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Growth and Bioactive Compound of Guava (*Psidium guajava*) on Different Frequencies of Leaf Harvesting

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ABSTRACT

The research objective was to evaluate the growth and bioactive compound of 9 varieties of guava with different frequencies of leaf harvesting. The study was conducted at Bogor Agricultural University, Biopharmaca Research Station, Bogor in August 2006 to March 2007. A Randomized Split Plot Design in Time were laid out with 2 factors and followed by Duncan's Multiple Range Test. The main plot were the 9 guava varieties, which were: White Boyolali, White Wikasari, White Karanganyar, Red Solo, White Imogiri, Red Pejimatan, Red Imogiri, Red Boyolali, and White Solo. The sub-plot were leaf harvesting frequencies: every month, 2 and 3 months. The highest total wet weight leaf harvesting found on White Karanganyar (1491 g plant^{-1}), which was no different with Red Imogiri, White Wikasari, Red Pejimatan, Red Solo, White Imogiri, and Red Boyolali. Harvesting every 2 months produced on the first and second harvest dry weight (375 and 375 g plant^{-1}), which was no different with harvesting every month (344 and 298 g plant^{-1}).Qualitative analysis of bioactive compound of 9 guava varieties showed four groups, which were: White Solo, Red Solo and White Boyolali (group 1); Red Imogiri, White Karanganyar, White Wikasari, and White Imogiri (group 2); Red Boyolali (group 3); and Red Pejimatan (group 4).

Keywords: Guava, leaf bioactive compound, harvest

INTRODUCTION

Guava (*Psidium guajava*) is a tropical plant that also can grow in the subtropics. Rainfall intensity of 1000-2000 mm month^{-1} and 23-28 °C is needed for the its growth (Badan Perencanaan Nasional, 2006). Qian dan Nihorimbere (2004) stated that total phenolic in guava is 575.3±15.5 and 511.6±6.2 mg equal to gallic acid g^{-1} leaf dried weight. Gutiérrez *et al.* (2008) stated that extracts and metabolites of this plant, particularly those from leaves and fruits possess useful pharmacological activities. Guava is mainly known for its antispasmodic and antimicrobial properties (Lutterodt *et al.*, 1999), and has also been used extensively as a hypoglycemic agent. Many pharmacological studies have demonstrated the ability of this plant to exhibit antioxidant, hepato-protection, anti-allergy, antigenotoxic, antiplasmodial, cytotoxic, cardioactive, anticough (Garcia *et al.*, 2003), antidiabetic, antiinflamatory activities, supporting its traditional uses, that suggested a wide range of clinical applications for the treatment of infantile rotaviral enteritis, diarrhea, and diabetes. They further stated that other uses of guava leaves extract are as antimutagenic, and as antiasthma. Cushnie and Lamb (2005) stated that increasingly, this class of natural products is becoming the subject of anti-infective research, and many groups have isolated and identified the structures of flavonoids possessing antifungal, antiviral, and antibacterial activity. Moreover, several groups have demonstrated synergy between active flavonoids as well as between flavonoids and existing chemotherapeutics.

Pruning is widely used in horticulture to control tree shape and balance between vegetative and reproductive growth. In pruning there were reaction to pruning originates from competition between organs, or reassignment of bud fates depending on apical dominance, or from new bud-break occurrences (Cokelaer *et al.*, 2010). Pruning for guava fruit production was grouped into 3 categories, i.e.: (1) to shape the canopy; (2) to maintain the canopy, and (3) for fruit production (Parimin, 2005). Leaf harvest activity in great quantity which also is one of pruning product will decrease the number of leaf per plant. Geiger (1987) stated that assimilate distribution on plant that will be affected by the decreasing leaf that functioning as the source in distributing photosyntate and metabolites. DeJong *et al.* (2009) stated that there is a lack of general understanding and appreciation about the processes involved in governing shoot and tree growth and development.

This research was aimed to study the growth and bioactive compound of nine varieties of guava with different frequencies of leaf harvesting.

MATERIALS AND METHODS

The research was carried out from August 2006 to March 2007 at the Biopharmaca Research Station (250 m above sea level), and at the Laboratory of Soil Department of Bogor Agricultural University, and at the Laboratory of Indonesian Medicinal and Aromatic Crops Research Institute, Bogor, Indonesia.

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Four year-old guava trees from seeds, hand counter, laboratory equipment for flavonoid analysis, and UV spectrometer were used.

The guava plants were planted 250 cm x 250 cm. Pretreatment by pruning the canopy 50 cm above soil surface at 8 month after planting (MAP). Cow manure 5 kg per plant were given for conditioning at 8 and 14 MAP.

Split Plot Design in Time with 3 replications and Duncan's Multiple Range Test (DMRT) with α=5% were used in this experiment. The main plot were the 9 guava varieties, which were: White Boyolali, White Wikasari, White Karanganyar, Red Solo, White Imogiri, Red Pejimatan, Red Imogiri, Red Boyolali, and White Solo. The sub-plot were leaf harvesting frequencies: every month, 2 and 3 months (Table 1).

The first harvest at the beginning of the experiment (0 Weeks of Observation/WO or 8 MAP) was used to uniform the plant height. Two pairs of leaves were being left at the height of 50 cm above the ground.

Variables observed from 2-22 WO were: the plant height, leaf number, stem diameter 5 cm above the ground, branch number, leaf dry weight, branch dry weight, leaf area index, leaf qualitative bioactive content (Materia Medica Indonesia, 1995).

RESULTS

Average rain intensity was 277.2 mm month^{-1}. Guava varieties significantly affected plant height 2 WO, stem diameter 2 and 4 WO. Leaf number fluctuated according to the rain intensity. Time affected leaf number at harvesting every 1, 2, and 3-month (Table 2).

The data showed that the peak of leaf number achieved on 20 and 24 WO, with the highest value on harvesting every 3-months, which were 13.15 and 84.82% higher than harvesting every 2-months and 1-months, respectively. The longer the time for harvesting, the higher the leaf number.

Table **1.** Time of leaf harvesting, at 50 cm of plant height with 2 pairs of leaves being left

Harvesting Treatment	Time of Harvesting (Weeks of Observation/WO)													
	0	2	4	6	8	10	12	14	16	18	19	20	22	24
1st pruning	■													
Every month			■		■		■		■		■		■	
Every 2-months					■				■				■	
Every 3-months							■						■	

Table **2.** The effect of varieties and time of observation on leaf number at different harvesting frequencies

Treatment	Harvesting Frequencies (Every Month)		
	1	2	3
Varieties			
White Solo	211.9	459.1	502.2
Red Boyolali	210.3	472.5	546.1
Red Imogiri	249.0	471.9	700.2
Red Pejimatan	263.2	410.9	617.7
White Imogiri	295.2	410.3	639.9
Red Solo	263.9	486.7	614.8
White Karanganyar	293.9	532.2	**735.3**
White Wikasari	260.0	579.7	685.1
White Boyolali	207.2	338.0	608.3
Time of observation (WO) *)			
6	99.1 l	■	■
8	142.9 h	■	■
10	212.9 f	275.5 h	■
12	252.1 de	315.3 g	■
14	279.9 d	355.6 f	510.1 f
16	317.6 c	397.6 e	563.0 e
18	361.5 b	524.9 d	610.8 d
20	**403.2 a**	563.0 c	653.9 c
22	193.6 g	608.5 b	695.2 b
24	242.2 ef	**658.6 a**	**745.2 a**

Note: Figures followed by different letters in the same row significantly different at 5% DMRT test, *): Transformation $(X + 0.5)^{0.5}$

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Harvesting every 1 and 2-months gave the highest wet and dry branch weight at the first harvest, i.e. 101.57, 92.62, 103.87, and 91.05% higher than the wet and dry weight of harvesting every 3-months (838.9 and 699.1 g). Whereas in the second harvest, i.e. 68.77, 59.78, 103.87, 90.99% higher than the wet and dry weight of harvesting every 3-months (838.0 and 699.3 g) (data not showed).

The highest canopy diameter 18 WO (data not showed) was found on Red Solo and White Wikasari being harvested every month, White Solo and White Wikasari being harvested every 2-months and Red Imogiri, Red Pejimatan, White Imogiri, Red Solo (the highest value, 120.7 cm), White Karanganyar and White Wikasari that being harvested every 3-months.

The highest leaf area index at the end of experiment was found on Red Boyolali being harvested every 2-months, Red Boyolali, Red Imogiri, Red Pejimatan (the highest value 0.20), and White Imogiri that being harvested every 3-months (data not showed).

The branch number fluctuated with time, but at the end of the experiment (24 WO) the branch number showed insignificant difference on different harvesting frequencies. White Karanganyar was not one of the varieties that had the highest branch number (data not showed).

The highest wet and dry weight on the first and second harvest was found on White Karanganyar, i.e. 1041.5, 355.4, 997.0 and 344.4 g per plant which were 64.07, 91.28, 72.07, and 100.23% higher than the lowest wet and dry weight that was found on White Boyolali (Table 3).

Harvesting every one and two-months gave a significantly higher wet and dry leaf weight on first and second harvest, i.e. 1,692, 146, 72, 168, 46, 113, and 168%, respectively higher than wet and dry leaf weight of harvesting every three-months the on first and second harvest, i.e. 559, 140, 559, and 140 g per plant (Table 4). Total dry weight of the first and second harvest at the end of the experiment showed that harvesting every one and two-months were higher 130 and 168% than harvesting every three-months (280 g per plant) (Figure 1).

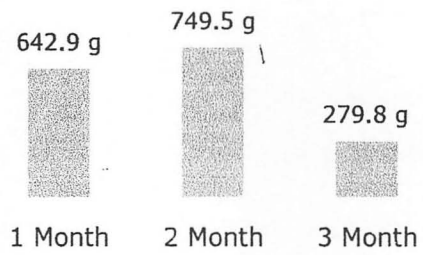

Figure **1.** Leaf harvesting frequencies on total leaf dry weight (g)

Grouping for qualitative analysis of guava leaf were based on differences in triterpenoid and glycoside content, whereas for alkaloid, saponin, tanin, phenolic, and steroid were the same (Table 4).

Table **3.** Interaction of guava variety and leaf harvesting to leaf wet and dry weight on the first and second harvest

Treatment	Variables			
	First Harvest		Second Harvest	
	Leaf Wet Weight	Leaf Dry Weight	Leaf Wet Weight	Leaf Dry Weight
Varieties	.....g plant-1.....			
White Solo	751.7	257.6	707.2	246.6
Red Boyolali	741.1	262.5	685.7	248.6
Red Imogiri	846.8	267.1	780.1	250.5
Red Pejimatan	850.5	283.2	783.8	266.6
White Imogiri	868.7	282.5	799.3	265.2
Red Solo	895.6	329.9	815.1	310.0
White Karanganyar	1041.5	355.4	997.0	344.4
White Wikasari	936.0	352.7	869.3	336.1
White Boyolali	634.8	185.8	579.4	172.0
Harvesting Frequencies	.....g plant-1.....			
1 month	**10021.1 a**	**344.4 a**	**818.8 a**	**298.5 a**
2 month	**960.7 a**	**374.7 a**	**960.8 a**	**374.8 a**
3 month	559.2 b	139.8 b	559.2 b	140.0 b

Note: Figures followed by different letters in the same column and treatment significantly different at 5% DMRT test

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Table 4. Qualitative Analysis of Guava Leaf

Variety	Alkaloids	Saponins	Tannins	Phenolics	Flavonoids	Steroid	Triterpenoids	Glycosides
Group 1								
White Solo	++++	++++	++++	+	++++	++++	+	++++
Red Solo	++++	++++	++++	+	++++	++++	+	++++
White Boyolali	++++	++++	++++	+	++++	++++	+	++++
Group 2								
Red Imogiri	++++	++++	++++	+	++++	++++	+	+++
White Karanganyar	++++	++++	++++	+	++++	++++	+	+++
White Wikasari	++++	++++	++++	+	++++	++++	+	+++
White Imogiri	++++	++++	++++	+	++++	++++	+	+++
Group 3								
Red Boyolali	++++	++++	++++	+	++++	++++	++	+++
Group 4								
Red Pejimatan	++++	++++	++++	+	++++	++++	++	++++

DISCUSSION

Leaf -area increase data was not corresponding with the leaf number, leaf wet and dry weight, and branch wet and dry weight, i.e. White Karanganyar that had leaf area value 0.12 which was significantly lower that the other varieties mentioned earlier, but had a higher leaf number, leaf wet and dry weight, and branch wet and dry weight. This showed the possibility of that White Karanganyar had smaller leaf with a higher weight or thickness per leaf, whereas other varieties had a thinner leaf.

The highest canopy diameter 18 WO on 18 WO, trees that being harvested every month already been harvested for 4 times, whereas on harvesting 2 and 3-months already harvested for 2 and 1 times, respectively. Harvesting every 1 and 2-months gave a stable wet and dry weight that were significantly higher than every 3-months in the first and second harvest (Table 3). This data showed that harvesting more frequently will supported canopy with more branches and had a more compact branch in the canopy that supported more leaves. The same phenomenon also observed on the total dry leaf weight. Other possibility was that old leaves abscissed with longer harvesting interval.

Glycosides is a secondary products formed from one or more sugar molecules added to a non-sugar biologically active molecule, most glycosides function as deterrents to herbivores (The Free Dictionary, 2011).

There is a possibility that the differences in glycoside content in different guava group on Table 4 showed that different needs and utilization of each plant group. Faure (2002) stated that other possibility of glycosides function is as components of the architecture of eukaryotic and prokaryotic cells and may also be involved in signaling between cells or organisms.

CONCLUSION

The highest total wet weight leaf harvesting found on White Karanganyar (1491 g plant^{-1}), which was no different with Red Imogiri, White Wikasari, Red Pejimatan, Red Solo, White Imogiri, and Red Boyolali. Harvesting every 2 months produced on the first and second harvest dry weight (375 and 375 g plant^{-1}), which was no different with harvesting every month (344 and 298 g plant^{-1}). Qualitative analysis of bioactive compound of nine guava varieties showed four groups, which were: White Solo, Red Solo and White Boyolali (group 1); Red Imogiri, White Karanganyar, White Wikasari, and White Imogiri (group 2); Red Boyolali (group 3); and Red Pejimatan (group 4).

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