

Measurement of Effective Dose Detox for Workers Exposed to Benzene Toxins in Sidoarjo Paint Industry

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Abstract

One of the aromatic hydrocarbon compounds, namely benzene. Benzene is a colorless liquid with a sweet odor (sweet odor), volatile in the air, soluble in water and flammable. Today the use of benzene used by the paint manufacturing industry. However, the concentration of benzene that exceed standards required threshold value will negatively impact the health of workers in Sidoarjo Paint Industry. Benzene can threaten the safety and human health if inhaled because it can damage the blood forming system profile in humans. The purpose of this research is to reduce the exposure of benzene by determining the effective dose of toxin detox benzene in the paint industry, Sidoarjo, East Java. This study was an observational study with cross-sectional approach. result the average concentration of benzene in the workplace respondents was 3.28 mg / m³. The average effective dose should be consumed by the respondent for the avocado intake is 0,011 mg / day, chicken intake 0,026 mg / day, intake of grapefruit 0.033 mg/day, and carrot intake was 0.063 mg /day.

Keywords: Benzene, an effective dose of detox, paint factory worker

Introduction

One of the aromatic hydrocarbon compounds, namely benzene which has many uses for human life, especially in the industrial sector¹⁴. Epidemiological studies prove benzene as a carcinogen substance, have toxic effects on the blood and bone marrow. The International Agency for Research on Cancer (IARC) classifies benzene into the group-1A carcinogen material, a material that proved to be carcinogenic to humans. Contained toxic levels of benzene contained in the human circulatory system can cause leukemia². NIOSH (National Institute of Occupational Safety and Health) said that workers exposed to organic solvents, it is estimated to reach 9.8 million people, mainly workers who work on the production of paints, adhesives, glues, coatings, grease solvent / cleaning materials, production dyes, polymers, plastics, textiles, printing inks, agricultural products, and pharmaceuticals^{1,2}. NIOSH estimates that more than 2

million workers in the United States the possibility of exposure to benzene.¹. In Indonesia, definitive data regarding the effects of benzene on workers association has not been found¹⁴.

Benzene includes components of gasoline and toxins commonly regarded as the work¹⁶. Benzene is a toxic chemical that can lead to acute myeloid leukemia^{10,12}. Benzene when oxidized in Phase 1 will produce benzene quinone, which is a source of increased toxicity. To complete benzene required in Phase 2 detoxification enzymes CYP2E1¹¹. metabolic enzymes play an important role in the activation or detoxification benzene¹⁵. Benzene is initially oxidised to benzene oxide by the liver cytochrome P450 2E1 (CYP2E1) in the liver¹⁴.

BO detoxification in vivo occurs by reaction with glutathione, some metabolites of benzene aromatic rings opened or catalyzed by enzymes II metabolites such as glutathione-S-transferase (GSTs) or to form the derivative is less toxic or non-toxic and excreted through the urine¹⁷. To reduce or even eliminate toxins in the chemical, diperlukan⁴ biotransformation process. High levels of antioxidants needed to neutralize these substances, compensate for the damage caused by free radicals and protects the liver and cells of the CYP2E1¹¹. Foods rich in beef liver, brain, and salmon; Sulfation

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rich foods are eggs, sulfation of chicken, beef and tuna, and foods rich in glutathione are avocado, asparagus, carrots, tomatoes, oranges, and broccoli⁹.

Research using food to detoxify benzene is still very limited. Therefore, this study aimed to determine the CYP2E1 enzyme-rich food intake, sulfation, and glutathione required to detoxify benzene in every worker in Sidoarjo Paint Industry.

Benzene is one of the aromatic hydrocarbon compounds are widely used in the rubber industry, oil refining, chemical plants, shoe factories, and oil-related industries. Benzene is also found in public facilities such as cigarette smoke, gas stations, fuel burning cars, and so on. According to the Agency for Toxic Substances and Disease Registry (ATSDR), hazardous and toxic chemicals contained in oil content, namely benzene, toluene, xylene, ethylene, TPH (Total Petroleum Hydrocarbon) and Polycyclic Aromatic Hydrocarbon (PAHs). Of the six chemicals benzene exposure are very serious impact on health.

American Conference of Government Industrial Hygienists (ACGIH) in 2006 set the Threshold Limit Value (NAV) of the chemical benzene in the workplace that is the maximum value allowed is 0.5 ppm and certainly belonged carcinogenic to humans (A1 = Confirmed Human carcinogen)¹⁴. National Institute for Occupational Health and Safety (NIOSH) set the recommended exposure limit or REL (recommended exposure Limit) for 8 hours of work that is equal to 0.1 ppm. In Indonesia alone, according Permenakertrans 13 / MEN / X / 2011, 2011, NAB allowable benzene is 0.5 ppm.⁶ While based on the Minimum Risk Level (MRL) set for the ATSDR 2007 was 0,009 ppm benzene every day to give effect acute and 0,003 ppm every day cause chronic effects².

Workers in the paint industry is working populations that have high levels of benzene higher risk of exposure, especially through inhalation in a continuous exposure period. Workers in the paint industry is constantly exposed to benzene because it is in an environment which emit benzene coming from the engine fuel pump when filling the fuel oil, fuel oil storage facilities as well as issued by the exhaust of vehicles during refueling queue. ATSDR (2007) states that the main exposure occurs via inhalation, although the dermal exposures (contact with the skin) and oral sex also may occur. Effects of acute exposure to high levels of benzene

can occur immediately after exposure. Then the high concentration of benzene exposure (at least 200 ppm) are repeated can cause permanent damage to the central nervous system. Chronic exposure to benzene in the workplace associated with hematological disorders (such as thrombocytopenia, aplastic anemia, pancytopenia, and acute leukemia) (ATSDR, 2007).

Areas of the paint industry as a working environment that has a high exposure to benzene, supposedly necessary efforts to reduce the negative effects of exposure to benzene so as not to cause health problems for workers. Based on previous studies of benzene in the workplace, has not done research on effective dose detox toxic benzene in the workplace that have exposure to benzene. Therefore, the authors are interested in discussing the size of an effective dose of toxic benzene in the area detox paint industry.

Material and Method

The subjects are workers in the paint industry Sidoarjo. Criteria for inclusion in this study were male workers who had worked in the paint industry and are willing to be used as respondents. The sample was 24 people.

The variables that need to be calculated first is the effective dose intake needed by each individual to calculate the weight, length of employment (years), worked on average each day (hour), and the working time in a week (days) of the respondents, as well as the measurement of the concentration, benzene at five points in the industry. weight measurement using the scale body weight. Working length measurement, the average work every day, and time workweek obtained through in-depth interviews with respondents. Then, the measurement of the concentration of benzene in the workplace by using the NIOSH 1501 method of measurement with activated charcoal carbon pipe using the technique of gas chromatography (NIOSH 1501, 2003). The study was approved by the Ethics Committee of the Faculty of Public Health.

Then, look for the intake (formula) with the following formula:

intake non carcinogen

$$= \frac{C \times R \times tE \times fE \times Dt}{Wb \times 30 \times 365}$$

C = concentration of benzene (mg / ml)

R = benzene reaction rate (m3 / h)

te = working time / day (hours)

Fe = working time / week (day)

Dt = working time (years)

Wb = weight (kg)

Calculate the effective dose per day with the calculation results noncarcinogen intake (intake) above, using the formula below:

$$\text{effective dose of food} = \frac{\text{intake}}{\text{days}}$$

$$= \frac{\text{intake toxin} \frac{\text{m}^3}{\text{day}} \times \text{Mr enzym detox}}{\text{Mr toxin}}$$

Findings

Benzene concentration (n = 24)

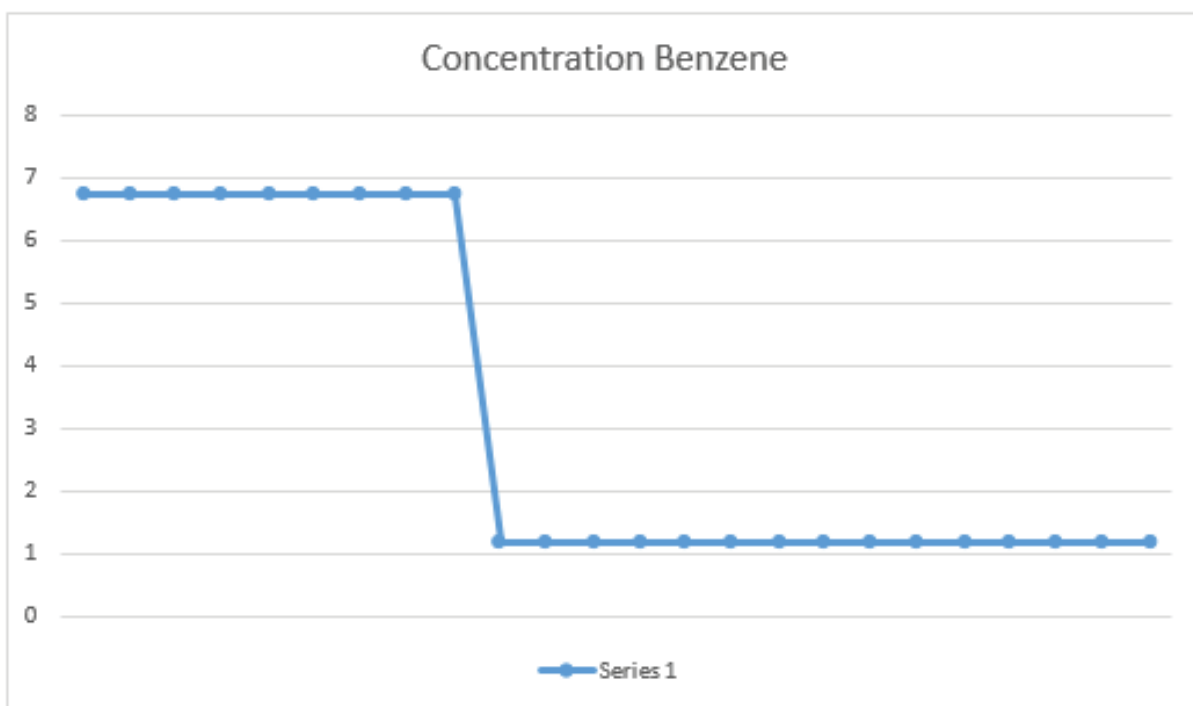


Figure 1. Concentration Benzene

In Figure 1, shows that the benzene concentration maximum of 6.7508 mg / m³ and the lowest of 1.1975 mg / m³. So that the average benzene in Sidoarjo paint

industry was 3.28 mg / m³.

Comparison of Predicted Benzene intake Detox

Table 1. Comparison of Predicted Benzene Detox intake (Intake of Beef Liver, Brain Cow, Fish Salmon) (n = 24)

C (Mg / m3)	DE Avocado	DE Chicken	DE Orange	DE Carrot
6.7508	0.028338827	0.067493999	0.083412395	0.157887748
6.7508	0.03438338	0.081890187	0.101203911	0.191564545
6.7508	0.034359332	0.081832912	0.101133127	0.191430562
6.7508	0.035142143	0.083697317	0.103437251	0.195791938
6.7508	0.042399454	0.100981906	0.124798393	0.23622553
6.7508	0.024928185	0.059370943	0.073373524	0.1388856
6.7508	0.035142143	0.083697317	0.103437251	0.195791938
6.7508	0.029900104	0.071212462	0.088007854	0.166586294
6.7508	0.031630783	0.075334385	0.093101928	0.17622865
1.1975	0.001219578	0.002904644	0.003589702	0.006794793
1.1975	0.00168381	0.004010295	0.004956119	0.009381225
1.1975	0.001387943	0.003305635	0.004085266	0.007732825
1.1975	0.002968493	0.007069999	0.008737452	0.016538748
1.1975	0.000866271	0.00206318	0.002549779	0.004826368
1.1975	0.00182267	0.004341015	0.005364839	0.010154874
1.1975	0.00219233	0.005221428	0.006452896	0.012214411
1.1975	0.002703563	0.00643902	0.007957657	0.015062708
1.1975	0.001375232	0.003275361	0.004047852	0.007662005
1.1975	0.000432937	0.001031118	0.001274306	0.002412079
1.1975	0.002798375	0.006664833	0.008236727	0.015590948
1.1975	0.000396461	0.000944244	0.001166943	0.002208856
1.1975	0.000186725	0.000444719	0.000549605	0.001040324
1.1975	0.002798375	0.006664833	0.008236727	0.015590948
1.1975	0.00182267	0.004341015	0.005364839	0.010154874
3.28	0.011315372	0.026949587	0.033305622	0, 063 042 784

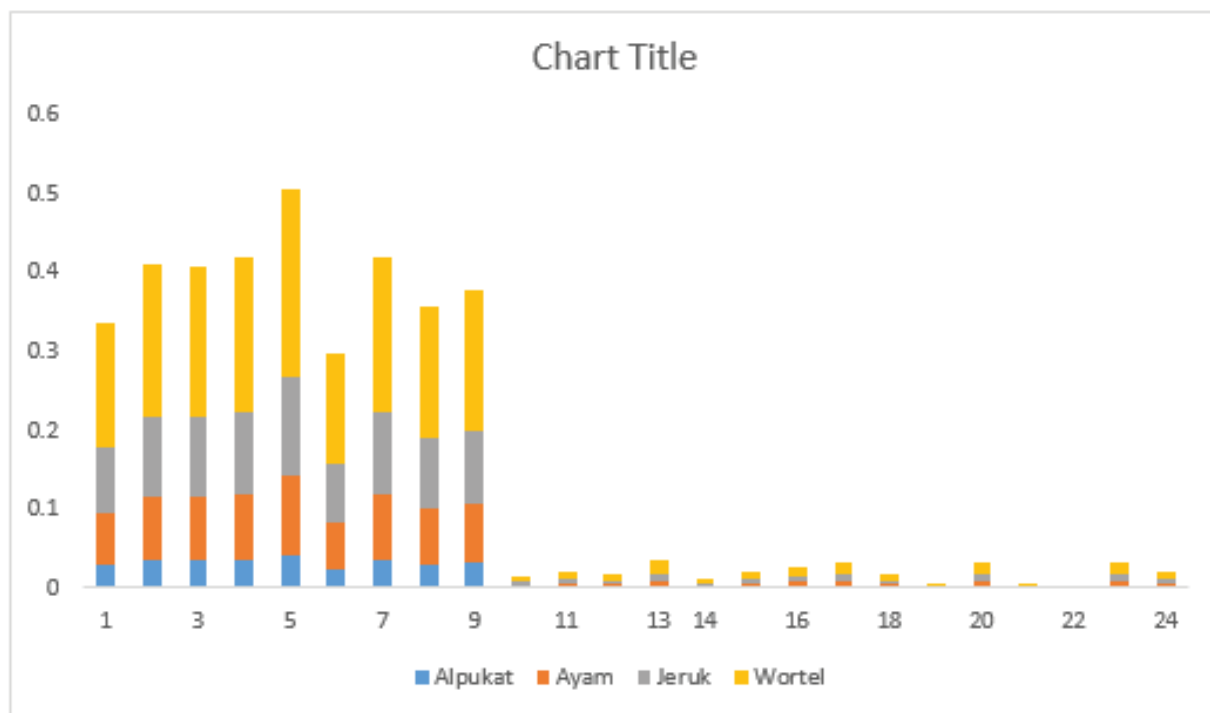


Figure 2. Comparison Prediction Detox benzene intake (Intake Avocado, Chicken, Orange, Carrots) (n-24)

In Table 1 and Figure 2, shows that the highest benzene concentration of 6.7508 mg / m³ and the lowest of 1.1975 mg / m³. So that the average benzene in Sidoarjo paint industry was 3.28 mg / m³. The average effective dose should be consumed by the respondents to the intake of avocado is 0,011 mg / hr, chicken intake of 0,026 mg / day, The intake of citrus 0,033 mg / hr, and carrot intake was 0.063 mg / hr.

Discussion

Detoxification is the process that is toxic to less toxic compounds. The detoxification process to be non-toxic eliminated through urine and bile. Food-based nutrition continues to be investigated for its role in modulating the metabolic pathways involved in the detoxification process. Some of the publications that have used the cell, animal and clinical studies indicate that the component-based foods and nutrients can modulate the process of conversion and excretion of toxins from the body.

CYP2E1, Sulfation, and glutathione are enzymes that work on phase 2 of the biotransformation⁹. CYP2E1 are involved in detoxification reactions-activation of a variety of endogenous and exogenous compounds. Rat hearts showed that the effect of the amount of

protein in CYP2E1 activity increased CYP2E1 enzyme activity increased^{2,6}. Sulphation is one of a number of liver detoxification pathway, particularly the phase II detoxification. The sulphation detoxification of toxins, it is an antioxidant and detoxification compound produced a powerful agent in the cytoplasm of every cell of the human body^{3,13}.

Related glutathione antioxidant enzyme involved in the metabolism and detoxification of cytotoxic and carcinogenic compounds as well as reactive oxygen species.

The generation of reactive oxygen species occur in relatively prolonged hypoperfusion conditions such as aging. The etiology of presbycusis is much less certain; However, the genetic cause is most likely complex. The effects of aging shows a variety of inter-wide.

The results showed that each individual has a different cost. This is because each individual has a different effective dose of food. The effective dose can also bedepending on the amount of inhaled benzene concentration, weight, and length of employment. The higher the concentration of benzene in the body, the greater the mass of food needed detox. This is in

accordance with the formula that has been made in previous studies suggesting that he has a synergistic relationship with the concentration of 8 weight, length of employment, and the concentration of benzene can affect the intake of non-carcinogens in each individual that can influence the effective dose of food. This is consistent with previous research that says that the genetic variance, sex, and weight may play a role in the biotransformation enzymes⁹.

By knowing the foods that can be used to detoxify benzene exposure of the body, in the paint industry Sidoarjo who have a high risk of exposure to benzene can prevent this is through food. In addition, knowing the estimated costs to be incurred in order to prevent exposure to benzene through this food, workers can choose foods that can detoxify benzene in the body with the food that is in line with workers' earnings in the paint industry Sidoarjo.

Sulphation is one of a number of liver detoxification pathway, particularly the phase II detoxification. Sulphation system is important in detoxification of several drugs, food additives and especially the gut bacteria and toxins from environmental contaminants. Glutathione is an antioxidant and detoxification compound produced a powerful agent in the cytoplasm of every cell of the human body. In broad terms, these studies have found glutathione to protect against oxidative stress, detoxification of chemicals and toxins, improve immune function, and support healthy aging. One of the toxins that can be detoxified is benzene.

The results showed that each individual has different needs detoxification intake. This is because each individual has a different effective dose of food. The effective dose can also depend on the amount of inhaled benzene concentration, weight, and length of employment. The higher the concentration of benzene in the body, the greater the mass of food needed detox. This is in accordance with the formula that has been made in previous studies suggesting that he has a synergistic relationship with the concentration of a substance. Weight, length of employment, and the concentration of benzene can affect the intake of non-carcinogens in each individual that can influence the effective dose of food. This is consistent with previous research that says that the genetic variation, sex.

By knowing which foods can be used to detoxify the body's exposure to benzene from, shoe workers who

have a high risk of exposure to benzene can prevent this is through food. In addition, knowing the estimated costs to be incurred in order to prevent exposure to benzene through this food, workers can choose foods that can detoxify benzene in the body with the food that is in line with workers' earnings in the paint industry Sidoarjo.

Conclusion

To complete the detoxification benzene required in Phase II enzyme CYP2E1 enzyme necessary, sulfation, and glutathione. CYP2E1-rich foods are beef liver, brain, and salmon; Sulfation rich foods are eggs, chicken sulfation, beef and tuna, and foods rich in glutathione are avocado, asparagus, carrots, tomatoes, oranges, and broccoli. Weight, length of employment, and the concentration of benzene can affect the intake of non-carcinogens in each individual that can influence the effective dose of food. By knowing the estimated costs to be incurred in order to prevent exposure to benzene through this food, workers can choose foods that can detoxify benzene in the body with the food that is in line with workers' earnings in the Paint Industry Sidoarjo.

Consequences of benzene exposure in workers obtained from the use of benzene which is very much needed and important role in many industrial processes. This can negatively impact the health of workers if efforts to control or reduce the exposure is not done well. Karsinogenen effect is one of the harmful effects resulting from exposure to benzene in the workplace, especially in the paint industry.

Therefore, the average benzene in Sidoarjo paint industry was 3.28 mg / m³, the average effective dose should be consumed by the respondents to the intake of avocado is 0,011 mg / hr, chicken intake of 0,026 mg / day, The intake of citrus 0,033 mg / hr, and carrot intake was 0.063 mg / hr. So that to reduce the impact of exposure to benzene into the body of the workers in the paint industry needed feeding benzene detoxification. Feeding is different in each individual adjusted to the concentration of benzene, weight, and duration of action.

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Ethical Clearance: The study was approved by the Ethics Committee of the Faculty of Public Health,

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