

## Qualitative morphology of *Pycnanthus angolensis* (Welw.) fruits and seeds

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### ABSTRACT

Fresh fruits were randomly collected from two locations each in Osun, Oyo, and Ekiti States due to availability. Each fruit, aril and seed, was matched with Munsell Colour Chart to determine the colour variations of *Pycnanthus angolensis* Welw. Colour changed from light olive (10Y 5/4) to dark olive green (5GY3/4), to yellow 2.5Y7/8 and 5Y7/8 (Ajaba), pale olive 10Y6/4 or pale yellowish green 5GY6/4 to olive green 5GY4/4 or pale olive 10Y6/4 to light olive brown 2.5Y5/6 or olive 5Y5/6 (Gbongan), dark olive green 5GY3/4 to olive yellow 5Y6/8 to yellow at 2.5Y and 5Y7/8 (Idito), dark olive 10Y3/4 to dark olive green 5GY3/4 to olive yellow 2.5Y 6/8 and 5Y 6/8 (Adewumi), pale olive 10Y6/4 to olive yellow 5Y6/8 to 2.5Y7/8, 5Y7/8 or 8/8 (Otun) and light olive 10Y5/4 to dark olive green 5GY3/4 to olive yellow 5Y6/8 or yellow 2.5Y7/8 (Ayetoro). Colour of seeds varied from Reddish brown, dark reddish brown, brown to dusky red. Dark reddish brown in Ajaba 2.5YR 2.5/3 and 5YR3/4, dark reddish brown 5YR3/3 and 2.5YR2.5/3 (Idito) and 2.5YR and 5YR3/4 (Ayetoro), reddish brown (Gbongan) 2.5YR4/4 Or 4/3, 5YR4/4, brown 7.5YR4/4 and dusky red 2.5YR2.5/3, 5R and 10R 3/3 and 3/4 (Adewumi and Otun). The colour of the arils matched to the red group but varied from light red, light pink, pinkish white to pink. The colour of the matured fruits, seeds and aril of *P. angolensis* is grouped to yellow, brown and red respectively.

**Keywords:** Qualitative, morphology, fruit, colour, provenance

### INTRODUCTION

Colour is a notable feature of plants and colouring is often the first characteristic that we are aware of on seeing a plant for the first time, but for scientific purposes, colour has traditionally been considered by botanists to be secondary as a distinguishing feature. Plant structure has always come first for the purpose of identifying plants (Simpson, 2011). This view dates back at least to the Swedish botanist, Carl Linnaeus, who in his *Philosophia Botanica* of 1751 (Freer Linnaeus, 2003), wrote that “colour

within the same species is remarkably sportive, and so is of no value in definitions” and so warns his readers “not to put too much trust in colour”. Simpson (2011) opined that variation in colour is often of high value in ornamental plants, and where flowers, foliage and fruit colour can be diagnostic, and even quite subtle colour differences may distinguish one cultivated variety, or ‘cultivar’, from another. Where wild plants are concerned, colour can be a useful supplementary identification aid; for example in the identification of winter stems

of deciduous trees and shrubs. Indeed some field guides are arranged by colour. When new species are found, named and described, a sample of the plant is preserved to create a permanent reference. The preservation of such 'herbarium specimens' is achieved by pressing and drying. Unfortunately living colour is usually lost on such treatment and consequently herbarium specimens do not create a permanent reference for colour features (Simpson, 2011). The colour of fruits is an important parameter to visually identify ripeness for most fruit varieties and rapid change in surface colour, often, from green to yellow can be seen during the maturity period of many fruits. Therefore when harvesting and marketing fruits, fruit surface colour can be used as maturity index, quality index as well as fruit damage index and can be a good parameter to determine the maturity of fruits from the day of harvest. Fruit colour, size, accessibility, chemistry, infructescence morphology and crop size are among the most studied traits known to influence fruit choice by seed dispersers (Willson and Whelan, 1990, Herrera, 2002, Jordano, 2000, Schaefer and Schaefer, 2007).

*Pycnanthus angolensis*, an evergreen tree mainly grows in the West and Central African countries like; Ghana, Sierra Leone, and Cameroon. This plant is generally known as African nutmeg. It is a large, with a small crown of branches at right angles to the bole. *Pycnanthus angolensis* has some common names aside of African nutmeg such as; Akomu in Yoruba, Walele in Ivory Coast, Eteng in Cameroon, Calabo in Spanish (Wikipedia, 2015), and Lolako in Zaire (Forest Products Laboratory. Forest Service, USDA. 2015)

After the Second World War, the tree is generally recognized and acceptable for general use and distribution because of the

destruction of wood and planks. This evergreen tree grows up to 40 meters tall and usually up to a meter wide, sometimes up to 1.5 meters or more. The trunk is straight and cylindrical with fissures and flaking bark. The sap is honey-colored and turns red in time. The branches are in whorls. The leathery leaves are up to 31 centimeters long by 9 wide. The blades have pointed tips, heart-shaped bases, and thick midribs. They are hairless on top and coated with rusty, felt like hairs on the undersides. The leaves usually bear signs of insect damage, a feature so common that it is considered characteristic of the species. The flowers are arranged in dense, rusty panicles up to 15 centimeters long. The individual flowers are difficult to see in the tight panicle until the stamens develop, (Orwa et al., 2009) being only about a millimeter long. The flowers are hairy and fragrant (Stannard, 1997) The fruit is a rounded drupe reaching over 3 centimeters long and wide, borne in clusters (Orwa et al., 2009). It is hairy brown when new, turning yellow-orange, and has cartilaginous flesh that dries woody (Stannard, 1997). It contains a black seed with a red aril (Stannard, 1997) which resembles that of nutmeg (Mapongmetsem, 2007). The fruit ripens over a long period continuing into the next flowering season, which begins around October (Orwa et al., 2009). Colour can simply be an attribute of a plant, but for scientific identification purposes, colour can also be diagnostic, distinguishing, or helping to distinguish, a plant from an otherwise similar species or cultivar. Hence the accurate recording of colour has been a feature of botanical illustration since its beginnings (Simpson, 2011).

## **MATERIALS AND METHODS**

Based on the information obtained from reconnaissance survey, random sampling at

75 % based on flowering and fruiting pattern was used to select two locations from each of the three selected States namely Oyo, Osun and Ekiti along rain forest zone across the South-western part of Nigeria. From each state, two locations consisting of the tree with flowering and fruiting stage were selected as representative of each state. In this work, fruits were collected at three developmental stages from six locations in Osun, Oyo, and Ekiti States. Each fruit from each location was matched with Munsell Colour Chart (2009) to determine the colour variations with the maturity of *Pycnanthus angolensis* Welw. Fruits and each randomly selected seed with their aril from six locations were matched with Munsell Colour chart.

## RESULTS

The surface colour was considered as a quality parameter subject to change with the maturity of fruits. Many unripe fruits initially show greenish surface colour which gradually changes to yellow colour when they mature. The change of colour patterns is similar within each fruit category. The consumer often judges the ripeness of the fruits by its colour. If the relationship between the surfaces colour of a fruit category and the maturity from six locations can be determined, this is also useful for grading fruits when they are being harvested.

## Fruit Maturation/Fruit Colour

The basic fruit colours of *Pycnanthus angolensis* Welw from the six provenances at maturity matched to the yellow group but there was variation in the colour strength between these provenances and to some extent, interference of light olive brown/olive in Gbongan, olive yellow in Otun and Ayetoro.

There were different colours showing the stages of Fruit Maturation in the developmental stages of *P. angolensis*. In terms of the morphological descriptions of the fruits, it was observed that Fruit colour changed from one stage of immaturity to maturity and from one location to another (Table 1 and Plate 1). During maturation, fruit colour changed from light olive (10Y 5/4) to dark olive green (5GY3/4), upon attaining physiological maturity the epicarp takes to yellow 2.5Y7/8 and 5Y7/8 in Ajaba, pale olive 10Y6/4 or pale yellowish green 5GY6/4 to olive green 5GY4/4 or pale olive 10Y6/4 to light olive brown 2.5Y5/6 or olive 5Y5/6 in Gbongan, dark olive green 5GY3/4 to olive yellow 5Y6/8 to yellow at 2.5Y and 5Y7/8 in Idito, dark olive 10Y3/4 to dark olive green 5GY3/4 to olive yellow 2.5Y 6/8 and 5Y 6/8 at maturity in Adewumi, pale olive 10Y6/4 to olive yellow 5Y6/8 to 2.5Y7/8, 5Y7/8 or 8/8 in Otun. Fruit colour changed from light olive 10Y5/4 to dark olive green 5GY3/4 to olive yellow 5Y6/8 or yellow 2.5Y7/8 at maturity in Ayetoro (Table 1). This description is in agreement with the Munsell colour chart (2009).

**Table 1.** Fruit colour of *P. angolensis* in selected locations

Location	Colour Code	Reference Number	Color-code	Reference Number	Colour Code	Reference Number
Ajaba	Light Olive	10Y5/4	Dark Olive - Green	5GY3/4	Yellow	2.5 7/8 or 5Y7/8
Gbongan	Pale olive	10Y6/4	Olive green	5GY4/4	Light olive brown	2.5Y5/6 or 5Y5/6
	Pale yellowish Green	5GY6/4	Pale olive	10Y6/4	Olive	5Y5/6
Idito	Dark olive- Green	5GY3/4	Olive yellow	5Y6/8	Yellow	2.5Y7/8 or 5Y7/8
Adewumi	Dark olive Green	10Y3/4	Dark Olive-	5GY3/4	Olive yellow	2.5Y6/8 or 5Y6/8
Otun	Pale olive	10Y6/4	Olive yellow	5Y6/8	Yellow	2.5Y 7/8 or 5Y7/8 or 8/8
Ayetoro	Light Olive	10Y5/4	Dark Olive - Green -	5GY3/4	Olive yellow Yellow	52.5Y 7/8 Y6/8

Source: Munsell Colour Chart (2009).

### Seed Colour

Seed sources of *P. angolensis* revealed slight difference in seed colour pattern of their seed-coat (Table 2 and Plate 1). Seeds collected from Ayetoro, Idito and Gbongan matched to the Yellowish red group (YR) colour pattern, Ajaba matched to the red (5R) and yellowish red groups (5YR) at medium range while Adewumi and Otun matched to red groups at medium and high range (5R-10R) and yellowish red at low range (2.5YR).

The colour of *P. angolensis* seeds is very variable. The colour of seeds varied from Reddish brown, dark reddish brown, brown

to dusky red. They are dark reddish brown 2.5YR 2.5/3 and 5YR3/4 in Ajaba reddish brown 2.5YR4/4 OR 4/3, 5YR4/4, /brown 7.5YR4/4 in Gbongan, dark reddish brown 5YR3/3 and 2.5YR2.5/3 in Idito and 2.5YR and 5YR3/4 in Ayetoro, dark reddish brown 2.5YR2.5/3, 5R and 10R 3/3 and 3/4/ dusky red in Adewumi and Otun. It is difficult to distinguish between species depending on the colour of seed, because of the narrow range of colour degree between species, and most species have the same seed colour. Dark reddish brown was found in seeds collected from Ajaba, Idito, and Ayetoro, reddish brown in Gbongan and

dusky red from seed sourced from Adewumi and Otun.

**Table 2: Seed and Aril colour of *P. angolensis* in selected locations**

Location	Seed Code Colour	Reference Number	Aril Code Colour	Reference Number
<b>Ajaba</b>	Dark reddish brown	5R7/8	Light red	5R7/8
	Dark reddish brown	5YR3/4	Light red	7.5R7/8
<b>Gbongan</b>	Brown	7.5YR4/4	Light red	2.5YR6/6
	Reddish brown or 4/3	2.5YR 4/4	Light red	10Y6/6
	Reddish brown	5YR 4/4	Light red	7.5R7/8
<b>Idito</b>	Dark reddish brown	2.5YR 2.5/3	Light red	7.5R6/6
	Dark reddish brown	5YR3/3	Light red	7.5R6/8
<b>Adewumi</b>	Dark reddish brown	2.5YR2.5/3	Light pink	7.5R8/3
	Dusky red	5R3/4	Pinkish white	2.5YR8/2
	Dusky red	10R3/4	Light pink	5R8/3
<b>Otun</b>	Dark reddish brown	2.5YR 2.5/4	Pink	2.5YR 8/3
	Dusky red	5R3/3	Pink	.5YR 8/3
	Dusky red	7.5R 3/3	Dusky red	0R 3/3
<b>Ayetoro</b>	Dark reddish brown	2.5YR 2.5/3	Light red	2.5YR 7/6
	Dark reddish brown	5YR3/4	Light red	

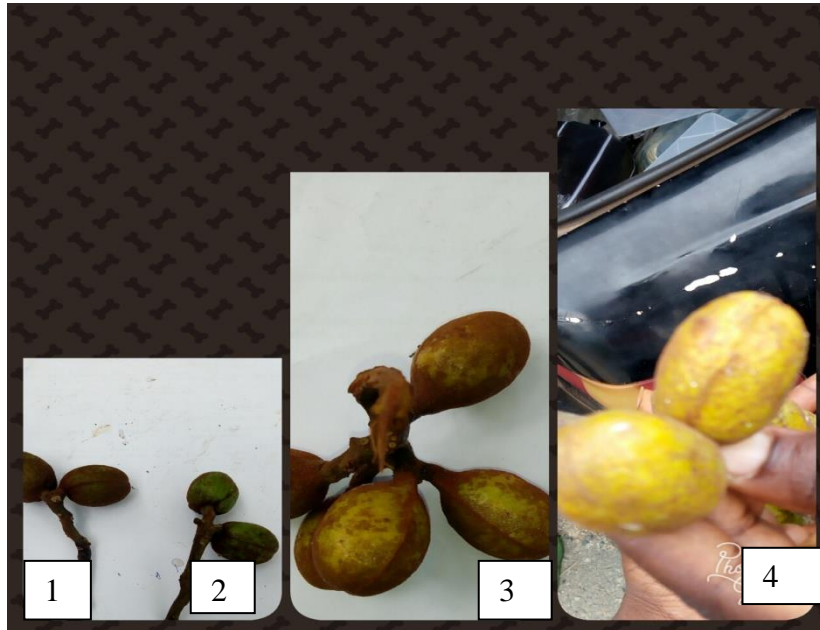
#### Aril colour

The colour of the aril of *P. angolensis* is of high diagnostic and systematic value at different levels. The colour of the arils matched to the red group but varied from light red, light pink, pinkish white to pink. However, the arils were light red in Ajaba at 5R 7/8, and 7.5R 7/8, Gbongan 2.5R, 7.5R

6/8 and 10R 6/6, Idito 7.5R 6/8 and 6/6 and Ayetoro 2.5YR 7/6, light pink/pinkish white in Adewumi at 7.5R 8/3, 2.5YR 8/2 and 5R 8/3, pink in Otun 2.5YR8/3 and 8/4 respectively (Table 2 and Plate 2). The colour is also used to distinguish between sources, of these light red was the most common color in Ajaba, Gbongan, Idito and

Ayetoro, for it is light pink/pinkish white in

Adewumi and pink in Otun.



**Plate1** Different colours showing the stages of Fruit Maturation: 1-3-Not mature and 4 -Fully mature



**Plate 2** Variations in seed and aril of selected seed sources of *P. angolensis*

## DISCUSSION

The surface colour of fruits is an important parameter to visually identify ripeness for most fruit varieties. Rapid change in surface colour, often, from green to yellow can be seen during the maturity period of many fruits. Therefore when harvesting and marketing fruits, surface colour can be used as maturity index, quality index as well as fruit damage index (Amarasinghe and Sonnadara, 2009).

Surface colour of fruits is also a good parameter to determine the maturity of fruits from the day of harvest (Amarasinghe and Sonnadara, 2009). There were different colours showing the stages of Fruit Maturation in the developmental stages of *P. angolensis*. In terms of the morphological descriptions of the fruits, it was observed that fruit colour changed from one stage of immaturity to maturity and from one location to another. Fruits collected from Ajaba, Adewumi, Otun, Ayetoro and Gbongan matched to the Yellow group (Y) colour pattern which varied from light olive, pale olive and dark olive while Idito matched to the green (G) group which varied into dark olive green at immaturity. At maturity all fruits sourced from six locations matched to the yellow group but there was variation in the color strength between these provenances. Yellow colour in Ajaba and Idito, light olive brown/ olive in Gbongan, olive yellow in Otun and Ayetoro. Fruit colour is considered as an index of seed maturation particularly in forestry by several researchers (Khullar *et al.*, 1991, Srimathi, 1997). Willan (1985) also revealed that fruit colours would serve as a tool for collection of good quality seeds in forestry as the persons involved in the collection process are mostly lacking in technical skill. Even though, Bums and Dalen (2002) reported that ecological and

evolutionary processes responsible for fruit colour remain elusive.

The colour of the aril is of high diagnostic and systematic value at different levels. The colour of the arils matched to the red group but varied from light red, light pink, pinkish white to pink. However, the arils were light red in Ajaba at 5R 7/8, and 7.5R 7/8, Gbongan 2.5R, 7.5R 6/8 and 10R 6/6, Idito 7.5R 6/8 and 6/6 and Ayetoro 2.5YR 7/6, light pink/pinkish white in Adewumi at 7.5R 8/3, 2.5YR 8/2 and 5R 8/3, pink in Otun 2.5YR 8/3 and 8/4 respectively (Table 4.6). The colour is also used to distinguish between sources, of these light red was the most common color in Ajaba, Gbongan, Idito and Ayetoro, for it is light pink/pinkish white in Adewumi and pink in Otun. This result is similar to Kitamura *et al.* (2011) who reported that red was the most common color of nutmeg arils (45 spp.), followed by orange (26 spp.), yellow (9 spp.), and pink (2 spp.). Similarly, within a study site, red arils were the most common in Myristicaceae (N = 7 spp.), followed by orange (3 spp.) in Budo-Sungai Padi National Park, southern Thailand.

The color of *P. angolensis* seeds is very variable. The colour of seeds varied from Reddish brown, dark reddish brown, brown to dusky red. They are dark reddish brown 2.5YR 2.5/3 and 5YR 3/4 in Ajaba reddish brown 2.5YR 4/4 OR 4/3, 5YR 4/4, /brown 7.5YR 4/4 in Gbongan, dark reddish brown 5YR 3/3 and 2.5YR 2.5/3 in Idito and 2.5YR and 5YR 3/4 in Ayetoro, dark reddish brown 2.5YR 2.5/3, 5R and 10R 3/3 and 3/4 /dusky red in Adewumi and Otun. It is difficult to distinguish between species depending on the colour of seed, because of the narrow range of colour degree between species, and most species have the same seed colour but with interference of dark reddish brown found in seeds collected from

Ajaba, Idito, and Ayetoro, reddish brown in Gbongan and dusky red from seed sourced from Adewumi and Otun.

## CONCLUSION

Change of surface colour of a fruit with the maturity can be used as a parameter to measure the ripeness. Often, unripe fruits show greenish surface colour which changes to yellowish colour when they ripen gradually. There were different colours showing the stages of Fruit Maturation in the developmental stages of *P. angolensis*. In terms of the morphological descriptions of the fruits, it was observed that fruit colour changed from one stage of immaturity to maturity and from one location to another. Fruits collected from Ajaba, Adewumi, Otun, Ayetoro and Gbongan matched to the Yellow group (Y) colour pattern which varied from light olive, pale olive and dark olive while Idito matched to the green (G) group which varied into dark olive green at immaturity. At maturity all fruits sourced from six locations matched to the yellow group but there was variation in the color strength between these provenances. Yellow colour in Ajaba and Idito, and interference from light olive brown/ olive in Gbongan, olive yellow in Otun and Ayetoro, dark reddish brown found in seeds collected from Ajaba, Idito, and Ayetoro, reddish brown in Gbongan and dusky red from seed sourced from Adewumi and Otun Fruit colour is considered as an index of seed maturation particularly in forestry by several researchers (Khullar et al., 1991, Srimathi, 1997). The colour of the matured fruits, seeds and aril of *P. angolensis* is grouped to yellow, yellowish red (reddish brown) Sand red respectively.

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