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Assessment of Borax Contamination in Crackers from Jenangan Subdistrict Market: Findings and Recommendations

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ABSTRACT Borax is a prohibited additive according to the Regulation of the Minister of Health of the Republic of Indonesia Number 033 of 2012 because the negative impact of borax on human health causes disorders of the central nervous system, kidney and liver function, and death. The purpose of this study was to determine the borax content in crackers sold in Jenangan Subdistrict Market in 2023. This research uses descriptive research. The research methods were organoleptic test and borax qualitative test (Rapid test). The object of this research is cracker products sold in Jenangan Subdistrict Market using total sampling, namely 21 crackers from 3 sellers in Jenangan Subdistrict Market. The data analysis used was descriptive analysis in tabular form. The results obtained, from 21 samples of crackers examined by organoleptic test method, 21 samples were good in smell and taste, 3 samples were difficult to crush in texture, 6 samples were less bright in color, slightly dull and even tended to be dark and dull, while in the qualitative test from 21 samples, 3 samples (14.3%) were positive for borax. In conclusion, the borax test of this study was conducted by means of organoleptic test method and qualitative test obtained the results of 3 samples containing borax. The recommendations of this study are to increase the knowledge of cracker producers about the dangers of borax for health so that they can find alternative ingredients that are safer for health, for the public to better understand how the characteristics of crackers containing borax in order to maintain their health, and for the government to carry out regular supervision of Food Additives in circulation so that they are safe for public consumption.
INDEX TERMS borax; crackers; organoleptic test; qualitative test

I. INTRODUCTION

Food is a product made from agricultural, plantation, forestry, fishery, livestock and aquatic products. Food is usually processed or not as a need for human food and drink. In the process of food preparation and processing, raw materials, additives, and other materials are usually used [1]. Food additives are additional ingredients that are usually included or mixed in the processing process of a food product that functions as a modifier of the shape and nature of food products and can increase the nutritional value and quality of food. The use of food additives in food products must comply with the standards set by the government [2].

Based on the Regulation of the Minister of Health of the Republic of Indonesia No. 033 of 2012, borax is an additive that is prohibited from being used in the processing of food products. One of the uses of borax in food is mixed in cracker products. Borax is a chemical that functions as an inhibitor of microbial growth and development. Borax functions as an ingredient in the manufacture of medicines such as ointments, powders, and eye drops [3]. Borax also functions as a soldering agent, cleaner, wood preservative, and disinfectant [4]. However, borax is still often found in food products such as noodles, meatballs, and crackers. The function of borax in these foods can improve texture[5].

The ban on the use of borax in food has been established by the government as stipulated in the Regulation of the Minister of Health of the Republic of Indonesia Number 033 of 2012 [2]. The use of borax in food has impacts that can endanger human health such as food poisoning with symptoms of diarrhea and vomiting, impaired kidney function, and death [6].

The use of borax in food is banned by the government due to its harmful effects on human health. The use of borax can be found in the processing of crackers. In a market in the Surakarta area, borax was examined in crackers. Of the 30 samples taken, 80% of the crackers contained borax [7]. Crackers containing borax are characterized by a slightly dull

color and tend to be darker, and a texture that is difficult to crush [8].

Crackers containing borax when consumed can cause food poisoning characterized by abdominal pain, decreased appetite, loss of concentration, dehydration, and liver damage [9]. An incident of food poisoning due to borax occurred in 2018 in Yogyakarta with survey results of 23.82% of samples not meeting the requirements. As much as 9% of the unqualified food was caused by the use of banned food additives, one of which was borax [10]. herefore, the government prohibits the use of borax in food. Food products with borax added violate the provisions of the Regulation of the Minister of Health of the Republic of Indonesia No. 033/2012 on Food Additives. People have human rights, one of which is to fulfill the need for healthy and quality food. Health Law No. 36/2009, Article 111 paragraph (1), stipulates that every human being is obliged to consume food and beverages that meet hygienic standards and requirements. Food products containing borax, such as crackers, indirectly have a negative impact on health, thus violating the rules set by the government regarding the fulfillment of healthy and quality food needs. The effects of borax consumption will affect the human body such as poisoning after consuming borax-containing food products characterized by symptoms of dizziness, vomiting, diarrhea, and stomach cramps. If borax is consumed over a long period of time or consuming foods containing borax continuously, it can cause damage to the central nervous system, impaired kidney and liver function, and death [6]. Humans have human rights, one of which is related to the fulfillment of healthy and quality food needs [11]. Humans must consume food that complies with hygiene and sanitation standards and requirements, and is free from contaminants that endanger human health [1]. Therefore, it is necessary to monitor the use of borax in food to protect public health.

Based on the impact of borax use, it is necessary to examine cracker products that are suspected of using borax in their processing. Data on the number of cracker producers in Ponorogo Regency in the period 2020-2022 are 384 cracker producers, with the largest number in Jenangan District, namely 55 producers. The produced crackers are then distributed to markets in Ponorogo Regency, one of which is the Jenangan District market. Based on the survey conducted, there are 3 sellers in the Jenangan District Market who sell various types of crackers processed by cracker producers. In 2020-2022, an inspection was conducted on 9 cracker producers in Ponorogo District with the result that 2.1% of cracker producers still used borax in their products. In the preliminary test in 2023, 5 cracker samples were obtained from the Jenangan District Market in Ponorogo Regency. The laboratory test results on these samples tested 40% positive for borax [12].

Based on these data and considering the negative impact of borax which is harmful to human health, it is necessary to further monitor the use of borax in crackers sold in the Jenangan District Market. This study collaborated with the Ponorogo District Health Office to test borax content in crackers using the rapid test method. The borax test on cracker samples using this rapid test kit consists of curcumin test strips and borax reagent. If the test strip changes color to orange, red, and brick red, then the sample is positive for borax [13].

II. METHODS

This study uses descriptive research which aims to determine and identify the borax content in crackers sold in Jenangan Subdistrict Market in 2023. The object of this research is crackers sold in Jenangan Subdistrict Market in 2023. The sampling technique was total sampling based on the number of crackers sold by 3 sellers in Jenangan Subdistrict Market in 2023. The number of samples taken was 21 crackers with the sample criteria being raw crackers of the type of onion crackers, shrimp paste, milkfish, puli, shrimp and fish, rambak crackers.

The methods used in this study were organoleptic test and borax qualitative test conducted by 30 panelists consisting of regional health laboratory officers, laboratory analysts, health department and community. Organoleptic test was conducted by testing the physical quality of crackers including smell, taste, texture, and color with a data collection tool in the form of a scoring sheet. The borax qualitative test was conducted using the curcumin paper test method with a rapid test kit as the data collection tool. This rapid test kit consists of curcumin test strips and borax reagent.

Data were collected using primary data, namely through organoleptic tests and qualitative laboratory tests on cracker samples obtained from the Jenangan District market, and secondary data, namely data on the number of cracker producers who still use borax for the 2020-2022 period from the Health Office and data on the number of cracker producers in Ponorogo Regency for the 2020-2022 period from the Trade Office. Samples were examined with a data collection tool. The research procedure was carried out by smoothing the crackers then weighing 25 grams and putting them in an erlenmeyer tube. Smooth crackers were added with 50 ml of warm water and then homogenized. The sample liquid was filtered using filter paper and then put into a test tube. Borax reagent was added as much as 3 drops into the sample liquid then stirred until mixed. The sample that has been added with borax reagent is dripped using a dropper pipette on a curcumin test strip. If the test strip changes color to orange, red, and brick red, the sample is positive for borax.

III. RESULTS

A. ORGANOLEPTIC TEST

The organoleptic test was conducted by non-standardized panelists with a total of 30 panelists by observing the smell, taste, texture, and color of the crackers. The following are the results of the physical quality assessment of crackers based on the cracker odor criteria described in TABLE 1. The results of TABLE 1 above show that of the 21 samples examined, 100% have a good category in the quality of cracker odor

with assessment criteria for the good category which has the characteristics of a strong raw material odor and no musty odor. However, each panelist has a different assessment for each sample. This is because each panelist has different sensitivities and basically the human senses also vary.

TABLE 1
Results of odor quality assessment on crackers in Jenangan sub-district market

Odor quality	Frequency (f)	Percentage (%)
Good	21	100%
Suffient	0	0%
Less	0	0%

The following are the results of the physical quality assessment of crackers based on the cracker flavor criteria described in TABLE 2.

TABLE 2
Results of taste quality assessment on crackers in Jenangan sub-district market

Taste quality	Frequency (f)	Percentage (%)
Good	21	100%
Suffient	0	0%
Less	0	0%

From the results of TABLE 2 above, it was found that out of 21 samples examined, 100% had good criteria on the taste quality of crackers after frying with assessment criteria for the good category which has the characteristics of savory crackers, there is a taste of raw materials, and a little flavoring. However, each panelist had different ratings on each sample. This is because each panelist has different sensitivities and basically the human senses are also different.

The following are the results of the physical quality assessment of crackers based on the cracker texture criteria described in TABLE 3.

TABLE 3
Results of texture quality assessment on crackers in Jenangan sub-district market

Texture quality	Frequency (f)	Percentage (%)
Good	18	85.7%
Suffient	2	9.5%
Less	1	4.8%

The results of TABLE 3 above show that of the 21 samples examined, 85.7% had good criteria, 9.5% had sufficient criteria, and 4.8% had insufficient criteria on the texture quality of crackers with assessment criteria of for the good category having characteristics that are easy to crush, for the sufficient category having characteristics that are slightly/less crushable, and for the insufficient category having characteristics that are difficult to crush. The fair and poor assessment categories are caused by the texture quality characteristics of crackers that are slightly harder to crush than crackers in the good category.

The following are the results of the physical quality assessment of crackers based on the cracker color criteria described in TABLE 4.

TABLE 4
Results of color quality assessment on crackers in Jenangan sub-district market

Color quality	Frequency (f)	Percentage (%)
Good	15	71.4%
Suffient	4	19%
Less	2	9.5%

From the results of the TABLE 4 above, 71.4% of the 21 samples examined had good criteria, 19.1% had sufficient criteria, and 9.5% had poor criteria on the color quality of crackers with assessment criteria for the good category having bright and clean color characteristics, for the sufficient category having less bright and slightly dull color characteristics, and for the poor category having characteristics that tend to be dark and look dull. In the fair and poor assessment categories, the color quality characteristics of the crackers are slightly duller than the crackers in the good category.

B. QUALITATIVE TEST

The borax qualitative test was conducted using the curcumin paper test method using the rapid test with positive results indicated by changes in curcumin paper to orange, red, or brick red color. The borax qualitative test on these crackers uses the rapid test method. This method is a rapid test kit containing a bottle of borax reagent and curcumin test paper. The borax rapid test method is carried out by observing the color change that occurs on the curcumin paper test strip after dipping it into the food test sample. The following are the results of the physical quality inspection of the crackers:

TABLE 1
Qualitative Test Results of Borax Crackers Sold in Jenangan Subdistrict Market

Borax content	Frequency	Percentage (%)
Positive	3	14,3
Negative	18	85,7

The cracker samples were examined using the curcumin paper test method and 14.3% of the samples were positive for borkas. This is indicated by the color change on the curcumin paper from yellow to orange, red, to brick red. The color change on the curcumin paper is caused by the content of curcumin which can break the bonds of borax into boric acid and bind it into a red color. [14].

IV. DISCUSSION

A. ORGANOLEPTIC TEST

Crackers containing borax are characterized by a musty and rancid odor, bitter taste and dominant preservatives, a texture that is difficult to crush, and a color that looks dull. Based on the organoleptic test conducted by 30 non-standardized panelists, the odor quality obtained average results in the

good category with the physical characteristics of the dominant smell of cracker raw materials. In the taste quality test results, there were 3 samples that fell into the sufficient category with the physical characteristics of savory cracker taste, there was a flavoring taste, and a little taste of raw materials. In the texture quality test results, there were 8 samples in the sufficient category with the physical characteristics of the texture of crackers that were rather easy to crush, and there was 1 sample in the insufficient category with physical characteristics that could not be crushed. In the color quality test results, there were 9 samples that fell into the sufficient category with physical characteristics of the color looking a little bright and not dull, and there were 3 samples that fell into the insufficient category with physical characteristics of the color looking dull and tending to be dark.

Quality inspection of crackers is carried out using the organoleptic test method, where human sensory testing is the main tool in assessing product quality. Evaluation of organoleptic examination includes examination of characteristics related to the quality of color, smell, taste, and texture for product assessment. Organoleptic tests are conducted by panelists who make subjective assessments of product quality requirements. Panelists are divided into standard panelists and non-standard panelists. The minimum number of panelists in organoleptic assessment in one test is 6 standard panelists and 30 non-standard panelists [15].

The sensory characteristics of the panelists are different, thus affecting the results of the organoleptic test assessment. In the results of the organoleptic test assessment of the quality of odor and taste of crackers, the results were 100% in the good category where the assessment criteria were 6-9. Panelists' assessment of the quality of the smell and taste of crackers ranged from 6-9 where each panelist had a different assessment. This is due to different sensory factors in each human being. Factors that affect the sensitivity of the human sense of taste are the age of the panelist, disease factors, and other factors that can inhibit flavor identification. In addition, degeneration changes in cells and organs also cause a progressive decline in organ function [16].

Based on the results of the study on the assessment of odor quality in crackers, out of 21 samples, 100% were obtained with good assessment criteria. This is indicated by the physical characteristics of the crackers, namely the absence of musty and rancid odors. According to [17], the odor in crackers is caused by the temperature of the steaming and frying time, the reaction of various compounds contained in the crackers, and the oxidation of fat to produce volatile and non-volatile compounds. The odor in crackers increases due to the percentage of flour added and the raw materials used, it can also be caused by the length of the drying process carried out because the use of high heat such as in the drying or frying process of crackers will produce odor in a material.

Based on the results of the research on the assessment of flavor quality (after frying) in crackers, out of 21 samples, 100% were obtained with good assessment criteria. This is indicated by the physical characteristics of crackers that have a savory taste, a strong taste of raw materials, and a lack of flavoring. Based on [15], crackers containing borax have physical characteristics with a savory cracker taste but a strong flavoring taste, little or no taste of the raw materials, and a bitter taste on the tongue. Generally, the taste of crackers has good characteristics, savory, and the dominant taste of the raw material. Cracker flavor is caused by the interaction between chemical compounds, temperature, concentration, and other ingredients. The flavor composition of crackers is related to the protein present in the food. The more protein, the more savory the crackers taste. However, during the processing of crackers, if borax is added, crackers containing borax will taste bitter on the tongue. The addition of borax affects the flavor of the concentration of crackers added. The higher the amount of borax added, the more bitter the taste of the crackers will be. According to [18], the flavor of crackers mainly comes from the ingredients used. During processing, the interaction of the ingredients used can affect the flavor of the crackers after processing.

Based on the results of the study on the assessment of texture quality in crackers, out of 21 samples, 85.7% had good criteria, 9.5% with sufficient criteria and 4.8% with insufficient criteria. In samples that have sufficient and insufficient criteria, because crackers have a texture that cannot or is difficult to crush. Based on [15], crackers containing borax are characterized by a texture that is difficult to crush. This is due to the characteristics of borax itself which, when added to food, thickens and has a texture that is difficult to crush. According to [19], crackers containing borax have a texture that is difficult to crush because the addition of borax to food can increase the viscosity of the mixed solution used in the cracker making process. The hard-to-crumble texture of crackers can also be caused by an increase in the amount of water content. When the crackers are fried, the texture of the crackers becomes crunchy. This is because frying results in a decrease in water content and an increase in the texture of the material. According to [20], the factors that cause crackers to be difficult to crush are the incomplete gelatinization process of starch in the dough and the reduced amylopectin content. This causes the voids formed during frying to be smaller, denser, and have fewer voids.

Based on the results of the research on the assessment of the color quality of crackers, out of 21 samples, 71.4% had good criteria, 19% with sufficient criteria, and 9.5% with insufficient criteria. In samples that have sufficient and insufficient criteria, because the crackers have a color that looks a little dull. Based on [15], crackers containing borax are characterized by a dull color and tend to be dark. The formation of cracker color is caused by the reaction process between ingredients and the manufacturing process. The appearance of color on the surface of crackers is caused by the maillard reaction. According to [21], maillard reaction is a process where when heated, it causes a reaction between

reducing sugars and amino acids. The maillard reaction affects the formation of flavor and color in various processed foods. This maillard reaction takes place at temperatures between 150 - 260 ^{o}C which is equivalent to the heating temperature in the cooking process. The level of color intensity in crackers depends on the length of time, temperature, addition of chemical compounds, and ingredient composition. Increasing the substitution of cracker ingredients such as flour will increase calcium and protein which sometimes leads to a decrease in the brightness of the cracker color. The protein content in crackers also affects the intensity of the browning reaction, causing the color of the crackers to look dull.

Based on the results of the organoleptic test assessment, it is known that the samples of crackers sold in the Jenangan Subdistrict Market have 3 samples that have the characteristics of crackers containing borax with an indication of the texture of crackers that are difficult to crush, and the color of crackers that look dull and tend to be darker.

B. QUALITATIVE TEST

This qualitative test of borax in crackers uses the rapid test method. This method is in the form of a rapid test kit containing a borax reagent bottle, curcumin paper test strip, empty glass bottle, and vaculab. The borax rapid test method is carried out by observing the color change that occurs on the curcumin paper test strip after dipping it into the food test sample [22]. According to [23], the advantage of using a rapid test kit is that testing food samples is easy to do, because the steps are easy to perform. Then, the time to process and provide test results is not long, because the reaction between the curcumin test strip and the sample takes about 10 minutes to get the results. However, this rapid test kit also has the disadvantage that the test material is quite expensive and researchers only know whether the tested food contains borax or not.

Based on the results of the borax examination in crackers using the rapid test method, of the 21 samples taken at the Jenangan Subdistrict Market, 85.7% were negative for borax and 14.3% were positive for borax as indicated by the color change of the curcumin paper from yellow to red. The borax positive cracker samples when examined using the organoleptic test produced physical characteristics such as a texture that was difficult to crush and a color that looked rather dull. These results indicate that the use of borax has started to decrease in the community. According to [24], crackers containing borax when tested cause a change in color on curcumin paper. If the result is positive for borax, the curcumin paper changes color from yellow to orange or brick red. This is because the curcumin compound contained in turmeric breaks the bond of borax with boric acid then binds to an orange to reddish complex in acidic conditions, then produces a red to brick red color in food products containing borax [5][25].

The addition of borax to crackers aims to add a good and crunchy texture. Borax belongs to the borate mineral group which is a natural chemical compound. The physical properties of borax are in the form of white crystals and are soluble in water, and have weak alkaline properties with a pH of (9.15 - 9.20). Another name for borax is Sodium Tetraborate with the chemical formula $Na_2[B_4O_5(OH)_4].8H_2O$ which consists of the elements Sodium, Boron, Oxygen, and Hydrogen. Borax is a crystalline compound and has the property of dissolving easily in water. When dissolved in water, borax crystals turn into sodium hydroxide and boric acid. Based on its function, this compound is not for food processing but for the manufacture of glass products, wood preservatives, and mixtures in plant fertilizers. The use of borax in food products can be harmful to the human body [26].

The use of borax in food products certainly violates the rules set by the Regulation of the Minister of Health of the Republic of Indonesia No. 033/2012 on Food Additives. Fulfillment of healthy and quality food is a human right. People must consume food that meets health standards and requirements in accordance with Law No. 36/2009 on Health in Article 111 paragraph (1). Foods containing borax, such as crackers, indirectly have a negative impact on health. The impact of consuming borax will cause symptoms of dizziness, vomiting, diarrhea, and stomach cramps if used in high doses. If food products are consumed in the long term by the community, the impact on health can cause damage to the central nervous system, as well as impaired kidney and liver function [6]. So borax is prohibited from being used in food because it can damage and have a harmful impact on humans.

The use of borax in crackers is used by producers because crackers containing borax have a texture that is difficult to crush, add crispness after frying, and as a preservative so that the storage of crackers can last longer [27]. Based on the purpose of using borax in food products, it is necessary to conduct research on the use of alternatives to borax that have the same properties and purpose as the use of borax in food products. Based on research [28], an alternative ingredient to borax that is safe for human health is seaweed. Seaweed contains alginate, keraginan, and agar which can affect the texture of crackers because it acts as a natural thickener. Crackers that use seaweed in the manufacturing process produce a sticky texture, yellowish white color, savory and delicious taste [29]. Meanwhile, crackers that use borax in the manufacturing process produce a sticky and strong texture, brownish color, and bitter taste. In addition, crackers using seaweed have nutritional benefits, namely seaweed has mineral content that is beneficial to the body to improve human health [30]. Seaweed as a borax substitute in crackers has a low fat content that is safe for consumption by people with high cholesterol, high vitamin C content to strengthen the immune system, while Ca content can be used to form bones in children and reduce osteoporosis in adults.

The use of borax in crackers is used by producers because crackers containing borax have a texture that is difficult to crush, add crispness after frying, and as a preservative so that the storage of crackers can last longer [31]. Based on the

purpose of using borax in food products, it is necessary to conduct research on the use of alternative borax substitutes that have the same properties and purpose as the use of borax in food products. An alternative ingredient to borax that is safe for human health is seaweed. Seaweed contains alginate, keraginan, and agar which can affect the texture of crackers because it acts as a natural thickener [29]. Crackers that use seaweed in the manufacturing process produce a sticky texture, yellowish white color, savory and delicious taste [28].

V. CONCLUSION

This study aimed to determine the borax content in cracker samples sold in the Jenangan Subdistrict market. Organoleptic and qualitative borax tests were conducted and the results showed that there were 3 samples of crackers containing borax with the physical characteristics of a slight and slightly musty odor of the raw material. The taste of the crackers was savory, with little flavoring, and little taste of the raw materials. The texture of the crackers was less crushable. The color of the crackers is not bright, tends to be dark and looks dull. From these characteristics, a qualitative borax test was conducted and the results of the 3 samples were positive for borax. The recommendation of this study is to provide knowledge for cracker producers about the dangers of borax so that they can find alternative ingredients to replace borax for their production, while for the public to be more observant and careful in consuming crackers sold in the market for their health. And for policy makers, in this case the government is expected to conduct regular supervision of the use of Food Additives circulating in the community so that food and beverages in circulation are safe for consumption.

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