



Density of Cockroaches in Perimeter and Port Buffer Areas: Analysis of Sanitation and Physical Environment Factors

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ABSTRACT

English translation. Based on Permenkes RI No. 50 of 2017, the port must be free from cockroaches with standard quality index of cockroach population <2 . This study aims to describe the density of cockroaches in the port area and analyze sanitation and physical environmental factors related to cockroach density. Type quantitative research through analytical observational research design with cross sectional design. The location of the research in the perimeter and buffer area of Tanjung Emas Port, Semarang City. Catching cockroaches was carried out at 51 food stalls with observations of sanitation and physical environment. Catching English translation. cockroaches using a sticky trap placed at one point in each food stalls. The results showed an index of cockroach populations in the perimeter area of 9.74 and 5.4 in the buffer area. Based on the Chi Square test, there was a correlation between sanitation of food stalls and density of cockroaches ($p < 0.0001$; $OR = 3.75$). There is a relationship between temperature ($p < 0.0001$; $r = 0.59$) and humidity ($p < 0.0001$; $r = 0.52$) with cockroach density, based on spearman tests. The density of cockroaches in food stalls in the port area both in the perimeter and buffer area is related to sanitation and the physical environment. It is recommended that the owner of the food stall to always maintain sanitation and carry out cockroach control measures.

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Kepadatan Kecoa di Wilayah Perimeter dan Buffer Pelabuhan: Analisis Sanitasi Faktor Lingkungan Fisik

ABSTRAK

Berdasarkan Permenkes RI No. 50 tahun 2017, pelabuhan harus bebas dari kecoa dengan standar baku mutu indeks populasi kecoa <2 . Penelitian ini bertujuan untuk menggambarkan kepadatan kecoa di wilayah pelabuhan dan menganalisis sanitasi dan faktor lingkungan fisik terkait dengan kepadatan kecoa. Jenis penelitian kuantitatif melalui rancangan penelitian observasional analitik dengan desain cross sectional. Lokasi penelitian di wilayah perimeter dan buffer Pelabuhan Tanjung Emas Kota Semarang. Penangkapan kecoa dilakukan pada 51 warung makan dengan pengamatan sanitasi dan lingkungan fisik. Penangkapan kecoa menggunakan sticky trap yang ditempatkan pada satu titik di setiap warung makan. Hasil penelitian menunjukkan indeks populasi kecoa di wilayah perimeter yaitu 9,74 dan 5,4 di wilayah buffer. Berdasarkan uji Chi Square didapatkan hubungan korelasi sanitasi warung makan dan kepadatan kecoa ($p < 0,0001$; $OR = 3,75$). Ada hubungan suhu ($p < 0,0001$; $r = 0,59$) dan kelembaban ($p < 0,0001$; $r = 0,52$) dengan kepadatan kecoa, berdasarkan uji spearman. Kepadatan kecoa pada warung makan di wilayah pelabuhan baik di area perimeter dan buffer berhubungan dengan sanitasi dan lingkungan fisik. Disarankan pemilik warung makan untuk selalu menjaga sanitasi dan melakukan tindakan pengendalian kecoa.

Kata kunci:

Kepadatan kecoa
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INTRODUCTION

Cockroaches are insects that belong to the free-living Arthropoda phylum. Cockroaches live in groups and prefer damp and dark places to hide (Cochran, 1999) (Ogg et al., 2006). Cockroaches were active and have the habit of looking for food at night (nocturnal). The cockroaches habit of looking for food in dirty places such as in household sewage drains, septic tanks, garbage piles and cockroaches has the behavior of regurgitating food that has been eaten, this can easily transmit the disease to the humans by contaminating and destroying food (Sucipto DC, 2011). Cockroaches were insects that play an important role in health, especially in disease transmission. Cockroaches acted as a mechanical vector for the spread of disease agents originating from bacteria, viruses, protozoa, worms (helmin) and fungi, as well as causing allergic reactions, diarrhea and asthma (Sucipto DC, 2011) (Sigit et al., 2006).

In Indonesia, there are 51 Port Health Offices with 304 working areas. The port is the gateway to the point of entry (PoE), which is a place to change the mode of transportation, a place for loading and unloading cargo, a place for loading and unloading food supplies stored at the port (Triatmodjo, 2010). Ports play a very important role in the distribution of vector-borne between countries and between islands (Law No. 17 of 2008 on Shipping, 2008) (WHO, 2016). Based on the Republic of Indonesia Minister of Health Regulation No. 50 of 2017, that ports must be free from the presence of disease-transmitting vectors including cockroaches with a standard quality standard for the cockroach population index <2 (Indonesian Ministry of Health, 2017b).

Port Health Office has the authority to prevent and control insects/vector animals that in and out of the port by monitoring, evaluating and supervising according to the standards and requirements that have been determined at least once a month. One of the monitoring activities carried out is the sanitation supervision of food processing places such as canteens/food stalls. In each port area, there is a canteen/food stalls that have the potential to be a place of investment for vectors of disease transmitters such as cockroaches. Supervision of environmental sanitation in the port area aims to create a port that is free from vector (cockroach) reproduction (Indonesian Ministry of Health, 2017b).

Based on the Minister of Health of the Republic of Indonesia Decree No. 264 / Menkes / SK / III / 2004 The Area of Tanjung Emas Port Semarang is divided into two monitoring areas, namely the perimeter area with 11.24 hectares and a buffer of 136.36 hectares. The Port of Tanjung Emas is a fairly wide international port and there are many canteens/food stalls so, it has the potential to be a place of infection for disease-transmitting vectors such as cockroaches. The Port of Tanjung Emas must be free from the presence of vector (cockroach) transmitting diseases with a standard quality standard for the cockroach population index <2 (Indonesian Ministry of Health, 2014).

Based on the survey data, Tanjung Emas Port is the working area of Port Health Office Class II in Semarang which has the highest cockroach density, namely in 2020 the cockroach density is far above the quality standard and is included in the high cockroach density category with a density index of 8.8 (Semarang Port Health Office Class II, 2020). This has experienced an increase in cockroach density from 2019, which is included in the low cockroach density category with a density index of 1.1. In 2017 the cockroaches density with a density index of 4.58 and in 2018 the density of cockroaches with a density index of 5.25 (Semarang Port

Health Office Class II, 2020). This condition can be a risk factor for the spread of disease caused by cockroaches in the Tanjung Emas Port area.

Based on research result conducted by Kusumaningrum B. at the Port Health Office Class II in Mataram of 2018, the affected factor of cockroach density is the sanitation of Food Management Place (Kusumaningrum, 2018). Furthermore, based on the research results conducted by Firmansyah M. it was obtained evidence that environmental temperature and humidity were related to density (Firmansyah, 2017).

This research aims to analyze the correlation between sanitation and physical environmental factors with cockroach density in the port area.

METHOD

This research is quantitative research through analytic observational research design with a cross-sectional design. The samples in this research were 51 food stalls in Tanjung Emas Port and all cockroaches caught in these food stalls. Respondents in this study were the owners/persons in charge of the food stalls sampled.

The criteria for taking locations sample are as follows

1. Inclusion criteria, namely, all food processing places (food stalls) in Tanjung Emas Port that have a permit from the food stall owner.
2. Exclusion criteria, namely, food processing places (food stalls) that were not operating/closed at the time of the research.

The sanitation assessment at food stalls used an observation sheet that is filled in at the time of setting the cockroach traps. Temperature and humidity were obtained from measurements in the field during the installation and collection of cockroach traps. This research was conducted in November 2020. Cockroach traps (sticky traps) were installed for one night, from 4 p.m. until the next day at 7 a.m. which was monitored for 3 consecutive nights. The species of cockroaches that were caught were identified according to the identification key of cockroach in the book *Cockroaches: Pictorial Keys Arthropods, Reptiles, Birds and Mammals of Public Health Important* by Harry D. Pratt, then the cockroach density calculations were carried out using the cockroach population index formula.

From the data collection result, the data were analyzed using the Chi-Square test and the Spearman Correlation test with alpha 5% or 0.05.

RESULT AND DISCUSSION

Based on the research result with 3 repetitions, the total number of cockroaches caught in 23 food stalls of the perimeter area was 672, the cockroach density was high with a density index (9.74). Meanwhile, there were 454 food stalls in the buffer area, the cockroaches density was moderate with a density index (5.4).

Based on table 1. the cockroaches density at 23 food stalls in the perimeter area that unqualified were 21 (91%). Meanwhile, the cockroaches density at 28 food stalls in the buffer area unqualified were 19 (68%). This is supported by the location of food stalls in the perimeter area where there is a supply of foodstuffs in the storage area. The leftovers in the kitchen are a source of food for cockroaches. Based on the theory, cockroach density was influenced by the

availability of food (Sigit et al., 2006). By eliminating the food sources of cockroaches at food stalls kitchen, it can reduce

the presence of cockroaches at the food stalls.

Table 1.
The Density of Trapped Cockroaches at Food Stalls in the Perimeter Area and Port Buffer Area

Food Stalls Location	Cockroach Density					
	Qualified (<2)			Unqualified (≥2)		
	f	%		f	%	
Perimeter	2	9		21	91	
Buffer	9	32		19	68	

Based on research by the directorate general of pest control in Saudi Arabia, as many as 100% of cockroaches were found in restaurants with the highest density (40%) of all cockroaches caught in all catching locations (Noureldin, & Farrag, 2008). Another study conducted by Jeffery et al. in

Kuala Lumpur, it was also stated that the most cockroaches were caught from restaurant kitchens, namely in 5 of the 6 zones of the Kuala Lumpur Federal Territory (Jeffery et al., 2012).

Table 2.
Cockroach Species Caught in Perimeter Area and Port Buffer Area

Food Stalls Location	Cockroach Density					
	<i>Periplaneta americana</i>			<i>Blatella germanica</i>		
	f	%		f	%	
Perimeter	542	81		130	19	
Buffer	332	73		122	27	

Based on table 2. Cockroach species caught in catching locations at food stalls in the perimeter area are *Periplaneta americana* (81%) and *Blatella germanica* (19%). In the buffer area, namely *Periplaneta americana* (73%) and *Blatella germanica* (27%). This was in line with the research by Shahraki GH. which stated that the most common cockroach species found were *Periplaneta americana* and *Blatella germanica* (Shahraki et al., 2013), (Noureldin, & Farrag, 2008). This was in line with the theory that the cockroach species most often found in port areas are *Periplaneta*

americana and *Blatella germanica* (Indonesian Ministry of Health, 2017a). Based on the journal written by Dini M., it was stated that cockroaches were generally in areas where food is available (Rachael et al., 2010).

Another study revealed that restaurants are places where *Periplaneta americana* was infested (66.7%) (Davari et al., 2017). The *Periplaneta americana* species was the dominant cockroach species found in research surveys at food stalls (Widiya et al., 2018) (Sitanggang et al., 2018).

Table 3.
The Relationship between Sanitation and Cockroach Density at Food Stalls in the Port Area

Sanitation	Cockroaches Density						P value	OR CI 95%
	Qualified		Unqualified		Total			
	n	%	n	%	n	%		
Good	11	21,6	3	5,9	14	27,5	0,000	3,75 (1,62 - 8,68)
Poor	0	0,0	37	72,5	37	72,5		
Total	11	21,6	40	78,4	51	100,0		

Based on table 3. the results of the chi-square test of sanitation with the cockroaches density at food stalls in the port obtained a p-value <0.0001, which means that there was a significant relationship between sanitation and cockroach density at food stalls in the port area. Poor sanitation of food stalls has a 3.75 times risk of cockroach density compared to good sanitation of food stalls (OR = 3.75; 95% CI = 1.62 - 8.68). This was in line with research by Kusumaningrum B. which stated that poor sanitation is related to the density of cockroaches at food stalls in the port (Kusumaningrum, 2018). Another study by Memona H. stated that poor sanitation has an effect on increasing the cockroaches density in the environment (Memona et al., 2017).

The assessment of sanitation facilities components which unqualified of food stalls in the port area is that the doors of the food stalls are not tightly closed (98%). The assessment of the sanitation facilities components which unqualified was that the toilet floor had cracks (90.2%) and trash bins had no cover (64.7%) and the wastewater treatment system had no

grease traps (64.7%). The assessment of kitchens that unqualified was the kitchen that had food scraps or leftovers (62.7%).

Based on the research results from Shahraki GH. showed that there was a relationship between cracks / gaps in the building with the presence of cockroaches in the building and the kitchen which is a part of food stalls that has a high level of cockroach density. There was a significant relationship to the level of kitchen cleanliness with the presence of cockroaches, cockroaches in the kitchen (40.3%) and trash cans (22.3%) (Shahraki et al., 2013). Based on Noureldin's research, as many as 76.4% of cockroaches were caught in the kitchen. Then, the preferred habitats for cockroaches were under and above the refrigerator, in the trash, and under the sink (Noureldin, & Farrag, 2008). Kitchens and toilets were suitable hiding places for cockroaches with the availability of food (Shahraki et al., 2013) (Widiya et al., 2018). Therefore, kitchen sanitation really needs to be maintained in reducing the cockroaches density.

Based on the research by Harahap AA. stated that kitchen rooms with uncovered trash cans have a high cockroaches density (Harahap, 2016). Poor waste management can cause unpleasant odours and can become a breeding ground for cockroaches (Mandagie, 2011). One of the requirements for trash bins that there was a sufficient number of trash cans in each waste-producing place that is closed and impermeable (Ikhtiar, 2017).

In the study of cockroach density and affected factors of cockroaches in urban communities by Shahraki GH. cockroaches seen visually from moved trash containers (8%) (Shahraki et al., 2013). The use of good trash can reduce the cockroach density by covering the trash can and removing

the trash from the garbage generator in the kitchen for no more than 24 hours.

Wastewater Treatment System which does not have grease traps at food stalls in the port was being a factor that supports the presence of cockroaches in food stalls. Dehghani R.'s research in Iran revealed that in Wastewater Treatment System there was various organic waste which was a source of food for cockroaches. Having a good Wastewater Treatment System can reduce the presence of cockroaches (Dehghani et al., 2014). Based on the theory of the Wastewater Treatment System, it should be cleaned every day so, can facilitate the passage of wastewater. The presence of a grease trap can help clog of Wastewater Treatment System (Ikhtiar, 2017).

Table 4.
Relationship of Temperature and Humidity with Cockroach Density at Food Stalls in the Port Area

Correlations	Cockroach Density	
	Correlation coefficient	Sig (2-tailed)
Temperature	-0,59	0,000
Humidity	0,52	0,000

Based on table 4. the result of the Spearman correlation test between temperature and cockroach density in the port was obtained a p-value = <0.0001 with a correlation coefficient of -0.59, which means that there was a strong relationship between temperature and cockroach density at food stalls in the port area. The result of the spearman correlation test between humidity and cockroach density in the port was obtained a p-value = <0.0001 with a correlation coefficient of 0.52, which means that there was a strong relationship between humidity and cockroach density at food stalls in the port area.

The results above are in line with Firmansyah M.'s research which stated that the cockroaches density on passenger ships was related to the temperature with a p-value = 0.004 with a correlation coefficient of 0.529 and humidity with a p-value = 0.000 with a correlation coefficient value of 0.808 (Firmansyah, 2017). Another study conducted by Mahmoud stated that the humidity and cockroaches density in the hospital had a strong relationship with a p-value = 0.010 (Mahmoud, 2013).

From the measurement results, the average temperature at the food stalls is 32.8 ° C with an average humidity of 61.3% RH. Cockroaches caught are mostly found in kitchens with a temperature range of 29.1-33.4 ° C with a humidity of 58-70% RH. This was in line with research from Cahyani LK, the air temperature at the place of foodstuff selling and the traditional market in Semarang City where there are cockroaches is ranging from 30.3-32.4 ° C with a humidity of 54.6% RH - 64.3% RH (Cahyani et al., 2018). Based on the theory, the optimum temperature for cockroaches was around 24-33 ° C (Ogg et al., 2006).

Based on the research conducted by Memona et al. revealed that environmental conditions during the summer will cause cockroaches to hide in the room. Warm temperatures with high humidity can increase cockroach breeding (Memona et al., 2017). Another study from Firmansyah M. stated that the distribution of cockroaches was found in humidity ranging from 50% -78% (Firmansyah, 2017).

CONCLUSION

Based on the research results, the cockroach species caught at food stalls of Tanjung Emas Port are *Periplaneta americana* and *Blatella germanica*. The cockroaches density at food stalls in the *perimeter* area is classified as high with a density index (9.74). The cockroaches density at food stalls in the *buffer* area of Tanjung Emas Port is classified as medium with a density index (5.4). The average temperature at the food stalls is 32.8 ° C with an average humidity of 61.3% RH. The cockroaches density at food stalls in the Tanjung Emas Port area, both in the *perimeter* and *buffer* areas was related to sanitation and the physical environment such as temperature and humidity.

It is recommended to Semarang Port Health Office Class II Semarang in the working area of Tanjung Emas Port to increase vector control (cockroaches) at food stalls in the perimeter area and port buffer areas, conduct socialization activities regarding food stall sanitation and integrated cockroach control efforts to those in charge of food stalls and conduct the activities of vector (cockroach) survey and the implementation of routine control at least four times a year.

To the owner/person in charge of food stalls in the port area to always maintain sanitation and take proper cockroach control measures in food stalls, so, it can create food stalls that are clean, safe, comfortable, healthy. Then, it can reduce cockroach density figures in ports to under quality standards so, there is no mechanical transmission of disease from cockroaches to communities in the port area.

For future researchers, it is hoped that can analyze more other factors deeply related to cockroach density.

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Conflict of Interest Statement

The authors state that there is no potential conflict of interest with respect to the writing and publication of this article.

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