

## ANALYSIS OF ASCORBIC ACID AND BORAX USING PURPLE SWEET POTATO EXTRACT AS A COLORIMETRIC SENSOR IN FOOD AND DRINKS USING DIGITAL IMAGES

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### ABSTRACT

The addition of ascorbic acid and borax to food and drinks if it exceeds the threshold limit can have dangerous effects on consumers. This research aims to create a simple and fast but accurate method for analyzing ascorbic acid and borax, using purple sweet potato extract as a colorimetric sensor and quantitative analysis using digital images. The results of the digital image have an accuracy of 99% with LOD (Limit of Detection) of 1.96% and LOQ (Limit of Quantity) with a value of 6.53% for ascorbic acid. As for borax, the LOD is 0.54% and the LOQ is 1.78%. Semi-quantitative tests for ascorbic acid and borax in food and drinks can be carried out using a cotton test kit. The wet noodle food sample tested (purchased from around the Bengkulu University campus) was proven not to contain borax because there was no color change. However, the packaged drink tested positive for ascorbic acid as indicated by a color change from purple to pink.

Keywords: ascorbic acid, borax, purple sweet potato extract, digital image, cotton test kit.

### INTRODUCTION

Preservatives are substances (usually chemicals) used to prevent the growth of spoilage bacteria (Tahir, Nardin, & S., 2019). Ascorbic acid or vitamin C has the molecular formula ( $C_6H_8O_6$ ) and a molecular weight of 176.13 g/mol (Damayanti & Prasetya, 2021). The maximum limit of vitamin C that can be tolerated by the body and does not cause side effects is 2000 mg per day. However, it is safer for health to consume less than 1000 mg of vitamin C per day. If it exceeds the threshold limit, it can cause diarrhea, nausea, vomiting, heartburn, stomach cramps, headaches, and insomnia. In this regard, the risk factors for kidney stones can increase in certain people (Dokteranda, 2012).

Borax is a crystalline compound, white in color, odorless and stable at normal pressure temperatures. Borax is a dangerous chemical compound for food whose chemical name is sodium tetraborate ( $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ ). The bad impact of consuming borax is that it causes gastrointestinal irritation, which is characterized by headaches, dizziness, vomiting, nausea and diarrhea. Further symptoms are characterized by the body becoming weak, kidney damage, even shock and death if swallowed 5 – 10 g/kg body weight (Suseno, 2019).

Purple sweet potatoes are one of a kind of *Ipomoea potatoes L. Poir* which has a deep purple color in its sweet potato flesh, so it attracts a lot of attention. The purple color of sweet potatoes is caused by the purple pigment anthocyanin which spreads from the skin to the flesh of the sweet potato. This concentration of anthocyanin is what causes several types of purple sweet potato to have different shades of purple (Salzabilah, Inayah, & Khaer, 2022).

The quantitative analysis method that is starting to develop now is the digital image method which is a combination of digital photos and colorimetry. This method has good potential in quantitative analysis because this method is simple, cheap, and has high potential in colorimetric analysis (Dinata, Firdaus, & Rina, 2019). This method is carried out with the help of an application to measure red-green-blue or RGB colors and a summary of the analyte concentration (Permana, et al., 2023).

In this study, researchers also made a cotton test kit which has been added with purple sweet potato extract. This is for the identification of ascorbic acid and borax in food and drinks in a simple, fast, cheap, and accurate manner. The aim of this research is to create a new qualitative and quantitative analysis method that is fast, simple but accurate in detecting ascorbic acid and borax in food and drinks.

## **METHOD**

### **Tools and materials**

The tool used in this research is the Genesys 20 UV-Vis Spectrophotometer (Thermo Fisher Scientific, USA). The filter paper used is Whatman (UK), cuvette, grated coconut, purple sweet potato peeler, basin, tissue, watch glass, stirring rod, napkin, knife, beaker, measuring cup, measuring flask, glass funnel, dropper, bottle vials, spray bottles, analytical balances,

micropipettes, mini studio boxes, and cotton buds. The applications used is a cell phone camera, Microsoft Excel, imageJ, and Minitab.

The materials used in this research were purple sweet potatoes, wet noodles (food samples), packaged drinks (drink samples), distilled water, sodium nitrate, sodium sulfate, sodium nitrite, magnesium sulfate, formalin, ascorbic acid, and borax.

## **Procedure**

### **Making purple sweet potato extract**

After that, peel the purple sweet potato skin, and wash the purple sweet potato. Then, 50 grams of purple sweet potato were grated and weighed using an analytical balance. After weighing, the purple sweet potato is squeezed using a clean napkin. Next, add 100 ml of distilled water and mix it with the squeezed purple sweet potato. After that, stirred and filtered using a glass funnel and Whatman filter paper. The resulting purple sweet potato extract was put into a 100 ml vial and stored at room temperature.

### **Preparation of solutions for selectivity tests**

In the selectivity test, several preservatives were used, namely Sodium nitrate, Sodium sulfate, Sodium nitrite, Magnesium sulfate, Formalin, Ascorbic acid and Borax. The standard solution was prepared with a concentration of 5% of each ingredient and diluted to 0.5%.

### **Determination of sensitivity**

Determination of sensitivity using a solution of Sodium nitrate, Sodium sulfate, Sodium nitrite, Magnesium sulfate, Formalin, Ascorbic acid, Borax, and distilled water (as a blank). Each solution was put into 6 ml 10 ml vials using a micropipette. Next, 15 drops of purple sweet potato extract were added to the solution in the vial. Then, 3 ml of each solution was put into a cuvette. Observe the color changes that occur. After that, it was photographed for digital image data and measured using a UV-Vis spectrophotometer instrument.

### **Preparation of a standard solution of ascorbic acid and 10% borax**

Put 10 grams of ascorbic acid and borax each into a 100 ml measuring flask and distilled water is added to the mark.

### **Preparation of standard solutions of ascorbic acid and borax**

Preparation of a standard solution of ascorbic acid and borax solution is carried out using the dilution method. Dilution of ascorbic acid solution is made into several concentrations, namely: 0.5%; 1%; 1.5%; 2%; 2.5%; and 3% using the following dilution formula:

### **Determination of wavelength**

The maximum wavelength of the UV-Vis spectrophotometer was determined using a standard solution of ascorbic acid and borax to which purple sweet potato extract was added. Absorbance values were taken in the wavelength range 400-800 nm. The maximum wavelength is determined based on the maximum absorbance.

### **Making a calibration curve using the UV-Vis spectrophotometer method**

Ascorbic acid solution and borax solution with varying concentrations of 0.5%; 1%; 1.5%; 2%; 2.5%; Put 3% 6 ml each into a 10 ml vial, then add 15 drops of purple sweet potato extract. 3 ml of each solution was put into a cuvette. Next, the absorbance at the maximum wavelength was measured as data for analysis using the UV-Vis spectrophotometer method. Creation of calibration curves using the application Microsoft Excel with the linear line equation as follows:

### **Retrieval of RGB color component value data from standard analysis of ascorbic acid and borax using digital images**

The ascorbic acid and borax solution in the cuvette which had been synthesized and the absorbance value was searched using the UV-Vis spectrophotometer method, was then photographed in a mini studio box for analysis of ascorbic acid and borax. After that, carry out data processing using the application imageJ, minitab and Microsoft Excel Find the RGB intensity using the Lambert-Beer equation as follows:

$$A = \log \frac{I_0}{I_t} \quad (1)$$

Information :

A = Absorption intensity of the color component,

$I_0$  = Intensity value of the color component of the blank solution,

$I_t$  = Intensity value of the color component of the stock solution

### **Testing samples of packaged drinks with purple sweet potato extract**

Sample testing is carried out by looking for samples of packaged drinks. Samples of packaged drinks were weighed at 0.5 gr, 1 gr, 1.5 gr, 2 gr, 2.5 gr, and 3 gr. Then, put it into a 100 ml measuring flask with 100 ml of distilled water added to each and homogenize. After that, the drink sample solution was filtered using a glass funnel and Whatman filter paper. Put 6 ml of solution from the filtered bottled drink into a vial and add 15 drops of purple sweet potato extract. Then, put 3 ml of the solution from the packaged drink into the cuvette that has been dripped with purple sweet potato extract. Observe the color change in the sample.

### **Testing samples of wet noodle food with purple sweet potato extract**

Sample testing is carried out by looking for wet noodle samples. Each sample of wet noodles was weighed at 5 grams and then crushed using a mortar. Then put it in a beaker with 25 ml of water added and stir using a spatula. The wet noodle sample solution was filtered using a glass funnel and Whatman filter paper. Put 6 ml of the filtered solution into a 10 ml vial and add 15 drops of purple sweet potato extract. Then, put 3 ml of the wet noodle solution into the cuvette that has been dropped with purple sweet potato extract. Observe the color change in the sample.

### **Cotton test kit**

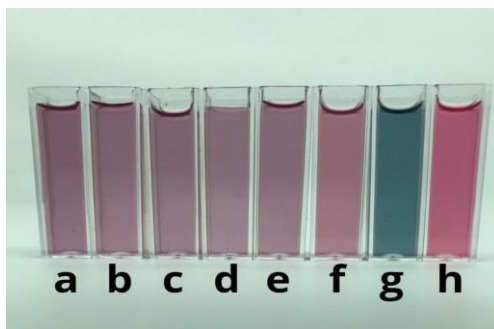
Manufacturing cotton test kit made using cotton buds with a top stem or cotton stem which is used to attach a color change indicator (colorimetry) as a sensor. The indicator used is purple sweet potato extract which has been attached to cotton buds and let stand 1 day until dry. How to use a cotton test kit: prepare samples of wet noodles and packaged drinks to be tested, then enter/paste cotton test kit into samples of wet noodles and packaged drinks to be tried for 1 minute. After that cotton test kit is taken and see the results.

## **RESULTS AND DISCUSSION**

Extraction is a method of separating two or more components by adding the appropriate solvent (Safari, et al., 2019). The purple color of purple sweet potatoes is caused by the presence of natural dyes called anthocyanins. Anthocyanin is a flavonoid derivative compound that can give red, purple, blue colors to flowers, leaves, tubers, fruits and vegetables depending on the pH of the environment where they are located (Mahmudatussa'adah, et al., 2014).

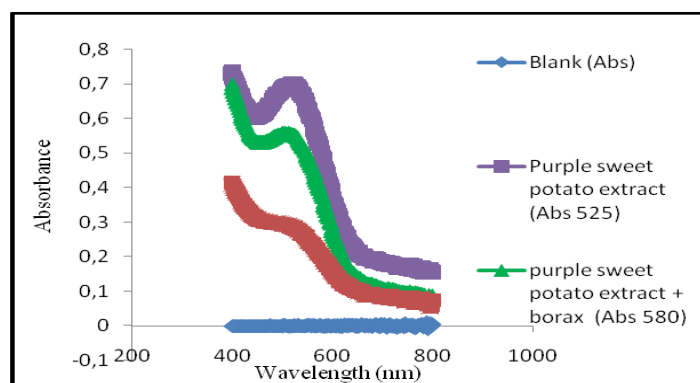
The anthocyanin content of purple sweet potato is not much lower than other types of plants, ranging from 14.68 to 210 mg/100 g of raw material (Garmini, 2021). The results of purple sweet potato extract have a pH of 6, which means purple sweet potato is acidic. According to (Mahmudatussa'adah, et al., 2014) Testing purple sweet potato anthocyanin at pH 1-14 shows that at pH 1-3 (strong acid) the color is red, at pH 4-6 (weak acid) it turns purple, at pH 7 it turns blue, at pH 8-9 (weak base) is green and at pH 10, 11, 12, 13, 14 is yellow. Purple sweet potatoes become strongly acidic when an ascorbic acid solution with a pH of 3 is added, resulting in a color change from purple to pink. However, when purple sweet potato is added to a borax solution with a pH of 9, the color changes from purple to green.

The selectivity test solution is made using distilled water, sodium nitrate solution, sodium sulfate, sodium nitrite, magnesium sulfate, formalin, ascorbic acid and borax. The standard solution was prepared with a concentration of 5% of each ingredient and diluted to 0.5%. 6 ml of each solution was put into a 10 ml vial using a micropipette. Next, 15 drops of purple sweet potato extract were added to the solution in the vial. Then, 3 ml of each solution was put into a cuvette. The selectivity test is a way of measuring the ability of a reagent which only measures certain substances carefully and thoroughly in the presence of other components that may be present in the sample matrix (Pratiwi, Wardaniati & Dewi, 2019). This selectivity test shows positive results with a color change to pink (ascorbic acid) and turns green (borax). The color change that occurs is caused by the amphoteric nature of purple sweet potato anthocyanin, namely its ability to react with acids and bases. Under acidic conditions, anthocyanins are red and turn green under alkaline conditions (Setyawati & Daryanti, 2020). This proves that purple sweet potato as a natural indicator can detect the presence of ascorbic acid and borax in food and drinks.



**Picture 1.** Selectivity test of purple sweet potato extract against various types of preservatives, namely (a) distilled water, (b) Sodium nitrate solution, (c) Sodium sulfate, (d) Sodium nitrite, (e) Magnesium sulfate, (f) Formalin, (g) Borax, (h) Ascorbic acid

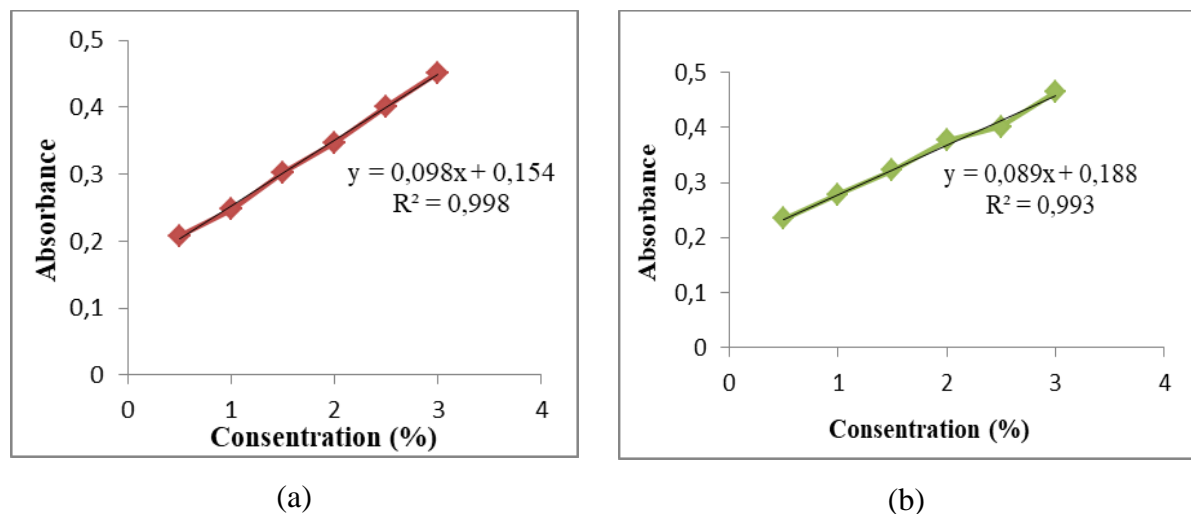
Next, namely forming an absorbance spectrum on a UV Vis Spectrophotometer in the range of 400-800 nm. In purple sweet potato extract, the maximum wavelength is 525 nm. Meanwhile, the maximum wavelength of purple sweet potato extract + borax is 580 nm and the maximum wavelength of purple sweet potato extract + ascorbic acid is 528 nm. This can be seen in picture 2.



**Picture 2.** Visible light spectrum with maximum wavelength

After that, the resulting 10% stock solution was diluted to several concentrations, diluting the ascorbic acid and borax solutions to several concentrations of the standard solution, namely 0.5%; 1%; 1.5%; 2%; 2.5%; and 3%. Put 6 ml of each solution into a 10 ml vial and add 15 drops of purple sweet potato extract. After mixing, put 3 ml into a cuvette. The absorbance spectrum data for each cuvette was measured using a UV Vis spectrophotometer.

A calibration curve is a relationship between the response of an instrument and a known quantity (concentration) of an analyte. From the calibration curve, a linear equation is obtained which states the relationship between concentration and absorbance. The calibration curve is also referred to as the standard curve. The function of a calibration curve is to determine the concentration of a substance in a sample whose concentration is unknown by comparing the unknown concentration with a set of standard samples whose concentration is known (Nisah & Nadhifa, 2020). The results of the calibration curve taken from absorbance data based on concentration can be seen in Picture 3.



**Picture 3.** (a) Ascorbic acid and (b) borax calibration curve analysis using purple sweet potato extract using a UV-Vis spectrophotometer.

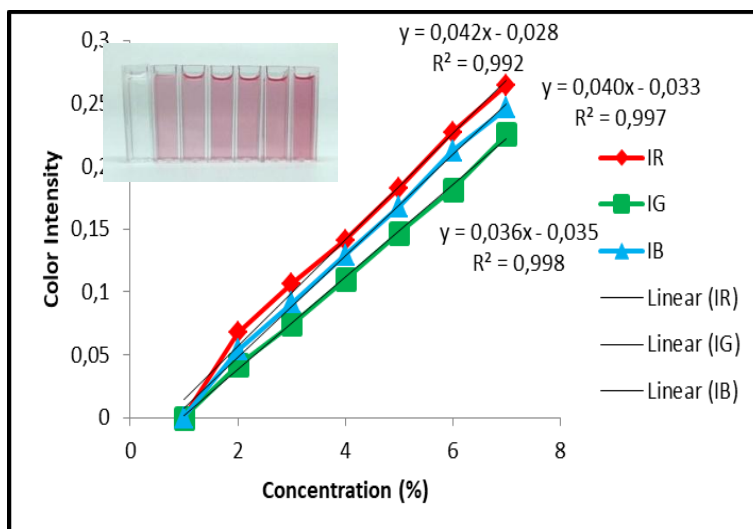
Based on Figure 3(a), it can be seen that the calibration curve formed has the equation  $y = 0,098x + 0,154$  with a value of  $R^2 = 0,998$  and in Figure 3(b) the calibration curve formed has  $y = 0,089x + 0,188$  with an  $R^2$  value = 0,993. Therefore, if the  $R^2$  value is close to 1, the better the level of data suitability (Anugrah Divine et al., 2021).

Next, analyze the levels of ascorbic acid and borax using digital image methods. A solution of ascorbic acid and borax in a cuvette was synthesized and the absorbance value was searched using the UV-Vis spectrophotometer method, then photographed in a mini studio box and then analyzed digitally by looking for each RGB color intensity value. Data for searching RGB values from the imageJ application can be seen in Table 1.

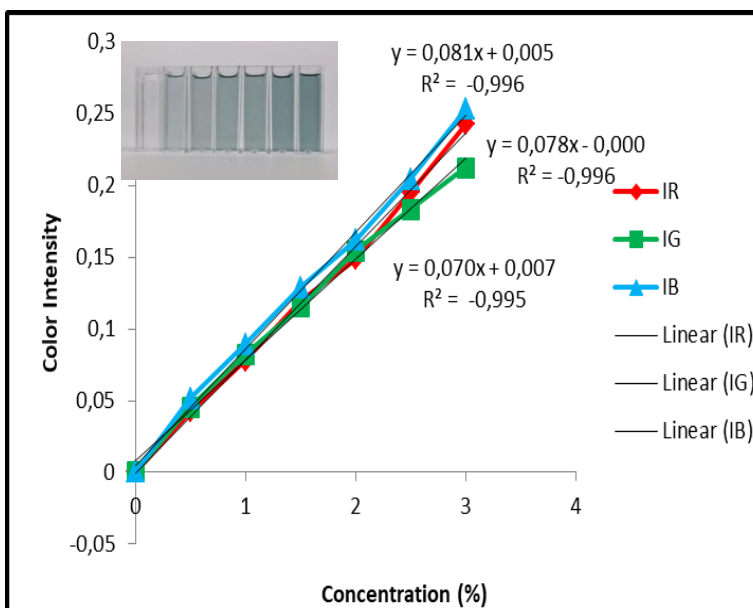
**Table 1.** RGB values of Ascorbic Acid and Borax from the application imageJ

Concentration %	Ascorbic Acid			Borax		
	R	G	B	R	G	B
0	198.104	194.216	196.305	196.573	194.586	199.527
0,5	169.553	176.417	173.445	178.267	175.188	177.188
1	155.110	163.641	159.188	164.314	160.969	162.374
1,5	143.119	150.742	145.782	149.288	149.264	148.267
2	130.217	138.408	133.427	139.636	136.405	137.546
2,5	117.503	127.885	120.480	125.503	127.655	124.714
3	107.729	115.637	111.421	112.509	119.413	111.467

Based on the RGB data in Table 1, then look for the intensity value of each color component with results as in Picture 4 and Picture 5.



**Picture 4.** RGB color intensity value of Ascorbic Acid



**Picture 5.** RGB color intensity values in Borax

Based on Picture 4. Color component calibration curve Red has a slope and the highest correlation coefficient (R<sup>2</sup>). In picture 5. The color component calibration curve Blue has a slope and the correlation coefficient (R<sup>2</sup>) is the highest, so it can be used for further sample measurements. Then, the digital image is a photo of the results cell phone with arrows showing concentrations from lowest to highest.

The digital image calibration curve has 3 color components, namely the R color component (Red), G (Green), and B (Blue). In ascorbic acid, the color component R (Red) has a significant slope with a value of  $R^2 = 0.992$  with a straight line equation value, namely  $y = 0,042x - 0.028$ . Then, in borax, color component B (Blue) has a significant slope with a value of  $R^2 = 0.996$  with a straight line equation value, namely  $y = 0,081x - 0,005$ .

The line equation obtained will be used for analysis of ascorbic acid and borax in samples where the concentration of ascorbic acid and borax is unknown. Next, the calibration curve equation for the color components is used to determine the LOD (Limit of Detection) or the minimum detection limit of the packaging and obtained a value of 1.96% ascorbic acid and LOQ (Limit of Quantity) or the limit of quantification with a value of 6.53% ascorbic acid. Meanwhile, LOD (Limit of Detection) or minimum detection limit obtained a value of 0.54% borax and LOQ (Limit of Quantity) or the limit of quantification with a value of 1.78% borax. The digital image method provides the same measurement results as the UV-Vis spectrophotometer which is characterized by an  $R^2$  close to 1, so it can be concluded that the digital image method developed by this researcher is accurate. After that, samples of packaged drinks with purple sweet potato extract were tested, the results can be seen in Picture 6.

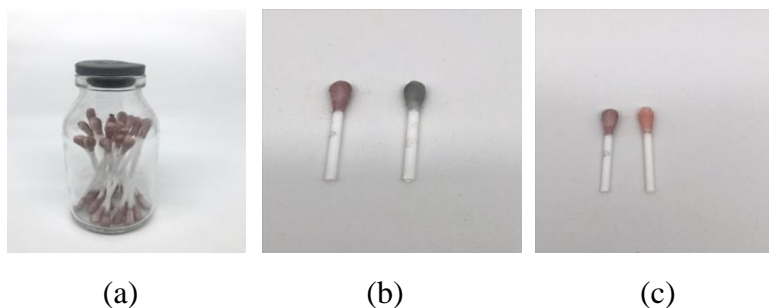


**Picture 6.** Digital image measurement results of packaged drink samples

The test results for packaged drink samples were positive for containing ascorbic acid with a color change from purple to pink. In the analysis carried out using a UV-Vis spectrophotometer test and digital images, the accuracy value  $R^2 = 0.994$  or close to 1 was obtained. Based on the research that has been carried out, purple sweet potato extract can be used as a detector for ascorbic acid in drinks.

Based on this research, detecting ascorbic acid and borax in food and drinks is a cotton test kit which is made using cotton buds with the upper stem or cotton stem used to attach the

color change indicator as a sensor (purple sweet potato extract). The test results for the cotton test kit can be seen in picture 7.



**Picture 7.** (a) cotton test kit + purple sweet potato extract, (b) cotton test kit changes color to green (indicating that the wet noodle sample contains borax), (c) cotton test kit changes color to pink (indicating that the packaged drink sample contains ascorbic acid)

## CONCLUSION

The digital image method provides the same measurement results as the UV-Vis spectrophotometer which is characterized by an  $R^2$  close to 1, so it can be concluded that the digital image method developed by this researcher is accurate. This was proven by the wet noodle food samples tested (purchased from around the Bengkulu University campus) that did not contain borax because there was no color change. However, the packaged drink tested positive for ascorbic acid as indicated by a color change from purple to pink.

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