2024

PhilRice R&D Highlights

RICE CHEMISTRY AND FOOD SCIENCE DIVISION

Philippine Rice Research Institute
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DIVISION

Rice Chemistry and Food Science Division

DIVISION HEAD: **HENRY M. CORPUZ**

EXECUTIVE SUMMARY

The Division is boosting the productivity and profitability of rice-farming systems by evaluating grain quality (GQ) characteristics of rice, innovating technologies for additional uses of rice and its by-products, and promoting these high-quality and value-added products to benefit consumers, farmers, and food manufacturers. The Division specifically 1) determines the GQ characteristics of rice breeding materials to support the Institute's varietal improvement program and research projects, 2) assesses the nutritional quality and potential health benefits of rice and its products, 3) develops and characterizes nutritious rice-based products with income-generating potential for improved health and nutrition, and 4) automates GQ evaluation methods and protocols to expedite the generation and delivery of rice grain quality data and information to various stakeholders.

This year, the Division implemented four core-funded projects, one RCEF-funded project, and two extra core-funded projects. The first core-funded project is to enhance the breeding and genebank operations, and contribute to the identification of genotype-specific packages of technologies that yield superior GQ for increased adoption of high-yielding varieties among farmers. The project also supported the development of high-yielding rice varieties by assessing the GQ and health-promoting properties of promising rice lines. In 2024, 822 pre-NCT rice lines and 513 genebank rice accessions were evaluated for GQ based on the parameters specified by breeders and other researchers.

The second core-funded project is to enrich the value of rice by developing client-focused rice-based products for MSMEs, farmers' cooperatives, and other stakeholders. Product development, building capacity, and supporting market readiness through research, training, and collaboration were the focus of this project. Market surveys were conducted nationwide to determine the current situation and landscape of rice-based food products in the country. The project also compiled secondary data on 68 rice-based food products from various provinces, including their origin, cultural significance, preparation methods, and

current status. The project team established connections with key agencies to support rice-based product manufacturers in Region XI. Additionally, hands-on training on product development, labeling, and marketing of rice-based products was provided to empower the members of a farmers' cooperative in San Francisco, Luna, Apayao.

The third core-funded project is to scale up and commercialize nutritious and rice-based products with income-generating potential. The technology and commercialization readiness levels of PhilRice Tapuy, Nutri Rice Milk, and buffalo milk-based yogurt enriched with stabilized bran (SRB) were reassessed. A market survey and feasibility study were also conducted to determine consumer acceptability and market potential of these products. Potential investors were identified to manufacture and market the PhilRice Tapuy and SRB-enriched yogurt.

The fourth core-funded project is to modernize and automate rice quality assessment methods and ameliorate the accessibility and utilization of grain quality information to improve the breeding program for high-yielding and climate-resilient rice varieties with excellent eating and nutritional quality. The smartphone-assisted rice grain measuring application underwent significant enhancements for improved functionality and user experience. Recent pilot tests of the upgraded application have demonstrated a prediction accuracy ranging from 96% to 97%. In addition, the documentation for the System Analysis and Design (SAD) smartphone-based determination of rice grain alkali-spreading value was completed. The Rice Information System-Grain Quality (RIS-GQ) dashboard was upgraded, enhancing data visualization and user interaction. Notable improvements include a refined filtering system that supports multiple selections, a convenient toggle for switching between bar and pie graphs, and the seamless integration of data on physical attributes, milling potential, and physicochemical properties.

The Division also provided the relevant GQ data for 316 NCT promising lines under an RCEF-funded component project. Lastly, RCFSD implemented two extra core-funded projects in 2024. The first project is to develop low-glycemic index (GI) rice lines and functional food products, and characterize high antioxidant rice donors with anti-cancer potential. In the second project, the market and consumer acceptability of rice-based food products supplemented with high-value crops was determined through market surveys and focus group discussions with consumers, food manufacturers, and farmers' cooperatives and associations in selected provinces throughout the country.

RCF-231-000: Grain Quality and Health-Promoting Properties of Rice

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The project aimed to enhance breeding and genebank operations as well as support the development of high-yielding rice varieties through the assessment of the grain quality and health-promoting properties of rice and the identification of genotype-specific packages of technologies (PoTs) tailored for newly released varieties to ensure their effective deployment across the country. It also aimed to increase the value of rice for improved health outcomes, advance rice science and technology, and strengthen research capacity at PhilRice by evaluating the glycemic index (GI) and glycemic load (GL) of rice.

In 2024, from 895 pre-National Cooperative Test (NCT) rice lines and samples harvested from 2022 to 2024, 81 entries with acceptable grain quality were identified. Of the 513 rice germplasm collections in the PhilRice genebank, 306 had preferred intermediate amylose content (AC) and 120 for gelatinization temperature (GT), with 78 showing both characteristics. Additionally, two restorer lines and 12 entries were identified among 50 parental lines/hybrids and 126 hybrid breeding lines evaluated for AC and GT. These promising lines were recommended to breeders to aid in selection.

The glycemic index (GI) of locally grown pigmented and non-pigmented rice was assessed through in vitro and in vivo studies. Two unpolished pigmented varieties and one polished non-pigmented variety were selected for clinical trials, showing medium in vitro GIs between 60.39 and 62.05. Ten participants from UP Diliman evaluated the GIs and glycemic loads (GL) of these samples. Prior to the trials, cooking times and serving sizes were optimized based on carbohydrate content, and additional physicochemical and antioxidant properties were measured.

Clinical trials were conducted by administering test foods (rice) and a reference food (glucose) to the participants. Capillary blood samples were collected before and after the consumption of both foods. An iAUC trapezoidal graph was generated to quantify the glycemic response following the intake of the foods.

Results showed that the representative samples exhibited in vivo GI values ranging from low to high (48.86-70.75). Black rice had the lowest GI; Dinorado had medium; white polished rice had the highest GI. However, all samples were classified as medium GL (12.25-17.75). The in vitro and in vivo GI values for all three samples did not vary widely.

The project also supported the development of the packages of technologies (PoTs) for newly released varieties to ensure effective nationwide deployment. During the 2023 wet season, irrigated lowland (IL) varieties NSIC Rc 438, Rc 440, Rc 442, and Rc 580 were applied with five NPK treatments under continuous flooding conditions. For Rc 438, F3 (Low NPK, Full Rate) resulted in longer milled rice grains, improved brown rice yield, higher MR protein content (PC), and faster MR cooking time. F2 (High NPK, Half Rate) was effective in enhancing head rice yield and cooked BR texture for this variety. Rc 440 showed better results with F4 (Low NPK, Half Rate), producing translucent, longer MR grains, along with enhanced PC, while maintaining softer cooked MR. For Rc 442, F2 improved head rice yield and MR PC. F2 emerged as the most favorable treatment for Rc 580, showing improved HR yield and PC, reduced chalkiness, faster MR cooking time, and consistently soft cooked MR.

During the 2024 dry season (DS), five (5) IL varieties released in 2021 were evaluated: NSIC Rc 622, Rc 624, Rc 628, Rc 632, and Rc 636. For Rc 622, F1 (High NPK, Full Rate) resulted in the highest PC and shortest cooking time for both MR and BR. In Rc 624, F4 (low NPK at half rate) produced lighter MR grains, enhanced PC, softer cooked MR, the fastest BR cooking time, and comparable eating quality to the control (F5). F4 also increased BR yield and PC lighter grain color, softer cooked MR, and the fastest BR cooking time for Rc 628. Lastly, F1 improved BR yield and PC for Rc 632, and resulted in softer cooked MR, shortened cooking time, and soft texture for cooked MR.

The findings highlight that varying NPK fertilizer rates have distinct effects on rice quality and yield across different varieties. High NPK levels at half rate generally enhanced the PC, cooking times, and texture; low levels at half rate produced whiter grains and better eating quality. Optimizing NPK treatments can significantly enhance both rice yield and quality, with each variety responding uniquely to specific fertilizer applications.

RCF-232-000: Consumer-Driven Rice-Based Products for Farming Communities and Micro-to-Small-Scale Enterprises

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This project enhances the value of rice by developing client-focused rice-based products that serve as a source of income and nutrition. It focused on product development, capacity-building, and market readiness for MSMEs and farming cooperatives. In Luzon, rice-based food products were documented across 13 sites, including Sariaya, Quezon; Balaoan, La Union; and various locations in Pangasinan, Rizal, Laguna, Batangas, and Isabela. The documentation included product names, ingredients, processes, and consumption patterns, revealing that most products use glutinous rice and are primarily consumed as snacks.

In the Visayas, Biliran Province State University (BiPSU) has completed data collection for their study, "Mapping the Landscape of Rice-Based Food Products in Biliran," which covered all eight municipalities and surveyed 405 respondents. The study provided insights into the socio-demographic profile of producers, the rice varieties used, production volume, and marketing strategies. Results showed that producers manufacture an average of 12,700 units annually, generating a total revenue of Php 111 million. Sales are primarily conducted through pre-orders and walk-ins, with promotion mainly through peddling. Key challenges that lead to production discontinuation include management difficulties and health issues.

Meanwhile, in Mindanao, the University of Southeastern Philippines (USeP) initiated partnerships for a survey in Nabunturan, Davao de Oro, known as *Bibingka City*. To support R&D, the project team established linkages with key agencies such as the DTI Regional and Provincial Offices, Food and Drug Administration (FDA) Region XI, Department of Tourism (DOT), DSWD, DOLE, DA, and Agricultural Training Institute (ATI) Region XI.

The project also compiled secondary data on 68 rice-based food products from various provinces, detailing their origin, cultural significance, preparation methods, and current status (Figure 1). This information was used to develop IEC materials in collaboration with the Cagayan Museum and Historical Research

Center to provide region-specific insights. Furthermore, a skills training was conducted in San Francisco, Luna, Apayao for 15 members of the FRANSE Agricultural Cooperative to be involved in processing, labeling, and marketing three rice-based products.

RCF-233-000: Consumer-Driven Products for Rice-Based Enterprises to Help Increase Income of Farmers in Support of Rice R4D

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The project aimed to assess and validate the technologies, identify issues and gaps related to production and quality, provide necessary interventions, opportunities, and strategies to tackle these issues, and facilitate technology transfer and commercialization.

The technology for producing two rice-based food products (PhilRice Tapuy and NutriRice Milk) was improved and validated (Figures 2 and 3). The efficiency of the laboratory-prepared starter culture in producing quality rice wine was evaluated, enhanced, and validated in both laboratory and real-world settings. The produced rice wine exhibited alcohol content and sensory attributes comparable to the existing PhilRice Tapuy. Meanwhile, the shelf-life of the current NutriRice Milk was extended by developing two new variants: Instant and Sterilized. Both products received high consumer acceptance and demonstrated sensory quality comparable to the existing formula.

To identify commercial opportunities and target consumer segments for these priority products, three market surveys were conducted: (1) rice wine consumers, (2) rice wine producers (Figure 4), and (3) NutriRice Milk consumers (Figure 5). A total of 175 rice wine consumers across five provinces in Luzon were surveyed. Information on consumer behavior and preferences toward rice wine consumption was gathered. The majority of respondents from La Union and Benguet prefer to drink rice wine with slightly higher alcohol content, while rice

wine with moderate alcohol content is favored by most consumers in Zambales, Ifugao, and Mountain Province. The preferred volume is 750 ml at a price of less than Php 200.00 for La Union, Benguet, and Mountain Province, and Php 200.00-Php 300.00 for Zambales and Ifugao. January and December are the preferred months for purchases due to the colder weather. Weddings and birthdays are the most favored occasions for respondents. Social media is the preferred platform for promotion. Taste and product safety are the top attributes valued by respondents.

The survey involving 14 rice wine producers generated new insights into current production trends and market demand for rice wine in the Philippines. Glutinous rice serves as the most common ingredient in winemaking. Some producers prefer traditional rice varieties such as Katagi Red, Black, and White Binggawan, and Red and Black Ballatinaw, while others opt for modern varieties such as PSB Rc 42, Rc 222, and Rc 216. The most prevalent processing method involves cooking the rice, followed by inoculating it with either traditional *bubod* or commercial yeast. Three producers utilize *am*, the liquid portion obtained after boiling the rice, instead of the cooked rice itself. The finished products are sold in *pasalubong* and OTOP outlets, family-owned stores, public markets, restaurants, and through online platforms such as Shopee and Lazada. The products are also promoted during exhibits and trade fairs.

For NutriRice Milk, a collaborative project with the Department of Agri-Management (DAM) at the College of Agriculture, Central Luzon State University, was established to determine its market dynamics and consumer insights. Preliminary results revealed that most respondents are highly satisfied with the product's aroma, taste, and consistency. Many are willing to pay for NutriRice Milk regardless of its price or volume. The preferred volume is 200 ml due to its convenience for immediate consumption.

A series of meetings with a potential adopter of the PhilRice Tapuy technology and the Business Development Division were conducted, during which the investor was provided with an updated feasibility study.

Stabilized rice bran (SRB) was utilized to improve the nutritional quality of the scoop- and drink-type buffalo milk-based (BMB) yogurts developed by PhilRice in collaboration with the Philippine Carabao Center (PCC at CLSU) (Figures 6 and 7). The addition of SRB raised their phytochemical content, antioxidant activity, and nutritional value while maintaining sensory quality compared to the control. Both products were found safe for consumption based on acceptable microbial counts and the absence of pathogens.

To ensure the successful commercialization of the developed products, a training program was conducted on the processing, physicochemical analysis, and sensory evaluation of BMB yogurt co-fermented with SRB for collaborators from the State University of Northern Negros and the PCC at La Carlota Stock Farm

(PCC at LCSF). These partner agencies will facilitate the transfer of the technology in Negros Occidental. A technology pitching session was held for cooperatives in Negros through PCC-LCSF, where the San Julio Agrarian Reform Beneficiaries Cooperative (SJARBC) was identified as a potential adopter of the technology. A follow-up site visit and meeting with SJARBC provided valuable insights into their capacity and readiness for technology adoption. To review and evaluate the proposed transactions between the licensor and licensee, relevant documents and reports were submitted for examination by the Fairness Opinion Board (FOB) of the Department of Science and Technology-Region III (Figure 8).

RCF-234-000: Modernized Rice Quality Assessments for the Development of High-Yielding, Climate-Resilient, and High-Quality and Nutritious Rice

HENRY M. CORPUZ, ROSALY V. MANAOIS, EVELYN H. BANDONILL, MARISSA V. ROMERO, AMELIA V. MORALES, GEROME A. CORPUZ, MA. ANGELIQUE N. DELA CRUZ, BERNANDO S. PERALTA, VICTOR M. MATA, ALJON L. LAUREANO, MIGHTY JEMUEL C. SOTTO, NEHEMIAH L. CABALLONG, LUIS ALEJANDRE I. TAMANI, AND ARTURO C. AROCENA JR.

The local rice breeding program develops high-yielding, climate-resilient, disease-resistant, and nutritious rice varieties that have consumer-preferred grain qualities to ensure food security and mitigate the threats of climate change. Consumer acceptability of rice is dictated by the grain quality characteristics, which are categorized into milling recovery, physical attributes, physicochemical properties, cooking, and sensory qualities. Rice quality parameters are commonly determined through visual inspections, manual measurements, and conventional methods. However, these approaches are time-consuming, subjective, prone to human error, and require enormous resources (e.g., human, time, and supplies). To ameliorate the efficiency and accuracy of assessing rice quality, there is a pressing need to modernize and improve these conventional methods. Implementing innovative approaches and methodologies can provide faster, real-time, and reliable data on grain quality, benefiting the breeding program and various stakeholders involved in the rice industry.

DA-PhilRice leads the rice breeding activity for different ecosystems through the National Cooperative Testing (NCT) Program and receives a lot of samples from various breeding institutions for grain quality evaluation. Responsible for this critical task is the Rice Chemistry and Food Science Division, which conducts thorough

screenings of breeding materials from PhilRice breeders, as well as rice entries submitted to the NCT program from other institutions. Since the inception of the NCT, RCFSD has amassed an extensive database of grain quality data pertaining to all Philippine rice varieties and breeding lines. However, this wealth of vital rice grain quality information remains underutilized because the raw data are usually unprocessed and inaccessible to all intended users. This necessitates the consolidation of all available grain quality data and the establishment of an online database and management system to easily access and keep track of relevant grain quality information and trends. This platform will not only streamline data storage and management but also enable users to archive, analyze, and export the data efficiently, ultimately enhancing the usability of grain quality information in rice breeding and other purposes.

The Rice Grain Measuring Application underwent mighty enhancements to improve functionality and user experience (Figures 9 and 10). A new landing page grants direct access to grain quality analysis, history, and researcher input. Notable features include a page for analyzed images with grain identifiers and measurement details, as well as a history page for previewing samples. Text input fields were transformed into dropdown selections, and a mechanism to prevent multiple clicks on the save button minimizes duplicate entries. The three-rotation capture method achieved 97% accuracy, while the single-capture method reached 98%. Pilot tests at PHilMech and PhilSCAT showed 97% and 96% accuracy, respectively, with results validated against conventional caliper measurements (Figure 11).

The documentation for the System Analysis and Design (SAD) of the Alkali-Spreading Value (ASV) smartphone application has been completed. This comprehensive documentation includes several key components: current and proposed process flow diagrams that outline the app's functionality, an entity-relationship diagram to illustrate the data structure, a relational diagram for understanding data relationships, a detailed data dictionary for reference, and wireframes that provide a visual representation of the app's layout and navigation.

Enhancements to the Rice Information System-Grain Quality (RIS-GQ) Dashboard improved data visualization and user interaction. Key updates include a refined filtering system that allows multiple selections, a toggle for switching between bar and pie graphs, and the integration of physical attributes, milling potential, and physicochemical properties data. Clickable graphs with corresponding data tables were introduced, along with options to download graphs in various formats and export all data tables. Summaries for sensory evaluations and cooking parameters were added, alongside a metadata table. Most features are available for both rice varieties and pre-NCT lines dashboards, except for sensory evaluation and cooking parameter summaries (Figures 12-13).

Improvements to the Rice Varieties and Pre-NCT Lines pages expedited data management and user efficiency. Users can now filter selections, toggle columns, and perform bulk operations with an updated data entry format. An export function was added, along with error-catching and validation to ensure accurate data input. Inline editing capabilities include notifications for successful updates.

Enhancements to the RIS-GQ login and registration included a password preview option, dropdown selections instead of text fields, and the removal of unnecessary data fields. A forgot password feature allows users to reset their passwords via email, while a profile settings page enables users to update information and change passwords. The user management page is restricted to administrators for modifying user details, and logging functionality was added to track system activities.

A data management module for the Rice Grain Measuring Application was developed, including a table list view, data export functionality, and a detailed analysis view for grain measurements and analysis images. It also features edit functionality and activity logging to track system updates.

RCEF-FUNDED PROJECT

RCS-003-002D: Grain Quality Evaluation of NCT Rice Lines and Check Varieties

EVELYN H. BANDONILL, MARISSA V. ROMERO, LYNNDEN C. LUCAS, MARY MICHELLE M. VELASQUEZ, CARMELA P. TUBERA, KAYE H. HERNANDEZ, FAYE MARION C. SEBASTIAN, JAN KENNEY D. GONZALES, OLIVER C. SOCO, ROMMEL D. CAMUS, EDELWEISS E. SAJISE, ANGELINA DR. FELIX (UP-LOS BAÑOS), MARY JOY A. MANALO, ANTONIETA D. PEÑALOZA, AND ALVARO R. AGARIN (PHILRICE-LOS BAÑOS)

The Grain Quality evaluation component of the National Cooperative Testing (NCT) Project continued to support the rice varietal improvement program by providing the grain quality (GQ) data required for the recommendation of new rice varieties, alongside yield performance, agronomic characteristics, and tests for insect pest and disease resistance. The 216 entries from the 2023 Wet Season (WS) cropping were assessed for milling recovery, physical attributes, physicochemical properties, health-promoting factors, Instron hardness, cooking, and eating quality, yielding GQ data for 168 entries. This process identified 79, 4, and 98 promising lines that met the standards for milling, physical, and physicochemical properties, respectively, with 50 promising lines passing all the GQ standards

except for chalky grains. Among the Special-Purpose Pigmented entries, black PR52811SPR-13-1-2-2 (Entry A) exhibited the highest total anthocyanin content (552.03 mg C3GE/g), while red PR52831SP-28-3 (Entry B) had the highest total phenolic content (2.35mg GAE/g), and red PR50405SP-B-25-2 (Entry C) obtained the highest DPPH radical scavenging activity (2.37 mg TE/g).

For the 100 2024 Dry Season entries evaluated for the various GQ parameters, data of 67 entries were reported where 53 entries had acceptable MR, 13 had acceptable PA, and 48 entries obtained low to intermediate Amylose Content (AC)-Gelatinization Temperature (GT) combination with predicted tender to slightly tender cooked rice texture, and consequently identified 31 entries with good grain quality. Among the Special-Purpose Pigmented entries, black Entry A had the highest total anthocyanin content (490.24 mg C3GE/g), while red Entry C had the highest total phenolic content (1.07mg GAE/g), and red Entry B had the highest DPPH radical scavenging activity (5.03 mg TE/g). In 2024, 71 2023 WS and 22 2024 DS promising lines were deliberated on where 1 upland, 1 saline-tolerant, 3 special purpose-micronutrient, and 8 hybrid entries were recommended as varieties for commercial release.

EXTRA-CORE PROJECTS

RTF-022-340E: OneRicePH Module 4: Development of rice with low glycemic index (GI) and characterization of rice with high antioxidant activity and anti-cancer potential for healthier rice niche markets

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Socio-economic advancements have led to lifestyle choices that often include unhealthy dietary patterns and increased sedentary behavior. Such practices can heighten the body's susceptibility to free radicals, resulting in oxidative damage. Prolonged oxidative stress is associated with the development of non-communicable diseases (NCDs) such as diabetes, cardiovascular diseases, and certain types of cancer. In the Philippines, rice constitutes a significant portion of daily caloric intake, making it a crucial component in efforts to combat the

rise of NCDs through dietary changes. Rice is primarily made up of starch and has an intermediate to high glycemic index (GI), which measures how quickly carbohydrates in food affect blood sugar levels. Lowering the GI of rice can help slow down the digestion of starch, providing a more sustained release of energy during metabolism. Meanwhile, pigmented rice varieties are good sources of antioxidants that can neutralize free radicals, thus helping to mitigate oxidative stress. Development of new rice cultivars that combine the health benefits of low-GI and pigmented rice presents a promising approach to reducing the risk of NCDs and promoting healthier dietary practices.

In 2024, 7 varieties with low, 58 with medium, and 10 with high GI were identified out of the 75 samples sent to IRRI for in vitro GI analysis. In addition, the 44 seed-increased rice samples including three low and medium-GI varieties (PSB Rc 86, Rc 182, and Rc 278) harvested from 2023 wet and 2024 dry seasons cropping obtained the following results in 2023 WS: AC (13.7-26.1%), GC (25.5-55.5mm), breakdown (1040.5-3147.0), final viscosity (3337.0-6194.5), setback (1348.5-3172.5), HWS value (0.2666-0.5017), and HWI value (0.0034-0.0994) and in 2024 DS: GC (25.5-58.5mm), GT (2.3-7.0), HWS value (0.1347-0.4599), and HWI value (0.0247-0.1514), tender to hard.

To explore the market potential of low-GI rice, survey data will be collected in 2025 from households in provinces with (1) high diabetes rates and (2) high per capita rice consumption. The technical and ethical aspects of the market study were approved by the Dr. Paulino J. Garcia Memorial Research and Medical Center - Institutional Review Board.

To develop rice-based products from low-GI rice donors, bulk production and shelf-life evaluation of ready-to-eat (RTE) fried rice (chao fan) made from NSIC Rc 182 or IRRI 147 were conducted (Figure 14). Sensory characteristics, water activity, microbial load, and sensory properties of the developed product were recorded from Week 0 to Week 21. The RTE fried rice remained acceptable in its 21st week of storage at room temperature based on the parameters considered and data gathered.

To understand how environmental factors affect the GI level, the low-GI rice donors, PSB Rc 86 and NSIC Rc 182 were planted and established in 4 sites (Nueva Ecija, Isabela, Negros, and Agusan). Likewise, to further develop healthier rice varieties, 8 F2 populations were generated from crossing low-GI donor (NSIC Rc 182) with high-yielding modern varieties, NSIC Rc 572, 558, 402, and Rc 506, and were established for selection in 2024 WS. Furthermore, 10,000 anthers of two F2 populations were cultured and are currently in callus induction.

Meanwhile, 5 pigmented rice varieties were identified with high retention of antioxidant activity after cooking. Raw, cooked, unpolished, and polished forms of these rice samples were also processed for solvent extraction. The resulting extracts were evaluated for their anti-proliferative activity against A549 human lung

cancer cells and MRC5 human normal lung fibroblasts. Potency was quantified as half maximal inhibition concentration (IC50, mg/L). MTT assays revealed that, after treatment with pigmented rice extracts, only the raw and cooked unpolished forms had significant effects on the proliferation of cancer cells. Mt. Violet and Galo black rice samples were the only varieties that showed anti-proliferative effects on A549 cells without compromising MRC5 cells. On the other hand, human colon cancer cells from HCT-116 and MCF7 human breast cancer cells were also used to further evaluate the anti-proliferative effects of high antioxidant varieties (Dinorado, Ballatinaw, and Ominio). Results indicated that the extracts exhibited varying potency in inhibiting the proliferation of different cell types. The extracts demonstrated lower potency in suppressing the proliferation of HCT-116 cells compared to MCF7 and A549 cells.

Furthermore, the mechanism by which the bioactive compounds in the Ballatinaw rice extract inhibit A549 cell proliferation was evaluated by quantifying the mRNA expression levels of apoptosis-related genes - ataxia-telangiectasia mutated (ATM), tumor protein 53 (p53), B-cell lymphoma 2 (BCL2), BCL2-associated X (BAX), and cysteine aspartase 3 (Casp 3) - relative to glyceraldehyde-3-phosphate dehydrogenase (GAPDH) housekeeping gene. Results suggest that concentrations ranging from 0 to 400 µg/mL of Ballatinaw extract inhibited cancer cell proliferation by inducing the early stages of A549 cell apoptosis, without significantly affecting the growth of MRC5 normal cells.

RTF-022-382: Product Development and Market Assessment of Rice-based Food Products Supplemented with High-Value Crops (NutriRice Crop)

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Prior to the development of rice-based food products (RBFPs) supplemented with high-value crops (HVC), a product concept test, which included focus group discussions (FGD) and a market survey, was conducted to assess the market potential of the products. The FGDs were further divided into two groups: (1) Farmer Cooperatives Associations (FCA) and (2) consumers. Seven FGD sessions were conducted across the country; those with the FCA were held in San Narciso, Zambales; Naguilian, La Union; Cebu City, and Davao City; those with consumers

took place in Quezon City, Cebu City, and Davao City. During the activity, four previously PhilRice-developed RBFPs were presented.

Among the RBFP presented, bread with stabilized rice bran and instant brown rice congee received the highest ranking from both FCA and consumers. The FCA expressed their willingness to manufacture and market the products once the technologies become available. They believe that introducing a new product poses a challenge that can be addressed through strong marketing strategies (e.g., multi-channel distribution, e-commerce, online marketing, exhibits, and trade fairs). According to them, the key to producing a high-quality product is thorough training in processing technology. Meanwhile, consumers expressed a positive inclination to purchase the products once they are launched in the market. They are willing to pay Php 5.00 to 20.00 per piece for bread with stabilized rice bran and HVC, and Php 20.00 to 50.00 per serving of instant brown rice congee with HVC.

Meanwhile, carrot, squash, sweet potato, purple yam, malunggay, and mushrooms were chosen as the crops that would best complement the two RBFP. The participants believe these HVCs will raise the quality, nutritional composition, and marketability of the products.