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IDENTIFICATION OF FLY DENSITY IN TRADITIONAL MARKETS OF MALANG CITY, EAST JAVA

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ABSTRACT

Identification of Fly Density in Traditional Markets of Malang City, East Java. *The environment plays a crucial role in the emergence and spread of diseases. Environmental sanitation is particularly essential in public places such as markets, as these locations are frequented by the community on a daily basis. Poor market sanitation conditions can facilitate the breeding of disease vectors, such as flies. Therefore, this study aimed to identify fly density as an indicator of environmental sanitation quality. This research employed an exploratory observational design by observing market environmental conditions and recording the number of flies trapped using a fly grill at four observation points in Traditional Market X, Malang City. The results indicated that temperature and humidity were interrelated and influenced each other. The average fly density at the four observation points ranged from low to moderate and high categories. The beef stall showed a moderate to low category (3.0, 0.6, 0.2); the chicken meat stall showed a low to moderate category (0.2, 1.2, 3.2); the goat meat and fish stall showed a low to high category (1.2, 1.8, 8.8); while the food and beverage stall showed a low category (0, 0, 0.4).*

INTRODUCTION

The environment plays a crucial role in the history of disease emergence [1]. Environmental health conditions that do not meet established standards contribute to the continued spread of diseases, resulting in increased morbidity and mortality rates [2,3]. Environmental health is a fundamental pillar of public health and therefore requires special attention. Management of the environmental health sector in public areas is implemented as an effort to safeguard the environment through improvement measures as well as inspections of environmental health quality and quantity. The implementation and supervision of sanitation in public places aim to protect communities from the risk of disease transmission and other health disturbances[4].

One public space that requires particular attention in environmental sanitation is the market. Markets are among the most frequently visited public places, where people engage in daily buying and selling activities [5,6]. Generally, markets sell various types of raw food materials as well as ready-to-eat foods and beverages. A healthy market provides the community with easy and affordable access to fresh and nutritious foods while supporting safe and healthy food trading and consumption practices [7]. However, traditional markets commonly have inadequate waste management systems and substandard building conditions [8]. According

to data from the Central Bureau of Statistics (BPS), in 2019 there were approximately 14,182 traditional markets in Indonesia, with East Java ranking first with 2,249 traditional markets [9]. Poor sanitation conditions in traditional markets serve as pathways for disease transmission from one person to another, either through direct or indirect contact [10].

Environments with low sanitation standards can trigger the presence of disease vectors, such as flies [11]. Markets become favorable breeding sites for flies due to the generation of wet waste, organic waste, temporary waste disposal sites, and wastewater drainage systems [9]. Waste is defined as the residual material from human activities that is no longer needed or used [12]. An increase in waste volume that is not accompanied by improvements in waste management facilities and infrastructure results in increasingly complex waste-related problems [13]. The greater the amount of waste present in markets, the higher the fly density in the surrounding environment [14].

Flies are insects whose life cycles are closely associated with human activities. Several commonly encountered species include Musca domestica (house fly), Stomoxys calcitrans (stable fly), Phaenicia sp. (green fly), Sarcophaga sp. (flesh fly), and Fannia (lesser house fly) [15]. The fly life cycle consists of four stages: egg, larva, pupa, and adult. In a single oviposition, a fly can produce approximately 120–130 eggs, which hatch within 8–16 hours [16]. Body parts of flies that serve as media for disease transmission include the legs, wings, body hairs, and mouthparts [9]. In addition, fly regurgitation and feces also have the potential to transmit various diseases [16].

Flies play a detrimental role as vectors of diseases such as cholera, diarrhea, food poisoning, dysentery, and typhoid fever [17]. This is consistent with Syahrizal (2017), who reported that flies pose health problems by carrying various pathogenic microorganisms and harmful germs [18]. Flies habitually move between dirty or contaminated sites that serve as habitats for disease-causing microorganisms [19], and subsequently contaminate the surfaces on which they land, including food and beverages, as observed in cases of diphtheria, diarrhea, helminthiasis, and salmonellosis [20]. Therefore, flies are considered major vectors of foodborne diseases capable of transmitting bacteria, fungi, parasites, and viruses [21]. Flies may also cause discomfort, visual pollution, skin irritation, reduced comfort, and decreased appetite [22].

In 2020, the coverage of diarrhea cases in Indonesia across all age groups reached 44.4%, while among children under five years of age it was 28.9%. Provincial disparities in diarrhea case management for all age groups ranged from 4.9% in North Sulawesi to 78.3% in West Nusa Tenggara (NTB). For diarrhea case management among children under five, provincial disparities ranged from 4.0% in North Sulawesi to 61.4% in West Nusa Tenggara, while East Java recorded a coverage of 41.5% [23]. A study by Saiful (2019) reported that out of 18 chicken meat samples examined, 9 samples were contaminated with Escherichia coli. Furthermore, among 13 beef samples examined, 38% were found to be contaminated with Escherichia coli [24]. Another study by Putri (2019) reported that flies are highly attracted to food sources such as milk, sugar, human feces, processed foods, blood, animal feces, and carcasses [25].

A rapid and effective method for assessing fly density is the use of a fly grill [26]. The advantages of the fly grill include its construction from easily obtainable materials, simple manufacturing process, low cost, and higher accuracy due to calculations based on grill blocks [27,28]. Fly grills are generally constructed from arranged wooden slats and are effective for measuring fly density [17]. Markets represent one of the most favorable environments for flies, as they contain various dry foods, wet foods, standing water, waste, fruits, vegetables, equipment, and other materials. Therefore, this study aimed to assess fly density levels in a market area located in the center of Malang City. The selected market is the one closest to the urban core of the city.

MATERIALS AND RESEARCH METHODS

This study employed a quantitative approach with an exploratory observational research design. The study observed fly density as an indicator of sanitation conditions in a market [29]. The results of the observations were recorded using observation sheets and subsequently presented in the form of frequency distribution tables describing fly density levels. The survey method applied a cross-sectional approach, in which measurements were conducted at a single point in time based on the existing conditions.

The research was conducted at Traditional Market X located in Malang City, East Java. Data collection was carried out on Friday, October 13, 2023.

The population in this study comprised all trading areas within Traditional Market X, Malang City. The samples consisted of four selected locations: the beef stall, the chicken meat stall, the goat meat and fish stall, and the food and beverage stall. At each of these locations, measurements of temperature, humidity, and fly density were performed.

The instruments and materials used in this study included a fly grill, a hygrothermometer, a timer, stationery, and observation sheets. The fly grill used by the researchers was made of wooden slats with a width of 2 cm, a thickness of 1 cm, and a total length of 80 cm. The number of wooden slats composing the fly grill ranged from 16 to 26 pieces. The fly grill was placed at each selected location to measure fly density levels [14].

Data processing and analysis in this study involved univariate analysis using frequency distribution to identify fly density levels at Traditional Market X, Malang City. Fly density measurements obtained using the fly grill were categorized according to the criteria presented in Table 1 [12].

Table 1. Categories of Fly Density Levels

Average Number of Flies (individuals)	Fly Density Category	Description
0–2	Low	Not considered a problem
3–5	Moderate	Observation of potential fly breeding sites is required
6–20	High / Dense	Observation of fly breeding sites is required and, if possible, planning of fly control measures
≥ 21	Very high / Very dense	Immediate observation of fly breeding sites and implementation of fly control measures are strongly required

RESEARCH RESULTS AND DISCUSSION

The study was conducted on 13 October 2022 at Market X in Malang City, as fly populations as disease vectors are often concentrated in public places such as markets [9]. The fly grill was placed at predetermined points for 30 seconds for each measurement, and measurements were repeated 10 times at each point. The assessment of fly density was carried out at four locations within the market that were suspected to have high levels of fly density. The first location was the beef stall area, the second was the chicken meat stall area, the third was the goat meat and fish stall area, and the fourth was the food and beverage stall area. At all four locations, measurements of temperature, humidity, and fly density were conducted.

Fly density measurement using a fly grill was based on the behavior of flies, which tend to alight on edges or sharply angled surfaces [29]. This finding is consistent with previous studies [14,30] stating that flies commonly land on flat surfaces, hanging ropes, or vertical bars, as well as in shaded, wet, humid, foul-smelling, and dirty areas, particularly around food sources or breeding sites. In addition, flies are highly attracted to fruits, fresh meat, fresh fish, wet foods, feces, and waste [31]. Flies are strongly drawn to pungent odors, foul smells, piles of moist waste, vegetable residues, and leftover fish or meat scraps [9]. Furthermore, the presence of

flies is also influenced by environmental temperature and humidity conditions within the market.

Table 2. Temperature Measurements at Market X, Malang City

Measurement	Morning (°C)	Daytime (°C)	Afternoon (°C)
1	28,22	30,88	29,13
2	27,24	29,62	28,78
3	28,18	30,02	29,18
4	27,83	30,45	29,13
Rata-rata	**27,87**	**30,24**	**29,06**

Based on Table 2, the results of temperature measurements at Market X in Malang City showed that the highest temperature occurred during the daytime, reaching 30.88 °C in the first measurement, while the lowest temperature was recorded in the morning at 27.24 °C in the second measurement. The average temperatures obtained were 27.87 °C in the morning, 30.24 °C during the daytime, and 29.06 °C overall. These temperature conditions fall within a range suitable for fly reproduction. Such temperatures are considered highly favorable for the survival, development, and growth of insects [32]. Temperature plays a crucial role in influencing the reproduction of animals or insects [33]. Temperature is closely related to climate, as climate strongly affects all aspects of ecosystems, including the behavior of living organisms and their physiological responses. Climatic conditions may vary over time in response to global warming.

Table 3. Humidity Measurements at Market X, Malang City

Measurement	Morning (°C)	Daytime (°C)	Afternoon (°C)
1	66,2	61,2	65,0
2	70,3	62,5	65,4
3	70,2	63,2	66,5
4	68,5	62,2	65,0
Average	**68,8**	**62,28**	**65,48**

Based on Table 3, the results of humidity measurements at Market X in Malang City showed that the highest humidity percentage was recorded in the morning, at approximately 70.3% during the second measurement, while the lowest humidity percentage occurred during the daytime, at approximately 61.2% in the first measurement. The measurements indicated that the average humidity at Market X in Malang City was 68.8% in the morning, 62.28% during the daytime, and 65.48% in the afternoon. These findings indicate that the humidity conditions in the market were within a range suitable for the survival and development of flies. Humidity conditions in the market are influenced by ambient air conditions, which are also closely related to air temperature. Essentially, air humidity plays a significant role in affecting insect development, reproduction, activity, and growth [34].

Based on Tables 2 and 3, it is evident that environmental temperature and humidity at Market X in Malang City are interrelated. In the morning, lower average temperatures were accompanied by higher average humidity levels, whereas during the daytime, higher average temperatures were associated with lower average humidity levels. These findings are consistent with previous studies [31,35], which reported that environmental temperature and humidity are closely related in influencing fly density in market environments. Higher temperatures tend to reduce surrounding humidity, while lower temperatures are associated with increased humidity [31,35]. As air temperature increases, humidity decreases, leading to reduced (suboptimal) fly activity [36]. An increase in humidity to 90% combined with a relatively high temperature of 32 °C has been shown to enhance the reproductive capacity of flies, facilitating the development from larval stages to adults [37]. Flies exhibit optimal activity at temperatures ranging from 20–25 °C, with activity decreasing at temperatures below 10 °C or above 40 °C, and mortality occurring at temperatures exceeding 45 °C [14].

Table 4. Results of Fly Density Measurements at Market X, Malang City

Location	Time	Total (Highest Measurement Value)	Average	Category
Beef stall	Morning	15	3	Moderate
	Daytime	3	0,6	Low
	Afternoon	1	0,2	Low
Chicken meat stall	Morning	1	0,2	Low
	Daytime	6	1,2	Low
	Afternoon	16	3,2	Moderate
Goat meat and fish stall	Morning	6	1,2	Low
	Daytime	9	1,8	Low
	Afternoon	44	8,8	High
Food and beverage stall	Morning	0	0	Low
	Daytime	0	0	Low
	Afternoon	2	0,4	Low

The identification of fly density refers to an indicator that represents the number of flies present at a specific location, expressed through an index, with the research instrument used in this study being a fly grill. This study was conducted at four different points to measure fly density. Observations at each point were carried out for 30 seconds and repeated 10 times. Fly density measurements were conducted at three different time periods, namely in the morning, midday, and afternoon. Fly density measurements using a fly grill conducted in the morning yielded different average results at each observation point.

Based on Table 4, the results of fly density measurements at Market X in Malang City showed that the highest total fly density was recorded at the goat meat and fish stall area, with measurement values ranging from 6 to 44 flies. In contrast, the lowest total fly density was observed at the food and beverage stall area, with measurement values ranging from 0 to 2 flies. The range of the highest total fly counts at these locations is consistent with the average values obtained, where the highest average was found at the meat and fish stalls during the afternoon (8.8), while the lowest average was recorded at the food and beverage stalls during the morning and midday (0). Most of the measurement results fell into the low category; however, two measurements were classified as moderate, namely at the beef stall area in the morning and at the chicken meat stall area in the afternoon, while one measurement was classified as high at the goat meat and fish stall area in the afternoon.

At the first location, the beef stall area, the highest average fly density occurred in the morning and was classified as moderate. This moderate level can be attributed to the preference of flies for meat and offal present at the stall. At the second location, situated in front of the chicken meat stall area, the highest average fly density was recorded in the afternoon and was also categorized as moderate. Chicken meat stalls are highly attractive to flies, as meat stalls generally provide favorable conditions for fly presence. At the third location, adjacent to the goat meat and fish stall area, the highest average fly density was recorded in the afternoon and was classified as high. This represented the highest fly density measurement recorded at Market X in Malang City. This condition is likely due to the texture of goat meat and fish, which tends to be moist. These findings are consistent with a study by Fitri (2020), which reported that flies are strongly attracted to organic materials, moist environments, waste, garbage, and food sources [(38)]. The fourth location, the food and beverage stall area, showed the highest average fly density in the afternoon but remained within the low category. This is likely because the area is relatively dry and crowded, making it less attractive to flies. Although a variety of foods are sold in this area, vendors maintain a high level of cleanliness. Overall, based on the four sampling points, the average fly density fell within the moderate category, indicating the need for preventive measures targeting fly breeding sites. Therefore, environmental conditions play a significant role in determining the level of fly density in a given area.

A study by Husin (2017) demonstrated that higher numbers of flies are associated with higher fly density levels, indicating poor or unhealthy sanitation conditions within the market environment [(39)]. Fly density increases due to the presence of sites that attract flies to land and breed, such as scattered waste around vendor stalls, fruit, vegetable, and meat

selling areas, as well as foul-smelling food residues [29]. The maximum allowable fly density is 30 flies per grill net in waste disposal and drainage areas [40].

Several diseases that potentially originate from market environments are related to hygiene and sanitation, as poor environmental conditions can adversely affect the health of surrounding communities [41]. The presence of fly populations is closely associated with the occurrence and spread of diseases transmitted by infectious agents originating from such environments [42]. Several types of flies that pose significant public health concerns include green flies, blue flies, latrine flies, and houseflies [43]. Flies play a role in transmitting human pathogens, including protozoa, cysts, enteroviruses, and bacteria [19]. This is consistent with the findings of Hutasuhut (2022), which reported that flies are commonly regarded as disease-carrying vectors affecting humans [44]. Flies prefer dirty environments such as garbage disposal sites, livestock enclosures, fecal matter, and latrines, and they can transfer bacteria and pathogens to food and beverages consumed by humans. Fly vectors can cause the spread of diseases such as diarrhea, cholera, typhoid fever, and other gastrointestinal diseases associated with poor environmental health conditions.

Environmental sanitation in market areas is critically important, as markets are public facilities that facilitate the rapid spread of diseases, particularly through food, beverages, water, and air [45]. Since markets are frequently visited by the public, they are required to maintain cleanliness. Market roofs should be leak-free and allow proper water drainage. Floor construction should be level, non-slip, easy to clean, and impermeable, typically made of ceramic materials. Market walls should be clean and light-colored. Handwashing facilities should be available in several areas, and waste bins should be placed at strategic locations throughout the market. Poorly managed market waste can attract flies, increasing the likelihood of contact between flies and humans [44]. Drainage systems at meat vendor areas should be adequately maintained. Market facilities and infrastructure should be managed optimally by both market authorities and local governments to ensure comfort for vendors and visitors. These findings are consistent with a study by Flies (2019), which emphasized that environmental conditions play a crucial role in the development and spread of diseases [1]. Markets are categorized as public spaces, and traditional markets play a vital role in human life as centers for trade and daily necessities [46].

Based on the results of this study, fly density levels at Market X in Malang City were found to fall within the moderate and high categories, indicating the need for monitoring fly breeding sites and implementing fly control strategies. Market environmental sanitation involves efforts to monitor, prevent, control, and manage environmental factors that may contribute to disease transmission within market areas [7]. Environmental health improvement measures and protective actions should be implemented in market areas that do not meet health standards, along with vector control targeting disease-carrying animals such as flies [7]. Routine fly control through monitoring fly density is essential to assess the potential risk of fly-borne diseases [14].

Fly density control aimed at reducing fly populations in market environments can be implemented through several approaches, including biological control measures such as policy implementation for the use of insecticides to reduce disease vectors, technical control measures such as installing fly traps, and policy-based controls through regulations on waste accumulation and management in markets [14]. Fly control through improvements in environmental sanitation and hygiene practices is considered more effective and provides longer-lasting benefits [47]. A study by Rahim et al. (2020) reported that fly density was very high at waste disposal sites within market environments due to inadequate waste transportation systems and the use of uncovered waste containers. Operational waste collection services for organic waste in markets should be conducted at least once daily, or with rotation intervals of 1–4 days, to prevent decomposition caused by waste accumulation in market areas [48].

CONCLUSIONS AND RECOMMENDATIONS

The fly density measurements at the four observation points in Market X, Malang City, ranged from low to moderate and high categories. Although these conditions do not currently indicate a critical public health problem, they underline the importance of continuous monitoring of potential fly breeding sites and the implementation of strategic control measures within the market environment. Fly presence is influenced by environmental factors, particularly temperature and humidity, which support fly survival and reproduction. Therefore, efforts to control fly populations should prioritize improvements in environmental sanitation through proper waste management practices, including preventing indiscriminate waste disposal, maintaining routine environmental cleaning, and ensuring regular market waste collection. Market vendors should be encouraged to dispose of waste in designated containers. Where necessary, the use of insecticides or fly control devices may be applied as complementary measures. These interventions should be implemented in an integrated and sustainable manner to reduce fly breeding potential and maintain a healthy market environment.

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