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Identification of metal content in food using gravimetric and iodometric methods: The case on children's food

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Abstract
The metal content is one indicator of the eligibility of food consumption, including food for children. In this research, identification of Lead (Pb), Mercury (Hg), Cadmium (Cd), and Arsenic (As) metals on pentol, bakso, cilok, cireng, and cimin samples by gravimetric and iodometric methods. The identification of metals by the gravimetric method shows that the metal content in all samples is below the threshold, where the highest metal content is the lead metal in the cimin sample of 0.0439 mg/kg. The identification of metals by the iodimetry method showed that the metal content in all samples was below the threshold, where the highest metal content is the lead metal in the cimin sample of 0.0436 mg/kg. Thus, all samples are categorized as safe for consumption.

Keywords: Gravimetric, Iodometric, Metals content

1. Introduction

The metal content in children's snacks is one indicator that is often ignored by parents and children themselves. Difficult identification and lack of parental knowledge about hazardous food are the main reasons for metal content being ignored (Scaglioni et al. 2018), (Anggiruling et al. 2019). In addition, indicators of the appearance, taste, and aroma of products are often used as benchmarks for consumption-friendly snacks by children and parents (Iklima, 2017), (Hastutik and Putri, 2018), (Hayati and Nuriya, 2018), (Tambunan et al. 2019). Children's snacks are actually allowed to contain a lot of ingredients such as flavoring, coloring, preservatives, sweeteners, minerals, and metal content but are not allowed to pass the specified threshold and use materials that are included in the allowed category (SNI 7387: 2009), (BPOM No.23: 2017). Utilization of materials such as tartrazine (Illing, 2011), cyclamate (Sari et al. 2017), aspartame (Dali et al. 2013), rhodamin B (Yunita et al. 2015), (Devitria and Sepryani, 2017) and methanyl yellow (Pertiwi et al. 2014), saccharine (Abbas et al. 2019), (Yunantariningsih et al. 2019), (Misrawati et al. 2020), and formalin (Kartini and Mukti, 2017) have been carried out since a long time ago (Wariyah and Dewi, 2013). This utilization does not always cause negative impacts as long as it is used according to the rules and does not exceed the utilization threshold.

However, at this time the use of hazardous materials is increasingly being used in food products specifically for children's snacks. The use of harmful dyes and their use is not permitted in children's snacks is increasingly prevalent (Tuslinah and Aprillia, 2017). Also, the use of preservatives and hazardous food additives is increasingly being used (Paramanitya and Aprilia, 2017), (Santi, 2017), (Ali and Gustina, 2019). In addition to coloring agents, preservatives, and food additives, the use of additives (Al-Harthy et al. 2017) and some dangerous metals pose a serious threat to children's snacks (Pressman et al. 2017). The use of hazardous substances is carried out to obtain greater profits, better product appearance, and related product durability (Nurdin and Utomo, 2018). Also, the level of education, knowledge, and attitude of traders is one of the factors in the use of hazardous materials (Irawan and Ani, 2016), (Erniati, 2017).

The use of additives in food is a very dangerous action (Martyn et al. 2012). These additives can engineer nutrients in food and tend to degrade these nutrients (Baker-Smith et al. 2019). Food contaminated with additives tend not to have nutrients and damage human nerve cells. Additives in the form of metals and heavy metals are the most dangerous pollutants and are easily applied to food products (Simorangkir et al. 2017). These metals are harmless and tend to be beneficial to the human body if used according to procedures and do not exceed the utilization threshold (Anton et al. 2019), (Mahmoud and Grigoriou, 2019). Metals such as lead (Perdana et al. 2017), (Nasution and Silaban, 2017), copper, mercury, and arsenic (Ariansyah et al. 2012) are some of the metals that are often used in food products, especially children's food. The use of these metals and exceeding their limits can damage nerve tissue, inhibit growth, and damage the nervous system of the human brain (Harefa, 2018). Therefore, efforts are needed so that the use of metal in children's snacks can be controlled and not used massively.

Indiscriminate consumption by children is caused by several factors including parental knowledge, children's knowledge, and trader knowledge. Therefore, concrete efforts are needed so that these factors can be controlled and the use of hazardous materials is minimized. True parents know the effects of non-hygienic chemicals and food on the health and growth of children, but that knowledge is general so that ongoing counseling and other training are needed (Atma, 2015). The socialization of a variety of children's snacks, product processing, and product eligibility are important factors in increasing parental knowledge (Adriansyah et al. 2017), (Sari et al. 2020). Health education (Angraini et al. 2019), health education (Aini, 2016), and stimulus awareness of healthy snacks (Nurbiyati and Wibowo, 2014), (Susanti, 2019) are very important for the community. Increasing student knowledge through animation media has a significant impact on children's consumption habits (Hanytasari, 2015), (Santoso et al. 2018). Education about food safety and production improvement, it is important to be socialized to traders (Oktava et al. 2018).

In addition to these efforts, analysis is needed to provide information to the public regarding the metal content of children's snacks, both to parents, children, and traders themselves. Various kinds of metal analysis can be done, both with the use of the latest technology and conventional methods. Gravimetric and iodometric methods are conventional methods that can be used to identify mineral content (Nurmastika et al. 2018), (Harefa et al. 2020) and metal content (Harefa et al. 2019) in a sample. The method is relatively simple that can be practiced at school and home.

2. Methods

The study was conducted at the chemical laboratory of the Universitas Kristen Indonesia in November 2019 - January 2020. The research samples were pentol, bakso, cilok, cireng, and cimin which were sold around Cawang, East Jakarta. The variables analyzed were the metal content of Lead (Pb), Mercury (Hg), Cadmium (Cd), and Arsenic (As) with gravimetric and iodometric methods procedures as shown in Fig 1.

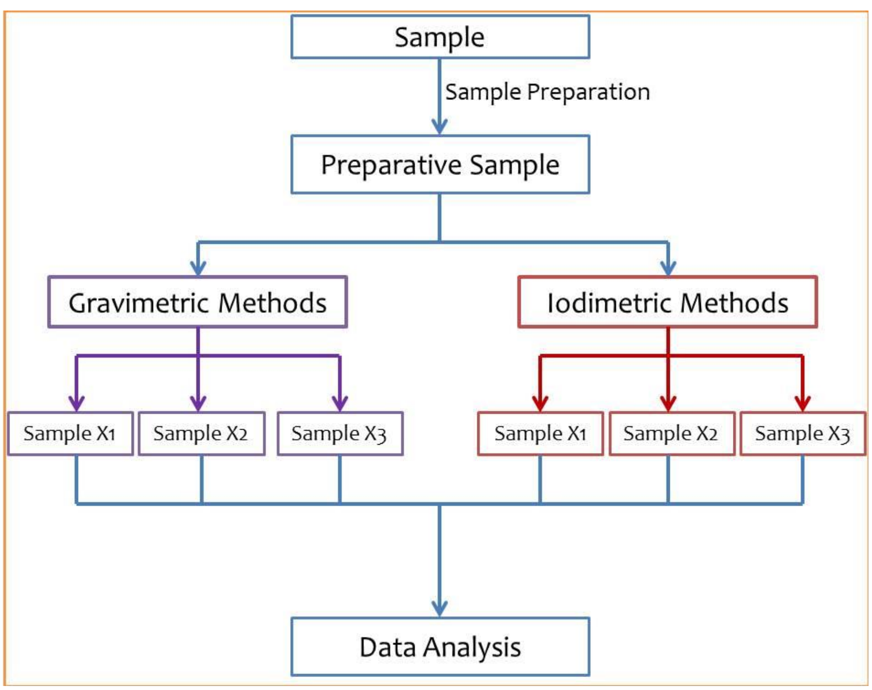

Fig 1. The Study Procedure

Note:
X = Pentol; Bakso; Cilok; Cireng; and Cimin
X1 = repetition of the first measurement
X2 = repetition of the second measurement
X3 = repetition of the third measurement

The preparative sample is separated into two parts. The first part is for measuring metals content by the gravimetric method and the second part is for measuring metals content by the iodimetry method. Metal content in the sample was measured three times by the gravimetric and iodometric methods. The threshold for metal content in foodstuffs as in Table 1 (SNI 7387: 2009), (BPOM No.23: 2017).

Table 1
Metal Content Threshold in Food Materials

Metals	Metals Threshold
Lead (Pb)	1.0 mg/Kg
Mercury (Hg)	0.05 mg/Kg
Cadmium (Cd)	0.4 mg/Kg
Arsenic (As)	0.5 mg/Kg

Pentol as sample A, bakso as sample B, cilok as sample C, cireng as sample D, and cimin as sample E.

3. Results and Discussion

Measurement of the levels of each metal was repeated three times for each sample by gravimetric and iodometric methods. The results of measurements of metal content areas in Table 2.

The metal content of each sample is measured three times of repetition for each metal. The measurement results are averaged, then compared with the metal threshold analyzed. The data shows that the metal content in the sample is below the threshold and is safe for consumption. The identification of metal content in the sample is done by gravimetric and iodometric methods. Measurement data using the gravimetric method as in Fig 2.

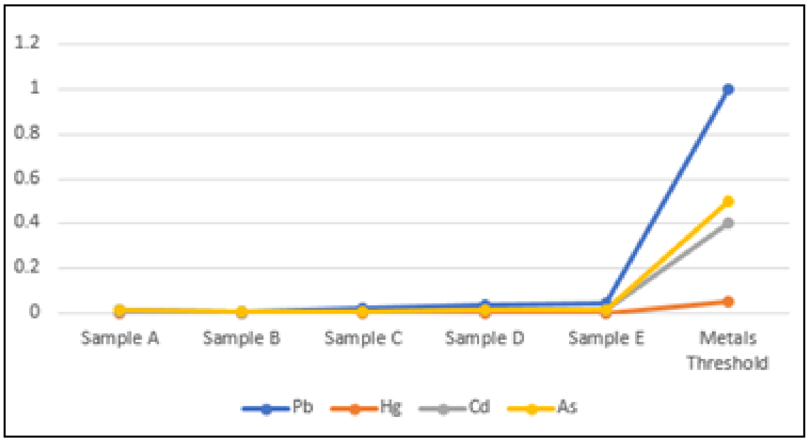

Fig 2. Identification of Metals by Gravimetric Method

Table 2
The Metals Content of Each Sample

		Metals Content Measurement							
		Gravimetric Method				Iodimetric Method			
		Pb (mg/kg)	Hg (mg/kg)	Cd (mg/kg)	As (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Cd (mg/kg)	As (mg/kg)
Sample A	A1	0.0211	0.0006	0.0094	0.0161	0.0181	0.0005	0.0093	0.0158
	A2	0.0164	0.0004	0.0121	0.0149	0.0182	0.0005	0.0118	0.0159
	A3	0.0182	0.0004	0.0089	0.0162	0.0191	0.0004	0.0099	0.0154
	Mean	**0.0186**	**0.0005**	**0.0101**	**0.0157**	**0.0185**	**0.0005**	**0.0103**	**0.0157**
	Decision	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**
Sample B	B1	0.0082	0.0002	0.0042	0.0089	0.0079	0.0002	0.0041	0.0098
	B2	0.0081	0.0002	0.0033	0.0101	0.0078	0.0002	0.0038	0.0104
	B3	0.0111	0.0001	0.0043	0.0092	0.0119	0.0003	0.0041	0.0096
	Mean	**0.0091**	**0.0001**	**0.0039**	**0.0094**	**0.0092**	**0.0002**	**0.0040**	**0.0099**
	Decision	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**
Sample C	C1	0.0221	0.0005	0.0081	0.0092	0.0219	0.0006	0.0081	0.0094
	C2	0.0201	0.0004	0.0078	0.0093	0.0206	0.0003	0.0079	0.0091
	C3	0.0181	0.0004	0.0081	0.0088	0.0211	0.0004	0.0079	0.0088
	Mean	**0.0201**	**0.0004**	**0.0080**	**0.0091**	**0.0212**	**0.0004**	**0.0079**	**0.0091**
	Decision	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**
Sample D	D1	0.0411	0.0008	0.0142	0.0114	0.0391	0.0007	0.0141	0.0112
	D2	0.0386	0.0006	0.0118	0.0116	0.0388	0.0005	0.0124	0.0117
	D3	0.0391	0.0006	0.0134	0.0132	0.0392	0.0008	0.0138	0.0132
	Mean	**0.0396**	**0.0007**	**0.0131**	**0.0121**	**0.0391**	**0.0007**	**0.0134**	**0.0121**
	Decision	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**
Sample E	E1	0.0446	0.0009	0.0157	0.0127	0.0436	0.0008	0.0158	0.0123
	E2	0.0442	0.0009	0.0161	0.0127	0.0438	0.0009	0.0159	0.0123
	E3	0.0428	0.0007	0.0161	0.0133	0.0434	0.0007	0.0161	0.0138
	Mean	**0.0439**	**0.0008**	**0.0159**	**0.0129**	**0.0436**	**0.0008**	**0.0159**	**0.0128**
	Decision	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**	**SE**

Note:
SE = safe to eat

Measurement of metal content in the sample using the gravimetric method shows that the metal content in the sample is lower than the threshold. The data shows that the sample is safe for consumption in terms of metal content. In addition to identification with the gravimetric method, identification is also carried out with the iodimetry method as in Fig 3.

Measurement of metal content in the sample using the gravimetric method shows that the metal content in the sample is lower than the threshold. The data shows that the sample is safe for consumption in terms of metal content.

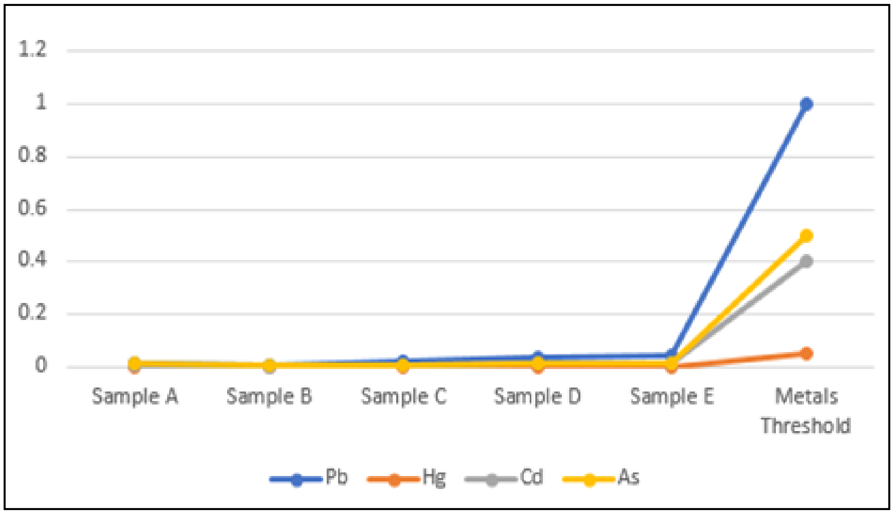

Fig 3. Identification of Metals by the Iodometry Method

3.1 Food Safety

Table 2 shows that pentol, bakso, cilok, cireng, and cimin are considered safe for consumption in terms of the metal content of Lead (Pb), Mercury (Hg), Cadmium (Cd), and Arsenic (As). Identification of metals by the gravimetric method as in Fig 2, shows that the metal content in all samples is below the threshold, where the highest metal content is the lead metal in the cimin sample of 0.0439 mg/kg. Likewise with the identification of metals by the iodimetry method as in Fig 3, shows that the metal content in all samples is below the threshold, where the highest metal content is the lead metal in the cimin sample of 0.0436 mg/kg.

However, all research samples contained metals based on identification by gravimetric and iodometric methods. Even though it is below the threshold and is categorized as safe for consumption, education to the community is important to be carried out continuously. Education about food safety and production improvement, it is important to be socialized to traders (Oktava et al. 2018). The socialization of a variety of children's snacks, product processing, and product eligibility are important factors in increasing parental knowledge (Adriansyah et al. 2017), (Sari et al. 2020). Health education (Angraini et al. 2019), health education (Aini, 2016), and stimulus awareness of healthy snacks (Nurbiyati and Wibowo, 2014), (Susanti, 2019) are very important for the community. Likewise for children, increasing knowledge about safe consumption products through various media and counseling can provide education about consumption habits (Hanytasari, 2015), (Santoso et al. 2018).

The use of additives in food is a very dangerous action (Martyn et al. 2012). These additives can engineer nutrients in food and tend to degrade these nutrients (Baker-Smith et al. 2019). Food contaminated with additives tend not to have nutrients and damage human nerve cells. Additives in the form of metals and heavy metals are the most dangerous pollutants and are easily applied to food products. These metals are harmless and tend to be beneficial to the human body if used according to procedures and do not exceed the utilization threshold (Anton et al. 2019), (Mahmoud and Grigoriou, 2019). Metals such as lead (Perdana et al. 2017), copper, mercury, and arsenic (Ariansyah et al. 2012) are some of the metals that are often used in food products, especially children's snacks. The use of these metals and exceeding their limits can damage nerve tissue, inhibit growth, and damage the nervous system of the human brain (Harefa, 2018). Therefore, efforts are needed so that the use of metal in children's snacks can be controlled and not used massively.

4. Conclusion

The sample in this study is the final product ready for consumption. All research samples contained Lead (Pb), Mercury (Hg), Cadmium (Cd), and Arsenic (As) below the threshold and were categorized as safe for consumption. The identification of metals by the gravimetric method showed that the metal content in all samples was below the threshold, where the highest metal content is lead metal in cimin samples of 0.0439 mg/kg. The identification of metals by the iodimetry method showed that the metal content in all samples was below the threshold, where the highest metal content is the lead metal in the cimin sample of 0.0436 mg/kg.

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