TOTAL PLATE COUNT OF BACTERIA ON FOOD CONTAINER BOXES IN THE NUTRITION INSTALLATION OF A HOSPITAL IN GORONTALO

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ABSTRACT

Food container hygiene is an important component of hospital food safety because contaminated food-contact surfaces may contribute to microbial transmission during food preparation and distribution. This study aimed to determine the Total Plate Count (TPC) of bacteria on food container boxes used in the Nutrition Installation of a hospital in Gorontalo. A quantitative descriptive design was employed, involving 15 food container boxes used for patient meals. Samples were collected aseptically and examined microbiologically using Nutrient Agar (NA) media, followed by bacterial enumeration using the Total Plate Count method. The results showed detectable bacterial growth on all examined food container boxes, with bacterial counts ranging from 0.0013 to 0.0048 CFU/cm². The lowest bacterial count was observed in sample C, while the highest was recorded in sample O. All bacterial counts were below the maximum reference limit of $\leq 1 \times 10^4$ CFU/cm² applied in this study based on SNI 7388:2009 and PerBPOM No. 13 of 2019. These findings indicate that although viable bacteria were detected on all examined food container boxes, their bacterial loads remained within the applicable microbiological reference limit. The study highlights the importance of maintaining routine cleaning, disinfection, hygienic handling, and periodic microbiological monitoring of food container boxes to support food safety and sanitation in hospital nutrition services.

Keywords: *Total Plate Count; bacterial contamination; food container hygiene; hospital food safety; food-contact surfaces*

INTRODUCTION

Food safety is an essential component of hospital service quality because food provided to patients is directly related to nutritional recovery, infection prevention, and overall patient safety. Unlike food services in the general population, hospital nutrition services operate in an environment where consumers may have increased susceptibility to infection because of illness, weakened immunity, or underlying medical conditions. Consequently, maintaining appropriate hygienic and sanitary conditions throughout food preparation, handling, storage, and distribution is particularly important. Previous research has demonstrated that hospital nutrition and dietary services require systematic monitoring of hygiene practices and environmental conditions to minimize microbiological hazards and ensure the safety of food served to patients [1].

Food-contact surfaces and equipment represent important potential sources of microbiological contamination in institutional food services. Containers, utensils, preparation equipment, and other surfaces may become contaminated

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through inadequate cleaning, inappropriate handling, residual food materials, or contact with contaminated hands and surrounding environments. In hospital food and nutrition units, microbiological assessments have identified contamination on equipment and food-contact surfaces, demonstrating that these areas can serve as potential reservoirs for microorganisms [2]. Similarly, contamination has been reported on equipment, utensils, and the hands of food handlers in hospital nutrition and dietary services, highlighting the importance of effective sanitation and hygienic handling practices throughout the food service process [3].

Food container boxes are particularly important because they are directly involved in the handling, storage, and distribution of food. If containers are not adequately cleaned and sanitized, microorganisms can remain on their surfaces and potentially be transferred to food during subsequent use. The presence of organic residues can further support microbial persistence and increase the possibility of cross-contamination. Therefore, the hygienic condition of food containers should not be evaluated solely through visual inspection, as apparently clean surfaces may still harbor microorganisms. Microbiological examination provides a more objective approach for determining the level of contamination and evaluating the effectiveness of sanitation procedures.

One commonly used microbiological parameter for assessing the general microbial quality of food and food-contact environments is the Total Plate Count (TPC). TPC provides an estimation of the number of viable microorganisms present in a sample and can be used as an indicator of general hygienic conditions. In food-service environments, microbiological testing has been applied to evaluate hygiene quality and to support sanitation management practices [4]. In hospital nutrition services, microbiological monitoring is particularly relevant because contamination of food-contact surfaces may facilitate the transmission of microorganisms within the food preparation and distribution chain. The implementation of systematic food safety approaches, including microbiological monitoring and critical control measures, has therefore been emphasized in hospital food systems [5].

Effective sanitation of food-contact materials is consequently an important component of hospital food safety. Cleaning and disinfection procedures must be sufficiently effective to reduce microbial contamination and prevent the recontamination of surfaces before their subsequent use. This concern extends beyond containers and utensils to other materials used during food preparation and handling. For example, research in a hospital food and nutrition unit has demonstrated the importance of evaluating disinfection methods for commonly used cloths and sponges because these materials may themselves become reservoirs of microorganisms [6]. Such findings reinforce the need for routine microbiological evaluation as part of broader environmental sanitation and food safety management.

Despite the importance of microbiological hygiene in hospital nutrition services, evidence concerning the bacterial load specifically present on food container boxes remains relatively limited, particularly in local hospital settings in Indonesia. Existing studies have predominantly examined general hygienic-sanitary conditions, food-contact equipment, utensils, food handlers, or

sanitation materials rather than focusing specifically on the bacterial load of food container boxes used in hospital nutrition installations [2][3][6]. This creates a practical research gap because food containers represent a direct interface between the food service process and the patient and may constitute a potential pathway for microbial transfer when sanitation practices are inadequate.

Therefore, assessing the bacterial load of food container boxes through Total Plate Count analysis is important for providing empirical evidence regarding their microbiological hygiene status. Such information can support hospital nutrition units in evaluating the effectiveness of existing cleaning and sanitation procedures and in identifying potential areas requiring improvement. Accordingly, this study aims to determine the Total Plate Count of bacteria on food container boxes in the nutrition installation of a hospital in Gorontalo. The findings are expected to contribute to the assessment of food-contact surface hygiene and provide evidence for strengthening food safety and sanitation practices in hospital nutrition services.

Literature Review

Food Container Hygiene

Food container hygiene refers to the condition and management of containers used for storing, handling, and distributing food to ensure that their surfaces do not become sources of microbial contamination. In hospital nutrition services, container hygiene is particularly important because food is prepared and distributed to patients who may have greater vulnerability to infection. The cleanliness of food containers depends not only on their visible appearance but also on the effectiveness of cleaning, washing, disinfection, drying, and handling procedures. Microbiological studies of hospital food and nutrition units have demonstrated that food-contact equipment and surfaces can harbor microorganisms when sanitation practices are inadequate [2]. Therefore, food container hygiene can be theoretically understood as a fundamental preventive measure that interrupts the accumulation and transfer of microorganisms throughout the hospital food service chain.

Bacterial Contamination

Bacterial contamination refers to the presence and persistence of viable bacteria on food, food-contact surfaces, equipment, utensils, or containers as a consequence of environmental exposure, handling, inadequate sanitation, or cross-contamination. From a microbial ecology perspective, bacteria can survive and persist on surfaces when environmental conditions, organic residues, moisture, and sanitation practices support their maintenance. In hospital food services, contaminated equipment and food-contact surfaces may become potential reservoirs from which microorganisms can be transferred to food or other surfaces [2]. The transmission of bacteria through contact surfaces also demonstrates that contamination is not necessarily restricted to a single location but can move through interconnected handling processes [7]. Thus, bacterial contamination of food container boxes represents an important microbiological concern because contaminated containers may contribute to the circulation of microorganisms within the food distribution process.

Total Plate Count

Total Plate Count (TPC), also referred to as total viable count or aerobic plate count in relevant microbiological applications, is a quantitative microbiological method used to estimate the number of viable microorganisms

capable of growing under specified culture conditions. TPC does not identify a particular bacterial species; rather, it provides an overall estimation of viable microbial load and can therefore be used as an indicator of general microbiological quality and hygiene conditions [8]. In food and food-service environments, microbiological enumeration methods have been applied to assess hygiene conditions and evaluate the effectiveness of sanitation procedures [4]. Within this study, TPC provides the principal analytical basis for determining the bacterial load present on food container boxes, allowing their microbiological condition to be assessed quantitatively rather than solely through visual observation.

Hospital Food Safety

Hospital food safety encompasses the systematic control of biological, chemical, and physical hazards throughout food preparation, handling, storage, transportation, and distribution to prevent adverse health consequences among patients. Biological hazards, particularly bacterial contamination, are a significant concern because hospital patients may be more susceptible to infection than healthy populations. The application of preventive food-safety systems such as Hazard Analysis and Critical Control Point (HACCP) emphasizes the identification and control of potential contamination points throughout food service processes [5]. Evidence from hospital nutrition services also indicates that contamination can occur on equipment, utensils, food-contact surfaces, and food handlers, demonstrating the importance of integrated hygiene controls [2]. Consequently, maintaining microbiological quality of food containers is theoretically part of the broader hospital food-safety system because containers represent a potential contact point between food, personnel, equipment, and patients.

Environmental Sanitation

Environmental sanitation refers to practices designed to maintain hygienic conditions in the physical environment by controlling sources and pathways of microbial contamination. Within hospital nutrition installations, environmental sanitation includes the cleaning and disinfection of food-contact surfaces, equipment, utensils, containers, work areas, and materials used during food preparation and distribution. The microbiological condition of hospital environments can vary according to the frequency of human contact, cleaning practices, environmental conditions, and the effectiveness of sampling and sanitation procedures [9]. Moreover, studies examining the transfer of *Staphylococcus aureus* have demonstrated the potential role of hands and contact surfaces in bacterial transmission, reinforcing the relationship between environmental cleanliness and contamination control [7]. Therefore, environmental sanitation constitutes an important theoretical component in understanding bacterial contamination of food containers because inadequate sanitation may increase the microbial burden remaining on container surfaces.

Relationship Between Hygiene, Contamination, and TPC

The theoretical relationship among food container hygiene, bacterial contamination, and TPC can be explained through the principle that inadequate sanitation increases the probability of microorganisms remaining on food-contact surfaces, while effective cleaning and disinfection should reduce the viable microbial population. TPC provides a quantitative means of observing this microbial burden and can consequently

function as an indirect indicator of the hygienic condition of a container. Previous research has applied microbiological enumeration to evaluate hygiene quality in food-service environments, demonstrating the usefulness of microbial counts in identifying differences in sanitation conditions [4]. In hospital nutrition services, where contamination may occur through equipment, food-contact surfaces, and handling processes, TPC can therefore provide objective microbiological evidence of the condition of food container boxes [2]. Based on this theoretical relationship, higher bacterial counts may indicate insufficient sanitation or possible contamination during handling, whereas lower counts suggest better microbiological control.

RESEARCH METHODS

Research Design

This study employed a quantitative approach with a descriptive research design to determine and describe the bacterial load present on food container boxes used in the Nutrition Installation of a hospital in Gorontalo. The quantitative approach was selected because the study generated numerical data representing the number of viable bacterial colonies obtained through Total Plate Count (TPC) analysis. The descriptive design was used to provide an objective description of the microbiological condition of the examined food container boxes without manipulating the study variables. The bacterial load was expressed quantitatively in colony-forming units per square centimeter (CFU/cm²) and subsequently compared with the applicable microbiological quality standard to determine whether the examined containers met the established requirements.

Research Location and Period

The research was conducted at the Nutrition Installation of a hospital in Gorontalo, Indonesia, where food container boxes are used in the preparation, handling, and distribution of meals for patients. The study was carried out from September 27 to October 2, 2025, covering the process of sample collection, laboratory examination, bacterial enumeration, and recording of the microbiological results. The research location was selected because the Nutrition Installation represents a critical component of the hospital food service system, in which the hygienic condition of food-contact equipment is directly relevant to food safety and patient protection.

Population and Sample

The population in this study consisted of food container boxes used in the Nutrition Installation of the hospital in Gorontalo. A total of 15 food container boxes used for patient meals were selected as research samples. The samples were identified using alphabetical codes from A to O to facilitate laboratory examination and data analysis while maintaining consistent sample identification. Each selected container was examined for its bacterial load using the Total Plate Count method, and the resulting microbial count was expressed as CFU/cm². The selection of food container boxes as the sampling unit was based on their direct contact with food and their potential role as a surface through which microorganisms may be transferred during food handling and distribution.

Sample Collection

Samples were collected from the surfaces of food container boxes used in the hospital Nutrition Installation under conditions representative of their routine use. The sampling procedure was conducted aseptically to minimize the possibility of external contamination during collection, transportation, and laboratory

processing. Each sample was assigned a specific identification code from A to O, and the collected samples were subsequently transported for microbiological examination. Appropriate aseptic procedures were maintained throughout the sampling process to ensure that the bacterial counts obtained reflected the microbiological condition of the sampled container surfaces as accurately as possible.

Total Plate Count Analysis

The bacterial load of the food container boxes was determined using the Total Plate Count (TPC) method. Samples obtained from the container surfaces were processed and inoculated onto Nutrient Agar (NA) media under appropriate microbiological examination procedures. Following incubation under the specified laboratory conditions, visible bacterial colonies developing on the culture media were counted and used to determine the number of viable microorganisms present in each sample. The bacterial concentration was calculated and expressed as CFU/cm², representing the number of viable bacterial colonies per unit surface area of the food container box. TPC was used because it provides a quantitative estimate of the viable microbial population and can be used to describe the general microbiological hygiene condition of food-contact surfaces.

Data Analysis

The data obtained from the laboratory examination were analyzed descriptively by presenting the bacterial counts obtained from each of the 15 food container box samples. The results were expressed in CFU/cm² and compared with the applicable microbiological quality limit used as the reference standard in the study. The analysis focused on identifying the minimum and maximum bacterial counts and determining the compliance status of each sample with the specified limit. Because this study was descriptive in nature, no inferential statistical test was applied; the interpretation focused on describing the bacterial contamination levels and determining whether the examined food container boxes met the established microbiological requirements.

Reference Standard

The microbiological results were interpreted by referring to SNI 7388:2009 and Regulation of the Indonesian Food and Drug Authority (PerBPOM) No. 13 of 2019, with the maximum reference value stated in the study as $\leq 1 \times 10^4$ CFU/cm². Samples with bacterial counts below the applicable maximum limit were categorized as meeting the microbiological standard, whereas samples exceeding the established limit would be categorized as not meeting the standard. This comparison was used to provide an objective assessment of the microbiological hygiene status of food container boxes used in the hospital Nutrition Installation.

RESEARCH RESULT

Bacterial Count on Food Container Boxes

Microbiological examination was conducted on 15 food container boxes used for patient meals in the Nutrition Installation of a hospital in Gorontalo. Bacterial growth was observed on the Nutrient Agar (NA) media used for the examination, indicating the presence of viable bacteria on the examined food container surfaces. The Total Plate Count (TPC) method was subsequently used to quantify the bacterial load in each sample. The results of the microbiological examination are presented in Table 1.

Table 1. Total Plate Count of Bacteria on Food Container Boxes

Sample Code	Bacterial Count (CFU/cm²)	Maximum Limit (CFU/cm²)	Status
A	0.00275	≤ 1 × 10⁴	Meets the standard
B	0.003	≤ 1 × 10⁴	Meets the standard
C	0.0013	≤ 1 × 10⁴	Meets the standard
D	0.00225	≤ 1 × 10⁴	Meets the standard
E	0.0016	≤ 1 × 10⁴	Meets the standard
F	0.002	≤ 1 × 10⁴	Meets the standard
G	0.0034	≤ 1 × 10⁴	Meets the standard
H	0.0032	≤ 1 × 10⁴	Meets the standard
I	0.0028	≤ 1 × 10⁴	Meets the standard
J	0.0022	≤ 1 × 10⁴	Meets the standard
K	0.002	≤ 1 × 10⁴	Meets the standard
L	0.0036	≤ 1 × 10⁴	Meets the standard
M	0.0042	≤ 1 × 10⁴	Meets the standard
N	0.0046	≤ 1 × 10⁴	Meets the standard
O	0.0048	≤ 1 × 10⁴	Meets the standard

Source: Primary Research Data 2025

The results presented in Table 1 show that all 15 food container box samples exhibited detectable bacterial counts, with values ranging from 0.0013 to 0.0048 CFU/cm². The lowest bacterial count was recorded in sample C at 0.0013 CFU/cm², while the highest was observed in sample O at 0.0048 CFU/cm². The remaining samples showed bacterial counts between these two values, with samples M and N recording 0.0042 and 0.0046 CFU/cm², respectively. Although bacterial growth was detected in all examined samples, the bacterial counts recorded in the study were below the maximum reference limit of ≤ 1 × 10⁴ CFU/cm² specified in the reference standards used in this study, namely SNI 7388:2009 and PerBPOM No. 13 of 2019. Accordingly, based on the stated reference limit, all 15 samples were classified as meeting the applicable microbiological standard.

DISCUSSION

Bacterial Contamination of Food Container Boxes

The present study found detectable bacterial growth on all 15 food container boxes examined in the Nutrition Installation of a hospital in Gorontalo, with bacterial counts ranging from 0.0013 to 0.0048 CFU/cm². The presence of bacterial colonies on all examined samples indicates that the container surfaces were not completely free from viable microorganisms, even though the observed counts remained below the microbiological reference limit applied in this study. This finding is consistent with the broader understanding that food-contact surfaces can serve as reservoirs for microorganisms when exposed to food residues, handling, moisture, or environmental contamination. Food-contact surfaces are particularly important in food safety because microorganisms present on these surfaces may subsequently be transferred to food or other contact points through repeated handling and use [10]. Similarly, studies of food preparation environments have demonstrated that microbiological contamination can occur at different stages of food handling, emphasizing the importance of maintaining hygienic conditions throughout the food service process [11].

The detection of bacterial growth in all samples should not, however, be interpreted as evidence that the food container boxes were unsafe for patient use.

Rather, the results demonstrate the presence of viable microorganisms at measurable levels. The microbiological significance of these findings depends on the quantity of microorganisms detected, the organisms involved, the sampling conditions, and the applicable microbiological criteria. Since the present study employed TPC without bacterial identification, the detected colonies cannot be assumed to represent pathogenic bacteria such as *Escherichia coli*, *Salmonella*, or *Staphylococcus aureus*. This distinction is important because TPC primarily provides an overall quantitative indication of viable microbial load rather than identifying specific pathogenic organisms. Nevertheless, the detection of microorganisms provides useful information for evaluating the hygienic condition of food-contact surfaces and the effectiveness of sanitation procedures.

Total Plate Count as an Indicator of Hygiene

The TPC results provide a quantitative description of the microbiological condition of the food container boxes. Among the 15 samples, sample C had the lowest bacterial count at 0.0013 CFU/cm², whereas sample O had the highest count at 0.0048 CFU/cm². Although the difference between the lowest and highest values indicates variation in bacterial load among individual containers, all values remained substantially below the maximum reference value of $\leq 1 \times 10^4$ CFU/cm² used in this study. Consequently, all examined samples were classified as meeting the applicable microbiological standard. The use of microbial counts as an indicator of surface hygiene is consistent with previous research demonstrating the value of microbiological assessment for evaluating the cleanliness of food-contact surfaces [12][13]. Thus, TPC can provide hospital nutrition services with an objective measure that complements visual inspection, because surfaces that appear clean may still contain viable microorganisms.

The relatively low bacterial counts observed in this study may indicate that the existing cleaning and sanitation procedures applied to the food container boxes were generally effective in limiting bacterial accumulation. This interpretation is supported by research emphasizing the importance of appropriate cleaning and disinfection in controlling microbial contamination on food-contact surfaces. Almeida et al. [6], for example, demonstrated the relevance of effective disinfection procedures in a hospital food and nutrition unit, particularly for materials that can function as microbial reservoirs. Similarly, evidence from hospital surface-disinfection research highlights the importance of systematic cleaning and disinfection practices in reducing bacterial contamination and maintaining hygienic environmental conditions [14]. Therefore, the low TPC values observed in the present study may reflect the cumulative effect of routine sanitation, although the study design does not allow the effectiveness of a particular cleaning procedure to be established causally.

Food Container Hygiene and Cross-Contamination Risk

Although all samples met the reference limit, the detection of viable bacteria on every examined container remains relevant from a food-safety perspective. Food container boxes are repeatedly handled during food preparation,

storage, transportation, and distribution, creating multiple opportunities for microbial transfer. Contamination can originate from food residues, workers' hands, utensils, surrounding surfaces, or inadequate cleaning and drying procedures. The risk is particularly important in hospital nutrition services because food is prepared for patients whose health status may increase their vulnerability to infection. Research on hospital food safety has identified hygiene practices and food handling as important factors in controlling microbiological hazards. Patmawati et al. [15], for example, examined risk factors associated with *E. coli* contamination in hospital staff meals, illustrating the continuing importance of controlling bacterial contamination within hospital food systems. Likewise, Sibiya et al. [16], emphasized the role of food safety knowledge and personal hygiene among hospital food-service workers in maintaining safe food-handling practices.

The variation in bacterial counts among the samples may also reflect differences in the conditions or handling history of individual containers. Sample O recorded the highest value, while sample C recorded the lowest value, despite all samples being subjected to the same general food-service environment. Such variation may be associated with differences in cleaning effectiveness, frequency of use, exposure to food residues, handling, drying, or environmental contact. However, these factors were not independently measured in the present study and therefore should be regarded as possible explanations rather than confirmed causes. Future research could strengthen this interpretation by simultaneously evaluating sanitation procedures, container washing methods, drying conditions, frequency of reuse, and microbiological contamination at different stages of the food distribution process.

Implications for Hospital Food Safety

From a hospital food-safety perspective, the finding that all 15 food container boxes complied with the applied microbiological reference limit represents a positive indication of the microbiological condition of the examined containers. Nevertheless, compliance with a numerical limit should not be interpreted as an indication that no further hygiene control is required. Food safety is a continuous process in which contamination risks must be controlled throughout preparation, handling, storage, transportation, and distribution. Research on food-contact surfaces has emphasized that microorganisms can persist on surfaces and that effective sanitation is necessary to minimize opportunities for microbial transfer [10]. In hospital environments, continuous monitoring is particularly important because food services operate within a healthcare setting where the consequences of microbiological contamination may be more significant for vulnerable patients.

The findings therefore support the continued implementation of routine cleaning, disinfection, proper drying, and hygienic handling of food container boxes within the Nutrition Installation. Periodic microbiological monitoring using TPC can complement existing sanitation procedures by providing quantitative evidence of the microbial condition of food-contact surfaces. Such monitoring can help identify changes in contamination levels over time

and provide an objective basis for evaluating whether sanitation practices remain adequate. However, TPC should be considered one component of a broader food-safety monitoring system rather than a standalone indicator of food safety, particularly because it does not determine the identity or pathogenicity of the microorganisms detected.

Comparison With Previous Studies

The findings of this study are broadly consistent with previous studies demonstrating that microorganisms can be detected on food-contact surfaces even when hygiene and sanitation procedures are implemented. Amaiach et al. [12], highlighted the importance of microbiological assessment in evaluating the quality of food-contact surfaces in collective catering, while Bukhari et al. [11], demonstrated the relevance of microbiological evaluation throughout food preparation processes. The present study extends this body of evidence by specifically examining food container boxes used in a hospital Nutrition Installation and quantifying their bacterial load using TPC. Unlike studies that focus primarily on general food preparation surfaces, utensils, or food handlers, this study provides a focused assessment of containers that directly participate in the handling and distribution of meals to patients. The finding that all samples complied with the reference limit suggests that the examined containers were within the acceptable microbiological condition according to the standard applied, while the detection of viable bacteria indicates that continued sanitation and monitoring remain necessary.

CONCLUSION

The study concludes that all 15 food container boxes examined in the Nutrition Installation of a hospital in Gorontalo showed detectable bacterial growth, indicating the presence of viable microorganisms on the examined food-contact surfaces. Nevertheless, the bacterial counts remained below the maximum microbiological reference limit applied in this study, indicating that all examined containers met the applicable microbiological standard. These findings suggest that the microbiological condition of the food container boxes was generally acceptable at the time of examination, although the presence of viable bacteria demonstrates the continuing importance of sanitation control. Therefore, the Nutrition Installation should consistently maintain proper cleaning and disinfection procedures, ensure hygienic handling and adequate drying of food containers, and conduct periodic microbiological monitoring using TPC to detect potential changes in contamination levels. Future studies are also recommended to identify the bacterial species present and examine specific sanitation factors that may influence bacterial contamination, thereby providing a more comprehensive assessment of food container safety in hospital nutrition services.

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