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Total Plate Count of Turmeric-Tamarind Herbal Medicine Sold in Mojayan Traditional Market, Klaten, Indonesia

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ABSTRACT

This study assessed microbial contamination in turmeric-tamarind herbal medicine (*jamu kunyit asam*) sold in Mojayan Traditional Market, Klaten, using the Total Plate Count (TPC) method. This descriptive observational study analyzed three samples collected from different vendors. Each sample was diluted, cultured on Plate Count Agar (PCA), and incubated at 37 °C for 24 hours to determine microbial colony counts. The microbial load ranged from 1.92×10^6 to 2.55×10^6 CFU/mL, all below the maximum permissible limit of 5×10^7 CFU/mL as regulated by BPOM (Regulation No. 29 of 2023). These findings indicate that the products are microbiologically safe for consumption. However, further preventive measuresincluding improved hygiene practices, use of clean water, and regular microbial surveillance are recommended to reduce long-term risks, especially for vulnerable populations.

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ABSTRAK

Penelitian ini mengevaluasi cemaran mikroba pada jamu kunyit asam yang dijual di Pasar Tradisional Mojayan, Klaten, menggunakan metode Total Plate Count (TPC). Penelitian ini merupakan studi observasional deskriptif yang menganalisis tiga sampel dari pedagang berbeda. Setiap sampel diencerkan, ditanam pada media Plate Count Agar (PCA), lalu diinkubasi pada suhu 37 °C selama 24 jam untuk menghitung jumlah koloni mikroba. Hasil menunjukkan jumlah mikroba berkisar antara 1,92 × 10^6 hingga 2,55 × 10^6 CFU/mL, seluruhnya berada di bawah batas maksimum yang diizinkan sebesar 5 × 10^7 CFU/mL sesuai Peraturan BPOM Nomor 29 Tahun 2023. Temuan ini menunjukkan bahwa produk jamu tersebut aman dikonsumsi secara mikrobiologis. Namun, tindakan pencegahan seperti peningkatan kebersihan, penggunaan air bersih, dan pengawasan mikroba secara berkala tetap disarankan untuk menurunkan risiko jangka panjang, terutama bagi kelompok rentan.

Kata Kunci:
Jamu kunyit asam; Angka Lempeng Total; Cemaran mikroba; Pasar tradisional; Keamanan pangan

1. Introduction

Indonesia is rich in natural resources, including medicinal plants that have long been utilized in traditional health systems. One of the most widely consumed traditional medicines is *jamu*, a herbal concoction made from native Indonesian plants, which continues to be relied upon for health maintenance and the treatment of various ailments [1] Despite its generally bitter taste [2], *jamu* remains a popular choice among Indonesians, with 49.53% of the population reported to use it for treating illnesses and 95.6% recognizing its benefits [3].

The National Agency of Drug and Food Control (BPOM) classifies Indonesian traditional medicines into three categories: *jamu*, standardized herbal medicine (*obat herbal terstandar*), and phytopharmaca (*fitofarmaka*), each subjected to distinct regulatory requirements. However, not all *jamu* products comply with proper safety and quality standards, especially *jamu gendong* a traditional herbal drink sold by street peddlers in reusable containers. These are often produced in home industries with minimal sanitation oversight and are typically distributed without official permits [4].

A major concern regarding *jamu gendong* is microbial contamination, particularly from total aerobic microbes, molds, and yeasts. Such contamination may occur due to inadequate hygiene during processing, improper handling of raw materials, or unsanitary storage conditions. High microbial loads can affect product stability, reduce therapeutic value, and pose health risks to consumers [5], [6]. Therefore, it is essential to conduct microbial safety testing such as Total Plate Count (TPC) and Mold and Yeast Count (AKK) to ensure compliance with health regulations. According to BPOM Regulation No. 32 of 2019, the maximum limit for TPC in traditional herbal preparations is 1 × 10^5 CFU/mL, and for AKK, it is 1 × 10^3 CFU/mL [5].

Among the various *jamu* formulations, turmeric-tamarind (*kunyit asam*) is one of the most popular. This preparation combines turmeric (*Curcuma domestica* Val.) and tamarind (*Tamarindus indica* L.), both known for their antioxidant, anti-inflammatory, and antibacterial properties [7],[8],[9]. Turmeric-tamarind herbal medicine is widely consumed for managing menstrual discomfort, reducing inflammation, and improving digestion [10]. However, its widespread consumption in informal settings raises

concerns about microbial safety, particularly when the product is prepared and distributed without adequate sanitary controls.

Mojayan Village in Klaten Regency has long been recognized as a hub for traditional *jamu* production and sales. The Mojayan Traditional Market serves as a central point for *jamu gendong* trade, where many vendors still rely on traditional production methods without formal microbial testing. Given this context, it is necessary to evaluate the microbiological quality of turmeric-tamarind herbal medicine circulating in this area. Such testing is crucial not only for ensuring public safety but also for supporting the sustainability and credibility of Indonesia's traditional medicine industry.

2. Methods

Study Design and Sampling

This research used a descriptive observational design aimed at assessing microbial contamination in turmeric-tamarind herbal medicine (*jamu kunyit asam*) sold at Mojayan Traditional Market, Klaten. Five samples were collected purposively from different vendors to represent commonly distributed products in the area [5].

Tools and Materials

This study used essential microbiological laboratory equipment including an analytical balance, autoclave, laminar airflow cabinet, dry heat oven, colony counter, vortex mixer, micropipettes, and sterile Petri dishes. The materials consisted of turmeric-tamarind herbal medicine samples collected from Mojayan Traditional Market, Plate Count Agar (PCA, Merck®), and sterile distilled water (Merck®) for sample dilution. Glassware was sterilized using a dry heat oven at 121 °C for 1 hour, and culture media were autoclaved at 121 °C for 15 minutes before use, following standard protocols [6], [9].

Preparation of Culture Medium

The PCA medium was prepared by dissolving 5.875 grams of PCA powder in 250 mL of sterile distilled water. After complete dissolution, the solution was sterilized in an autoclave at 121 °C for 15 minutes. Once cooled to room temperature, the medium was aseptically poured into sterile Petri dishes for use in total plate count analysis [11].

Sample Sample Preparation and Serial Dilution

One milliliter (1 mL) of each herbal sample was mixed with 9 mL of sterile distilled water and homogenized using a vortex mixer to achieve a 10^{-1} dilution. Serial dilutions were then prepared up to 10^{-5} using the same 1:10 dilution technique. Each tube was vortexed to ensure complete homogenization [12].

Total Plate Count Assay

From each dilution, 1 mL was pipetted into sterile Petri dishes in triplicate and mixed with 10 mL of molten PCA medium. Plates were gently rotated to ensure even distribution and allowed to solidify. They were incubated in an inverted position at 37 °C for 24–48 hours. Colony growth was observed and counted using a colony counter [12].

Data Analysis

Colony counts from triplicate plates were averaged, and the results were expressed as CFU/mL. These values were then compared with the maximum permissible microbial limits set by the Indonesian Food and Drug Authority (BPOM), which states that traditional herbal liquids should not exceed 1×10^5 CFU/mL for total aerobic microbial contamination [13].

3. Results and discussion

The Total Plate Count (TPC) results of turmeric-tamarind herbal medicine (jamu kunyit asam) obtained from Mojayan Traditional Market, Klaten, revealed microbial loads ranging from 1.92×10^6 to 2.55×10^6 CFU/mL. These values are significantly below the maximum permissible limit of 5×10^7 CFU/mL as regulated by the Indonesian National Agency for Drug and Food Control (BPOM Regulation No. 29 of 2023) [13]. This suggests that, despite being produced in traditional and potentially uncontrolled environments, the products meet microbiological safety standards and are considered safe for consumption.

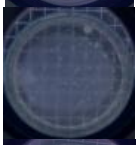
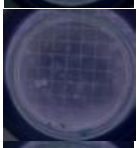
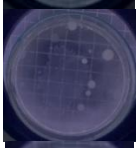
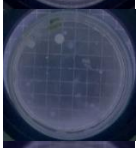
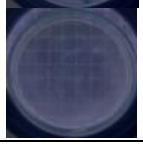
Table 1. Total Plate Count of Turmeric-Tamarind Herbal Medicine from Sellers in Mojayan Traditional Market, Klaten

Dilution	Seller	Petri Dish I	Petri Dish II	Petri Dish III	Total Plate Count (CFU/mL)
10^{-1}	1	TNTC	TNTC	TNTC	
10^{-2}	1	TNTC	TNTC	TNTC	
10^{-3}	1	TNTC	TNTC	TNTC	**2.39×10^6**
10^{-4}	1	105	99	93	
10^{-5}	1	48	40	26	
10^{-1}	2	TNTC	TNTC	TNTC	
10^{-2}	2	TNTC	TNTC	TNTC	
10^{-3}	2	TNTC	TNTC	TNTC	**2.55×10^6**
10^{-4}	2	134	102	99	
10^{-5}	2	42	46	32	
10^{-1}	3	TNTC	TNTC	TNTC	
10^{-2}	3	TNTC	TNTC	TNTC	
10^{-3}	3	TNTC	TNTC	TNTC	**1.92×10^6**
10^{-4}	3	121	113	104	
10^{-5}	3	50	42	47	

Notes:
TNTC *(Too Numerous To Count): indicates that the number of colonies on the plate exceeded countable limits.*
CFU/mL*: Colony Forming Units per milliliter.*
Total Plate Count is calculated from countable dilutions using standard microbiological methods as referenced in Indonesian FDA guidelines (BPOM No. 29 of 2023*) [13]*

As presented in **Table 1**, the first three serial dilutions (10^{-1} to 10^{-3}) across all samples showed TNTC (Too Numerous To Count) results, indicating high microbial loads in undiluted and mildly diluted samples. Accurate microbial enumeration was achieved at 10^{-4} and 10^{-5} dilutions. The calculated total colony counts were 2.39×10^6 CFU/mL for Seller 1, 2.55×10^6 CFU/mL for Seller 2, and 1.92×10^6 CFU/mL for Seller 3. Based on these values, the mean microbial load was 2.29×10^6 CFU/mL. These variations likely reflect differences in hygiene practices, water quality, and raw material handling among vendors.

Table 2. Visual Appearance of Microbial Growth on Petri Dishes from Seller 1 at Different Dilutions

Dilutions	Petry Dish I	Petry Dish II	Petry Dish III
10^{-1}			
10^{-2}			
10^{-3}			
10^{-4}			
10^{-5}			

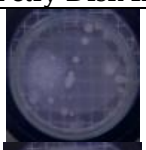
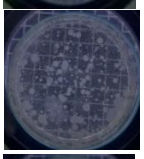
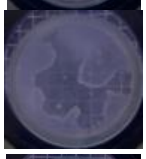
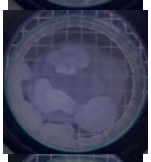
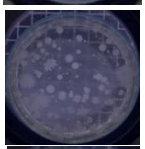
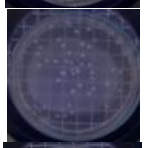
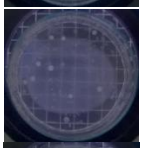
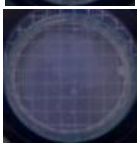
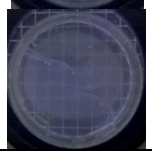
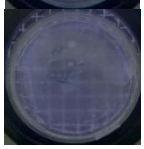
Note: *TNTC (Too Numerous To Count) indicates confluent microbial growth that prevents accurate enumeration. Clear and countable colony morphology was observed at 10^{-4} and 10^{-5} dilutions, whereas early dilutions were confluent and uncountable.*

This result is comparable to a study by Tivani [14], who reported a TPC value of 1.8×10^6 CFU/mL in *jamu temu ireng* from Brebes. Similarly, Dewi et al. [15] found TPC values ranging from 1.7×10^6 to 2.5×10^6 CFU/mL in *beras kencur* herbal drinks sold in traditional markets of Central Java. These studies reinforce the microbial range observed in this study and support the notion that most *jamu gendong* preparations, although traditionally made, can meet microbiological safety standards when basic hygiene is maintained.

Visual observation of microbial colonies presented in **Tables 2, 3, and 4** corroborates the quantitative results. Samples from Seller 1 exhibited a more uniform and clearly separated colony distribution at higher dilutions, indicating relatively better sanitation or preparation procedures. In contrast, Seller 2's samples showed overlapping colonies even at the 10^{-4} dilution, suggesting a higher level of microbial contamination likely associated with inadequate hygiene, poor water quality, or suboptimal storage conditions.

Multiple factors may contribute to the variations in microbial load. Improper washing of turmeric roots and tamarind pulp—both commonly contaminated with soil and organic debris—may introduce bacterial and fungal spores into the final product. Previous studies have shown that the use of unclean ingredients or contaminated water significantly increases microbial contamination in jamu [14], [15]. Water quality plays a vital role in this regard; the use of unboiled or reused water without sterilization introduces microbial risks. Boiling the water before use has been shown to reduce the microbial load significantly [4].

Table 3. Visual Appearance of Microbial Growth on Petri Dishes from Seller 2 at Different Dilutions

Dilutions	Petry Dish I	Petry Dish II	Petry Dish III
10^{-1}			
10^{-2}			
10^{-3}			
10^{-4}			
10^{-5}			

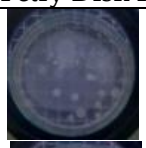
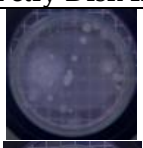
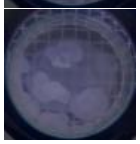
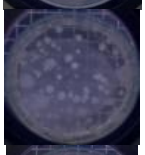
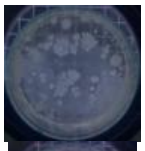
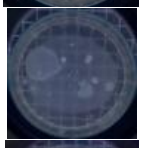
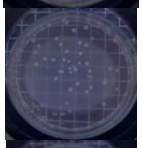
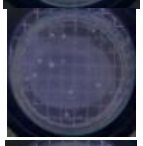
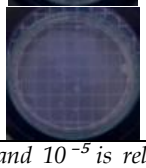
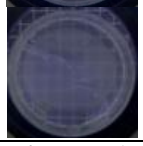
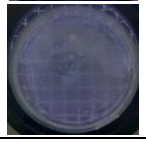
Note: *Plates at 10^{-2} and 10^{-3} still exhibit overlapping colonies, indicating higher microbial contamination compared to Seller 1. Distinct colonies are observable starting at 10^{-4}.*

Personal hygiene of vendors is another contributing factor. Field observations indicated that several vendors cleaned their hands using cloths rather than soap and water, while some did not wash their hands at all. These unsanitary practices have been previously associated with elevated TPC values in traditional food and drink products [9]. Moreover, equipment cleanliness and packaging practices further influence contamination levels. Many vendors reused PET (Polyethylene Terephthalate) plastic bottles for packaging. According to BPOM guidelines, PET containers coded I–PETE are designed for single use only, as repeated usage may result in polymer degradation and leaching of carcinogenic substances [13].

Environmental conditions in the market, such as dust, exposure to vehicle emissions, and poor ventilation, also contribute to microbial contamination. Research by Dewi et al. demonstrated that the presence of *Aspergillus* spp. in turmeric-tamarind jamu was often associated with airborne contamination in open market environments [15]. Similar findings were reported by Hamida et al., who observed increased microbial presence in jamu samples stored in non-sterile roadside stalls [17].

Despite all samples falling below the threshold defined by BPOM, the consistently high initial microbial counts highlight the importance of preventive action. Although pathogenic bacteria were not identified in this study, the risk of cumulative exposure from continuous consumption of contaminated jamu remains, particularly for vulnerable populations such as children, the elderly, and immunocompromised individuals [16]. Chronic exposure to low-level microbial contamination may lead to gastrointestinal infections or dysbiosis, especially among individuals with weakened immunity [18].

Table 4. Visual Appearance of Microbial Growth on Petri Dishes from Seller 3 at Different Dilutions

Dilutions	Petry Dish I	Petry Dish II	Petry Dish III
10^{-1}			
10^{-2}			
10^{-3}			
10^{-4}			
10^{-5}			

Note: *Colony distribution at 10^{-4} and 10^{-5} is relatively uniform. Early dilutions (10^{-1} to 10^{-3}) remain TNTC, consistent with microbial trends observed in other sellers.*

Therefore, good manufacturing practices (GMP) must be promoted among jamu producers and vendors. Simple interventions—such as handwashing with soap, use of boiled or sterile water, proper cleaning of raw ingredients, and utilization of single-use or sanitized packaging—can substantially reduce microbial risks. Regulatory bodies must also conduct regular surveillance to monitor microbial quality in traditional herbal medicine markets. In addition, consumer awareness on hygienic jamu handling and safe storage practices should be enhanced through public health campaigns [19].

This study was limited by the small number of samples (n = 3 vendors), which may not fully represent the entire spectrum of jamu products sold in the region. Additionally, the study focused solely on aerobic microbial counts (TPC) without assessing mold, yeast, or pathogenic species such as *E. coli* or *Salmonella*. Future research should expand the sample size, include microbial species identification, and assess the presence of chemical residues and heavy metals to comprehensively evaluate product safety.

4. Conclusion

The Total Plate Count (TPC) value of turmeric-tamarind herbal medicine samples obtained from Mojayan Traditional Market, Klaten, was 2.29×10^6 CFU/mL, which is below the maximum allowable microbial contamination limit of 5×10^7 CFU/mL as stated in BPOM Regulation No. 29 of 2023, indicating that the products are microbiologically safe for consumption. Nevertheless, the high microbial presence observed at low dilutions and inconsistent hygiene practices among vendors suggest potential risks if proper handling procedures are neglected. Therefore, it is recommended that vendors be educated in basic hygiene practices, such as handwashing, clean water usage, and equipment sanitation; regulatory bodies should

conduct regular microbial monitoring in traditional markets; and future research should include broader sampling, identification of microbial species, fungal counts, and chemical contamination analysis to ensure comprehensive product safety.

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Conflicts of Interest:

The authors declare no conflicts of interest.

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