Optimization of Solvent and Concentration of Turmeric (*Curcuma longa* Linn.) Extract For Strip-Test As Borax Detection Tool

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ABSTRACT (10 PT)

Borax, a well-known toxic substance, had been banned as food additive in many countries, including Indonesia. Vomiting, fatigue, renal failure, cancer and even sudden death were reported as its toxic effect. There are many studies about Borax identification had been carried out, including instrumental procedures and alternative tests using natural indicator from the plants, such as turmeric. Alternative tests were low-cost, simple and easy to do. However, a certain solvent and concentration of turmeric for borax detection has not studied yet, which made a gap in borax analysis using a natural indicator. This research aims to determine the effect of turmeric solvent extraction and its concentration on borax detection results using the Turmeric Paper Test Kit. Turmeric powder was macerated with three different solvents (methanol, ethyl acetate and n-hexane) for 3 days. The highest yielded extract was methanol extract, followed by ethyl acetate and n-hexane extract. Solution of Turmeric extract in various solvents were prepared in many concentrations and dripped on paper of strip-test detection tool and leaved to dry. Borax detection was performed with dripped on strip-test detection tools, and discoloration of turmeric paper was observed. The most optimal solvent in this research is methanol extract with 10.000 ppm concentration, and discoloration to reddish-brown color.

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1. INTRODUCTION

Food additives are mixed materials added to food in the manufacture, processing, preparation, treatment, packing, packaging, storage, or transportation of food to produce or are expected to produce (directly or indirectly) with the aim of making the nature or form of food in accordance with what is intended, expected[1]. According to the Regulation of the Head of BPOM RI Number 36 of 2013 concerning the Maximum Limit for the Use of Food Additives, preservatives are food additives to prevent or inhibit fermentation, acidification, decomposition, and other damage to food caused by microorganisms [2].

Previously, borax commonly used as preservative[3], increase food elasticity[4], strengthen and brighten the food[5], also make the chewy texture[6]. Until the Joint FAO/WHO Expert Committee on Food Additives (JECFA) banned this compound, because it is inaplicable as a food additive[4]. Borax is a crystalline compound, white in color, odorless and stable at normal pressure temperatures but also very toxic. Borax accumulation in the body could give some adverse reaction such as vomiting, fatigue, and renal failure because it has a toxic effect that can harm the metabolic system of human health such as irritation of the respiratory tract, skin, eyes, and target organs such as blood, kidneys, heart, respiratory system, central nervous system, liver, lymph, digestive system, eyes, reproductive system, and skin[7]. The use of borax for a long time and in large quantities can cause cancer. Increasing the dose of borax can result in edema, cell inflammation, neovascularization, and very high doses which result in sudden death[8][9]. As a result, many countries have banned this substance as food additive[4], [5], including Indonesia[1]. According to the Regulation of the Minister of Health of the Republic of Indonesia No. 033 of 2012 concerning food additives, borax is one of the types of food additives that are prohibited from being used in food products, even consuming 5 – 10 g/kg body weight, or 5,000 – 10,000 ppm can cause weakness, kidney damage, even shock and death.

Borax is a sodium salt of $Na_2B_4O_7.10H_2O$ which is often used in various non-food industries including soldering materials, paper, cleaning agents, glass, antiseptics, wood preservatives, cockroach control, and ceramics. Pyrex glass which is often used in laboratory glassware is made with a mixture of borax[10]. However, some sellers are still stubborn about adding borax with the excuse of making a profit. This attitude is shown mostly by the sellers who only have low education so that their level of knowledge about the dangers of borax is still doubtful or insufficient[11]. The use of borax could be caused by several factors, including the lack of knowledge of producers about the dangers of using borax in food and the aim to obtain a lot of profit. Studies on the borax content in food have been carried out in various cities, such as a study by Suseno which reports that the study on meatballs in Medan City found 8 out of 10 meatball samples analyzed positively containing borax [12]. Nurkholidah *et al* state that out of 17 sellers of meatball sticks sold in Elementary Schools in Bangkinang District, it is revealed that almost all sellers use borax in the meatball stick products with the highest content of 2.32 mg/g sample [13]. In Meulaboh city, the results of qualitative testing using turmeric paper and shallot extract show that as many as 20 meatball samples sold around Meulaboh city were absent of borax. This can be seen from the absence of color change on the two indicators or test equipment, i.e. using turmeric paper and shallot extract [14].

Various studies on borax identification have been carried out, both instrumental procedures and simple evaluation. Borax could be identified using spectrophotometer UV-Vis (Colorimetry)[15], [16],[17] FTIR-ATR[18], optic fiber[19], liquid chromatography inductively coupled plasma mass spectrometry (LC-ICP-MS)[4], and high-throughput SELEX for screening borax-specific ssDNA aptamer[5]. Meanwhile, a simpler way to identify borax also growing rapidly, such as a drop test [20], [21], tooth picks[22] flame test and turmeric paper[23], [24]. Those simple evaluation, mostly using a natural indicator from turmeric[21], purple cabbage and sappanwood[25], and fluorescent probe from water hyacinth leaves[26]. Instrumental methods described before, were expensive and need special procedures, while the alternative tests are low cost, simple and easy to do.

In Indonesia, turmeric is easy to obtain, and the presence of Borax could be confirmed by discoloration, to a red orange to red color in food products containing borax[27]. Simply put, curcumin in turmeric can break the bonds of borax into boric acid and form curcumin boron cyano complex, a complex rosin compound[22]. This reaction is easy to observe, but still there are no exploration about turmeric concentration that could detect the presence of borax in food. Hence, it is become an uncertain condition for detecting Borax using a natural indicator from turmeric. In this study, various concentrations of turmeric extract and various solvents were used. The purpose of this study is as follows, namely to determine whether there is an effect of turmeric concentration on the detection results on the Turmeric Paper Strip-Test Kit, and to determine whether there is an effect of solvent on the detection results on the Turmeric Paper Strip-Test Kit.

2. RESEARCH METHOD

TOOLS

Laboratory equipment made of glass, filter paper, glass bottles, oven, dropper,

PLANT RAW MATERIAL

Turmeric (Curcuma longa Linn.).

CHEMICAL MATERIAL

Aquadest, methanol, ethyl acetate, and n-hexane (PT. Smart Lab Indonesia, Indonesia), Borax (Merck).

TURMERIC POWDER PREPARATION

The turmeric tuber flesh is dried in an oven at a temperature of around 60-70ºC to remove the moisture content. After drying, turmeric is ground using a grinder until it becomes a fine powder. Then the sample was sieved through a 60 mesh sieve.

TURMERIC EXTRACT PREPARATION

The turmeric powder that has been made is then added with a solvent in a ratio of 1:5 (until the simplicia powder is submerged in the solvent). Then do the maceration for 3 days. The collected macerate was then aerated at a cool temperature (air-conditioned room) until it became a thick extract.

PREPARATION OF TURMERIC PAPER STRIP-TEST KIT

The process of making this borax detector is as follows:

1. Prepare a solution of Turmeric extract in various solvents (methanol, ethyl acetate, n-hexane) with various concentration series (1,000 ppm; 2,500 ppm; 5,000 ppm; 7,500 ppm; 10,000 ppm). Each made as much as 10 mL.
2. Stir until smooth and transfer to a wider container.
3. Take mica plastic size 7x1 cm
4. Take filter paper, cut a 1x1 cm square and dip it in the turmeric solution, back and forth using tweezers until evenly distributed over the entire surface of the filter paper.
5. Then place it on a baking sheet to dry by aerating.
6. After drying, store in a closed container. Turmeric Paper Strip-Test Kit is ready to use.

(Hartati, 2017 with modification).

Figure 1. Test strip sketch

PREPARATION OF BORAX SOLUTION

A 1000 ppm borax solution was made by weighing as much as 100 mg of borax into a 100 mL volumetric flask. Dissolve with distilled water up to 100 mL (Adawiyah, 2014 with modification).

QUALITATIVE TEST ON THE TURMERIC PAPER TEST KIT

The test was carried out by dripping 2-3 drops of a 1000 ppm borax solution onto the turmeric paper test kit that had been made. Let stand a few moments until the paper dries and the resulting color is stable. Observe the color change that occurs.

DATA PROCESSING

Data obtained from laboratory test results is then processed and entered into a table which is then described.

3. RESULTS AND ANALYSIS (10 PT)

3.1 Turmeric Powder Preparation

Figure 2. Turmeric powder

The yield of symplisia was 62.145% while the powder yield was 25.866%. Making simplisia powder can reduce the size of the turmeric rhizome so that it will be able to increase the surface area of the turmeric rhizome and will optimize the extraction process.

3.2 Turmeric Extract Preparation

(a) (b) (c) (d)

Figure 3. Turmeric extract preparation

(a) Maceration process, (b) Metanol Extract, (c) Etil Acetate Extract, (d) n-Hexane Extract

Curcuma longa L. a family of Zingiberaceae, contain curcumin, as the main component of turmeric, demethoxycurcumin and bisdemethoxycurcumin, as secondary components, as part of the “curcuminoid” family [28][29]. Curcumin is a hydrophobic polyphenolic compound derived from turmeric rhizome, which consists about 2-5% of the total rhizome content and is a more valuable component of turmeric[30]. Due to the activity of natural indicator for detecting borax, turmeric powder macerated using three different solvent methanol, ethyl acetate and n-hexane. In this study, polar and non-polar organic solvents have been used to extract curcumin from *C. longa* L. The highest yield extract obtained from methanol solvent, yields 5,14 g extract (14,69%), followed by ethyl acetate (3,63 g; 10,37%) and n-hexane (1,71 g; 4,89%). This result showed that methanol is the best solvent to extract turmeric powder. This result relevant to Priyadarsini’s study which states that curcumin known readily soluble in polar solvents like methanol and ethyl acetate[31]. Curcumin is almost insoluble in water in acidic and neutral pH, so water extraction could be impossible to extract the curcumin. Creating a detection tool could be simple and easy to do, but using an inappropriate solvent to extract the main natural indicator, could give a wrong analysis. Even in Kiamahalleh et al study, they reported that the maximum amount of curcumin extracted at the optimum condition with subcritical water extraction was only 3.8wt%[30].

3.3 Qualitative Test on The Turmeric Strip-Test

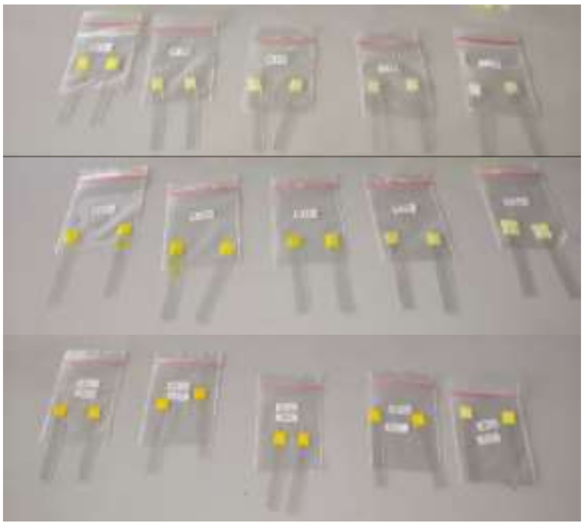


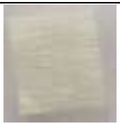
Figure 4. Result of qualitative test on the turmeric strip-test

Qualitative test of borax using turmeric strip-test showed discoloration of turmeric paper. Curcumin, which contained in turmeric paper reacted to borax, and showed color changes. Curcumin compounds found in turmeric could break down borax bonds into boric acid and bind them into a complex color of rosocyanine (brownish red) in an acidic atmosphere, thus causing a red orange to red color in food products containing borax [27]. Curcumin is very sensitive to Ph change, that can cause structure formation[20]. The discoloration of turmeric paper from yellow to reddish, was the reason of turmeric utilization as natural indicator material to detect the presence of borax in alternative test. Another content contained in turmeric is essential oil (volatile oil) 1-3% which has characteristics of sharp smell and taste. The smell and taste come from several substances contained in the oil so that turmeric can be used as a traditional medicine to prevent some diseases [32]. Curcumin which is known as the most biologically active form of curcuminoids family in turmeric, can form a molecular complexes with various charged species, including tetraedric boron complexes (rosocyanine)[27], which inclined the use of it as natural indicator.

Methanol extract has given the most intense color of turmeric extract, with yellow color on turmeric paper compared to ethyl acetate and n-hexane extract. It could be happened, prompt to curcumin levels as major compound in turmeric extract. The higher the concentration of turmeric extract used, the more intense the color changes on the paper (Table 1). Those concentrations of various turmeric extract, also influenced borax identification using turmeric strip-test detection tool. Turmeric extract that produced the most intense color in this study was EM 10.000 ppm with the color result in the form was yellow orange, meanwhile after dripping Borax solution, it become the most optimal discoloration with the result reddish-brown color.

Table 1. Result of qualitative test on the turmeric strip-test

Concentration	**Warna yang dihasilkan**	
	Before	**After**

EH 1.000 ppm		
EH 2.500 ppm		
EH 5.000 ppm		
EH 7.500 ppm		
EH 10.000 ppm		
EE 1.000 ppm		
EE 2.500 ppm		
EE 5.000 ppm		
EE 7.500 ppm		
EE 10.000 ppm		
EM 1.000 ppm		
EM 2.500 ppm		
EM 5.000 ppm		
EM 7.500 ppm		

EM 10.000 ppm		

*EH = Extract of n-Hexane; EE = Extract of Etil Acetate; EM = Extract of Metanol

4. CONCLUSION

Thus, based on the results of the tests that carried out, choosing the right solvent to extract the curcumin, as main natural indicator in detecting the prescence of Borax must be done. In accordance to that, deciding a concentration of turmeric extract used in a detection tool requisite a proper concentration to simplify the color changes observation. Increasing the concentration of turmeric has an effect in the form of increasing the intensity of the color results in the test kit. The magnitude of the increase in color was in line with the increase in the concentration of turmeric extract. The higher the concentration of turmeric extract used, the more intense the color produced. The concentration of turmeric extract that produced the most intense color in this study was EM 10.000 ppm with the color result in the form was yellow orange. The type of solvent also affects the intensity of the color results in the test kit. The most optimal solvent in this research is EM (Metanol Extract) 10.000 ppm with the result reddish-brown color.

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