

## Enrichment of toxicology laboratory in the new era of covid-19: preliminary qualitative test of preservatives in processed food

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### Abstract

The purpose of this current study is to design a qualitative test of preservatives in processed food to enrich materials for toxicology laboratory by utilizing simple, rapid, and eco-friendly household materials. This research employed true experimental design that involved in 58 students who enrolled in the Toxicology laboratory class. The six variety of food items containing formalin and five food items containing borax were tested qualitatively using fruit extract as natural indicator. The test equipment indicator was extracted indicators from dragon fruit (*Hylocereus polyrhizus*) and turmeric (*Curcuma longa*) using water extraction process. The results of this experiment showed that both of the extract can be used to rapidly detect the presence of formalin and borax contained in the processed food. Survey analysis showed the positive responses from students toward the implementation of home-practical exercise approach. This home-hands-on activities help them to develop their thinking and hands-on abilities through home-experiments experiences. This findings provide an alternative approach for conducting practical exercise at home and or online learning as well by utilizing easily available, safe, and affordable materials. This home-practical exercise enriched alternative strategies for conducting laboratory work during the long classroom activity closure due to Covid-19 pandemic.

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## 1. Introduction

In general, processed food cannot last long to be stored, especially food ingredients. Because those foods contain of high water concentration. Increasing consumer demand encourages producers to prepare large quantities of processed food ingredients. To avoid damage in processed food, foods are stored for a long time using artificial preservatives. According to the Regulation of the Minister of Health of the Republic of Indonesia Number: 033 of 2012 concerning Food Additives, preservatives are food additives to prevent or inhibit fermentation, acidification or other breakdown of food caused by microorganisms [1]. The preservatives used are usually formaldehyde and borax. These preservatives may inhibit the growth of bacteria, so that food ingredients do not rot or spoil quickly. However these preservative chemicals may damage human health if consumed by people for long time period. Testing for the presence of preservatives in food can be done quantitatively or qualitatively. The identification of borax in processed food can be done by two methods [2]. Qualitative methods are direct observation with the sense of sight and quantitative methods using a spectrophotometer, namely absorbance measurements based on wavelengths. Quantitatively, the test must be carried out in the laboratory by analyzing the food sample. The presence of preservatives in the food, can be tested in the laboratory [3]. Meanwhile, qualitative testing can be done easily and at low cost. Even the community can also carry out qualitative tests to identify the presence of chemical preservatives in the processed food. It cannot be denied that there are still people or traders who use food preservatives [4]. Otherwise, it can reduce production costs, especially for small traders [1]. The presentation of this paper discusses types of food preservatives, risks to public health and environmentally friendly qualitative testing. The discussion is carried out by compiling information from several related articles and producing a paper that can contribute to the enrichment and development of toxicology laboratory activities. This laboratory activity supports the Toxicology course which studies the chemicals that are around us. Laboratory activities cannot be separated in science learning, especially biology. Students can acquire science process skills (KPS) through practical exercise [5]. Through laboratory activities, students can understand the theory deeply [6]. In addition, students may develop basic skills in an experiment/research, understand biology material/concepts and motivate learners [7] and provide students with an initial approach to learn [8]. These laboratory activities are designed to be carried out in their respective homes. This is done because of limitations in conducting face-to-face lectures and offline laboratory activities. Experimental activities can also be carried out without using a laboratory. This has been done by several previous researchers. The Light and Optical Take-Home Experiment Kit in science learning have been developed [9]. Meanwhile chemistry-related experiments with the application of home experiments can also improve students' science process skills and learning motivation [10]. The toxicology practical laboratory, namely qualitative testing of food preservative chemicals, was designed in order to complete the lecture of Toxicology online learning during the Covid-19 pandemic.

## 2. Materials and Methods

Preliminary qualitative test is done to 6 food items containing formaldehyde and 5 food items containing borax. This experiment is done for designing guide practical exercise. Dragon fruit and turmeric extract are used as natural indicator to test the presence of formaldehyde. Meanwhile, the presence of borax is indicated by turmeric extract. This writing method is carried out through literature study [11, 12]. In this research, literature data is a theory to be studied and analyzed in order to obtain objective results. Furthermore, the research technique used in thesis writing is by researching and understanding books, documents or other written sources and data from preliminary test. Any writing that has been prepared by someone is proof of an event [13].

After the data is obtained through the literature study, then an interpretation of the data is carried out to obtain facts about the study to be discussed. The data is compiled and arranged systematically and written in a structured manner. From the results of these writings can be obtained a view, opinion and a conclusion.

### 3. Results and Discussion

The preservatives discussed are formaldehyde and borax. The discussion includes: the chemical structure of preservatives, the use of preservatives, the effects of these preservatives on human health and the results of qualitative tests of preservatives in food consumed by the public.

#### 3.1. Formalin

Formalin or formaldehyde exist naturally in several plant and animals as their traditional metabolism [14]. Characteristically, formalin has strong-smelling, colorless, and usually available in the form of an aqueous solution that is a mixture of water and 40% of formaldehyde [15]. Formalin may also consist of a saturated solution of formaldehyde, methanol and water with percentage of formaldehyde reached to 37-50%. Methanol (7-15%) is particularly added as a stabilizer to retard its polymerization [16]. Formaldehyde on the market has various formaldehyde levels, between 20 - 40%. Ordinarily, formalin was made through the catalytic oxidation of alcohol and its statement is  $\text{CH}_2\text{O}$ . In the dilute aqueous phase, formaldehyde dominantly available in form of monomeric hydrate, methylene glycol, while in concentrated aqueous, the formaldehyde predominated by polyoxymethylene glycol [17]. Formalin was get used to preserve plant, animal or other organisms for academic purposes such in the laboratory activities. This compound has been also used to preserve dead human bodies from rotting. However, some sellers are using this chemical illegally to preserve edible items [18]. In the world of photography, formaldehyde is used as a hardener for gelatine and paper layers. fertilizer forming material in the form of urea, material for making perfume products, corrosion inhibitor for oil wells, material for foam insulation, and adhesive material for plywood products. In non-food production, formaldehyde is used as a germ killer in floor cleaners, warehouses, clothes and boats, fly and insect repellent, silk-making materials, dyes, glass mirrors and explosives [19]. Due to its inflicting cavity cancer in humans, the World Health Organization (WHO) classified formaldehyde was carcinogenic to humans 14 (Suwanaruang, 2018). The National Institute for Occupational Safety and Health (NIOSH) has stated that formalin level of 20 ppm is very harmful to human life. Considering it, OSHA set some standard regulations in utilizing formalin. For instance, In the workplace like lab, office permissible exposure limit (PEL) for formalin is 0.75 parts per million parts of air (0.75 ppm) [3]. Another standard is the short-term exposure limit (STEL) that's range is 2ppm [18]. In Indonesia, several laws that prohibit the use of formaldehyde as a food preservative are Minister of Health Regulation No. 722/1988, Minister of Health Regulation No. 1168/Menkes/PER/X/1999, Law No. 7/1996 on Food and Law No. 8/1999 on Consumer Protection. This is due to the residual hazard being carcinogenic to the human body [19]. Formalin is easily absorbed through the respiratory and gastrointestinal tract. In these organs, formaldehyde will be metabolized to formic acids (formate) in the nasal mucosa, liver, and erythrocytes of living organisms, and is then excreted in the urine and feces, or is converted into carbon dioxide and exhaled [20]. Considering those processes, inhalation of formalin seem does not have any negative effect. However, subsequent to being metabolized, rapidly inhaled of formalin may hastily form covalent bonding to protein, amino acids, and nucleic acids, and these interactions triggered the toxic effects of formalin [21]. The effects of formaldehyde on food in humans are chronic. This will be felt after a few years later. Formalin can react quickly with the mucus lining of the digestive and respiratory tracts. In the body, formalin will be oxidized to form formic acid, especially in the liver and red blood cells. Use of food can cause poisoning in the human body, namely acute abdominal pain accompanied by vomiting,

depression of the nervous system or circulatory failure [22]. Formalin also has a chronic effect on levels of SGOT (Serum Glutamic Oxaloacetic Transaminase) and SGPT (Serum Glutamic Pyruvate Transaminase) in Wistar rats [23]. The formalin identification test can be carried out using natural ingredients dragon fruit and turmeric extract. This natural material is relatively easy to obtain and low cost. Food qualitative test can be seen in Table 1.

**Table 1. Qualitative test of formaldehyde in food using natural ingredients**

No.	Type of food	Qualitative test	Discoloration
1.	Salted fish		
2.	Meatball sticks		
3.	Noodle	Dragon fruit peel extract and	The red turns to a faded white
4.	Tofu	lime juice	
5.	Rebon shrimp		
6.	Cracker		

### 3.2. Borax

Borax is a white crystalline compound that is odorless and stable at room temperature [24]. This chemical compound is called sodium tetraborate ( $\text{NaB}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ ). When it dissolved in the water, these compounds become hydroxide and boric acid ( $\text{H}_3\text{BO}_3$ ). This chemical is commonly used as an antiseptic, germ killer, anti-fungal agent, wood preservative, and antiseptic in cosmetics. This borax compound is a dangerous preservative and that is not permitted to be used as a mixture of food ingredients. Borax also has antiseptic properties and is commonly used by the pharmaceutical industry. In the pharmaceutical industry, borax is used for medicinal herbs because it has antiseptic properties, for example ointments, powders, solutions for compresses, mouth rubs, eyewash and for industries such as ceramics, paper, glass, wood preservatives, antiseptics, and cockroach control [25]. In the Minister of Health Regulation No.722 /MenKes /Per /IX /88 borax is declared a hazardous material and is prohibited from being used in food manufacturing. The purpose of giving borax in food is to improve the structure and texture of food. Borax given to meatballs and rice cake will make the meatballs/rice cake chewy and durable [2]. Crackers containing borax will be expanded and become crunchy texture. The negative effects of using borax in food can have an impact on human health. Borax can cause blood vessel dilation, destruction of proximal tubular epithelial cells, and interstitial lymphocyte inflammatory cell infiltration in the histopathology of rat kidney organs [26]. The results of experiment [27] also show that borax can cause sperm motility and sperm membrane integrity in mice. In large quantities, borax causes fever, anuria (no urine formation), coma, stimulates the central nervous system, causes depression, apathy, cyanosis, decreased blood pressure, kidney damage, fainting and even death [28]. Chronic poisoning can be caused by prolonged absorption. The consequences include anorexia, weight loss, vomiting, diarrhea, skin rashes, alposia, anemia and convulsions.

**Table 2. Qualitative Test of Borax in Food Using Natural Ingredients**

No.	Type of food	Qualitative test	Discoloration
1.	Salted fish		
2.	Yellow noodle	Turmeric extract	Yellow to brown
3.	Rice cake		
4.	Meet ball		
5.	Nugget		

The use of borax when consumed continuously can interfere with intestinal digestion, disorders of the nervous system, depression and mental confusion. In certain amounts and doses, borax can cause mental degradation, as well as damage to the digestive tract, kidneys, liver and skin because borax is rapidly absorbed by the respiratory and digestive tracts, injured skin or mucous membranes [29]. Borax identification tests can be carried out using natural ingredients. This natural material is relatively easy to obtain and cheap in price. Natural ingredients of turmeric extract can be used in the qualitative test of foods containing borax (Table 2) Below.

### ***3.3. The process of testing chemicals in food using natural test materials***

Dragon fruit skin contains anthocyanins which can detect formaldehyde. Anthocyanins are water-soluble pigments found in flowers and leaves and produce colors from red to blue. Anthocyanin natural dyes are flavonoid compounds that are classified as benzopyran derivatives. Anthocyanins will change color with changing pH values. At high pH, anthocyanins tend to be blue or colorless, while those for low pH tend to be red. Most anthocyanins produce a purplish red color at a pH of less than 4. Anthocyanins have a pH of around 2-3, almost the same as the pH of formalin. Therefore, the color of anthocyanins remains stable when reacting with formalin because formalin is acidic. The properties of formalin and anthocyanin both have acidic properties so that formalin will cause the color of anthocyanins to remain red [30]. Curcumin is a yellow compound found in the rhizome of turmeric. This compound is a curcuminoid, which is a mixture of curcumin, demethoxycurcumin and bisdemethoxycurcumin. This natural test is based on the reaction between borax and curcumin compounds. Curcumin can detect the presence of borax content in food by breaking down the borax bonds into boric acid and binding it into a rosine color complex or commonly known as the boron cyano-curcumin complex [31].

### ***3.4. Qualitative testing guidelines***

Based on those preliminary experiment, guideline for practical exercise is designed. Below are "Guidelines in conducting qualitative tests for identification of chemicals in food". There are 2 stages that need to be prepared, namely: preparing extracts of food extracts to be tested, and preparing natural test materials.

#### **A. Preparation of food extracts to be tested**

1. Take 100 gr of food samples.
2. Grind the food ingredients using a blender.
3. Then add 50 ml of aquadest
4. Filter the ingredients to get the extract water from these food ingredients.
5. The filter results are put into a glass, and ready to be tested

#### **B. Preparation of natural test materials and testing**

1. Prepare 100 grams of turmeric and 1 dragon fruit skin.
2. Each natural ingredient is crushed to get their extract
3. Prepare a cotton wrapped around the end of the cotton bud.
4. Dip the cotton bud swab into the natural test material.
5. Then do the test by dipping a cotton bud swab that already contains the natural test material into a glass containing extracts of food ingredients
6. All extract of food ingredients are tested by turmeric and dragon fruit extract
7. Wait for about 5-10 minutes
8. Observe the color change from the test material to another color on the cotton bud.

9. During the student doing practical exercise, observation table has to be written (Table 3)

10. Students should give the summary for food containing formaline and borax.

**Table 3. Identification of the presence of borax content**

No	Name of Student	Type of food	Location	Qualitative test	Observation result	Conclusion
1.		Salted fish				
2.		Meet ball lid				
3.		Noodle				
4.		Yellow tofu				
5.		Rebon shrimp				
6.		Cracker				
7.		Fish ball				
8.		Nugget				
9.		White tofu				

## 4. Conclusion

The limited implementation of practical activities in laboratories due to the New Normal Covid 19 encourages educators to design practical materials, so that students can do it in their homes. This subject material is the testing or identification of formaldehyde and borax preservative chemicals in processed foods using natural ingredients. These natural ingredients are turmeric and dragon fruit skin. The materials needed are very easy to obtain at low cost so that they can be obtained by students. Observations during practical exercise can also be followed by students without experiencing difficulties. So there is no reason if the toxicology practical exercise cannot be carried out during the new era of Covid-19 pandemic.

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