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Food Safety Study of Petis Crackers in Kendal Regency, Central Java

Akhmad Mustofa[1]*, Nanik Suhartatik, Gigih Pranata, Ridofan Aji Pradana

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ABSTRACT

Food safety is a science that deals with preparing, managing, and storing food or beverages to be safe from physical, biological, and chemical contamination. The processing of *petis* (condiments of fermented fish or shrimp) crackers is one of the categories of SMEs in Kendal Regency, Central Java. The study aimed to evaluate the heavy metals of iron (Fe), lead (Pb), and other chemical features and to survey the processing of petis crackers. This is a descriptive study of an observational nature with a quantitative approach, especially by doing laboratory observations. The study also carried out qualitative observations using questionnaires regarding the manufacturing of petis crackers. Petis is food or items cooked in a thick, clayey, and elastic condiment group. The results showed that Fe levels vary from 48.00 to 82.00 mg/kg and Pb from 40.00 to 50.00 mg/kg. The average chemical properties of the petis crackers are as follows: 2.45% ash, 13.27% moisture, 3.13% protein, 0.15% fat, and 81.0%carbohydrate. The lead content surpasses the maximum limit of the standard set by the BPOM (The Indonesian Food and Drug Supervisory Agency).

Keywords: food safety, heavy metal, Kendal, petis crackers

INTRODUCTION

Food safety is one of the areas that is currently a concern for people all over the world (Uyttendaele *et al.* 2015). Research on food safety has been carried out to improve the quality of public health, starting from research on the quality of contamination in food (Aliya *et al.* 2018), risk factors in the processing (Cho *et al.* 2020), evaluation of the food safety of fresh fruits and vegetables (López-Gálvez *et al.* 2021), techniques to reduce total contamination in food products (Koutsoumanis *et al.* 2023), and cases of poisoning caused by food consumption (Nasheri *et al.* 2019). Meanwhile, the analysis of potential insecurity of food products in Indonesia has also not been carried out much. Some of them that have been studied are borax and microbial contamination in Solo *karak* products (Pamungkas *et al.* 2021), *cilok* and its sauce (Yuliastuti *et al.* 2021), fruit juice (Astuti *et al.* 2020), and fresh milk (Shari 2023).

The increasing interest of the public in visiting from one place to another, accompanied by an interest in cuisine in a particular area, makes traditional food producers develop the potential of their regions (Wijayanti *et al.* 2014). Culinary tourism does not only focus on food that can be consumed on the spot but also on food that can be used as souvenirs. Crackers are one of the traditional products that are often used as souvenirs. Ordinary crackers are chosen because of their long-lasting nature and crispy texture, and they are relatively cheap and easy to carry. According to BPS (2024), Indonesia's per capita weekly consumption of crackers reaches 74.72 (commodity units). Indonesia exported 15,925 tons of crackers in 2022 (Data Indonesia 2023).

Kendal Regency is one of the areas located on the northern coast of Java, and most people make a living as fishermen. One of the catches is shrimp and fish. Shrimp and fish are used for direct consumption and processed into fish-petis crackers and shrimp-petis crackers, which are typical souvenirs of Kendal Regency. What is meant by shrimp-petis crackers or fish-petis crackers are crackers processed like generally making crackers, but at the end of the process, the crackers are soaked in a solution of fish or shrimp petis.

Based on the survey results, Kendal's typical shrimp-petis crackers and fish-petis are produced with production equipment made of iron that rusts easily, so it is different from the recommendation from BPOM, namely, using stainless steel (BPOM 2023). The cracker production process still uses simple, locally made equipment and must meet reasonable food processing procedures standards. Drying crackers are also done by sun drying, by placing them on the bottom of the ground using a base made of woven bamboo or straw. The

Faculty of Food Technology and Industry, Slamet Riyadi University, Surakarta City, Jawa Tengah 57136, Indonesia
* Coressponding Author: Email: garadaiva@gmail.com

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drying site is also on the side of major intercity roads between provinces, commonly used for large and small vehicle traffic. One of the risk factors for food sold on the side of the road is the high level of microbial contamination (Salamandane *et al.* 2023), which increases the number of food poisoning cases.

In addition to microbial contamination, heavy metals are another type of invisible contamination that can be found in food. Heavy metal contamination is likely from the soil, the environment (air), pesticide use, and water (Zakaria *et al.* 2021). Likewise, Kendal's typical crackers that are sun-dried on the side of the road can be contaminated with heavy metals. Koch *et al*. (2022) said that heavy metal poisoning can cause nephrotoxicity, which is poisoning that occurs in the kidneys caused by certain substances. In some cases, consuming food contaminated with heavy metals can affect the nervous system; if it hits the child, it will interfere with the process of psychological development (Karatela *et al.* 2020; Maghfiroh and Rahim 2024).

Air pollutants can generally be grouped into substances and particles. Particle size varies from 0.1 to 10 nm (Miller 2022). Motor vehicles contribute to pollution by producing CO, hydrocarbons, NOx, SOx, and particles (Saputra 2018). The level of pollutants in the form of gases and particles increases as the number of motor vehicles increases. Therefore, the study aimed to measure Pb and Fe contamination in shrimp-petis and fish-petis crackers produced by the micro, small, and medium enterprises (SMEs) in Kendal Regency. The research results are expected to be used as a reference to determine the next policy. After all, the existence of petis crackers can drive the economy in Kendal Regency and can be used as an attraction for prospective tourists.

METHODS

This research was observational descriptive research with a quantitative approach. The approach is to conduct laboratory analysis on samples taken from 7 cracker SMEs in Kendal City. The analysis included Pb and Fe levels in 7 samples taken from the sampled SMEs. The samples taken were fish-petis and shrimp-petis crackers. Each SME produces these two types of crackers. Qualitative data was obtained through interviews with cracker business owners about the processing of the petis crackers. Initial identification of possible causative factors or sources of contaminants in the production process in 7 SMEs was carried out by conducting direct observations at the production site. Heavy metals were analyzed using the atomic absorption spectrometer. Proximate analysis followed the AOAC (2012) methods to determine the content of moisture, ash, fat, and protein, while carbohydrates (by difference) followed the method presented by Winarno (2008).

Equipment

The equipment used for this study were blenders, funnels, beaker glasses, hot plates, filter paper, porcelain exchange rates, digest flasks, measuring flasks 100 mL and 250 mL, volume pipettes, atomic absorption spectrophotometers (Perkin Elmer Pinnacle 900T), kilns, analytical scales, desiccants, spatulas, mortars, Kjeldahl flasks, aluminum cups, pipettes, tumeric paper, furnaces, test tubes, ovens, porcelain cups, and distillers.

Materials

The ingredients used were fish-petis and shrimp-petis crackers. The petis crackers were obtained from 7 SMEs in Kendal Regency, Central Java. The chemicals used were HCl, NaOH, H_2SO_4, HBO_3, and petroleum ether.

RESULTS AND DISCUSSION

Petis Cracker Preparation

Seven SMEs prepared petis crackers using tapioca flour as raw materials. The process began by mixing tapioca flour with water and then kneading it into an elongated cylinder. The dough was steamed, drained, and cut into thin slices. The slices were then sundried until dry. After drying, the crackers were soaked in a fish or shrimp petis solution for 10 minutes, sundried until dry, and packed. The solution contained fish or shrimp petis and some spices such as garlic, coriander, and salt.

Ash

The ash, iron. and lead levels of fish-petis and shrimp-petis crackers are presented in Table 1. The crackers analyzed were dry (uncooked) and unfried crackers. Ash content was closely related to the mineral content of foodstuffs (Mumtazah 2021). The ash content in fish-petis crackers was 1.87–2.83%. The highest ash content of fish-petis crackers was found in P3 products, while the lowest was in P7 fish-petis crackers. The average ash content in fish-petis cackers was 2.39%. In contrast to fish-petis crackers, the ash content in shrimp-petis cracker samples could reach 4.01% (the highest), with an average shrimp-petis crackers of 2.51%. According to SNI 01-2713-2009, the ash content in fish crackers is a maximum of 1%. The results showed that the ash content in fish-petis crackers and shrimp-petis did not meet the SNI requirements. The high ash content in both cracker types is affected by adding petis (by soaking in petis solution) and spices in the manufacturing process.

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Table 1 Ash, iron (Fe), and lead (Pb) levels in fish-petis and shrimp-petis crackers

Producer	Fish-petis			Shrimp-petis		
	Ash (%)	Fe (mg/kg)	Pb (mg/kg)	Ash (%)	Fe (mg/kg)	Pb (mg/kg)
P1	2.10±0.01[b]	48.00	3.00	2.10±0.03[ab]	51.00	3.00
P2	2.29±0.01[c]	50.00	4.00	1.98±0.28[a]	62.00	4.00
P3	2.84±0.01[g]	60.00	4.00	4.10±0.01[c]	60.00	4.00
P4	2.48±0.00[d]	57.00	4.00	2.61±0.08[b]	66.00	4.00
P5	2.49±0.00[e]	82.00	4.00	2.27±0.02[ab]	59.00	4.00
P6	2.69±0.00[f]	61.00	5.00	2.41±0.16[ab]	91.00	9.00
P7	1.88±0.00[a]	59.00	5.00	2.08±0.43[a]	74.00	5.00
Rerata	2.40±0.32	59.57	4.14	2.51±0.72	66.14	4.71

Remarks: The numbers followed by different letters showed a real difference according to the Tukey 5% test.

According to Thiansilakul and Benjakul (2007), the addition of substances that have the potential to form salts during the hydrolysis process affects the increase in ash content.

The ash content in fish-petis crackers and shrimp-petis is also affected by the processing process's cleanliness and the raw materials' purity level. Based on the observation results, the process of making fish-petis crackers and shrimp-petis in the 7 SMEs studied started from mixing the dough manually on a cement table. After the dough is formed, the dough is steamed using a boiler made of used iron drums. The cooling of cracker dough is carried out in the production room. Simple process technology and lack of attention to hygiene and sanitation have the potential to cause high ash content in fish-petis crackers or shrimp-petis. This follows Husna *et al*. (2014), who state that a material's mineral content and the raw material's cleanliness and purity are closely related to the ash content. It can be indirectly concluded that ash levels that are too high and above the limit of reasonableness can be used to indicate whether the processing process is good, the type of ingredients used, and the nutrition of a food ingredient. It is different if the raw materials processed are mineral sources, such as fishbone crackers as a source of calcium. The calcium content of *belida* fish bone crackers can reach 5.62%, with a bone meal of 5% (Kusumaningrum and Asikin 2016).

Iron

The iron (Fe) content in fish-petis or shrimp-petis crackers ranged from 48.00 mg/kg to 91.00 mg/kg. The average for fish-petis crackers was 59.57 mg/kg, while for shrimp-petis crackers, the average was 66.14 mg/kg (ppm). Iron is one of the essential components that play a role in the body's metabolic system. Iron is a heavy metal that makes up hemoglobin or myoglobin, and it carries oxygen throughout the body. Under free conditions, iron can form hydroxy radicals through the Fenton reaction. Hydroxy radicals can attack organic molecules around them, such as proteins, fats, or DNA, causing damage. Iron that fails to bind to proteins can also cause damage to the gastrointestinal system and plasma cells (Jaishankar *et al.* 2014).

The safe limit for heavy metal consumption of Fe in humans varies according to age, gender, and weight. Humans generally obtain 10-20 mg of Fe/day through food. Too much heavy metal iron will harm a person's health (Jaishankar *et al.* 2014). High levels of heavy metal Fe can come from contamination of production equipment exposed to corrosion. Steaming the crackers was carried out using a boiler made of scrap iron drums whose surface had peeled off. Using used drums is the main factor in the high Fe levels in the crackers. In addition, cutting tools in the form of corroded machines and knives are also one factor for the high levels of Fe in fish-petis and shrimp-petis crackers.

Lead (Pb)

The average lead (Pb) level of fish-petis crackers was 4.14 mg/kg, while for shrimp-petis crackers was 4.71 mg/kg. One SME (code P6) has a very high Pb level (9 mg/kg). The Food and Drug Supervisory Agency (BPOM) provides a maximum standard for Pb residues in foods not explicitly stated to be 2 mg/kg (BPOM 2022). In general, all types of crackers do not meet the standards set by BPOM.

Heavy metal contamination is suspected to be due to fish-petis crackers and shrimp-petis drying on the side of public roads. High vehicle volumes cause air pollution caused by motor vehicle smoke, triggering air pollution around drying sites. Lead-containing motor vehicle fuels are the most significant source of lead in the atmosphere and a major factor in lead in food contamination (Clark and Knudsen 2013). Pb contamination of the soil and surrounding environment is another result of industrial emissions (Liang 2016). Gusnita (2012) stated that in 2011, the lead levels in the Semarang city area reached 2.41 µg/Nm^3.

The level of Pb in fish-petis crackers and shrimp-petis crackers is lower when compared to the heavy metal content of Pb in *kemplang* crackers in a study conducted

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by Ariansyah *et al*. (2017), which was 10.8 mg/kg, but still higher when compared to rice crackers (3.43 mg/kg) as reported by Istiqomah *et al*. (2023).

Interview Data with Cracker Producers

This study also conducted simple interviews with 7 producers. The results of the interviews are seen in Table 2. Most crackers were dried on the road side or in an open-air, closed yard, but they were still near a public road. Drying was carried out twice, before and after being soaked in a petis solution, so the chance of being contaminated by lead from vehicle smoke would be higher.

Although every producer has received counseling from the relevant local agencies, and some of them know about SNI for crackers, it is suspected that they have not understood that one of the requirements for crackers is that they must not contain heavy metals, as stated in the SNI Fish Crackers 01-2713-2009 (BSN 2009). It can be seen from how they process the crackers (Figures 1 and 2).

Chemical Analysis of Crackers

The chemical analysis of the crackers is tabulated (Table 3). The results displayed are an average of the 7 SMEs. All manufacturers used similar compositions of ingredients, so the results showed a manageable number of differences. The measurements were water content, protein, fat, and carbohydrates (*by difference*). The moisture content of food will be related to the shelf life of a product. The higher moisture content will cause the product to have a shorter shelf life and is also favored by microorganisms that can poison the product and harm humans (Mannaa and Kim, 2017; Azis & Akolo, 2019; Rahmawati *et al.* 2022; Suloi *et al.* 2023). Foodstuffs containing high fat can suffer damage caused by oxidation. Fat undergoes an oxidation reaction, which causes damage due to rancidity changes in taste and aroma (Sari *et al.* 2019).

Figure 1 Cooking tapioca flour using a scrap iron drum.

Figure 2 Drying crackers.

Table 2 Interview results with 7 petis cracker manufacturers

Producer	Origin of tapioca flour	Origin of fish/shrimp petis	Water source	Dough cutter	Where to dry crackers	Knowing the SNI for crackers	Received counseling on processing from the government
P1	Supplier	Supplier	Well water	Kitchen knives	Open air but closed area*	Yes	Once
P2	Supplier	Supplier	PDAM	Machine	Roadside yard	Just heard	Once
P3	Supplier	Supplier	PDAM	Machine	Roadside yard	Yes	Once
P4	Supplier	Supplier	PDAM	Machine	The yard is open air but closed area	No	Once
P5	Supplier	Supplier	PDAM	Machine	The yard is open but closed area	Yes	Once
P6	Supplier	Supplier	PDAM	Machine	Roadside yard	Yes	Once
P7	Supplier	Supplier	Well water	Machine	Roadside yard	No	Never

*The yard of the house is open air but has walls on each side.

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(Mahfuz *et al.* 2017). The ingredients in the manufacture

Table 3 Results of chemical analysis of petis crackers

Item	Fish-petis (%)	Shrimp-petis (%)
Moisture	13.28±0.07	13.25±0.06
Protein	3.10±0.01	3.16±0.02
Fat	0.05±0.01	0.25±0.01
Carbohydrate	81.17±0.04	80.83±0.03

Moisture

According to SNI 01-2713:2009, the maximum threshold for fish cracker moisture content is 12%. The moisture content of fish-petis and shrimp-petis crackers exceeded the maximum fish cracker moisture content set by SNI (Table 3). The drying affects the high and low moisture content, the material's composition, and the thickness of the cutting of the crackers. Drying was carried out by utilizing heat from direct sunlight so that it is greatly affected by the weather. The observation was in February, and it is still in the long dry season. Salamah (2008) stated that the material's thickness, texture, and air humidity affect the high and low moisture content. Thin products would cause water to evaporate quickly so that the moisture content is lower, and the thickness of the material would make it difficult for water to evaporate, causing a high moisture content in the product. This moisture content was slightly higher than the moisture content of *kemplang* crackers, reaching 9.23–12.47% (Agusnia *et al*. 2022).

Fat

The average fat content in fish-petis crackers was 0.05%, while for shrimp-petis crackers was 0.25%. Fat content is affected by the drying process. The longer the drying process of crackers, the lower the moisture content and the higher the percentage of fat content, and vice versa (Mahfuz *et al.* (2017). According to SNI 01-2713:2009, the maximum fat content in uncooked crackers is 0.5% (bb). The fat content of petis crackers meets the standards set by SNI. The fluffiness of crackers will be affected by the fat content because some of the fat components will be absorbed to form a fat layer on the surface of the granules to prevent water penetration during the gelatinization process (Winata *et al*. 2015).

The fat content of petis crackers is lower than that of crackers sold in traditional Cinde Palembang (Winata *et al.* 2015). The fat content ranged from 7.55% to 15.75%. The low content in fish-petis crackers in the Kendal Regency is affected by the raw materials used to make the crackers that do not contain high fat**.**

Protein

The protein content in food is also affected by the drying time, and along with the decrease in moisture content, the percentage of protein content will increase of fish-petis crackers also affect the high and low protein content of the products, considering that the primary ingredients were tapioca flour, which contains only 0.76% protein (Wiratakusumah *et al.* 1990). According to Dewita *et al.* (2018), products with high protein content are made from ingredients with high protein content, while products with low protein content are made from ingredients with low protein content. Their protein content influences the quality of fish crackers because protein plays a vital role in the body. The protein content of fish crackers and shrimp crackers is lower when compared to the protein levels of fish crackers conducted by Sianita *et al*. (2020). Sholawat Ummi Fish Crackers have a protein content of 17.82%.

Carbohydrate

The carbohydrate content of fish-petis and shrimp-petis crackers is very high, above 80%. This is due to the ingredients, which were tapioca flour mixed with spices and petis. The carbohydrate content in tapioca itself is high, 88.2%, with protein and fat of 1.1% and 0.5%, respectively (Nilai Gizi 2018).

CONCLUSION

The average iron content was 59.57 mg/kg for fish-petis and 66.14% for shrimp-petis crackers. Lead residue in fish-petis crackers averages 4.14 mg/kg, while shrimp-petis crackers reach 4.71 mg/kg. Heavy metal residues in fish or shrimp-petis crackers have not met food safety standards. It is necessary to make efforts to develop and socialize Good Medicine Manufacturing Practices and implement good hygiene and sanitation in the process of making petis crackers. Petis crackers are a local asset that must be preserved and developed.

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