

MODEL MATEMATIS SIFAT FISIK GABAH VARIETAS INPARI 32 SELAMA PENYIMPANAN DALAM KEMASAN PADA VARIASI SUHU DAN KELEMBAPAN RELATIF

INTISARI

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Gabah merupakan bahan biologis higroskopis yang mutunya mudah berubah selama penyimpanan akibat interaksi dengan suhu dan kelembapan relatif lingkungan. Perubahan kadar air selama penyimpanan dapat memengaruhi aktivitas air, densitas, warna, kerusakan fisik, serta umur simpan gabah. Penelitian ini bertujuan untuk memodelkan perubahan sifat fisik gabah varietas Inpari 32 selama penyimpanan dalam kemasan pada variasi suhu dan kelembapan relatif, serta menentukan kondisi penyimpanan terbaik berdasarkan perubahan mutu dan prediksi umur simpan. Gabah kering giling varietas Inpari 32 dikemas menggunakan karung anyaman polipropilena dan disimpan pada kombinasi suhu 20, 30, dan 40°C dengan kelembapan relatif 50, 70, dan 90%. Penelitian disusun menggunakan rancangan acak lengkap faktorial dengan tiga ulangan. Parameter yang diamati meliputi perubahan massa, kadar air, aktivitas air, densitas, warna, butir rusak, butir hampa, dan benda asing. Pemodelan dilakukan menggunakan pendekatan kesetimbangan massa air, kinetika perubahan mutu, serta *Accelerated Shelf-Life Testing* berbasis kadar air kritis.

Hasil penelitian menunjukkan bahwa suhu, kelembapan relatif, dan interaksinya memengaruhi perubahan sifat fisik gabah selama penyimpanan. Pada RH 50%, gabah cenderung mengalami desorpsi sehingga kadar air menurun dan mutu fisik lebih stabil. Sebaliknya, pada RH 90%, gabah mengalami adsorpsi uap air yang menyebabkan peningkatan kadar air, aktivitas air, serta kerusakan fisik, terutama butir rusak. Model kesetimbangan massa air menunjukkan kemampuan prediksi yang baik dengan nilai koefisien determinasi sebesar 0,9842–0,9990 serta nilai SSE dan RMSE yang rendah. Berdasarkan klasifikasi mutu SNI 0224:2023, butir hampa relatif stabil pada kelas Premium, sedangkan benda asing menjadi salah satu pembatas mutu akhir pada sebagian besar perlakuan. Parameter kadar air dan butir rusak menjadi faktor pembatas utama pada kondisi RH tinggi, khususnya RH 90%. Prediksi umur simpan menunjukkan bahwa kondisi penyimpanan terbaik adalah RH 50% pada suhu 20°C dengan umur simpan sekitar 367–384 hari, sedangkan kondisi paling kritis adalah RH 90% pada suhu 40°C dengan umur simpan sekitar 65–75 hari. Dengan demikian, penyimpanan gabah Inpari 32 sebaiknya dilakukan pada kelembapan relatif rendah hingga sedang dengan suhu terkendali untuk memperlambat kemunduran mutu dan memperpanjang umur simpan.

Kata kunci: gabah, Inpari 32, kelembapan relatif, model matematis, umur simpan

MATHEMATICAL MODELING OF THE PHYSICAL PROPERTIES OF INPARI 32 PADDY DURING PACKAGED STORAGE UNDER DIFFERENT TEMPERATURE AND RELATIVE HUMIDITY

ABSTRACT

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Paddy is a hygroscopic biological material whose quality is highly influenced by storage temperature and relative humidity. During storage, moisture exchange between paddy and the surrounding environment may alter its moisture content, water activity, density, color, physical quality, and shelf life. This study aimed to develop mathematical models describing the changes in the physical properties of Inpari 32 paddy during packaged storage under different temperature and relative humidity conditions, and to determine the most suitable storage condition based on quality deterioration and shelf-life prediction. Dry milled Inpari 32 paddy was packed in woven polypropylene sacks and stored at three temperature levels, namely 20, 30, and 40 °C, combined with three relative humidity levels of 50, 70, and 90%. The experiment was arranged using a factorial completely randomized design with three replications. The observed parameters included mass change, moisture content, water activity, density, color attributes, damaged grains, empty grains, and foreign matter. Mathematical modeling was performed using a water mass-balance approach, quality deterioration kinetics, and Accelerated Shelf-Life Testing based on critical moisture content.

The results showed that temperature, relative humidity, and their interaction affected the physical quality changes of paddy during storage. At 50% RH, paddy tended to undergo desorption, resulting in decreased moisture content and more stable physical quality. In contrast, storage at 90% RH promoted moisture adsorption, which increased moisture content, water activity, and physical deterioration, particularly the percentage of damaged grains. The water mass-balance model showed good predictive performance, with coefficient of determination values ranging from 0.9842 to 0.9990, supported by low SSE and RMSE values. Based on the SNI 0224:2023 quality classification, empty grains remained relatively stable within the Premium class, whereas foreign matter became one of the limiting factors for final quality in most treatments. Moisture content and damaged grains were the main limiting parameters under high relative humidity conditions, especially at 90% RH. Shelf-life prediction indicated that the best storage condition was 50% RH at 20 °C, with an estimated shelf life of approximately 367–384 days, while the most critical condition was 90% RH at 40 °C, with an estimated shelf life of approximately 65–75 days. Therefore, Inpari 32 paddy should be stored under low to moderate relative humidity and controlled temperature conditions to slow quality deterioration and extend its shelf life.

Keywords: paddy, Inpari 32, relative humidity, mathematical model, storage, shelf life