Media Kesehatan Masyarakat Indonesia
Volume 17 Issue 4 2021
Website : http://journal.unhas.ac.id/index.php/mkmi

Environmental Health Risk Analysis of Dust Exposure on Employees in PT. Cassia Co-op Indonesia in Jambi

Analisis Risiko Kesehatan Lingkungan Paparan Debu pada Pekerja di PT. Cassia Co-op Indonesia di Jambi

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ARTICLE INFO

eISSN: 2356-4067
DOI:10.30597/mkmi.v17i4.14858
Published online Des, 2021

Keywords:
Risk assessment;
dust;
TSP;

Kata Kunci:
Analisis risiko;
debu;
TSP;

ABSTRACT
The dust has a negative impact that can affect workers' health. This study aimed to analyze the environmental health risks of dust exposure on workers at PT. Cassia Co-op Indonesia in Jambi. Descriptive quantitative research was conducted using an *Analisis Risiko Kesehatan Lingkungan (ARKL)* approach, including analysis of hazard identification, dose response, exposure assessment, and risk characteristics. 61 respondents from the production division were selected as samples with a disproportionate stratified random technique. Data was collected using a questionnaire and Total Suspended Particulate (TSP) concentration from company's secondary data. The results of measuring dust levels at 2 (two) points obtained a concentration value that was still below the threshold, but 77% of respondents experienced health problems related to TSP dust. The real-time intake value of TSP exposure of workers was not at risk of health problems (RQ<1) at both measurement points, and the intake lifespan value of TSP exposure was at risk of health problems (RQ>1) for all workers in the 15th year at point 1. It is recommended for companies to conduct regular health checks on workers, provide PPE and apply the standard use of PPE, make rules that prohibit smoking while working, and increase the location and frequency of testing for TSP dust levels in the company.

ABSTRAK
Debu memberikan dampak negatif yang dapat mempengaruhi kesehatan pekerja. Penelitian ini bertujuan untuk menganalisis risiko kesehatan lingkungan akibat paparan debu pada pekerja di PT. Cassia Co-op Indonesia di Jambi. Penelitian kuantitatif deskriptif dilakukan dengan pendekatan Analisis Risiko Kesehatan Lingkungan (ARKL), meliputi analisis identifikasi bahaya, dosis respon, penilaian pajanan dan karakteristik risiko. Sebanyak 61 responden dari bagian produksi terpilih sebagai sampel dengan teknik disproportionate stratified random. Pengumpulan data menggunakan kuesioner dan konsentrasi Total Suspended Particulate (TSP) dari data sekunder perusahaan. Hasil pengukuran kadar debu di 2 (dua) titik didapatkan nilai konsentrasi yang masih di bawah standar nilai ambang batas, namun sebanyak 77% responden mengalami gangguan kesehatan terkait debu TSP. Nilai intake realtime pajanan TSP pekerja belum berisiko gangguan kesehatan (RQ<1) pada kedua titik pengukuran, dan nilai intake lifespan pajanan TSP berisiko gangguan kesehatan (RQ>1) pada seluruh pekerja pada tahun ke-15 pada titik 1. Disarankan kepada perusahaan untuk melakukan pemeriksaan kesehatan secara berkala pada pekerja, menyediakan APD dan menerapkan standar penggunaan APD, membuat aturan larangan merokok saat bekerja, serta menambah lokasi dan frekuensi pengujian kadar debu TSP di perusahaan.

INTRODUCTION

The growth of the wood processing industry is quite rapidly due to the increase in forest consumption every year, while the process uses energy and natural raw materials on a large scale tends to produce air pollution in the form of dust particles. About 10-13% of the chopped and crushed wood dust particles fly in the air, potentially causes air pollution in the work environment and health problems.[1]

Dust in the work environment causes complaints in the throat and nose, such ascough, respiratory problems and other infections up to death.[2] The World Health Organization (WHO) estimates about 3 million deaths per year from exposure to outdoor air pollution, and about 6.5 million deaths (11.6% of all global deaths) are attributed to indoor and outdoor air pollution. Nearly 90% of deaths from air pollution occur in lower middle income countries, and two-thirds of them occur in Southeast Asia and Western Pacific region.[3] Outdoor air pollution is a risk factor for approximately 58% of premature deaths from ischemic heart disease and stroke, 18% of deaths from COPD and Lower Respiratory tract infection, and 6% of deaths from lung cancer.[4] In Indonesia, about 70% of worker morbidity is caused by exposure to high dust.[5]

The threshold value for wood dust that can be accepted by human is 5 mg/m^3 with an exposure duration of < 8 hours/day for 5 working days. Dust concentrations that exceed quality standards will affect health.[6]A study by Rahman, et al in 2008 showed that the longer humans are in a polluted air environment, the greater the risk of health problems and the number of risk agents entering the body. Timber industry workers who have a working period of > 5 years have a 13.5 times risk of suffering from lung function disorders compared to a working period of 5 years.[1,7,8]

PT. Cassia Co-op Indonesia is a company in the field of cinnamon processing which located in Sungai Penuh City and Kerinci Regency, Jambi Province. The company is process cinnamon into a broken and clean product, cinnamon stick, essential oils, tea bag cut products, cut and sifted, and powder (cinnamon bark powder),[9] which through some processing process such as drying, cutting, counting, milling, and sawmills that produce dust as a source of air pollution. This condition causes workers who are active to be very vulnerable to air pollution due to exposure to dust in the long term.

The results of the initial survey found the condition of wood dust scattered in the workplace while some workers did not appear use respiratory Personal Protective Equipment (PPE) such as masks. The results of the interviews revealed that some workers often had symptoms of health problems such as coughing, shortness of breath, and dizziness. Based on clinical data company throughout 2020, obtained diseases related to dust exposure where from about 511 patients who visited, 195 (38.3%) suffered from ISPA, 68 patients (13.3%) with Bronchitis, 15 patients (2.9%) with Bronchopneumonia, and 6 patients (1.2%) with Asthma. PT Cassia Co-op Indonesia is known to have made efforts in monitoring the work environment, but no analysis has been done to determine the risk of environmental hazards to workers, especially exposure to dust from the process of cinnamon to lead export commodity from Kerinci-Jambi province which is very popular in the international market. This study aims to Analyze the Environmental Health Risk of dust exposure on workers including hazard identification, dose-response analysis, exposure analysis and risk characterization at PT. Cassia Co-op Indonesia in Kerinci-Jambi Province.

MATERIAL AND METHOD

Study design was a quantitative descriptive using the *Analisis Risiko Kesehatan Lingkungan (ARKL)* approach *with* 4 steps consisting of hazard identification, dose-response analysis, exposure analysis and risk characterization. The samples were exposed to the production employees directly by cinnamon dust timber which processed a total of 61 respondents selected by disproportionate stratified random sampling Technique,[10] and met the inclusion criteria that have worked at least one year. Data were collected by interview using a questionnaire, while the concentration of Total Suspended Particulate (TSP) was taken from secondary data belonging to the company's latest environmental monitoring results using *HVAS* gravimetric method according to SNI 19-7119.3-2005.

RESULTS

Characteristics of Respondents

Age of workers as respondents ranged from 19 to 63 years, an average of 30.3 years (SD =

8.068) and an average bodyweight of 60.52 kg (SD = 8.142). Most of the respondents were male (81.97%), had high school education (75.41%), and did not smoke (44.26%). Based on using of PPE (personal protective equipment), the majority used masks (100%) and gloves (93.44%), while protective glasses were only 41% (Table 1).

Hazard Identification

Hazard identification was carried out by analyzing dust concentration (TSP), dust sources, and health risks from dust exposure (Table 2). TSP dust concentration measurement results at two points are considered to represent the working environment at the production known that TSP levels at one point amounted to 0.54279 mg/m^3 higher than point 2 of 0.08962 mg/m^3. The TSP level at point 1 was above the quality standard value/QSV (0.23 mg/m^3), but both did not exceed the threshold value/TV (5 mg/m^3).

Table 1. Characteristics of Workers

Characteristics	n=61	%
Gender		
Male	50	81.97
Female	11	18.03
Education		
Elementary School	2	3.28
Junior High School	2	3.28
Senior High School	46	75.41
College	11	18.03
Smoking Status		
Not Smoking	27	44.26
Mild	17	27.87
Moderate	13	21.31
Weight	4	6.56
Use of PPE		
Mask	61	100
Goggles	25	41.98
Gloves	57	93.44

Source: Primary Data, 2020

Table 2. Measurement of TSP Concentration

Location	Levels (mg/m^3)	QSV (0.23 mg/m^3)	TV (5 mg/m^3)
Point 1	0,54279	> QSV	< TV
Point 2	0,08962	< QSV	< TV

Source: PT. Cassia Co-op Indonesia, 2020

Observation results revealed that airborne dust particles were visible to the naked eye in the production section which wassourced from the cinnamon wood processing process using special production machines such as cutting, chopping and refining. From the interviews, it is known that generally respondents have experienced health complaints related to exposure to wood dust in their working environment, including coughing (29.5%), coughing up phlegm (19.7%), sneezing (52.5%), shortness of breath (9.8%), chest pain (16.4%), itching in the nose (37.7%), skin irritation (41%), and eye irritation (32.8%).

Dose-Response Analysis

The dose-response analysis used in this study was for non-carcinogenic inhalation exposures expressed by Reference Concentration (RfC). This dose is needed to find a safe value for non-carcinogenic effects or to determine the quantitative value of toxicity in particular risk agent that can cause adverse health effects on the population at risk. The dust reference dose is not available yet in IRIS but it can be derived from the NAAQS with the primary standard for PM10 being 50 g/m^3 (annual arithmetic mean), so because 68% TSP is Pm10, the value C = 0.7353 mg/m^3. Therefore, the safe concentration (RFC = I), then to the RFC, the following equation applies:

$$RfC = \frac{CxRxt_E x f_E x D_t}{W_b x t_{avg}}$$

Description:
C = 0,7353mg / m^3
R = 0.83 m^3/ h
t_E = 24 hours/day
f_E = 350 days/year
D_t = 30 years
t_{avg} = 365 days × 30 years

Then using the substitution with default value of US-EPA exposure, the RfC value is 0.0020 mg/kg/day.

Exposure Analysis

Exposure analysis was described based on workers' activity pattern, inhalation rate, and calculation of TSP intake. The pattern of worker activity is seen from the length of exposure, frequency of exposure, and duration of exposure based on the production division group (Table 3).

Table 3 illustrates that in general, the average length of dust exposure to workers is 8.34 hours/day with the largest average in the division Blending (8.75 hours/day) and the smallest

average in the Grinding and Stick division (8 hours/day). The total average value for the frequency of exposure was 283.39 days/year with the highest average in the KHL Stick division (308.17 days/year) and the lowest in the Stick division (258.67 days/year). The average total exposure duration was 3.64 years with the highest average exposure duration in the Grinding division (6.25 years) and the lowest in the KHL Drying division (1.84 years). This average value is entered into the intake formula so that the TSP intake value and the risk level (RQ) of the population are obtained from 8 divisions. Inhalation rate value (R) is used as the default value for Exposure Factor of US-EPA for adults' inhalation of 20 m3 / day with average body weight 70 kg converted to units of m^3/ h to R = 0.83 m^3/ O'clock.

Calculation of the TSP intake value was carried out during the study (*realtime*) and is projected for the next 30 years (life*span*). The analysis showed that the lowest realtime exposure TSP intake was in the KHL Drying (0.0004 m/kg/day) in point 2, while the highest was in the Distillation (0.0112 mg/kg/day) in point 1 (Table 4). In lifespan exposure, the projected TSP intake values in point 1 and point 2 from the 5th to the 30th year continue to increase. The TSP intake value in point 1 is projected to exceed the RfC value (0.020 mg/kg/day) or unsafe from the 15th year and above, while in point 2 it is still within the safe limit until the 30th year (Figure 1 & 2).

Table 3. Time, Frequency and Duration of Dust Exposure to Workers

Division	n	Time Exposure (t_E)		Frequency Exposure (f_E)		Duration Exposure (D_t)	
		Mean	SD	Mean	SD	Mean	SD
Blending	4	8.75	0.957	260.25	3.500	5.75	1.258
Crushing	9	8.33	0.707	271.67	22.836	5.56	2.068
Distillation	3	8.33	0.577	264	0	5.67	1.528
Drying	4	8.50	1	268.75	25.500	4	0.816
Grinding	4	8	0	262.50	3.317	6.25	0.957
KHL Drying	19	8.47	0.772	296.53	48.883	1.84	0.898
Stick	12	8.25	0.622	308.17	45.674	1.92	0.669
KHL Stick	6	8	0	258.67	6.314	5.50	1.643
Total	**61**	**8.34**	**0.68**	**283.39**	**39.601**	**3.64**	**2.199**

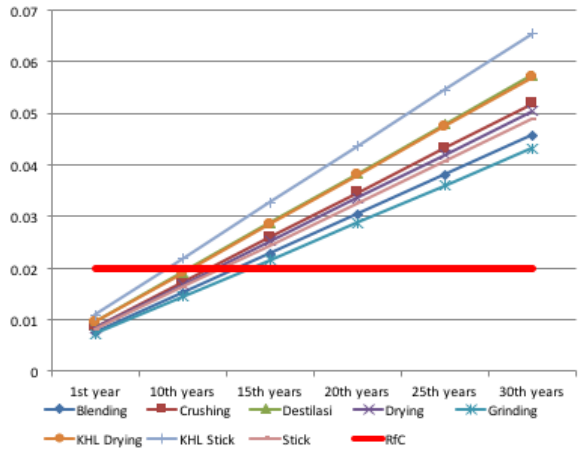
Source: Primary Data, 2020

Table 4. Real Time and Lifespan TSP Intake

TSP Intake (mg/kg/day)	Real Time	Projection (Year)					
		5	10	15	20	25	30
Point 1							
Blending Division	0,0087*	0,0076*	0,0152*	0,0228*	0,0305*	0,0381*	0,0457*
Crushing Division	0,0096*	0,0086^	0,0173^	0,0259^	0,0345^	0,0432^	0,0518^
Destilasi Division	0,0112*	0,0096*	0,0191*	0,0287*	0,0382*	0,0478*	0,0573*
Drying Division	0,0066*	0,0084*	0,0168*	0,0252*	0,0335*	0,0419*	0,0503*
Grinding Division	0,0091*	0,0072*	0,0144*	0,0216*	0,0288*	0,0360*	0,0432*
KHL Drying Division	0,0026^	0,0095*	0,0190*	0,0284*	0,0379*	0,0474*	0,0568*
KHL Stick Division	0,0041*	0,0109*	0,0218*	0,0327*	0,0436*	0,0545*	0,0654*
Stick Division	0,0089*	0,0081*	0,0163*	0,0244*	0,0325*	0,0406*	0,0488*
Point 2							
Blending Division	0,0014*	0,0013*	0,0025*	0,0038*	0,0050*	0,0063*	0,0075*
Crushing Division	0,0016*	0,0014^	0,0029^	0,0043^	0,0057^	0,0071^	0,0086^
Destilasi Division	0,0019*	0,0016*	0,0032*	0,0047*	0,0063*	0,0079*	0,0095*
Drying Division	0,0011*	0,0014*	0,0028*	0,0042*	0,0055*	0,0069*	0,0083*
Grinding Division	0,0015*	0,0012*	0,0024*	0,0036*	0,0048*	0,0060*	0,0071*
KHL Drying Division	0,0004^	0,0016*	0,0031*	0,0047*	0,0063*	0,0078*	0,0094*
KHL Stick Division	0,0007*	0,0018*	0,0036*	0,0054*	0,0072*	0,0090*	0,0108*
Stick Division	0,0015*	0,0013*	0,0027*	0,0040*	0,0054*	0,0067*	0,0081*

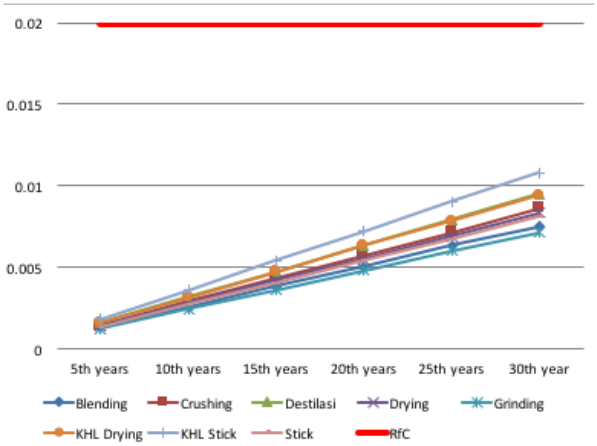
Source: Primary Data, 2020

Description: * = Mean ^ = Median



Source: Primary Data, 2020

Figure 1. Lifespan TSP Intake (Point 1)



Source: Primary Data, 2020

Figure 2. Lifespan TSP Intake (Point 2)

Risk Characteristics

Risk Characteristics are an effort to determine how big the risk level of a risk agent as TSP enters the body. The risk level in this study is only for non-carcinogenic effects which are expressed by the Risk Quotien (RQ) Notation by dividing the value intake TSP with RfC obtained from IRIS.

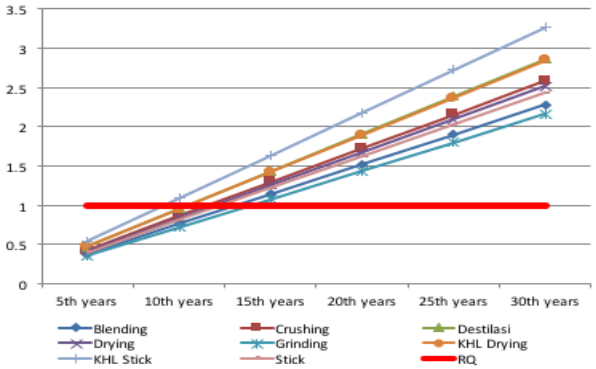
The results of real time risk level analysis in point 1 and point 2 obtained RQ values below the safe limit (RQ<1), in point 1 the lowest was in the KHL Drying division (0.1300) and the highest in the Distillation division (0.5602), while in point 2 the lowest value in the KHL Drying division (0.0215) and the highest in the Distillation division (0.0925) (Table 5).

Furthermore, the projected TSP risk level for lifespan exposure was illustrated in Figure 3 & 4. Table 6 explains that in lifespan exposure, the projected RQ value in point 1 and point 2 from the 5th to the 30th year continues to increase. In point 1, projections with an RQ value >1 (risky) occur in the 15th year and above, while at point 2, until the 30th year it is still not risky.

Table 5. Realtime TSP Intake

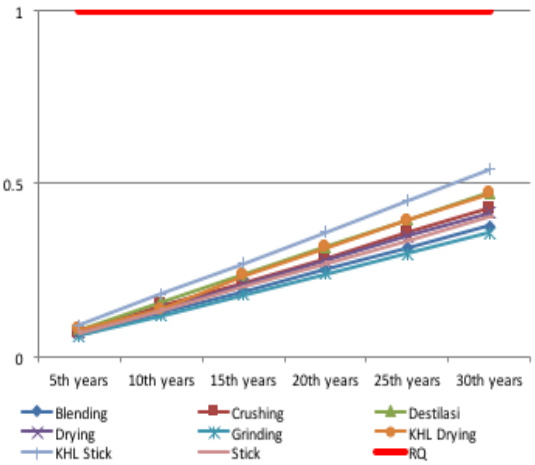
Population Group	RQ (mg/kg/day)	
	Point 1	Point 2
Blending Division	0,4369*	0,0721*
Crushing Division	0,3711*	0,0792*
Distilling Division	0,5602*	0,0925*
Drying Division	0,3295*	0,0544*
Grinding Division	0,4541*	0,0750*
KHL Drying Division	0,1300^	0,0215^
KHL Stick Division	0,2072*	0,0342*
Stick Division	0,4423*	0,0730*

Source: Primary Data, 2020
Description: * = Mean ^ = Median



Source: Primary Data, 2020

Figure 3. Lifespan RQ Projection (Point 1)



Source: Primary Data, 2020

Figure 4. Lifespan RQ Projection (Point 2)

Table 6. Real Time and Lifespan RQ TSP by Sampling Point

RQ (mg/kg/ day)	Real Time	Projection (Year)					
		5	10	15	20	25	30
Point 1							
Blending Division	0,4369*	0,3806*	0,7612*	1,1418*	1,5225*	1,9031*	2,2837*
Crushing Division	0,3711*	0,4315^	0,8629^	1,2944^	1,7258^	2,1573^	2,5887^
Distilling Division	0,5602*	0,4778*	0,9556*	1,4334*	1,9111*	2,3889*	2,8667*
Drying Division	0,3295*	0,4193*	0,8386*	1,2578*	1,6771*	2,0964*	2,5157*
Grinding Division	0,4541*	0,3601*	0,7202*	1,0803*	1,4405*	1,8006*	2,1607*
KHL Drying Division	0,1300^	0,4740*	0,9480*	1,4221*	1,8961*	2,3701*	2,8441*
KHL Stick Division	0,2072*	0,5450*	1,0901*	1,6351*	2,1801*	2,7251*	3,2702*
Stick Division	0,4423*	0,4062*	0,8125*	1,2187*	1,6250*	2,0312*	2,4374*
Point 2							
Blending Division	0,0721*	0,0628*	0,1257*	0,1885*	0,2514*	0,3142*	0,3771*
Crushing Division	0,0792*	0,0712^	0,1477^	0,2137^	0,2850^	0,3562^	0,4274^
Distilling Division	0,0925*	0,0789*	0,1578*	0,2367*	0,3156*	0,3944*	0,4733*
Drying Division	0,0544*	0,0692*	0,1385*	0,2077*	0,2769*	0,3461*	0,4154*
Grinding Division	0,0750*	0,0595*	0,1189*	0,1784*	0,2378*	0,2973*	0,3568*
KHL Drying Division	0,0215^	0,0783*	0,1365*	0,2348*	0,3131*	0,3913*	0,4696*
KHL Stick Division	0,0342*	0,0900*	0,1800*	0,2700*	0,3600*	0,4500*	0,5399*
Stick Division	0,0730*	0,0671*	0,1342*	0,2012*	0,2683*	0,3354*	0,4024*

Source: Primary Data, 2020

Description: * = Mean ^ = Median

DISCUSSION

Characteristics of Respondents

Age is one of the risk factors in workers that can increase the incidence of acute respiratory infections (ARI).[6] Increasing age will increase the number of damaged lung alveoli and decrease body resistance, as well as a decreasing in the respiratory system when the age reaches over 30 years.[6] The average body weight of the respondents was 59 kg, which ranged from 47 to 87 kg. This value is smaller than the US EPA standard adult body weight of 70 kg, but close to the IRIS Asian exposure standard weight of 55 kg. Based on the intake results, it was found that respondents with low body weight had higher intake values than respondents with high body weight. This was in line with research conducted by Sari, which concludes that the lower the body weight, the greater the *intake* received, on the other hand, high body weight is less likely to raise the risk of health problems.[11]

According to Purba et al, that there is no relationship between gender and pulmonary function disorders, where men and women have the same risk of pulmonary function disorders.[12] From the aspect of education, a good knowledge of health and the environment will be in line with efforts to protect themselves from the effects due to exposure to contaminant.[13] However, looking at the number of respondents with health problems of 77%, and those who have a higher education level (High School and Bachelor Degree) of 93.4%, it is suspected that the level of knowledge does not guarantee to avoid symptoms that arise due to exposure to dust.

Smoking is a risk factor for the incidence of ARI. Smoking has a toxic effect that causes irritation to the respiratory tract mucosa, thereby increasing the tendency to ARI.[6,13] Smoking habit can increase the risk of ARI as much as 2.2 times,[6] and cause respiratory system disorders such as lung cancer, acute irritant symptoms, chronic respiratory symptoms, chronic obstructive pulmonary disease, and respiratory infections. Smoking will increase the amount of air pollutants that enter the body so that it is riskier to get ARI disease.[13]

The result of this study found about 100% of respondents use mask while working, protective glasses (41%) and gloves (93.4%). Although most respondents have used PPE but still have health complaints, this is due to the use of masks that are not related with the provisions so that dust enters the respiratory tract. In line with the research conducted by Tong R et al, which says that the use of a mask that does not wear a respirator can cause a hazard of air into the respiratory tract.[14] In addition, complaints of skin irritation (41%) require respondents to use gloves when working to prevent direct skin contact with wood dust. In line with the research conducted by Putri F, found no association between

exposure to wood dust with an incidence of irritant contact dermatitis of workers sanding PT X Jepara.[15]

Hazard Analysis

The measurement results show that the concentration of TSP in PT. Cassia Co-op Indonesia, in point 1 is 0.54279 mg / m3 above the ambient air quality standard according to PP No. 22 of 2021, but still below the threshold value according to Permenaker No. 5 of 2018, while in point 2 the concentration of TSP is 0.08962 mg/m^3 and still safe because it is below the threshold value and quality standard. Although it is said to be safe, one day it can cause health problems related to the length of exposure as proven by the presence of respondents with health complaints such as sneezing, coughing, dizziness, chest pain, and so on. This is in line with the research of Fuadi, et al who concluded that the potential for hazards in the workplace will enter and accumulate in the body influenced by the length of exposure and the continuity of exposure. The longer the exposure, the more dust particles will accumulate in the body, which will cause health problems.[6]

The TSP concentration value in this study is lower than the results of research conducted by Nafisa (2016) with the highest value of 16.987 mg/m^3 and the research conducted by Herdianti (2018) with the lowest value of 3.26 mg/m^3.[1,16] This condition is probably because the measurement of TSP concentration is not carried out in all points of original emergence of Dust risk agents, so it is less accurate. Measurements were carried out in two points during the day because the activities in company were densely packed during the day. This is in line with research conducted by Anugrah, which shows that the highest dust concentration results are in the midday.[17]

Based on the source of exposure, it is known that the potential source of exposure that produces TSP dust comes from the production activities of cinnamon bark processing, namely the chopping process, cutting process and refining process. Dust can arise due to natural processes or mechanical processes such as cutting, breaking, refining, packing, packaging, and others arising from an object or material either from both organic and Non-organic.[2,18]

Working environmental conditions such as the presence of dust will affect the productivity and health of workers. Workers who are often exposed to dust will be at risk for health problems in the form of infectious or non-infectious diseases. Health problems can be seen from the perceived complaints/symptoms such as coughing, coughing up phlegm, shortness of breath, skin irritation, eye irritation, itchy nose, shortness of breath, and wheezing.[6]The results showed that the majority of workers experienced health complaints. According to the research of Purba, et al, which found 58.06% of respondents with respiratory disorders, and the research conducted by Riani where most of the respondents experienced subjective complaints (84.7%) and the most common respiratory complaints were sneezing (80.3%). Sneezing and coughing are two of the most common symptoms felt due to the presence of dust in the ambient air as a non-specific form of body defense when the concentration of pollutants, especially particulates or TSP, is in the threshold.[12,19]

Dose-Response Analysis

National ambient air quality standard PP no. 22 of 2021 cannot be substituted in the RfC equation because the default value of exposure factor is not known, so the reference dose is taken from the literature of previous studies where the RfC value for TSP is 0.020 mg/kg/day. These results were obtained from the default value of the US-EPA exposure factor and the TSP value taken from the NAAQS primary standard for PM_{10} was 50 g/m^3 (annual arithmetic mean) because 68% TSP was Pm_{10}, then the TSP Primary Standard was 73.53 g /m^3 and converted to 0.7352 mg/m^3.[7,20]

Exposure Analysis

The results of the study obtained that the average daily length of exposure for respondents was 8 hours/day which calculated from the reduction between the total working time a day and the rest time. This shows the maximum daily exposure time of workers in the study longer than Undang-Undang Cipta Kerja No. 11/2020 for 8 hours / day or 40 hours / week.[21] This condition is due to the high production activity that is adjusted to the market demand for cinnamon so that workers choose to fill overtime to increase their income. However, long exposure

while working will affect lung function. The greater the daily exposure value, the greater the risk of health problems. Indriyani et al stated the respondents exposed to TSP over 8 hours/day have a risk to get impaired lung function.[8]

The results of the analysis obtained the value of the exposure frequency of 264 days/year. This result is not in line with the US-EPA's default exposure value for the work environment of 250 days/year. The difference of 14 days is because workers in the Production section at PT. Cassia Co-op Indonesia utilizes holidays overtime for additional income.[20]

The results of the study found that the duration of exposure (D_t minimum) was 1 year and the maximum duration was 8 years. Based on health complaints, it is known that the workers who have the least complaints are workers with more than 4 years of working, because they are used to air pollution. in the beginning of working, the researcher felt more sensitive and often experienced health complaints, but over time, health complaints decreased. This is in line with research conducted by Riani that health complaints are related to decrease respiratory tract sensitivity so that they are not too sensitive to exposure to pollutants in ambient air. This occurs when the concentration of TSP pollutants in the ambient air is still below the quality standard.[19]

The rate of inhalation (R) obtained based on provisions of the US-EPA's IRIS is equal to 20 m^3/ day and converted to 0,83 m^3/ h, this value using inhalation adult with average body weight of 70 kg according to the exposure factor in America.[20] The inhalation rate value does not use the national exposure factor because there is no default value for the exposure factor in Indonesia.

The highest non-carcinogenic intake for exposure real time in point 1 and point 2 is 0.0112 mg/kg/day and still below the RfC value (0.02 mg/kg/day), but the exposure lifespan in the 15th year projected intake in point 1 has exceeded the RfC, while in point 2 up to 30 years it is still said to be safe. This happens because of the difference in the value of the TSP concentration in each point. The greater the value of the exposure factor, the greater the intake value.

Risk Characterization

The results of this study obtained therisk level of real time population in point 1 and point 2, a minimum of 0.0215 and a maximum of 0.5602 (RQ<1), meaning that in general respondents are safe from the risk of non-cancer health problems due to exposure to TSP in the air when study was carried out. Based on the lifespan risk level, the projected RQ value in point 1 exceeds the safe limit (RQ>1) in the 15th year for the entire population, meaning that the respondent is still safe in the location for 8 hours/day, 294 days/year for a maximum of 15 years. The next period of exposure to TSP in respondents will be at risk of experiencing non-carcinogenic health problems. This result is different from the Research conducted by Falahdina, which found a high level of real time exposure risk (RQ>1).[22] This is probably due to differences in the characteristics and patterns of respondents' activities in the workplace.

This study has limitations because it only predicts the risk level of health problems due to TSP which is non-carcinogenic (RQ), while predicting the level of carcinogenic risk using the value of ECR (Excess Cancer Risk) is not carried out. In addition, the prediction of this risk level is subjective depends on the researcher's perspective and there is no control over other factors so it is possible that the reality of risk is not precisely defined.

CONCLUSION AND RECOMMENDATION

Based on the intake lifespan of TSP exposure, all production workers at PT. Cassia Co-op Indonesia will be at risk of experiencing health problems in its 15th year. Therefore, it is recommended for companies to take control measures to reduce the risk of health problems for workers due to exposure to TSP from cinnamon, including: regular health checks of workers by conducting lung function tests (spirometry), providing complete PPE, especially masks with a respirator and apply the correct use of PPE, make smoking rules while working, add a wet filter at the dust source, and increase the location and frequency of TSP dust level testing in the company.

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