Quality of Chili Powder Soaked with Lime (*Citrus aurantiifolia*) and Tamarind (*Tamarindus indica*) Solution after Water Blanching

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Abstract. Drying process leads to the decrease of the quality and nutrition of hot chili powder. Soaked with chemical solution such as sodium metabisulphite and citric acid can maintain the quality of hot chili powder. These chemicals are relatively expensive and not readily found. Fruits that have organic acids, natural, easy to find, and relatively cheap are lime and tamarind. The research aimed to determine the effect of hot chili powder soaked with lime and tamarind solution and determine the fruit that can replace chemical solution. Randomized Block Design with 2 factors was used in this research. The first factor was type of soaking solution (lime solution and tamarind solution). The second factor was acid concentration (5%, 10%, 15%). The observed data were analyzed statistically using Analysis of Variance (ANOVA) with 5% confidence interval. Then tested using LSD (Least Significance Different) test or DMRT (Duncan Multiple Range Test) with 5% confidence interval. The best results was showed by 15% lime solution. The sample results had color a * 22.28, total color value 173.77 ASTA, capsaicin level 76427.54 ppm, total phenolic content 9.07 mg GAE/g, total flavonoid content 30.76 mg QE/g, ascorbic acid content 0.66 mg/g, and IC 50 is 213.11 ppm.

Keywords: Blanching, Chili, Lime (*Citrus aurantiifolia*), Tamarind (*Tamarindus indica*)

1. Introduction

Chili (*Capsicum frutescens*) prices usually increase in certain months, such as rainy months [1] due to constant/increasing demand from industries that produce spicy food while the chili production even decrease during rainy season. Processed chili is an alternative to make sure people can still consume chili when the price of fresh chili is expensive. One technique for extending the shelf life of chili is processed into chili powder. This process also functions as a preservation because by this technique the water content in chili decreases, thereby reducing the level of food damage [2]. However, the drying process during chili powder manufacture causes a decrease in the quality and nutrition of chili powder [3].

In the production process of chili powder, soaking in a chemical solution such as sodium metabisulfite, citric acid, and ascorbic acid can maintain the quality of chili powder is normally applied [4]. Immersion with sodium metabisulfite 0.3% and citric acid 1% can improve the quality of dried chili in terms of color, total carotene, total phenol including antioxidant activity, and total ascorbic extract [5]. These chemicals have disadvantages due its relatively expensive price, and not
readily found, and moreover people tend to prefer things that are natural. Fruits that have organic extracts, are natural, and are easily found in the Indonesia market. Lime and tamarind for example are available throughout the year at relatively low prices. The purpose of this study was to determine the effect of soaking in lime solution and tamarind solution on the quality of chilli powder and to know the fruit that can replace chemical solutions in the manufacture of chilli powder.

2. Methods

2.1 Materials
The materials used in this study include fresh chili (Capsicum frutescens), Lime, Tamarind, Ethanol Pro-Analysis (99%) Merck, DPPH Powder, Ascorbic Extract, KI Powder, Iodine, Starch, Standard Capsaicin, Galic Acid, Folin Reagent, Sodium Carbonate 7.5%, Quercetin, Aquades, 5% NaNO2 and 10% AlCl3

2.2 Tools
The tools used in this study include Cabinet drier, Gas Stove, Knife, Pot, Refrigerator (Electrolux), UV-Vis Spectrophotometer (Jenway), Modified-Microwave Assisted Extraction (Anton Paar), Microplate reader (BMG Labtech ), Microplate 96-well (Cost 96), Microplate shaker, Micropipette (Finnapipette), Microtube, Microtip, Vortex, Oven (Binder), Analytical Scales (Denver), Desiccators, Blenders (Miyako), 40 mesh sieves, Measuring cups ( Pyrex), Iron Spatula, Glass Stirrer, Watch Glass, Thermometer, Drop Pipette, Measuring Pipette (Pyrex), Suction Ball, Glassware (Pyrex), Measuring Pumpkin (Pyrex), Glass Funnel, Dark Glass Bottle, Erlenmeyer (Pyrex), Test tube (Pyrex), Test tube rack, fine filter paper, rough filter paper

2.3 Research design
Randomized Block Design with 2 factors was used in this research. The first factor was type of soaking solution (lime solution and tamarind solution). The second factor was extract concentration (5%, 10%, 15%). The observed data were analyzed statistically using Analysis of Variance (ANOVA) with 5% confidence interval. Then tested using LSD (Least Significance Different) test or DMRT (Duncan Multiple Range Test) with 5% confidence interval.

To make chili powder, first, chili were weighed and washed. Then the chili were blanched (90°C, 3 minutes), and soaked in a solution of tamarind or lime with concentration of: 5%, 10%, 15% in 200 ml of water (v / v). For the control chili was soaked with sodium metabisulfite 0.3% and citric extract 1% (v / v). The parameter analysed were pH of the solution, color, capsaicin content, extract color, vitamin C, antioxidant activity, total phenol, flavonoid of chili powder. After that, the best treatment was determined using the multiple attribute method (Zeleny, 1982). The results of the best treatment were compared with control.

3. Results and Discussion

3.1 Analysis of Fresh Chili
The fresh chili was analyzed for its water content, capsaicin content, total color (ASTA value = American Spice Trade Association/ Extractable Color in Capsicums and Their Oleoresins based on the spectral absorbance at 460 nm), total phenol, total flavonoids, antioxidant activity, vitamin C levels, and color (Table 1).

Based on table 1, it is found that chilli has a high moisture content. The water content in chilli is very high and causing the chili to be easily damaged. Moisture content in food can determine the freshness and storability of food stuffs, high water content makes bacteria, yeast and mold more easily grow and develop [9].
### Table 1. Chemical Composition of Fresh Chili

| Parameters                  | Amount      | References |
|-----------------------------|-------------|------------|
| Water content (%)           | 84.54±2.59  | 87.84*     |
| Capsaicin (ppm)             | 33315.13    | 355.8**    |
| Total Colour (ASTA value)   | 199.98±4.95 | 142.55**** |
| Total Phenol (mg GAE/g)     | 11.57±0.67  | 16.75±42***|
| Total Flavonoid (mg QE/g)   | 36.21±1.13  | 40.51±23***|
| Antioxidant Activity/IC50 (ppm) | 163.2±13.40 | 625±0.01***|
| Vitamin C (mg/g)            | 1.122±0.09  | 3.79±3.3***|

Note: Each analysis data is the average of 4 replicates [6], [7], [5], [8].

The results of the analysis of capsaicin levels, total color values, total phenols, total flavonoids, antioxidant activity, and vitamin C levels have values that are different from the results of the references. This difference can be due to the type of variety, the level of maturity, the difference in growing places, and the use of methods in extracting bioactive compounds in the sample [10].

3.2 pH of Soaking Solution

The pH value of soaking solution ranged from 2.4 - 2.9. The results from analysis of variance (ANOVA) showed that the type and concentration of extract significantly affected the pH of the immersion solution (Figure 1).

![Figure 1. pH of Soaking Solution at different extract concentration](image)

The higher the concentration of the extract the lower the pH value. Lime solution had a lower pH value than tamarind solution. This is because pH reflects the concentration of hydrogen ions in solution. The higher the extract concentration, the higher the hydrogen ion, and the higher extractability level in a solution and causes a pH value less than 7 [11].

3.3 Chemical Characteristic of Chili Powder

Analysis of the chemical characteristics of chili powder include color, capsaicin, vitamin C levels, total phenol, total flavonoids and antioxidant activity (IC 50) presented in Table 2. The result showed that, the higher the extract concentration, the higher the total color value and the lime solution has a lower total color value than the Javanese tamarind solution. Soaking with extract can maintain the red color of chili powder because the extract acts as an antibrowning agent in chili. Extracts can inhibit the formation of brown pigments due to maillard reactions and a decrease in pH because extracts can also inhibit oxidation which causes browning of fruits or vegetables [19].
Table 2. The Chemical Characteristic of Chili Powder

| Treatment | Extract Color (ASTA Value) | Capsaicin (ppm) | Vitamin C (mg/g) | Total Phenol (mg GAE/g) | Total Flavonoid (mg QE/g) | Antioxidant Activity IC50 (ppm) |
|-----------|----------------------------|-----------------|------------------|------------------------|--------------------------|-------------------------------|
| Lime 5%   | 136,778±1,486              | 78007,39±4268,91| 0,557±0,006      | 8,523±0,137            | 24,795±1,381             | 259,213±17,018                |
| Lime 10%  | 151,431±2,811              | 73992,39±562,99 | 0,586±0,014      | 8,751±0,208            | 27,083±2,229             | 237,227±4,970                 |
| Lime 15%  | 173,769±2,571              | 76427,54±5738,35| 0,659±0,009      | 9,071±0,173            | 30,767±2,361             | 213,111±17,512                |
| Tamarind 5% | 152,822±2,116          | 78988,82±3261,32| 0,522±0,020      | 8,169±0,107            | 21,352±1,255             | 264,877±21,688                |
| Tamarind 10% | 172,798±1,362           | 74555,20±4830,27| 0,561±0,018      | 8,524±0,257            | 25,138±1,576             | 252,469±5,867                 |
| Tamarind 15% | 197,241±2,357           | 75490,84±3757,00| 0,633±0,013      | 8,84±0,213             | 28,74±1,328              | 233,306±8,276                 |

Note: 1) The number after ± is the standard deviation value. 2) Each data is an average of 4 replicates.

The capsaicin levels of chili powder ranged between 73000 - 78000 ppm. The results showed that the type and concentration of extract had no significant effect on capsaicin levels. Factors affecting capsaicin levels are the processing and chili genotypes. Drying process can increase the spiciness level of a chili because the heating process causes excessive heat which reduce water content and increase capsaicin content [5]. The difference of capsaicinoid levels between chilli types also caused by the expression of P1 gene that plays a role in the character of spiciness [20].

The results of the analysis of vitamin C levels ranged between 0.5 - 0.66 mg / g. The results showed that the type and concentration of extract significantly affected vitamin C levels. Based on Table 3 above, the higher the concentration of extract, the higher levels of vitamin C. Lime solution also has a higher vitamin C content compared to the tamarind solution. Soaking chili in extract solution can maintain vitamin C levels in the product. Loss of vitamin C in powder products due to exposure of heat from the drying temperature can be reduced by soaking in acidic solution [2]. Soaking chili with citric extract after blanching can maintain vitamin C levels compared to chili which is only blanched [5].

The results of the analysis of total phenols ranged from 8-9 mg GAE / g. The results showed the type and concentration of extract significantly affected the total phenol. Based on Table 2, the higher extract concentration, the higher total phenol. Lime solution also had a higher total phenol than tamarind solution. Extract immersion is thought to cause degradation of cell membrane so that phenol easily exits from the cell. acidic conditions cause many vacuole walls to break, making it easier for phenol compounds to exit the cell [21]. Phenol also has acidic properties so that extract soaking can provide suitable conditions for phenol extract [22].

The results of total flavonoid analysis ranged from 21-30 mg QE / g. The results showed that the type and concentration of extract significantly affected total flavonoids. Based on the result above, the higher the extract concentration, the higher the total flavonoids on samples. Lime solution also have a higher total flavonoids than tamarind solution. Soaking with extract solution is thought to cause the cell membrane degraded so that phenol easily exits from the cell. Acidic conditions cause many vacuole walls to break, making it easier for phenol compounds including flavonoids (as part of phenol) to exit the cell [21].

The results of the IC50 antioxidant activity analysis of chilli powder ranged from 214-265 ppm. Based on Table 2, the higher the extract concentration, the lower the IC50 value. Lime solution has a lower IC50 value than the tamarind solution. This can be caused by the total phenol content, total flavonoids, and vitamin C levels that are maintained due to extract immersion. The higher concentration of total phenol, total flavonoids, and vitamin C levels, will caused higher antioxidant activity (lower IC50 value). The antioxidant activity in chili is affected by total phenol, total flavonoids, and vitamin C levels, where the higher total phenol, total flavonoid, and vitamin C levels have a lower IC50 value [23].
Antioxidant activity of different extracts depends on DPPH radical scavenging activity at pH condition. Previous research (18) reported that methanol extract from peanut shells had higher antioxidant activity at neutral and acidic pH. Antioxidant activity of different extracts from cocoa products is higher at alkaline pH (19). The phytochemical component in each plant depends on the type of species such as wax or non-waxed species, the material, fresh or dry, and parts used as leaves, fruit or bark, and selected compounds such as carotenoids, non-polar molecules and simple phenols, polar compounds are also a determinant factor of differences in phytochemical compounds (20). Antioxidant activity is influenced by the functional properties of residuals (ie ascorbic extract, total carotenoids and total phenols, flavonoids) and when compared with fresh chili, decreased antioxidant activity is influenced by thermal processes (5).

3.4 Physical Characteristic of Chili Powder
Analysis of the physical characteristics of chili powder in this study was a color, include: L (brightness), a (redness), and b (yellowness) which can be seen in table 3.

Based on table 3, the higher the extract concentration, the lower L color value and the lime solution has a higher L color value than the tamarind solution. Fresh lime juice contains 6.15% citric extract, 0.52% malic extract, 0.09% lactic extract, and a small amount of tartaric and bitartaric potassium [20]. Tamarind flesh contains 6.63% tartaric extract, 5.27% bitartaric potassium and 2.20% citric extract [17]. The appearance of the color of the solution, the lime solution has the color of a yellow and clear solution while the tamarind solution has the color of a brown solution. Soaking the brown tamarind solution can reduce the brightness level of the product. So that the L color value with immersion of tamarind solution has a low value. The color of brown in tamarind is due to the darkening of the tannin which indicates that the tannin content is getting higher [18].

Table 3. The Physical Characteristics of Chili Powder

| Treatment     | Brightness Level (L) | Redness Level (a) | Yellowness Level (b) |
|---------------|----------------------|-------------------|----------------------|
| Lime 5%       | 58.460±0.921         | 17.205±0.189      | 36.415±1.704         |
| Lime 10%      | 58.328±1.224         | 19.240±0.198      | 35.95±1.17           |
| Lime 15%      | 58.258±1.274         | 22.275±0.567      | 35.935±1.399         |
| Tamarind 5%   | 57.533±0.534         | 19.633±0.189      | 35.398±0.847         |
| Tamarind 10%  | 57.415±1.092         | 22.273±0.051      | 36.26±0.857          |
| Tamarind 15%  | 57.075±1.202         | 26.425±0.329      | 35.233±0.577         |

The higher the extract concentration, the higher the color value a (redness) and the lime solution has “a” lower color value than the Javanese tamarind solution. Soaking with extract can maintain the red color of chili powder because the extract acts as an antibrowning agent in chili. Extracts can inhibit the formation of brown pigments due to maillard reactions and a decrease in pH because extracts can also inhibit oxidation which causes browning of fruits or vegetables [19].

Note: 1) The number after ± is the standard deviation value. 2) Each data is an average of 4 replicates.

Soaking in fruit extract does not affect the yellowish color due to the use of low extract concentrations and the results of each treatment which produces a dominant red color. So that the yellowish color of each treatment is not significant at the color value b.

3.5 Best Treatment
Determination of the best treatment used Zeleny multiple attributes method. The parameters used are reddish color (a *), total color value (ASTA), capsaicin, total phenol, total flavonoids, vitamin C levels, and antioxidant activity (IC 50). The results showed that the best treatment was the treatment using of 15% lime solution. After obtaining the best treatment, then the results be compared with the results of control by soaking in 0.3% sodium metabisulfite solution + 1% citric extract, and 1% citric extract solution. The results of comparative analysis was shown in table 4.
Table 4. Comparison of control analysis with the best treatment of chilli powder

| Parameter                        | 0.3 Na trium metabisulfit + 1% citric extract | 1% Citric extract | 15% Lime |
|----------------------------------|---------------------------------------------|-------------------|---------|
| Color a* (ASTA)                  | 24.1±0.35                                   | 19.4±0.28         | 22.28±0.57 |
| Total color value (ASTA)         | 182.39±6.29                                 | 150.96±4.9        | 173.76±2.6 |
| Total capsaicin (ppm)            | 75028.58                                    | 72416.73          | 76427.54 |
| Total phenol (mg GAE/g)          | 9.3±0.09                                    | 8.6±0.29          | 9.07±0.17 |
| Total flavonoid (mg QE/g)        | 32.18±2.73                                  | 26.06±1.4         | 30.76±2.36 |
| Total Vitamin C (mg/g)           | 0.68±0.01                                   | 0.63±0.02         | 0.66±0.09 |
| Antioxidant activity IC50 (ppm)  | 208.98±10.3                                 | 218.6±12.5        | 213.11±17.5 |

Note: 1) The number after ± is the standard deviation value. 2) Each data is an average of 4 replicates.

Based on table 4, each parameter of best treatment has a lower average value compared to the control of 0.3% sodium metabisulfite solution + 1% citric extract. Then the paired t-test was tested to find out whether there was a difference in the value of the control with the best treatment. Paired t-test analysis shows that each parameter does not give a significant difference with the control, it can be seen with a p-value <0.05. This can be stated even though the the best treatment had lower mean value than the control, there is no significant difference between the two samples.

4. Conclusion
The best treatment resulted using the Zeleny method was obtained by combination of soaking with 15% lime solution. The result from the best treatment sample were; color a * 22.28 ± 0.57, total color value 173.769 ± 2.57 ASTA, capsaicin level 76427.54 ppm, total phenol 9.07 ± 0.17 mg GAE / g, total flavonoids 30, 76 ± 2.36 mg QE / g, vitamin C levels 0.66 ± 0.09 mg / g, and IC 50 amounted to 213.11 ± 17.51 ppm. Based on paired t-test analysis, the best test results have a chemical characteristic (color value, total color value, capsaicin content, total phenol, total flavonoids, vitamin C levels, and antioxidant activity IC50) which are not different from control. Soaking with lime 15% solution has the same effect as soaking with synthetic chemical substances in maintaining physical and chemical characteristics of chili powder.

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