2019

PHILRICE R&D HIGHLIGHTS

RICE CHEMISTRY AND FOOD SCIENCE DIVISION

Contents

DIVISION

Rice Chemistry and Food Science

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Executive Summary

The Rice Chemistry and Food Science Division (RCFSD) helps in improving the productivity and profitability of rice farming by determining grain quality characteristics of rice, developing technologies on other uses of rice and its by-products, and promoting these high-quality and value-added products to benefit consumers/farmers, food manufacturers, and other stakeholders. These were accomplished through the following projects: (1) Assessment of the grain quality and safety of rice; (2) Nutrition, health, and wellness potential of Philippine rice and rice-based crops; and (3) Laboratory management of the RCFSD.

The first project aimed to provide reliable data on rice grain quality characteristics to ensure that rice available to the different stakeholders have good grain quality and are safe for consumption. The second project delved on other characteristics of rice beyond the conventional grain quality parameters assessed in the first project. The third project focused on improving and implementing quality management in all RCFSD laboratories, compliant with national and international standards to ensure the delivery of high-quality outputs from the first two projects.

Through the first project, breeders were provided with grain quality data of early generation breeding lines, which assisted them in screening rice lines for advanced trials. This will consequently contribute to the attainment of the goal on increasing the productivity of rice farming in a sustainable manner. Additionally, this project promoted the advancement of rice science by improving or updating methods for routine grain quality testing, particularly the determination of size and shape and amylose content of rice through rapid and/or automated techniques. Lastly, it could aid in crafting relevant policies to ensure the safety of Filipino consumers through assessment of heavy metal and pesticide residues of local and imported commercial rice from the National Food Authority, which is a move towards a science-based and supportive rice policy environment.

The second project aimed to develop rice and rice-based products and by-products with enhanced value for better quality, health, nutrition, and income. It determined consumer knowledge of RiceBIS households and their acceptability of functional food products from rice, such as complementary rice-based food for older infants and rice beverage for children. This project also explored the health-promoting properties of a by-product (lees) from a rice-based alcoholic beverage (tapuy) and its potential uses as an ingredient in food and feed for Nile tilapia fingerlings.

The last project, the implementation of laboratory management of the RCFSD contributed in strengthening the institutional capability of PhilRice by ensuring standards in laboratory protocols through updating the laboratory manual; capacitating laboratory personnel; calibrating, validating, and/or conducting preventive maintenance of applicable laboratory equipment; developing an automated chemical inventory system; and complying to legal requirements and regulations.

PROJECT 1

Assessment of Grain Quality and Safety of Rice

EH Bandonill

Grain quality remains to be one of the important selection criteria in the rice breeding program, especially at this time when local rice has faced a stiff competition with imported rice owing to Rice Tariffication Law. To further enhance the development of high-yielding varieties, address the growing need for fast and reliable information on rice grain quality, as well as meet the increasing demand for quality rice, this project, which comprise four studies was implemented.

In the first study, there were 511 rice breeding lines/entries, also called pre-NCT (National Cooperative Testing for Rice Project) lines, from 2018 WS and 2019 DS evaluated for grain quality. Majority had good performance in terms of brown rice, milled rice, and head rice recovery, chalky and immature grains, grain length, and amylose content (AC). There were 57 lines from different breeding groups identified for recommendation to the breeders, which will significantly help in their selection process.

To make the routine analyses of physical and physicochemical properties of breeding samples more efficient and effective, rapid and/or automated techniques for size and shape and amylose content determination were optimized. In the automated measurement of rice grain dimensions, the flatbed scanner-based digital image acquisition and processing system using Phyton Program algorithm showed consistent and highly acceptable performance. Compared with manual measurement, this automated measurement of kernel dimensions was four times faster and had accuracy of 95-99% based on coefficient of determination. In the development of fast and accurate methods of determining AC in rice, two techniques were tested: the use of rapid test kit and the microplate reader. For the test kit procedure, head rice grain samples polished for 30-sec and at least 4-h storage of staining solution were needed for more accurate classification of rice samples, with the most reproducible results most evident using low-AC samples and the least in high-AC varieties. Validation of the optimized method was higher when experienced analysts were employed. The actual test took approximately 60min to complete. In the optimization of microplate-based AC evaluation, starch gelatinization was tested using boiling water bath and 18 to 24-h soaking, with the latter having higher accuracy. Further refinement of the whole process shall be conducted for reliable measurement of AC. These outputs have contributed to achieving the outcome "Advanced rice science and technology as continuing sources of growth."

Lastly, the grain quality of 20 raw and cooked local (1) and imported (19) milled rice samples collected from selected warehouses of the National Food Authority (NFA) showed that all the rice samples had 47.9-72.1% head rice based on milled rice, following the procedures in the National Cooperative Testing (NCT) Manual (1997). Vietnam samples had high amount of discolored grains and had tender cooked rice indicated by intermediate AC and intermediate to high-intermediate GT. Samples from the other countries had high AC and intermediate to low gelatinization temperature (GT), indicating moderately tender cooked rice. The organochlorine and organophosphorus pesticide concentrations of the samples were all below the Maximum Residue Level (MRL). However, owing to the lower limit of detection of the equipment used to measure other organophosphorus pesticide: Dichlorvos, Mevinphos, Phorate, and Diazinone were not detected; thus, safety of the rice samples for these compounds is still uncertain. All rice samples had arsenic, mercury, and cadmium concentrations below the MRL, while four imported rice had lead levels that exceeded the MRL (0.20mg/kg): two from Myanmar and one each from Vietnam and Thailand. These results contributed to the project's goals of providing faster and reliable data on rice grain quality characteristics and ensuring that the rice, which every consumer eats is safe. These efforts will support the Institute's vision of achieving a "rice-secure" Philippines and in improving the competitiveness of the Philippine rice industry through the improved methods and information generated from the project.

Centralized Grain Quality Screening

AV Morales, EH Bandonill, RB Rodriquez, JD Adriano, JMC Avila, and VM Mata

Five hundred eleven rice entries composed of direct-seeded rice (DSR), preliminary yield trial-special purpose (PYT-SP), advanced mutants (Adv mutants), advanced putative mutants (Mutants), general yield trial (GYT), preliminary yield trial-transplanted (PYT-TPR), traditional rice varieties (TRV), and other samples were submitted by breeders and researchers of the Plant Breeding and Biotechnology Division, Crop Protection Division, and PhilRice-Isabela for grain quality (GQ) evaluation. One hundred percent (100%) of the received samples were completely analyzed based on the breeders requested parameters. Majority of the samples met the GQ standards for brown rice, milled rice and head rice recovery, chalky and immature grains, grain length, and amylose content (AC), while only 237 samples passed the GQ standards for grain shape and 130 for gelatinization temperature (GT). Fifty-eight (58) mutant lines were also subjected to sensory evaluation, in which majority of the samples had slightly cohesive to cohesive, slightly tender to tender, and slightly smooth to smooth cooked rice quality. Overall, the pre-NCT rice lines generally met the

standards for milling potential, physical attributes, and AC, which resulted in 57 lines with properties suited for breeding selection; thus, reducing the cost of GQ evaluation and maximizing the resources in the breeding program.

Automated Size and Shape Measurement for Brown and Milled Rice Using Digital Image Processing

JG Tallada, EH Bandonill, and JD Adriano

To fast track the routine determination of grain size and shape, an image processing system for digital measurement of milled and brown rice was developed in 2018. A Python-based program was written to measure kernel length and width using minimum enclosing rectangle (MER) and ellipse-based models from about 1000 kernels of both forms of rice. The MER was found to give more accurate results. To evaluate the soundness of the algorithm and the regression models for MER, a validation set consisting of 56 kernels of milled and 56 kernels of brown rice were manually and digitally measured. A new flatbed scanner was used to capture images of the singulated kernels. Comparing manual and digital measurements of length and width of the kernels, the standard error (0.08 mm) and accuracy based on coefficient of determination (r2 = 0.95 to 0.99) were found consistent with the results of model development sample set and validation sets. The manual measurement took about 44-48sec/ kernel on the average, while the automated measurement took 12sec/kernel or about 4 times quicker. The developed system can replace the manual measurement of rice length and shape with high speed and accuracy.

Development of Rapid Methods of Amylose Content Determination

RV Manaois, CA Cacerez, and HM Corpuz

Amylose content (AC) is an important property in the development of new rice varieties and in the selection of appropriate varieties for various processing applications. This study was conducted to develop fast and reliable methods for routine analysis of AC for use by different stakeholders. Procedures for rapid test kit and the use of microplate reader for AC estimation were improved/optimized based on the conventional colorimetric method of Juliano et al. (2012). The test kit was refined by optimizing the concentration and volume of ethanol, milling degree of samples, and storage time of staining solution. Highest accuracy was

obtained using 5mL of ethanol and with 95% concentration. Highest accuracy (97%) was recorded in samples polished for 30sec, with repeatability of 92% as analyzed by two laboratory workers. Freshly prepared staining solution stained darker, resulting in less discernable color differences among samples. Color differences among samples were more perceptible using the solution stored for 4 to 8h, with mean accuracy of 93% as determined by two analysts. Stains became lighter, less blue, and more yellow as storage time progressed up to 24h. Validation by three non-project staff resulted in an average accuracy of 85%, indicating the need for a certain degree of training prior to the use of the kit. Testing took an average of 60min using the optimized procedure, excluding the 4-h minimum storage time of iodine staining solution, and was most reproducible for low-AC varieties. Microplate procedure was initially optimized through testing of two gelatinization treatments: overnight soaking in alkali and using boiling water bath. The treatments resulted in 75% and 50% accuracy, respectively. Further enhancements will be conducted to ensure the accuracy and reliability of the procedure, with faster turnaround of results suitable for routine testing of numerous samples.

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

HF Mamucod, RM Bulatao, JPA Samin, PR Belgica, GA Corpuz, FH Bordey, and JM Sales

As the government imports rice from neighboring countries to meet the country's declining buffer stock, the right of every Filipino to access safe and high-quality rice remains a top priority. This study aimed to generate information on the quality and safety of local and imported rice samples acquired by National Food Authority (NFA). Twenty rice samples (19 imported and 1 local) were collected from different NFA warehouses and evaluated for grain quality and presence and concentration of pesticide residues and heavy metals. The rice imports had 27.9-52.1% broken rice. Length and shape of the rice samples were defined by the country of origin: medium and intermediate for Myanmar, extra-long to long and slender for Thailand, and long and slender for Vietnam and Philippines. AC and gelatinization temperature (GT) were also associated with the country of origin. Myanmar, Thailand, and Philippines had high AC (22. 27.4%) and intermediate to low GT (4.9 – 6.8 ASV) rice, while Vietnam had intermediate AC (18. 21.7%) and intermediate to high-intermediate GT (4.1-4.7 ASV) rice. The raw rice samples were mostly dull, slightly gray with slightly hard to hard grains. The cooked samples were generally bland, cream

to slightly cream with varying texture. In terms of pesticide residue content, all the samples met the MRLs for organochlorine and organophosphorus pesticides. The arsenic, mercury, and cadmium content of the rice samples were also below the MRLs. However, two samples from Myanmar, one from Vietnam, and one from Thailand exceeded the MRL for lead (0.20mg/kg). Further tests such as sensory evaluation of stale cooked NFA rice is recommended as some consumers give impression that NFA rice easily gets spoiled.

PROJECT 2

Nutrition, Health, and Wellness Potential of Philippine Rice and Rice-based Crops

RG Abilgos-Ramos

With the increasing prevalence of non-communicable illnesses (cancer, diabetes, and cardiovascular diseases) owing to poor diet and lifestyle, market for wellness products and functional foods is also expanding. This project assessed the potential of local rice and rice-based crops as source of nutrition, health, and wellness for consumers. First, consumer knowledge and acceptability of functional food products were determined, and then the potential health-promoting components of rice wine lees and its suitability as a food/feed ingredient were evaluated. These studies addressed the nutrient gaps in the diet of the most nutritionally-vulnerable groups - the women and children. Functional products like complementary food for older infants and rice wine lees as functional ingredient can supply some of the essential nutrients needed (e.g., protein, iron) by the target population. For the first study[A1] , demand and acceptability for functional products such as complementary food for older infants and rice beverage for children were found high. Functional products from rice were found highly acceptable to male and female respondents in five RiceBIS sites covered by the study. Moreover, affordability, good taste, and nutritional or health benefits were among the attributes that influence buying decisions of male and female respondents. Other considerations and factors influencing marketability of functional products were: availability, recommendations from family members and/or health professionals, and personal preference.

In the second study, tapuy lees was found as a source of peptides with antioxidant properties. Acceptable protein-rich noodle products were also developed using tapuy lees flour. In addition, fish feed was formulated with 30-40% lees and fed to tilapia fingerlings that showed significant weight gain after 4 months. Both studies addressed the nutrient gaps in the diet of the most nutritionally-vulnerable groups- the women and children. Functional products like complementary food for older infants and rice wine lees as functional ingredient supply some of the essential nutrients needed (e.g., protein, iron)

Pushing Rice in the Era of Functional Food: Consumer Knowledge and Acceptability

RG Abilgos-Ramos, JF Ballesteros, ESA Labargan, and RR Mendoza

This study assessed consumer knowledge and acceptability of functional food products (FF) such as complementary foods for both female and male 6 months- to 2 years old and rice beverage for toddlers and pre-school children in five RiceBIS sites. Purposive sampling using pre-tested questionnaire was made. Results showed that among the five sites covered this 2019, Bicol had the highest number of male respondents while Quezon had the lowest. Most number of female respondents were from Quezon while lowest in Midsayap. Male respondents from Negros (100%) and female from Bicol (63.9%) were the most aware about functional foods. Respondents from Negros were older than those from Midsayap. Households in Midsayap had the highest mean monthly income while Agusan had the lowest. Bicol respondents had higher educational attainment while Agusan and Negros had lower years spent in school. Nutritional value and naturalness were important for female respondents from Bicol, while respondents from Agusan gave the highest rating on the attributes of the rice-beverage product concepts for being new. All households covered by the survey had 1 to 2 children who are 6-mo to 6-yr old. Top three considerations of male respondents for buying beverages were affordable price, good taste, and healthy/nutritious foods while the female respondents' considerations were good taste, healthy/nutritious, and affordable price. Male respondents' top reasons of buying complementary food were: affordability, ease of preparation, recommended by friends/family, and personal preference. On the other hand, female respondents highly considered readily available, affordable, and easy to prepare products. Majority of both male and female respondents were aware and knowledgeable about FF as food with added beneficial ingredients. In addition, functional products from rice were highly acceptable to consumers as indicated by high purchase intention and willingness to substitute. Based on the market data obtained, high demand for rice-based functional products in the local market is projected in the next five years .

PROJECT 3

Quality Improvement on the Laboratory Management of the Rice Chemistry and Food Science Division

RM Bulatao

For more than 25 years, RCFSD has continued to deliver quality outputs accomplished through intensive research and strong linkages with private sectors and other research agencies. A key factor in the delivery of these outputs is good laboratory management. This year, the RCFSD improved and implemented quality management in all RCFSD laboratories compliant with national and international standards through this project. First, the existing RCFSD Laboratory Manual was updated through consolidation and harmonization of all test methods and protocols to generate consistent, accurate, and reproducible data among the analysts. As one of the research divisions, RCFSD houses around 40 state-of-the-art laboratory equipment and analytical tools, which require periodic preventive maintenance, calibration, and validation for optimum performance, longer service, and prevention from further damage and deterioration. In 2019, 87 laboratory equipment and materials (e.g. pH meters, UV-Vis spectrophotometer, and centrifuge) were calibrated by external service providers. Another 20 equipment (e.g., analytical balances, ovens, and refrigerators) were calibrated by in-house trained calibrators based on the RCFSD calibration and preventive maintenance plan. Validation (e.g., pipettors and balances) and preventive maintenance of some analytical equipment (e.g., Ultra-performance liquid chromatography, gas chromatography-mass spectroscopy, and protein analyzer) were also performed. Additionally, the protocol for in-house treatment of chemical wastes generated from amylose and protein analyses was established. About 1,310L of chemical wastes were treated and disposed accordingly. Chemical management was also made easy through the initial development of a fast and cost-effective automated chemical inventory system. The system was designed to monitor the real-time addition (entry) and deduction (withdrawal) of chemicals in and out of the stockroom. Furthermore, in compliance with the Philippine Drug Enforcement Agency (PDEA), list of PDEA controlled chemicals (e.g., acetone, hydrochloric acid, and sulfuric acid) consumed and stored by RCFSD was consolidated and submitted to the Procurement and Property Management Division. Lastly, in an effort to continuously improve the skills and competitiveness of laboratory personnel, four in-house trainings on basic operation and troubleshooting of newly acquired equipment, one training on calibration of balances and enclosures, and one training on basic photography for proper documentation of research results and activities were conducted.

Abbreviations and Acronyms

AYT - Advanced Yield Trial
ABE - Agricultural and Biosystems Engineering
AEW - Agricultural Extension Worker
ATI – Agriculture Training Institute
AESA - Agro-ecosystem Analysis
AC - Amylose Content
BLB - Bacterial Leaf Blight
BLS -Bacterial Leaf Streak
BCA - Biological Control Agent
BS - Breeder Seeds
BPH -Brown Planthopper
BPI - Bureau of Plant Industry
CGMS - Cytoplasmic Genic Male Sterility
COF - Commercial Organic Fertilizer
CDA - Cooperative Development Authority
DAS - Days After Sowing
DAT - Days After Transplanting
DF - Days to Flowering
DM- Days to Maturity
DAR - Department of Agrarian Reform
DA-RFOs - Department of Agriculture-Regional Field Offices
DoF - Department of Finance
DOLE - Department of Labor and Employment
DTI - Department of Trade and Industry
DSR - Direct-seeded Rice
DS - Dry Season
FBS – Farmers' Business School
FC - Farmers' Cooperative
FSM - Farming Systems Models
FAA - Fish Amino Acid
FGD - Focused Group Discussion
FSP - Foundation Seed Production
FRK - Farm Record Keeping
GABA - Gamma-aminobutyric Acid
GT - Gelatinization Temperature
GAD - Gender and Development
GYT - General Yield Trial
GCA - Genetic Combining Ability
GIS - Geographic information system
GEMS - Germplasm Management System
GAS - Golden apple snail
GL - Grain length
GQ - Grain quality
GW - Grain Weight
GY - Grain Yield
GLH - Green Leafhopper
GOT - Grow Out Test
HR - Head Rice
HRA - Heat Recovery Attachment
HIPS – Highly-intensified Production System
HQS - High-quality Rice Seeds
HON - Hybrid Observational Nursery
HPYT - Hybrid Preliminary Yield Trial
ICT - Information and Communication Technology
IEC - Information Education Communication
IBNM - Inorganic-based Nutrient Management
ICM - Integrated Crop Management
IPM - Integrated Pest Management
JICA - Japan International Cooperation Agency
IRRI - International Rice Research Institute
IA - Irrigators' Association
KP - Knowledge Product
KSL - Knowledge Sharing and Learning
LCC - Leaf Color Chart
LFT - Local Farmer Technicians
LGU - Local Government Units
LPS - Low Pressure Steam-operated
SB - Stemborer
LE-CYPRO - Lowland ecotype Cyperus rotundus
MFE - Male Fertile Environment
MSE - Male Sterile Environment
MAS - Marker-assisted Selection
MRL - Maximum Root Length
MR - Milled Rice
MER - Minimum Enclosing Rectangle
MOET - Minus-one Element Technique
MC - Moisture Content

MAT - Multi-Adaptation Trials
MCRTP - Multi-crop Reduced Till Planter
MET - Multi-environment Trial
MYT - Multi-location Yield Trial
NAAP - National Azolla Action Program
NCT - National Cooperative Test
NFA - National Food Authority
NRAM - National Rice Awareness Month
NSIC - National Seed Industry Council
NSQCS - National Seed Quality Control Services
N - Nitrogen
NBSP - Nucleus and Breeder Seed Production Project
NFGP - Number of Filled Grains Panicle
ON - Observation Nursery
OSIS - One Stop Information Shop
OBNM - Organic-based Nutrient Management
PL - Panicle Length
PW - Panicle Weight
PVS - Participatory Varietal Selection
PWD - Person with Disabilities
PhilMech - Philippine Center for Postharvest Development and Mechanization
PRISM - Philippine Rice Information System
PhilRice - Philippine Rice Research Institute
PSA - Philippine Statistics Authority
PTC - PhilRice Text Center
P - Phosphorus
PVS - Plant Variety Selection
K - Potassium
QTL - Quantitative Trait Loci
RCBD - Randomized Complete Block Design
RSP - Registered Seed Production
RBB - Rice Black Bug
RCEF - Rice Competitiveness Enhancement Fund
RCEP - Rice Competitiveness Enhancement Program
RCM - Rice Crop Manager
RHGEPS - Rice Hull Gasifier Engine Pump System
RPH - Rice Planthopper
RSTC - Rice Specialists' Training Course
RTV - Rice Tungro Virus
RBFHS - Rice-based Farming Household Survey
KQ - Kernel Quality
SV - Seedling Vigor
ShB - Sheath Blight
ShR - Sheath Rot
SMS - Short Messaging Service
SNP - Single Nucleotide Polymorphism
SWRIP- Small Water Reservoir Irrigation Project
SRB - Stabilized Rice Bran
SUCs - State Universities and Colleges
SB - Stem Borer
TESDA - Technical Education and Skills Development Authority
TDF - Technology Demonstration Farm
TRV - Traditional Rice Varieties
TOT - Training of Trainers
TPR - Transplanted Rice
URBFS - Upland Rice-Based Farming
WS - Wet Season
WCV - Wide Compatibility Variety
YSB - Yellow Stemborer

Editorial team

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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