Comparative evaluation of proximate composition and vitamin C of *Physalis angulata* Linn and *Physalis peruviana* Linn in West Java, Indonesia

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Abstract. This study aimed to evaluate the proximate and vitamin C of Physalis. Two species of Physalis, namely, *P. angulata* L. and *P. peruviana* L., used as models for a comparative study. Proximate composition, fiber, and vitamin C of all part of Physalis, i.e., leaf, stem, bud, and fruit of Physalis were analyzed. *Physalis angulata* collected from Pagaden subdistrict (latitude: 6030'24" S, longitude: 107048'74"E, elevation: 55 MAMSL) Subang District, West Java Province, and *Physalis peruviana* collected from Pamulihan subdistrict (latitude: 6052'27.06"S, longitude: 107049'24.95"E, elevation: 947 MAMSL), Sumedang district, West Java Province. The results of the study showed that the existence of proximate composition and vitamin C in plant shoot of *P. angulata* and *P. peruviana* relatively evenly spread. The proximate composition and vitamin C of *Physalis angulata* had the same pattern as compared to that of *Physalis peruviana*. The results of paired sample test showed that there were no significant differences in proximate composition and vitamin C between *Physalis angulata* and *Physalis peruviana*.

1. Introduction

*Physalis* is one of the family Solanaceae genera. *Physalis* genus consists of 75 species, most of which found in America with only a few species in Europe and Asia [1]. The *Physalis angulata* L., is native to Brazil, specifically the North and Northeast regions [2]. The *Physalis peruviana* is native to the Andes, widely cultivated in Peru [3]. Because of the various compounds of nutrition, *Physalis angulata* had more potential rather than that of *Physalis peruviana* [4, 6].

In Indonesia terminology, there is no different name between *Physalis angulata* and *peruviana*, both of them called as “Ciplukan” or “Cecendet”. *Physalis* itself contained some dubious species, but in general, morphologically the significant differences between *Physalis angulata* and *peruviana* were as follows. *Physalis angulata* is an annual herb up to 100 cm tall, while *Physalis peruviana* is perennial herb, 0.5-2 m tall. The leaves of *Physalis angulata* are arranged spirally, ovate to lanceolate, 4–15 cm x 2.5–10 cm, while those of *peruviana* are sub-opposite, ovate, 5-15 cm × 4-10 cm. The flowers of *Physalis angulata* are axillary, while those of *peruviana* are solitary. The fruits of *Physalis angulata* had a globose berry 10–16 mm in diameter, while those of *peruviana* had a globose berry, 1-2 cm in diameter [7].

There were many researchers worked on *Physalis angulata* and *Physalis peruviana*. Some of the researchers working in the field of phytochemical and pharmacology, among others were [8] researched on phsalin of *Physalis angulata* and lancifolia, antineoplastic activity [9], antibacterial activity [10], physicochemical properties [11,12], chemotaxonomic [13], chemical compounds and bioactivities [14], antioxidant and anti-cancer [15,16], nutritional value and functional properties [17-
The comparison of proximate composition of *Physalis angulata* and *Physalis peruviana* are still rare. Therefore, this study aimed to evaluate the comparison of proximate composition and vitamin C content of *Physalis angulata* and *Physalis peruviana* grown in West Java Province, Indonesia. This study also to profile overall their nutritional information for consumption, and other product diversification development purposes.

2. Materials and methods

2.1 Materials
*Physalis angulata* Lour (PA) samples were collected from Pagaden subdistrict (latitude: 6030′24” S, longitude: 107048′74”E, elevation: 55 MAMSL) Subang district, West Java-Indonesia and *Physalis peruviana* (PP) samples collected from Pamulihan subdistrict (latitude: 6052′27.06”S, longitude: 107049′24.95”E, elevation: 947 MAMSL), Sumedang district, West Java-Indonesia (Fig. 1). Botanical authentication was performed by a Botanist from “Herbarium Bogoriense”, Research Center for Biology, Indonesian Institute of Sciences (No. 886/IPH.1.01/If.07/IV/2018), where the voucher specimen has been deposited.

![Figure 1. Physalis angulata (A) and Physalis peruviana (B)](image)

2.2 Sample preparation
Fresh leaves, stems, bud and fruit of both Physalis, namely, *Physalis angulata* and *Physalis peruviana*, washed, then examined for moisture content, ash, fiber, fat, protein, carbohydrate and vitamin C content using the methods described by [23].

2.3 Statistical analysis
Data were tested for normality and presented in mean ± standard deviation (STD). Proximate composition of both plant shoot of *P. angulata* and *P. peruviana* were analyzed using analysis of variance (ANOVA). Duncan Multiple Comparison Test determined the significant differences among the means of different parameters. The comparison of both Physalis analyzed using a 2-Independent Sample (Mann-Whitney U Test).

3. Results and discussions

3.1 Proximate composition
The proximate analysis, namely, moisture, ash, protein, lipid, carbohydrates, and crude fiber of *Physalis angulata* and *Physalis peruviana*, were compared. The comparison of the moisture content of both Physalis described in table 1.
Table 1. The moisture content of plant part of *P. angulata* and *P. Peruviana*

| Plant part | Moisture (%) | *P. angulata* | *P. peruviana* |
|------------|--------------|---------------|---------------|
| Stem       | 71.69±0.01\textsuperscript{aD} | 71.35±0.05\textsuperscript{aD} |
| Leaf       | 75.72±0.02\textsuperscript{aB} | 76.25±0.25\textsuperscript{aB} |
| Bud        | 72.23±0.02\textsuperscript{aC} | 72.39±0.03\textsuperscript{aC} |
| Fruit      | 76.71±0.04\textsuperscript{aA} | 76.50±0.04\textsuperscript{aA} |

Data were presented mean±standard deviation (SD) (n=3). Values followed by different letters in rows and columns show significant differences (P<0.05). Uppercase (vertical) and lowercase (horizontal).

The moisture content of *Physalis angulata* was range from 71.69 to 76.71 (Table 1). The fruit of *Physalis angulata* had the highest moisture content, followed by the others. These results were an agreement with *Physalis peruviana*, which fruit part of *Physalis peruviana* had the highest moisture content (76.50%). Ramadan and Morsel [24] reported that the moisture content of *Physalis peruviana* fruit is 78.90%. The comparison of moisture content between *P. angulata* and *P. peruviana* using the Mann-Whitney test. The analysis showed that there is no significant difference for both Physalis at the moisture content (p >0.05). These results might be caused by type and temperature of drying of both Physalis were the same, using tray drier, at 45°C, for 6 hours. According to [25], food processing methods affected the physicochemical properties.

The comparison of the ash content of both Physalis are described in table 2. The ash content of stem, leaf, bud, and fruit of *Physalis peruviana* ranged from 2.10% to 5.33%. Meanwhile, the ash content of *Physalis angulata* ranged from 2.06% to 5.71% (table 2). According to [24], the ash content of *Physalis peruviana* fruit is 1%.

| Plant part | Ash (%) db | *P. angulata* | *P. peruviana* |
|------------|------------|---------------|---------------|
| Stem       | 5.71±0.03\textsuperscript{aA} | 5.33±0.03\textsuperscript{aA} |
| Leaf       | 2.71±0.62\textsuperscript{aA} | 2.42±0.02\textsuperscript{aA} |
| Bud        | 3.01±0.01\textsuperscript{bB} | 4.15±0.15\textsuperscript{aB} |
| Fruit      | 2.06±0.04\textsuperscript{aD} | 2.10±0.10\textsuperscript{aD} |

Data were presented mean±standard deviation (SD) (n=3). Values followed by different letters in rows and columns show significant differences (p<0.05). Uppercase (vertical) and lowercase (horizontal).

The analysis of variance (ANOVA) showed that part of the plant of *Physalis angulata* and *Physalis peruviana* influenced the ash content (p<0.05). The stem part of both Physalis had the highest ash content (5.71% and 5.33%, respectively), followed by the other part of the plant (Table 2). The Mann-Whitney test showed that there is no significant difference in the ash content between *P. angulata* and *P. peruviana* (p>0.05), except for the ash content in the bud part of the plant (p<0.05). According to [26], the plant material with high ash content indicated an abundant amount of inorganic nutrients. The geographic, time of harvest and climate affected the chemical composition of the plant [27][28]. These statements were an agreement with [29] that reported the geographic origin could change the physiochemical, mineral, and antioxidant properties of *Labisia pumila* var. *alata* plant.

The fiber content of stem, leaf, bud, and fruit of *Physalis angulata* and *Physalis peruviana* are shown in table 3. The crude fiber of *P. angulata* ranged from 4.41% (fruit) to 18.01% (stem). Meanwhile, the crude fiber of *P. peruviana* ranged from 4.48% (fruit) to 18.93% (stem). Ramadan and Morsel [24], reported that the crude fiber of *Physalis peruviana* fruit is 4.9% [24]. Ramadan and Morsel were higher than reported the results of this study on the crude fiber content. It might be the difference in the geographic, time of harvest, and climate of the plant growth [27-29].
Table 3. The fiber content of plant part of P. angulata and P. peruviana

| Plant part | P. angulata     | P. peruviana    |
|------------|-----------------|-----------------|
| Stem       | 18.01±0.05  
|            | aA             | 18.93±0.04  
|            | abc            | aA             |
| Leaf       | 15.61±0.61  
|            | abc            | 15.99±0.01  
|            | abc            | abc           |
| Bud        | 13.39±0.01  
|            | bc             | 15.92±0.01  
|            | abc            | abc           |
| Fruit      | 4.41±0.04  
|            | aD             | 4.48±0.02  
|            | abc            | abc           |

Data were presented mean±standard deviation (SD) (n=3). A>B>C>D; Values followed by different letters in rows and columns show significant differences (p<0.05). Uppercase (vertical) and lowercase (horizontal).

Table 3 showed that the part of the plant was a significant difference in the crude fiber content of P. angulata and P. peruviana (p<0.05). The stem of both Physalis had the highest crude fiber content (18.01% and 18.93%, respectively), followed by leaf > bud > fruit. Mann-Whitney test showed that there is no significant difference in the crude fiber content between P. angulata and P. peruviana (p>0.05), except for the crude fiber content in bud part of the plant (p<0.05).

The lipids content of plant parts of P. angulata and P. peruviana described in table 4. The lipids content of P. angulata ranged from 0.12% (stem) to 4.70% (fruit). Meanwhile, the lipids content of P. peruviana ranged from 0.24% (stem) to 4.68% (fruit). These results were an agreement with [24], in which the lipid content of fruit P. peruviana is 0.1 – 0.2%. According to [27,28], the difference in the geographic, time of harvest, and climate of the plant growth influenced the lipid content, especially on the fruit part of both Physalis.

Table 4. The lipids content of plant part of P. angulata and P. peruviana

| Plant part | P. angulata     | P. peruviana    |
|------------|-----------------|-----------------|
| Stem       | 0.12±0.02  
|            | aB             | 0.24±0.03  
|            | abc            | ab            |
| Leaf       | 0.43±0.02  
|            | ab             | 0.47±0.01  
|            | abc            | abc           |
| Bud        | 4.70±0.10  
|            | aA             | 0.93±0.04  
|            | abc            | bB            |
| Fruit      | 4.70±0.05  
|            | aA             | 4.68±0.05  
|            | abc            | abc           |

Data were presented mean±standard deviation (SD) (n=3). A>B>C>D; Values followed by different letters in rows and columns show significant differences (P<0.05). Uppercase (vertical) and lowercase (horizontal).

Table 4 showed that the fruit part of P. angulata or P. peruviana had the highest lipid content (4.70% and 4.68%, respectively), followed by bud, leaf, and stem of Physalis (p<0.05). The comparison of both Physalis, namely, P. angulata and P. peruviana, showed that there is no significant difference in the lipids content between P. angulata and P. peruviana (p>0.05), except for the lipids content in bud part of the plant (p<0.05). According to [30], the different vitamins, minerals, carbohydrates, and lipids possessed by the species Physalis.

The protein content of stem, leaf, bud, and fruit of Physalis angulata were 2.23 %, 2.66 %, 2.91%, and 4.04 %, respectively. Meanwhile, those of Physalis peruviana were 1.98 %, 2.54 %, 2.86 %, and 3.65 %, respectively. The comparison of the protein content of both Physalis described in table 5.
Table 5. The protein content of plant part of *P. angulata* and *P. peruviana*

| Plant part | Protein (% db)       |
|------------|----------------------|
|            | *P. angulata*        | *P. peruviana*       |
| Stem       | 1.98±0.02<sup>AB</sup> | 2.23±0.01<sup>AD</sup> |
| Leaf       | 2.54±0.32<sup>AC</sup> | 2.66±0.02<sup>AC</sup> |
| Bud        | 2.86±0.01<sup>AB</sup> | 2.91±0.03<sup>AB</sup> |
| Fruit      | 3.65±0.01<sup>Aa</sup> | 4.03±0.03<sup>AA</sup> |

Data were presented mean±standard deviation (SD) (n=3). A>B>C>D; Values followed by different letters in rows and columns show significant differences (P<0.05). Uppercase (vertical) and lowercase (horizontal).

Table 5 showed that plant part of *Physalis angulata* and *Physalis peruviana* influenced the protein content (p<0.05). The fruit part of both Physalis had the highest protein content (3.65% and 4.03%, respectively), followed by bud, leaf and stem of Physalis (table 5). The Mann-Whitney test showed that there was no a significant difference in the protein content between *P. angulata* and *P. peruviana* (p>0.05).

The carbohydrates content of stem, leaf, bud, and fruit of *Physalis peruviana* ranged from 1.78% to 7.98%. Meanwhile, for the carbohydrates content of *Physalis angulata* ranged from 1.84 % to 7.97% (table 6). Ramadan and Morsel [24] reported the carbohydrates content of *Physalis peruviana* fruit is 19.6%. These results was higher than the results of this study. It might be cause by the difference in the geographic and time of harvesting.

Table 6. The carbohydrates content of plant part of *P. angulata* and *P. peruviana*

| Plant part | Carbohydrate (%db)       |
|------------|--------------------------|
|            | *P. angulata*            | *P. peruviana*            |
| Stem       | 1.84±0.03<sup>AC</sup> | 1.78±0.01<sup>AD</sup> |
| Leaf       | 2.36±0.01<sup>AC</sup> | 2.12±0.02<sup>AC</sup> |
| Bud        | 3.16±0.02<sup>AB</sup> | 3.28±0.02<sup>AB</sup> |
| Fruit      | 7.97±0.01<sup>Aa</sup> | 7.98±0.01<sup>AA</sup> |

Data were presented mean±standard deviation (SD) (n=3). A>B>C>D; Values followed by different letters in rows and columns show significant differences (P<0.05). Uppercase (vertical) and lowercase (horizontal).

The analysis of variance (ANOVA) showed that part of the plant of *Physalis angulata* and *Physalis peruviana* influenced the carbohydrates content (p<0.05). The fruit part of both Physalis had the highest carbohydrates content (7.97% and 7.98%, respectively), followed by bud > leaf > stem (Table 6). The Mann-Whitney test showed that there was no a significant difference in the carbohydrates content between *P. angulata* and *P. peruviana* (p>0.05).

The vitamin C content of stem, leaf, bud and fruit of *Physalis angulata* were ranged from 4.01 to 19.79 mg/100 gram, meanwhile for *Physalis peruviana* ranged from 1.48 mg/100 gram to 17.13 mg/100 gram (table 7). The comparison of protein content of both Physalis are described in table 7.

The analysis of variance (ANOVA) showed that part of the plant of *Physalis angulata* and *Physalis peruviana* influenced the vitamin C content (p<0.05). The fruit part of both Physalis had the highest vitamin C content (17.13% and 19.79%, respectively), followed by bud > leaf > stem (Table 7). The Mann-Whitney test showed that there was no significant difference in the vitamin C content between *P. angulata* and *P. peruviana* (p>0.05), except for the fruit and bud part of the plant (p<0.05). The vitamin C content of fruit and bud of *P. peruviana* higher than *P. angulata*. Ramadan
[31] reported that vitamin C content of fruit *Physalis peruviana* is 46 mg/100g. The vitamin C content results of this study lowest than Ramadan’s reported.

**Table 7.** The vitamin C of plant part of *P. angulata* and *P. peruviana*

| Plant part | *P. angulata* (mg/100 g) | *P. peruviana* (mg/100 g) |
|------------|-------------------------|--------------------------|
| Stem       | 1.48±0.03<sup>abD</sup> | 4.01±0.01<sup>abC</sup> |
| Leaf       | 5.80±0.03<sup>abR</sup> | 8.13±0.03<sup>abG</sup> |
| Bud        | 9.35±0.01<sup>abB</sup> | 7.90±0.01<sup>abB</sup> |
| Fruit      | 17.13±0.01<sup>bA</sup> | 19.79±0.01<sup>aA</sup> |

Data were presented mean±standard deviation (SD) (n=3). A>B>C>D; Values followed by different letters in rows and columns show significant differences (P<0.05). Uppercase (vertical) and lowercase (horizontal).

4. Conclusion

The proximate composition and vitamin C of *Physalis angulata* and *P. peruviana* relatively, evenly spread. The part of plant of *Physalis angulata* and *Physalis peruviana* influenced the proximate composition and vitamin C content. The fruit of both physalis had the highest of lipids, protein, carbohydrates and vitamin C content, meanwhile for the ash and crude fiber content, the stem part of both Physalis had the highest values than other part of plant. The comparison, using Mann-Whitney test, of both Physalis showed that there were no significant differences of proximate composition and vitamin C between *P. angulata* and *P. peruviana*.

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