**Report of *Physalis angulata* L. from Madura: Quality Profile**

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**Abstract.** *Physalis* is one of the annual indigenous herbaceous which has many benefits as traditional medicine. This study aimed to determine the content of citric acid, flavonoids, sugar content, chlorophyll and fiber of 2 genotypes *Physalis* from Madura. The study was designed using nonfactorial completely randomized design with *Physalis* genotype as treatment, i.e., CM 1 (genotype of Madura *Physalis* 1) and CM 2 (genotype of Madura *Physalis* 2). The results showed that genotype *Physalis* Madura 1 contains higher citric acid, flavonoids, and sugar content. Whereas, the content of chlorophyll and fiber was lower. Citric acid contents were ranged from 0.06 to 0.36%, sugar levels 9.6-14.6 °Brix, flavonoid level 37.6-118.6 mg 100 g\(^{-1}\) and fiber content range from 0.58 to 1.41%. Genotype CM1 is recommended genotype as a source of chemical content for medicinal used especially in Madura Region with a dry condition.

**Keywords:** *Physalis angulata*, Madura, quality, profile, medicine

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**1. Introduction**

*Physalis angulata* L. (Solanaceae) is a widely distributed indigenous herb in the tropical [1, 2]. Formerly this plant was known as weeds, but it was cultivated recently because of traditional medicine properties [3]. Wide range use for medicine such as diabetes, hepatitis, asthma and malaria, treatment of cancer, and its extracts showed antipyretic, analgesic/antinociceptive, antidiuretic, anti-inflammatory, antirheumatic, and cervicitis [4]. The genus Physalis contains several species grown for their ornamental and edible fruits [4].

As edible fruit with medicinal properties, it was often found in the modern market. Physalis also processed into jam, jelly, juices, and liqueur [5, 6]. The character considered of this fruit were taste, color, and nutraceuticals content ensure the quality reliability of Physalis fruit for medicinal and its processing product. *Physalis* fruit also has a specific sour and sweet taste and give high flavor on food processing product [6]. Citric acid and sugar content of fruit attributing the flavor of the fruit. Nutraceuticals have a responsibility to the medicinal property of plant [7]. The previous report about nutraceuticals of Physalis in Indonesia was a phenolic compound with large therapeutically effect [8]. It has not covered Physalis of Madura Region and its flavonoid content yet. Flavonoid is the most important Phenolic substance which has antioxidant activity dan immunomodulatory effect in human and also acts as a growth regulator, the defensive mechanism at environment stress like pest and pathogen attack [9]. Dietary Fiber of fruit play an important role in the digestive function and improve blood control of glucose and cholesterol level [10]. Nutraceutical production in the plant depends on genetic and environmental factor [9].
Physalis angulata L. is native in Madura, well known as Nyor-nyoran. This plant is used as traditional medicine to heal diabetes and as immunomodulatory. It often grows wild on the side of the road and edge of the rice field. Madura region commonly has a dry climate, but it has specific soil physical properties and good nutrition, so it produces a high-quality medicinal plant like temulawak and long pepper [11, 13]. Madura has a local clone of Curcuma xanthorriza Rox, which has high curcumin. Madura also provides good nutrition for the growth of new varieties of Curcuma could produce better curcumin content and rhizome weight than planting in other regions [11, 12]. Long pepper from Madura also has higher piperin and essential oil than other places in Indonesia [13].

The study objective was to determine quality characteristic including citric acid, sugar, flavonoid, chlorophyll, and fiber of 2 Physalis genotype from Madura. The report of the chemical content of Physalis is important to give a recommendation about raw material quality for traditional medicine industry.

2. Methods
The study was designed using nonfactorial completely randomized design with Physalis genotype as treatment, i.e., CM 1 (genotype of Madura Physalis 1) and CM 2 (genotype of Madura Physalis). Each treatment was repeated 12 times.

2.1. Plant Material
The genotypes were characterized with the colour of fruit peel and calyx which enclose the fruit. CM 1 have purple spots on the fruit peel and calyx while CM 2 do not have it. The plant propagated generatively using seed grown in polybag at the experimental garden of the Agrotechnology Departement University of Trunojoyo Madura at 5 m above sea level.

![Figure 1. Plant Material, (a) CM 1 (genotype of Madura Physalis 1) and CM 2 (genotype of Madura Physalis 2)](image)

2.2 Chemical content analysis

2.2.1 Sugar. Sugar content was measured by penetrometer. Each observation was repeated 3 times.

2.2.2 Citric Acid. The citric acid test was conducted by acid–base titrations. The sample was prepared by weighing 5 g of filtrated fruit puree in Erlenmeyer and add 3 drops of phenolphthalein indicator. Sample with indicators then titrated with 0.5 M NaOH until a constant pink color change. The result expressed as % citric acid in fruit flesh.

2.2.3 Flavonoid. Flavonoid analysis according to the modified method of Meda [14]. The sample was prepared by macerated 10 g fruit puree with 20 mL ethanol 96%. The filtrate from maceration as much as 5 mL was mixed with 5 mL AlCl₃. Absorption reading was taken 10 minutes with a mixed solution of methanol and sample without AlCl₃ on triplo. The total flavonoid yield obtained by a standard curve of quercetin standard and expressed it as milligram of quercetin equivalents per 100 g extract.
2.2.4 Crude fiber. Crude fiber was analyzed by SNI 01-2891-1992. The sample was prepared by weighing 4 g fruit puree, then taking it in organic solvents 3 times to eliminate the fat. Dry sample was boiled with 50 mL of 1.25% H$_2$SO$_4$ solution and then add 50 mL of 3.25% NaOH and boil again for 30 minutes. The result of boiling was filtrated through a Buchner funnel containing Whatman 41 non-gray filter paper which has been dried, and the weight is known. The residue of filtration was washed on filter paper with 1.25% H$_2$SO$_4$, hot water, and 96% ethanol. The filter paper and its residue were put into a weighing box that is known its weight was dried at a temperature of 105 °C and cooled it until constant weight.

2.2.5 Chlorophyll. Chlorophyll analysis according to methods [15]. Sample preparation was conducted by extracted chlorophyll from leaves by acetone 85%. The filtrate of it was taken. Absorption reading of filtrate was held by spectrophotometer at 644 and 663 nm wavelength.

3. Results and Discussion

Figure 2 showed the sugar content was higher in the purple genotype (CM1) than green genotype (CM2), around 16.4 and 10.7 °Brix respectively. CM 2 suitable for diabetics. The °Brix of CM 1 higher than °Brix of P. Peruviana and P. pubescent [16, 17, 18]. Total sugar in purple genotype (CM1) was rapidly increased from 2 to 3 week after planting. The highest sugar accumulation in CM1 may be required for anthocyanin biosynthesis in purple Physalis [19]. This study demonstrated that increasing sugar content occurred in the purple genotype, whereas in green genotype was slight. Cape gooseberry (Physalis peruvian L.) grow at infertility soil, easily cultivated, low water needs, and fertilizer has made it a potential crop for marginal land [20]. Sugar content in fruits Physalis reported was significantly related to the altitude and the ecotype [20].

![Figure 2. The sugar content of Physalis fruit](image)

The research showed citric acid contents was raged from 0.06 to 0.36%. This result was lower than citric acid content in mangosteen fruit range from 1.3 to 3.3 mg·g$^{-1}$DW [16]. Chemical change during ripening cause composition change components, e.g. sugars, non-volatile organic acids, and amino acids. It affects the taste and flavor of ripe fruit. [21]. The ratio of organic acids with sugars specified the sensory, flavor, and final fruit quality. Quantification of citric acid in fruit juices has been carried out to evaluate the quality in many fruits respectively [22]. Citric acids are commonly found in fruits and berries; citric acid is a major organic acid complexion with oxidant metals [21]. CM 1 has better taste than CM 2 with higher °Brix and low acidity, so it can be further developed into a variety of processed products and fresh consumed food.
Figure 3. The citric acid content of *Physalis* fruit

The results showed that flavonoid content was increasing with time. As shown in Figure 3, the data shows clearly that the flavonoid content in CM1 was higher than CM2. This result was in contrast to *P. angulata* fruit from Mexico which does not contain flavonoid [9]. The flavonoids as the major role in red, blue, and purple pigments in the plant [23]. This may suggest that flavonoids content was higher in the purple genotype (CM1) than the green one (CM2). The riches flavonoids content in grape berries were associated with fruit development during water deficits, similar to the Madura region was a dry condition [18]. Flavonoid biosynthesis in plants was affected by light intensity, temperature, altitude, soil type, water, nutritional status, and various developmental processes [24]. Flavonoids are secondary metabolite often produced in direct response to environmental stress conditions [25]. Contrary to flavonoids, chlorophyll content was higher in green genotype compared to the purple one. However, green color in the plant is rich chlorophyll, decreasing photosynthesis rate in CM1 in order to produce higher flavonoid content [26]. The number of anthocyanins increased, and the fruit color became darker [27].

Figure 4. Flavonoid content of *Physalis* fruit

Regardless of genotype, fiber content was increased until 3 weeks after planting then gradually decrease with aged (Figure 4). Fiber content was range from 0.58 to 1.41%. This research showed fiber content was higher in the green genotype than the purple one. This may suggest that related to chlorophyll content was important to photosynthetic activity and produced carbohydrates. Possible reasons for the increase in fiber content was probably due to an increase in the content of insoluble dietary fiber fractions such as cellulose and lignin, during the maturation of the leaves [28]. That dietary fiber (DF) may reduce the risk of premature death from all causes, especially from cardiovascular diseases and infectious and respiratory diseases [29]. DF has accepted as an essential constituent of a healthy diet and recommended a daily intake of 25-35 g, or 3 g/1000 kJ [30].
Figure 5. The fiber content of Physalis fruit.

Similar to fiber, chlorophyll content was high produced in green genotype than purple one about 10.75 and 7.61 mg.L⁻¹, respectively (Figure 5), generally coincided with previously reported [31]. Chlorophyll is the photosynthetic organelle in the green plants. Previously reported that the chlorophyll index in mangosteen was highest in a branch with fruit production [32]. Total chlorophyll content per leaf area unit may be a good indicator of the strength of photosynthetic tissue; high chlorophyll content is a desirable characteristic because it indicates a low degree of photoinhibition of the photosynthetic apparatus [33]. Chlorophyll loss is associated with environmental stress and a high correlation between the chlorophyll content and photosynthesis rate [34]. Chlorophyll measurement provides a direct insight into the sum of nitrogen kinetics [35]. The results suggest that the quality of Physalis fruit could be due to greater allocation of photosynthate into fruits [36].

Figure 6. Chlorophyll content

4. Conclusion
Genotype CM 1 contains higher citric acid, flavonoids and sugar content but has a lower chlorophyll and fiber than genotype CM 2. The range of citric acid content between 0.06-0.36%, sugar content 9.6-14.6%, Brix level 37.60-118, flavonoid 60 mg.100g⁻¹ and fiber content 0.58-1.41%. Genotype CM1 is recommended genotype as a source of chemical content for medicinal used especially in Madura Region with a dry condition.

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