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Examination of Borax in Meatballs: Qualitative Analysis

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Abstract: Borax is a chemical that is hazardous to health and is often misused as a food additive. The addition of this chemical is to make food chewier and more durable. It is important to test the presence of borax in snacks around us. The purpose of this study was to test the presence of borax in meatballs sold in the town square in one of the cities in East Java. The test method was carried out qualitatively, namely organoleptic test, $AgNO_3$ test, turmeric extract test, and borax test kit. These three qualitative test methods are very easy to do, even for the general public. The results showed that all three meatball samples tested positive for borax. Organoleptically, meatballs containing preservatives do not easily become soft (remain chewy), do not give off a bad smell for longer, and do not grow mold easily. This kind of research is important to anticipate the emergence of diseases due to borax abuse. For similar research, a pH test is recommended on meatballs suspected of containing borax, which have been crushed and soaked in water. This is because borax compounds dissolve easily in water (especially hot water) and can form an alkaline condition.

Keywords: borax detection, qualitative analysis, food safety, turmeric extract

1. INTRODUCTION

Borax has long been produced in Indonesia and is produced from salt fields or mud craters [1]. Borax has other names which are commonly known by the public as bleng, pijer or gendar [2]. Borax or sodium tetraborate functions as an antiseptic or bacteria killer and this function makes this compound used as a food preservative. Currently, borax is widely used by food manufacturers as a food ingredient, such as meatballs, noodles, crackers, and dried fish [3]. The addition of borax to food is intended to produce a more chewy food and a longer shelf life [4]. Borax is a carcinogenic compound [5]. The impact of consuming food containing borax cannot be seen directly, but will be felt after it accumulates in the body, and many people still do not know the dangers of borax [6]. The organ that can be damaged by the accumulation of borax in the body is the liver. Borax will damage the liver's function in filtering toxic substances to cause inflammation [7].

There are two methods of testing the presence of borax in food, namely qualitative and quantitative. In general, qualitative methods are often used in testing the presence of borax. In salted fish, the presence of borax can be detected by qualitative tests, namely the turmeric paper test, the flame test, and the $AgNO_3$ precipitation test [8]. Qualitative testing for the presence of borax in food can also use turmeric extract [7]. The presence of borax in meatballs was tested qualitatively using $BaCl_2$ solution and quantitatively using a UV-Vis spectrophotometer at a wavelength of 428 nm [9]. Qualitative testing for the presence of borax in wet noodles was carried out using curcumin paper and $KMnO_4$ solution [10].

Based on several qualitative tests that have been conducted, research is needed regarding a test for the presence of borax that is easy to perform and affordable for the general public. Previous studies have used instruments that are not easily available to the general public (such as UV-Vis spectrophotometry or FTIR) and materials that are not widely known (silver nitrate and barium chloride). From the literature review that has been conducted, there has been no research that combines qualitative tests for the presence of borax that are easy to perform and require materials to obtain, namely the use of turmeric extract and a test kit. However, the use of chemical reagents (specifically silver nitrate) for the borax test is still needed to strengthen the test results. The purpose

of this study is to conduct a test for the presence of borax in meatballs that is easily implemented by the general public using turmeric extract, a test kit, and silver nitrate ($AgNO_3$). Research on borax testing in meatballs sold around the town square in one city in East Java is crucial. This is crucial because these meatballs are highly popular. Data on the borax content in meatballs in this area is crucial for providing input to the local health department for follow-up action.

2. MATERIALS AND METHODS

The sample in this study was meatballs sold by meatball sellers around the town square in one of the districts in East Java. The meatball sellers whose meatballs were used in this study were selected using purposive sampling. The inclusion criteria for this technique were meatball sellers with a high number of customers. From these criteria, there were three meatball sellers whose meatballs would be taken. The three test meatballs were coded B1, B2, and B3, while the meatballs without preservatives were coded TP.

The meatball vendors whose meatballs were used in this study were selected using a purposive sampling technique. This technique had the inclusion criteria of meatball vendors frequently visited by the public.

2.1. Materials and Tools

2.1.1. Materials

The materials used in this study were test meatballs, homemade meatballs (without preservatives), $Na_2B_4O_7.10H_2O$ (p.a), distilled water, turmeric, 1N $AgNO_3$, and borax test kit (Labstest). Other consumables used were aluminium foil, toothpicks, and filter paper. The use of homemade meatballs was as a control during the organoleptic test of the test samples.

2.1.2. Tools

The tools used in this study included knives, scar, blenders (Philips), beaker glasses (Herma), measuring cups (Herma), test tubes, droppers, stirring rods, glass funnels, test tube racks, measuring flasks, turtle spoons, and analytical scales (Ohaus).

2.2. Sample Preparation

2.2.1. Preparation of positive control solution

The positive control used in this study was a sodium borax solution. The procedure for making it was 1) weighing 1 g of $Na_2B_4O_7.10H_2O$; 2) putting the $Na_2B_4O_7.10H_2O$ into a 100 mL measuring flask; 3) adding distilled water to the measuring flask up to the boundary mark; and 4) shaking until homogeneous [1]. Borax had the property of being easily soluble in water and at room temperature, and not easily soluble in alcohol solvents [11].

2.2.2. Preparation of meatball samples

The meatball samples prepared were homemade meatballs (without preservatives) and meatballs from meatball sellers (samples suspected of borax). For each test, 10 grams of meatball samples were used. The meatball samples were chopped and mashed with a blender. After being mashed, 100 mL of distilled water was added and stirred until homogeneous. The next stage was to go through a filtration process using filter paper repeatedly until a filtrate without dregs is obtained. This sample preparation procedure is a compilation of two sample preparation procedures from two previous studies [4], [12].

2.2.3. Preparation of turmeric extract

The turmeric rhizome was peeled. The next stage, the turmeric rhizome was grated. Then, the grated turmeric was filtrated. The turmeric filtrate was used for testing.

2.3. Qualitative analysis of borax

The presence of borax was identified using qualitative tests. Qualitative tests were the analysis of the presence of an atom, ion, or compound in a sample by providing non-numerical information such as color changes, odor, boiling point, and melting point [13]. The qualitative tests used in this study include organoleptic tests, $AgNO_3$ reagent tests, turmeric extract tests, and test kit

tests. Each qualitative test will be repeated three times. A pro-analyst borax solution will be used as a positive control. For the organoleptic test, a homemade meatball, guaranteed to be borax-free, will be used as a negative control.

2.3.1. Organoleptic Tests

Organoleptic testing was the analysis of the physical properties of a sample using the senses to obtain non-numerical information, including shape, smell, color, taste, and texture [14]. The purpose of the organoleptic test in this study was to determine the shelf life of the test sample. Organoleptic testing would be carried out after the test sample has undergone changes, whether in terms of shape, color, smell, taste, or texture. Product quality was influenced by storage location [15], so this study would examine the results of organoleptic tests of test samples stored in open and closed spaces. In organoleptic testing, researchers are accompanied by a research assistant to observe any changes that occur during the observation process. Therefore, the results are objective and accurately reflect the actual conditions.

2.3.2. $AgNO_3$ Reagent Tests

In a 10 mL test sample, 1 mL of 1N $AgNO_3$ was added. After that, shaking was carried out. The presence of borax was indicated by the formation of a white precipitate [16].

2.3.3. Turmeric Extract Tests

Several toothpicks were soaked in turmeric extract for 3 hours and turned over until evenly distributed. After being soaked for 3 hours in turmeric extract, the toothpicks were drained and dried. After drying, the toothpicks were inserted into the test sample for 5-20 seconds. Identification of the presence of borax was indicated by a change in color on the toothpick to brick red or brownish red. The test was said to be negative for borax if the color of the toothpick remains turmeric yellow [17].

2.3.4. Test Kit Test

The test kit to test the presence of borax was equipped with a reagent and yellow paper (turmeric paper). The procedure was 1) prepare 1-3 mL of test sample in a test tube; 2) add 1-5 drops of reagent to the test tube and shake until homogeneous; and 3) drip the test sample that has been mixed with the reagent on the turmeric paper. Identification of the presence of borax was indicated by a change in the color of the turmeric paper, namely yellow to brick red or brownish red. This procedure is according to the instructions of the test kit used (Labstest).

3. RESULTS AND DISCUSSION

Borax is one of the ingredients that is prohibited from being used as a food additive or abbreviated as BTP [18]. This compound should be used in non-food industries, such as antiseptics, cleaning agents and wood preservatives [1]. However, many traders misuse this compound as a food additive for reasons of quality and durability [12]. Borax is carcinogenic which can trigger cancer if consumed [19]. Identification of the presence of borax in meatball samples was carried out using qualitative tests. The types of tests include organoleptic tests, $AgNO_3$ tests, turmeric extract tests, and test kit tests.

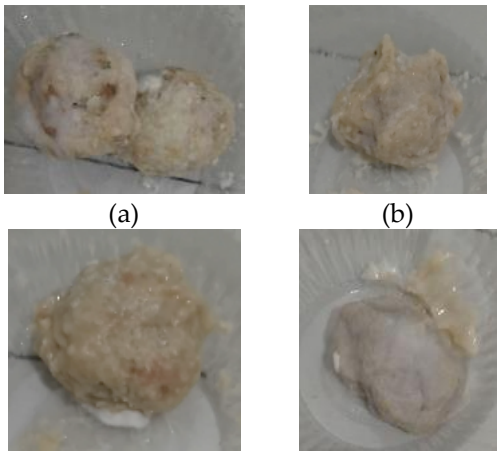
3.1. Organoleptic Tests

Meatballs are foods that contain carbohydrates (flour) and protein (meat). The criteria for damage or rotten food containing carbohydrates are marked by the presence of mold, while for food containing protein, there is a rotten smell and a soft texture [20]. The organoleptic test in this study focused more on observing texture, odor, and the presence or absence of mold. Organoleptic tests are divided into two, namely open space (Table 1) and closed space (Table 2).

Based on Table 1, it can be concluded that homemade meatballs (without preservatives) have experienced changes in texture, odor, and the appearance of mold after one day of storage in an open space. For the test meatball samples, they began to experience signs of damage or rot after two days of storage in the open space. However, between B1, B2, and B3, the test sample that took the longest time to be damaged or rotten was sample B1. The characteristics of damaged or rotten meatballs can be seen in Figure 1.

Table 1. Organoleptic Test Results of Meatball Samples in Open Spaces

Day	Sample	Texture	Odor	Presence of Mold
0	TP	chewy	the distinctive smell of meatballs	no mold visible
	B1	chewy	the distinctive smell of meatballs	no mold visible
	B2	chewy	the distinctive smell of meatballs	no mold visible
	B3	chewy	the distinctive smell of meatballs	no mold visible
1	TP	not chewy	bad odor	moldy
	B1	chewy	the distinctive smell of meatballs	no mold visible
	B2	chewy	odorless	no mold visible
	B3	chewy	odorless	no mold visible
2	TP	not chewy	bad odor	moldy
	B1	chewy	odorless	no mold visible
	B2	not chewy	bad odor	no mold visible
	B3	not chewy	bad odor	no mold visible
3	TP	not chewy	bad odor	moldy
	B1	not chewy	bad odor	moldy
	B2	not chewy	bad odor	moldy
	B3	not chewy	bad odor	moldy



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

Figure 1. Characteristics of damaged or rotten meatballs: (a) meatballs without preservatives; (b) sample B1; (c) sample B2; and (c) sample B3

Meatballs that do not contain preservatives have a shorter shelf life, but the test meatball sample has a much longer shelf life. So, it is estimated that the test meatball sample contains compounds that act as preservatives and borax is usually used as a preservative [11]. Sample B1 had a longer shelf life than B2 and B3, even though all three were thought to contain borax as a spoilage inhibitor. This is likely due to the addition of more borax to sample B1 than to the other two test samples, thus taking longer to spoil. A chewy food texture is a sign of the presence of borax compounds [11], [19]. The bad smell in food is the result of the growth and activity of microorganisms that damage the protein in meat [21]. While the appearance of mold is a sign of food spoilage due to damage to the carbohydrate content in food [20].

Based on Table 2, it can be concluded that meatballs without preservatives stored in a closed room have a longer shelf life than meatballs without preservatives stored in an open room. This is because the decomposition of meatballs without preservatives stored in a closed room occurs on the second day of storage, marked by the growth of mold, a foul odor, and no longer being chewy. However, meatballs without preservatives stored in an open room have experienced decomposition on the first day of storage. For the test meatball samples that are estimated to contain preservatives (borax), decomposition began to occur on the second day of storage. So, there is no significant effect of the closed or open storage treatment on the test meatball samples. Efforts to minimize the

decomposition process require packaging or wrapping [22] and storage in a closed room is also one effort to minimize decomposition.

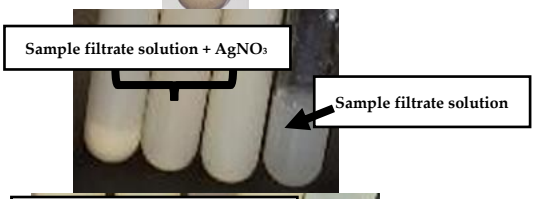
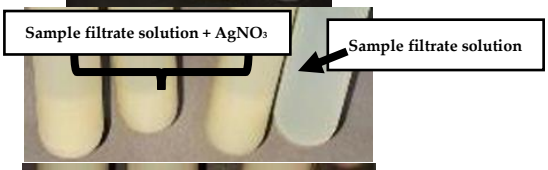
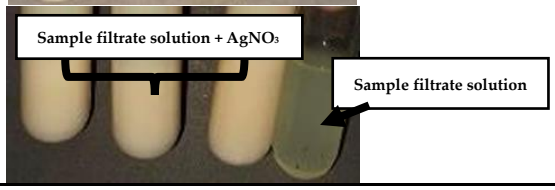
Table 2. Organoleptic Test Results of Meatball Samples in Closed Spaces

Day	Sample	Texture	Odor	Presence of Mold
0	TP	chewy	the distinctive smell of meatballs	no mold visible
	B1	chewy	the distinctive smell of meatballs	no mold visible
	B2	chewy	the distinctive smell of meatballs	no mold visible
	B3	chewy	the distinctive smell of meatballs	no mold visible
1	TP	chewy	bad odor	no mold visible
	B1	chewy	the distinctive smell of meatballs	no mold visible
	B2	chewy	the distinctive smell of meatballs	no mold visible
	B3	chewy	the distinctive smell of meatballs	no mold visible
2	TP	not chewy	bad odor	moldy
	B1	not chewy	odorless	no mold visible
	B2	not chewy	bad odor	no mold visible
	B3	not chewy	bad odor	no mold visible
3	TP	not chewy	bad odor	moldy
	B1	not chewy	bad odor	moldy
	B2	not chewy	bad odor	moldy
	B3	not chewy	bad odor	moldy

3.2. $AgNO_3$ Tests

Identification of the presence of borax using $AgNO_3$ reagent is indicated by the presence of white precipitate [16]. In this test, a positive control containing borax solution is used. Each test is repeated three times. The results of this test can be seen in Table 3.

Table 3. $AgNO_3$ Test Results

No.	Items Tested	Test Results	Decision
1	Positive control		White precipitate
2	B1		White precipitate (+)
3	B2		White precipitate (+)
4	B3		White precipitate (+)

If borate ions or tetraborate ions react with silver ions, a white silver borate precipitate will form. The reaction that occurs can be seen in Equation 1.

$$BO_3^{3-} + 3\,Ag^+ \rightarrow Ag_3BO_3 \downarrow \quad (a)$$

$$B_4O_7^{2-} + 2\,Ag^+ \rightarrow Ag_2B_4O_7 \downarrow \quad (b)$$

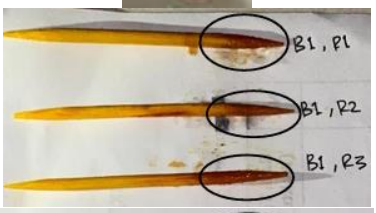
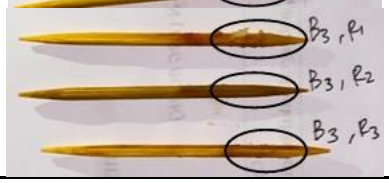
Equation 1. Reaction equations: a) borate ion with silver ion; b) tetraborate ion with silver ion.

From Table 3, it can be concluded that all test meatballs were positive for borax. This is because after being reacted with $AgNO_3$ solution, a white precipitate was formed. The $AgNO_3$ test results were consistent with the organoleptic test results. Both tests concluded that the meatball samples contained borax. This research data also supports previous research related to testing the presence of borax in food using silver nitrate ($AgNO_3$) [8].

3.3. Turmeric Extract Tests

Test the turmeric extract using a toothpick soaked in turmeric extract. Identification of the presence of borax is indicated by the change in color of the toothpick from yellow (after being soaked in turmeric extract) to brick red or brownish red [17]. The results of this test can be seen in Table 4.

Table 4. Turmeric Extract Test Results

No.	Items Tested	Test Results	Decision
1	Positive control		Brick red or brownish red (+)
2	B1		Brick red or brownish red (+)
3	B2		Brick red or brownish red (+)
4	B3		Brick red or brownish red (+)

Based on Table 4, it is concluded that all meatball samples contain borax compounds. This is because there is a color change to brownish red. Turmeric extract can function as a borax detector because turmeric extract contains curcumin compounds that play a role in breaking down bonds in borax compounds to become borax acid which is marked by a brownish red complex [1]. Borax compounds are very soluble in hot water, remain soluble in cold water, and can form alkaline conditions, but cannot dissolve in alcohol [7] (Equation 2).

$$Na_2B_4O_7.10\,H_2O\,(s) \xrightarrow{\text{water}} 2\,Na^+(aq) + B_4O_7^{2-}\,(aq) + 10\,H_2O\,(l) \quad (a)$$

$$B_4O_7^{2-}\,(aq) + 7\,H_2O\,(l) \leftrightarrow 4\,B(OH)_3\,(aq) + OH^-\,(aq) \quad (b)$$

Equation 2. Reaction equation of borax compound in water

Borax compounds in water can also release borate ions (BO_3^{3-} or $B(OH)_4^-$). Borate ions can form complexes with β-diketone groups (-CO–CH_2–CO-) or cis-diol in organic compounds (one of which

is curcumin). The resulting complex of curcumin with borax can be seen in Figure 2 and Equation 3. This complex compound (Figure 2) will give a characteristic color (brownish red).

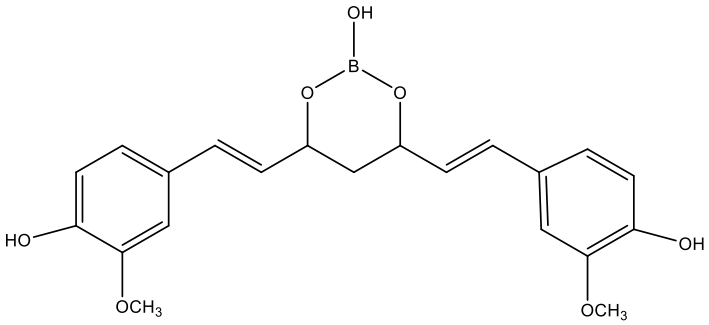


Figure 2. Complex compound of curcumin and borate ion

$$B(OH)_3 + 3\,ROH \leftrightarrow B(OR)_3 + 3\,H_2O$$

Equation 3. Boron complex with alcohol or polyalcohol

Equation 3 shows the reaction between borate ions or borax compounds with alcohol or polyalcohol compounds and will form boron esters [23].

3.4. Test Kit Tests

In testing with this test kit is basically the same as testing using turmeric extract. The yellow paper in this test kit is not actually named, but it is possible that it is tumeric paper or curcumin paper. Testing borax with curcumin paper has a positive criterion of containing borax if there is a color change to brown [3]. If testing for the presence of borax on tumeric paper, then the positive criterion for borax is marked by a color change from yellow to reddish brown [12]. The positive color of borax on turmeric paper can be seen in Figure 3. The results of this test can be seen in Table 5.

Table 5. Test Kit Test Results

No.	Items Tested	Test Results	Decision
1	Positive control		Brick red or brownish red (+)
2	B1		Brick red or brownish red (+)
3	B2		Brick red or brownish red (+)
4	B3		Brick red or brownish red (+)

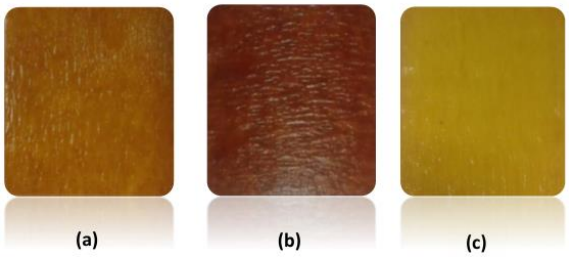


Figure 3. μg/mL, (c) negative control [12].

Based on Table 5 and Figure 3, it shows that all meatball samples were identified as having borax. This is because of the color change to brick red or brownish red on the turmeric paper. The brick red or brownish red stains on the turmeric paper were the most in sample B1. This is supported by the organoleptic test which showed that sample B1 had the longest shelf life (the longest to rot).

Research results indicate that food business owners are misusing borax to avoid losses and are misusing it to extend the shelf life of food. Borax's water-soluble nature allows this dangerous compound to be added to various food preparations. However, the government does not permit this use because it can cause organ damage if accumulated over time.

4. CONCLUSION

It's important for people to independently test for the presence of borax in food. The negative impact of this hazardous substance accumulating in our bodies is organ damage. Qualitative tests, such as those used in this study, can identify the presence of borax. These include the turmeric extract test, a test kit, and the $AgNO_3$ test. All three qualitative tests are easy to perform and reliable. The research suggests that if the qualitative test indicates the presence of borax, further testing should be conducted to determine the borax content. Examples of these tests include the UV-Vis test.

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Conflicts of interest: The authors declare no conflict of interest.

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