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MORPHOLOGICAL CHARACTERS OF KOPYOR COCONUT GROWN IN SUMENEP, MADURA, INDONESIA

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ABSTRACT

One of the centers of kopyor coconut in Java was located in Sumenep, Madura. The original kopyor coconuts mostly grown in a home garden and mixed with the normal palms. Recently, the local goverment has been implementing some programs to extend the growing area of kopyor coconut. The potentials of kopyor coconut gemplasm of this area, however, have not been fully explored. The original kopyor palms were characterized based on their morphological characters. In Sumenep was found only 1 (one) type of kopyor palm, tall variety, with 3 (three) colour forms: green, brown, and red form. Except for these tall variety no other dwarf variety had been observed. The average age of kopyor tall coconut trees was 10-25 years old. The number of nuts per bunch per tree were 9-18, while number of kopyor nuts per bunch were 1-5. Based on fruit components, Red Kopyor Tall Coconut smaller than the Green or Brown Kopyor. Observation on the endosperm revealed three distinct types of endosperm structure. Type A, the endosperm was separated from the shell and broken into small clumps; coconut milk little or none at all; very gentle and soft. Type B, some parts of the endosperm remain attached to the shell, soft, rough and relatively a lot of coconut water. Type C, the endosperm was soft and still attached to the shell with a lot of coconut water.

Key words: Cocos nucifera, tall variety, endosperm, coconut gemplasm.

INTRODUCTION

Coconut palm (2n = 2x = 32) is a member of the Arecaceae family (formerly Palmaceae), and the sub-family Cocoideae which has 27 genera and 600 species (Teulat *et.al*., 2000). The Cocos genus is mono-specific, no close botanical 'relatives'. *Cocos nucifera* is the only species in these genus (Harris, 1990). Kopyor palm (Macapuno in Philippines) is a variant of coconut (Foale, 2005) and resulted from natural mutation (Samonthe *et.al.*, 1989). It has nuts with abnormal endosperm. The endosperm structure is very soft and the meat separated from the shell becomes small fractions which is filled the entire its cavity. The tree produced normal and abnormal (kopyor) nuts in one bunch /inflorescence.

Although kopyor coconut contains an apparently normal embryo, it fails to germinate properly as the endosperm contains substances which are obviously lethal. Thus, pure-bearing kopyor coconut palms have not been obtained in nature. Usually farmers planted kopyor coconut by planting seedling nut from normal coconut tree but kopyor bearing. By this method and depending on where they are planted, the percentage of kopyor nuts produced very low, only 1-2 fruits per bunch (de Rosario, 1998). To develop pure (homozygote) kopyor seedling, the only way, is through *in-vitro* culture (embryo rescue technique). This seedling can produce 100% kopyor nuts (de Guzman and del Rosario, 1964)

The abnormalities of kopyor coconut endosperm is genetic and caused by several recessive factors (Zuniga, 1953). Kopyor traits driven by the recessive gene pairs, ie 50% of the female parent and 50% of the male parent. Kopyor nut will be formed if there is a cross between the pollen and stigma that each have kopyor properties (Tahardi, 1997). Kopyor trait is genetically controlled by the genotype of the endosperm (female) and genotype of pollen (male). When a kopyor coconut tree consistently female flowers pollinated by pollen of kopyor palm trees, it is certain the tree will produce 100% kopyor nuts.

Kopyor coconut like normal coconut can be classified into two types – Tall and Dwarf (Mashud and Manaroinsong, 2007). Kopyor tall palm trees have the appearance of the size larger than the dwarf, from the size of the stem to the crown. A distinctive feature is the presence of bol (the enlarged section at the base of the stem). They have large fruit size and begin flowering at the age of 5 - 7 years. Other properties are a flowering type in the pattern of cross-pollinated, so the variability between trees / individuals and the population is quite high. The kopyor dwarf coconut type has the appearance of trees with a smaller size than the tall in both the stem and crown. The trunk has no bol, small to medium fruit size and fruit number per bunch quite a lot. It starting produce nuts at the age of 3-4 years. Flowering type is self-pollinated, so the level of uniformity in the population is quite high.

Freemond *et al.* (1966) classified normal coconut into three varieties namely tall, dwarf, and hybrid/intermediate (var. aurantiaca). In the case of kopyor coconut also has been found hybrid species in certain location such as Pati, Central Java and Jember, East Java. In these areas kopyor hybrid coconut palm grown among the normal population. Until now no one has done exploration of coconut trees in

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East Java, especially in Sumenep so that populations and diversity of kopyor coconut at thi centers also unknown.

Superior genetic material is essential to the breeding programs of kopyor coconut. Therefore there is need for efforts to explore and identify the parent trees in the central areas. Until now there has been no collection of kopyor coconut as normal has. This collection can be used as a source of genetic material for conventional propagation and for the developing of coconut in vitro seedlings.

MATERIALS AND METHOD

Plant Material

Kopyor coconut trees older than 10 years and still productive were chosen as samples. Samples taken randomly with a population of 10 trees per location from 3 locations in Dungkek, Batang-batang and Gapuro District, Sumenep, Madura.

Character Morphology Measurement

Observation method using the Guidelines for Coconut Breeding Research Engineering Observations (Manual of Standardized Research Techniques in Coconut Breeding COGENT IPGRI, Santos, *et al.*, 1997).

Morphological characters were observed are as follows:

a. Stem Morphology

- Girth measurement at 20 cm above soil level (cm)
- Girth measurement at 1.5 m height (cm)
- Length (m) of stem with 11 leaf scars, measured starting from the bottom of the first leaf scar to the bottom of the 11th leaf scar.

b. Leaf Morphology

The oldest fully mature green frond was taken from the stem by detaching the entire leaf (petiole included). Variables were measured as follows:

- Petiole length (cm) - from base to the most proximal leaflet
- Petiole thickness (cm) - measured at insertion of first leaflet
- Petiole width (cm) – measured at insertion of first leaflet
- Rachis length (cm) - from the base of the petiole to the tip
- Number of leaflets - counted on one side of the frond that has the first leaflet closest to the base
- Leaflet length (cm) – used four leaflets (two on each side) near the middle of the rachis and recorded average of four measurements

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- Leaflet width (cm) - used the same leaflets as above and recorded average (at maximum width) of four measurements

c. Flower Morphology

Preferred samples were inflorescences with male flowers open, one inflorescence per palm.

- Length of peduncle (cm) - distance between the point where the bunch is attached to the palm and the base of the first spikelet
- Length of the central axis (cm) - measured from the first spikelet to the end of the axis
- Thickness of the peduncle (cm) - at the insertion of first spikelet
- Number of spikelets with female flowers
- Number of spikelets without female flowers
- Length of first spikelet bearing female flower
- Total number of spikelets
- Number of female flowers, total of female flowers

d. Fruit components

- Whole fruit-weight (g).
- Nut weight (g), fruit without the husk.
- Weight of split nut (g), fruit without the husk and coconut water.
- Shell weight (g).
- Meat weight (g).
- Thickness of meat/endosperm (cm).

e. Fruit appearance

- Shapes, colors, and sizes of fruit.

RESULTS AND DISCUSSION

Population of kopyor coconut *in situ* was very limited and concentrated in farmer's gardens in the small scale. There has been no clear information about the origin of the kopyor coconut trees. However, the kopyor coconut populations could be found in the area of Jember, Banyuwangi, Sumenep, and Pati (East Java and Central Java). In Jember, could be found tall and dwarf varieties of kopyor coconut (Sukendah *et al.*, 2002), in Pati was found three varieties such as tall, dwarf and hybrid, while in Sumenep we only found the tall variety.

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Observations of the kopyor tall variety that was in Sumenep, Madura, East Java showed that each group of farmer in the subdistrict average have 9-25 trees. Age kopyor coconut trees at that places an average of 10-25 years. The number of fruits per bunch per tree ranges from 9-18 pieces, with number of kopyor fruits about 1-5 per bunch. There were 3 types of kopyor tall coconut based on the colour of fruit: Green, Brown, and Red Kopyor Tall coconut. Number of Green kopyor more than Brown or Red Kopyor.

Stem and leaf characters of kopyor coconut palms showed that the average girth and stem length of Brown Kopyor smaller than the Green Kopyor (Table 1). Brown Kopyor had a stem girth of 150 cm with a stem length 11 m, while the Green Kopyor had a girth of 159.33 cm and stem length of 12.01 m.

Table 1. The average stem girth and stem length of Brown and Green Kopyor Tall palm in Sumenep, Madura, East Java

No.	Variety of kopyor	Stem girth (cm)	Stem length (m)
1.	Brown Tall	150.00	11.00
2.	Green Tall	159.33	12.01

Table 2. The average length and number of leaflets and other characters on Brown and Green Kopyor palm leaves in Sumenep, Madura, East Java

No.	Variety	Petiole length (cm)	Petiole thickness (cm)	Petiole width (cm)	Rachis length (cm)	Number of leaflets	Leaflet length (cm)	Leaflet width (cm)
1.	Brown Tall	116.00	2.00	7.00	350.00	91.00	128.00	5.13
2.	Green Tall	85.33	2.50	6.50	326.33	96.67	113.50	5.02

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Figure 1. Green Kopyor coconut leaves that have a leaflet very tightly (A) and Brown Kopyor with a distance between the leaflets a relatively large (B).

For petiole characters (length, thickness and width of the petiole) showed that Brown Kopyor coconut had a long and width petiole was greater than Green Kopyor, but had a thick petiole smaller (Table 2). Rachis length of Brown Kopyor was also longer, with it's length and width leaflets greater than the Green one, but the number of leaflets was less. This means that the distance between the leaflets in coconut Green Kopyor denser than Brown Kopyor coconut (Figure 1A & B).

Morphology of kopyor flower and inflorescense showed that the Brown Kopyor coconut had a peduncle shorter but thicker than the Greens. This seems to support the length of a longer inflorescence with the number of spikelets and flower number (male & female) which was much more than Green Kopyor (Table 3). Colour of flower and inflorescense on each type of kopyor coconut was very different. Green Kopyor coconut had a green inflorescence with female and male flowers colored light green (Figure 2A). Meanwhile Brown Kopyor coconut had reddish-brown flowers (Fig. 2B).

Table 3. The average length and thickness of peduncle, floral size and number of flowers on a inflorescence of kopyor palm in Sumenep, Madura, East Java

No.	Variety	Length of peduncle (cm)	Thikness of peduncle (cm)	Length of spikelet (cm)	Number of male flowers	Number of female flowers	Number of spikelets
1.	Brown Tall	24.00	5.00	44.00	15300.00	30.00	51.00
2.	Green Tall	51.00	4.50	38.67	7447.67	17.67	35.67

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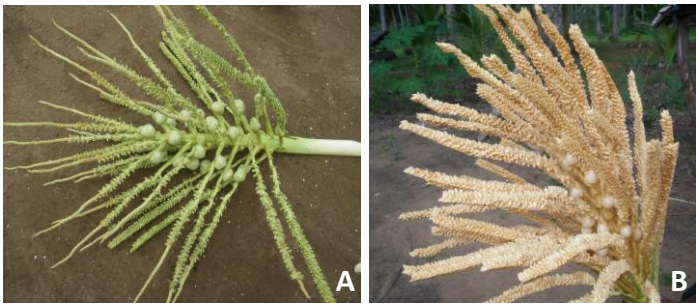

Figure 2. Morphology of inflorescence of Green Kopyor Tall coconut (A) and Brown Kopyor Tall (B).

Table 4. Fruit component characters of kopyor coconut in Sumenep, Madura, East Java

No.	Fruit colour	Fruit shape	Fruit size (cm)		Fruit weight (kg)	Nut weight (fruit weight without husk)	Fruit weight without husk & coconut water (g)	Meat weight (g)	Thickness of meat (cm)	Shell weight (g)
			diameter	length						
1.	Red	round	53.00	57.00	1.50	0.75	506.67	273.33	0.47	233.33
2.	Brown	egg-shaped	53.67	59.67	1.67	1.00	623.33	290.00	0.60	333.33
3.	Green	egg-shaped	57.40	64.70	1.85	1.00	616.00	279.00	0.53	318.00

Figure 3. Classification of kopyor tall coconut variety based on fruit colour. A. Green Kopyor Tall coconut, B. Brown Kopyor Tall, C. Red Kopyor Tall.

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Figure 4. Classification of kopyor coconut based on the structure of endosperm (meat structure). A. Type A: endosperm separated into small clumps which are separated from the shell, B. Type B: some of the endosperm remains attached to the shell. C. Type C: endosperm attached to the shell and is relatively soft, a lot of coconut water.

Characteristics of fruit component of Green, Brown and Red Kopyor Tall coconut indicated a difference between them in terms of fruit size, fruit weight, fruit weight without husk & water, endosperm weight, the meat thickness and shell weight. Meanwhile, the weight of fruit without the husk did not differ among types of Green and Brown Kopyor cconut (Table 4). Red Kopyor on average had a character of the fruit components smaller than the type of Green and Brown Kopyor. For example, the Red Kopyor meat was thinner, so that the weight of the meat (endosperm) was less. The shell weight was also smaller in line with the weight and size of the fruit for which the average was smaller than the Brown or Green Kopyor.

Endosperm structure of kopyor coconut was not the same in one type. We classified kopyor coconut endosperm structure in Sumenep, Madura, East Java into three types: Type A which had the characteristics: the endosperm was broken into small clumps and separated from the shell, very gentle and soft, coconut milk little or none at all. Type B: some portions of the endosperm separated and some remain attached to the shell, soft, and relatively had a lot of coconut water. Type C which had the characteristics of the endosperm attached to the shell and was relatively soft, a lot of coconut water (Fig. 4). Akuba *et al*. (2000) also classified kopyor coconut endosperm into 3 (three) types. The first type, endosperm which completely has broken so they called as "Puan" or "Kopyor". The second type, the endosperm was still intact but very soft so-called "Theeri" and the third type was a bit harder endosperm than "Theeri" called "Kapungan" (Akuba *et al.,* 2000). This suggests there may be differences in expression levels of kopyor trait between populations on the nature, resulting in a diversity of endosperm texture.

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CONCLUSION

There were 3 (three) types of kopyor tall coconut in Sumenep, Madura, East Java, namely Green, Brown and Red Kopyor Tall coconut. Age kopyor coconut trees 10-25 years on average. The number of fruits per bunch per tree ranged from 9-18 pieces with the number of kopyor fruits about 1-5. Red Kopyor Tall coconut in all fruit component characters was smaller than the Green or Brown Kopyor Tall.

Based on the character of the endosperm, there are three types: Type A: the endosperm was broken into small clumps and separated from the shell, very gentle and soft, coconut milk little or none at all. Type B: some of the endosperm separated, some remain attached to the shell, soft, and relatively a lot of coconut water. Type C : endosperm was soft and still attached to the shell, coconut water a lot.

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