Public Health Frontier

Public Health Frontier, vol. 2, pp. 13–17, 2026
Received 19 Oct 2025/published 10 Feb 2026
https://doi.org/10.36568/phf.v2i1.13

Identification of Fungi in Instant Pecal Sambal Sold at The Traditional Market of Parit Baru Village, Sungai Raya Sub-District

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*Cite (Vancouver): Salshabilla Putri Rizkiana, Supriyanto, Herlinda Djohan Identification of Fungi in Instant Pecal Sambal Sold at The Traditional Market of Parit Baru Village, Sungai Raya Sub-District Public Health Frontier. 2026;2(1):13 -17. doi: 10.36568/phf.v2i1.13

Abstract

Introduction: Indonesia has a tropical climate with high humidity that supports the growth of fungi in food products, including instant pecel sauce. This peanut-based product is easily contaminated by microorganisms, especially when the processing and storage conditions are unhygienic. **Methods:** This research used a descriptive design to identify the presence of fungi in instant pecel sauce sold at the Traditional Market of Parit Baru Village, Sungai Raya District. A total of 20 samples were collected from nine shops using a total sampling method. Fungal identification was carried out through macroscopic examination on Potato Dextrose Agar (PDA) media and microscopic examination using 10% KOH solution. **Results:** Of the 20 samples tested, eight (40%) showed fungal colony growth, while 12 (60%) were negative. Microscopic observation identified three types of contaminating fungi: Aspergillus sp., Rhizopus sp., and Penicillium sp. **Conclusion:** These findings, which reveal that 40% of instant pecel sauce samples were contaminated with potential mycotoxin-producing fungi like Aspergillus sp., Rhizopus sp., and Penicillium sp., highlight the critical need for vendors and small-scale producers to implement targeted improvements. Specifically, enhancing packaging integrity to prevent air exposure, controlling storage humidity in market stalls, and strictly adhering to food hygiene and sanitation principles during production are essential measures to mitigate fungal contamination and ensure product safety and quality for consumers

Keywords: Instant pecel sauce, Fungal contamination, Aspergillus sp., Rhizopus sp., Penicillium sp., Food safety

Introduction

Indonesia is a tropical country with high temperatures and humidity that support fungal growth. Unsanitary environmental conditions can contaminate air with organic and inorganic compounds and trigger health problems due to exposure to microorganisms such as bacteria, viruses, and fungi.[1]

Foodstuffs such as meat, vegetables, fruits, grains, and processed products contain high levels of nutrients that facilitate the growth of microorganisms. Unwanted microbial growth can reduce food quality and pose a risk of disease to consumers.[2] Therefore, food processing and storage must be carried out hygienically to ensure that food is safe for consumption and free of biological, chemical, and physical contamination.[3] Improper processing and storage can trigger the growth of contaminating microorganisms, such as fungi.[4]

Fungi are eukaryotic, non-chlorophyll-containing organisms with cell walls made of chitin or cellulose. Fungi are heterotrophic organisms that produce spores that can be harmful to human health. Their growth is influenced by factors such as humidity, pH, substrate type and temperature.[4] Under ideal environmental conditions, fungi grow optimally and produce mycotoxins. [5] Mycotoxins are toxic compounds resulting from fungal metabolism that reduce the quality and economic value of food and may pose health hazards. Some species, such as Aspergillus sp., produce aflatoxins and ochratoxins; Penicillium sp. produces ochratoxins; and Fusarium sp. produces trichothecenes and fumonisins.[6]

Mycotoxin contamination can cause various health problems, such as liver and kidney damage, digestive and hormonal disorders, and even cancer, especially when accompanied by malnutrition or infection.[7] Food contaminated by fungi usually exhibits a musty odor, discoloration, or moldy surfaces, although it may sometimes appear clean.[5]

Aspergillus and Penicillium are types of fungi that can cause health problems. Aspergillus, especially Aspergillus fumigatus, can lead to lung diseases, mainly in people with weak immune systems. These fungi can cause serious conditions like allergic bronchopulmonary aspergillosis and invasive aspergillosis[8,9] Aspergillus is also a common allergen and can make asthma and other breathing problems worse because it is widespread and can easily grow in the lungs[10,11] Penicillium, often found in buildings with water damage, can also cause allergies and lung diseases. These fungi grow in places with mold, and their spores can worsen asthma and hypersensitivity pneumonitis.[12] It is important to monitor and control these fungi to protect public health.[13]

Aspergillus and Penicillium are types of fungi that can cause health problems. Aspergillus, especially Aspergillus fumigatus, is linked to lung diseases. This is a big issue for people with weak immune systems. These

fungi can lead to serious conditions like allergic bronchopulmonary aspergillosis and invasive aspergillosis.[8,9] Aspergillus is also a common allergen. It can make asthma and other breathing problems worse because it is found everywhere and can easily grow in the lungs [10]

Sambal pecel is a ground peanut-based condiment mixed with other ingredients and used as a seasoning for pecel or gado-gado. This product is often packaged as instant sambal pecel to make it more practical and long-lasting, and preservatives and additional coloring agents are sometimes used.[14] However, prolonged storage still carries the risk of fungal contamination because peanuts are nutrient-rich media. Factors such as pH, temperature, humidity, and nutrient content also influence growth.[15]

Research by Novilasari (2023) showed that out of 18 samples of sambal pecel in Loa Janan District, 11 samples (61%) tested positive for Aspergillus sp., even though they were stored in a refrigerator. This indicates that improper handling and storage can allow mold growth. Similar conditions can be found in traditional markets that have humid and open environments, such as the Parit Baru Market in the Sungai Raya District, Kubu Raya Regency.

The Parit Baru Market was chosen because it is representative of the characteristics of other traditional markets in the area and is easily accessible for sampling. Considering these factors, this study was conducted to identify the presence of mold in instant sambal pecel sold at the Traditional Market of Parit Baru Village, Sungai Raya District, as an effort to support the safety and quality of local food.

Materials and methods

The research design is a plan that explains the methods of data collection and analysis so that the research can proceed efficiently and achieve its objectives.[16] This study used a descriptive design to describe the presence of fungi in instant pecel sauce sold at the Traditional Market in Parit Baru Village, Sungai Raya District, without analyzing the relationships between variables.

Population and Sample

The population of this study consisted of all shops selling instant pecel sauce at the Traditional Market in Parit Baru Village, Sungai Raya District, totaling nine shops.[16] The sample comprised instant pecel sauces sold in these nine shops, totaling 20 samples [17] .The samples were selected using the total sampling method, in which all available instant pecel sauce products were included as research samples.

Research Location

The research will be conducted from November 2024 to June 2025. All laboratory examinations were performed at the Microbiology Laboratory of Poltekkes Kemenkes Pontianak.

Data Type

The data used were primary data, namely the results of laboratory examinations for the presence of contaminant fungi in instant pecel sauce sold at the Traditional Market in Parit Baru Village, Sungai Raya District.

Data Collection Technique

The data collection technique involved total sampling by gathering all brands of instant pecel sauce available at the research location. Each sample was macroscopically observed and tested in the laboratory to detect the presence of contaminant fungi. The observation results were recorded in an examination table and summarized in a research results sheet.

The data collection instruments included laboratory tools and materials used for fungal identification. The researcher collected data with the assistance of a technical supervisor.

Examination Method

Fungal identification was conducted using culture methods on Potato Dextrose Agar (PDA) medium for macroscopic examination, as well as with 10% KOH solution for microscopic examination.

Macroscopic Observation

Fungi were identified based on the color, shape, size, and texture of the colonies grown on PDA medium.

Microscopic Observation

A portion of the fungal colonies was taken using an inoculating loop and placed on an object glass already dropped with 10% KOH. The preparation was covered with a cover glass and observed under a microscope at 10× and 40× magnifications.

Sample Preparation

A total of 50 g of instant pecel sauce was weighed and diluted with distilled water (aquadest) at a ratio of 1:3. The diluted sample was inoculated onto PDA medium using a sterile cotton swab in a three-way zigzag pattern and incubated at room temperature for 7 days[18]

Data Processing Technique

Data processing was performed to organize the raw data so it would be ready for analysis. The initial stage involved coding by assigning codes to each shop and sample to facilitate identification (Notoatmodjo, 2012). Each shop was coded T.A, T.B, and so on, while the instant pecel sauce samples were coded SP.1, SP.2, and so forth.

The research data were then systematically presented in distribution and frequency tables to make them easier to understand (Sugiyono, 2016). Data analysis was performed by calculating the percentage of fungal contamination in the samples using the formula P = f/n × 100%, where P is the percentage, f is the number of contaminated samples, and n is the total number of examined samples. The results were interpreted according to Firdaus (2020), as follows: 100%—all samples contaminated, 76–99%—almost all, 51–74%—most, 50%—half, 26–49%—almost half, 1–25%—a small part, and 0%—none contaminated.

Limitation's

Limitation of this study is the qualitative nature of the fungal identification method. The absence of quantitative data, specifically a colony-forming unit (CFU) count per gram of sample, means we cannot assess the level or extent of contamination. Consequently, the findings cannot be evaluated against national food safety standards, which typically specify maximum microbial limits, and we can only report on the presence or absence of fungi.

Results

This study aimed to identify fungal contamination in instant pecel sauce. Macroscopic examination was performed by observing the characteristics of fungal colonies on the media, including color, shape, size, and texture, while microscopic examination was used to confirm the type of fungus that grew.

Table 1. Frequency of Fungal Contamination in Instant Sambal Pecel Sold at Traditional Markets in Sungai Raya District

No	Fungi contamination	Total	Persentase (%)
1	(+) Positive	8	40
2	(-) Negative	12	60

Based on the results in Table 1, of the 20 samples examined, eight (40%) tested positive for fungal contamination, while 12 (60%) were negative or showed no fungal colony growth. These results indicate that nearly half of the instant pecel sauces sold in traditional markets are contaminated with fungi. The presence of fungi in food products can decrease their quality and pose health risks, especially if the fungi produce mycotoxins that are toxic to humans.

Discussion

Based on the results, a significant proportion (40%) of the instant pecal chili sauce samples tested positive for fungal contamination it was sold at the Traditional Market in Parit Baru Village, Sungai Raya District. The identification results revealed three main types of fungi: Aspergillus sp., Rhizopus sp., and Penicillium sp. These findings were obtained through macroscopic and microscopic observations. Colonies of Aspergillus sp. were round with a rough surface, dark brownish-black in color, and had a dense, yellowish-white base. Microscopically, the hyphae were non-septate (aseptate) and unbranched, and there were conidiophores with vesicles that were round or semi-round, and small, oval conidia arranged neatly at the ends of the sterigmata. According to Alvarez et al. (2010) and Kubicek and Haman (2002)[19], Aspergillus species are characterized by brownish-black colonies with white edges, and some colonies are round with a rough spore texture. Samson et al. (2010), Elmer et al. (1978) (in Simangunsong et al. 2019) state that some Aspergillus fungi have semi-round conidia with long, columnar conidiophores. The vesicles are semi-round and funnel-shaped, and conidia are attached in a single row at the ends of the sterigmata.

Other fungal colonies were grayish-white with a cotton-like surface. Microscopic observations revealed round sporangia, unbranched sporangiophores, aseptate hyphae, and rhizoids resembling roots. Based on these characteristics, the colony was identified as Rhizopus sp. These results are consistent with those of Jagat et al. (2021)[20], who reported that Rhizopus sp. has grayish-white, cotton-like colonies, lacks zonation or radial lines, and microscopically has rhizoids and oval-shaped sporangia.

The third type of fungus had white to yellowish colonies with a cotton-like texture. Microscopically, there were chains of single-celled conidia originating from phialides located at the tips of the branched metulae. Based on these characteristics, the fungus was identified as Penicillium sp. This result is consistent with that of Haryati et al. (2018),[21] who explained that Penicillium sp. forms round colonies that are yellowish-white in color, with a cottony surface. Microscopically, the conidia form long chains with rounded or cylindrical ends, arranged on phialides located at the tips of the metula branches.

The identification of Aspergillus, Rhizopus, and Penicillium species relies on both macroscopic and microscopic characteristics, supported by advanced techniques. Aspergillus species are ubiquitous, with some pathogenic types causing infections in immunocompromised individuals. Their colony morphology, conidiophores, and conidia are key identification features.[22,23] Rhizopus species are molds often associated with decaying organic matter, and some strains are opportunistic pathogens in humans. Their microscopic identification can be based on the presence of rhizoids and sporangia.[24] Penicillium species encompass both beneficial fungi, such as those used in antibiotic production, and spoilage organisms that can produce mycotoxins. The identification of Penicillium can be achieved through its characteristic branched conidiophores with phialides [25,26]

Regarding food safety standards, the Regulation of the Food and Drug Supervisory Agency of the Republic of Indonesia Number 13 of 2019 sets the maximum limit for mold and yeast contamination in chili sauce at 10^3 CFU/gram. However, this study did not involve dilution or colony count in CFU/gram units because the swab method was used. Therefore, the data obtained were qualitative and could not be directly compared to BPOM's standard provisions. The main focus of this study was to identify the types of fungi present.

The occurrence of fungal growth in several samples is thought to be caused by several factors. One of the primary factors is the packaging conditions. Some pecal chili sauce was found in plastic packaging that was not tightly sealed or was not airtight, allowing outside air and fungal spores to enter the package. In addition, the location where the product is sold influences contamination. Most products that tested positive for fungi were sold in the wet market area, close to vendors of raw foodstuffs such as meat and fish. These environments tend to be highly humid and susceptible to cross-contamination. Humidity measurements in these shops ranged between 70% and 80%, which is the optimal range for fungal growth.

Another factor that may contribute is the production process itself. Based on field observations, some pecal chili sauce products come from small-scale producers, such as micro, small, and medium enterprises (MSMEs). Processing and packaging in less hygienic environments can increase the risk of microbial contamination, including fungi. This is consistent with research conducted by Natalia D. B. Payon (2019)[27], which stated that improper storage and processing procedures can trigger fungal growth even after products have been packaged.

In contrast, several pecal chili sauce samples

did not show fungal growth. These negative results are thought to be related to better packaging quality, cleaner and less humid store environments, and well-organized product placements. Stores selling uncontaminated products were generally located in areas not too close to wet goods vendors. The humidity in these stores was measured between 65% and 69%, which is considered too low to optimally support fungal growth. In addition, the products were more neatly and tightly packaged, providing better protection against airborne fungal spores.

Conclusion

This study found that 40% of instant pecel sambal from Parit Baru Market was contaminated with fungi like Aspergillus sp. This is likely due to poor packaging and humid conditions. To ensure food safety, vendors need to be trained on better hygiene and use proper, sealed packaging.

Conflict of interest

The authors declare no conflicts of interest. (Either keep this sentence or describe any conflict of interest.)

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