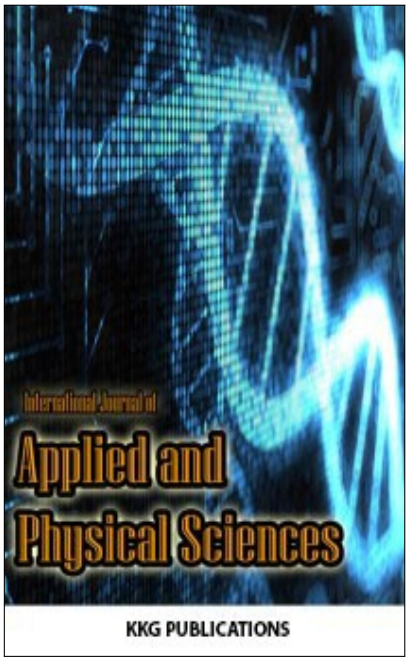

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VARIATION OF CAPSAICIN CONTENT OF LOCAL INDONESIAN MATURE GREEN AND RED CHILLI PEPPER (CAPSICUM FRUTESCENS)

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Abstract. In Indonesia, chili pepper is an important spice, and it is normally eaten fresh to increase appetite. It is consumed when it is still green but already mature, and for cooking spice, it is usually used when it is already red. People usually believe that mature red chili is more pungent than green one. Pungency has been known to be related to the capsaicin content of the chili fruit. In this research, the capsaicin content of 10 local Indonesian cultivars (G1, G2, G4, G5, G7, G8, G9, G10, G11, and G12) of chili pepper was measured. The ten cultivars have variations in fruit morphology and pungency. G1 is a dark green fruiting cultivar that the fruit is mostly eaten fresh; G2, G4, G5, G7 fruits are greenish-white in color when still young and mostly used for spice, G8 is a greenish-white short fruiting cultivar with pungent taste, G9 and G10 are tiny fruiting pungent cultivars, G11 is dark green with big diameter cultivar which has a little bitter and pungent taste and G12 cultivar is a very pungent cultivar which has Capsicum chilense appearance. The highest capsaicin content was showed by G2 and G4, while still green (36.19 mg/g and 36.76 mg/g respectively) or already red (40.45 mg/g and 40.65 mg/g respectively). All the cultivars showed higher capsaicin content when the fruit already became red than the mature green fruit.

INTRODUCTION

Chilli pepper belongs to the family Solanaceae, genus Capsicum [1]. The genus Capsicum has a special character that has a compound named capsaicin [2]. The capsaicin compound contained in chilli peppers produces spicy flavor/pungency. Spicy taste and burning of the capsaicin contained in chilli pepper are caused by the structure of six-carbon ring which is derived from phenylalkylamid alkaloids [3]. Compounds that play a role in determining the hot taste of chilli peppers in addition to capsaicin are dihydrocapsaicin, nordihidrocapsaicin, homocapsaicin 1, homodihidrocapsaicin 1, homocapsaicin II, homodihydrocapsaicin II, and nonivamida. On the other hand, there are also found other chilli varieties that are not pungent containing compounds capsiat, dihidrocapsiat, nordihidrocapsiat, and w-hydroxycapsaicin [4]. Chilli pepper that has a spicy flavor is used as a spice, whereas unpungent chilli is used as a vegetable. In the pharmaceutical field, capsaicin is used as a pain reliever (analgesic arthritis pain) and anti-inflammatory, capsaicin also has anticancer effects and active cause inflammation of the nerves [5]. Utilization of chilli in various fields influenced and affected the production and handling after harvesting chilli peppers. This study aims to determine the levels of capsaicin in chilli, red and green, so that it can be seen that harvesting time is right to produce high capsaicin or not.

LITERATURE REVIEW

Capsaicin is an active compound in chilli peppers; these compounds are hydrophobic, colorless, odorless and crystalline alkaloids when the animals interact with cell receptors [6]. More than 22 types of capsaicinoids are found in chilli, synthesized and accumulated in the epidermal cells of the placenta. Capsaicin and dihydrocapsaicin are found in high concentrations in chilli, while compounds such as capsiat, and homocapsaicin (a minor capsaicin compound) are found in small amounts. Capsaicin levels can be determined by chemical methods, sensory or with a tool (instrumental). Methods that have been developed include organoleptic, spectrophotometry, thin layer chromatography, gas liquid chromatography, and high pressure liquid chromatography [7].

The capsaicin content of chilli is influenced by several factors: the weather, the environment, varieties of chilli, organs of plants and fruit ripening stage when harvested [2]. Based on the plant organ, the highest capsaicin content is found in the placenta compared to its content in the leaves, seeds, flowers and fruit pericarp section [8]. An earlier report showed that capsaicin in vegetative organs such as seeds has a small amount. In fruit, capsaicin accumulates in interlocular septum epidermal of cells (fruit loculus) derived from tissue that connects the placenta to the pericarp [7, 9, 10].

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Based on fruit ripening stage, the content of capsaicin and other components (vitamin C, carotene) is highest during the initial phase of fruit ripening (40-50 days after the formation of fruit) [11]. According to Lang capsaicin in the chilli was first detected 10-15 days after flowering, capsaicin activity increased 20-30 days after flowering and decreased 40 days after flowering [8].

The difference in the content of capsaicin at the stage of fruit ripening is closely related to enzymes involved in the formation of capsaicin, such as capsaicin synthase, cinnamic acid-4- hydroxylase, r-coumaric acid-3-hidroxylase, caffeic acid-o-methytransferase and phenylalanin ammonia-lyase. The enzyme plays a role in the biosynthesis of capsaicin either in the metabolic pathways of fatty acid or phenyl propanoid pathway. Phenylalanin is a precursor on phenylpropanoid pathway to produce capsaicin in the form of phenolic structure, which causes stingy feeling and burning. During the process of fruit ripening, capsaicin will increase to a maximum point and decreases due to the degradation of peroxidase at 5-5-dicapsaicin and 4-o-5-dicapsaicinether. So, the already red chilli until the pericarp has wrinkles has a low level of spiciness [6].

METHODOLOGY

The material used in this study is cayenne pepper collected from several regions in Indonesia which are Malang (G1, G2, G4, G5, G7 and G11), Lombok (G8), NTT (G9 and G10), and Toraja (G12) (figure 2). Chilli is planted in polybags with mixed media chaff: soil: compost: manure = 1: 2: 1: 1, the treatment is done by watering, fertilizing and spraying of crop pests. Analysis of capsaicin was done by spectrophotometry with a wavelength of 280 nm [12]. The result of absorbance measurements of capsaicin from cayenne pepper sample concentration is calculated based on the equation of the standard curve. Making the standard curve is done by measuring the absorbance of a standard solution with a concentration of capsaicin 0.25; 0.5; 1.0; and 2.5 ppm. Chilli as much as 1 gram was mashed and added to 8 ml of 96% ethanol, and homogenized. Homogenates were filtered with Whatman paper, the filtrate was used for the measurement of capsaicin with a spectrophotometer. Capsaicin content measurement is calculated by the formula:

$capsaicin = \frac{c \times f}{w \times v}$

where:

C: capsaicin content

F: dilution factor

W: sample weight

V: volume of solvent

The capsaicin content is determined based on a standard solution of capsaicin (Sigma-Aldrich, Schnelldorf, Germany) [12]. The concentration of capsaicin sample is calculated using a linear curve equation Y = 0.0034 X + 0.0036, obtained from the standard solution (fig. 1).

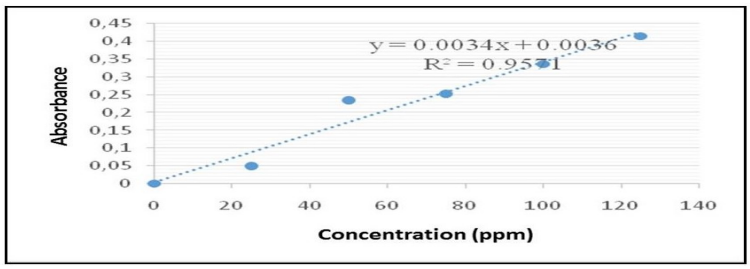

Fig. 1 . Capsaicin standard curve

RESULTS

Capsaicin content of mature red chilli was higher than mature green chili in all genotypes (table 1). Chilli pepper genotype 4 (G4) has the highest capsaicin content when the fruit is ripe (95.09 mg / 100 g), whereas the highest capsaicin content of the mature green chilli fruit was shown by G10 (14.59 mg / 100 g). The mature red fruit of G5 has the lowest content of capsaicin (24.91 mg / 100 g), while green chilli with low levels of capsaicin was shown by G8 (8.65 mg / 100 g). Among mature red chilli pepper originated from local Malang (G1, G2, G4, G5, G7, G11), G4 showed the highest capsaicin content (95.09 mg / 100 g) and the lowest capsaicin content was shown by G7 (33.22 mg / 100 g). However, when the chilli fruit was still green, the highest capsaicin content was shown by G1 (11.43 mg / 100 g), and the lowest was shown by G7 (8.69 mg / 100 g). The local chilli originated from NTT G10 has the highest levels of capsaicin either when already mature red or mature green fruit (61.70 mg / 100 g and 14.59 mg / 100 g, respectively) compared to G9 which has also originated from NTT. An extremely different capsaicin content between mature red and green fruit was shown by local chilli originated from Lombok (G8). When it is already red the capsaicin content is 62.87 mg / 100 g, however,

when it is still green the capsaicin content is 8.65 mg / 100 g. Local chilli originated from Toraja (G12) contains capsaicin of 70.11 mg / 100 g when ripe red and 13.69 mg / 100 g when still green. Differences in the levels of capsaicin in all genotypes, either from the same or different location, are due to genetic variation in chilli [2].

TABLE 1
CAPSAICIN CONTENT IN ALL GENOTYPES BASED ON MATURE RED AND GREEN STAGES

Genotype	Red	Green
G1	75.40 ± 8.89	11.43 ± 1.08
G2	93.12 ± 12.17	10.34 ± 1.34
G4	95.09 ± 11.13	9.30 ± 0.14
G5	24.91 ± 3.04	8.91 ± 0.63
G7	33.22 ± 6.27	8.69 ± 0.17
G8	62.87 ± 1.82	8.65 ± 0.19
G9	36.64 ± 2.37	13.45 ± 0.86
G10	61.70 ± 11.19	14.59 ± 0.24
G11	42.93 ± 8.16	9.21 ± 0.20
G12	70.11 ± 8.00	13.69 ± 0.18

Chilli pepper G1 has an elongated fruit shape; 3.06 ± 0.3 cm length; 0.92 ± 0.07 cm diameter. It has dark green unripe fruit with brown spots; red ripe fruit; taper end fruit (pointed); smooth fruit surface; rather notched (slightly corrugated); two loculus number; Long placenta 1/2 length of fruit (fig. 2a). G2 has elongated shape, greenish yellow young fruit color, and red ripe fruit. The fruit is 3.53 ± 0.30 cm length, 1.08 ± 0.07 cm diameter, has pointed end, rather wrinkled fruit surface (semi-wrinkled), the cross-sectional rather notched (slightly corrugated), has two loculus, and a long placenta, more than 1/2 length of fruit (fig. 2b). G4 has elongated shape, greenish yellow color young fruit, and red ripe fruit. The fruit is 4.09 ± 0.25 cm length, and 0.94 ± 0.07 cm diameter, has obtuse fruit base, pointed tip, semi-wrinkled surface, when sliced crosswise there are grooves on intermediate fruit, two loculus number, and placenta length more than 1/2 of the length of the fruit (fig. 2c). G5 has triangular-shaped, yellow-green color of young fruit, red ripe fruit, 3.95 ± 0.33 cm length, and 1.54 ± 0.13 cm diameter. The shape of the fruit base is cordate, blunt end, the fruit surface is wrinkled, two loculus, and placenta length more than 1/2 length of fruit (fig. 2d). G7 has an elongated shape, greenish yellow color of young fruit, red ripe fruit, 3.92 ± 1.68 cm length, and 0.73 ± 0.19 cm diameter. It has an obtuse fruit base, pointed fruit tip, semi-wrinkled fruit surface, two loculus, and placenta length of more than 1/2 of the length of the fruit (fig. 2e). G8 has a triangular shape, greenish yellow color young fruit, red ripe fruit, 1.5-2.5 cm length and 1.7 to 2 cm diameter, obtuse fruit base, blunt end fruit, semi-wrinkled fruit surface, slightly corrugated crosswise fruit grooves, two loculus, and placenta length more than 1/2 of the length of the fruit (fig. 2f).

Genotype 9 has triangular-shaped, dark green color of young fruit, brownish red ripening fruit, 1.39 ± 0.17 cm length, 2.29 ± 0. 45 cm diameter, pointed end, smooth fruit surface, two loculus and placenta 1/2 of the length of the fruit (fig. 2g). G10 has an elongated shape, greenish yellow color young fruit, red ripe fruit, 2.52 ± 0.57 cm length and 0.57 ± 0.043 cm diameter, obtuse fruit base, pointed fruit tip, smooth fruit surface, two loculus, and placenta length more than 1/2 of the length of the fruit (fig. 2h).

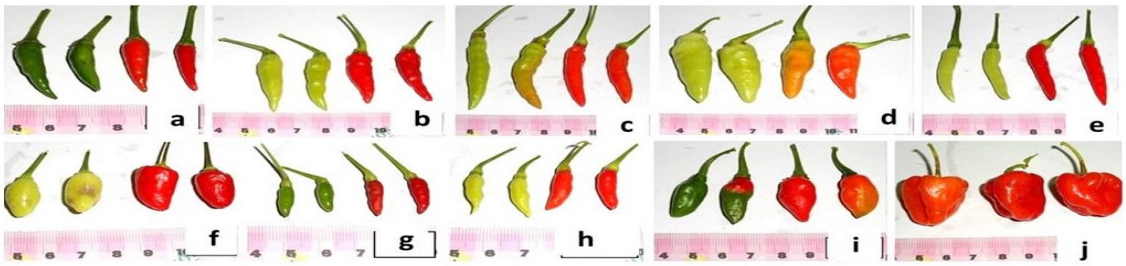

Fig. 2 . Chilli samples used in this reasearch. (a) G1, (b) G2, (c) G4, (d) G5, (e) G7, (f) G8, (g) G9, (h) G10, (i) G11, (j) G12

Genotype 11 has blocky shaped fruit, green unripe fruit, bright red ripe fruit, 3.58 $\pm$ 0.17 cm length, 1.53 $\pm$ 0.17 cm diameter, cordate fruit base, pointed fruit tip, wrinkled fruit surface, two or three loculus number and long placenta 1/4-1/2 of fruit length (fig. 2i). G12 had a blocky shaped fruit, unripe fruit with shades of light green or purple line, 3.84 $\pm$ 0.16 cm length, 3.5 $\pm$ 1.2 cm diameter, lobate fruit base, sunken end of the fruit, smooth fruit surface, two or three loculus and short placenta less than 1/2 of the length of the fruit (fig. 2j).

DISCUSSION AND CONCLUSION

The results generally show that ripe fruits have high levels of capsaicin which is higher than the young fruit (green). It also occurs in Capsicum sp. Hungary, the green chilli contains capsaicin lower base than chilli cook i.e. 27.8 mg / 100 g and 37.6 mg / 100 g [11]. The data are comparable with the data of this study, the levels of capsaicin in chilli youth in different genotypes (G1, G2, G4, G5, G7, G8, G9, G10, G11, and G12) are lower than the capsaicin in chilli cook. Gnayfeed observed that the capsaicinoids on C. annuum cultivar maximally increase when the color changes from green to orange (color break stage) and then decrease [13]. Iwai found that the activity of phenylalanin ammonia-lyase (PAL) was higher in the green fruit stage than red fruit [14]. The increase of PAL accelerates the degradation of phenylalanin and cinnamic acid, which have an effect on the increase of capsaicin. Different phenomenon happened on C. frutecens variety Lolo which has a high content of capsaicin when the fruit is still green, while C. frutecens variety Bandai and variety Beibehong showed the highest capasaicin content during the color break (green changes to orange or red [15]. According to Contreras-Padilla and Yahia, peroxidase activity influences the content of capsaicin in the chilli; the higher the peroxidase activity, the lower the content of capsaicin [16]. Di found that the concentration of capsaicin began to decline 50 days after flowering (DAF) [17], it is because of the oxidation of capsaicin and dyhidrocapsaicin by peroxidase enzyme. The enzyme peroxidase is generally located in the placenta and the outermost layer of epidermal cells on the fruit.

Based on these results, it can be concluded that based on the stage of fruit ripening, capsaicin has a high concentration when the fruit is red than green fruit.

Acknowledgment

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