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FROM DETECTION TO DECISION: THE ROLE OF HOYER'S SOLUTION IN MANAGING IMPORT RISKS OF SOYBEAN COMMODITIES

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Abstract
Indonesia's soybean production in 2022 was only able to meet 5% of the country's soybean consumption needs. Traffic for this commodity increases the risk of Peronospora manshurica, which is a quarantine plant pest organism that causes downy mildew epidemics. Hoyer's solution is known to increase the shelf life of characterization results, thereby increasing efficiency in quarantine activities. This activity aims to analyze the results of imported soybeans characterization using Hoyer's solution. Characterization of imported soybeans with the following stages: 1) administrative inspection, 2) sampling of imported soybean seeds, and 3) direct test. The imported soybeans in this observation were contaminated with P. Manchuria, which visually had greyish-white, crusty seed coats. Hoyers' solution effectively extends the life of preparations and is more efficient because P. Manchuria difficult to identify and cannot be grown on culture media. The discovery of fungi-like white crust symptoms on imported soybeans became the basis for the Animal, Fish, and Plant Quarantine Center's decision to provide fumigation or heating treatment to 80°C before distributing the commodity.

Keywords: *Direct Test; Downy Mildew; Fumigation.*

INTRODUCTION

Soybeans (*Glycine max*) are ranked fifth as the most imported commodity in Indonesia (Fikri, 2022; Triyanti et al., 2019). The value of Indonesia's soybean imports is determined by its consumption level (Statistics Indonesia, 2022). Indonesia's soybean consumption level in 2022 reached 2.9 million tons, but only 5% of which can be met from its own production (Kapli & Athifahullaila, 2022). Indonesia's soybean production in 2015-2022 showed a downward trend, while consumption tended to increase (FAO, 2024; Ministry of Agriculture, 2020). Indonesia's soybean consumption and production needs from 2015 to 2022 are presented in Figure 1.

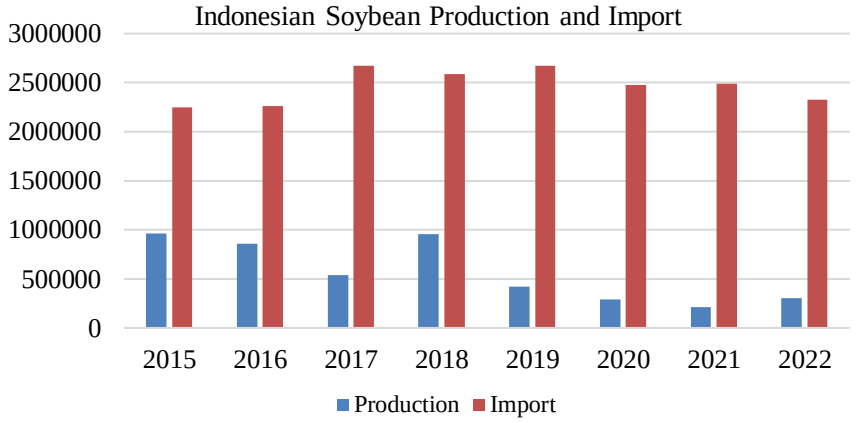

Figure 1. Soybean Consumption and Production 2015-2022
(Source: FAO, 2024; Ministry of Agriculture Data, 2022).

Peronospora manshurica is classified as the main Quarantine Plant Pest Organism in soybeans (Ministry of Agriculture, 2020). The high level of soybean imports correlates with the high risk of spreading *P. manshurica* (Kumala, 2018). Downy mildew is an epidemic caused by *P. manshurica* infection, which decreases the quality and size of soybean seeds (Zuntini et al., 2019; Taguchi-Shiobara et al., 2019). *P. manshurica* is biotrophic and is classified as a fungal organism. This disease has been reported to reduce 8–14% of soybean production in Brazil,

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America, and China (Molina et al., 2022). The development of this disease is very rapid at temperatures of 18–24°C and decreases at temperatures of 30°C (Dunn & Gaynor, 2020). The *P. manshurica* fungus has a high sporulation rate and is easily carried by the wind, making it a dangerous disease for cultivated plants, especially soybeans (Anitha et al., 2020). Indonesia's reliance on imported soybeans is a critical component of its national agribusiness sector. However, the high volume of imports carries a significant phytosanitary risk, primarily the introduction of quarantine plant pest organisms like *P. manshurica*. To minimize this threat and protect the domestic market, all imported commodities must undergo mandatory inspection at the Animal, Fish, and Plant Quarantine Agency.

Service Level Arrangement or the inspection service period for imported soybean commodities is set at only 3x24 hours (Ministry of Agriculture, 2015). The inspection must be economical, effective, and efficient to avoid high costs and prevent disruption to the flow of imported commodities. Soybean commodities that are too long inhibited in containers at high temperatures will accelerate the activity of respiratory enzymes (Rosentrater, 2022). Increased activity of respiratory enzymes can reduce the quality of soybean seeds, increase the rate of nutrient degradation, and affect the development of microorganisms. Innovation in the inspection process is needed to be more effective and efficient. Characterization can be carried out effectively and efficiently with Hoyers' solution so that the shelf life of the preparation increases. This activity can maintain the quality and ensure the safety of imported soybean seeds to prevent the occurrence of a downy mildew epidemic in Indonesia. The results of this activity are expected to provide additional information for importers and the public to ensure the safety of imported soybeans.

RESEARCH METHODS

Research Type and Design

The research was designed with a descriptive observational study, focusing on the characterization of quarantine plant pest organisms found in imported soybean commodities.

Location and Time of Research

The initial sampling and administrative inspection were carried out at TPK Semarang, while laboratory characterization was conducted at the Animal, Fish, and Plant Quarantine Agency. The duration of the study was four months, from July 17 to November 17, 2023. The quarantine plant pest organism characterization method for imported soybean commodities is carried out through several stages, including administrative inspection, sampling of imported soybean seeds, and direct tests.

Administrative Inspection

Administrative inspection takes place at the Terminal Petikemas Semarang (Figure 2). Administrative inspection refers to activities aimed at verifying the completeness, validity, and accuracy of the required documents. The required documents for imported soybean commodities include a Phytosanitary Certificate, Invoice, Bill of Lading, Shipping Instruction, Prior Notice, Certificate of Analysis, Health Certificate, Application for Import of Goods, Packing Declaration, and Entry Permit. The service period for inspecting imported soybean documents is 3x24 hours. Incomplete required documents for imported commodities will result in detention. Invalid or incorrect documents will be rejected. Only complete, valid, and correct documents will proceed to health inspection.

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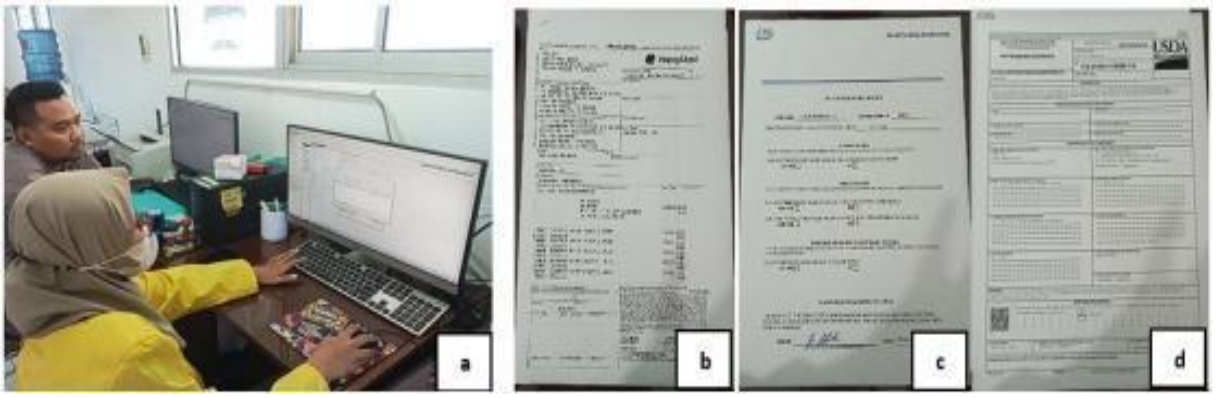

Figure 2. (a) Administrative check of electronic documents. b-d Required documents. (b) Bill of Lading (c) Packing declaration (d) Phytosanitary Certificate.
(Source: Personal Documentation, 2023)

Imported Soybean Seed Sampling

Sampling was conducted by taking each container of imported soybeans that had been recorded in the INSW Quarantine Office Class I Semarang system (Figure 3). The number of containers sampled is regulated in the Regulation of the Minister of Agriculture Number 12 of 2015. Samples from each container were taken using the purposive sampling method. Sampling of soybeans suspected of being infected with *P. manshurica* was carried out near the container door. The selection of this container door was based on the ecobiology of *P. manshurica* which usually lives in humid places. Humid places on ships include those found near container doors that may not be tightly closed, so that water leaks when transported by ship.

Figure 3. Soybean seed sampling. (a) sampling at the container door; (b) soybean samples number I. 4714, I.4715, I.4716, I.4717; (c) sorting of symptomatic soybean seeds.
(Source: Personal Documentation, 2023)

Two kilograms of samples were taken from each container using a Bag Trier and Plastic clips and then labeled. Samples from each document number were then taken to the Mycology Laboratory to select samples with symptoms that were visually visible. Visual observation was carried out to sort symptomatic soybean seeds. Symptomatic seeds are marked with a grayish-white crust on the surface of the soybean seeds. Symptomatic seeds were separated from the others and transferred to a petri dish to facilitate direct examination.

Direct test

The preparation of *P. manshurica* was conducted using a direct test method with Hoyer's solution (Figure 4). Symptomatic soybean seeds were placed on glass slides with Hoyer's solution, covered with a cover slip, and observed under a compound microscope with NIS-D software. Positive preparations were sealed and documented for further analysis.

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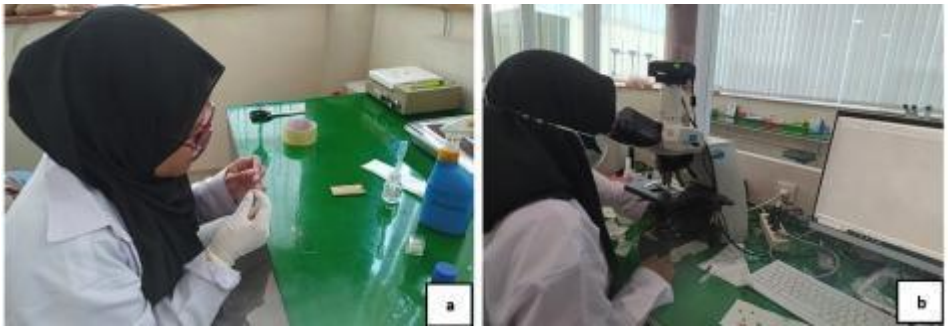

Figure 4. (a) direct test process. (b) observation on compound microscope and NIS-D element.
(Source: Personal Documentation, 2023)

Data Analysis Technique

The data analyzed included primary and secondary data. Primary data was obtained through active participation and direct observation in the field, while secondary data was obtained through interviews with field supervisors and employees, as well as technical manuals and notes from the Animal, Fish, and Plant Quarantine Central Java.

RESULTS AND DISCUSSION

Characterization of imported soybean commodities using Hoyer's as a mounting medium offers practical advantages for inspection, including longer shelf life of preparations and clearer visualization (Lado et al., 2022; Van Caenegem et al., 2023). Efficient preparation using Hoyer's methods helps inspectors work more effectively within this timeframe, while extending the shelf life of preparations for documentation and follow-up analysis. This efficiency is crucial to avoid delays that may increase inspection costs, disrupt commodity flow, and reduce soybean quality due to accelerated respiration and microbial growth during prolonged storage in containers (Rosentrater, 2022).

Visual examination found soybean grains with grayish-white crusts on the seed coat, indicating the imported soybeans were infected by *P. manshurica* (Figure 5). Stereoscopic observation using a computer and NIS-D elements shows the microscopic structure of *P. manshurica* (Figure 6). According to the Regulation of the Minister of Agriculture No. 25 of 2020, soybeans that are infected by *P. manshurica* require mandatory treatment measures. These treatments can be conducted through fumigation or heat treatment. Fumigation using methyl bromide or phosphine must be performed by the National Plant Protection Organization (NPPO) of the country of origin or by an authorized registered company, with the treatment period lasting up to a maximum of 21 days. As an alternative, heat treatment can be applied to targets resistant to phosphine, carried out at a temperature of 80 °C for 24 hours (Sakka et al., 2022). Following successful treatment, the imported soybean commodities may be released, with the release process formalized by the issuance of a Release Certificate, thereby allowing the carrier media to officially enter the territory of the Republic of Indonesia.

Figure 5. Soybean grains visualization. (a) Visual form of *P. manshurica*; (b) Microscopic form of *P. manshurica* in a stereo microscope at 1.5x10 magnification.
(Source: Primary Data, 2023)

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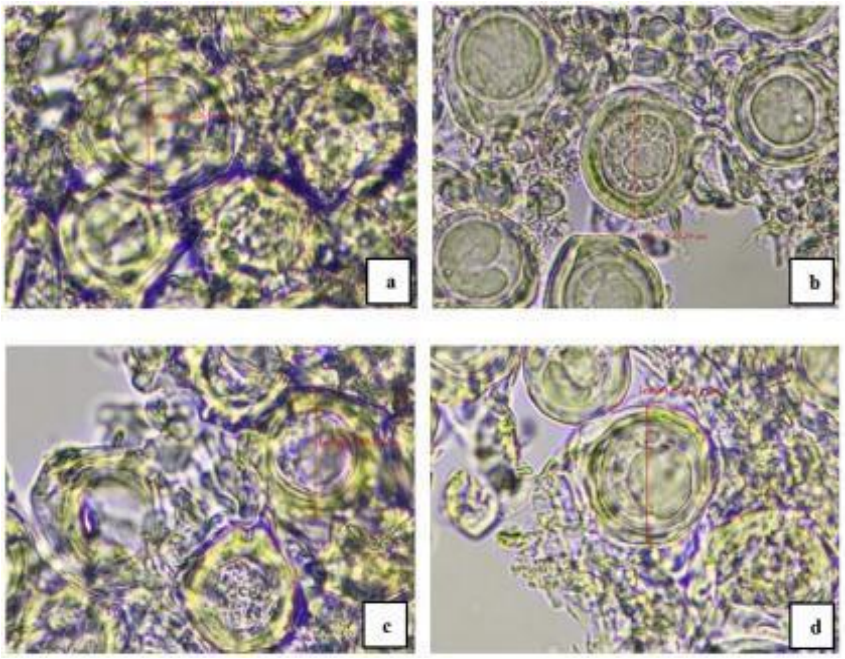

Figure 6. Microscopic observations of *P. manshurica* (a) Sample I.4714 (b) Sample I.4715 (c) Sample I.4716 (c) Sample I.4717.
(Source: Primary Data, 2023)

Indonesia's soybean import procedures are a concrete example of how quarantine regulations play a direct role in maintaining the stability and security of the agribusiness supply chain. Quarantine measures not only ensure that imported commodities are free from quarantine plant pest organisms such as *P. manshurica*, but also guarantee that the supply of soybeans for the food and feed industry remains safe and reliable. This regulation is crucial because soybeans are a strategic agricultural commodity widely used as raw material for tofu, tempeh, soy sauce, livestock feed, and various processed foods that support national food security (Rosentrater, 2022). By implementing strict inspection and treatment procedures, the government minimizes the risk of pest entry that could disrupt domestic agricultural production while also safeguarding the continuity of industrial processing and distribution (Sakka et al., 2022). In this way, quarantine regulations serve not only as a biosecurity measure but also as an integral part of strengthening Indonesia’s agribusiness sector in the face of increasing global trade competition.

Overall, the findings highlight that strict quarantine regulations and effective treatment measures are not only essential for preventing the entry of quarantine plant pest organisms such as *P. manshurica* but also play a pivotal role in safeguarding soybean quality, ensuring a stable supply for the food and feed industry, and strengthening the resilience of Indonesia’s agribusiness sector in the global trade context.

CONCLUSIONS AND SUGGESTIONS

The results of characterization confirmed that the imported soybeans were infected with *P. manshurica*. Characterization using Hoyer as an efficient mountant increases the shelf life of the preparation. Based on these findings, the quarantine office decided to apply fumigation or heat treatment at a temperature of 80 °C before the commodity could be distributed.

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