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MICROBIOLOGICAL QUALITY EVALUATION OF TURMERIC–TAMARIND JAMU BASED ON TOTAL PLATE COUNT AT NGEPOS MARKET, KLATEN REGENCY

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ABSTRACT

Turmeric–tamarind jamu is a widely consumed ready-to-drink traditional herbal beverage in Indonesia. Because it is commonly prepared and sold under non-sterile conditions, microbiological quality is an important aspect of consumer safety and regulatory compliance. Total Plate Count (TPC) is a standard indicator used to assess the microbial quality of food and beverage products and to determine compliance with microbiological standards. One milliliter of turmeric–tamarind jamu was homogenized with 9 mL of sterile distilled water to obtain a 10^{-1} dilution. Serial dilutions were prepared up to 10^{-5}. One milliliter from each dilution was inoculated in duplicate onto sterile Petri dishes, followed by the addition of 10 mL of Plate Count Agar (PCA). The plates were gently mixed, allowed to solidify, and incubated in an inverted position at 37 °C for 24–48 h. Sterility controls were included for the medium, diluent, and working environment. Colony-forming units were enumerated using a colony counter, and the average TPC was calculated from countable plates. The results showed that turmeric–tamarind jamu from the first seller had a TPC value of 2.28×10^2 CFU/mL, while that from the second seller had a TPC value of 2.14×10^2 CFU/mL. These values were well below the maximum permissible microbial limit specified in *Badan Pengawas Obat dan Makanan* (BPOM) Regulation No. 29 of 2023 for boiled herbal preparations ($<5\times10^7$ CFU/mL), indicating that all samples complied with the applicable microbiological quality standards.

Keywords : *Klaten Regency; microbiological quality; ready-to-drink jamu; total plate count; turmeric–tamarind jamu*

INTRODUCTION

Jamu is a traditional Indonesian herbal beverage that is widely consumed in both household and commercial settings. Among the various formulations, ready-to-drink turmeric–tamarind jamu is one of the most popular products sold in traditional markets. Because it is commonly prepared using fresh plant materials, processed manually, and often distributed without strict hygienic control or refrigeration, this beverage is susceptible to microbial contamination during production, handling, and storage (A'yunin et al., 2019; Atmoko et al., 2020). Consequently, ensuring its microbiological quality is essential to protect consumer safety and to verify compliance with national microbiological standards. Total Plate Count (TPC) is a widely accepted method for evaluating the overall microbial load and serves as an important indicator of the hygienic quality of ready-to-drink herbal beverages (BPOM RI, 2023).

TPC is a standard microbiological method used to estimate the number of viable aerobic mesophilic microorganisms in food and beverage products as an indicator of hygienic quality and manufacturing sanitation. According to ISO 4833-1:2013, samples are serially diluted, inoculated onto Plate Count Agar (PCA), incubated aerobically at 30 ± 1 °C

for 72 ± 3 h, and colonies within the countable range of 30–300 colony-forming units (CFU) per plate are enumerated. Results are expressed as CFU/mL for liquid products or CFU/g for solid products. In Indonesia, BPOM Regulation No. 29 of 2023 establishes a maximum TPC limit of $<5 \times 10^7$ CFU/L for boiled traditional herbal preparations. Because ready-to-drink turmeric–tamarind jamu is commonly produced and marketed under traditional conditions with limited preservation, TPC serves as an essential parameter for evaluating microbiological quality and compliance with regulatory safety standards (Tahiluddin et al., 2022; BPOM RI, 2023).

The microbiological quality of ready-to-drink turmeric–tamarind jamu is influenced by several factors throughout production and distribution. Fresh plant materials naturally carry environmental microorganisms, and additional microbial contamination may occur during washing, processing, handling, packaging, or storage if good hygiene and sanitation practices are not consistently implemented (Michel et al., 2024; Afiah et al., 2025). Because turmeric–tamarind jamu is commonly prepared using traditional methods and marketed as a ready-to-drink beverage, monitoring the overall viable microbial population is essential for evaluating product hygiene and process quality. TPC provides an estimate of the total aerobic viable microorganisms present in the product and is widely used as an indicator of microbiological quality and compliance with established regulatory standards. However, TPC does not identify specific microorganisms or distinguish between spoilage organisms and pathogens; therefore, its results should be interpreted solely as an indicator of overall microbial quality rather than evidence of the presence or absence of pathogenic microorganisms (BPOM RI, 2023).

In Indonesia, the microbiological quality of traditional herbal medicines is regulated by Badan Pengawas Obat dan Makanan (BPOM) Regulation No. 29 of 2023 on the Microbiological Contamination Requirements for Traditional Medicines, which specifies microbiological limits for different categories of traditional medicinal products. For boiled traditional herbal preparations (sediaan rebusan), the maximum permissible TPC is $<5 \times 10^7$ CFU/mL. Compliance with this regulatory criterion provides an important indicator of microbiological quality and manufacturing hygiene for ready-to-drink herbal products. Accordingly, TPC determination is widely applied to evaluate whether herbal beverages meet the established microbiological requirements and to support quality assurance through improved processing, sanitation, and handling practices (BPOM RI, 2023; Critzer et al., 2024).

Although several studies have evaluated the microbiological quality of traditional herbal beverages in Indonesia, published data specifically describing the TPC of ready-to-drink turmeric–tamarind jamu sold at Ngepos Market, Klaten Regency are not available. Previous local investigations have generally examined herbal beverages from different regions or have focused on broader microbiological parameters and production practices, limiting direct comparisons with products marketed at Ngepos Market. Because microbiological quality may vary according to local raw material sources, handling practices, processing conditions, and vendor hygiene, location-specific data are needed to evaluate compliance with the applicable BPOM microbiological standards. Therefore, this study provides a preliminary assessment of the TPC of turmeric–tamarind jamu obtained from the two vendors available at Ngepos Market during the sampling period. Although the sample size is limited and does not represent all turmeric–tamarind jamu producers in Klaten Regency, it establishes baseline microbiological data for this market and may serve as a reference for future studies involving a larger number of vendors and repeated sampling over time (Al-Sharify et al., 2025).

This study aimed to determine the TPC of two ready-to-drink turmeric–tamarind jamu samples obtained from vendors at Ngepos Market, Klaten Regency, and to compare the

measured values with the maximum permissible TPC limit specified in BPOM Regulation No. 29 of 2023 for boiled traditional herbal preparations. Because TPC measures only the aerobic viable microbial load, the findings should be interpreted as an indicator of microbiological quality and regulatory compliance rather than a comprehensive assessment of microbial safety. The results are limited to the tested samples and do not represent all turmeric–tamarind jamu products marketed in the region. Furthermore, this study did not include pathogen-specific analyses, such as yeast and mold counts, coliforms/*Escherichia coli*, *Salmonella sp*., or *Staphylococcus aureus*; therefore, additional microbiological testing and broader sampling are recommended to provide a more comprehensive evaluation of product safety.

METHODS

Tools and Materials

The tools used in this study include analytical scales (Ohaus®), test tubes (Pyrex®), erlenmeyers (Pyrex®), measuring cups (Pyrex®), micropipettes (Dragon LAB®), yellow tip (Onemed®), Petri dish (Normax®), Laminar Air Flow (Biobase®), autoclave (Equitron®), oven (Capp®), colony counter (J-2®), stove, cool box (Lion Star®), Vortex (Thermo-Fischer®). The materials used in this study were turmeric-tamarind jamu from the Ngepos Market Klaten Regency, Plate Count Agar (Merck®), sterile distilled water (Merck®).

Study Design and Objective

Descriptive cross-sectional laboratory study to determine the Total Plate Count of ready-to-drink Turmeric–Tamarind Jamu samples collected from traditional market of Ngepos, Klaten regency and to compare results with national microbiological limits based on *Badan Pengawas Obat dan Makanan* (BPOM RI, 2023).

Sample Collection

Two independent ready-to-drink turmeric–tamarind jamu samples were collected from two different vendors at Ngepos Market, Klaten Regency. Approximately 250–500 mL of product was obtained from each vendor and transferred into sterile screw-capped bottles. Each sample was labeled with a unique sample identification code, collection date, collection time, vendor information, and relevant storage details. After collection, the samples were transported to the laboratory in a cooler containing ice packs and maintained at 5–7 °C during transport. The time elapsed between sample collection and laboratory analysis was 2.5 h. Upon arrival at the laboratory, the samples were analyzed immediately for TPC, and no refrigerated storage prior to analysis was required (Djide & Sartini, 2018).

Materials and Reagents

Plate Count Agar (PCA) was prepared according to the manufacturer's instructions by dissolving 5.875 g of dehydrated medium in 250 mL of distilled water. The medium was sterilized by autoclaving at 121 °C for 15 min, cooled to 44–47 °C, and used for the pour plate procedure. Serial dilutions of the samples were prepared using 0.1% sterile peptone water as the diluent to maintain microbial viability during dilution. Briefly, 1 mL of turmeric–tamarind jamu was aseptically transferred into 9 mL of sterile 0.1% peptone water to obtain a 10^{-1} dilution and homogenized using a vortex mixer. Subsequently, 1 mL of each dilution was transferred into the next tube containing 9 mL of diluent to prepare serial decimal dilutions up to 10^{-5}. Blank controls consisting of uninoculated PCA medium and sterile diluent were processed in parallel, and no microbial growth was observed, confirming the sterility of the culture medium and diluent throughout the analysis (Wati, 2018).

Total Plate Count Assay

From each serial dilution, 1 mL was aseptically transferred into two sterile Petri dishes (duplicate technical replicates), after which approximately 10 mL of molten PCA (44–47 °C) was added using the pour plate technique. The plates were gently mixed by rotating in a figure-eight motion to ensure uniform distribution of the inoculum and allowed to solidify before incubation in an inverted position at 37 °C for 24–48 h, according to the laboratory protocol. The two independent samples obtained from different vendors represented the biological replicates, whereas the duplicate plates prepared from each dilution represented the technical replicates. Blank controls consisting of uninoculated PCA medium (medium control) and sterile diluent (diluent control) were processed and incubated under the same conditions. In addition, an environmental control was prepared by exposing a sterile PCA plate to the laboratory environment during sample handling. All control plates showed no visible microbial growth, indicating acceptable sterility of the medium, diluent, and laboratory environment throughout the analysis (Dewi et al., 2022).

Colonies were enumerated using a colony counter, and only plates containing 30–300 colonies were considered countable in accordance with the selected TPC standard. Plates with colony numbers exceeding this range were recorded as Too Numerous To Count (TNTC) and were excluded from enumeration. When duplicate countable plates were available at the same dilution, their counts were averaged. The TPC values was calculated using the formula:

$$TPC = \frac{\Sigma C}{nxd}$$

where ΣC is the sum of colonies counted on the selected countable plates, n is the number of plates counted at the selected dilution, and d is the corresponding dilution factor. Final results were expressed as colony per grams of turmeric–tamarind jamu and rounded to two significant figures (Djide & Sartini, 2018).

RESULT AND DISCUSSION

Table 1. Total Plate Count for Turmeric-Tamarind Jamu (Seller 1)

Dilution	Total Plate Count		Total Plate Count (colonies/grams)
	Petry Dish I	Petry Dish II	
10^{-1}	TNTC	TNTC	
10^{-2}	TNTC	TNTC	
10^{-3}	$3{,}78 \times 10^2$	$3{,}29 \times 10^2$	$2{,}28 \times 10^2$
10^{-4}	$2{,}96 \times 10^2$	$2{,}87 \times 10^2$	
10^{-5}	$1{,}55 \times 10^2$	$1{,}73 \times 10^2$	

Table 2. Total Plate Count for Turmeric -Tamarind Jamu (Seller 2)

Dilution	Total Plate Count		Total Plate Count (colonies/grams)
	Cawan Petri I	Cawan Petri II	
10^{-1}	TNTC	TNTC	
10^{-2}	TNTC	TNTC	
10^{-3}	$4{,}19 \times 10^2$	$3{,}52 \times 10^2$	$2{,}14 \times 10^2$
10^{-4}	$2{,}62 \times 10^2$	$2{,}31 \times 10^2$	
10^{-5}	$1{,}68 \times 10^2$	$1{,}94 \times 10^2$	

The results of TPC for the two ready-to-drink turmeric–tamarind jamu samples collected from Ngepos Market, Klaten Regency are presented in Tables 1 and 2. The calculated TPC values were 2.28×10^2 colonies/grams for the sample obtained from the first vendor and 2.14×10^2 colonies/grams for the sample obtained from the second vendor. These values were substantially lower than the maximum permissible TPC limit of $<5 \times 10^7$ colonies/grams specified in BPOM Regulation No. 29 of 2023 for boiled traditional herbal preparations (BPOM RI, 2023). Although the regulatory limit is expressed in CFU/g, the present study reports results in CFU/mL because the analyzed product was a ready-to-drink liquid beverage. Therefore, the tested samples demonstrated low aerobic viable microbial counts and were consistent with the selected BPOM TPC criterion. However, because this study evaluated only TPC, the findings should not be interpreted as evidence of overall microbiological safety or the absence of specific pathogens, yeasts, molds, or microbial toxins. The relatively low TPC values observed in both samples may reflect acceptable hygiene during raw material handling, preparation, and distribution, as well as the use of adequately heated water during production. Nevertheless, these factors were not directly evaluated in the present study and therefore cannot be identified as the causes of the observed microbial counts. Similar observations of TPC values within the applicable microbiological limits have been reported for traditional herbal beverages marketed in other regions of Indonesia (Aprilianti, 2021). Future studies should include a larger number of vendors, repeated sampling over different production days, and pathogen-specific analyses, including yeast and mold counts, coliforms/*Escherichia coli*, *Salmonella* spp., and *Staphylococcus aureus*, to provide a more comprehensive assessment of the microbiological quality of ready-to-drink turmeric–tamarind jamu.

The microbiological quality of ready-to-drink herbal beverages can be influenced by hygiene and sanitation practices during raw material handling, processing, packaging, and storage. Previous studies have reported that inadequate cleaning of raw plant materials, insufficient sanitation of food-contact surfaces, poor personal hygiene, and improper handling may increase the overall microbial load of traditional herbal products (Hadijah, 2018). However, these factors were not systematically assessed in the present study through a standardized observation checklist or hygiene audit. Therefore, the measured TPC values cannot be directly attributed to any specific production or handling practice. The results should be interpreted solely as an assessment of the aerobic viable microbial count of the tested samples, while future studies should combine TPC analysis with structured observations of vendor hygiene and processing practices to better identify factors associated with microbiological quality (Tivani, 2018).

During sample collection, the ready-to-drink turmeric–tamarind jamu obtained from the two vendors was observed to be dispensed in different types of serving containers, including glass cups and plastic bottles. These observations were recorded solely to describe the products available at the point of sale and were not included as variables in the microbiological analysis. Consequently, the present study does not permit any inference regarding the influence of packaging type on the TPC values. Evaluation of the relationship between packaging materials, handling practices, storage conditions, and microbiological quality would require a larger sample size and a study design specifically intended to compare these factors(Hapsari & Kurniawanti, 2022) (BPOM RI, 2019)

Personal hygiene during the preparation and serving of ready-to-drink herbal beverages is recognized as an important component of good hygienic practices because food handlers may contribute to microbial contamination through direct contact with products or food-contact surfaces. Previous studies have reported that inadequate hand hygiene and improper handling during preparation and serving are associated with increased microbial loads in traditional beverages. However, personal hygiene practices were not systematically

evaluated in the present study, and no standardized observational checklist was used during sample collection. Therefore, the measured TPC values cannot be attributed to specific vendor hygiene practices. Future investigations should incorporate structured observations of personal hygiene and food-handling practices together with microbiological analyses to better evaluate factors associated with the microbiological quality of ready-to-drink turmeric–tamarind jamu.

CONCLUSION

The TPC values of Turmeric–Tamarind Jamu at Ngepos Market, Klaten Regency are 2.28×10^2 colonies/grams and 2.14×10^2 colonies/grams which indicates that the samples of ready-to-drink turmeric-tamarind jamu do not exceed the contamination limit set by *Badan Pengawas Obat dan Makanan* No. 29 of 2023, where the limit of microbial contamination in internal medicine liquids is $\leq 5 \times 10^7$ colonies/grams.

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