Agrotech Journal
Url: http://usnsj.id/index.php/ATJ
Email: editor.atj@usnsj.com

Effect of The Drying Time of Unhulled Rice on The Rice Quality of Variety Inpari-7

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ARTICLE INFO

e-ISSN: 2548-5148
p-ISSN: 2548-5121
Vol. 7 No. 2, December 2022
URL: http://dx.doi.org/10.31327/atj.v7i2.1871

Abstract

High rice consumption necessitates an improvement in rice quality. Rice quality issues can result from pest attacks, unhulled rice transportation, harvesting, and drying. An alternative is to use a drier to enhance the quality of rice. Therefore, research to evaluate the quality of rice dried in a dryer with various drying times is required. The Rice Milling Unit, Harapan Village Unit Cooperative (VUC), Tiroang Sub-District, Pinrang District, located at coordinates 3O48'41"S and 119O42'5E, was the site of this study. This study was set up using a Randomized Block Design (RBD), with the treatment of unhulled rice drying duration, namely drying according to farmers' customs (A0), drying for 10 hours (A1), and drying for 12 hours (A2) using a dryer at an average temperature of 65OC. The results showed that a good percentage of whole grains, broken grains, groats grains, whitewash grains, yellow grains, red grains, unhulled grains, and foreign grains were obtained by drying the grain using a dryer for 12 hours. The novelty of this research is the finding of the right unhulled rice drying time using a dryer

Keywords: carbohydrates, drying floor, head rice, red grains, rice quality

A. Introduction

Rice is one of the food crop products that are consumed daily by the community. Rice is used as the main source of carbohydrates (Wan, J., Wu, Y., Pham, Q., Li, R. W., Yu, L., Chen, M. H., Boue, S. M., Yokoyama, W., Li, B., & Wang, T. T. Y. 2021; Wang, Z., Wei, K., Xiong, M., Wang, J.-D., Zhang, C.-Q., Fan, X.-L., Huang, L.-C., Zhao, D.-S., Liu, Q.-Q., & Li, Q.-F., 2021) because it is easy to obtain, tastes good, and can be combined with other food ingredients

In economics, rice is the source of income for people, the economic stability index, and the main basis for government food policies (Arifin, A., Biba, M. A., & Syafiuddin, S., 2021; Suvi, W. T., Shimelis, H., & Laing, M. 2020), this causes the quality of rice production to be considered. The phenomenon of low rice quality will affect the selling price and consumer interest in consuming rice.

The low quality of rice can be caused by a slow harvesting process (Zhang, N., Wu, W., Wang, Y., & Li, S., 2021; Zhang, N., Wu, W., Li, S., Wang, Y., Ma, Y., Meng, X., & Zhang, Y., 2022), which causes the rice plants to fall down and the rice seeds to germinate. In addition, the slow transport of unhulled rice from ricefields to unhulled rice processing site (An, K., Kim, S., Shin, S., Min, H., & Kim, S. 2021; Said, S. A., Darma, R., & Tenriawaru, A. N., 2021) causes the drying process to be slow and resulting in the unhulled rice turning black and the rice brown. Another phenomenon is the not-right unhulled rice drying process and the presence of Paraeucosmetus pallicornis attacks (Abdullah, T., Aminah, S. N., Kuswinanti, T., Nurariaty, A., Gassa, A., Nasruddin, A., & Fatahuddin, F., 2020; Sjam, S., Surapati, U., Adiwena, Syatri, A., Dewi, V. S., & Rosmana, A., 2018) which cause the skin of the unhulled rice to become spots, so the rice tastes not better when consumed

The community has not understood good unhulled rice drying techniques, so they still rely on natural drying by utilizing sunlight and drying floors. Drying in this way still has several obstacles and shortcomings. One of which is unfavorable weather, which can result in poor drying effectiveness it greatly affects the quality of rice and its shelf life.

Using a dryer is an alternative that can solve the problem of drying rice and can be used in unfavorable weather. Therefore, research is needed to determine the quality of rice dried in dryers with different drying times. The novelty of this study is to find out the proper drying time in the dryer.

B. Methology

This research was carried out at the rice mill unit of the Harapan Village Unit Cooperative (VUC), Tiroang District, Pinrang District (coordinates: 30°48'41" S, 119°42'5" E).

1. Research Methods

The studies were designed based on a Randomized Block Design (RBD) with the treatment of drying time for rice grains, namely drying time according to farmers' habits (Control, A0), drying time of 10 hours (A1), and drying time of 12 hours (A2), drying for 10 and 12 hours using a dryer at an average temperature of 65OC. Each treatment was carried out 3 times. The rice quality components observed were based on the Indonesian National Standard (SNI, 6128/2008), namely: whole grains (%), broken grains (%), groats grains (%), whitewashing grains (%), yellow grains(%), red grains(%), unhulled grains (grains/100 g) (%) and foreign grains (%).

2. Data Analysis

Observational data were analyzed using analysis of variance based on a randomized block design, and Duncan's test was continued if the treatment showed a significant effect.

C. Result and Discussion

The results of the analysis of variance showed that the difference in drying time had a significant effect on the physical quality of rice. Duncan's test results showed that drying for 12 hours resulted in a higher percentage of whole grains and a lower percentage of broken grains and groats, as shown in Figure 1.

Whole rice grains are rice grains that are not broken and expressed as percentages (Müller, A., Nunes, M. T., Maldaner, V., Coradi, P. C., Moraes, R. S. de, Martens, S., Leal, A. F., Pereira, V. F., & Marin, C. K., 2022; Scariot, M. A., Karlinski, L., Dionello, R. G., Radünz, A. L., & Radünz, L. L., 2020) so that they have the best quality of rice and have a negative correlation with grains of broken and groats (Indrasari, S. D., Apriyati, E., Purwaningsih, H., Ardhiyanti, S. D., Kusbiantoro, B., Wening, R. H., & Usyati, N., 2022; Sulistyo, A., Mubarak, A., & Hendris, 2021). Figure 1 shows that the drying of 12 hours with a dryer resulted in the percentage of whole rice grains being 96.61%. Drying of 12 hours using a dryer possibility to be able to reduce the moisture content of unhulled rice up to 14% so that the rice grains have strong bonds between particles and unbroken.

Rice quality requirements SKI 6128/2008 state that drying for 12 hours using a dryer is in quality I, while the floor drying system is categorized as quality IV. Drying for 10 hours using a dryer is not recommended because it does not meet the requirements of SNI. (Badan Stardarisasi Nasional-BSN, 2008).

Broken rice grains are rice grains that are broken and have a size of 0.2 mm to 0.6 mm from the whole rice grains, while the groats rice grains are rice grains with a smaller size of 0.2 mm that are also part of grains of whole rice. The use dryer with a drying time of 12 hours will produce broken rice grains classified as quality I, while the use of a dryer in the form of a drying floor will result in broken rice grains classified as quality II (Badan Stardarisasi Nasional-BSN, 2008).

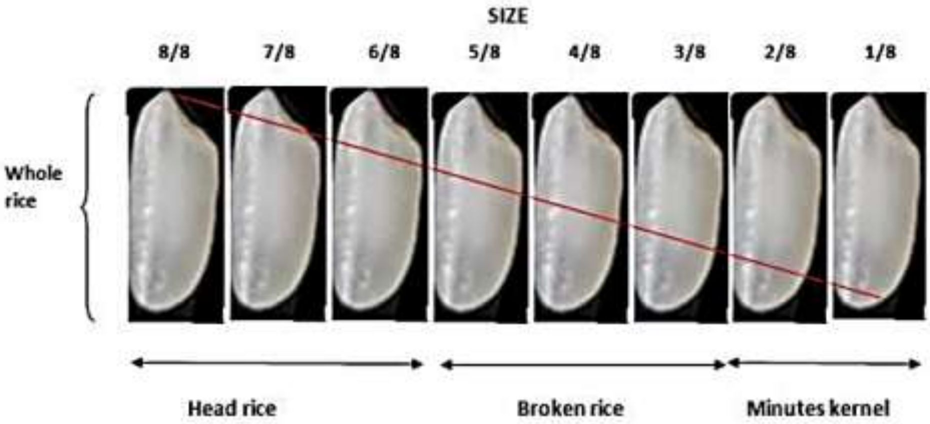

Figure 1. Shape and size for rice (https://www.jica.go.jp)

Figure 2 shows the percentages of broken rice grains and groats rice grains which are higher for drying using a drying floor and dryer for 10 hours. This is probably because of the relatively high unhulled rice water content (>14%), so the pores between the starch crystals bind larger to water, and the bonds between the amylum crystals become weak and break easily (Chumsri, P., Panpipat, W., Cheong, L. Z., & Chaijan, M., 2022; Gabriel, A. A., Solikhah, A. F., & Rahmawati, A. Y., 2021).

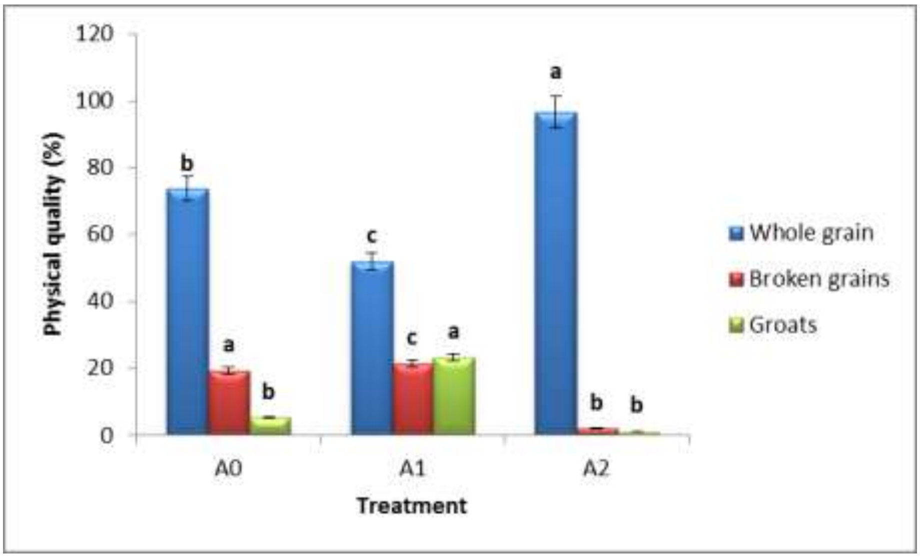

Figure 2. The average percentage of whole rice grains, broken rice grains, and groats rice grains in the treatment of unhulled rice drying time on the quality of rice grains varieties inpari-7. Drying time according to farmers' habits (Control, A0), drying time of 10 hours (A1), and drying time of 12 hours (A2), drying for 10 and 12 hours using a dryer

The microstructure of rice grains shows clusters of irregular starch crystals (Khan, A. H., Min, L., Ma, Y., Zeeshan, M., Jin, S., & Zhang, X., 2022; Lin, G., Yang, Y., Chen, X., Yu, X., Wu, Y., & Xiong, F., 2020). Different rice varieties have different crystal sizes and the influenced by genetic factors and pre-and post-harvest treatment of rice (Cao, C., Shen, M., Hu, J., Qi, J., Xie, P., & Zhou, Y., 2020; Indrasari et al., 2022; Li, Y., Liu, H., Wang, Y., Shabani, K. I., Qin, X., & Liu, X. Y., 2020). Figure. 3 shows microscopically that large rice crystals are composed of smaller crystals. Each starch crystal is encased in a transparent film, which makes the starch crystal tighter and cleaner, making the coated crystals appear smoother. The pores between the crystals are also clearly shown in Figure. 3.

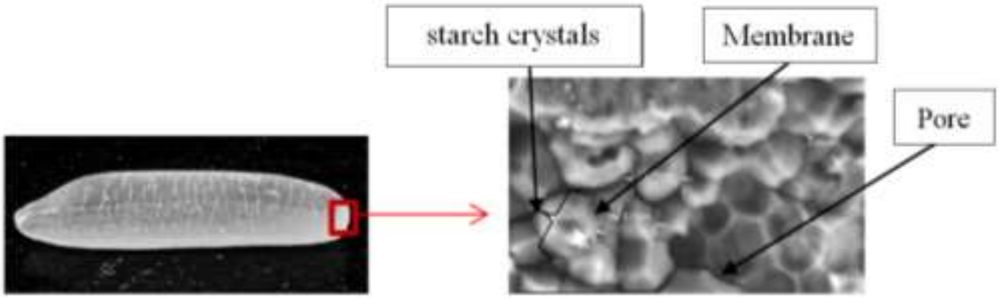

Figure 3. Microstructure of rice grains

The starch crystals in rice are composed of two glucose polymers (amylose and amylopectin) bound by glycosidic bonds (He & Wei, 2020; Jin & Xu, 2020; Zhu, J., Yu, W., Zhang, C., Zhu, Y., Xu, J., Li, E., Gilbert, R. G., & Liu, Q., 2020) The smaller the amylose content or higher the amylopectin content, the fluffier the rice (Bautista & Counce, 2020; Munawar & Sabaruddin, 2021). Furthermore, the fluffier of rice, the smaller the starch crystal density value, so the rice is easily broken (Li, H., Liu, B., Bess, K., Wang, Z., Liang, M., Zhang, Y., Wu, Q., & Yang, L., 2022; Wang, G., Yan, X., Wang, B., Hu, X., Chen, X., & Ding, W., 2022).

The pores between the starch crystals function as channels for liquid absorption from the environment into the rice (Rajabnezhad,S., Ghafourian, T., Rajabi-Siahboomi, A., Missaghi, S., Naderi, M., Salvage, J. P., & Nokhodchi, A., 2020; Sarifudin, A., Keeratiburana, T., Soontaranon, S., Tangsathitkulchai, C., & Tongta, S., 2020). The smaller the pores in rice, the faster absorption of liquids into the rice (Aravind, N. R., Sathyan, D., & Mini, K. M., 2020; Keeratiburana, T., Hansen, A. R., Soontaranon, S., Blennow, A., & Tongta, S., 2020). Thus, the pore size of rice can determine the value of its compressive strength (Jaya N. A., Yun-Ming, L., Cheng-Yong, H., Abdullah, M. M. A. B., & Hussin, K., 2020; Vieira, A. P., Toledo Filho, R. D., Tavares, L. M., & Cordeiro, G. C., 2020). The larger the pore space and the greater the porosity value of rice, the more fragile the rice, so the compressive strength value will be smaller (Nuaklong P., Jongvivatsakul, P., Pothisiri, T., Sata, V., & Chindaprasirt, P., 2020; Rattanachu, P., Toolkasikorn, P., Tangchirapat, W., Chindaprasirt, P., & Jaturapitakkul, C., 2020).

The rice milling process is a process that changes unhulled rice into rice, where unhulled rice experience a physical process to release the husk (husk). So, recommended the water content of unhulled rice reaches 14% (Arsyad & Maryam, 2020; Saeed, A. A. H., Harun, N. Y., Bilad, M. R., Afzal, M. T., Parvez, A. M., Roslan, F. A. S., Rahim, S. A., Vinayagam, V. D., & Afolabi, H. K. 2021; Utami & Ulfa, 2022). If the water content of unhulled rice is lower than 14%, the rice grains will easy to break (Mahanani & Inrianti, 2021; Yang, W., Zheng, Y., Sun, W., Chen, S., Liu, D., Zhang, H., Fang, H., Tian, J., & Ye, X., 2020), so rice produced is more in the form of broken rice grains. Meanwhile, if the water content of unhulled rice exceeds 14%, the grinder machine will work very hard, and the resulting bran will clog the sieve holes during grinding, so the rice produced is easily cracked and broken (Kumoro, A. C., Lukiwati, D. R., Praseptiangga, D., Djaeni, M., Ratnawati, R., Hidayat, J. P., & Utari, F. D., 2019; Permatasari, 2020; Tang, Z., Li, Y., Zhang, B., Wang, M., & Li, Y., 2020).

Rice color is a characteristic of rice that can be directly assessed and can influence consumer decisions in choices. The rice color is a significant sensory parameter. Usually, the whiter the rice color, the higher the price (Arslan, M., Zareef, M., Tahir, H. E., Guo, Z., Rakha, A., Xuetao, H., Shi, J., Zhihua, L., Xiaobo, Z., & Khan, M. R., 2022; Jeesan & Seo, 2020). Muller et al., (2022) and Ziegler, V., Paraginski, R. T., & Ferreira, C. D (2021) stated that the factors that affect the color or browning of rice are temperature, humidity, grain moisture content, and storage time.

Analysis of variance showed that the percentage of whitewashing grains and yellow grains were influenced by differences in the drying time of the unhulled rice, while red grains were not affected by the drying time of unhulled rice. The results of Duncan's test showed that drying for 12 hours gave a percentage of red grain and yellow grains that were different from other treatments with lower percentage values, as shown in Figure 4.

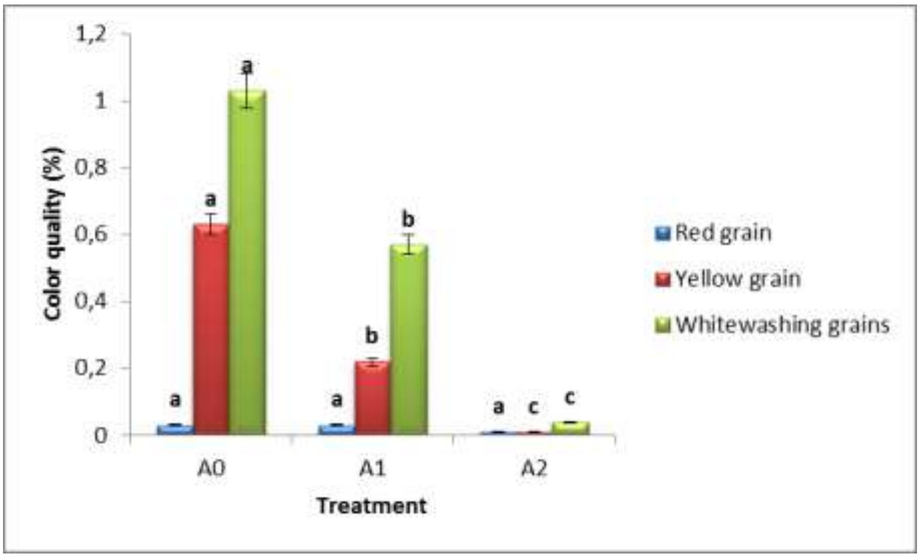

Figure 4. The average percentage of whitewashing grains, yellow grains, and red grains in the treatment of unhulled rice drying time on the quality of rice grains varieties inpari-7. Drying time according to farmers' habits (Control, A0), drying time of 10 hours (A1), and drying time of 12 hours (A2), drying for 10 and 12 hours using a dryer

Yellow grains are whole rice grains, broken rice grains, or groats that are yellow, yellow-brown, or pseudo-yellow caused to physical processes or activities of microorganisms (De, 2020; Ziegler et al., 2021). Generally, rice with water content > 14% will degrade caused of non-enzymatic browning reactions by the reaction between reducing sugars and groups of amine free from amino acids or proteins (Maillard reaction). The Maillard reaction will cause the rice to be yellow to brown (Lang, G. H., Kringel, D. H., Acunha, T. dos S., Ferreira, C. D., Dias, Á. R. G., Zavareze, E. da R., & de Oliveira, M., 2020; Liu, Y., Shad, Z. M., Strappe, P., Xu, L., Zhang, F., Chen, Y., & Li, D., 2022). In addition, the attack of fungus also causes rice that yellow color (Jamali, H., Sharma, A., Roohi, & Srivastava, A. K., 2020).

Grains whitewash are rice grains that are half or more white like chalk (chalky) and have a soft texture caused by physiological factors (Utami & Ulfa, 2022). One of the factors that cause the rice to whitewash is not optimal harvest time, so it produces green grains, and when in the mill obtained grains are whitewashed, and consumers do not like milled rice which has whitewashed grains high percentage of caused easy attack by pests during storage. (Yuriansyah, 2017).

Foreign objects are something that not classified as rice, such as straw, bran, panicles, gravel, soil grains, sand, metal, wood pieces, glass pieces, other grains, dead insects, and other objects (Millati, T., Alhakim, H. M., & Febriana, F., 2021; Yuriansyah, 2017). While, the unhulled rice grain is unhulled rice that has not been or partially exfoliated in the milling process, including broken rice grains that still have husks (Iswanto, P. H., Dr. Ir. Arief RM Akbar, M., & S.TP.Meng Sc, A. R., 2018; Yuriansyah, 2017).

Analysis of variance showed that the difference in drying time did not significantly affect the percentage of milled rice impurities as indicated by the average percentage of unhulled rice grain and foreign objects. The average of percentage unhulled rice grain and rice impurities found in 12 hours of drying was lower than according to farmers' habits and 10 hours of drying time, as shown in Figure 5.

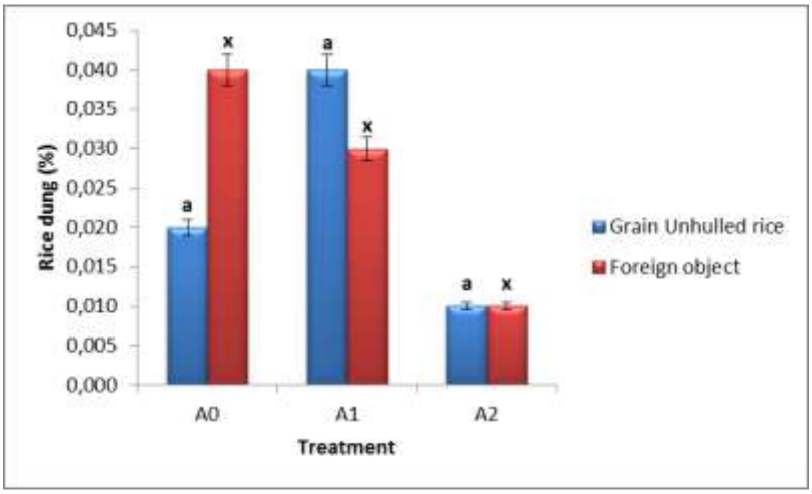

Figure 5. The average percentage of unhulled rice grain and rice impurities in the treatment of unhulled rice drying time on the quality of rice grains varieties inpari-7. Drying time according to farmers' habits (Control, A0), drying time of 10 hours (A1), and drying time of 12 hours (A2), drying for 10 and 12 hours using a dryer

D. Conclusion

The quality of rice using a dryer for 12 hours of drying showed a better percentage of whole grains/head rice, broken grains, groats, grain whitewash, yellow/broken grains, red grains, unhulled grains, and foreign grains compared to other treatments.

E. References

Abdullah, T., Aminah, S. N., Kuswinanti, T., Nurariaty, A., Gassa, A., Nasruddin, A., & Fatahuddin, F. (2020). The role of ants (Hymenoptera: Formicidae) in rice field. IOP Conference Series: Earth and Environmental Science, 486(1). https://doi.org/10.1088/1755-1315/486/1/012167.

An, K., Kim, S., Shin, S., Min, H., & Kim, S. (2021). Optimized supply chain management of rice in south korea: Location–allocation model of rice production. Agronomy, 11(2), 1–14. https://doi.org/10.3390/agronomy11020270.

Aravind, N. R., Sathyan, D., & Mini, K. M. (2020). Rice husk incorporated foam concrete wall panels as a thermal insulating material in buildings. Indoor and Built Environment, 29(5), 721–729. https://doi.org/10.1177/1420326X19862017.

Arifin, A., Biba, M. A., & Syafiuddin, S. (2021). The contribution of rainfed rice farming to income and food security of farmers' household. Journal of Socioeconomics and Development, 4(2), 180. https://doi.org/10.31328/jsed.v4i2.2252.

Arslan, M., Zareef, M., Tahir, H. E., Guo, Z., Rakha, A., Xuetao, H., Shi, J., Zhihua, L., Xiaobo, Z., & Khan, M. R. (2022). Discrimination of rice varieties using smartphone-based colorimetric sensor arrays and gas chromatography techniques. Food Chemistry, 368(March 2021), 130783. https://doi.org/10.1016/j.foodchem.2021.130783.

Arsyad, M., & Maryam, S. (2020). Evaluasi Tingkat Kualitas dan Mutu Beras Hasil Penggilingan Padi di Kecamatan Duhiadaa Kabupaten Pohuwato. Perbal: Jurnal Pertanian Berkelanjutan, 8(1), 8–18.

Badan Stardarisasi Nasional-BSN. (2008). SNI 6128:2008 Beras. https://www.bsn.go.id.

Bautista, R. C., & Counce, P. A. (2020). An Overview of Rice and Rice Quality. Cereal Foods World, 65(5). https://doi.org/10.1094/cfw-65-5-0052.

Cao, C., Shen, M., Hu, J., Qi, J., Xie, P., & Zhou, Y. (2020). Comparative study on the structure-properties relationships of native and debranched rice starch. CYTA - Journal of Food, 18(1), 84–93. https://doi.org/10.1080/19476337.2019.1710261.

Chumsri, P., Panpipat, W., Cheong, L. Z., & Chaijan, M. (2022). Formation of Intermediate Amylose Rice Starch–Lipid Complex Assisted by Ultrasonication. Foods, 11(16). https://doi.org/10.3390/foods11162430.

De, S. (2020). Strategies of Plant Biotechnology to Meet the Increasing Demand of Food and Nutrition in India. International Annals of Science, 10(1), 7–15. https://doi.org/10.21467/ias.10.1.7-15.

Gabriel, A. A., Solikhah, A. F., & Rahmawati, A. Y. (2021). Tensile Strength and Elongation Testing for Starch-Based Bioplastics using Melt Intercalation Method: A Review. Journal of Physics: Conference Series, 1858(1). https://doi.org/10.1088/1742-6596/1858/1/012028.

He, W., & Wei, C. (2020). A critical review on structural properties and formation mechanism of heterogeneous starch granules in cereal endosperm lacking starch branching enzyme. Food Hydrocolloids, 100, 105434. https://doi.org/10.1016/j.foodhyd.2019.105434.

Indrasari, S. D., Apriyati, E., Purwaningsih, H., Ardhiyanti, S. D., Kusbiantoro, B., Wening, R. H., & Usyati, N. (2022). Physical, milling quality and physicochemical characteristics of local rice cultivars from South Kalimantan, Indonesia. IOP Conference Series: Earth and Environmental Science, 1024(1), 012060. https://doi.org/10.1088/1755-1315/1024/1/012060.

Iswanto, P. H., Dr. Ir. Arief RM Akbar, M., & S.TP.MengSc, A. R. (2018). Pengaruh Kadar Air Gabah Terhadap Mutu Fisik Beras Giling (in Bahasa). Jtam Inovasi Agroindustri, 1(1), 12–23.

Jamali, H., Sharma, A., Roohi, & Srivastava, A. K. (2020). Biocontrol potential of Bacillus subtilis RH5 against sheath blight of rice caused by Rhizoctonia solani. Journal of Basic Microbiology, 60(3), 268–280. https://doi.org/10.1002/jobm.201900347.

Jaya, N. A., Yun-Ming, L., Cheng-Yong, H., Abdullah, M. M. A. B., & Hussin, K. (2020). Correlation between pore structure, compressive strength and thermal conductivity of porous metakaolin geopolymer. Construction and Building Materials, 247, 118641. https://doi.org/10.1016/j.conbuildmat.2020.118641.

Jeesan, S. A., & Seo, H. S. (2020). Color-induced aroma illusion: Color cues can modulate consumer perception, acceptance, and emotional responses toward cooked rice. Foods, 9(12), 1–19. https://doi.org/10.3390/foods9121845.

Jin, Q., & Xu, X. (2020). Microstructure, gelatinization and pasting properties of rice starch under acid and heat treatments. International Journal of Biological Macromolecules, 149, 1098–1108. https://doi.org/10.1016/j.ijbiomac.2020.02.014.

Keeratiburana, T., Hansen, A. R., Soontaranon, S., Blennow, A., & Tongta, S. (2020). Porous high amylose rice starch modified by amyloglucosidase and maltogenic α-amylase. Carbohydrate Polymers, 230, 115611. https://doi.org/10.1016/j.carbpol.2019.115611.

Khan, A. H., Min, L., Ma, Y., Zeeshan, M., Jin, S., & Zhang, X. (2022). High-temperature stress in crops male sterility yield loss and potential remedy approaches. Plant Biotechnology Journal, 2022, 1–18. https://doi.org/10.1111/pbi.13946.

Kumoro, A. C., Lukiwati, D. R., Praseptiangga, D., Djaeni, M., Ratnawati, R., Hidayat, J. P., & Utari, F. D. (2019). Effect of drying and milling modes on the quality of white rice of an Indonesian long grain rice cultivar. Acta Scientiarum Polonorum, Technologia Alimentaria, 18(2), 195–203. https://doi.org/10.17306/J.AFS.2019.0657.

Lang, G. H., Kringel, D. H., Acunha, T. dos S., Ferreira, C. D., Dias, Á. R. G., Zavareze, E. da R., & de Oliveira, M. (2020). Cake of brown, black and red rice: Influence of transglutaminase on technological properties, in vitro starch digestibility and phenolic compounds. Food Chemistry, 318(February), 126480. https://doi.org/10.1016/j.foodchem.2020.126480.

Li, H., Liu, B., Bess, K., Wang, Z., Liang, M., Zhang, Y., Wu, Q., & Yang, L. (2022). Impact of Low-Temperature Storage on the Microstructure, Digestibility, and Absorption Capacity of Cooked Rice. Foods, 11, 1642. https://doi.org/10.3390/foods11111642.

Li, Y., Liu, H., Wang, Y., Shabani, K. I., Qin, X., & Liu, X. (2020). Comparison of structural features of reconstituted doughs affected by starches from different cereals and other botanical sources. Journal of Cereal Science, 93, 102937. https://doi.org/10.1016/j.jcs.2020.102937.

Lin, G., Yang, Y., Chen, X., Yu, X., Wu, Y., & Xiong, F. (2020). Effects of high temperature during two growth stages on caryopsis development and physicochemical properties of starch in rice. International Journal of Biological Macromolecules, 145, 301–310. https://doi.org/10.1016/j.ijbiomac.2019.12.190.

Liu, Y., Shad, Z. M., Strappe, P., Xu, L., Zhang, F., Chen, Y., & Li, D. (2022). A review on rice yellowing: Physicochemical properties, affecting factors, and mechanism. Food Chemistry, 370, 131265. https://doi.org/10.1016/j.foodchem.2021.131265.

Mahanani, A. U., & Inrianti. (2021). Perbandingan tumpukan beras Bulog terhadap populasi kutu beras (Sitophilus oryzae L.) dan mutu beras selama masa simpan di Kabupaten Jayawijaya. Jurnal Ilmiah Pertanian, 17(2), 86–92. https://doi.org/10.31849/jip.v17i2.5191.

Millati, T., Alhakim, H. M., & Febriana, F. (2021). Mutu Giling dan Warna Beberapa Varietas Beras di Banjarbaru. Prosiding Seminar Nasional Lingkungan Lahan Basah, 6(1), 1–6.

Müller, A., Nunes, M. T., Maldaner, V., Coradi, P. C., Moraes, R. S. de, Martens, S., Leal, A. F., Pereira, V. F., & Marin, C. K. (2022). Rice Drying, Storage and Processing: Effects of Post-Harvest Operations on Grain Quality. Rice Science, 29(1), 16–30. https://doi.org/10.1016/j.rsci.2021.12.002.

Munawar, A. A., & Sabaruddin, Z. (2021). Fast classification of rice (Oryza sativa) cultivars based on fragrance and environmental origins by means of near infrared spectroscopy. IOP Conference Series: Earth and Environmental Science, 644(1). https://doi.org/10.1088/1755-1315/644/1/012003.

Nuaklong, P., Jongvivatsakul, P., Pothisiri, T., Sata, V., & Chindaprasirt, P. (2020). Influence of rice husk ash on mechanical properties and fire resistance of recycled aggregate high-calcium fly ash geopolymer concrete. Journal of Cleaner Production, 252. https://doi.org/10.1016/j.jclepro.2019.119797.

Permatasari, A. (2020). Factors That Affect Rice Crops Price Estimation Based on Grain Mill Enterprise in Ploso Jombang, Indonesia. Social Sciences Studies Journal, 6(71), 4371–4377. https://doi.org/10.26449/sssj.2656.

Rajabnezhad, S., Ghafourian, T., Rajabi-Siahboomi, A., Missaghi, S., Naderi, M., Salvage, J. P., & Nokhodchi, A. (2020). Investigation of water vapour sorption mechanism of starch-based pharmaceutical excipients. Carbohydrate Polymers, 238(January), 116208. https://doi.org/10.1016/j.carbpol.2020.116208.

Rattanachu, P., Toolkasikorn, P., Tangchirapat, W., Chindaprasirt, P., & Jaturapitakkul, C. (2020). Performance of recycled aggregate concrete with rice husk ash as cement binder. Cement and Concrete Composites, 108, 103533. https://doi.org/10.1016/j.cemconcomp.2020.103533.

Saeed, A. A. H., Harun, N. Y., Bilad, M. R., Afzal, M. T., Parvez, A. M., Roslan, F. A. S., Rahim, S. A., Vinayagam, V. D., & Afolabi, H. K. (2021). Moisture content impact on properties of briquette produced from rice husk waste. Sustainability (Switzerland), 13(6). https://doi.org/10.3390/su13063069.

Said, S. A., Darma, R., & Tenriawaru, A. N. (2021). Marketing Efficiency in Rice Commodity Supply Chain Management in Kalukku District, West Sulawesi Province. IOP Conference Series: Earth and Environmental Science, 921(1). https://doi.org/10.1088/1755-1315/921/1/012089.

Sarifudin, A., Keeratiburana, T., Soontaranon, S., Tangsathitkulchai, C., & Tongta, S. (2020). Pore characteristics and structural properties of ethanol-treated starch in relation to water absorption capacity. Lwt, 129(May), 109555. https://doi.org/10.1016/j.lwt.2020.109555.

Scariot, M. A., Karlinski, L., Dionello, R. G., Radünz, A. L., & Radünz, L. L. (2020). Effect of drying air temperature and storage on industrial and chemical quality of rice grains. Journal of Stored Products Research, 89. https://doi.org/10.1016/j.jspr.2020.101717.

Sjam, S., Surapati, U., Adiwena, Syatri, A., Dewi, V. S., & Rosmana, A. (2018). Detection of fungi from rice black bug Paraeucosmetus pallicornis Dallas (Hemiptera: Lygaeidae) and inhibition with crude extract of Calatropis gigantea (Asclepiadaceae). IOP Conference Series: Earth and Environmental Science, 157(1). https://doi.org/10.1088/1755-1315/157/1/012038.

Sulistyo, A., Mubarak, A., & Hendris. (2021). A Hedonic Pricing Model of Rice in Traditional Markets. IOP Conference Series: Earth and Environmental Science, 748(1), 012022. https://doi.org/10.1088/1755-1315/748/1/012022.

Suvi, W. T., Shimelis, H., & Laing, M. (2020). Farmers' perceptions, production constraints and variety preferences of rice in Tanzania. Journal of Crop Improvement, 00(00), 1–18. https://doi.org/10.1080/15427528.2020.1795771.

Tang, Z., Li, Y., Zhang, B., Wang, M., & Li, Y. (2020). Controlling rice leaf breaking force by temperature and moisture content to reduce breakage. Agronomy, 10(5). https://doi.org/10.3390/agronomy10050628.

Utami, A. U., & Ulfa, R. (2022). Efek Lama Pengeringan Terhadap Kadar Air Gabah Dan Mutu Beras Ketan. Jurnal Teknologi Pangan Dan Ilmu Pertanian (JIPANG), 4(6). https://ejournal.unibabwi.ac.id/index.php/jipang/article/view/2031%0Ahttps://ejournal.unibabwi.ac.id/index.php/jipang/article/download/2031/1315.

Vieira, A. P., Toledo Filho, R. D., Tavares, L. M., & Cordeiro, G. C. (2020). Effect of particle size, porous structure and content of rice husk ash on the hydration process and compressive strength evolution of concrete. Construction and Building Materials, 236, 117553. https://doi.org/10.1016/j.conbuildmat.2019.117553.

Wan, J., Wu, Y., Pham, Q., Li, R. W., Yu, L., Chen, M. H., Boue, S. M., Yokoyama, W., Li, B., & Wang, T. T. Y. (2021). Effects of Differences in Resistant Starch Content of Rice on Intestinal Microbial Composition. Journal of Agricultural and Food Chemistry, 69(28), 8017–8027. https://doi.org/10.1021/acs.jafc.0c07887.

Wang, G., Yan, X., Wang, B., Hu, X., Chen, X., & Ding, W. (2022). Effects of milling methods on the properties of rice flour and steamed rice cakes. Lwt, 167(August), 113848. https://doi.org/10.1016/j.lwt.2022.113848.

Wang, Z., Wei, K., Xiong, M., Wang, J.-D., Zhang, C.-Q., Fan, X.-L., Huang, L.-C., Zhao, D.-S., Liu, Q.-Q., & Li, Q.-F. (2021). Glucan Water-Dikinase 1 GWD1 an ideal biotechnological target for potential improving yield and quality in rice. Plant Biotechnologi Journal, 2021(19), 2606–2618. https://doi.org/10.1111/pbi.13686.

Yang, W., Zheng, Y., Sun, W., Chen, S., Liu, D., Zhang, H., Fang, H., Tian, J., & Ye, X. (2020). Effect of extrusion processing on the microstructure and in vitro digestibility of broken rice. Lwt, 119, 108835. https://doi.org/10.1016/j.lwt.2019.108835.

Yuriansyah, Y. (2017). Milled Rice Quality Evaluation of Some Hope Strain Rice Field Rice (Oryza sativa L.). Jurnal Penelitian Pertanian Terapan, 17(1), 66–76. https://doi.org/10.25181/jppt.v17i1.42.

Zhang, N., Wu, W., Li, S., Wang, Y., Ma, Y., Meng, X., & Zhang, Y. (2022). Comprehensive Evaluation of Paddy Quality by Different Drying Methods , Based on Gray Relational Analysis.

Zhang, N., Wu, W., Wang, Y., & Li, S. (2021). Hazard analysis of traditional post-harvest operation methods and the loss reduction effect based on five time (5t) management: The case of rice in jilin province, china. Agriculture (Switzerland), 11(9). https://doi.org/10.3390/agriculture11090877.

Zhu, J., Yu, W., Zhang, C., Zhu, Y., Xu, J., Li, E., Gilbert, R. G., & Liu, Q. (2020). New insights into amylose and amylopectin biosynthesis in rice endosperm. Carbohydrate Polymers, 230, 115656. https://doi.org/10.1016/j.carbpol.2019.115656.

Ziegler, V., Paraginski, R. T., & Ferreira, C. D. (2021). Grain storage systems and effects of moisture, temperature and time on grain quality - A review. Journal of Stored Products Research, 91, 101770. https://doi.org/10.1016/j.jspr.2021.101770.