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ARSENIC CONTAMINATION SURVEY IN WHITE RICE IN ACEH
(Survei cemaran Arsen pada nasi putih di Aceh)

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ABSTRACT

White rice as the major staple food for Indonesian people has the opportunity to be contaminated with chemical hazards. Research in USA shows that arsenic is contained in rice. The arsenic emissions of 75% are estimated to originate from the mining, fertilizers and pesticides. This study aims to determine qualitatively arsenic contamination of white rice consumed by Acehnese people and how to cook it. A total of 30 white rice samples were obtained with purposive technique from the Aceh Health Polytechnic employees who brought breakfast. The the consideration that they come from various regions in Aceh. Arsenic analysis contamination in samples was carried out using arsenic test kit. Data collected is in the form of interviews about white rice cooking techniques and the analysis of arsenic contamination. The results showed that white rice consumed by the employees was safe from arsenic and that the rice cooking technique on a household is feasible. Besides that the arsenic test was also carried out on white rice sold in stalls, the results were positive. This indicates that white rice is consumed by people in Aceh, there are those which are contaminated with arsenic. This study provides evidence that the contamination is still present in rice which has been processed into rice cooked.

Keywords: *Arsenic contamination, arsenic test kit, household, stalls, white rice*

ABSTRAK

Nasi putih sebagai salah satu sumber makanan pokok di Indonesia memiliki peluang tercemar bahan kimia yang sangat berbahaya. Penelitian di USA menunjukkan bahwa arsen terkandung di dalam beras, 75% emisi arsen diperkirakan berasal dari aktivitas penambangan, pemupukan dan pestisida. Penelitian ini bertujuan untuk mengetahui cemaran arsen secara kualitatif pada nasi putih di Aceh dan bagaimana teknik memasaknya. Penelitian ini merupakan survey deskriptif berbasis laboratorium. Populasi adalah seluruh pegawai Poltekkes Kemenkes Aceh. Sebanyak 30 sampel nasi putih dicuplik secara purposif dari 30 orang pegawai yang membawa bekal sarapannya. Pertimbangan bahwa mereka berasal dari berbagai daerah di Aceh. Analisis arsen menggunakan arsen test kit. Data primer dikumpulkan dari hasil wawancara tentang teknik memasak nasi putih dan hasil analisis arsen pada nasi putih. Hasil penelitian menunjukkan bahwa nasi putih yang dikonsumsi oleh pegawai Poltekkes Kemenkes Aceh aman dari cemaran arsen. Hasil ini menegaskan bahwa teknik memasak nasi pada skala rumah tangga dapat menghasilkan nasi putih yang bebas dari cemaran kimia arsen. Analisis arsen juga dilakukan pada nasi putih yang dijual di warung sebagai pembanding, hasilnya positif. Ini menunjukkan bahwa nasi putih yang dikonsumsi oleh masyarakat Aceh, ada yang tercemar arsen. Penelitian ini membuktikan bahwa cemaran arsen masih ada pada beras yang telah diolah menjadi nasi.

Kata kunci: *Arsen test kit, cemaran arsen, nasi putih, rumah tangga, warung*

INTRODUCTION

Food has a very important role in public health. Food quality can be viewed from several aspects, including delicacy, nutrient content and public health. Foods that look attractive, delicious and nutritionally high do not mean anything at all if they are not safe for consumption. One of them is because the food acts as an intermediary media for contamination of chemical contamination for the consumer's body. This is in line with Minister of Health Regulation No. 1096/Menkes/Per/VI/ 2011.[1]

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White rice as one of the main food sources in Indonesia has the opportunity to be contaminated with very dangerous chemical contamination. Research in USA shows that arsenic is contained in rice.[2] This has something to do with the condition of rice planting in waterlogged conditions, although it cannot yet be explained whether the water makes inorganic arsenic which is naturally actually locked in soil minerals so that it is more easily absorbed by plants. This explanation was also strengthened by Prof. Djoko Said Damardjati, researcher from the Indonesian Ministry of Agriculture's Research and Development Agency that arsenic in rice is largely determined by environmental factors where the rice grows; "It could be if the fields are ex-mining or from fertilizers used. Rice fields near the factory or polluted rivers are also feared to make arsenic found in rice," he said.[3]

Arsenic is one of the toxic metals which is often classified as metal, but is more nonmetallic. Arsenic unlike other metals that form cations, arsenic is in the form of anions, such as H_2AsO_4.[4] Arsenic cannot be damaged by the environment, only moves towards water or soil carried by dust, rain or clouds through the process of mineral erosion and volcanic eruptions. 75% of arsenic emissions are estimated to come from human activities, especially mining activities, providing fertilizers and pesticides. Arsenic levels in the soil vary from 1 ppm to 100 ppm.[5] Arsenic contamination in the human body can come from water, soil, air, and food, both from natural ingredients and from processing. The content of arsenic in various types of food can be seen in table 1 below.

Table 1. Arsenic levels in various of food

Types of food	Arsenic levels (µg/g wet weight)
Fish	4,64
Shrimp, squid, seafood	4,64
Meat	0,49
Beef	1,30
Vegetables	0,41
Grains	0,41
Table salt	2,71
Rice	1,60

Source: Astawan, 2004[6]

Based on the description and information in table 1 above, the content of arsenic in rice attracted the attention of researchers to conduct further testing in the Aceh region. Considering this region as a national food storage area. Increased rice production in Aceh has reached 2,2 million tons in 2016 with a planting area of 447.718 Ha. Improving the quality and increasing productivity of rice clearly requires efforts to fertilize and eradicate pests. So that it is suspected to cause pollution. Coupled with activities affecting pollution, namely oil and gas, coal, gold and iron in Aceh.

Based on FAO and WHO stipulating the maximum allowable arsenic intake in food is 2 µg/day/kg body weight. USA stipulates the amount of arsenic in food that can be consumed is less than 0.04 mg/day of seafood, while the total amount of arsenic that can be consumed is 0,2 mg/day. Total arsenic extraction from food without arsenic exposure from industries of less than 0,3 mg/day.[5]

The results of the analysis of heavy metal content in food have been widely reported. Likewise for arsenic, it is known the level of contamination in various food ingredients such as fish, shellfish, spinach, and rice. But there is still very little information regarding contamination of arsenic in white rice. Arsenic contamination is thought to still be present in rice which has been processed into rice and then cooked into rice. It is also possible that this could be related to rice cooking techniques in the community. This motivated researchers to assess the quality of the staple food of the Acehnese people, from the aspect of chemical safety given the possibility of high levels of arsenic pollution in Aceh.

METHOD

The research is a laboratory-based descriptive survey. Survey techniques are conducted by interviewing respondents. Qualitative analysis of arsenic contamination in white rice samples using the arsenic test kit. The tools and materials used in this study were 1 package of arsenic rapid test kit (Merck: Merckoquant), equipped with a preparation tube,

test tube, stirring rod, litmus paper and distilled water.

The population of this study was all employees of Aceh Health Polytechnic of Ministry of Health (is called Poltekkes Kemenkes RI Aceh). The consideration is that employees come from all parts of Aceh. Usually the rice cooking technique is a hereditary habit that is brought from the family environment. A total of 30 white rice samples were extracted from 30 employees with certain considerations, so that large and remote samples could not be taken. The sample selection technique is purposive sampling, because it is considered to have the information needed for research based on criteria determined by researchers. The criterion is that the respondent brings white rice supplies to the campus for the breakfast menu before starting activities.

Arsenic contamination analysis in white rice samples in this study was carried out using arsenic rapid test kit (Merck: Merckoquant). Using of a rapid test kit begins with standardization before being applied.

Working standard is prepared by taking as much as 10 mL of stocked arsenic trioxide solution into a 1000 mL volumetric flask, 10 mL of 2 N sulfuric acid and freshly boiled water was added to the boundary mark then cooled. The solution is stored in a glass container and to be used within 3 days. Each mL of arsenic standard solution contains ~ 1 µg arsenic.

Arsenic rapid test kit are applied with adding 20 grams of white rice sample in each coded preparation tube. As much as 30 ml of distilled water or hot water is added to each test tube. Sample is crushed using a stirring rod until it dissolves completely. pH of the sample solution was identified using litmus paper and seek that the pH of the sample solution is neutral. As much as 1 ml of the sample solution is puted in a test tube; 4 drops of arsenic reagent - 1 were added and observed; 4 drops of Arsenic reagent - 2 were added and observed.

RESULT AND DISCUSSION

The results of this study were based on a survey of Poltekkes Kemenkes RI Aceh employees as much as 30 people who brought rice box for breakfast before starting their activities. The frequency distribution of respondents characteristic is presented in table 2 below:

Table 2. The frequency distribution of respondents characteristic (n= 30)

Characteristics		n	%
Sex	Female	24	80,0
	Male	6	20,0
Units	Office Center	7	23,3
	Pharmacy Department	4	13,3
	Nutrition Department	6	20,0
	Midwifery Department	4	13,3
	Dental Health Department	5	16,7
	Environmental Health Department	4	13,3

Based on table 2 the information obtained based based on sex consisted of 24 women (80,0%) and 6 men (20,0%). Distribution of respondents based on units is 7 people in the office center (23,3%); 4 people in pharmacy department (13,3%); 6 people in nutrition department (20%); 4 people in midwifery department (13,3%); 5 people in dental health department (16,7%); and 4 people in environmental health department (13,3%).

1. Rice Cooking Technique

Furthermore, the results of interviews using questionnaires about rice cooking techniques are shown in table 3. Based on table 3 it is known that the dominant respondents did not soak rice before cooking (76,7%). The amount of rice washing before cooking varies from 2 to 5 times, dominant 3 times (60,0%), only 1 respondent (3,3%) who washed rice 5 times. Rice : water ratio used for cooking also varies among 30 respondents, the dominant respondents using a 1: 1 ratio (66,7%). The remaining 5 people (16,7%) use the 1: 2 and 2: 1 ratio. The stirring during cooking rice is done by all respondents. Likewise, the treatment after cooking, all respondents stored their rice in warmer.

Table 3. The frequency distribution of rice cooking technique (n= 30)

Rice cooking technique		n	%
Soaking rice before cooking	No	23	76,7
	Yes	7	23,2
Amount of rice washing	2	8	26,7
	3	18	60,0
	4	3	10,0
	5	1	3,3
Rice: water ratio for cooking	1 : 1	20	66,7
	1 : 2	5	16,7
	2 : 1	5	16,7
Stirring during cooking	Yes	30	100,0
	No	0	0
Others	Store in warmer	30	100,0

How to process food is one aspect that affects the safety of food for consumption. Unhygienic and inappropriate food processing can cause contamination. This is in line with Minister of Health Regulation No. 1096/Menkes/Per/VI/2011, that food can act as an intermediary for contamination of chemical contamination for the body of its consumers.[1] As a result, foods that are delicious in taste and high in nutrition do not mean anything if they are not safe for consumption.

A study conducted by Andy Meharg (a professor of biology at Queens University, Belfast, Northern Ireland) suggested that the way to cook rice that is commonly done turns out to leave arsenic poison. Meharg himself did three ways to cook rice to ensure there was residual arsenic in rice. The first way to do this is to mix rice and water (ratio 1: 2). The water continues to be evaporated during the cooking process like we usually do. As a result, this arsenic poison is still present in the rice that is ready for consumption. The next way is to use water and rice (ratio 5: 1). After the water is removed, the arsenic level in rice can decrease by 50%. Meanwhile, the last method used is to soak the rice overnight before cooking. In this way, the arsenic level in rice decreases by 80%. Thus through its publication, Meharg recommends soaking rice overnight before washing with clean and cooked water to significantly reduce arsenic levels in rice.[3]

The results of this study also prove an important finding that the process of cooking rice by boiling it in a pan until the water evaporates, it turns out that it can cause rice to be contaminated with arsenic poisons from various hazardous chemicals.[7] For this reason, it is strongly recommended that the use of rice cooking equipment be safe so that the risk of contamination can be minimized.

2. Arsenic Qualitative Identification

The results of data analysis based on sampling white rice consumed by each respondent are presented in table 4 below:

Table 4. Qualitative identification of arsenic result

Code	R1	R2	Result
C (-)	Clear	Brown	-
C (+)	Clear	Yellow	+
S (a)	Clear	Brown	-
S (b)	Clear	Yellow	+

Notes:
C (-) : negative control treatment
C (+): positive control treatment
S (a) : treatment of household white rice samples
S (b) : treatment of stalls white rice samples

Based on the results of the study in table 4, it can be explained that the qualitative test of arsenic content in white rice samples from home showed a negative result. This result applies equally to 30 samples of white rice. Positive results were shown in testing of samples of white rice sampled in one of the rice stalls in Banda Aceh.

The development of modern technology today has triggered many cases of environmental pollution. This impact must be controlled, given the vitality of human health problems and the surrounding environment. Heavy metals are generally toxic to living things, although some of them are needed in small quantities. Through some intermediaries such as air, food and water contaminated with heavy metals, these metals can be distributed to the human body and some will accumulate. If this continues for a long period of time it can reach a number that endangers the survival of living things.[7]

The results of the study showed that white rice was consumed by Poltekkes Kemenkes RI Aceh employees; safe from contamination of arsenic while white rice sampled in one of the rice stalls in Banda Aceh is positive for arsenic. This indicates that white rice is consumed by people in the city of Banda Aceh and its surroundings, there are those which are contaminated with arsenic metals. This study provides evidence that contamination of arsenic is still present in rice which has been processed into rice and then cooked into rice, as a result of qualitative tests on white rice obtained from stalls. Arsenic contamination is not found in white rice processed in household.

The difference in results for the two types of samples according to the origin of sampling, can be caused by the quality of rice, cooking techniques and the conditions of different cooking equipment. The white rice consumed by Poltekkes Kemenkes RI Aceh employees is very likely to be different from white rice at the stalls.

Research in USA shows that arsenic is contained in rice. This has something to do with the condition of rice planting in waterlogged conditions, although it cannot yet be explained whether the water makes inorganic arsenic which is naturally actually locked in soil minerals so that it is more easily absorbed by plants. This explanation was also strengthened by Prof. Djoko Said Damardjati, researcher from the Indonesian Ministry of Agriculture's Research and Development Agency that arsenic in rice is largely determined by environmental factors where the rice grows; "It could be if the fields are ex-mining or from fertilizers used. Rice fields near the factory or polluted rivers are also feared to make arsenic found in rice," he said. In line with Meharg's statement, the presence of arsenic poison was caused by pesticides and various other industrial chemicals used when planting rice or even processing rice before being distributed to homes.[3]

Arsenic is one of the heavy metals that has very toxic properties with the effect of damaging the environment. The effect of arsenic exposure on human health can be acute or chronic. Some cases of health problems that have been reported such as intestinal and gastric irritation, decreased white blood cell productivity and red blood, skin changes and lung irritation. Arsenic can also accelerate the development of cancer, causing infertility and miscarriage.[8]

Based on this study, it can be explained that the technique of processing rice into rice greatly influences the chemical safety aspects of rice, especially from arsenic pollutants. In further research, it is expected to analyze the quality of rice and the condition of rice cooking equipment used in rice stalls in Banda Aceh. Thus the risk factors for arsenic contamination in white rice will be identified at the scale of the rice stalls.

CONCLUSION

Based on the survey results of arsenic contamination in white rice consumed by employees of Aceh Health Polytechnic of Ministry of Health, it can be concluded that the qualitative test of arsenic shows a negative result in household rice sample. The qualitative tests of arsenic shows positive results in rice stalls sample. The rice cooking technique on household produces white rice that is free of chemical contamination as arsenic. To overcome doubts that rice used on a household scale turned out to be all arsenic-free, it would be followed up with a chemical food safety study of rice distributed in Aceh.

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