampton, UK. 2001:55.

[10] Kengue, J; Tchuenguem Fohouo, F.N and Adewusi, H.G. Towards the Improvement of *Safou (Dacryodes edulis)*, Population and Reproductive Biology. *Forests, Trees and Livelihoods* 2002:12:73-84.

[11] Kinkela, T; Niamayoua, R.K; Mampouya, D and Silou, T. Variations in morphologica characteristics, lipid content and chemical composition of Safou (*Dacryodes edulis* (G.Don) H.J Lam) according to Fruit distribution: A case study. *African J.of Biotechnology* 2006:**5**(12):1233-1238< http://www.bioline.org.br> Accessed 20th August, 2007.

[12] Mbofung, C.M.F; Silou, T and Mouragadia, I. Chemical characterization of Safou (*Dacryodes edulis*) and evaluation of its potential as Ingredient in nutritious biscuits. *Forests, Trees and livelihood* 2002:12:105-117.

[13] Nwokeji, E.M; Nwufo, M.I; Ibe, A.E and Ogbedeh, K.O. Investigation on the Uses and Fungal diseases of African pear (Dacryodes edulis, G.Don H.J. Lam) in Imo state, Nigeria. *Nig. J. of plant Protection* 2005:**22**: 9-16.

[14] Omoti, U and Okiy, D.A. Characteristics and composition of the pulp oil and cake of the African pear_(*Dacryodes edulis*). *J. Sci/.food Agric*. 1987:**38** (1): 805-809.<http://www3.interscience.wiley.com/journal> Accessed 12th April, 2006.

[15] Onana, J. M.. A Synoptic revision of *Dacryodes*(Burseraceae) in Africa, with a new species from Central Africa. Kew Bulletin 2008:63:385-400

[16] Onuegbu, N.C and Ihediohanma, N.C. Some proximate Analysis of African pear (*Dacryodes edulis*). *Jn, Appl. Sci. Environ. Manage*. (JASEM) 2008:12(1)83-85 (ISSN 1119-8362)

[17] Silou, T (1996). Le safoutier_(*Dacryodes edulis*) Un arbre mal connu. *Fruits* **51** (1): 47-59.

[18] Waruhiu, A.N; Kengue, J; Atangana, A.R; Tchoundjeu, Z and Leakey, R.R.B . Domestication of *Dacryodes edulis*: Phenotypic variation of fruit traits in 200 trees in Cameroon. *J. food, Agriculture and Environment* 2004 :**2** (1): 340-346.

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