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Identification of Nitrite, Borax, and Formaldehyde Content of Homemade Pork Sausages in Pontianak City Market

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ABSTRACT

Meat is one of the animal-based food products produced by livestock such as beef cattle, goats, chickens, and pigs. It is generally processed into several products, such as sausages, meatballs, salami, corned beef, jerky, and nuggets. Most meat-processed products industries use food additives to improve the quality of the products, such as nitrites. This research aims to determine residual nitrites content in pork sausage and the detection of prohibited food additives, such as borax and formaldehyde. This research used qualitative and quantitative test methods. The data obtained was statistically analyzed using descriptive analysis. The samples used were 10 homemade pork sausages marketed in Pontianak City Market. The parameters observed were nitrite content, borax, and formaldehyde qualitative detection. The research results showed that there were 4 samples out of 10 homemade pork sausages in Pontianak City Market that were found to be higher than the permissible range (>30 µg/g) of residual nitrites and were detected not to contain borax and formaldehyde. In order to provide food safety, education on the use of nitrites and the regulation regarding food additives are needed for the homemade pork sausage producers in Pontianak City Market. Hence consumers are protected from the harmful effects of nitrites, borax, and formaldehyde.

Keywords: Borax, Formalin, Nitrite, Sausages

INTRODUCTION

Meat is edible parts of livestock such as beef cattle, goats, chickens, and pigs. Meat is generally processed into several processed products, such as sausages, which are processed by grinding meat. Mixing the ground meat with spices and other ingredients such as fillers, binders, and food additives such as synthetic dyes and preservatives, then stuffed into the sausage casings. According to Ismanto & Subaihah (2020)Sausage is a commonly consumed processed meat product and has become many people's favorite food. Pork is one of the meats used for making sausages, besides beef, veal, mutton, and chicken.

Synthetic dyes in pork sausage processing aim to increase the color, whereas preservatives are used to extend the shelf life of sausages. Synthetic dyes and preservatives are added to pork sausages as food additives. According to Fadlillah et al. (2015)Food additives are added to food to enhance its sensory characteristics. Nitrite is a food additive often used as a coloring and preservative in sausages. It helps stabilize the bright red color in meat, which is most desirable in meat products and contributes to flavor characterization(Paudel et al., 2021).

Nitrite is a food additive that is used as a preservative in various types of processed meat to inhibit the growth of *Clostridium botulinum* bacteria, maintain the color of the meat so that it is attractive, and also as a flavor enhancer for the meat (Hadisoebroto et al., 2019). Nitrites are generally safe to use in food processing; however, nitrites have potential adverse health effects at a certain level. The use of nitrites in food is permissible according to the Regulation of the Minister of Health of the Republic of Indonesia Number 33 of 2012 regarding Food Additives. Further, the residual nitrites content in food is a maximum of around 20-30 mg/kg according to Peraturan Kepala Badan Pengawas Obat dan Makanan (BPOM) Number 36 of 2013 regarding The Maximum Limit Use of Preservatives Food Additives.

In addition to nitrites, borax and formaldehyde are still widely used as preservatives in food despite being nonfood preservatives and being banned from food processing. Badan Pengawas Obat dan Makanan

(BPOM) Regulation Number 7 of 2018 regarding Prohibited Raw Materials in Processed Foods mentioned that borax and formaldehyde are prohibited in food products. Borax is a chemical compound named sodium tetraborate, which has soft crystals in form; when dissolved in water, it decomposes into sodium hydroxide and boric acid. (Asmi et al., 2023). Whereas formalin or formaldehyde (CH_2O) is a solution that has a powerful odor and is colorless, formalin contains 10-15% alcohol as a stabilizer so that formaldehyde does not polymerize. (Safitri, 2023).

Improper use of food additives in processed meat products can affect consumer health. Sodium nitrite enters the body through food; nitrite can react with hemoglobin and cause methemoglobinemia (Frimana et al., 2023). Frequently consuming foods containing borax will cause brain, liver, and kidney disorders (Earnestly et al., 2023). Meanwhile, long-term consumption of formalin can be a carcinogen (cancer cause) (Chumaidi et al., 2022).

Pork sausage is one of the processed meats quite popular among non-Muslim communities in Pontianak City, so it is necessary to monitor nitrite food additives and the detection of prohibited food additives such as formalin and borax. Based on these problems, it was necessary to identify the nitrites, borax, and formaldehyde content in pork sausages marketed in the Pontianak City market.

MATERIALS AND METHODS

Tools and Materials

The tools used in this research were analytical scales, 50 and 100-mL volumetric flasks, micropipette, Erlemeyer flask, beaker glass, Whatman 42 paper, test tubes, vortex mixer, scissors, hot plate, refrigerator, numerical paper, wool glass filter, white paper, and Spectrophotometer UV-Vis. The samples used in this research were homemade pork sausages from Pontianak City Market, distilled water, saturated NaCl, sulfanilamide solution, N-(1-naphthyl) Ethylenediamine Dihydrochloride (NED) solution, 0.5% Phenylhydrazine, 5% Sodium Nitroprusside, and NaOH 10%.

Research Methods

This research used pork sausage samples from Pontianak City Market, Pontianak City, West Kalimantan. Pork sausage samples were taken from 10 traders, one from each trader. The research was conducted at the Animal Health Services Laboratory, Veterinary Public Health, and West Kalimantan Province Veterinary Clinic. This research uses quantitative and qualitative methods. The data obtained were statistically analyzed using descriptive analysis.

Determination of Nitrites Content in Pork Sausages

Nitrites content in pork sausages was determined using spectrophotometric determination. In brief, 0.5 g of ground pork sausage sample were taken and then transferred into a 50 mL volumetric flask, then 40 mL of distilled water and 3 mL of saturated NaCl solution were added. Subsequently, distilled water was added until the meniscus was homogenized on the engraved line. The sample was then placed in an ultrasonic device for 30 minutes at 40°C. After 30 minutes, the sample then cooled until it reached room temperature. Then, it was filtered using the Whatman No. 42 filter. The filtrates were collected in a 100 mL Erlenmeyer flask, 10 mL of the filtrates were transferred into a 50 mL Erlemeyer flask, and then 0.5 mL of sulfanilamide solution was added. The sample solution was then stirred and incubated for 5 minutes. After incubation, 0.5 mL of NED solution was added, homogenized, and incubated for 15 minutes. Absorbance was measured in a UV-Vis spectrophotometer with a wavelength of 541 nm.

$$\text{C Nitrite } (\mu g/mL) = \frac{\text{Absorbance} - \text{Intersep}}{\text{Slope}}$$

$$\text{C Nitrite } (\mu g/g) = \frac{\text{C Nitrite } (\mu g/mL) \text{ x Volume sample}}{\text{Weight sample}}$$

Borax Detection Test Determination

A sample of 25 g of pork sausage was weighed, 50 mL of distilled water was added and homogenized, and then the solution was heated to a temperature of ± 80°C. The sample solution is soaked in water and then stored and refrigerated for 30 minutes. The sample solution was then filtered with a wool glass. Subsequently, 10 mL of the filtrate was taken, then 0.7 mL of concentrated HCl was added and homogenized using a vortex. The solution was dropped on turmeric paper and then dried on white paper, and the same procedure was for the standard solution. The color changes in the sample were observed and compared with the standard solution. The results were read ≥ 1 hour to ≥ 2 hours at room temperature.

Formaldehyde Detection Test Determination

Cut the pork sausage sample into small pieces, then the sample was weighed for 5 g and transferred to a test tube. After that, 10 mL of distilled water was added and homogenized using a vortex mixer. Then, the three reagents were put into the test tube immediately. The reagents were 3 drops of 0.5% phenylhydrazine, two drops of 5% sodium nitroprusside, and 3 drops of 10% NaOH. The color changes that occurred were observed. A positive reaction was indicated by the formation of a dark blue color, and the formation of an orange-red color indicates an adverse reaction.

RESULTS AND DISCUSSION

Nitrite Content of Pork Sausages

The results of the nitrite content test on 10 samples of pork sausages from 10 traders that were marketed at Pontianak City Market showed that 4 out of 10 samples had higher nitrite content than the maximum limit use of nitrites permitted by the BPOM. According to Peraturan Kepala Badan Pengawas Obat dan Makanan (BPOM) Number 36 of 2013 regarding The Maximum Limit Use of Preservatives Food Additives, the residual nitrites content permitted in processed meat food products is 30 mg/kg (30 µg/g**)** maximum. The nitrate content of 10 pork sausage samples is shown in Table 1.

Table 1. Nitrite content in pork sausages at Pontianak City Market

Code of Sample	C Nitrite (µg/g)	Interpretation
241812	22.2347	< Threshold
241813	35.2424	**> Threshold**
241814	17.4298	< Threshold
241815	21.8622	< Threshold
241816	19.0446	< Threshold
241817	52.6554	**> Threshold**
241818	11.0439	< Threshold
241819	36.0768	**> Threshold**
241820	38.2934	**> Threshold**
241821	14.5161	< Threshold

Note: K(+) 40 ppm : C Nitrite 54.84; < (below), > (above).

The results of the analysis of the nitrite content of homemade pork sausages marketed at the Pontianak City Market found 4 out of 10 samples of pork sausages that exceeded the residual nitrites threshold limit; the samples were 241813 (35.2424 µg/g), 241819 (36.0768 µg/g), 241820 (38.2934 µg/g), and the highest nitrites content in sample code 241817 (52.6554 µg/g). The four pork sausage samples exceeded the threshold for nitrites used in processed meat products, namely 30 µg/g (PerKBPOM, 2013).

Nitrites are used in pork sausage making during curing, which aims to obtain attractive colors. They are also used as a preservative to prevent the growth of pathogenic bacteria such as Clostridium botulinum and extend shelf life. Nitrites are also able to improve flavor and stabilize the color of meat. However, residual nitrites that exceed the maximum threshold limit in the long term can have negative health impacts.

Some of the processed products that use nitrites were found to have nitrosamine compounds. Nitrosamine formation occurred as a result of proteolysis and lipolysis reaction during the ripening of the sausages (Sallan et al., 2023). Nitrosamine is associated with pathogenic and carcinogenic risk (Lu et al., 2023). Carcinogenic nitrosamines are formed naturally when amines in food react with sodium nitrite in processed meat products. In the presence of acid or heat, nitrosamines are converted to diazonium (Earnestly et al., 2023). Volatile nitrosamines are categorized in group 2B, which has the potential to cause cancer in the human body (Brand et al., 2020).

A total of 6 out of 10 pork sausage samples from 10 traders had nitrite content below the maximum threshold limit for processed meat products. However, the concentration found was still relatively high. The residual nitrite content in homemade pork sausages marketed in the Pontianak City Market was higher than the residual nitrite content in chicken and beef sausages in Makassar City based on Islamiati et al. (2023) research, which reported that chicken

and beef sausages the residual nitrites content in Makassar City, around 0.37-0.43 µg/g, chicken sausage (0.37 µg/g) and beef sausage (0.43 µg/g) in details. Moreover, Devi et al. (2020) reported that the nitrite content in chicken sausages in Denpasar City ranged from 0.395-12.004 µg/g. Consuming processed meat products containing long-term nitrites can harm health because excess nitrites can accumulate in the human body. Therefore, people should be aware of food safety and use nitrites wisely in manufacturing.

Borax Detection in Pork Sausages

The results of the borax detection test on 10 samples of pork sausages from 10 traders marketed at Pontianak City Market showed that 10 10 samples were detected negative containing borax. Table 2 shows the detection of borax content in ten samples of homemade pork sausages marketed at the Pontianak City Market.

Table 2. Borax content in pork sausages at Pontianak Market

Code of Sample	Discolouration	Interpretation
241812	No brick red formation	Negative
241813	No brick red formation	Negative
241814	No brick red formation	Negative
241815	No brick red formation	Negative
241816	No brick red formation	Negative
241817	No brick red formation	Negative
241818	No brick red formation	Negative
241819	No brick red formation	Negative
241820	No brick red formation	Negative
241821	No brick red formation	Negative

The detection of borax in pork sausages using the curcumin paper method. In this test, the changes of color in curcumin paper were observed. The color changes from yellow to brownish red or brick red. The color change occurred due to acidity; the curcumin will turn yellow in acidic conditions, whereas it will turn brownish red or red brick red in alkaline conditions.

The test results showed that 10 samples of homemade pork sausages marketed in the Pontianak City Market contained negative borax. The absence of borax content in the homemade pork sausage samples was indicated by the lack of color change in the turmeric paper dripped in the sample solution. Borax is a compound that has alkaline properties. When turmeric paper reacts with an alkaline compound, it will form a boro-curcumin compound. The boro-curcumin compound gives a brownish-red color. (Asmi et al., 2023).

Borax is used in processed products as a preservative to inhibit the growth of pathogenic microorganisms, thereby extending shelf life. Besides being a preservative, borax also aims to improve the texture quality of processed meat products by making them elastic. Borax can bind water so that processed products become more elastic. However, borax has side effects if consumed. Consuming foodstuffs and processed meat products that contain borax over a long period can negatively impact health. This happens because borax will be absorbed by the body and stored cumulatively in the brain, testicles, and liver until the dose of borax in the body becomes high (Muharrami, 2015).

Producers' awareness of processed meat products has improved, and they have started leaving borax in production. This research showed the awareness of producers of borax use; all of the traders were proven not to use borax, and 10 out of 10 samples of homemade pork sausages at Pontianak City Market all negatively contained borax. The following research by Alifia et al. (2023), which reported that MSMEs marketed 14 meatball samples and six nuggets in Bandung City via e-commerce Shopee and Tokopedia. The results showed that all samples were negative or did not contain borax. Research done by Darmawati et al. (2022) reported that beef meatballs found in Baolan District, Tolitoli Regency, showed that no meatballs were detected to contain borax.

Based on this research, several previous studies have shown that processed meat product producers have begun to leave borax as an additional ingredient. However, monitoring the use of borax in processed meat products must

continue so that no producers misuse the borax in food products.

Formalin Detection in Pork Sausages

The results of the formalin detection test on ten samples of pork sausages from 10 traders at Pontianak City Market showed that ten samples were all negative and contained formalin. Table 3 shows the formalin detection results of 10 samples of homemade pork sausages marketed in the Pontianak City Market.

Table 3. Formaldehyde detection result in pork sausages at Pontianak City Market

Code of Sample	Discolouration	Interpretation
241812	Dark blue does not form	Negative
241813	Dark blue does not form	Negative
241814	Dark blue does not form	Negative
241815	Dark blue does not form	Negative
241816	Dark blue does not form	Negative
241817	Dark blue does not form	Negative
241818	Dark blue does not form	Negative
241819	Dark blue does not form	Negative
241820	Dark blue does not form	Negative
241821	Dark blue does not form	Negative

The formalin detection was analyzed on 10 samples of homemade pork sausages marketed in Pontianak City Market. The result showed no color changes in the sample solution from orange-red to dark blue. This indicates that all homemade pork sausage samples were detected as not containing formalin. Formalin is a chemical compound used as a pest-killing agent (disinfectant) that is widely used in industry. .(Hidayaturrohman et al., 2023).

The purpose of using formalin is as a preservative to extend the shelf life of food or processed meat products. Consuming foodstuffs or processed meat products that contain formaldehyde can harm consumers' health. Chumaidi et al. (2022) stated that the short-term effects of using formalin can result in allergies, irritation, watery eyes, redness, dizziness, vomiting, nausea, burning sensation, and stomach aches. Another impact of formalin is reducing spermatogenic cells, which can cause infertility (Dhalila, 2017). Badan Pengawas Obat dan Makanan (BPOM) Regulation Number 7 of 2018 regarding Prohibited Raw Materials in Processed Foods mentioned that formalin is not permitted use in foods.

This research on homemade pork sausages at Pontianak City Market showed that pork sausage producers are aware of the prohibitions and impacts of using formaldehyde; as a result, the producers did not use formaldehyde as an additional ingredient. However, the use of formalin in several food products is still often found in several areas, according to the research results of Alifia et al. (2023), which reported 7 samples of meatballs marketed by MSMEs in Bandung City via e-commerce Shopee and Tokopedia contained formaldehyde. Moreover, the research results of Tiadeka et al. (2022) reported that 25% of snacks in the Muhammadiyah 1 Gresik High School environment were positive, containing formaldehyde, one of which was sausage products.

This research showed that producers of processed pork products in Pontianak City Market no longer use formaldehyde as an additional ingredient. Therefore, education and monitoring processes must always be carried out for producers of processed meat products in Pontianak City so that consumers will be safe from the harm of formaldehyde.

CONCLUSION

Research showed that 4 out of 10 samples of homemade pork sausages marketed in Pontianak City Market had nitrite content above the threshold limit of 30 µg/g and were detected not to contain borax and formaldehyde. Based on this research, education is needed for pork sausage producers regarding the use of nitrites as well as supervision of producers of processed meat products in Pontianak City Market so that consumers will be safe from the harm of nitrites, borax, and formaldehyde. Pork sausage products in Pontianak City Market no longer use formaldehyde and borax as additional

ingredients. Therefore, education and monitoring processes must always be carried out for producers of processed meat products in Pontianak City so that consumers will be free from the dangers of nitrites, formaldehyde, and borax.

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