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Full Paper

God's Crown (*Phaleria macrocarpa* (Scheff.) Boerl: Thymelaceae): An introduced Fruit with Pharmaceutical Potential in the Philippines

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The God's crown (*Phaleria macrocarpa* (Scheff.) Boerl) tree also known as Makhota Dewa is a member of the Thymelaceae family. It was introduced from Indonesia by the late Dr. Roberto E. Coronel in 2009. The tree fruited for the first time in 2014. Morphological characterization of the tree, leaf, fruit, seed and seedlings was conducted for 2 yr. A fruiting God's crown tree is 165.5 ± 6.37 cm high with a canopy spread of 156.5 ± 9.19 cm. It produces fruit all year round, but the peak of harvest season occurs in February. The trunk has a diameter of 20.25 ± 0.21mm. The mature leaves are green, narrow ovate, glabrous with very short petioles. Fruits are globose to heart shape, small sized (21.16 ± 12.04 g), with red (RHCC 46C) and thin peel, white flesh (RHCC N155B) that is dry with mild aroma. It has high flesh portion of 79.56 ± 5.45% and with 1 to 2 small, brown (RHCC 200B) seeds.

Keywords: God's crown, Makhota Dewa, *Phaleria macrocarpa* (Scheff.) Boerl), Thymelaceae, Simalakama

INTRODUCTION

The God's crown (*Phaleria macrocarpa* (Scheff.) Boerl), a member of the Thymelaceae family, is an introduced species in the Philippines. It is also known as 'Makhota Dewa' in Papua New Guinea, 'Makuto rato' or 'Raja obat' in Java, 'Simalakama' in Sumatra Indonesia (Mazza, and), 'Pau' in China (http:// www.shaman-australis.com/, 2006). It is called God's Crown, which is a direct translation in English of the Malay word "Makhota Dewa". The relatives of God's crown are *Phaleria cumingii* (Meisn.) which can be found all over the Philippines and *Phaleria platyphylla* Merr. that is found in Mindanao and Panay islands (Co 2011). God' crown is an indigenous species in neighboring countries such as Malaysia and Indonesia. It originated from Papua New Guinea where it thrives in 10 – 1200 m above sea level. The plant is a small evergreen, spreading tree that produces attractive red fruits. The fruit species was introduced in the Philippines by the late Dr. Roberto E. Coronel in 2009.

God's crown is a vigorous shrubby tree that grows 1– 2.5 m high and the trunk diameter reaches up to 15 cm (Mazza n.d.). Specimens from the wild grows taller with a height of 1–18 m (Altaf 2013). The plant can be grafted or can be propagated by seeds. Since the seeds belong to the recalcitrant type, Asrity (2013) suggested that seeds are best sown fresh or after a slight desiccation since electrolytes leakage and eventually death of the seed may occur if sowing is delayed. The seeds of God's crown germinate in moist but not very wet medium at a temperature of 25 -28°C (http://www.sunshine-seeds.de). It grows and thrives well in tropical areas like the Philippines. Trees that grow out of seeds developed fragrant white flowers yearly 5 yr after planting in soil. The fragrant small flowers then produce fruits that are red in color when ripe. The seed of God's crown is reported to be poisonous (Yosie 2011), but it contains anti-cancer properties.

Phalaeria macrocarpa is a famous fruit species due to its usage as herbal medicine in Indonesia and Malaysia. Indigenous people use different parts of the tree to treat cancer, inflammation, diarrhea and other diseases. This pharmaceutical potential led to several studies to prove its effectivity. Chemical and cytotoxicity analysis have shown the potential use of *Phalaeria macrocarpa* for ethnopharmacology. Analysis verified claims that it has strong anti-oxidant property found in the leaves (Susilawati et al. 2011), anti-tumor compounds on the fruit (Riwanto 2011), anti-hyperglycemic substances on the fruit pericarp (Salih 2016), anti-inflammatory compounds on the leaves (Fariza et al. 2012) and anti-microbial substances on the fruits (Hendra 2011). Most importantly, a study showed that God's crown has anti-proliferative activity against two types of cancer cells (MDA-MB-231 and MCF-7 human breast adenocarcinoma cell lines (Tandrasasmita 2010). It also showed properties that are vasorelaxant in nature (Oshimi 2008). In addition, sperm viability was also improved when pelleted extracts of *P. macrocarpa* was fed to male rats (Parhizkar 2013). Having multiple compounds with high bioactivity and effectivity, characterization, chemical analysis, and utilization of this fruit are essential.

The plant is not found among the list made by Fr. Manuel Blanco (1827) nor is it included in the book

'Flora of Manila' by ED Merrill (1912). Thus, no introduction of this species was recorded by that time. Its introduction was done by the late Dr. Roberto E. Coronel from Bogor, Indonesia where a tree was grown under local conditions in the RC Fruit Conservation Farm located at Brgy. Mabacan, Calauan, Laguna, Philippines.

Since *P. macrocarpa* is a promising fruit tree that bear fruits for the first time in the Philippines, this needs to be documented and evaluated. Similarly, other introduced species such as "Lovi-lovi" (*Flacuortia enermis* Roxb.) (Magdalita et al. 2015), "Araza" (*Eugenia stipitata* Mc Vaugh) (Coronel et al. 2012), "Kepel" (*Stelechocarpus burahol*), Cedar Bay Cherry (*Eugenia carissoides* F. Muell.) and Giant Soursop (*Annona montana* Macfayd.) (Magdalita et al. 2014) were documented and characterized. This study aimed to document, characterize and evaluate the tree and leaf morphology, including fruit and seed characteristics; and propagate God's crown by seeds.

MATERIALS AND METHODS

In 2010, open pollinated seeds of God's crown brought from Indonesia were sown in the RC Fruit Conservation Farm in Mabacan, Calauan, Laguna. The tree which developed from the seeds was maintained in the farm. In 2014, the tree, leaf and fruit characteristics were evaluated for the first time in 4 yr and re-evaluated in 2015. During each evaluation, 20 leaves and 20 fruits were randomly taken from the fruiting tree.

The tree characters evaluated were height, canopy spread, trunk girth, and month of harvesting. The leaf characteristics assessed were leaf blade length, width, petiole length, color (adaxial and abaxial), base, apex, texture, margin, venation and phyllotaxy. Qualitative evaluation of leaf shape, apex, margin and venation were based from the standard descriptions and illustrations found in the book, "Vascular Plant Systematics" (Radford et al. 1974), while the evaluation of leaf color, petiole color, fruit peel, flesh and seed color were based on the Royal Horticultural Colour Chart [RHCC] published by the Royal Horticultural Society [RHS] of London, fifth edition (RHS 1966). The leaf color was carefully matched with the chart and the corresponding color hue was identified and further matched with the color coordinate to determine the description of the actual color.

The shape of fruit, seed and leaf were determined based on the varietal selection standards found in the 'Guidelines for Evaluation, Selection and Registration of New Fruit Crops Varieties" (FCTWG-NSIC 2009). Twenty ripe fruits were characterized based on whole fruit shape, weight, length, width, peel and flesh color and texture, and edible portion. Fruit weight was measured using a digital balance while length and width were measured using a vernier caliper and total soluble solids (TSS) were measured using a hand-held refractometer. Furthermore, the seed characteristics including the number of seeds per fruit, total seed weight per fruit, individual seed weight, seed length, width, thickness, seed color, and shape were also assessed.

Twenty seeds extracted from the mature fruits were germinated in a mixture of garden loamy soil and sand (2:1, v/v) at the Institute of Plant Breeding, College of Agriculture and Food Science, University of the Philippines Los Baños. The germinated seedlings were then transferred to individual plastic bags (5x8 cm^2) containing a mixture of garden loamy soil and coir dust (1:1, v/v).

The successfully germinated seedlings were maintained in the screenhouse and after 1 yr, the primary characteristics of the seedling such as plant height, canopy spread and stem diameter were evaluated. The mean and standard deviation of all phenotypic characters of the leaves, fruit and tree of God's crown were taken. Mode was used to assess the qualitative traits.

RESULTS AND DISCUSSION

Tree and leaf characteristics

The tree is a new species adapted to the Philippine condition and reported to be a good source of beneficial bioactive compounds for pharmacological uses. Several studies have proven anti-inflammatory (Fariza et al. 2012), anti-oxidant (Susilawati et al. 2011), anti-hypergylcemic, anti-proliferative to cancer cells (Aripin et al. 2011) and anti-sterility (Parhizkar 2013), anti-tumor, anti-bacterial, cytotoxic (Altaf et al. 2013) properties that can be explored for processing into medicine. Furthermore, Aripin et al. (2011) isolated and patented two compounds: DLBS1425E2.2 and DLBS1425F1 that are effective for non-proliferation of cancer cells. The compounds can be used for development of drugs to combat gynecological diseases such as cancer and cysts in ovary and breast.

The tree and leaf characteristics of God's crown are shown in Table 1. The tree stands at a height of 165.5 ± 6.37 cm with a canopy diameter of 156.5 ± 9.19 cm (Figure 1). It is a small to medium-sized tree that is best suited for gardens and front yards. The size of the tree makes it a potential container plant for urban landscapes. The trunk is greyish brown (RHCC 199B) with a girth of 20.25 ± 0.2121 mm. The tree is vigorous despite being small.

The opposite leaf phyllotaxy of the plant is shown in Figure 2A, while the adaxial and abaxial leaves of God's crown of both mature and immature leaves are shown in Figure 2B and 2C, respectively. The leaves are 12.52 ± 1.47 cm long and 4.6 ± 0.79 cm wide, narrow ovate, smooth, having an entire margin with a pinnate venation. The apex is acuminate, while the base is petiolate. It has a glabrous texture. The adaxial side of the young leaves is green (RHCC

Table 1. Tree and leaf characteristics of God's Crown (*Phaleria macrocarpa* (Scheff.) Boerl)

	Parameters evaluated	Description
Tree	Height (cm)	165.5 ± 6.37
	Canopy spread (cm)	156.5 ± 9.19
	Trunk girth or diameter (mm)	20.25 ± 0.21
	Trunk color	Grayish brown
	Vigor	High
	Yield	58 fruits
	Harvest season	February
Leaf	Arrangement	Opposite
	Blade color of mature leaf (adaxial)	RHCC N137A (Green)
	Blade color of mature leaf (abaxial)	RHCC 147B (Yellow green)
	Blade color of young leaf (adaxial)	RHCC N137B (Green)
	Color of young leaf (abaxial)	RHCC 146C (Yellow Green)
	Shape	Narrow ovate
	Apex	Acuminate
	Base	Petiolate
	Texture	Glabrous
	Margin	Entire
	Venation	Pinnate
	Length (cm)	Range: 10 – 15.5 Mean: 12.52 ± 1.47
	Width (cm)	Range : 3.3 – 6.3 Mean: 4.6 ± 0.79
Petiole	Length (mm)	Range: 4 – 6 Mean: 5.08 ± 0.59
	Color	RHCC 138D (Green)

N137B), while the abaxial side is yellow green (RHCC 146C). In addition, the adaxial side of the mature leaf is green (RHCC N137A) while the abaxial side is yellow green (RHCC 147B). The leaf petiole is also green (RHCC 138D) and measures 5.079 ± 0.587 mm long.

Fruit characteristics

Ripe fruits are generally harvested during February.Fruits do not mature uniformly, some are still immature green, the others are already mature exhibiting red tinge on the apex. Because of this ripening behavior of the God's crown, fruits can be harvested daily especially during the peak of harvest.

Figure 3 shows the fully ripened fruits of God's crown with a red peel. Since this is a new introduction, it is still not known in the Philippines. However, this fruit is very popular in Indonesia, Papua New Guinea and Malaysia due to its multiple pharmacological potentials. Thus, God's crown in the Philippines can also be used as potential source of medicines to treat various serious illnesses like cancers.

God's crown is an ovate fruit (Figure 3) that has an average weight of 21.16 ± 12.04 g and measures 38.07 ± 7.14 cm long and 27.47 ± 6.23 cm wide

Table 2. Fruit characteristics of God's Crown (*Phalaeria macrocarpa* (Scheff.) Boerl)

	Parameters evaluated	Description
Fruit	Shape	Ovate
	Weight (g)	21.16 ± 12.04
	Length (cm)	38.07 ± 7.14
	Width (cm)	27.47 ± 6.23
	Peel color	RHCC 46C (Red)
	Texture	Smooth
	Aromaticity	Mild
Seed	Color	RHCC 200B (Brown)
	Shape	Globose
	Number	1.77 ± 0.44
	Individual seed weight (g)	0.4 ± 0.34
	Total seed weight	0.92 ± 0.60
	Seed length (mm)	10.41 ± 0.15
	Seed width (mm)	10.45 ± 0.11
	Seed thickness (mm)	0.82 ± 0.13
Flesh	Color	RHCC N155B (White)

Table 3. Seedling characteristics of God's Crown (*Phalaeria macrocarpa* (Scheff.) Boerl)

	Parameters evaluated	Description
Seedling	Plant height (m)	0.60 ± 0.04
	Canopy diameter (m)	0.45 ± 0.10
	Stem diameter (cm)	0.81 ± 0.18
	No. of secondary branches	5.29 ± 1.70
	Stem color	RHCC 146B (Yellow green)
	Total no. of leaves	62.67 ± 17.06
Leaf	Leaf shape	Narrow Ovate
	Thickness	0.35 mm
	Length (mm)	122.87 ± 23.75
	Width (mm)	34.21 ± 10.18
	Seed germination (%)	35

(Table 2). The peel is smooth and shiny. The flesh is white (RHCC N155B) that accounts for 79.56 ± 5.45 % of the whole fruit (Figure 3). The flesh is dry. The fruit has an average of 1.76 ± 0.439 seeds per fruit. The seeds are brown (RHCC 200B), globose and 10.41 ± 0.15 mm long, 10.45 ± 0.11 mm wide and 0.82 ± 0.13 mm thick. The total seed weight per fruit is 0.92 ± 0.60 g, while individual seed weighs 0.4 ± 0.34 g.

Seedling characteristics

Freshly derived seeds from the mature fruits of God's crown germinated on a mixture of garden loamy soil mixed with sand (2:1 v/v). Out of 20 seeds sown, only 7 germinated (35 %) and developed into plants (Figure 4). After 1 yr, the seedlings that were

Figure 1. Tree of God's crown bearing a fruit (red arrow) that is growing in the RC Fruit Conservation Farm in Brgy. Mabacan, Calauan, Laguna, Philippines. The tree was propagated from an open-pollinated seed (A). Fruiting habit of "God's crown" showing a single ripening fruit borne on the terminal end of the branch (B)

Figure 2. The opposite leaf arrangement of God's crown (A) adaxial and abaxial leaf surface of young leaves (B), and adaxial and abaxial leaf surface of mature leaves (C)

transferred in pots using a mixture of garden soil and coir dust (1:1 v/v) grew uniformly. One-year old seedlings of God's crown are 0.60 ± 0.040 cm high with a canopy spread of 0.45 ± 0.10 cm, and stem diameter (Table 3) of 0.81 ± 0.18 cm. It has 5.29 ± 1.70 secondary branches that are yellow orange (RHCC 146B). The narrow ovate green (RHCC 146C) seedling leaves are 122.87 ± 23.75 mm long, 34.21 ±

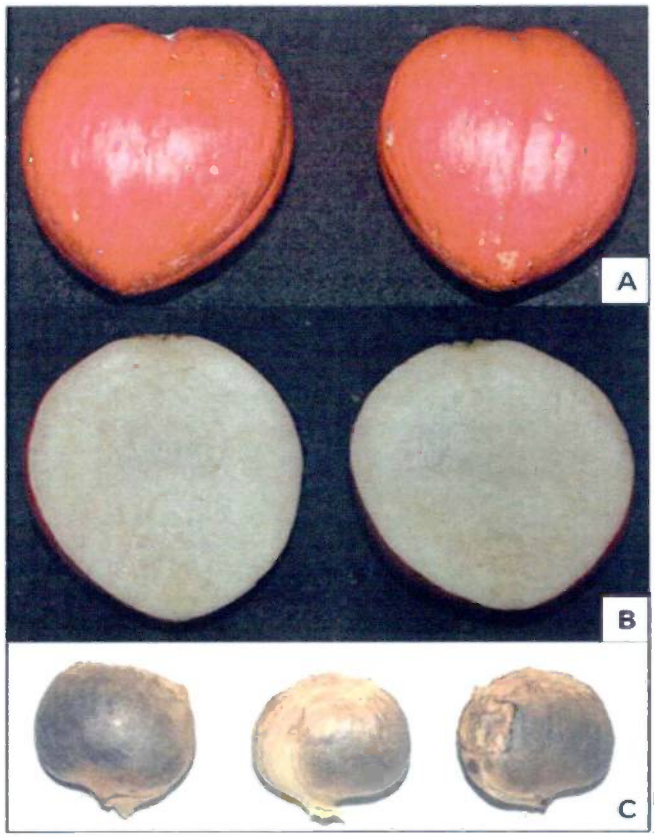

Figure 3. The fruit (A), flesh (B) and seeds (C) of God's crown (*Phalaeria macrocarpa)*

Figure 4. One-year old seedling of God's crown (A) and flower buds (B) emerging from a one-year old seedling.

10.18 mm wide and 0.35mm thick. Each seedling has a total of 62.67 ± 17.06 number of leaves. White fragrant flowers were borne on 1-year old seedlings (Figure 4B).

CONCLUSION AND RECOMMENDATION

Characterization and evaluation of new fruit introduction in the Philippines called God's crown from Indonesia indicated that it is a small to medium-sized tree with a height of 165.5 ± 6.37 cm, and a canopy spread of 156.5 ± 9.19 cm at the time of first fruiting. It can bear fruit throughout the year. A 5-yr old tree produced 58 fruits that were harvested for the first time on February 2014. It is a vigorous, shrubby and evergreen tree, and thornless with a greyish brown trunk (RHCC 199B) measuring 20.25 ± 0.21 mm. The leaves are green, ovate, glabrous with a short (5.08 ± 0.59) petiole. The fruit is ovate with an average weight of 21.16 ± 12.04 g.

A ripe fruit has red peel (RHCC 46C) with white flesh (RHCC N155B). It contains an average of 1.77 ± 0.44 seeds in a fruit. The seeds are reported to be poisonous, however, they are known to contain anti-cancer properties. Freshly extracted seeds germinated 2-3 wk after sowing with 35% germination and, developed into vigorous seedlings. The seedlings are 0.60 ± 0.040 cm tall with a canopy spread of 0.45 ± 0.10 cm and trunk diameter of 0.81 ± 0.18 cm a year after germination.

Since God's crown is a new fruit introduction in the Philippines, its potential for pharmacological use can be explored. In addition, propagation is necessary in order to multiply the plant. It is also recommended that the possible occurrence of pests and diseases and their control measures including its use for climate change adaptation be studied.

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