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Literature study of borax analysis on meatballs circulating in indonesian traditional markets using various methods

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ABSTRAK

Boraks adalah senyawa kimia yang mengandung unsur Boron (B). Tujuan dari penelitian ini adalah untuk mengetahui apakah bakso yang beredar di berbagai pasar di Indonesia mengandung boraks, dalam kadar berapa, dan bagaimana membandingkan hasil analisis dengan berbagai metode berdasarkan studi literatur. Rancangan penelitian ini menggunakan metode studi kepustakaan yang dilakukan dengan mempelajari jurnal tentang penelusuran jurnal analisis boraks pada bakso dengan menggunakan berbagai metode. Uji kuantitatif menggunakan uji titrasi alkalimetri, spektrofotometri UV-Vis, dan spektrofotometri Visible. Hasil uji organoleptik pada bakso yang mengandung boraks berwarna putih pucat, berbau seperti bakso pada umumnya tetapi sedikit berbau kimia, dan berasa kenyal. Uji nyala dari 3 penelitian positif mengandung boraks dengan adanya warna hijau dari nyala. Uji kertas kunyit dari 2 penelitian positif mengandung boraks dengan perubahan warna pada kertas kunyit dari kuning menjadi merah kecoklatan. Uji titrasi alkalimetri dari 2 penelitian positif mengandung boraks dengan perubahan warna pada akhir titrasi menjadi merah muda dengan kadar 3,82 ppm dan 0,06-5,15%. Pengujian dengan spektrofotometri UV-Vis diperoleh hasil dengan panjang gelombang 555 nm dengan linearitas yaitu R=0,9995 dan akurasi 96,09%-104,62%, dengan kadar tertinggi 2414,375 g/mL dan terendah 129,375 g/mL . Uji spektrofotometri tampak diperoleh hasil dengan panjang gelombang 620 nm yaitu bakso sebelum dibakar dengan nilai 0,54 ppm.

Key word:
Borax
Meatball
Turmeric
Spectrophotometry
Analysis Chemistry

ABSTRACT

Borax is a chemical compound that contains the element Boron (B). The purpose of this study is to determine whether meatballs circulating in various markets in Indonesia contain borax, in what levels, and how to compare the results of the analysis with various methods based on a literature study. The design of this research is to use a literature study method which is done by studying journals about tracing borax analysis journals on meatballs using various methods. The quantitative test used alkalimetric titration test, UV-Vis spectrophotometry, and Visible spectrophotometry. The results of the organoleptic test on meatballs containing borax were pale white in color, smelled like meatballs in general but had a slight chemical smell, and tasted chewy. The flame test of 3 positive studies contained borax in the presence of a green color from the flame. Tumeric paper test from 2 positive studies contained borax with a color change on the tumeric paper from yellow to brownish red. Alkalimetric titration test from 2 positive studies contained borax with a color change at the end of the titration to pink with levels of 3.82 ppm and 0.06-5.15%. Tests with UV-Vis spectrophotometry obtained results with a wavelength of 555 nm with a linearity that is R=0.9995 and an accuracy of 96.09%-104.62%, with the highest level of 2414,375 g/mL and the lowest 129,375 g/mL. Visible spectrophotometry test obtained results with a wavelength of 620 nm, namely the meatballs before being burned with a value of 0.54 ppm.

Pendahuluan

Meatball is a typical Indonesian food that is favored by many people and is a processed meat product that is usually served hot and has high nutritional value because it is rich in animal protein, which is very much needed by the human body, especially for growth. Meatballs are processed products from meat, both beef, chicken, fish, and shrimp1. The main raw materials in making meatballs are beef and other additives such as flour, salt, ice, Sodium Tripolyphosphate (STPP) and seasonings. Meatballs made from the ground beef is then added with tapioca flour, binder, seasoning, and water. So that a dough is formed and shaped like a small ball with a size of about (8-10 g), then boiled. Foods of animal origin such as meat, milk, and eggs and their processed products are generally perishable and have the potential to contain biological, chemical and or physical hazards, known as potentially hazardous foods (PHF)[1].

Meatballs can be made from various kinds of meat, namely beef, chicken, fish, or shrimp. Meatballs are made from ground beef with the main additives being table salt (NaCl), tapioca flour, and seasonings. The meatballs are made into a round shape like marbles with a weight of 25-30 g per item. Meatballs are also usually used in a mixture of various other dishes[2].

Food safety is one of the problems that must get attention, especially in developing countries such as Indonesia, because it can have a negative impact on health. The reason is the lack of knowledge, skills, and responsibility of food producers on food quality and safety, especially in small industries or home industries. To get food as desired, often in the manufacturing process additional ingredients are added, better known as food additives (BTP) or food additives. BTP which is often used in the manufacture of meatball dough is borax. The Food and Drug Supervisory Agency states that if borax is added to a mixture of meatball dough, it will make the meatballs very chewy, tend to be slightly white in color, and have a savory taste[3].

Borax is a white crystalline compound, odorless, and stable at room temperature. Borax is a chemical compound with the Latin name sodium tetraborate ($NaB_4O_7.10H_2O$). Borax or borax acid is usually used as an ingredient for making detergents and antiseptics4. Borax can be analyzed qualitatively or quantitatively. Borax qualitative test can be done using turmeric paper[5].

Consuming borax in food is not directly bad, but it accumulates (buried) little by little in the liver, brain, kidneys and testes. Borax is not only absorbed through digestion but can also be absorbed through the skin. Borax is absorbed in the body in small amounts will be excreted through urine and feces, and very little through sweat. Borax can also interfere with metabolic enzymes. According to BPOM, the highest dose and can be fatal to health is the dose for adults ranging from 15-20 g and for children 3-6 g[6].

The results of the analysis conducted by research on meatballs in the city of Medan from 10 samples of meatballs showed that 80% of the samples examined contained borax (eight samples out of ten samples) and the borax content obtained in meatballs was between 0.08%-0.29%3. Sari's research (2020) stated that the quality test of skewered meatball snacks sold in elementary schools in Salo District, Kampar Regency from 16 samples of meatballs showed that 9 samples were positive for borax. Based on some of the results of the research above, it shows that Borax is still widely used in food mixtures, even though its use has been banned because it can have a negative impact on health[7].

Based on the above background, researchers are interested in conducting this literature study, namely to review the extent and whether there is still the use of hazardous materials borax that is still being carried out by meatball traders in Indonesia. This literature study is also expected to make people understand and be more careful in buying and consuming meatballs sold in the market.

Article Selection Process

In this literature study, qualitative and quantitative research methods are used, namely through literature studies. Qualitative research is research that is descriptive in nature, so it requires a deeper understanding of the data obtained. While quantitative research uses data in the form of numbers or calculations from a number of statistical analysis methods, the

results of which will be the basis for making decisions and conclusions[8].

This literature search was carried out through an electronic database, namely Google. The use of this electronic database is because the database is a secondary literature that can lead to the primary literature, making it easier to search for articles that are relevant to the research objectives, where many scientific articles are available in the database. In conducting a search for these scientific articles using the right keywords, so that it plays a very important role in finding the information needed quickly and accurately.

A study requires an object of research, so that research can run effectively and efficiently. So it is impossible for all articles from keyword search results to be reviewed because there are so many articles in the database. Therefore, it is necessary to collect article data that is relevant to the research objectives and how to filter the articles obtained based on inclusion and exclusion criteria.

Based on a literature search through each database using the keywords, namely borax "or" sodium tetraborate" or "meatballs" or "in English, namely borax" or "boric acid" or "meatballs, there are 30 articles that have been screened based on inclusion criteria. . The inclusion criteria were determined based on the theory which was to determine the analysis of borax in meatballs circulating in all Indonesian traditional markets. Of all the articles that use various methods, these were taken with the aim of knowing whether borax has the potential to be contained in the meatball food. The novelty of the year of publication of the article also needs to be considered, so that the information obtained is not too long, therefore the year of publication of the article is included in the inclusion criteria for articles that must be published in the last 10 years, namely from 2012-2021.

In addition, so that there are no errors in understanding the contents of the article, the articles included in the study must be in Indonesian or English. Articles obtained must also be from indexed journals, namely National journals must be indexed by sinta 1-4 and international journals indexed by Scopus. Then as many as 30 articles were excluded from the previous database, there were some articles that were incomplete and there were also some articles that were not indexed. however, the article can be used as a supporting article to complete an article that is incomplete in terms of the method. Thus, the results of the search for literature studies based on these inclusion and exclusion criteria are several articles which will then be studied comprehensively in order to obtain accurate information regarding the analysis of borax levels in meatballs.

Qualitative Analysis

Borax qualitative test can be done by several methods, including organoleptic, flame test, and color test using turmeric paper. According to research conducted by Perdana (2009), the organoleptic test of meatballs can be seen in terms of color, aroma, and elasticity. Based on a literature review, it is said that if meatballs are detected to contain borax, the color looks pale white, smells like meatballs in general but has a slight chemical smell, and tastes chewy[9].

According to research conducted by Aryani, et al., (2018), namely the analysis of the borax content in processed foods marketed around campus by using a purposive sample technique (samples are taken randomly). The samples used were as many as 20 samples, which before testing, the samples were prepared first, namely the samples were weighed, cut into small pieces, then baked at a temperature of 120^{o}C. The function of the sample oven at a temperature of 120^{o}C, so that the sample is completely dry and does not contain solvents so that it is easy to carry out the next test. Then the sample is put into a porcelain dish, then ignited on a 800^{o}C temperature. The function of annealing at a temperature of 800^{o}C, namely the process of ashing the sample. Then the test is carried out with a flame test. The results obtained after burning from the flame are green, this indicates that the meatball sample contains borax (positive)[10].

Then the research conducted by Harimurti, et al., (2020), namely the identification of borax in skewered meatballs circulating in Bantul Regency, a special area of Yogyakarta. In this study, samples were taken from 17 sub-districts, each of which 2 samples

were taken, and the total sample was 34 samples. Prior to the test, sample preparation was carried out, namely the sample was weighed as a whole, added 50 ml of CO_2-free water, the sample was mashed using a mortar and stamper, filtered using filter paper, then the filtrate obtained was heated using an electric stove until dry. The dry sample was tested for flames from 34 samples, of which there were only 26 samples which indicated the presence of borax (positive), because during the combustion process the color of the flame changed to green, then the sample could be said to contain borax[11].

Based on the results of the three studies, the principle of the flame test is to add sulfuric acid and methanol as reagents. The purpose of adding sulfuric acid and methanol which will later react as a catalyst, then produce trimethyl borate $(CH_3O)_3B$ compounds. Trimethyl borate is a liquid with a low boiling point and highly flammable, then if the sample is during the combustion process, a green flame will appear which indicates that the meatball sample (positive) contains borax. And if the sample (negative) contains borax then the flame is blue.

Figure 1. Sample with Borax12

The green flame color appears due to heating of the Boron (B) atom contained in the methyl borate $(CH_3O)_3B$ compound. The reaction is as follows[13]:

$3CH_3OH + H_3BO_3 + H_2SO_4 \rightarrow (CH_3O)_3B + 3H_2O$

In contrast to the research conducted by Buyang, et al., (2016), namely the qualitative analysis of borax in beef meatballs circulating in the traditional market of Merauke Regency, namely by means of a random sampling technique and then a test, namely the flame test. Before the borax examination process, the sample was prepared first by weighing the meatball sample, cutting it into small pieces, and ashing the sample before reacting with sulfuric acid and methanol, then the meatball sample was ready for testing. The results obtained in this study were the color of the fire was bluish red, which indicated that the meatball sample did not contain borax (negative)[14]. The results of the flame test from the three researchers can be seen in Table 1:

Table 1. Flame test results

No	Author	Sample	Result
1.	Buyang, *et al*., (2016)	Meatball	(-)
2.	Aryani, *et al*., (2018)	Meatball	(+)
3.	Harimurti, *et al*., (2020)	Meatball	(+)

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. Curcumin is very sensitive to Ph change, that can cause structure formation[15].

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[18]. 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)[19], which inclined the use of it as natural indicator.

Tumeric paper is paper that is yellow in color, containing curcumin compounds made from turmeric extract16. Based on the results of research from Anreny, et al., (2017), namely the borax content test in beef meatballs circulating in traditional markets in Merauke Regency. In this study, the sampling technique was random,

then tested with tumeric paper. Prior to the borax inspection process, the sample was prepared in advance by weighing the sample as much as 5 grams, crushed, added 20 ml of distilled water, the distilled water served as a sample solvent. Then the sample solution was put into a centrifugation tube, the solution was centrifuged for 2 minutes at a speed of 3000 rpm. The sample was first centrifuged so that the sample separated from the solvent, then the supernatant from the solution was taken. After that, the test was carried out by dripping the supernatant on tumeric paper. The results obtained in this study did not contain any meatballs containing borax (negative)[17].

Meanwhile, according to research by Aryani, et al., (2018) in this study, the samples to be tested were 20 samples, and there was only 1 sample of processed food containing borax (positive), the sample of processed food containing borax was meatballs. Prior to testing, the sample was prepared first, by weighing the sample as much as 100 g, mashed with a mortar, added 50 ml of CO2-free water. The function of the addition of CO2-free water is as a solvent in the sample. Then filtered using filter paper, then the filtrate is taken. After this, the test was carried out with tumeric paper. The results of the qualitative test using tumeric paper were obtained which showed a change in color, namely the sample contained borax (positive)[10].

According to research by Harimurti, et al., (2020), namely the identification of borax in skewered meatballs circulating in Bantul Regency, a special area of Yogyakarta. In this study, samples were taken from 17 sub-districts, each of which 2 samples were taken, and the total sample was 34 samples. Before testing, the sample was prepared first, by weighing the sample, adding CO_2-free water, the function of adding CO_2-free water was as a solvent in the sample. Then the sample was mashed using a mortar and stamper, filtered using filter paper, then the filtrate was taken, then further tested on tumeric paper. Based on the results of the qualitative test using tumeric paper, when the sample is dropped into the tumeric paper, the tumeric paper changes color from yellow paper to brownish red, which all of these samples show that there is borax content (positive)[11].

Based on the results of the three studies, the principle of the test with tumeric paper is to attach the tumeric paper to the sample of meatballs that are detected to contain borax. Tumeric paper containing curcumin has two groups, namely ketones and enols. Where the ketone group and the hydroxyl group interact with boric acid, resulting in a red compound called rosocyanin.

The reaction of curcumin with boric acid can be seen as follows (Figure 2):

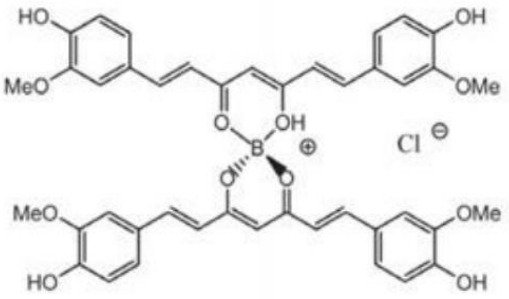

Figure 2. Reaction of curcumin with boric acid11

The results of the test with tumeric paper from the three researchers:

Table 2. Tumeric paper test results

No	Author	Sample	Sample Preparation	Result
1.	Anreny, *et al.*, (2017)	Bakso	Dengan aquades	(-)
2.	Aryani, *et al.*, (2018)	Bakso	Air bebas CO_2	(+)
3.	Harimurti, *et al.*, (2020)	Bakso	Air bebas CO_2	(+)

In accordance with the results of research conducted by Lestari et al. (2022), deciding a concentration of turmeric extract used in a detection tool requisite a proper concentration to simplify the color changes observations. 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 (Methanol Extract) 10,000 ppm with the result reddish-brown color[5].

Quantitative Analysis

Alkalimetric titration test conducted by Aryani et al. (2018), namely the analysis of borax content in processed foods marketed around campus. Then a quantitative test was carried out using the alkalimetric titration method, the samples used were 20 samples and the samples were obtained by purposive sampling. At the time of testing the sample in which the meatball sample was added with glycerol, the glycerol was in the form of a cosolvent in which a solvent was added in a system to help dissolve or increase the stability of a substance. Cosolvents have two properties, namely hydrophilic (like water) and hydrophobic (dislike water). These two properties will help in increasing the solubility of a solution. After the sample is dissolved using glycerol, then the sample is titrated with NaOH, NaOH is used as a secondary standard solution because the sample is acidic so it is titrated with an alkaline solution (NaOH)[10].

In the quantitative test, the titration here uses a phenolphthalein indicator, where the phenolphthalein indicator is a solution that functions to determine the equivalence point in the titration, then the phenolphthalein pH range is between 8.3-10. The equivalence point is the point at which the compound is completely used up. When there is a color change, the end point of the titration has been reached. The end point of the titration is a condition marked by a change in the color of the solution to pink (pink) and indicates that the titration time can be stopped with the acquisition of a concentration of 3.82 ppm. After the end point of the titration, the volume of NaOH used was 10 ml. The results obtained from the meatball samples contained borax (positive). The following is the reaction that occurs between boric acid and NaOH.

H3BO3 + NaOH NaH2O3 + H2O

When boric acid is reacted with sodium hydroxide, sodium trioxide is formed.

The alkalimetric titration test conducted by Harimurti, et al., (2020) research is the identification of borax in skewered meatballs circulating in Bantul Regency, a special area of Yogyakarta. In this study, samples were taken from 17 sub-districts, each of which 2 samples were taken, and the total sample was 34 samples. Then for the quantitative test, namely by akalimetric titration using a secondary standard solution of 1 N NaOH which has been standardized and is used to measure the concentration of borax in skewered meatballs. Furthermore, the solution is added again with a phenolphthalein indicator which is the function of the phenolphthalein to determine the equivalence point in the titration. The equivalence point is the point at which the compound is completely used up. When the color changes to pink (pink), the end point of the titration has been reached. The end point of the titration is a condition marked by a change in the color of the solution and indicates when the titration can be stopped[11].

The test using UV-Vis spectrophotometry conducted by Adu, et al., (2021) research is the determination of boron in food products by distillation of boric esters using UV-Vis spectrophotometry. In this study, the sample used was 30 samples, but only 5 samples were taken that were not washed and then the borax content in the sample was analyzed. Prior to the test, the sample was distilled first, by separating the borax content in the sample using ethanol solvent and reacting it with curcumin solution, then stored in a vessel at room temperature for 24 hours. This was done in order to separate the borax from the sample, to make it easier to perform the test using a UV-Vis spectrophotometer. The analysis was carried out by measuring the absorbance of the sample using a wavelength of 555 nm. Prior to quantitative analysis, the test method using UV-Vis spectrophotometry was validated first, validation aims to determine that the analytical method is really accurate and can be used as a validation parameter. Based on the results of quantitative analysis, it is known that the lowest level is 1.406 mg/kg and the highest level is 3.589 mg/kg. Then the linearity test in the concentration range 1.2-4.8 ppm by giving a correlation coefficient value of R=0.999520.

Meanwhile, based on research conducted by Suseno (2019), namely the analysis of borax in meatballs using a UV-Vis spectrophotometer. In this study, the samples of meatballs used were 12 samples taken randomly in 2 places. Prior to testing, sample preparation was carried out first, namely weighing 5 g of the meatball sample, added 20 ml of distilled water, blended until smooth, the refined sample was put into a centrifugation tube, centrifuged for 2 minutes at a speed of 3000 ppm, the supernatant was taken with filtered using filter paper, then the resulting supernatant is ready for testing. Based on the research results, it is known that the maximum wavelength of borax is 428 nm[3]. The results obtained can be seen in Table 3:

Tabel 3. Borax concentration2

No.	Sample Code	Test Result (μg/mL)
1.	A1	131,875
2.	A2	1467,5
3.	A3	0
4.	A4	186,25
5.	A5	512,5
6.	B1	2414,375
7.	B2	129,375
8.	B3	450
9.	B4	262,5
10.	B5	222,5
11.	B6	0
12.	B7	0

The regression equation obtained from standard readings of borax in various concentrations is y=0.002x+0.003 with R=0.998. Based on this equation, the borax concentration of the sample can be identified. The results of borax analysis obtained using a UV-Vis spectrophotometer showed that 9 out of 12 were positive for borax. In the positive sample, the highest concentration was in sample B1 of 2414,375 g/mL, and the lowest concentration was in sample B2 of 129,375 g/mL.

The comparison of levels obtained from each researcher can be seen in Table 4:

Table 4. Comparison of borax levels from each researcher

No	Author(s)	Method	Concentration
1.	Aryani, et al., (2018)	Titrasi alkalimetri	3,82 ppm
2.	Harimurti, et al., (2020)	Titrasi alkalimetri	0,06 – 5,15%
3.	Suseno, (2019)	Spektrofotometri UV-Vis	129,375 –
4.	Adu, et al., (2021)	Spektrofotometri	2414,375
5.	Masdianto, et al., (2020)21	UV-Vis	μg/mL

Conclusions

Based on the results of the literature study by collecting related journals according to the titles taken, it can be concluded that:

1. There are still meatball traders circulating in traditional markets in Indonesia who cheat on their merchandise and add one of the food additives, namely borax which is dangerous for consumption which can cause toxicity to the body.
2. For the borax content contained in meatballs from the research of Adu, et al., (2021) using UV-Vis spectrophotometry, the highest level was 3.589 mg/kg and the lowest was 1.406 mg/kg. Alkalimetric titration tests from 2 researchers, namely Aryani, et al., (2018) and Harimurti, et al., (2020) were positive for borax with a change in the final color of the titration to pink with levels of 3.82 ppm and 0.06-5.15%. Tests with UV-Vis spectrophotometry obtained results with a wavelength of 555 nm with a linearity that is R=0.9995 and an accuracy of 96.09%-104.62%, with the highest level of 2414,375 g/mL and the lowest 129,375 g/mL. Visible spectrophotometry test obtained results with a wavelength of 620 nm, namely the meatballs before being burned with a value of 0.54 ppm and after being burned with a value of 0.50 ppm.
3. From the results of the analysis using a literature study regarding the acquisition of results with various methods, namely for the qualitative test using the organoleptic test, the flame test, and the tumeric paper test. The quantitative test used alkalimetric titration, spectrophotometry UV-Vis, and Visible spectrophotometry. From the results

obtained, it turns out that there are still many meatballs containing borax with various ratios of levels, according to the method of analysis carried out by the researcher.

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