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Borax Risk Assessment in Meatball That Circulating Around Vocational School Darussalam Martapura

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Abstract
Meatball is one of the snack that are often found in schools in South Kalimantan. There are indications of Borax contamination to preserve food. Such conditions actually make students consume unhealthy food. The use of borax is only allowed as a detergent and antiseptic making agent. Exposure to borax can have an effect on the central nervous system, kidneys and liver. Given the importance of studying the risk of these hazardous substances to health, a Borax risk assessment is needed. This method is a way to predict the health impacts that occur from exposure to harmful substances. The impact in question is the estimated magnitude of non-carcinogenic risk and carcinogenic risk expressed by RQ (Risk Quotient) and ECR (Excess Cancer Risk). The research sample consisted of meatball samples extracted from 4 (four) merchant locations around the school. The respondents of the study were students of SMK Darussalam Martapura class X and XI with Purposive Sampling techniques with inclusion criteria. The research instruments consist of borax examination tools, UV vis spectrophotometers, anthropometric measuring instruments and interview fill sheets. The average Borax concentration on meatball was 0.0875 mg / g. The intake value of non-carcinogenic effects is still below the reference dose value (RfD<0.2 mg/kg/day), as well as the intake value of carcinogenic effects is still below the NOAEL value (<0.113 (mg/kg/day)1). The non-carcinogenic risk level is categorized as safe (RQ≤1), but the carcinogenic risk level (ECR) value is >1/10,000 meaning that the risk level is unsafe so that it can cause carcinogenic effects. Risk management is needed through decreasing the concentration of exposure and limiting the amount of consumption so that students avoid the health effects caused. The suggestions from this study focus on the need for supervision, guidance and policies that prevent the emergence of negative food safety issues.
Keywords: Intake, risk level, non-carcinogen, carcinogen, risk management
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1. Introduction

Risk assessment is an approach to knowing and estimating health risks in humans. This method is carried out through five stages including hazard identification, hazard characterization (response dose analysis), exposure analysis, risk characterization and risk management. These steps are also called risk assessment or Environmental Health Risk Analysis (ARKL) (Director General of PP and PL of the Ministry of Health, 2012). In Indonesia, ARKL is still not widely known and used as a method of assessing environmental impacts on health. Several European Union countries, America and Australia this method has become a process of centra idea legislation and regulation of environmental impact control (Basri, 2014).

Risk assessment or risk assessment is important to be carried out in order to predict the impact due to exposure to certain substances that have the potential to cause health problems in people who are exposed to or consume these materials. One of the snack food ingredients that is very familiar among the people of South Kalimantan is meatball. This snack is delicious, savory and a favorite food. Meatball is made from processed beef, chicken, and fish, tapioca flour and spices which are rounded then boiled, steamed then skewered using a stick and dipped in chili or tomato sauce. Meatball is one of the foods or snacks that are often found in the school environment and are often consumed by most school-age children.

Darussalam Martapura Vocational High School (SMK) is one of the private vocational schools whose location is quite strategic because it is located in the center of education in the city of Martapura. The location of the school on the edge of the highway makes it easy for vendors to sell snacks around the school so that students can easily access it. The motivating factor for students of this school to buy snack food is because the body's need for nutrients for adolescent growth, good taste, instant food and affordable prices. On the other hand, there are concerns about food safety issues regarding the content of harmful food additives in school children's snack food. Students' ignorance of the negative impact of exposure to harmful additives to snack food makes school children actually behave in unsafe snack food consumption.

Food safety is one of the issues that must get attention, especially in developing countries such as Indonesia, because it can have a negative impact on health. The reason is still low knowledge, skills, and responsibility of food producers for food quality and safety, especially in small industries or home industries. To get food as desired, often in the manufacturing process added additional ingredients better known as food additives (BTP) or food additives (Safitri et al, 2019).

The addition of BTP is actually allowed, while it is still allowed and the levels are still within safe limits and do not endanger consumer health. However, many producers or sellers do not understand and do not pay attention to this, and deliberately add harmful chemicals that are actually used as food additives even though they are not intended for food, for example borax (Rohmawati, 2017).

Borax is a white crystalline compound that is odorless and stable at room temperature and contains the mineral Boron. Borax is a chemical compound with the name sodium tetraborate ((NaB4O7)10H2O). If dissolved in water it will become hydroxide and boric acid (H3BO3) (Subiyakto, 1991). Borax or borax acid is usually used as a detergent and antiseptic ingredient (Tubagus, 2013). Consuming foods containing borax does not have direct adverse effects, but borax will accumulate little by little because it is absorbed in the consumer's body cumulatively. The ban on the use of borax is also strengthened by the Regulation of the Minister of Health of the Republic of Indonesia Number 33 of 2012, concerning food additives, that Sodium Tetraborate, better known as Borax, is classified as an additive that is prohibited from being used in food. Borax is still found in traditional markets with products called salt bleng or pijer. This ingredient belongs to the category of Food Additives (BTP) which are dangerous and prohibited by the government to be included in food. However, due to ignorance often food processors add these harmful ingredients.

Borax is often misused as a chewer, preservative and improves appearance in making meatballs (Junianto, 2013). If often exposed due to consuming borax, it will cause disorders of the brain, liver, fat and kidneys. In large quantities, borax consumed causes fever, anuria, coma stimulates the central nervous system, causes depression, apathy, cyanosis, hypotension, kidney damage, cancer, fainting and even death.

The results of research showing that there is borax in snack food have found as many as 138 food samples in the form of positive meatballs containing borax in Sponyono Market and Jagir Market Surabaya (Yulianto, 2013). In 2014 there were 3 (three) Extraordinary Events (KLB) of culinary poisoning in Banjarbaru City. This poisoning is experienced by school-age children who are mostly expected to eat processed meat snacks such as meatball, sausages, nuggets, empek-empek, otak-otak, dumplings, and others (Banjarbaru City Health Office, 2015).

Health effects caused by exposure to borax hazardous materials can be estimated through health risk assessment through environmental health risk analysis (ARKL) methods. Several research results on human health risks due to boron state that the source of boron is found in groundwater sources and children and adolescents are the most at-risk groups ((Rahman et al, 2021). Another study found boron content in fish tissue Tilapia nilotica, water and sediments of Lake Edku, Egypt. The results of the health risk analysis found that tilapia consumption from the lake did not pose a risk because the risk level was still below one (RQ<1). Statistical analysis and assessment of human health risks to boron in lake water showed a greater impact in children than in adults (Abeer et al, 2012).

The results of Li's (2022) research on health risk assessment of boron content in the mountains of Southern Tibet explained that the cause of the high concentration of boron comes from hot springs and is used as drinking water around Tibet. Boron content in geothermal water in the study area reached 42.36 mg / L, far exceeding the drinking water limit set by the World Health Organization (0.5 mg / L). Health risk assessment to drinking water in the study area shows that the hazard index (HI) of drinking water in mixed regions is higher than 1 indicating that children are at high health risk than adults (Li et al, 2022).

Health risk assessment of boron contamination in groundwater basaltic geology of semi-arid region of Maharashtra stated that the B content in drinking water is above the WHO threshold. It is stated that children have a higher risk of non-carcinogenic than adults and infants Ajaykumar et al, 2020).

The discovery and concentration of boron naturally in nature along with health risk assessments in children, adolescents and children have been widely studied. In Indonesia, borax findings are actually added to hawker food. The Center for Drug and Food Insight (BPOM) in Banjarmasin in 2021 has conducted food supervision of 103 samples. The test results obtained as many as 17 samples did not meet the requirements because they contained Rhodamine B (5 samples), Borax (2 samples), Formalin (3 samples), TMS Na cyclamate (2 samples) and TMS microbiology (4 samples) (BPOM Banjarmasin, 2021). Meatball is one type of School Children's Food (PJAS) which has great potential to contain borax which can make this snack food more chewy and not stale quickly. This is common in schools where meatball traders sell their wares to students including students of SMK Darussalam Martapura.

Given the importance of studying the health effects of borax exposure on health in adolescents in this study, it is necessary to assess health risks through Environmental Health Risk Analysis (ARKL). This step is carried out as a basis for estimating the amount of intake, risk quotient and excess cancer risk in students of SMK Darussalam Martapura.

2. Research Methods

This study uses the Environmental Health Risk Analysis (ARKL) method which is a method to calculate the estimated level of risk due to borax exposure in at-risk populations by considering the characteristics of the material and population. The steps include hazard identification, response dose analysis, exposure analysis, risk characteristics and risk management. The study was conducted in July – August 2023. A number of meatball were extracted from 4 (four) points where toll traders sell around the SMK Darussalam Martapura school with a total of 16 types of meatball samples. Purposive sampling techniques were applied in this study so that as many as 102 students were willing to become respondents and meet the criteria for research inclusion, including having consumed meatball at least 1 time per week. The research instruments consist of a Borax test kit, UV vis spectrophotometer, anthropometric measuring instrument and interview fill sheet. The collected data will first be tested for data normality and then descriptive analysis will be carried out, namely the explanation of the data in the form of tabulations of the number and percentage of data distribution obtained catgorically (gender). In addition, the distribution of min-max, mean, median, standard deviation and normal distribution data will be given for numerical data (weight, height, borax concentration, ingestion rate, duration of exposure, frequency of exposure and duration of exposure). For the calculation of intake using the following formula:

$$\text{Intake (I)} = \frac{C \times R \times f_E \times D_t}{W_b \times t_{avg}}$$

Information :

I : Borax intake (mg/kg/day)
C : Borax concentration in meatball (mg/L)
R : Ingestion rate (g/day)
f_E : Frequency of exposure (day / year)
D_t : Duration of exposure (years)
W_b : weight (kg)
t_{avg} : The average time period is 30 years x 365 days/ year = 10,950 days for non-carcinogenic risks and 70 years x 365 days/ year = 25,550 days for carcinogenic risks.

The level of non-carcinogenic risk is calculated using the following equation:

$$RQ = \frac{I}{RfD}$$

Information :

RQ : Risk level of borax (Non-carcinogenic effects)
I : Non-carcinogenic intake (mg/kg/day)
RfD : Borax reference dose is 0.2 mg/kg/day (mg/kg/day)
If the result is an RQ value of > 1, risk management must be carried out
While the carcinogenic risk level uses the following formula:

$$ECR = I \times SF$$

Information :

ECR : Risk level of borax (Carcinogenic Effect)
I : Intake of Rhodamine B (mg/kg/day)
SF : Slope Factor (Value of efficiency of risk agents with carcinogenic effects)
The SF value of borax is not available, but another experimental dose calculation can be used, NOAEL (No Observed Effect Level). The NOAEL value of borax is 8.8 mg / kg / day or equivalent to 0.113 (mg / kg / day)-1 (EPA, 2006).
Risk management is needed to minimize the impact of exposure of a risk agent through determining the concentration and number of safe limits.

Determination of non-carcinogenic safe limit concentrations, namely:

$$C_{nk} \text{ safe (ingesti)} = \frac{RfD \times W_b \times t_{avg}}{R \times f_E \times D_t}$$

While the determination of carcinogenic safe concentrations include:

$$C_k \text{ safe (ingesti)} = \frac{\frac{(0{,}0001)}{SF} \times W_b \times 70 \times 365}{R \times f_E \times D_t}$$

The calculation of the amount of safe consumption of non-carcinogenic risks is:

$$R_{nk}\,(\text{safe}) = \frac{RfD \times W_b \times t_{avg}}{C \times f_E \times D_t}$$

and the calculation of the amount of safe consumption of carcinogenic risks as follows:

$$R_k\ \text{safe (ingesti)} = \frac{\frac{(0{,}0001)}{SF} \times W_b \times 70 \times 365}{C \times f_E \times D_t}$$

3. Results & Discussion

Overall, the data characteristics of respondents in this study were mostly women as many as 53 people out of 102 people, aged at least 15 years and at most 19 years. The lowest weight is 33 kg and the highest is 90 kg. Body height ranges from 147 cm to 180 cm. Details of the distribution of data characteristics of class X and class XI respondents of SMK Darussalam are presented in table 1 below.

Table 1. Frequency distribution of respondent characteristics

No	Respondent characteristics	Class X (N=57; Male=32, Female=25)					Class XI (N=45; Boys=17, Girls=28)				
		Mean	Median	elementary school	Min	Max	Mean	Median	elementary school	Min	Max
1	Age (years)	16.2	16	0.90	15	19	17	17	0.79	16	19
2	Body Weight (kg)	51.73	48.8	13.72	33	90	51.75	49	13.01	34	85
3	Height (cm)	161.94	161	8.52	149	180	160.90	160	8.16	147	179

Source: Primary data

From the results of examining food samples of 16 types of meatball, an average borax concentration was obtained of 0.0875 mg/g. If we relate it to the respondents' activity patterns, we get the picture that in class X the average intake rate is 6.4 pieces/day. The average weight of 1 (one) meatball is 35 g, so the intake rate is 224 g/day, the exposure time is 1 year with the exposure frequency being 120.24 days/year. Meanwhile, in class In table 2 below, detailed results of respondents' activity patterns are displayed.

Table 2. Frequency distribution of respondents' activity patterns

No	Activity patterns	Class X (N=57; Male=32, Female=25)					Class XI (N=45; Boys=17, Girls=28)				
		Mean	Median	elementary school	Min	Max	Mean	Median	elementary school	Min	Max
1	Intake rate (fruit/day)	6.4	5	3.8	1	20	6.7	5	3.5	1	10
2	Duration of exposure (years)	1	1	0	1	1	2	2	0	2	2
3	Frequency of exposure (days/year)	120.24	100.2	70.14	50.1	350.7	155.31	150.3	95.19	50.1	501

Source: Primary data

Estimation of health risks due to exposure to borax on meatball is carried out through Environmental Health Risk Analysis (ARKL) measures. Exposure analysis is performed by calculating the intake of risky agents in the body. The intake in this study is the concentration of borax that is estimated to enter the student body based on the class at school. A real-time intake or the length of time students consume meatball containing borax in the study area to completion can be estimated.

The risk level of non-carcinogenic effects is expressed in the Risk Quotient (RQ) i.e. the intake value divided by the reference dose. For the level of risk of carcinogenic effects expressed in Excess Cancer Risk (ECR). ECR is obtained from the results of multiplying the intake by slope factor (SF). Risk management is carried out through the determination of safe concentrations and safe consumption amounts (Director General of PP and PL of the Indonesian Ministry of Health, 2012). The ARKL component data is presented in table 3 below.

Table 3. Environmental Health Risk Analysis (ARKL) of Borax

No	ARKL components	Class X		Class XI	
		Non-carcinogenic effects	**Carcinogenic effects**	**Non-carcinogenic effects**	**Carcinogenic effects**
1	Intake (I)	0.004 mg/kg/day	0.001 mg/kg/day	0.01 mg/kg/day	0.004 mg/kg/day
2	Non-carcinogenic risk level (RQ)	0.02	-	0.05	-
3	Carcinogenic risk level (ECR)	-	0.0002	-	0.0005
4	Determination of safe concentration (C)	4.20mg/g	0.04mg/g	1.55mg/g	0.016 mg/g
5	Determination of safe consumption amount (R)	10.75 g/day	0.11 g/day	4.16 g/day	0.04 g/day

Source: Primary data

Based on table 3 above, it is obtained that the non-carcinogenic realtime intake value in class X and class XI is still below the RfD value (<0.2 mg / kg / day), and the carcinogenic realtime intake value in class X and XI is still below the NOAEL value of <0.113 (mg / kg / day)-1 or <8.8 mg / kg / day. For RQ value ≤1, it means that the risk level is still safe for class X and class XI. While the ECR value in class X and class XI shows a result of >0.0001 which means the risk level is unsafe so that it can cause carcinogenic effects.

In line with research that states that children and adolescents have a high risk of receiving health effects due to boron exposure. However, around 90–95% of the samples studied are free from boron contamination because they have HQ values of <1 (Rahman et al, 2021). The results of statistical analysis and assessment of human health risks to boron have also been carried out at the lake site of Lake Edku, Egypt. The study showed that the impact was greater in this group of children than in adults. Detection of boron concentrations is also found in Tilapia nilotica fish tissue, water and lake sediments. Human consumption of fish from the lake does not pose any risk, but the hazard index for its meat is still below one (RQ<1). Meanwhile, no adverse effects were detected on skin-to-sediment contact studied in both children and adults, but boron showed long-term effects on human health (Abeer et al, 2012).

The results of Li's (2022) research on the health risk assessment of boron content in the mountains of Southern Tibet revealed that the boron content in geothermal water in the study area reached 42.36 mg / L, far exceeding the drinking water limit set by the World Health Organization (0.5 mg / L). Health risk assessments to drinking water in the study region showed that the hazard index (HI) of drinking water in mixed regions was higher than 1 (with an average of 1.594 for children and 1.366 for adults), indicating that children are at high health risk. higher health risks compared to adults (Li et al, 2022).

The calculation of non-carcinogenic intake and carcinogenic intake is divided into realtime intake and lifetime intake. In non-carcinogenic and carcinogenic realtime intakes, see the exposure that has occurred at the time of the study. Non-carcinogenic intake lifetime looks at projected exposure over 5 years, 10 years, 15 years, 20 years, 25 years and 30 years. While carcinogenic intake lifetime looks at projected exposure for 10 years, 20 years, 30 years, 40 years, 50 years, 60 years and 70 years. After calculating the intake, then the risk value is calculated. Table 4 below presents data on projected intakes and risk levels of non-carcinogenic effects for the next 30 years.

Table 4. Projection of intake and risk level of non-carcinogenic effects in the next 30 years

No	Projection	Non-carcinogenic intake (mg/kg/day)		Risk level non-carcinogenic effects (RQ)	
		Class X	Class XI	Class X	Class XI
1	5 years	0.02	0.02	0.10	0.14
2	10 years	0.04	0.05	0.20	0.28
3	15 years	0.06	0.08	0.31	0.42
4	20 years	0.08	0.11	0.41	0.56
5	25 years	0.10	0.14	0.52	0.70
6	30 years	0.12	0.16	0.62	0.84

Source: Primary data

Based on the table above, it was found that there was a trend of increasing intake values ranging from 5-year projections to 30-year projections. The lowest non-carcinogenic intake is in class X and class XI at 0.02 mg/kg/day at the 5-year projection. While the highest non-carcinogenic intake is found in the 30-year projection with a value of 0.12 mg / kg / day for class X, and 0.16 mg / kg / day for class XI. Thus, both class X and class XI non-carcinogenic intake values are still below the RfD value (<0.2 mg / kg / day). Meanwhile, the RQ value of the projected risk level for the next 30 years is still categorized as safe (RQ≤1) so that SMK Darussalam students are not at risk of non-carcinogenic diseases.

The projected amount of carcinogenic intake is estimated to be up to 70 years from now. Table 5 below presents the results of projected intakes and the level of risk of carcinogenic effects (ECR) over the next 70 years.

Table 5. Projected intake and level of risk of carcinogenic effects (ECR) in the next 70 years

No	Projection	Carcinogenic intake (mg/kg/day)		Projected risk level of carcinogenic effects (ECR)	
		Class X	Class XI	Class X	Class XI
1	10 years	0.01	0.02	0.002*	0.002*
2	20 years	0.03	0.04	0.004*	0.005*
3	35 years old	0.05	0.07	0.006*	0.008*
4	40 Years	0.07	0.09	0.008*	0.010*
5	50 years	0.08	0.12*	0.010*	0.013*
6	60 Years	0.10	0.14*	0.012*	0.016*
7	70 Years	0.12*	0.16*	0.014*	0.019*

Source: Primary data

From the table above, it is known that class X students have a carcinogenic intake value of 0.12 mg / kg / day in year 70 which means above the NOAEL value (>0.113 (mg / kg / day)-1). Likewise, for grade XI students, the projected carcinogenic intake values of 50 years, 0 years and 70 years respectively are 0.12; 0.14 and 0.16 mg/kg/day whose values are >NOAEL borax. In the calculation of the projected ECR value of 10 years to 70 years, a value of >1/10,000 or ECR >0.0001 is obtained. Thus, all of these time series all have an unsafe risk level category so that they are at risk of cancer.

Risk management is carried out if RQ>1 values and ECR>1/10,000 values are found. Risk management is carried out by calculating the safe concentration (C) and the amount of safe consumption (R). Table 6 below presents the risk management of borax.

Table 6. Borax risk management

No	Risk management / Effect	Safe concentration (mg/g)		Safe consumption amount (g/day)	
		Class X	Class XI	Class X	Class XI
1	Non carcinogenic	4.20	1.55	10.76	4.16
2	Carcinogenic	0.04	0.016	0.11	0.04

Source: Primary data

Based on previous risk calculations, it was found that realtime and lifetime ECR have a value of >1/10,000 so that risk management is needed, especially to avoid carcinogenic effects. From table 6 above, it is known that the safe concentration value of carcinogenic effects of class X students is 0.04 mg / g and 0.016 mg / g for grade XI students. For the amount of safe consumption of carcinogenic effects, the lowest value was in grade XI students of 4.16 g / day and for carcinogenic effects of 0.04 g / day. Thus, risk management is carried out by reducing the rate of intake or the amount of consumption to ≤0.04 g / day. In principle, risk management through considering the lowest value, concentration and amount of exposure consumption to avoid side effects that occur.

Furthermore, risk management can be done by reducing the amount of consumption of foods containing borax, including not consuming meatball, especially those sold on the roadside exceeding the limit of safe consumption in order to avoid disease disorders due to carcinogenic substances.

5. Conclusion

The realtime non-carcinogenic risk level (RQ) for grade X and class XI students is still safe (RQ ≤1), while the value of the realtime carcinogenic risk level (ECR) for grade X and class XI students is >0.0001 which means that the risk level is unsafe so that it can cause health effects in the form of cancer (carcinogenic effects). Therefore, risk management is needed by reducing concentration through reducing the amount of consumption and even avoiding meatball consumption. This decrease in concentration value and amount of consumption aims to prevent students from the health effects caused.

Communication, information and education efforts must continue to be carried out so that the public and food processors are educated and behave in good health to avoid unwanted effects. Efforts that can be made by schools include supervising hawker food in the school environment, including making healthy canteen policies or bringing provisions. Efforts to guide hawker food traders by the Health Office, monitoring the circulation of hazardous food additives in the market through inspection of salt bleng (salt containing boron) or pijer can be carried out by the POM Center and for further researchers can conduct other similar research on the assessment of hazardous substances such as formalin, dyes in other snack foods.

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