Formalin and Borax Qualitative Test Use Natural Indicator

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Abstract. The purpose of this study is to identify natural indicators that can be used to test the qualitative presence of formalin and borax. The results of this qualitative test can be used for student learning in schools, especially for harmful additive substances in food. Qualitative test using a drop test. Formalin test using extract flower of ribose ruellia, hibiscus rosa-sinensis L and Impatiens L balsamina, while for borax test using ruellia simplex, plumeria rubra, portulaca grandiflora and curcuma longa. Based on the results of the research that has been done, the extract can be used to determine the presence of borax and formalin with a drop test.

1. Introduction
Indonesia is currently still using formalin and borax for food, the materials is often used as an additional snack[1]. Formalin is a carcinogenic substance and has been known to cause negative effects on human health. Acute exposure leads to irritation in the eyes, nose and throat. Frequent exposure can also cause severe allergic reactions in the skin, eyes and respiratory tract. Chronic exposure to formaldehyde results in symptoms of neurasthenia, which include headaches, dizziness, sleep disorders, and memory loss[2]. While the borax doses of 200-640 mg boric acid / kg have been reported to be lethal, but the number has not been fully verified[3]. Another report states that the lowest deadly dose after accidental swallowing of boric acid by humans ranges from about 98 to 650 mg boron / kg body weight[4]. Death has been reported when boron is administered intravenously at 0.5 mg boron / kg body weight [5].

There have been various studies in formalin identification that have been carried out, the development of fluorophotometric methods for the determination of formaldehyde in environmental waters, based on the reaction of formaldehyde with acetooacetilide and ammonia [6]. Determination of formaldehyde levels in human saliva. Formaldehyde was determined as an addition to dimedone (formaldemethone) using OPLC[7]. Determination of total formaldehyde in drinking water samples in 1 liter of water was derivatized with 2,4-dinitrophenylhydrazine in acidic medium and then extracted with chloroform. After separation by solvent extraction, the product was confirmed using reverse phase liquid chromatography[8]. In 2010 proposed a simple and fast catalytic kinetic method (based on the catalytic effect of formaldehyde on cresylviolet oxidation by bromate in the presence of sulfuric acid) for the determination of the amount of formaldehyde in water samples. The method of identifying the most widely used formalin for aqueous samples is high performance liquid chromatography (HPLC). Other methods that can be used are colorimetry, fluorimetry, polarography, gas chromatography (GC), infrared detection, injection flow analysis and gas detector tubes[9]. HPLC or GC combined with mass spectrometers (MS) are the most sensitive techniques, but require very expensive costs.

There are several methods that have been used to test the presence of borax. There are three methods known for determining detailed boric acid in food, namely the titrimetric method using mannitol, and two colorimetric procedures using carminic acid or curcumin. Colorimetric procedures
with the curcumin method is found to be the most reliable and therefore will be the method of choice for the determination of boric acid in food [10]. Another method is fast quantitative analysis of boric acid by gas chromatography-mass spectrometry coupled with a simple and selective derivatization reaction using triethanolamine[11].

The methods for testing formalin and borax described above are expensive and they are less feasible for classroom instruction, in particular to be implemented for student in school. Alternative methods should be developed using simple, low cost, and accessible procedures[12]. Qualitative tests of formalin and borax can use natural indicators from plants around the environment so that they are cheap and easy to obtain. Students at school can use this qualitative test to identify the presence of formalin and borax.

2. Methodology

Materials
The tool used to test formalin and borax using the drop test method is, drop palette, pestle and mortal, knife, dropper pipette. While the materials used were: aquades, formalin, borax, for formalin test using flowers of *ribose ruellia, hibiscus rosa-sinensis* L and *Impatiens balsamina*, for borax test using flowers of *ruellia simplex, plumeria rubra, portulaca grandiflora* and *curcuma longa*.

Methods
The formalin test with natural indicators uses the following drops test:

a. Weigh 2 grams of natural indicator materials (flower *ribose ruellia, hibiscus rosa-sinensis* L and *balsamina Impatiens*) L), then cut them into small pieces
b. Grind the material by using mortal
c. Add 5 ml of distilled water to the crushed material and stir manually
d. Let the mixture settle and then decant the filtrate
e. Take 5 drops of the filtrate then add 5 drops of formalin solution
f. Observe the color changes that occur

The borax test with natural indicators uses the following drops test:

g. Weigh 2 grams of natural indicator materials (flower of *Ruellia Simplex, Plumeria Rubra, Portulaca Grandiflora* and *Curcuma Longa*), then cut them into small pieces
h. Grind the material by using mortal
i. Add 5 ml of distilled water to the crushed material and stir manually
j. Let the mixture settle and then decant the filtrate
k. Take 5 drops of the filtrate then add 5 drops of borax solution
l. Observe the color changes that occur

The test drops a natural indicator of plant extracts flower conducted the experiment for 3 times for each indicator. Flower plant extracts that can be used as indicators are those that can show color changes before and after adding formalin and borax.

3. Result and Discussion

Based on the results of the trial of 10% formalin solution using various ingredients that have been identified, 3 samples of indicators can be used, namely: *ruellia ribosa, hibiscus rosa-sinensis* L and *impatiens balsamina* L purple. The following are the results of the 10% formalin trial with these 3 types of indicators.

| Natural indicator | Drop test results |
|-------------------|-------------------|
| *Ruellia Ribosa*  | ![Before](image1.png) ![After](image2.png) |

Table 1. Test results of natural indicators
In general, the color of flowers is caused by flavonoid and carotenoid pigments which can attract attention to help pollination [13]. Flavonoids are the most common flower color pigment, and the dominant flavonoid pigment is anthocyanins. Anthocyanins are composed of anthocyanidin and sugar groups. They are the basis for most of the colors orange, pink, red, magenta, purple, blue, and blue-black. Common anthocyanidins are pelargonidin, cyanidin, peonidin, delphinidin, petunidin, and malvinidin, named after the genera from which they were first isolated. Most anthocyanins come from only the following three basic anthocyanidins: pelargonidin, cyanidin, and delphinidin [14].

The first natural indicator that can be used as a substance to identify formalin is *Ruellia Simplex*. The dyestuffs contained in ribose with purple color *Ruellia* are anthocyanins [15]. Anthocyanins are a biocative component of the flavanoid group found in flowers, leaves, yams, fruits and vegetables clinging to the Ph of the environment in which they are located [16][17]. Changes in Ph cause changes in the structure of the quinonoidal anhydrobase (A) Ph of 6.5-8 to Karbinol (B) Ph <6 [18]. Formalin solution which has a Ph of about 2.8-4.0 when mixed with the extract of ribosa *Ruellia* with purple color will experience a blue-green color change due to structural changes. Structure changes that cause completement color changes that can be observed as an indicator to determine the presence of formalin in a sample.

The second natural indicator that can be used is *Hibiscus rosa-sinensis L*. Hibiscus anthocyanins are phenolic natural pigments extracted from the dried flowers of Hibiscus that have been used effectively in folk medicines against hypertension, pyrexia and liver disorders. The pigments are contained in the flowers of Hibiscus species are anthocyanins such as cyanidin-3-glucoside and delphinidin-3-glucoside [19][20]. Ph has a major effect on the color of anthocyanins. They are redder and more intense in color at low (acid) Ph and bluer and less intense in color at a higher Ph. A change in the structure of anhydrobase which has a Ph of 6-7 is bluish-colored to a colorless structure of carbinol pseudabase Ph <4 and flavylium cation which has a Ph> 3 of reddish color [21]. Based on the results of the research that has been done it is known that *Hibiscus rosa-sinensis L* flower can be used as an indicator of formalin test because it can experience a change in color from bluish to pink.

The third indicator that can be used to identify the presence of formalin is the flower of *Impatiens balsamina L*. The color of *Impatiens balsamina L* flower is caused by anthocyanins [22]. Changes in the structure of anthocyanins occur from the structure of the quinonoidal anhydrobase (A) Ph 6.5 to 8 to Karbinol (B) Ph <6 [18]. This change is almost the same as the changes that occur in the flower *Ruellia Simplex*. With these changes, the *Impatiens balsamina L* flower can be used as an indicator of formalin.

Based on the results of 0.1 M borax solution using various plant extracts that have been identified, 4 samples of extracts give positive reaction, namely: *Ruellia Simplex, Curcuma Longa, Plumeria Rubca, and Portulaca Grandiflora*. The following are the results of the 0, 1 M borax trial with these 4 types of indicators.

| Natural indicator      | Drop test results |
|-----------------------|-------------------|
| *Ruellia Simplex*     | ![Image](before_after.png) |
| *Curcuma Longa*       | ![Image](before_after.png) |
Plumeria Rubra

The first natural indicator that is used as extract to identify borax is the *ruellia simplex*. The dyestuffs contained in *ruellia simplex* with purple color are anthocyanins[15]. Anthocyanins are a bioactive component of the flavonoid group found in flowers, leaves, yams, fruits and vegetables clinging to the Ph of the environment in which they are located [16][17]. The structure of anthocyanins changes at Ph 1, Ph 4.5 and Ph 7 [23]. Changes in Ph cause changes in the structure of the quinonoidal anidrobase Ph 6.5-8 to cis-chalcone Ph > 9[18]. Borax solution which has a Ph of around 9.5 when added drop wise to the extract of *Ruellia simplex* that shows purple color will experience a blue-green color change due to structural changes. Structural changes cause complement color changes that can be observed as an indicator to determine the presence of borax in a sample.

The second natural indicator used to identify borax is turmeric. Turmeric contains the main ingredient of yellow color known as curcumin [24]. Curcumin (1,7-Bis- (4-hydroxy-3methoxyphenyl)- hepta-1,6-diene-3,5-dione) is an oil-soluble pigment, practically insoluble in water at acidic and neutral Ph, soluble in alkali and very vulnerable form of Ph change [25]. However, in an aqueous system such as water, it can be understood that at alkaline Ph, the phenol group acid in curcumin donates hydrogen, forming phenolic ions which allow curcumin to dissolve in water. This form is not stable at neutral and alkaline Ph for a longer period of time and easily degrades into compounds such as vanillin, ferulic acid, etc. This form is stable at a Ph below 7.0 but with a decrease in Ph value, shifting the dissociation equilirium to a neutral form with very low water solubility [26]. The curcumin obtained from turmeric can be used to decompose the borax bond into boric acid and bind it into a rosa color complex or commonly called the complex boron cyanocurcumin compound which is a red colored substance. The color change from yellow to reddish on turmeric can be used as a natural indicator material to detect the presence of borax in laboratory activities.

Plumeria Rubra

The third flower that can be used as a natural indicator material is the *Plumeria rubra* flower. Two anthocyanins were isolated from ornamental reddish flowers of Plumeria rubra L. (Apocynaceae) by a combination of chromatographic techniques. The anthocyanin cyanidin 3-O-(2-glucopyranosyl-O-galactopyranoside) (75%), has previously been isolated only from Cornus suecica (Cornaceae) fruits, while the other (20%) was identified as cyanidin-3-O-galactopyranoside [27]. Anthocyanins cause red to blue color in plants [24]. The color changes that occur in *plumeria rubra* extract after being mixed with borax solution caused by changes in the structure of anthocyanins at Ph 9.5 as in the *ruellia simplex* flower.

The fourth indicator that can be used to identify borax is the flower of *Portulaca Grandiflora* which is an ordo of Caryophyllales plants. Betalain is a pigment that replaces anthocyanins in most families of the Caryophyllales plant ordo [28]. In food processing, betalain is less commonly used than anthocyanins and carotenoids, although this water-soluble pigment, stable between Ph 3 and 7, is suitable for coloring low-acid foods [29][30][31]. If *Portulaca Grandiflora* is mixed with borax solution which has a Ph of 9.5, it will change the structure of the betalain so that the color will change from pink to red purple. This color change justifies the use of *Portulaca Grandiflora* to be a natural indicator to identify the presence of borax.

4. Conclusion

Based on the results of the research that has been done, obtained information about natural indicators that can be used for qualitative tests to determine presence of formalin and borax using the drop test method. Procedures have been developed for qualitative testing of formalin and borax with natural indicators. This finding can be used as learning material for students in schools to be able to test qualitative the formalin and borax content. Natural indicators that can be used for formalin testing
using flower extract of *ribose ruellia*, *hibiscus rosa-sinensis L* and *Impatiens L balsamina*, while for borax test using *ruellia simplex*, *plumeria rubra*, *portulaca grandiflora* and *curcuma longa*.

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