Dale Bumpers National Rice Research Center
USDA-ARS
Stuttgart, Arkansas

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MONTHLY RESEARCH HIGHLIGHTS

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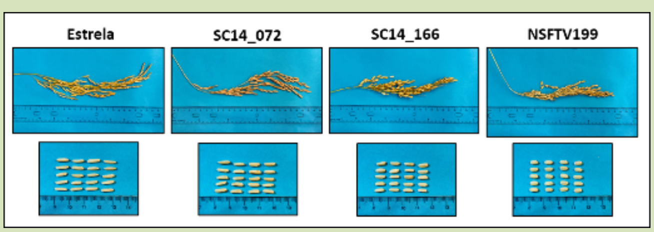
- **Recent Scientific Publications**

This addresses USDA-ARS Research Goal: Developing crop plants with architecture optimized for production efficiency

Eizenga, GC, McClung, AM, Huggins, TD. 2021. Registration of two *Oryza sativa* tropical *japonica* germplasm lines selected for panicle architecture and grain size traits. Journal of Plant Registrations 2021;1−10. https://doi.org/10.1002/plr2.20145

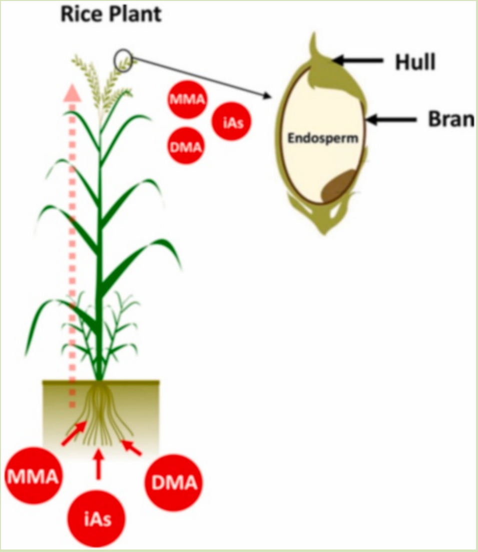
Since rice is a staple food for half the world's population, there is a need to increase rice yields. Increasing the number of seeds and the number of branches on the rice panicle (seed head) through breeding is a means of accomplishing this. The majority of rice grown in the United States is from the *Japonica* rice subspecies which is difficult to cross with the other major subspecies, *Indica*, because of seed sterility problems. Having rice germplasm available in the *Japonica* genetic background that possesses greater panicle branching and higher seed production will help U.S. rice breeders develop new cultivars with higher yield. Two *Japonica* germplasm lines, SC14_166 (GP-148, PI 698103) and SC14_072 (GP-147, PI 698102) have been released and are available for improving medium grain and long grain market classes of rice. The SC14_072, a long grain germplasm line, has at least two major genes associated with increased grain length that is a highly desired trait in the long grain market. The SC14_166, a medium grain germplasm line, possesses genes which increase the number of seed produced on the panicle. In addition, DNA markers were developed which are linked to these desired traits and will facilitate breeding efforts to improve yield and grain size in *tropical japonica*-based breeding programs.



Images of the panicles and kernels of the germplasm lines SC14_072 and SC14_166, and the parents, Estrela and NSFTV199, that they were derived from.

This addresses USDA-ARS Research Goal: Crop plants with enhanced nutritional quality

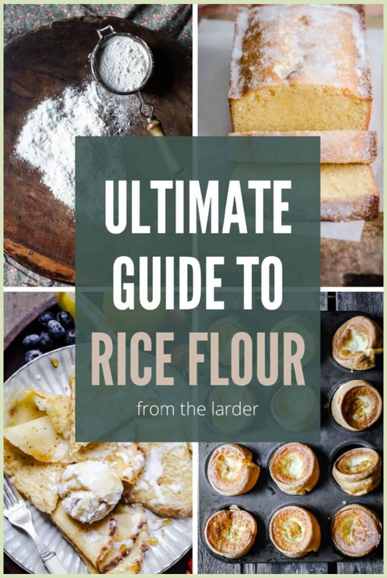
Weber, A.M., Baxter, B.A., **McClung, A.M**., Lamb, M.M., Becker-Dreps, S., Vilchez, S., Koita, O., Wieringa, F., Ryan, E.P. 2021. Arsenic speciation in rice bran: agronomic practices, postharvest fermentation, and human health risk assessment across the lifespan. Environmental Pollution. https://doi.org/10.1016/j.envpol.2021.117962.



Rice bran is rich in fatty acids, phytochemicals, B and E vitamins, and soluble and insoluble fibers that may have protective effects against colon cancer, enteric infections, and diseases. However, there have been concerns regarding the amount of arsenic (As) found in some rice products. The rice plant is able to thrive under saturated flooded field conditions - an environment that makes some soil compounds, like arsenic, more available for plant uptake. The inorganic form of As, considered more toxic to humans than other forms, is primarily localized in the outer bran layer of the grain. Thus, globally there are concerns about possible dietary exposure of As from rice bran consumption. This study aimed to assess the impact of global production sites, irrigation management, soil treatments with an As-based herbicide, organic versus conventional management systems, and bran fermentation treatments on As contents found in rice bran. Bran samples (53) were obtained from 10 rice producing countries and were analyzed for As content. Wide variation was found in inorganic As concentrations (619 to 17 ppm) depending on where the bran was produced. Agronomic practices and soil conditions were identified as major influencers for As accumulation in the grain. Water saving irrigation practices such as alternate wetting and drying allow for non-saturated conditions in the soil that may help reduce As accumulation in the grain. Rice bran sourced from organic production systems, which generally have higher soil organic matter, tended to have higher levels of As than conventionally produced sources, but this varied greatly among production sites. Post-harvest fermentation of bran had little effect on bran As contents. With the suite of health benefits associated with rice bran, it is imperative to better understand how various production and post-harvest processes can optimize health beneficial compounds while minimizing any non-desirable compounds.

This addresses USDA-ARS Research Goal: Current crops with new traits for new uses.

Siaw, M.O., Wang, Y.J., **McClung, A.M**. and Mauromoustakos, A., 2021. Effect of protein denaturation and lipid removal on rice physicochemical properties. *LWT*, *150*, p.112015.



Rice flour is growing in popularity as a food ingredient due to its hypo-allergenicity and bland taste. Cooking properties of rice flour are predominantly governed by starch with amylopectin responsible for starch swelling and pasting properties, whereas amylose is responsible for inhibiting starch swelling. However, proteins and lipids also impact sensory and cooking qualities and thus affect end-use properties. Glutelin accounts for 60-80% of the total protein content in rice and restricts starch swelling properties and starch gel hardness. Prolamin, which constitutes 20-30% of rice protein, causes significant decreases in gel hardness but increases in the breakdown viscosity of starch gel when heated. Although lipids constitute only 1.6-3.1% of the total weight of brown rice, they are highly concentrated in the outer layer of the grain close to the bran layer found in brown rice. This study was conducted to determine the combined impact of protein denaturation and lipid removal treatments on end-use properties including gelatinization and viscosity, swelling power, and water solubility of brown rice flours. Brown rice of four rice cultivars was evaluated using four protein denaturation (PD) treatments and four lipid removal (LR) treatments, as well as a combination of the two. Protein denaturation and LR exerted contrasting effects on the gelatinization temperatures of treated rice flour, and these effects were enhanced by treatment time. The high temperature applied during the PD treatment promoted protein-protein and protein-starch interactions, leading to increased gelatinization properties, and decreased pasting viscosities and swelling properties. Polar lipids acted as bridges to link starch granules and denatured proteins whereas the removal of non-polar lipids promoted protein-starch interactions and led to decreased pasting and swelling properties. The combined treatments resulted in more significant increases in gelatinization temperatures and decreases in pasting, swelling power and water solubility properties than the individual treatments. These results demonstrate that heat treatment can be employed to produce brown rice flour with improved heat and shear stabilities for specific applications for new food products using rice as an ingredient.

- **Technology Transfer**

  ✓ **<u>Interactions with the Research Community</u>**

  From August 2- 6, Dr. Yulin Jia, Biological Science Technicians Heather Box and Kristina Trahern attended 2021 plant health virtual meeting organized by American Phytopathological society (APS) (https://www.apsnet.org/meetings/annual/PlantHealth2021/program/Pages/default.aspx). This year APS had 1249 participants from thirty countries. On August 3, Dr. Jia presented a talk titled ‘Mapping rice genes involved in blast resistance, chalkiness and yield related components’ to 42 APS members and specialists and addressed questions from the audience.

On August 5, Dr. Georgia Eizenga, (Research Geneticist) with assistance from Dr. Jai Rohlia (Research Agronomist), Quynh Grunden and Tiffany Sookaserm, Biological Science Technicians, provided guidance to Rachel Imel, Master's student, and Karla Miserendino, on collecting gas exchange measurements related to photosynthesis from rice plants in the field and harvesting whole plant tissue. These results will be compared with measurements taken in the greenhouse and the controlled environment high throughput phenotypic facility at Purdue University. This study is a collaboration with Dr. Diane Wang (Purdue University).

Collecting gas exchange measurements from rice plants in the field.

Harvesting rice plant tissue for further evaluation at Purdue University.

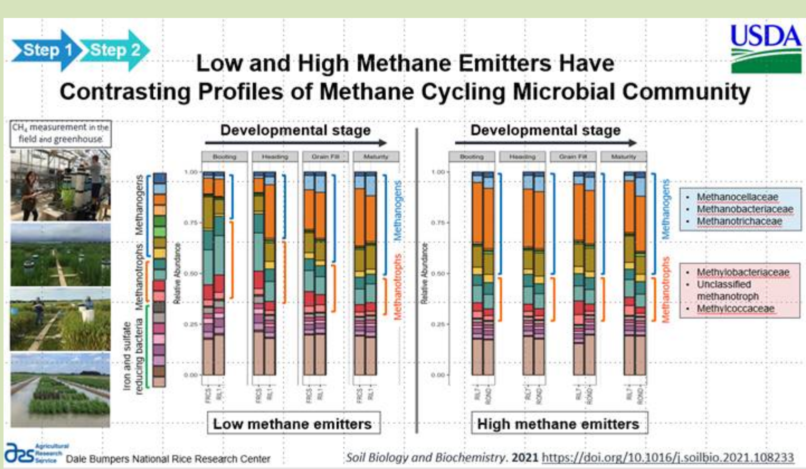
On August 10, the article "Keeping Arsenic Out Of Rice" in PNAS Front Matters by journalist Dr. Carolyn Beans described the research led by Dr. Jinyoung Barnaby's project and her HQ funded post-doc, Dr. Christina Fernandez-Baca, on reducing grain inorganic arsenic content in rice through genetics and cultural management. The story can be found at https://doi.org/10.1073/pnas.2113071118

On August 16, Drs. Jinyoung Barnaby and Yulin Jia attended the 38th virtual meeting of 2021 Mid Atlantic Plant Molecular Biology society (http://wp.towson.edu/mapmbs/agenda/). Ninety-two scientists, students, and Postdoctoral Research Associates attended the meeting. Dr. Barnaby presented an invited talk titled 'Exploring Mitigation Strategies for Methane Emissions Through Rice Genetics and/or Soil Microbiome' and Dr. Jia presented 'Genome Organization and Co-Evolutionary Biology of Host-Pathogen Interactions,'.

On August 18, Dr. Jinyoung Barnaby provided information regarding methanogenic microbial species associated with methane emissions to Drs. Desmond Jimenez, a chief science officer, and Natalie Breakfield, a VP of research and discovery, at the NewLeaf Symbiotics, Inc., St. Louis, MO.

On August 24, Dr. Jinyoung Barnaby presented an invited talk titled ‘System biology-driven breeding for crop improvement by integrating high-throughput omics technologies’ at the 2021 Korean Women in Science & Engineering Society, Ecoscience webinar series. About 50 scientists from academia, governmental institutes, industries in USA and South Korea attended the webinar.

On August 31, Drs. Yulin Jia and Jinyoung Barnaby gave invited presentations at the virtual Joint Agency Microbiome Symposium supported by the FDA, NIH, NIST, and USDA government agencies. Dr. Jia gave a talk on the role of the microbiome causing blast disease in rice and wheat, and Dr. Barnaby presented her research on the role of the soil microbiome causing methane emissions in rice.



- ✓ **Rice Germplasm Distributed**

  During the month of August, 428 rice genetic stocks were shipped to researchers in the United States from the Genetic Stocks *Oryza* (GSOR) collection.

  To fill the genetic gap in our World Rice Collection, 36 Oryza australiensis and 18 NERICA accession (derived from O. sativa x O. glaberrima crosses) have been imported from IRRI and Africa Rice, respectively. The accessions are currently in APHIS quarantine and will be grown out this winter in their greenhouses.

- **New Research Grants**

  A collaborative research project between Dr. Jai Rohila (ARS) and Dr. Brian Ward (Clemson University) titled "iCORP: Increasing Coastal Organic Rice Production in South Carolina Using Salt Tolerant Cultivars" was awarded $600K from the USDA National Institute of Food and Agriculture (NIFA)- Integrated Research, Education, and Extension Competitive Grants Program for research to be conducted over four years, October 2021 to September 2025.

  See the web version of all DBNRRC research highlights at: https://www.ars.usda.gov/southeast-area/stuttgart-ar/dale-bumpers-national-rice-research-center/docs/monthly-research-highlights/