The Effects of Solvents and Maltodextrin on the Characteristics of *Physalis angulata* L. Leaf Extract

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**Abstract.** The research aimed to study the influence of the use of solvent type with the addition of maltodextrin on various concentration on the *physalis angulata* leaves to obtain the maximal amount of flavonoid, polyphenol, and alkaloid. The *Physalis angulata* L leaf was extracted using a solvent of 70% ethanol, 100% distilled water and maltodextrin with concentrations of 0%, 3%, 6%, and 9%. The UV-VIS spectrophotometric method was used to analyze the quality of flavonoid and polyphenol compounds. The gravimetric method was used to analyze the alkaloid compounds. Results of analysis of *Physalis angulata* leaf extract showed that the treatment of 70% ethanol added with 9% maltodextrin obtained the highest average value of flavonoid. The average amount of flavonoid was 3268.20 mg GAE/g extract.

The treatment of 70% ethanol added with 6% maltodextrin produced the highest average value of alkaloid. The average amount of alkaloid was 53.16%. Results of advanced Duncan’s test showed that the highest average value of all parameters analyzed appeared that the best treatment was a solvent of 70% ethanol added with 9% maltodextrin.

**Keywords:** Alkaloid, *Ciplukan*, Flavonoid, Polyphenol, Spectrophotometry

1. Introduction

Indonesia is one of the second largest biodiversity countries in the world after Brazil which consists of tropical plants and marine biota, with as many as 30,000 species of plants, 2500 of which are medicinal [6]. Herbal medicinal products and herbal supplements derived from medicinal plants over the last three decades are increasing rapidly. From this case, it is evident that Indonesia has the potential to develop products from herbs based on functional foods. One of the herbaceous plants that have begun to be developed is *Ciplukan* [6]. *Ciplukan* (Latin: *Physalis angulata* L.) is the name of small fruit which is covered by the enlarged petals of flowers when it is ripe. This plant is usually used as a traditional medicine in which all the parts of the plant, i.e., roots, stems, leaves, and fruit can be used as a traditional herb that is able to treat degenerative diseases such as diabetes mellitus [3]. Diabetes is a metabolic disorder caused by the deficiency of insulin hormones produced by pancreatic beta cells. Lack of insulin causes the glucose not to be stored in the blood and not processed by the cells to become energy [5].
Physalis angulata L plants have the efficacy of treating diabetes mellitus because it contains secondary metabolite compounds including flavonoids, polyphenols, and alkaloids. Flavonoids and polyphenols are antioxidant compounds that function to overcome or neutralize free radicals. Alkaloids also have the ability to regenerate damaged pancreatic beta cells and the ability to inhibit the action of the α-glucosidase enzyme [8] [10] [11].

These secondary metabolites can be obtained by extracting materials from Physalis angulata L plants. Many factors can affect the content of extracted compounds, i.e., the type of solvent, and the process of evaporation. Therefore, this research aimed to study and determine the influence of the type of solvent and the addition of maltodextrin at different concentrations up to the level that would obtain maximal flavonoid, polyphenol, and alkaloid compounds from the Physalis angulata L leaf extract.

2. Methodology

2.1. Material and Tools

The materials used were Physalis angulata L leaves, 70% ethanol, 30% methanol, 10% NaOH, quercetin standard solution, methanol p.a, 10% AlCl₃, aquadest, 1M sodium acetate, ammonia, 1% ammonium hydroxide, standard solution of gallic acid, reagents Folin-Ciocalteau (1:10), and 7.5% Na₂CO₃. The equipment used are knives, analytical balance, 100 mL and 250 mL Erlenmeyer flasks, 100 mL glass beaker, filter paper, funnel, vacuum rotary, evaporator, refractometer, pH meter, Chromameter and UV-Vis spectrophotometry.

2.2. Research Method

The fresh Physalis angulata L leaves were obtained from Jabong area (Latitude 6°31’07.80”S, Longitude 107°46’41.07” E, and elevation 67 MAMSL), Subang, West Java. The leaves were washed and chopped into the same small size and extracted by maceration using 70% ethanol and water solvent with leaf and solvent ratio of 1:10. The mixture of chopped leaves and solvent was poured into an Erlenmeyer covered with aluminium foil stored for 24 hours, shaken occasionally, then filtered. The filtrate from the maceration was then added with maltodextrin in different concentrations of 0%, 3%, 6%, and 9%. The extract of the Physalis angulata L leaf was obtained by evaporating the mixture. There was two analysis applied to characterize the extract of Physalis anggulata leaf, i.e. qualitative and quantitative.

The qualitative analysis was applied to characterized the parameters of TPT, pH and colour of the extract. Further analysis of the quantitative test was applied to investigate the content of flavonoid, polyphenol, and alkaloid compounds. The levels of flavonoids were obtained by a UV-VIS spectrophotometric method at a 431 nm wavelength using quercetin as the standard solvent. The levels of polyphenols were determined using the UV-Vis spectrophotometry at wavelengths of 765 nm by using gallic acid as the standard solvent. The alkaloid content was tested using a gravimetric method in which the alkaloid compounds in the sample were precipitated using ammonium hydroxide then filtered and dried.

The experiment design used was a factorial in the interaction of randomized block design with a treatment design consisting of two factors. The first factor was the type of solvent (A) which consisted of water (a₁) and 70% of ethanol solvent (a₂). The second factor was the addition of maltodextrin (B) with concentration levels of 0 % (b₁), 3 % (b₂), 6 % (b₃), and 9 % (b₄). The factorial pattern used was 2 x 4 with 3 repetitions. The response designs were physical-chemical responses, consisted of TPT and pH. Physical responses were colour, consisted of brightness, redness and yellowness (L*, a*, b*), and chemical responses were content of flavonoids, polyphenols, and alkaloids.

3. Results and Discussion

The type of solvent and the addition of maltodextrin at different concentrations in the leaf extraction process affected physical-chemical, physical, and chemical responses. Each solvent had a different polarity that affected the amount of active compounds dissolved in the process of extraction and addition of maltodextrin at different concentrations. This also affected the level of content of
metabolite compounds obtained. The results of the research appeared that the best solvent to extract the *Physalis angulata* L leaves was the treatment of 70% ethanol added with 9% maltodextrin.

### 3.1. Total Dissolved Solids

The result of variation analysis showed that the solvent type (A) treatment using 70% ethanol and water solvent as well as the treatment of maltodextrin concentration (B) had significant effects (F count > F table 5%). The interaction of both treatments (AxB) also had a significant effect (F count > F table 5%). Table 1 showed the average value of total dissolved solids of the *Physalis angulata* L leaf extract.

**Table 1. Average value of total dissolved solids in *Physalis angulata* L leaf extract**

| Brix Percentage | Solvent     | Maltodextrin | Total    | Average   |
|-----------------|-------------|--------------|----------|-----------|
|                 | 70% Ethanol | Malto 0% (b₁) | 43.00    | 14.33 a   |
|                 |             | Malto 3% (b₂) | 105.80   | 35.27 d   |
|                 |             | Malto 6% (b₃) | 126.20   | 42.07 f   |
|                 |             | Malto 9% (b₄) | 139.20   | 46.40 h   |
| Water (a₁)      | Malto 0% (b₁) | 56.20        | 18.73 b  |
|                 | Malto 3% (b₂) | 105.80        | 35.27 d  |
|                 | Malto 6% (b₃) | 126.20        | 42.07 f  |
|                 | Malto 9% (b₄) | 139.20        | 46.40 h  |

Note: The same letters at the end of each average value do not show actual differences

The Results showed that the average total of dissolved solids (brix) in the thick *Physalis angulata* L leaf extract on each treatment showed a significant difference. The highest average treatment by water was the addition of 9% maltodextrin with a total of dissolved solids (brix) 42.93%. The highest average treatment by 70% ethanol solvent was the addition of 9% maltodextrin with a total of dissolved solids (brix) of 46.40%. Overall, it could be concluded that the highest average of the total dissolved solids was 46.40%, which was shown by the treatment of 70% ethanol solvent with the addition of 9% maltodextrin. The lowest average of that was 14.33% shown by the water solvent with 0% maltodextrin concentration. This indicated that the increasing level of maltodextrin concentration caused the total percentage of dissolved solids increased. It was expected that the content of phytochemical compounds in the extract was also at a high level.

Water was more polar than 70% ethanol. Water could extract polar compounds, whereas 70% of ethanol could extract both polar and nonpolar compounds because it had nonpolar alkyl groups. Therefore, total dissolved solids with 70% ethanol solvent had a higher average value than water. It could be postulated that the higher the total value of dissolved solids, the better the quality of the extract. The compounds measured as total dissolved solids included complex and simple sugars, organic acids, several classes of pigments, dilutable vitamin, and other organic compounds. Maltodextrin was a solid dye in the form of fine white power without taste. Maltodextrin could be obtained by partially hydrolyzing cassava starch with the α-amylase enzyme at a temperature of 85°C for 65 minutes. Maltodextrin is a mixture of maltose, maltooltriose, and maltotetraose. Therefore, the addition of maltodextrin can increase the total dissolved solids [13].

### 3.2. Value of pH

The result of variation analysis showed that the solvent type (A) treatment of 70% ethanol and water solvent, and the treatment of maltodextrin concentration (B) had a significant effect (F count > F table 5%). The interaction of both treatments (AxB) also had a very significant effect (F count > F table 5%). Table 2 showed the average pH value of the *Physalis angulata* L leaf extract.

Results of the analysis showed that the lowest average pH was 5.01 which had the highest acid content occurred in the treatment of water solvent with the addition of 9% maltodextrin. The highest
average pH was 5.62 which had the lowest acid content occurred in the treatment of ethanol with 0% maltodextrin. The characteristics of water solvents were more polar than solvents of 70% ethanol; this resulted in the lowest pH of 5.01 occurred in the treatment of water solvent with the addition of 9% maltodextrin. From the average value of treatments, it could be concluded that the higher the amount of maltodextrin addition, the lower the pH value. In other words, the content of the Physalis angulata leaf extract had more acid. The pH obtained in this study was classified as a weak acid, which in water it produced H⁺ ion imperfectly, and would result in a pH value ranged from 3-5. Acid strength is determined by the ability to produce H⁺ ions. The more H⁺ ions produced, the stronger the acid [14].

Table 2. Average pH value of Physalis angulata L leaf extract

| Solvent       | Maltodextrin | Total | Average |
|---------------|--------------|-------|---------|
| Water (a1)    | Malto 0% (b₁) | 16.01 | 5.34    |
|               | Malto 3% (b₂) | 16.06 | 5.35    |
|               | Malto 6% (b₃) | 15.11 | 5.04    |
|               | Malto 9% (b₄) | 15.03 | 5.01    |
| 70% Ethanol (a₂) | Malto 0% (b₁) | 16.85 | 5.62    |
|               | Malto 3% (b₂) | 15.76 | 5.25    |
|               | Malto 6% (b₃) | 15.68 | 5.23    |
|               | Malto 9% (b₄) | 15.91 | 5.30    |

Note: The same letters at the end of each average value do not show actual differences

3.3. Brightness Level (L*)

The result of variation analysis showed that the solvent type (A) treatment using 70% ethanol solvent and water solvent and the treatment of maltodextrin concentration (B) had a significant effect (F count > F table 5%). The interaction of both treatments (AxB) also had a significant effect (F count > F table 5%). The average level of brightness (L*) of the Physalis angulata L leaf extract was shown in Table 3.

Table 3. The average level of brightness (L*), redness (a*) and yellowness (b*) of the physalis angulata leaves extract

| Solvent       | Maltodextrin | L*    | a*    | b*    |
|---------------|--------------|-------|-------|-------|
| Water (a1)    | Malto 0% (b₁) | 30.035 | 0.692 | 3.637 |
|               | Malto 3% (b₂) | 30.695 | 0.126 | 2.652 |
|               | Malto 6% (b₃) | 31.052 | 0.222 | 2.085 |
|               | Malto 9% (b₄) | 31.343 | 0.093 | 2.215 |
| 70% Ethanol (a₂) | Malto 0% (b₁) | 28.738 | 0.714 | 4.614 |
|               | Malto 3% (b₂) | 30.403 | 0.192 | 2.596 |
|               | Malto 6% (b₃) | 30.866 | 0.157 | 2.618 |

Note: The same letters at the end of each average value do not show actual differences

The L* value indicates the brightness level from dark to light with a range value of 0-100. Results showed that the highest average of brightness was 31.343 occurred in the treatment of the water solvent with an addition of 9% maltodextrin. The lowest average value of that was 31.114 occurred in the treatment of 70% ethanol solvent with an addition of 9% maltodextrin. The overall treatment appeared that the highest value was caused by the chlorophyll content that was extracted. The extracts that used water solvent had a brighter green colour compared to that of the 70% ethanol solvent extracts which had a darker green colour. It meant that the 70% ethanol solvent could extract the physalis angulata leaf better than the water solvent. This results were in accordance with a study conducted by Widya, et al. [15], which stated that 85% alcohol and 85% acetone solvent could extract
the suji leaf greater than water solvent. Results of this study were also in accordance with the researched done by De Mann [12] which stated that Chlorophyll was easily extracted using organic solvents such as acetone, alcohol, methanol, ethyl acetate, pyridine, and dimethylformamide. Chlorophyll contains phytol groups that have low solubility towards the water.

The addition of maltodextrin affected the brightness of the Physalis angulata L extract, in which the higher the concentration of maltodextrin, the higher the brightness. This was due to the dissolved chlorophyll content in the extract would be bounded by the maltodextrin which caused the level of brightness to be higher.

3.4. Redness Level (a*)

The result of variation analysis showed that the solvent type (A) treatment of using 70% ethanol solvent and water solvent and the treatment of maltodextrin concentration (B) had a significant effect (F count > F table 5%). The interaction of both treatments (AxB) also had a very significant effect (F count > F table 5%) on the treatment of the study. The average redness level (a*) of the Physalis angulata L leaf extract was shown in Table 3.

The a* values show that the trend of colour from green to red with a range value of -100 to +100. The greater value of a* shows the trend of an increasingly red colour. Results of the analysis showed that the highest average level of redness in the treatment of water solvent with the addition of 6% maltodextrin was 0.184. The highest average level of redness in the treatment of 70% ethanol solvent with the addition 3% maltodextrin was 0.222. The highest average level of redness from both solvents was 0.222 which occurred in the treatment of 70% ethanol solvent with the addition of 3% maltodextrin. It was suspected that the reddish colour indicated the content of alkaloid and polyphenols. Alkaloid and polyphenols are phytochemical compounds that present in plants as pigment of orange, red, brownish red, and brown. It was expected that the addition of maltodextrin as a binder retained the flavonoid compound in the Physalis angulata L extract which could be lost due to processing and evaporation.

3.5. Yellowness Level (b*)

The result of variation analysis showed that the solvent type (A) treatment using 70% ethanol solvent and water solvent, and the treatment of maltodextrin concentration (B) had a significant effect (F count > F table 5%). The interaction of both treatments (AxB) also had a very significant effect (F count > F table 5%). The average yellowness level (b*) of the Physalis angulata L leaf extract was shown in Table 3.

The b* values show the trend of colour from blue to yellow with a range value of -100 to +100. The greater the value of b* shows a trend of colour increases to yellow. Results showed that the highest average of yellowness level was 3.577, obtained by the treatment of using the 70% ethanol solvent with an addition of 3% maltodextrin. Meanwhile, the lowest value was 2.652, obtained by the treatment of using the water solvent with an addition of 6% maltodextrin. The overall highest average value occurred in the treatment of using the 70% ethanol solvent. It was believed that the yellowness indicated the presence of flavonoid compounds in the extract. Flavonoids are one of the pigments found in plants as the pigment of yellow, orange, and yellowish orange colours. It was expected that the addition of maltodextrin as a binder could retain the flavonoid compounds in the Physalis angulata L extract which could be lost due to processing and evaporation.

3.6. Level of Flavonoid Compounds

The result of variation analysis showed that the solvent type (A) treatment using 70% ethanol solvent and water solvent, and the treatment of maltodextrin concentration (B) had a significant effect (F count > F table 5%). The interaction of both treatments (AxB) also had a significant effect (F count > F table 5%). The value of flavonoid compounds level in the Physalis angulata L leaf extract was shown in Table 4.

Table 4 showed that the average level of flavonoid compounds in the Physalis angulata L leaf extract were significant difference in each treatment, except in treatment a1b3 and a2b1 which showed similarity. The highest average of flavonoid in the treatment of water solvent with the addition of 9%
maltodextrin was 4,594 ppm. The highest average of that in the treatment using 70% ethanol with the addition of 9% maltodextrin was 8,439 ppm. Overall, it could be concluded that the highest average level of the flavonoid compounds in the *Physalis angulata* L leaf extract was 1,421 ppm, obtained by the treatment of 70% ethanol solvent with an addition of 9% maltodextrin. Otherwise, the lowest value was 1,421 ppm, obtained by the treatment of the water solvent and with addition of 0% maltodextrin. This showed that the higher amount of maltodextrin added, the higher the level of flavonoid compounds contained in the Physalis angulata L leaf which was extracted using the ethanol solvent.

| Flavonoid Level | Solvent | Maltodextrin | Total | Average |
|-----------------|---------|--------------|-------|---------|
|                 | Water (a₁) | Malto 0% (b₁) | 4.26  | 1.421 a |
|                 |         | Malto 3% (b₂) | 7.48  | 2.492 b |
|                 |         | Malto 6% (b₃) | 10.00 | 3.335 c |
|                 |         | Malto 9% (b₄) | 13.78 | 4.594 d |
|                 | 70% Ethanol (a₂) | Malto 0% (b₁) | 9.98  | 3.328 c |
|                 |         | Malto 3% (b₂) | 15.11 | 5.037 e |
|                 |         | Malto 6% (b₃) | 23.48 | 7.826 f |
|                 |         | Malto 9% (b₄) | 25.32 | 8.439 g |

Note: The same letters at the end of each average value do not show actual differences

Flavonoids play an essential role in capturing free radicals or functioning as natural antioxidants so that they can prevent complications or progression of diabetes mellitus by clearing excessive free radicals and sever the chain of free radical reactions. These antioxidant activities allow flavonoids to capture or neutralize free radicals, such as ROS or RNS, associated with phenolic OH groups in order to improve the state of damaged tissue. This meant that the inflammatory process could be inhibited, chelating metal could be bound, and the polyol pathway could be blocked by inhibiting the aldose reductase enzyme. Flavonoids also have an inhibitory effect on alpha-glucosidase enzyme by the hydroxylation bond and substitution on the β ring. The principle of inhibition is similar to that of acarbose which has been used as a drug for the treatment of diabetes mellitus, by producing delays of carbohydrate and disaccharide hydrolysis and glucose absorption as well as inhibiting the metabolism of sucrose into glucose and fructose [2] [7].

3.7. Level of Alkaloid Compounds
The result of variation analysis showed that the solvent type (A) treatment using 70% ethanol solvent and water solvent and the treatment of maltodextrin concentration (B) had a significant effect (F count > F table 5%). The interaction of both treatments (AxB) also had a significant effect (F count > F table 5%). The average value of the levels of alkaloid compounds could be seen in Table 5.

| Alkaloid Level | Solvent | Maltodextrin | Total | Average |
|---------------|---------|--------------|-------|---------|
|               | Water (a₁) | Malto 0% (b₁) | 74.73 | 24.91 a |
|               |         | Malto 3% (b₂) | 103.06 | 34.35 d |
|               |         | Malto 6% (b₃) | 127.42 | 42.47 f |
|               |         | Malto 9% (b₄) | 25.32 | 28.43 c |
|               | 70% Ethanol (a₂) | Malto 0% (b₁) | 107.33 | 35.78 e |
|               |         | Malto 3% (b₂) | 141.84 | 47.28 g |
|               |         | Malto 6% (b₃) | 159.48 | 53.16 h |
|               |         | Malto 9% (b₄) | 80.78 | 26.93 b |

Note: The same letters at the end of each average value do not show actual differences
Results showed that the average content of alkaloid compounds in the *Physalis angulata* L leaf extract on each treatment showed a significant difference. The highest average of alkaloid in the treatment of water solvent with the addition of 6% maltodextrin was 42.47%. The highest average of that using the 70% ethanol solvent with addition of 6% maltodextrin was 53.16%. Overall, it can be concluded that the highest average value of alkaloid content was 53.16% which occurred in the treatment of 70% ethanol solvent with addition of 6% maltodextrin. In each addition of 9% maltodextrin, there was a decrease in the alkaloid compound which made the addition no longer effective. However, it could be concluded that the higher the concentration of maltodextrin (up to 6%), the higher the alkaloid compounds contained in the leaf which was extracted using the ethanol solvent.

The alkaloid is widely used in medicine. One of the benefits is to treat diabetes mellitus. Alkaloids are shown to have properties that can regenerate the pancreatic β cell. With the improvement of the pancreas tissue, there is an increase in the amount of insulin in the body so that blood glucose can enter the cell, resulting in decreased blood glucose in the body. Alkaloids work by stimulating the hypothalamus to increase the secretion of Growth Hormone Releasing Hormone (GHRH), so the secretion of Growth Hormone (GH) in the hypophysis increases. High GH levels will stimulate the liver to secrete Insulin-like Growth Factor-1 (IGF-1). IGF-1 affects inducing hypoglycemia and lowering gluconeogenesis, so that blood glucose levels and insulin requirements decrease. The IGF-1 through a negative feedback system will normalize GH levels again [4].

### 3.8. Level of Polyphenol Compounds

The result of variation analysis showed that the solvent type (A) treatment using 70% ethanol solvent and water solvent and the treatment of maltodextrin concentration (B) had a significant effect (F count > F table 5%). The interaction of both treatments (AxB) also had a significant effect (F count > F table 5%) on the treatment of the study. The average value of the polyphenol compounds level could be seen in Table 6.

| Solvent       | Maltodextrin | Total    | Average |
|--------------|--------------|----------|---------|
| Water (a₁)   | Malto 0% (b₁) | 8381.33  | 2793.78 |
|               | Malto 3% (b₂) | 7175.72  | 2391.91 |
|               | Malto 6% (b₃) | 7527.00  | 2509.00 |
|               | Malto 9% (b₄) | 6323.46  | 2107.82 |
| 70% Ethanol (a₂) | Malto 0% (b₁) | 11286.00 | 3762.00 |
|               | Malto 3% (b₂) | 8659.29  | 2886.43 |
|               | Malto 6% (b₃) | 9270.85  | 3090.28 |
|               | Malto 9% (b₄) | 9804.59  | 3268.20 |

**Note:** The same letters at the end of each average value do not show actual differences.

The findings showed that the average content of polyphenol compounds in the *Physalis angulata* L leaf extract on each treatment showed the significant difference. The highest content of polyphenol was 3762 mg GAE/g extract obtained by the treatment of 70% ethanol solvent with no addition of maltodextrin (0%). In the treatments of 70% ethanol solvent with an addition of different maltodextrin concentrations, appeared that there was an increase in the polyphenol content as the percentage of addition increase. The highest average value of polyphenol content was 3268.20 mg GAE/g extract which was obtained by the addition of 9% maltodextrin.

In the treatment of water solvent, the highest value was 2793.78 mg GAE/g extract which was obtained without the addition of maltodextrin. It could be concluded that the highest polyphenol levels were obtained in the use of 70% ethanol solvent without the addition of maltodextrin. However, the addition of maltodextrin in the ethanol solvent proves that the higher the concentration of...
maltodextrin, the higher the polyphenol content even though the highest remained to be obtained without any addition of maltodextrin.

Polyphenols play a role in colouring a plant, for example, a leaf colour during autumn. Polyphenols are found in fruits, vegetables, and grains. The average human consumes up to 23 mg of polyphenols a day. Polyphenols are often present in polar glycosides and are easily soluble in polar solvents. The benefits of polyphenols include lowering blood glucose levels and protecting against various diseases such as cancer. Polyphenols help counter the formation of free radicals. Polyphenol antioxidants are able to reduce oxidative stress by preventing the chain reaction of superoxide to superoxide hydrogen by donating hydrogen atoms from the aromatic hydroxyl (-OH) group of polyphenols to bind free radicals and discharge them from the body through excretion systems. The role of polyphenols as antioxidants is thought to be capable of protecting pancreatic β cells from toxic effects of free radicals produced under conditions of chronic hyperglycemia [9] [1].

4. Conclusion
The results of the variation analysis of the parameters of brix, pH, brightness, redness, yellowness, levels of flavonoids, polyphenols, and alkaloids indicated that the solvent type (A) treatment using 70% ethanol and water, and the treatment of maltodextrin concentration (B) had a significant effect (F count > F table 5%). The interaction of both treatments (AxB) also had a very significant effect (F count > F table 5%). TPT observation showed that the highest average value was 46.40% obtained by the 70% ethanol treatment with an addition of 9% maltodextrin. The pH observation showed that the lowest average value, indicating the highest acid content, was 5.01, obtained in the treatment of water solvent with addition 9% maltodextrin. The brightness level (L*) observation showed that the highest average value was 31.343 obtained in the treatment of the water solvent with the addition of 9% maltodextrin. The redness level (a*) observation showed that the highest value was 0.222, obtained in the treatment of 70% ethanol with addition of 3% maltodextrin.

The yellowness level (b*) observation showed that the highest value was 3.577, obtained in the treatment of 70% ethanol with the addition of 3% maltodextrin solvent. The higher the concentration of maltodextrin added, the higher the average value of polyphenol compounds in the Physalis angulata L leaf extract. The highest average of flavonoid was 8,439 ppm, obtained in the treatment of 70% ethanol with the addition of 9% maltodextrin. The higher the maltodextrin concentration added (up to 6%), the higher the alkaloid compounds in the Physalis angulata L leaf extract. Otherwise, there was a decrease in the average of maltodextrin addition. The highest value of alkaloid was 53.16 % obtained in the treatment of 70% ethanol solvent with an addition of 6%.

In the use of 70% ethanol solvent, the addition of maltodextrins in different concentrations might increase the content of polyphenol compounds. However, the highest average value was 3762 mg GAE/g extract, obtained in the treatment of 70% ethanol solvent without any addition of maltodextrin. Overall, the 70% ethanol solvent had higher average value compared to the water solvent. Based on the Duncan advanced test table, the treatment based on the type of solvent and with the addition of maltodextrin as well as the combination of treatments had different effects. The highest value of all the analysis parameters was obtained by the treatment of 70% ethanol solvent and 9% maltodextrin.

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