

## RESEARCH

# Morphological description of *Jogorogo Mangosteen (Garcinia mangostana L.)*

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Received: 14 December 2009

Accepted: 2 February 2010

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### Abstract

This research aimed to obtain phenotypic information based on morphological character of *Jogorogo Mangosteen (Garcinia mangostana L.)*. This research was conducted with direct observation through primary and secondary data recording, and documenting parts of *Jogorogo Mangosteen* plant specifically, that was, in vegetative part: stalk and leave, as well as generative part: flower, fruit and seed. *Jogorogo Mangosteen* may reach hundreds years of life span, it had an average height of 9 meters, stalk diameter of 1 meter and crown diameter of 6 meter. The tree crown of *Jogorogo Mangosteen* plant was triangular in shape, with horizontal and irregular branching pattern and various densities. The leaves of *Jogorogo Mangosteen* were elliptic. The tip of the leaf was pointed, the base of the leaf was blunt, and the leaf edge was flat with the smooth and shining surface. The flower of *Jogorogo Mangosteen* was a hermaphrodit and a perfect flower. The fruit was small with  $\pm 59$  grams weight/flower with  $\pm 4.5$  cm long and  $\pm 4.45$  cm wide. The fruit was purple-blackish with the continuous fruit ripening with high fruit bearing level. The *Jogorogo Mangosteen* fruit was sweet with a little yellow sap. 1-2 seeds were formed in every *Jogorogo Mangosteen* fruit with 1.6 cm long, 0.8 cm wide and 2.75 thick. The seed is spheroid and ellipsoid with light brown color wrapped with white arilode.

**Key words:** Morphology, Mangosteen, Jogorogo

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## INTRODUCTION

Mangosteen tree is a kind of fruit plant. Indonesian mangosteen possesses a high potential for cultivation. Mangosteen fruit has sweet taste and strong flavor, therefore bears its name as "queen of fruits". European considered the mangosteen fruit taste is mix of pineapple, apricot, and orange. The texture of fruit is smooth like ice cream.

The mangosteen has been known for many centuries, however, the diversity of mangosteen has not been noticed yet. Reza and co-workers<sup>(1)</sup> consider this ignorance is a result of the fact that mangosteen can only form female flower, while male flower has never been formed. Therefore cross

fertilization is never occurred. Seed in female flower is formed by apomixis so that it inherits the characteristic of the female parent plant.

*Jogorogo Mangosteen* from Jogorogo regency, East Java is one of well known mangosteen for its sweet taste, strong flavor, and big fruit. The *Jogorogo Mangosteen* has a good quality for having little yellow latex (gamboges), a liquid that taste bitter. Moreover, the *Jogorogo Mangosteen* has smooth skin that makes it easy to peel the

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pericap off.

The cultivation of mangosteen has not been optimal as the plantation depends on natural apomixes seed. One of important factors to solve this problem is by identifying the genetic characteristic of the plant. Plant morphology and phenotypic character of *Jogorogo Mangosteen* is a key on overcoming problem in reproduction of mangosteen plant which has apomictic character. This research purposed on obtaining genetic information based on morphological characteristic of *Jogorogo Mangosteen* plant (*Garcinia mangostana* L.)<sup>(2)</sup>.

## MATERIALS AND METHODS

The identification of plant morphology of *Jogorogo Mangosteen* was carried on in Jogorogo area of Ngawi Regency, East Java Indonesia and was continued in Plant Cultivation Laboratory of Agriculture Faculty of UNS. Sample on this research was mangosteen plant in Jogorogo area. The research tools included thermos, plastic wrap, ruler, micrometer, meter line, label, camera and Munsell Color Chart.

Identification of plant morphology was analyzed descriptively based on direct observation through primary and secondary data recording. Documentation of part of *Jogorogo Mangosteen* plant specifically on vegetative part: stalk and leaves as well as on generative part: flower, fruit and seed were also made for identification.

Sample were randomly selected and divided as follow: tree description (data were obtained from 10 trees randomly selected in the research location), leaf description (data were obtained from sample of leaf selected from 20 mature leaves taken from 3 trees), flower description (data were obtained from 20 perfectly blooming flowers sample), fruit description (data were obtained from 20 mature fruit sample), and seed description (data were obtained from 20 healthy seed sample).

The variables observed in identification the morphology of *Jogorogo Mangosteen* included: tree, leaf, flower, fruit and seed description. The collected data were descriptively analyzed.

## RESULTS AND DISCUSSION

### The Jogorogo Area

Jogorogo area is part of Ngawi regency on the west border of East Java province in Indonesia. The Jogorogo area is  $\pm$  449 m above sea level and classified as a surging land with 15-40 % slope. Astronomically Jogorogo placed on 111° 13' EL - 111° 19' EL and 07° 30' SL - 07° 38' SL. The area of Jogorogo is 698,010 Ha, 5.4% of total area of Ngawi Regency<sup>(3)</sup>.

The rainfall of Ngawi during 2002-2006 was varied. The highest rainfall occurred in December to February. The average rainfall was 1509.76 mm/year<sup>(4)</sup>. The closest location for measuring the rainfall in Ngrambe indicated that the rain season of the year 2006 was started on November until May 2007. This season was in the same time with the flowering time and the harvesting time of *Jogorogo Mangosteen*.

### Tree Description

Mangosteen plant is a big tree. The height of mangosteen tree may reach tens meter and the life span may reach tens to hundreds years. The tree crown shape is varying with symmetrical distribution<sup>(1)</sup>.

Most of the *Jogorogo Mangosteen* trees were heritage from predecessor of the current owner. However some of the *Jogorogo Mangosteen* trees were grown by the current owner. This was determined by the age of mangosteen tree which reach hundreds years. Secondary data shows that the age of *Jogorogo Mangosteen* plant was quite varying, from 17 to hundreds years. The prediction of tree life span was made by calculating the age of the ancestor of the current owner.

**Table 1. Mean of stalk and tree crown variable from 10 samples**

Sample	Age (year)	Height of stalk (m)	Diameter of stalk (cm)	Diameter of tree crown (cm)
1	> 100	11.88	118	722
2	> 100	9.08	128.5	646
3	> 100	8.1	112.2	599.8
4	> 100	8.03	191	568
5	17	5.86	31	310
6	> 100	10.6	113	906
7	> 100	9.62	119.4	820
8	20 - 30	8.25	99	354
9	> 100	12.67	111	852
10	23	6.82	43	494
Mean	-	9.091	102.45	612.975

The tree height is the most observed indicator for growth and parameter of the effect of environment or treatment on the tree growth. This is because tree height is the easiest measurement for growth <sup>(5)</sup>. The tree height measurement was made by mathematical calculation to obtain an accurate data (Table 1). *Jogorogo Mangosteen* was considered as a high tree as the average height was  $\pm 9$  meter. The lowest height was 6 meter and the highest was 13 m.

The stalk is an important part of the tree as it can be recognized as the axis of tree. *Jogorogo Mangosteen* tree not only high but also big in stalk circumference. The stalk circumference was measured at 0.5 m above land surface. The average circumference was 102 cm. The smallest circumference was 31 cm, measured from 17 years old tree, while the biggest circumference was 191 cm.

The canopy of *Jogorogo Mangosteen* tree was triangle in shape with the crown size was small on the tip and getting bigger on the base. There were two triangle type of crown shape namely pyramidal and spherical. The pyramidal shape was looks like isosceles triangle, while the spherical shape was more alike equilateral triangle. The canopy shape is related to branching pattern. In general the branching pattern of *Jogorogo Mangosteen* tree was horizontal with the main branch form 90° angle to the axis or main stalk. However, due to its long life span, the branching pattern of *Jogorogo Mangosteen* tree was affected by non genetic factor and becomes irregular. Observation on tree sample 5, 8, and 10 showed that younger trees had lower branch

density than others. The branch density of those three samples were categorized as moderate density, the other samples were categorized as high density.

The stalk and tree crown description of *Jogorogo Mangosteen* tree mentioned above indicated that *Jogorogo Mangosteen* tree was physically big and high with triangle canopy shape. The tree age genetically and non-genetically affects other tree description. Observation of *Jogorogo Mangosteen* showed that the older the tree the more impact on tree height, stalk circumference, canopy and crown diameter. The canopy shape was affected by branching density and pattern.

### Leaf Description

*Jogorogo Mangosteen* leaves lied on every branch without stipula or leaf base. The mature leaves were dark green. The younger leaves were reddish brown and it changes into light green.

The leaf density depends on the branch density. The older the trees the higher the branch density, therefore the leaf density of *Jogorogo Mangosteen* tree differ according to the age. Hundreds years old tree had a high leaf density, 10-30 years old tree had moderate leaf density, and young mangosteen tree (0-5 years) had low leaf density.

The type of *Jogorogo Mangosteen* leaf was single leaf. The leaf structure can be differentiated into alternate and opposite structures. The *Jogorogo Mangosteen* leaves on the branch were alternate in structure.

Specifically the mangosteen leaves were elliptical with average length 17.5 cm and width 8.2 cm. The leaf tip was acuminate and the leaf base was blunt or oblique or obtusus. The leaf edge was flat (integer). The upper surface of the leaf was smooth and shiny while the lower part of the leaf was not shiny. The leaf frame was not bulging.

### Flower Description

Mangosteen flower has 4 sepal structured in two pairs. The flower composed of 4 petals with yellowish green and red color at the edge. It has much pollen and the ovary has 4-8 chambers with 4-8 stigma which never fall off until the fruit is ripened <sup>(6)</sup>.

The generative phase is started by the emerging of flower as reproductive organ. The *Jogorogo Mangosteen* age to start flowering has not known, related to the tree lifespan of hundreds years. The obtained data from sample 5 aging 17 year, the tree start flowering at age 14 year and from sample 10 aging 23 year, the tree start flowering at 17 years.

Observation of the first and the last flowering day on 2007, there were 4 flowering periods. On those 4 periods the average days for flower to perfectly bloom was 24-25 days. The regularity of flowering was the rising of flower in every year. Within the last 2 years *Jogorogo Mangosteen* was flowering regularly once a year. According to the owner of *Jogorogo Mangosteen* plant, the plant will start flowering at around end of October until mid December. In 2007-2008 the *Jogorogo Mangosteen* was flowering at mid October 2007 until end of December 2007 on the entire plant sample.

Mangosteen flower is a terminalis flower meaning that the flower rises in the tip of tree branch. The number of flower rising on every branch tips is varying. In one season, three flowers may rise in the branch tip. Mangosteen flower has characteristic parts that differentiate it from other flower. Ovary seat is part of mangosteen flower with blunt star in shape and located on the tip of stigma. The number of ovary seat was varying from 4, 5, to 6. The petals of mangosteen flower were

yellow in color and becoming reddish into the tip. *Jogorogo Mangosteen* flower had 4 petals with moderate size.

The abundancy of flower is the frequency of the amount of flower on each tree in one flowering season. *Jogorogo Mangosteen* had moderate abundancy of flower due to flowers in every tree was not blooming in the same time. The *Jogorogo Mangosteen* flowers rise from the upper part of tree crown down to the lower branch tip of the tree.

### Fruit Description

Mangosteen fruit is the main commodity in the cultivation of mangosteen plant. Mangosteen fruit is formed without fertilization or partenocarpy. In spite of that fact, fruit character has various phenotypes. The variability of phenotype is shown by the different plant profile in several locations of plantation <sup>(7)</sup>.

The majority of *Jogorogo Mangosteen* plants were hundreds year old. The information about the length of the tree to bear fruit was only known in some tree sample. In *Mangosteen* tree sample number 5, the first time of bearing fruit was when it 14 year old, while in sample number 10, the tree bearing fruit for first time at 17 year old.

The fruit bearing time of *Jogorogo Mangosteen* was started on the 4<sup>th</sup> week of November, by non-synchronous pattern (the fruit bearing time did not occur at the same time in one tree). The fruit ripening was occurring continuously in one period. The harvesting time was started on March until May or sometime prolonged into June. The fruit ripening required about 4 months (115-120 days). The ripening level of *Jogorogo Mangosteen* was high.

*Jogorogo Mangosteen* fruit had its speciality compared to other kind of mangosteen fruit. The fruit size was smaller but sweeter than others. *Jogorogo Mangosteen* fruit was spherical in shape with stunning ovary seat thickness and little dots around ovary seat. When the fruit ripened, cupat of *Jogorogo Mangosteen* was becomes black in color, round (spherical) with thickness ovary

seat and little pock formation around the ovary seat.

The *Jogorogo Mangosteen* fruit was rise in the branch tip singly or in cluster of 2 or 3 or even more. The fruit stalk was  $\pm 1.5$  cm long and green or reddish green in color. The fruit was  $\pm 4.5$  cm long and the diameter was  $\pm 4.45$  cm. Mangosteen fruit was a small fruit weighing  $\pm 59$  gram/fruit ( $< 90$  gram/fruit). The ripenned *Jogorogo Mangosteen* was purple or dark purple in color. Fruit pericap thickness was 4.5 cm and the pulp thicknes was  $\pm 4$  cm. Pulp texture was tender. The fruit quality was related to the fruit taste. The *Jogorogo Mangosteen* fruit had sweet taste with smooth pulp flavor. However, *Jogorogo Mangosteen* shows a moderate market appeal. This is because of its small fruit size so could be marketed in a simple wrapping.

The pulp in four fruit segments were 5 to 7, white or snowy white in color. The specialty of *Jogorogo Mangosteen* fruit was little or lack of yellow latex. Yellow latex could ruin the fruit taste, if the yellow latex mixed with the pulp it would make the fruit tasted bitter. The yellow latex (gamboges) could emerged in every part of mangosteen tree. The yellow latex can emerge as a result of wound caused by environment factor or the genetic trait.

At present, *Jogorogo Mangosteen* fruit can only be sold around the farming. The lack of means and infrastructure and low fruit production impedes the farmer to make mangosteen as the main commodity.

### Seed Description

One of genotypic characteristic of mangosteen plant is apomixes, a phenomenon of the zygote formation without fertilization. Mangosteen seed itself is apomixes. Apomixes on mangosteen is formed through incomplete meiosis. One or more unreduced embryo sacs grow around the nucleus tissue. Then, the unreduced egg cell grows becoming embryo with identical genetic character with the female parent. Usually, only one embryo

yellow color and reddish at the edge. *Jogorogo Mangosteen* flower was a perfect flower. It was composed of 4 sepals, 4 petals

becomes seed<sup>(9)</sup>. Therefore, apomictic plant will produce plant identical to the female parent<sup>(8)</sup>. Apomixes is thought to occur on mangosteen from longtime ago and is believed to be obligate apomixes, as mangosteen is only found as female plant and produce fertile seed<sup>(7)</sup>.

Mangosteen seed was laid on the inside of pulp. It was wrapping by arilode, white skin like web function as seed wrap. The number of mature seed in one fruit was 1 to 2. However, sometimes 3 seeds could be found in one fruit. The seed had 1.6 cm in length, 0.8 cm in width, and 0.275 in thickness. The *Jogorogo Mangosteen* seed were spheroid (its length and width were in similar size) or ellipsoid (its length was twice than the width) in shape. The seed color (after arilode was peeled of) was light brown.

Although the seed was formed asexually or vegetative, the seed was fertile. Mangosteen seed was recalcitrant, i.e. it could not be stored for a long time. *Jogorogo Mangosteen* plants cultivated recently were grown from seed. Mangosteen propagation from seed is very hard. Slow and weak root growths make the farmer to left behind this propagation method. Tissue culture is one of alternative solution to overcome problem in plant cultivation.

From the present data it could be concluded that *Jogorogo Mangosteen* plant may had hundreds year of lifespan with average hight 9 m, stalk diameter 1 m and crown diameter 6 m. The tree crown of *Jogorogo Mangosteen* tree was triangle in shape, spherical and pyramidal, with horizontal and irregular branching pattern. The branch density was quite varying from moderate to high density. *Jogorogo Mangosteen* leaf was dark green in color and elliptical in shape with length 17.5 cm long and width 8.2 cm. The tip of the leaf was pointed. The base of the leaf was blunt and the edge of the leaf was flat. The leaf surface was smooth and shiny. *Jogorogo Mangosteen* flower was located on the branch tip with

and 4-6 parts of ovary seat. *Jogorogo Mangosteen* flowered on mid October and last on late December with flowering phase

of 24-25 days. *Jogorogo Mangosteen* was beard fruit once a year. The fruit was small weighing  $\pm 59$  gram/fruit. The fruit was  $\pm 4.5$  cm long and  $\pm 4.45$  cm wide. The young fruit was light green and it was becoming dark purple when ripen. The fruit ripening occurs continuously with a high fruit bearing level. The fruit tastes sweet with little yellow latex. The *Jogorogo Mangosteen* seed was formed apomictically. The number of seed was 1-2/fruit with 1.6 cm long, 0.8 cm wide and 2.75 mm thick. The seed was spheroid and ellipsoid in shape with light brown color. It was wrapped with white arilode.

In the future, the management of *Jogorogo Mangosteen* cultivation needs to be improved to gain better yield and offspring. It is recommended to conduct further research on comparison of *Jogorogo Mangosteen* character with other mangosteen and to conduct cytological characterization and morphomolecular analysis of *Jogorogo Mangosteen*.

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