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Research Article

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Influence of photopheriod to red roselle (*Hibiscus sabdariffa* L.) calyx phytochemical content

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ABSTRACT

Red roselle is an ornamental and medicinal plant. The purpose of this study was to investigate the effect of photoperiod on the phytochemical content of red roselle. Red roselle cultivated on photoperiod variation of 8,9,10, 11 and 12 hours. Photoperiod influenced the phytochemical content of red roselle calix. Phytochemical content observed were water extract, fiber, ash, poliphenol, iron, omega-3, vitamin B1 , vitamin C, fats and protein. Ten hours of photoperiod provided optimum phytochemical content.

Keywords: red rosella calyx, phytochemical content, photoperiod

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INTRODUCTION

Each type of planthas different physiological reaction to the influence of the intensity, quality and duration of sunlight exposure.The differences in how plants respond to radiation are also called photoperiodism, it makes the plants are grouped into day-neutral plants, long day plants and short day plants.

Red roselle (*Hibiscus sabdariffa* Linn.) is a plant that grows on the short radiation length or short day plant [1,2,3],it is cultivated onlyin a certain time, so the production and supply of red roselle is not optimal. Red roselle is an ornamental plant that is consumed as medicine and used as industrial raw materials. Red roselle calyx used as raw materials for healthy drink (tea) and syrup. Due to compounds in calyx, red rosellehas benefit for health. Chemical compounds useful in the red roselle calyx are proteins, carbohydrates, calcium, phosphorus, iron, beta-carotene, thiamine, riboflavin, niacin, ascorbic acid. Red roselle calyx containing anthocyanin thatis efficacious as an antioxidant.

The length of the radiation is known as photoperiod. Photoperiodism affects plant growth in many ways. Photoperiod affects the flowering initiation and development of *Hibiscus* sp.[2,3,4], it also affects the harvest of *Ocirnum basilicum* (Sweet Basil) [5]. Manipulation of lighting and day length on the plant aimed to improve the growth, development and induce plants flowering. The light factor also affects the synthesis and anthocyanin content, chlorophyll and other metabolites in particular flavonoids [6]. The effects of photoperiod on the accumulation of many secondary metabolites have been reported in other species[7,8,9].

The objective of this study was to determine the effect of photoperiod on the phytochemical content of redroselle.

EXPERIMENTAL SECTION

Seeds of red roselle were planted directly to the hole in a pit, each pit has the size of 40 cm wide x 70 cm length x 30 cm height; 25 cm was the spacing between boundaries. The treatment carried out in this research was day length

using environmental manipulation technique. Plant was covered with black cloth. Exposure time were 8 hours of daylight (5.30 am to 13.30 pm without black cloth, and then covering with black cloth 13.30 pm to 5.30 am), 9 hours (5.30 am to 14.30 pm without black cloth, and then covering with black cloth 14.30 pm to 5.30 am), 10 hours (5.30 am to 15.30 pm without black cloth, and then covering with black cloth 15.30 pm to 5.30 am), 11hours (5.30 am to 16.30 pm without black cloth, and then covering with black cloth 16.30 pm to 5.30 am) and 12 hours without cover (control).

Harvesting was done after aborting red roselle or when the time of plantation reached 3-4 months. Harvesting was done by picking red rosella calyx using cutter or scissors. Dried material obtained by drying red roselle calyx at room temperature for 7 days until the constant weight. Red roselle calyx quality parameters measured were water extract, fiber, ash, polyphenol, vitamin C, vitamin B1, fat, protein, iron (Fe), and omega 3.

The design of the experiment was randomized block design. The treatment was repeated 5 times. Data were analyzed by analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Water extract

Photoperiod did not influence the water extract of dried red roselle calyx, but it had significant effect to fresh red roselle calyx. For the fresh red roselle calyx, the highest production of water extract obtained at 11 hours of photoperiod while the lowest production produced at 10 hours of photoperiod (Table 1).

Fiber

Photoperiod influencedthe fiber content of dried and fresh red roselle calyx. The fiber content of dried red roselle calyx obtained at 8 hours of photoperiod had significant difference from the results of9, 10, 11, and 12 hours of photoperiod. The highest fiber content of dried red roselle calyx obtained at 8 hours of photoperiod (18.49%) while the lowest fiber content obtained at 12 hours of photoperiod (17.45%). The fiber content of fresh red roselle calyx at low photoperiod (8,9, and 10 hours) showed significant difference and higher than the 11 and 12 hoursof photoperiod. The highest fiber content of fresh red roselle calyx obtained at 9 hours of photoperiod (1.80%) while the lowest fiber content obtained at 11 and 12 hours (1.64%) (Table 1).

Ash

Photoperiod had no effect on ash content of dried redroselle calyx however it affected the fresh redroselle calyx. The highest ash content of dry red roselle calyx obtained at 8 hours photoperiod (4.05%) while the lowest ash content obtained at 12 hours of photoperiod (3.76%). Photoperiod effectedash content of fresh red roselle calyx. The highest ash content of fresh red roselle calyx obtained at 10 hours of photoperiod (0.42%) while the lowest ash content obtained at 11 hours of photoperiod (0.34%) (Table 1).Generally10 hours of photoperiod provides optimal results in water extract, fiber and ash content of dry and fresh red roselle calyx.

Table 1. Water extract, fiber and ash content of dry and fresh redroselle calyx on different photoperiod

Photoperiod (hours)	*Water extract* (%)		Fiber (%)		Ash (%)	
	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight
8	34,15 a	3,54 ab	18,49 a	1,78 a	4,05 a	0,35 bc
9	35,11 a	3,47 b	17,59 b	1,80 a	3,93 a	0,35 bc
10	33,55 a	3,43 b	17,80 b	1,75 a	4,03 a	0,42 a
11	35,39 a	3,68 a	17,63 b	1,64 b	3,87 a	0,34 c
12	35,19 a	3,44 b	17,45 b	1,64 b	3,76 a	0,40 ab

Red roselle calyx quality parameter measured was chemical composition, relating to the efficiency of photosynthesis. Photosynthesis will form hexose sugars to be converted into fructose to translocate to other cells, forming structural components such as fiber. Hexoses can also be entered into the system and disassembled cell respiration to produce energy or processed into organic components which are used as structural metabolic compounds and food reserves are important, for example fats, proteins, chlorophyll and so on [10].

Poliyphenols

Photoperiod influencedthe content of polyphenols of dried red roselle calyx but it had no effect to fresh red roselle calyx. The highest polyphenols of dried red roselle calyx obtained at 10 hours of photoperiod (16.21%) while the lowest obtained at 8 hours of photoperiod (15.07%) (Table 2). The quality of red roselle is also influenced by the nature of the chemical or substance itself. For example, the content of polyphenols.Polyphenols is affected by phenylalanine and tyrosine as precursorr. Phenylalanine and tyrosine production is affected by light. The longer light exposure providesgreater phenylalanine and tyrosine content [11].

Iron (Fe)

Photoperiod influenced iron content of dried and fresh red roselle calyx. The highest Fe content of dried red roselle calyx produced at 8 hours of photoperiod (8.89 mg/100g) while the lowest produced at 11 hours of photoperiod (7.24 mg/ 100g). 9, 10 and 12 hours of photoperiod provided the same effect on the iron content of dried red roselle calyx. The highest content of Fe in fresh red roselle calyx highest obtained at 12 hours of photoperiod (0.95 mg/100g) while the lowest obtained at 9 hours of photoperiod (0.80 mg/100g) (Table 2).

Iron is an essential nutrient for plants because it is part of certain enzymes and part of protein that serves as an electron carrier in the light phase of photosynthesis and respiration. Ironis beneficial to health because it is a constituent of red blood cells. Iron is a micronutrient that plays a role in producing essential hemoglobin in red blood cells that carries oxygen to function from the lungs to body tissues and myoglobin in muscle cells.

Omega 3

Red roselle calyx contains high omega 3. Photoperiod influenced the omega 3 of dry and fresh redroselle calyx. 9 hours of photoperiod (25.67 mg/100 g) and 10 hours of photoperiod (25.72 mg/100 g) had the same effect while 12 hours of photoperiod produced low omega 3 (22.52 mg/100 g). For freshred roselle calyx, the highest content of omega 3 produced at 10 hours of photoperiod (2.52 mg/100g) and the lowest produced at 9 hours of photoperiod (2.29 mg/100g) (Table 2).

Red roselle is photoautotroph organisms that uses carbon dioxide as a carbon source for forming organic compounds, for example omega 3. This study reinforced that red roselle calyx has an important role for health. Omega 3 is an essential fatty acid needed for growth and development of the body [12]. Omega 3 has an important role in preventing and treating heart disease, hypertension, diabetes, and inflammatory and cancer. Formation of omega 3 polyunsaturated fatty acids involves acetyl-CoA in the Krebs cycle with hexose sugars glucose as a substrate of photosynthesis. This study showed thatthe omega 3 content of red rosellacalyx affected by radiation in the photosynthesis process. The highest content of omega 3 produced at 10 hours of photoperiod for dry and fresh red roselle calyx.

Tabel 2. Polyphenol, micronutrient, and omega-3 on dry and fresh red roselle calyx

Day length (hours)	Polyphenol (%)		Iron (Fe) (mg/100g)		Omega-3 (mg/100g)	
	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight
8	15,07 d	1,54 a	8,89 a	0,83 c	23,72 bc	2,38 ab
9	15,66 bc	1,50 a	7,86 b	0,80 c	25,68 a	2,29 b
10	16,21 a	1,58 a	7,72 b	0,86 bc	25,72 a	2,52 a
11	15,93 b	1,50 a	7,24 c	0,93 ab	25,26 ab	2,39 ab
12	15,52 c	1,56 a	7,98 b	0,95 a	22,52 c	2,44 ab

Vitamin B1

Photoperiod influenced the vitamin B1 content of dry and fresh red roselle calyx. The highest vitamin B1 content of dried red rosella calyx obtained at 10 hours of photoperiod (0.80 mg/100g) and the lowest at 12 hours of photoperiod (0.09 mg/100g). 8 and 9 hours of photoperiod had the same effect as 11 and 12 hours of photoperiod. The highest vitamin B1 content of fresh red roselle calyx produced at 8 hour of photoperiod (0.10 mg/100g) while the lowest produced at 10 hours of photoperiod (0.05 mg/100g) (Table 3).

Vitamin C

Photoperiod affected the vitamin C content of dried red rosella calyx but it had no effect to the fresh red roselle calyx. The highest vitamin C content of dry red roselle calyx obtained at 11 hours of photoperiod (85.12 mg/100g), this result was not significantly different from the result of 10 hours (85.03 mg/100g), the lowest content obtained at 8 hours of photoperiod (80.97 mg/100g) (Table 3).

Vitamin B1 has natural properties that are sensitive to light, longer irradiation causes a decrease in vitamin B1 in red rosella calyx. This is contrast to vitamin C that has natural properties that are not geographically sensitive to light.

Table 3. Vitamin and macromolecule compounds on dry and fresh red roselle

Photoperiod (hours)	Vitamin B1(mg/100g)		Vitamin C (mg/100g)		Fats (%)		Protein (%)	
	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight
8	0,67 b	0,10 a	80,97 c	8,29 a	0,11 c	0,03 a	0,24 b	0,02 c
9	0,69 b	0,06 c	84,03 b	8,34 a	0,11 c	0,03 a	0,24 b	0,04 b
10	0,80 a	0,05 c	85,03 a	8,32 a	0,36 a	0,04 a	0,30 a	0,04 b
11	0,10 c	0,09 ab	85,12 a	8,50 a	0,26 b	0,04 a	0,23 b	0,05 b
12	0,09 c	0,07 bc	83,65 b	8,19 a	0,11 c	0,04 a	0,20 c	0,06 a

Fat
Photoperiod effected the fat content of dried red roselle calyx but it had no effect to fresh red roselle calyx. The highest fat content of dried roselle calyx obtained at 10 hours of photoperiod (0.36%) and the lowest obtained at 8.9, and 12 hours of photoperiod (0.11%) (Table 3).

Protein
Photoperiod effectedthe protein content of dried and fresh red roselle calyx. The highest protein content of dried red roselle calyx obtained at 10 hours of photoperiod (0.30%) and the lowest is produced at 12 hours of photoperiod (0.20%).

Plant growth required lipids, proteins, chlorophyll and nucleic acids [13,14]. Photosynthesis provided the substrate for respiration in the form of hexose sugars. The macromolecules in dried and fresh red roselle calyx are generally produced at 10 hours of photoperiod.

This study showed that the content of polyphenols, vitamins B1, C, fat, protein, and omega 3 were affected by photoperiod. This study showedthat photoperiod associated with plant or leaf opportunity to receive a beam of sunlight to perform photosynthesis. This study showed that redroselle is a short-day plant, if red roselle exposed to excessive light or getting a longer exposure it will lead to the decrease of redroselle calyx chemical content. The results of this study are comparable with the results of the other research[15].Under high radiation condition, red roselle plant suffered from light saturation, this condition will not improve photosynthesis because carbon exchange rate will decrease. The leaves will utilize efficiently light energy at low exposure levels. This study showed that the highest chemical constituents of red roselle calyx obtained at 10 hours with the assumption that photosynthesis occurs efficiently at 10 hours of photoperiod.

CONCLUSION

This study showed that the content of polyphenols, vitamins B1, C, fat, protein, and omega 3 was influenced by the length of exposure. Red roselle is a short-day plant, if it exposed to excessive light or getting a longer exposure, it will lead to decrease of the chemical content of flower calyx. Under high radiation, red roselle suffered from light saturation level, this condition will not improve photosynthesis because carbon exchange rate will decrease. The leaves will utilize efficiently light energy at low exposure levels.

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