2018

NATIONAL RICE R&D
HIGHLIGHTS

RICE CHEMISTRY AND FOOD SCIENCE
DIVISION

PhilRice

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RICE CHEMISTRY AND FOOD SCIENCE
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EXECUTIVE SUMMARY

The Rice Chemistry and Food Science Division (RCFSD) conducts the grain quality (GQ) evaluation of rice under the Institute's varietal development program. The Division also develops analytical methods for the efficient and accurate determination of rice grain properties for various stakeholders and provides quality analytical services in support of the development of appropriate and best technologies for Filipino farmers. RCFSD is also responsible in developing technologies on other uses of rice and its by-products, and promotion of high-quality, value-added products to benefit farmers, consumers, food manufacturers, and other stakeholders.

In 2018, the Division implemented two research projects. The project *Assessment of the Grain Quality and Safety of Rice* aimed to provide faster and reliable data on rice grain quality (GQ) characteristics and to ensure that rice is safe to consume. Grain quality characteristics of early generation breeding lines is evaluated under this project to assist breeders in screening rice lines for advanced trials. It also focused on addressing the need for fast and reliable methods of analysis for the efficient delivery of services to clients, particularly breeders, and assessing the GQ, and heavy metal and pesticide residue contamination of commercial, specifically imported rice, to aid in crafting relevant policies to ensure the safety of Filipino consumers. This year, 522 of the 788 early generation lines, pre-NCT samples, and NSIC Rc 222 were analyzed. Majority satisfied the standards for milling and physical properties. These data helped breeders in the early selection of rice lines with desired traits depending on their breeding objectives. New and improved methods of determining the size and shape of grains and amylose content (AC) were developed, which contributed in achieving the outcomes "Advanced rice science and technology as continuing sources of growth." Lastly, GQ profile of commercial rice sourced from the National Food Authority was determined, while heavy metal and pesticide contamination are being evaluated.

The project *Nutrition, Health, and Wellness Potential of Philippine Rice and Rice-Based Crops* assessed the potential of local rice and rice-based crops as source of nutrition, health, and wellness for consumers. Value-added products and technologies on the uses of rice were developed to meet stakeholders' needs. This project determined consumer knowledge and acceptability of functional food products such as complementary rice-based food, developed two food products enhanced with protein using tapuy lees, and evaluated rice varieties in the PhilRice genebank with high phytochemical content and antioxidant activities. These efforts contribute to improving utilization of high-quality, safe, nutritious, healthy, and affordable rice, as well as rice-based crops and their products.

ASSESSMENT OF GRAIN QUALITY AND SAFETY OF RICE

EH Bandonill

This project consisted of four studies: (1) *Centralized Grain Quality Screening*, (2) *Automated Size and Shape Measurement for Brown and Milled Rice*, (3) *Development of Rapid Methods of Amylose Content Determination*, and (4) *Grain Quality and Safety Assessment of Local and Imported Milled Rice in the Philippines.*

In 2018, the centralized grain quality screening study received 788 early generation lines, pre-NCT samples, and NSIC Rc 222. Grain quality of 522 samples were analyzed while 256 samples are still being evaluated. Overall, GQ evaluation of the pre-NCT lines mostly satisfied the standards for milling and physical properties. For the automation of brown and milled rice size and shape, a new improved method was developed, which can automatically and accurately measure kernel sizes using a minimum enclosing rectangle geometric model while reducing the speed and tediousness of performing the task from 10min per sample (20 kernels) to less than 3min. This is scalable to a large number of kernels per sample. Meanwhile, the study on rapid method of determining amylose content developed a test kit with the updated colorimetric method of Juliano et al. (2012) with overall accuracy of 82.0%. Accuracy was lower in samples with borderline AC and in commercial samples with unknown AC. The method can simultaneously predict AC of up to 16 rice samples for 40min, which is faster than the colorimetric wet-lab assay (30 samples/day). One locally obtained NFA rice and 18 samples imported from Thailand, Vietnam, India, and Myanmar were tested for GQ and safety. Imported samples were mostly long to extra-long and slender with high AC and low to intermediate gelatinization temperature (GT). Samples from Thailand were mostly slightly creamish, slightly glossy, separated, and rough while those from Vietnam were slightly gray to white, slightly glossy, slightly cohesive, slightly tender, and slightly smooth.

Centralized Grain Quality Screening
AV Morales, EH Bandonill, R Tubera, RB Rodriquez, JD Adriano, and JMC Avila

This study evaluated early generation breeding lines for grain quality, particularly milling potentials, physical attributes, and physicochemical properties, to assist breeders in selecting lines for advanced trials. Exactly 788 early generation samples were received, with 522 samples analyzed for GQ. The 522, lines, along with 457 pre-NCT lines and 65 NSIC Rc 222 samples, were submitted by the PBBD, BDD, and other units within PhilRice and harvested in 2016 DS, 2017 WS, and 2018 DS. From this set, 259 lines were profiled for complete GQ, with most of these meeting the standards for brown rice (fair-good) and having good milled and head rice recoveries (Grade 1-Premium), long grain, and slender shape. Almost 50% of the entries had intermediate AC while only few entries passed the standards for chalky grains and GT. For 50 entries from rainfed-drought and submergence (Sub), additional parameters were measured such as weight of hull (23.7-28.8g), bran (8.4-13.6g), broken grains (5.4-44.1g); rough rice grain length and shape (8.7-10.6mm and 3.1-4.1, respectively);

and brown rice grain length and shape (6.2-7.7mm and 2.6-3.5). About 208 mutation entries were tested for AC only with the majority (151 entries) having acceptable intermediate AC. Overall, GQ evaluation of pre-NCT lines mostly satisfied the standards for milling and physical properties. The early generation screening identified entries with properties suited for special purposes; thus, reducing cost and maximizing resources in the breeding program. This study also provided supplementary testing to the Institute's standard tests for determining varietal purity to aid breeders and other stakeholders in decision-making, specifically in confirming the AC of Rc 222.

Automated Size and Shape Measurement for Brown and Milled Rice Using Digital Image Processing
JG Tallada and EH Bandonill

Grain kernel size is a key determinant of yield and consumer quality preference. This study aimed to develop a gender-sensitive digital image acquisition, processing and size measurement system for brown and milled rice kernels, and evaluate the statistical performance of the measurement models. Thirty-four rough rice samples of varying kernel sizes were processed to obtain brown and milled rice samples. Purposively, 1,000 kernels were selected to achieve a uniform distribution for length and width, which was measured using a dial Vernier caliper. Images of the kernels were captured using a flatbed scanner at 800 DPI and a singulation template. A Python OpenCV program was used to fit a minimum enclosing rectangle or ellipse geometric models to define the digital measurement of length and width. Studies were conducted for kernel sizes to be automatically and accurately measured using a minimum enclosing rectangle geometric model. Speed and tediousness of performing the task are also reduced from 10min per sample (20 kernels) to less than 3min, which was also scalable to a large number of kernels per sample. These outputs have contributed to achieving the outcome "Advanced rice science and technology as continuing sources of growth."

Development of Rapid Methods of Amylose Content Determination
RV Manaois and R Tubera

Amylose content (AC) is an important property of rice used as a criterion in the development of new varieties and in the selection of appropriate varieties for various processing applications by food processors. This study was conducted to develop a fast and reliable method for use in the routine analysis of AC in early generation rice lines and for field application by different stakeholders. A test kit has been developed with the updated colorimetric method of Juliano et al. (2012) as reference laboratory technique. The optimized test kit procedure involved defatting 1.5g rice grains with 95% ethanol for 5min and then drying, soaking in 10mL of 5%1:2 I2/KI solution at pH 9.3 for 5min, and drying for 10min. The AC class of the stained grains was identified by comparing the intensity of color with a chart containing actual images of stained varieties with known low, intermediate, and high AC classes. Overall accuracy of the procedure as tested by two analysts was 82.0%, with lower differentiation accuracy

in samples with borderline AC. This affected the repeatability, which ranged from 33.3 - 55.6%, and reproducibility of the procedure, 77.8%. Accuracy was lower when the method was tested on commercial samples with unknown AC, which could be due to variation in milling degrees between the commercial samples and the check varieties and the mixing of varieties with different AC classes common in commercial rices. With this method, AC of one rice sample can be determined for 25min or up to 16 samples could be predicted simultaneously for 40min, which is faster than the colorimetric wet-lab assay (30 samples/day). Further improvements are necessary to ensure more accurate results for application in field settings.

Grain Quality and Safety Assessment of Local and Imported Milled Rice in the Philippines

HF Mamucod, RM Bulatao, JPA Samin, R Tubera, PR Belgica, FH Bordey, and J Sales

As the government continues to import rice from neighboring countries to ensure sufficient rice supply in the country, access of every Filipino to quality and safe rice remains a national challenge. This study assessed the complete GQ profile (milling potentials, physical attributes, physicochemical properties, cooking parameters, sensory attributes, and instron hardness) and determine the presence and concentration of pesticide residues and heavy metals in local and imported NFA milled rice samples in the country. In 2018, one local and 18 imported rice samples, were collected from different regional and provincial NFA warehouses in the Philippines. Rice from Thailand (9), Vietnam (7), India (1), and Myanmar (1) were imported either through government-to-government (G-to-G) or government-to-private (G-to-P) schemes, packed with 15 or 25% broken rice, and shipped by different vessels. The collected samples were not generally defined by the country of origin, supplier, and scheme of importation. However, some shared common characteristics. Samples from Thailand, Myanmar, and India imported through G-to-P scheme were extra-long and slender while the local sample and those imported through G-to-G scheme, regardless of country (Thailand and Vietnam), were either long or extra-long and had intermediate or slender shape. All samples had moisture content below 14% as declared by the supplier. Protein content of all samples were within the normal range for rice. Fifteen samples had high AC while four (two from Vietnam, one from Philippines, and one from India) had intermediate AC with corresponding intermediate to high-intermediate gelatinization temperature. This same set of samples produced soft-to-medium cooked rice. In terms of cooking parameters, complete doneness was achieved at 80 g:130 mL rice-to-water ratio. Cooking time ranged from 15:03 to 18:06 (min:sec). All rice samples had no aroma and off-odor in both raw and cooked forms. Most of the raw samples were dull and slightly hard to hard. Samples from Thailand were mostly slightly creamish, slightly glossy, separated, and rough. Those from Vietnam were slightly gray to white, glossy, cohesive, tender, and smooth. All samples were bland and did not have off-taste. Evaluation of heavy metal and pesticide residue contamination is underway.

NUTRITION, HEALTH, AND WELLNESS POTENTIAL OF PHILIPPINE RICE AND RICE-BASED CROPS

RG Abilgos-Ramos

This project assessed consumer knowledge and acceptability of functional food products such as complementary rice-based food, determined the anti-cancer properties of pigmented rice varieties using breast cancer cell lines, and evaluated lees as a nutrition-enhancing ingredient in a food product (noodles). In the first study Pushing Rice in the Era of Functional Food: Consumer Knowledge and Acceptability, information on demand, perception on attributes, and acceptability of functional products (rice-based complementary food and beverage) showed that these products are new, relevant, compatible with their current customs, norms and practices, as well as unique. Nutritional value, naturalness, taste, flavor, and serving size were the top five attributes considered by consumers when buying functional products. For the study *Pigmented Rice Germplasms' (Deposited at PhilRice Genebank) Therapeutic Potentials Against Chronic Diseases,* six pigmented rice materials were characterized for their antioxidant activity and phytochemical content and now being tested in vivo for their anti-cancer potential. The study *Utilization of Rice Wine Lees for Food and Feed*, high protein noodles were developed by incorporating rice wine lees flour. This project provided information on potential of colored rice for pharmaceutical uses, value-added products, and market information for consumer-driven products for health, nutrition, safety, and income-generation (outcome 3 of the PhilRice strategic plan for 2017-2022).

Pushing Rice in the Era of Functional Food: Consumer Knowledge and Acceptability
JF Ballesteros, ESA Labargan, and RG Abilgos-Ramos

This study aimed to assess consumer knowledge and acceptability of functional food products such as complementary rice-based food product for both female and male 6-month- to 1-year-old infants and rice beverage for toddlers and pre-school children. Product concept testing through face-to-face interview of 100 parents of children aged 6 months to 6 years old was conducted in RiceBIS sites located in Zaragoza, Nueva Ecija; Batac, Ilocos Norte; and San Mateo, Isabela. Results indicated that majority (70%) of the parents declared that they do not know about functional foods. However, when presented with complementary rice-based food and rice beverage product concepts, they perceived that these were new, relevant/ useful, compatible to their current customs, norms and practices, and unique. Each attributed was rated >4 out of a unipolar 5-point Likert scale. The top five attributes considered by respondents whenever they buy complementary food for their children were nutritional value, naturalness, taste, flavor, and serving size. As for beverage, taste, nutritional value, flavor, availability and price were highly considered. All of the respondents were willing to buy the

rice-based complementary food and rice beverage, once available in the market, at P251-300 per pack and P21-25 per bottle.

Pigmented Rice Germplasms' (Deposited at PhilRice Genebank) Therapeutic Potentials Against Chronic Diseases

RM Bulatao, HF Mamucod, R Tubera, JPA Samin, MB Castillo, XGI Caguiat, and MC Ferrer

This study evaluated the anticancer properties of pigmented rice varieties using breast cancer cell lines (MCF7: Luminal A, HMT 3522 S2:HER2 positive and MDA-MB-231: Triple negative). Six pigmented rice samples composed of three black rice (*Ominio, Inipot-ibon*, and *Tapukoy*) and three red rice (*Chor-chor-os, Kawitan*, and *Pah-nga*) varieties were selected based on their antioxidant properties and used in the in vivo anticancer assay. Powdered rice extracts were prepared by soaking the pigmented rice samples with 85% methanol, evaporating the solvent using a rotary evaporator, and freeze-drying of the crude extract. Among the black rice samples, *Ominio* had the highest total anthocyanin and total phenolic content (TPC) while *Tapukoy* had the highest DPPH radical scavenging activity. For red rice samples, *Chor-chor-os* had the highest TPC and DPPH radical scavenging activity. The results suggest that pigmented rice samples are potential source of antioxidants, which might have anticancer properties. The evaluation of anticancer properties using breast cancer cell lines is being conducted at the University of the Philippines-Manila.

Utilization of Rice Wine Lees for Food and Feed

RV Manaois, AV Morales, LC Castillo, RD Camus

This study evaluated lees as a nutrition-enhancing ingredient in noodles, a food staple of many Filipino households. Flour was prepared using rice wine lees, a by-product generated in rice wine production, and tested for substitution to all-purpose flour in fresh and dry noodles. Fresh and dry noodles were prepared using lab-optimized protocols and tested for their sensory quality and acceptability, crude protein content, physical, and microbiological quality. In fresh noodles, up to 10% (w/w) tapuy lees flour (TLF) had comparable sensory quality and acceptability as the unsubstituted control, with enhancement in crude protein content of about 14%. In dry noodles, protein level was enhanced by about 29-30% and 37-41% at 15% and 20% TLF, respectively. The most acceptable substitution level in dry noodles was 15%. Dry noodles with 15% TLF could also be added with chili pepper leaves up to 1% (w/w) to further improve the nutritive value of the product. Both fresh and dry noodles were safe for consumption based on their microbial counts. Results suggested the suitability of TLF as a functional ingredient in noodles. Further evaluation of other nutritional components of lees and enhancement of its sensory characteristics are recommended to ensure the market success of products made from rice wine lees.

We are a government corporate entity (Classification E) under the Department of Agriculture. We were created through Executive Order 1061 on 5 November 1985 (as amended) to help develop high-yielding and cost-reducing technologies so farmers can produce enough rice for all Filipinos.

With a "Rice-Secure Philippines" vision, we want the Filipino rice farmers and the Philippine rice industry to be competitive through research for development in our central and seven branch stations, coordinating with a network that comprises 59 agencies strategically located nationwide.

We have the following certifications: ISO 9001:2008 (Quality Management), ISO 14001:2004 (Environmental Management), and OHSAS 18001:2007 (Occupational Health and Safety Assessment Series).

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