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Food and Water Safety Monitoring at Pattimura Airport, Ambon City

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ABSTRACT

According to WHO, in 2024, unsafe food is estimated to potentially cause 600 million cases of foodborne illnesses and 420,000 deaths. In 2017, 106 cases of foodborne illnesses in 24 provinces were confirmed by the National Agency of Drug and Food Control (BPOM). This research aims to evaluate temporary waste disposal sites; presence of flies; sanitation hygiene; room sanitation; chemical parameter testing in food samples; and chemical, biological, and physical parameter testing in drinking and clean water. The type of research used is descriptive research. This study aims to observe sanitation and laboratory examination results of food samples, drinking water samples, clean water samples, and ambient air samples at Pattimura Ambon Airport. The research design used is cross-sectional. Testing of water and food samples was conducted at the Environmental Health and Disease Control Technical Institute (BTKLPP). Based on the evaluation results, compliance with the use of work clothing by workers did not meet standards. In addition, the construction of restaurant walls and floors also did not meet standards, namely, they were not waterproof.

1. INTRODUCTION

Foodborne diseases are conditions caused by the consumption of food contaminated with microorganisms such as parasites, viruses, bacteria, physical agents, natural toxins, and chemicals. Foodborne diseases are a major concern because they threaten public health worldwide [1, 2]. According to the WHO in 2024, issues with unsafe food have the potential to cause 600 million cases of foodborne diseases and 420,000 deaths [3]. In 2017, 106 foodborne disease incidents affected 24 provinces and were confirmed by the Food and Drug Monitoring Agency (BPOM) [4]. These incidents were caused by homemade food (49.15%), ready-to-eat processed foods (20.34%), and catering services (15.25%) [5].

Lack of attention poor hygiene and environmental sanitation can affect the proliferation of microorganisms [6]. One microorganism that indicates environmental contamination is Escherichia coli [7]. Food contamination by Escherichia coli generally occurs through the fecal-oral route, where pathogens found in feces enter food through intermediary hosts such as hands, insects, the environment, and water. Hygiene measures consider various aspects, such as the Food Handling Place (FHP), sanitation facilities at the FHP, the food received until it is served, the condition of the equipment used, and the workers who handle the food directly [8].

Interventions in public health aim to prevent disease recurrence and manage it. Prevention includes controlling the spread of diseases, hygiene, sanitation, and community service structures to improve mental and physical health status and potentially extend life expectancy [9]. In this regard, special attention to sanitation facilities is crucial. If sanitation facilities are inadequate and do not meet health standards, the risk of contamination increases. Additionally, food can also be contaminated by disease-causing microorganisms, where the food served becomes an intermediary for microorganisms [10].

Airports play a significant role in preventing the spread of various diseases that can become epidemics. One of the supporting facilities provided by airports is restaurants that serve food to the public. There is a possibility that the food produced can cause health problems or disease outbreaks. Therefore, the hygiene and sanitation of food providers at airports must be strictly monitored to avoid the potential spread of foodborne diseases [11]. This study aims to observe cleanliness and laboratory test results microbiological and chemical analysis results of food samples, drinking water samples, and air samples at Pattimura Ambon Airport. Thus, it is expected to provide useful information in improving the

hygiene and sanitation of food providers at the airport [11].

2. METHOD

The type of research used is descriptive research. This study aims to observe sanitation and laboratory examination results of food samples, drinking water samples, clean water samples, and ambient air samples at Pattimura Ambon Airport. The research design used is cross-sectional, and the sources of data are primary and secondary data.

The variables measured in this study are the existing temporary waste disposal sites; the presence of flies; sanitary hygiene; space sanitation; examination of chemical parameters in food samples; and examination of chemical, biological, and physical parameters in drinking water and clean water. Parameter testing was carried out on two restaurants by random sampling with the names X and Y disguised. Testing of water and food samples was carried out at the Technical Center for Environmental Health and Disease Control (BTKLPP) in Ambon City. Data collection was conducted using the grab sampling technique in 2023 at the entrance of Pattimura Ambon Airport, Maluku Province. The samples in this study are the Food Handling Places (FHP) located adjacent to the toilets and the prayer room in the airport's arrival area.

3. RESULT

The first monitoring effort was carried out with the existing temporary waste storage around Pattimura airport. The aspects reviewed were temperature, humidity, and type of waste. The existing results are presented in Table 1.

The activity of vectors such as Mucus domestica and flies is associated with a combination of temperature and humidity. These vectors are known to prefer to live and reside in environments with average temperatures between 20 - 25℃ with humidity < 60% and avoid extreme heat and freezing temperatures [12-14]. Table 2 describes the presence of flies around Pattimura airport.

Table 1. Results of existing waste temporary storage at Pattimura airport, Ambon City, Indonesia in 2023

No.	Measurement Parameters	Results	Description
1	Temperature	30℃	Slightly high, and should be monitored
2	Humidity	60%	At the upper limit, should be controlled
3	Type of waste	Dry waste	Meets standard practice for waste sorting

Table 2. Results of existing flies at Pattimura airport, Ambon City, Indonesia in 2023

Observation Time	Repetitions (Flies)										Total of Flies
	1	2	3	4	5	6	7	8	9	10	
30 seconds	1	1	1	1	1	1	1	1	1	1	10

The results of environmental condition monitoring were followed by observations to determine fly density using a 10-session repetition method, as shown in Table 2. Observations in each session were conducted for 30 seconds to count the number of flies landing, resulting in a total of 10 flies from 10 repeated sessions, with one fly landing in each session. The presence of flies at Pattimura Airport Ambon is categorized as low. Observations of the number of flies in 30-second intervals were made to ensure more accurate and representative counting results. The choice of this interval considers the behavior of flies that tend to move quickly in a short period of time, so longer counts can increase the possibility of inaccurate data due to flies moving. This method is also in accordance with the standard of short observations that are often used in insect ecology research in open environments.

Fly infestations do not occur randomly; their successful reproduction depends on the interaction between temperature, humidity, and the type of available waste. Each fly species selects breeding sites based on interactions and adaptations to its body. Temperature acts as a conductor, regulating the pace of each developmental stage. Specific temperature ranges are crucial for egg hatching, larval growth, and the emergence of adult flies. Temperatures that are too low or too high beyond the optimal range for each fly species (e.g., 20-30℃ for house flies, 25-28℃ for fruit flies) can slow down or even halt the process [15, 16].

Humidity is another factor that attracts flies to colonize. Just like plants needing the right amount of water, flies depend on humidity to maintain their internal balance. Tomberlin highlights how eggs and larvae, the fragile seedlings of fly populations, require high humidity (70-90%) to develop properly and avoid desiccation [17]. Adult flies, being experienced veterans, can tolerate a wider range, demonstrating their adaptability. This interaction becomes more complex as high humidity can protect flies from extreme temperatures but can also trap heat and become detrimental in hot conditions [18].

Table 3. Results of existing sanitation inspection at restaurant X Pattimura airport, Ambon City, Indonesia in 2023

Variable	Result of Sanitation Inspection	Description
Food handlers		
Personal hygiene	Meet standard	
Health of food handlers in the last month	Healthy	
Wearing work clothes while working	No	Not wearing work clothes
Food storage area		
Clean	Yes	
Covered/protected from dust/insects/other disturbances	Yes	The storage area prevents food contamination

Requirements for eating/Drinking utensils		
Cleanliness of glasses/spoons/forks	Meet standard	
Storage method	Meet standard	
The dining table is always kept clean	Yes	
Dining Area Sanitation		
Waterproof floor	No	
Waterproof walls	No	
Cleanliness of the ceiling	Meet standard	
Sufficient room ventilation	Meet standard	
Handwashing station made of porcelain	Meet standard	
Adequate lighting	Meet standard	
Always maintains general cleanliness.	Meet standard	
Food storage requirements		
Different types of food stored separately	Yes	
Made of strong and clean materials	Yes	Equipped with food storage containers
Adequate supply of clean water	Yes	

Table 4. Results of existing sanitation inspection at restaurant Y Pattimura airport, Ambon City, Indonesia in 2023

Variable	Result of Sanitation Inspection	Description
Food handlers		
Personal hygiene	Meet standard	
Health of food handlers in the last month	Healthy	
Wearing work clothes while working	No	Not wearing work clothes
Food storage area		
Clean	Yes	
Covered/protected from dust/insects/other disturbances	Meet standard	
Requirements for eating/Drinking utensils	Yes	The storage area prevents food contamination
Cleanliness of glasses/spoons/forks		
Storage method	Meet standard	
The dining table is always kept clean	Meet standard	
Dining Area Sanitation	Yes	
Waterproof floor		
Waterproof walls	No	
Cleanliness of the ceiling	No	
Sufficient room ventilation	Meet standard	
Handwashing station made of porcelain	Meet standard	
Adequate lighting	Meet standard	
Always maintains general cleanliness	Meet standard	
Food Storage Requirements	Meet standard	
Different types of food stored separately		
Made of strong and clean materials	Yes	
Adequate supply of clean water	Yes	Equipped with food storage containers
Food handlers	Yes	

Table 5. Results of the chemical parameters checks on food samples at restaurant X and Y Pattimura airport, Ambon City, Indonesia in 2023

Sampling Points	Sampling Code	Result of Measurement			
		Borax	Formalin	Rhodamin B	Methyl Yellow
Restaurant X					
Fried noodles	K.314	Negative	Negative	Negative	Negative
Stir-fried tempeh	K.315	Negative	Negative	Negative	Negative
Fish with sauce	K.316	Negative	Negative	Negative	Negative
Restaurant Y					
Meatballs	K.317	Negative	Negative	Negative	Negative
Tofu with sauce	K.318	Negative	Negative	Negative	Negative
Fried noodles	K.319	Negative	Negative	Negative	Negative
Fish with sauce	K.320	Negative	Negative	Negative	Negative

However, this stage is incomplete without the main ingredient: the type of waste. Fly species have evolved to specialize in certain types of waste, with specific compositions and decomposition products attracting them and providing necessary nutrients for their developing offspring. For instance, house flies thrive on decaying organic matter, while fruit flies prefer sugary substrates [19]. Research found that the presence of certain volatile compounds emitted from decaying waste plays a significant role in attracting flies and influencing their egg-laying behavior [20]. Furthermore, Tables 3 and 4 are the results of the sanitation inspection at restaurant X and Y.

The results of Tables 3 and 4 on the sanitation inspection for foodborne disease control were based on the standardization criteria for food handlers, food storage areas for food to be served, eating/drinking utensils, dining area sanitation, and raw material storage areas in restaurants X and Y. Based on the inspection results, these restaurants have met

the requirements for restaurants or eating places as stipulated in the Minister of Health Decree Number 942 of 2003 [8].

The food industry is susceptible to physical, chemical, and biological contamination that is toxic to the body, thus requiring special attention from industry management to food safety systems [5]. Given the existing and emerging issues in food safety/quality management, this study aims to evaluate traditional and modern/new approaches to enhance Hazard Analysis and Critical Control Points (HACCP), food safety, and quality management in food and agricultural systems [21]. Table 5 provides the results of the chemical parameter checks on food samples at restaurants X and Y.

The laboratory examination results in Table 5 are in accordance with the Food Additive standards regulated in the Ministry of Health Regulation number 033 of 2012 [22] and have been declared safe through PPOMN No. 07/MM/2000, with no harmful additives found. It states that these dangerous Food Additives (BTP) can directly affect health, causing symptoms such as a burning sensation in the throat, irritation, headache, and nausea, while indirect (chronic/cumulative) effects include respiratory system disorders, kidney and liver disorders, reproductive system disorders, cancer, and death [23].

Ministry of Health Regulation number 033 of 2012 and No. 239/Menkes/Per/V/85 [24] also regulate prohibited Food Additives such as Borax, Formalin, Rhodamin B, and Methyl Yellow. The development of information technology and globalization has influenced lifestyles, especially in the concept of more practical, instant, and long-lasting consumption patterns [25], leading people to create techniques to preserve food, one of which is adding borax and formalin as food preservatives [26]. Rhodamin B and Methyl Yellow are red and yellow dyes used in the textile industry, and if consumed by humans, they can cause nausea, vomiting, diarrhea, cancer, cardiovascular and kidney diseases, liver function disorders, hormonal imbalance, premature birth, decreased immunity, nervous system development disorders, mental health disorders, learning disabilities/cognitive dysfunction, stomach issues, and damage to all vital organs and human organ systems [27, 28]. Table 6 explains the results of the microbiological parameter examination on food samples in restaurants X and Y.

Table 6. Results of the microbiological parameters checks on food samples at restaurant X and Y Pattimura airport, Ambon City, Indonesia in 2023

Sampling Points	Sampling Code	Threshold	Result of Measurement	Description
			Total Germ Plate Count	
Restaurant X				
Fried noodles	B.251		254×10^3 colony /gram	Meets criteria
Stir-fried tempeh	B.252	10^5 - 10^6 colony / gram	0	Meets criteria
Fish with sauce	B.253		40	Meets criteria
Restaurant Y				
Meatballs	B.254		216×10^3 colony /gram	Meets criteria
Tofu with sauce	B.255	10^5 - 10^6 colony / gram	0	Meets criteria
Fried noodles	B.256		90	Meets criteria

Table 7. Results of the physical and chemical parameters checks on drinking water samples at restaurant X and Y Pattimura airport, Ambon City, Indonesia in 2023

Parameters	Units	Threshold	Result of Measurement		Description
			K.311 Restaurant X	K.312 Restaurant Y	
PHYSICAL					
Turbidity	NTU	5	0.29	0.62	Meets criteria
Taste	-	Tasteless	Tasteless	Tasteless	Meets criteria
Odor	-	Odorless	Odorless	Odorless	Meets criteria
Temperature	℃	Ambient temperature ±300℃	29	29.1	Meets criteria
Total dissolve solid	mg/l	500	71.8	192.8	Meets criteria
Chemical					
Dissolved Iron (Fe)	mg/l	0.3	< 0.0339	< 0.0339	Meets criteria
Detergent	mg/l	0.05	< 0.001	< 0.001	Meets criteria
Hardness as $CaCO_3$	mg/l	500	76	172	Meets criteria
Chloride (Cl)	mg/l	250	34.599	69.198	Meets criteria
Nitrite (NO_2)	mg/l	3	0.0389	0.0402	Meets criteria
Dissolved Zinc (Zn)	mg/l	3	0.1064	0.0545	Meets criteria
pH	-	6-9	7.40	7.20	Meets criteria
Ammonia (NH_3)	mg/l	1,5	0.0191	< 0.0027	Meets criteria
Sulfate (SO_4^{2-})	mg/l	250	25.186	23.809	Meets criteria
Dissolved Copper (Cu)	mg/l	2	< 0.0335	< 0.0335	Meets criteria
Dissolved Manganese (Mn)	mg/l	0.4	< 0.0339	< 0.0339	Meets criteria
$KMnO_4$	mg/l	10	1.264	1.264	Meets criteria

Table 6 shows the results of microbiological examinations at both restaurants, represented by six food samples. Microbiological testing results show the Total Plate Count (TPC) of various food samples at Restaurants X and Y. TPC is used as an indicator of food hygiene quality and potential microbial contamination. The threshold value of 10^5-10^6 colonies/gram is based on applicable food safety standards, which indicate that food with TPC below this value is considered safe for consumption. Food samples such as fried noodles at Restaurant X (254×10^3) met the safe criteria

despite having TPC values close to the upper limit. In contrast, fried tempeh and fish with sauce had very low TPCs (0 and 40 colonies/gram), indicating a high level of hygiene. At Restaurant Y, meatballs had a TPC value of 216×10^3, which also met the safety standard. These results suggest that food handling procedures in both restaurants generally meet the recommended hygiene criteria. However, more in-depth analysis is required to ensure the consistency of these results across the entire food production process. Overall, the test indicating that they have met the Hygiene and Sanitation Standards for Catering Services and the Maximum Microbial Limits in Food as regulated in Ministry of Health Regulation No. 1096/Menkes/Per/VI/2011 [8] and BPOM Regulation No. 13 of 2019 [29]. The total plate count threshold is the agar plate count of bacteria from food and products performed on specific growth media (e.g., plate count agar) using standardized equipment conditions, handling, incubation time, temperature, and procedures [30]. Table 7 describes the results of drinking water inspections at restaurants X and Y.

Table 7 regarding the chemical examination of drinking water at Restaurant X and Restaurant Y, Pattimura Airport, Ambon in 2023 has been declared to meet the required standards according to the mandatory parameters outlined in the appendix of Ministry of Health Regulation No. 492/MENKES/PER/IV/2010 on drinking water quality standards [31]. The contamination of drinking water with toxic chemicals can disrupt the body's regulatory system, increasing the body's workload and posing a risk of chronic health disorders. Even though the concentration of contaminants is small, it can potentially bind with other toxic elements and increase the risk of health disorders [32]. Table 8 explains the results of the microbiological parameter examination of drinking water samples from restaurants X and Y.

Table 8. Results of the microbiology parameters checks on drinking water and drinking water samples at restaurant X and Y Pattimura airport, Ambon City, Indonesia in 2023

Microbiology Parameters	Units	Threshold	Result of Measurement B. 248 Restaurant. X		Description
Total *Coliform*	MPN/100 ml	0	< 1.1	< 1.1	Meets criteria
E. coli	MPN/100 ml	0	< 1.1	< 1.1	Meets criteria

The examination results of Restaurant X presented in Table 7 regarding the microbiology of drinking water has been declared to meet the required standards according to the mandatory microbiological parameters listed in Ministry of Health Regulation No. 492/MENKES/PER/IV/2010 [31] with a limit of <1.1 considered as 0/meeting the requirement. Water is an essential element for life, but the optimal temperature also allows bacteria to colonize and multiply, making water a medium for pathogen transmission [33]. Coliform bacteria are found in the environment and the feces of warm-blooded animals and humans, living at 32-37℃. The presence of coliforms in drinking water is an indicator of pathogens in the water system that can cause health symptoms related to digestive disorders [34, 35]. *Escherichia coli* (*E. coli*) is a gram-negative bacillus that is part of the normal intestinal flora. Diseases caused by Escherichia coli can resolve on their own, but in more severe cases, they can cause intestinal and extraintestinal diseases in humans, including diarrhea and dysentery, and even Hemolytic Uremic Syndrome (HUS), especially in children and the elderly [36, 37]. Table 9 explains the results of the physical and chemical parameters examination of clean water samples from restaurants X and Y.

Table 9. Results of the physical and chemical parameters checks on clean water samples at restaurant Y Pattimura airport, Ambon City, Indonesia in 2023

Parameters	Units	Threshold	Result of Measurement		Description
			K.311 Restaurant X	K.312 Restaurant Y	
Physical					
Turbidity	NTU	5	25	0.74	Meets criteria
Taste	-	Tasteless	Tasteless	Tasteless	Meets criteria
Odor	-	Odorless	Odorless	Odorless	Meets criteria
Temperature	℃	Ambient temperature ±30℃	29	29.1	Meets criteria
Total dissolve solid	mg/l	500	71.8	192.8	Meets criteria
CHEMICAL					
Dissolved iron (Fe)	mg/l	0.3	0.3	< 0.0339	Meets criteria
Detergent	mg/l	0.05	0.05	< 0.001	Meets criteria
Hardness as $CaCO_3$	mg/l	500	500	76	Meets criteria
Chloride (Cl)	mg/l	250	250	34.599	Meets criteria
Nitrite (NO_2)	mg/l	3	3	0.0389	Meets criteria
Dissolved zinc (Zn)	mg/l	3	3	0.1064	Meets criteria
pH	-	6-9	9	7.40	Meets criteria
Ammonia (NH_3)	mg/l	1,5	1.5	0.0191	Meets criteria
Sulfate (SO_4^{2-})	mg/l	250	250	25.186	Meets criteria
Dissolved copper (Cu)	mg/l	2	2	< 0.0335	Meets criteria
Dissolved Manganese (Mn)	mg/l	0.4	0.4	< 0.0339	Meets criteria

The results in Table 9 are the measurements of clean water used at the restaurants in Pattimura Airport Ambon, with criteria established on the water quality monitoring sheet as per hygiene sanitation standards in Minister of Health Regulation (Permenkes) No. 32 of 2017, and have passed the conditional test [38]. Water is an element widely used in the food industry, starting from the raw material stage, production, distribution, and consumption. The main dimensions that

water must be availability, access, stability, and quality, but in reality, its use is still underestimated. This assumption results in a lack of attention from the industry to the management of clean water to be used, thereby potentially spreading pathogens through water that can cause diseases [39]. Pathogens found in biofilms, such as nontuberculous mycobacteria (NTM) and Legionella bacteria, are the leading causes of hospitalization and death due to waterborne diseases in the United States. Routes of exposure to waterborne pathogens include swimming, drinking water, bathing, or inhaling water containing aerosols [40]. Table 10 explains the results of the microbiological parameters examination of clean water samples from restaurants Y.

Table 10. Results of the microbiological parameters checks on clean water samples at restaurant Y Pattimura airport, Ambon City, Indonesia in 2023

Microbiology Parameters	Units	Threshold	Result of Measurement B. 249 Restaurant Y		Description
Total *Coliform*	MPN/100 ml	0	< 1.1	< 1.1	Meets criteria
Escherichia coli	MPN/100 ml	0	< 1.1	< 1.1	Meets criteria

The testing conducted by taking clean water samples at Restaurant Y (Table 10) shows that the clean water meets the microbiological threshold parameters set by Minister of Health Regulation (Permenkes) No. 32 of 2017 on Environmental Health Quality Standards and Water Health Requirements for Hygiene Sanitation, Swimming Pools, Solus per Aqua, and Public Baths [38], with an indication that <1.8 is considered 0 or meets the requirements. Water used in the industry, especially the food industry, can directly contaminate food through microorganisms carried by clean water. These microorganisms can then colonize and multiply on food or objects used in the processing [41]. Particularly on raw food materials, microorganisms can survive for years even after being cleaned, adapting to environmental conditions.

4. CONCLUSION

The results of food and water safety monitoring activities found that the hygiene aspects of the handlers (compliance in using work clothes) were not following the established standards. Room sanitation is also not following established standards, especially in the construction of floors and walls that are not watertight. Food and water safety is something that needs to be done, and efforts to realize it by implementing good personal hygiene and space sanitation. Handler compliance and construction feasibility are recommendations that need to be followed up in this study.

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