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Rice Education Contest - Teaching the Youth about Rice Production

Every year, the Texas AgriLife Research and Extension Center at Beaumont hosts the Rice Education Contest for local high school students who are members of the Future Farmers of America (FFA). The purpose of this Contest is to introduce and instruct students about rice production and management in Southeast Texas. In addition to learning the details of rice production, the students hone their knowledge and skills in science, math, and English as part of their preparation for the Contest. In the past, competing high school FFA chapters have included East Chambers, Deweyville, Hamshire-Fannett, Hardin-Jefferson, Hull-Daisetta, Little Cypress Mauriceville, and Silsbee. Other high school chapters are encouraged to join in the Contest.

The Contest exam is composed of identification, multiple choice, fill-in-the-blanks, true or false, short-answer questions, and word problems involving math and application of rice production knowledge. Topics covered in the exam include agronomy, botany, entomology, plant physiology, genetics, plant pathology, and cereal chemistry.

Study materials for the Contest can be found in the Texas Rice Education Contest webpage (http://beaumont.tamu.edu/eLibrary/TexasRiceEducationContest_default.htm) and in the Texas Rice Production Guidelines webpage (http://beaumont.tamu.edu/eLibrary/eLibrary_default.htm) of the Beaumont Center's website. Some of the specific review material topics that can be found in the Rice Education Contest webpage include: morphology and development of the rice

Fig. 1. Hardin-Jefferson High School, 1st place winners of the Rice Youth Education Contest in 2008. From left to right: Jacob Luna, Royce Horn (not a contestant), Travis Kirk, Julia Horn, Dalton Horn, and Vo-Ag teacher Ken Abney. (Photo by Mo Way.)

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From the Editor ...

Educating our Future Leaders

Welcome to the April Issue of *Texas Rice*. We are behind schedule in producing this issue as a result of a recent health problem that slowed me down a bit. Please bear with us. I am hopeful we will be fully caught up with producing *Texas Rice* by the end of June.

This issue of *Texas Rice* contains two articles, the first provides an overview of the Center's Rice Education Contest, and the second addresses biofortification. The rice education contest is something Dr. Mo Way took it upon himself to foster since shortly after Dr. Arlen Klosterboer left the Center in 1996. Through Mo and Daun Humphrey's efforts, the Center carries out a very important research outreach server to southeast Texas FFA children. Without people like Mo and Daun, even in pretty much rural country towns such as Beaumont, it is easy to forget that U.S. food, fiber, and feed production provides our country with food security and the ability to purchase quality agricultural produce at an affordable price.

Biofortification basically entailed developing plants that have elevated levels of desirable vitamins and or minerals. By breeding for varieties with elevated levels, the diet in parts of the world where deficiencies occur can at least partially be alleviated. Vitamin A deficiency is but one of a number of vitamins and minerals that are in inadequate supply over a large part of the world. Summarizing from Drs. Samonte's and Tabien's article, nearly 50% of the countries worldwide either recommend supplementing vitamin A in the diet or have an inadequate supply in the food to the point this deficiency is a major health problem.

Surprisingly, in some cases, vitamin and mineral deficiencies in food are due to how the food is prepared for marketing, and in some cases for consumption, and not in the food itself. In the case of rice, the grain has high levels of vitamin A. Unfortunately, in the large majority of countries, including the U.S., people prefer to consume white rice and not brown rice. The process of milling brown rice is what converts it to white rice and is what removes most of the vitamin and mineral content, thereby greatly reducing its nutritional quality. While the consumption of brown rice continues to increase, it nevertheless represents an extremely small component of the rice that is consumed worldwide.

Even with its nutritional advantage, brown rice is not without problems, the foremost being the fairly rapid rate that it goes bad due to breakdown of the lipids that are found in the outer part of the grain. Secondly, brown rice takes far longer to cook than white rice. In many parts of the world this means greater consumption of fuel and greater use of water, both of which often must be hauled great distances for cooking.

If we cannot convince people to change their cooking and eating preferences what can we do? Researchers around the world are increasingly focusing their attention at developing rice varieties that have higher than normal levels of desirable vitamins and minerals in the parts of the grain that are not lost during milling. Golden Rice, which was a major point of national and international discussion a few years ago, avoids the milling problem by accumulating vitamin A in the endosperm of the grain, which is not lost during milling. Subsequent varietal selections have shown that it is possible to develop varieties whose endosperm vitamin A content

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Farming Rice

A monthly guide for Texas growers

Providing useful and timely information to Texas rice growers, so they may increase productivity and profitability on their farms.

Golden Rice –Vitamin A Biofortified Rice

Vitamin A Deficiency

Vitamin A is very important to the human body, since it is vital in various functions such as vision, gene transcription, immune function, embryonic development and reproduction, bone metabolism, formation of blood or blood cells, skin health, reducing the risk of heart disease, and antioxidant activity. Vitamin A deficiency (VAD) is the leading cause of preventable blindness in children. About 250,000 to 500,000 vitamin A-deficient children become blind every year, half of them dying within 12 months of losing their sight. There are 61 countries (out of 192 member countries of the United Nations) where UNICEF recommends vitamin A supplementation, as these countries (mostly in south Asia and Sub-Saharan African) have under the age of 5 years mortality rates (U5MRs) of at least 70 deaths per 1,000 live births. In addition, there are 35 other countries where vitamin A is a health problem (UNICEF, 2007). Due to the worldwide impact of VAD, it is referred to as the 'hidden hunger', together with iron, zinc, and iodine deficiencies (Mayer et al., 2008). To combat VAD, a combination of breastfeeding and vitamin A supplementation, coupled with long-term solutions, such as promotion of vitamin A-rich diets and food fortification is recommended by WHO.

Humans cannot manufacture vitamin A, hence, they have to ingest it as part of their diet. Vitamin A found in foods from animal sources (e.g. liver, whole milk, eggs) is called preformed vitamin A and is absorbed in the form of retinol, while vitamin A from colorful fruits (e.g. cantaloupe melon, papaya, and mango) and vegetables (e.g. carrots, sweet potatoes, and spinach) is called provitamin A or carotenoid or ß (beta)-carotene, which is converted into retinol (vitamin A) in the body after it is consumed (ODS, 2006).

Biofortification Strategy

Solutions to VAD have been traditionally through vitamin A supplementation, food fortification (adding minerals or vitamins during the postharvest processing of plant products), and consumption of foods rich in vitamin A. In recent years, there has been a new strategy recommended to solve these deficiencies and this is through biofortification, the breeding for staple foods that are high in minerals and vitamins. Biofortification may have the following advantages over fortification in the fight against malnutrition (Bouis, 2002):

- Biofortification would be cost-effective, since there is no need to buy and add the fortificants to the crop products as a post harvest handling process;
- Biofortification would be sustainable, since their profits would be an incentive for farmers to continue to produce these crops; and
- Biofortification can reach relatively remote rural areas where fortified food staples currently do not reach.

Micronutrient malnutrition-induced morbidity and mortality have been reduced worldwide through traditional methods of public health interventions (supplementation and food fortification), but both intervention strategies require continuous funding (Mayer et al., 2008). In contrast, the largest cost component for a biofortification strategy would be the research costs to breed for biofortified crop varieties, and this was estimated to be about $400,000 per year per crop over a 10-year period (Nestel et al., 2005). After the biofortified crop varieties are developed and adopted, only the costs for reliable seed production

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and seed deployment are needed (Mayer et al., 2008).

Golden Rice: Biofortified with Vitamin A

Some of the countries where rice is consumed at about 400 g/person/day include Cambodia, Lao People's Democratic Republic, and Myanmar, while countries where rice is consumed at about 200 g/person/day include Burkina Faso, China, Guinea, Guinea Bissau, India, Madagascar, Nepal, Philippines, Senegal, Sierra Leone, and Thailand. In these countries where the daily food intake is about 80% rice, the condition arises where the people are well-fed in terms of calories, but they may be malnourished in terms of other essential nutrients and vitamins (Fig. 1) (Mayer, 2007). From Mayer's study, it can be shown that the ratio of dietary vitamin A intake (DVAI) to recommended daily allowance (RDA) for vitamin A (300 µg/day for children), averaged for countries where rice consumption is 200 and 400 g/person/day, was lower where more rice is eaten. However, since rice is a major staple food of more than half of the world's population, its potential to deliver the much needed vitamin A to large human populations is very high. Rice has vitamin A in its bran, but it is usually removed through milling because it becomes rancid during prolonged storage. The solution to avoid or minimize the removal of the vitamin A through milling was to increase the vitamin A synthesized in the grain's endosperm. This was achieved by Ye et al. (2000), who reported their success in genetically engineering the provitamin A (ß-carotene) biosynthetic pathway into carotenoid-free rice endosperm. They added the DNA sequences of the following three plant enzymes into Japonica rice: phytoene synthase (*psy*) and lycopene ß-cyclase from Daffodils (*Narcissus pseudoarcissus*), and phytoene desaturase (*crtI*) from *Erwinia uredovora* to account for the missing or turned-off genes. The addition of these DNA sequences enabled the ß-carotene pathway in the rice endosperm starting from the substrate for provitamin A production that is present in the rice kernels. One of the transformed rice, Line 'zl lb', produces 1.6 µg/g carotenoid in its endosperm. A realistic goal is at least 2 µg/g provitamin A in homozygous lines (corresponding to 100 µg retinol equivalents at a daily intake of 300 g of rice per day) (Ye et al., 2000). The genetically modified vitamin A biofortified rice is called 'Golden Rice', whose milled rice is yellow in color due to the carotenoids that is produced in the endosperm of the grain. Since white milled rice is the current consumer preference, nutrition education programs should encourage consumers to switch to the more nutritious yellow milled rice varieties

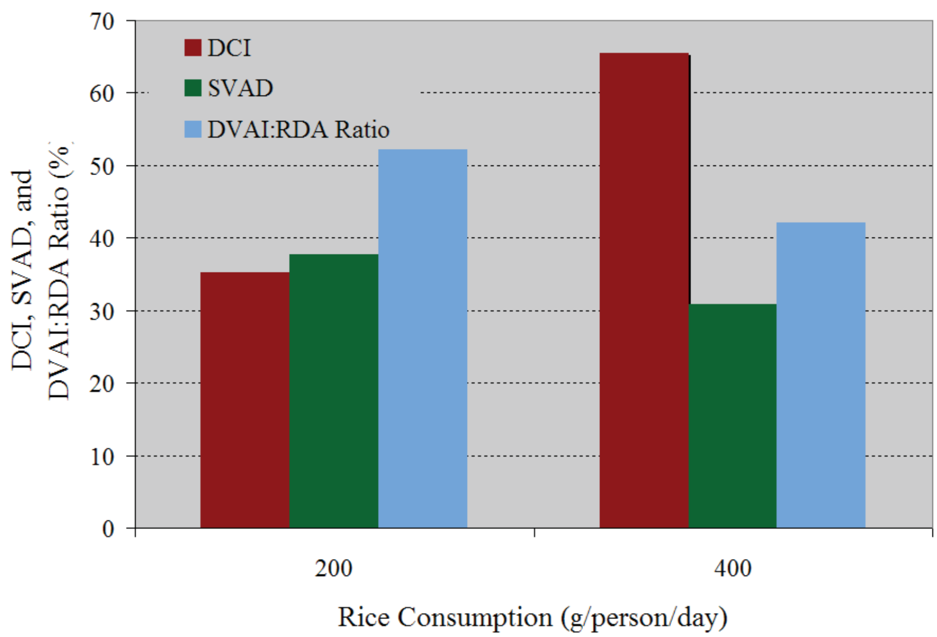

Fig. 1. Total daily caloric intake from rice (DCI), prevalence of subclinical vitamin A deficiency in children under 6 years old (SVAD), and ratio of dietary vitamin A intake (DVAI) to vitamin A recommended daily allowance (RDA; 300 µg/day for children) in countries consuming 200 and 400 g/person/day. (Graphed from data presented in Mayer, 2007).

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(Bouis, 2002). The motto 'Eat orange' was launched by the CGIAR Harvest Plus Challenge Program, which aims to promote the consumption of Golden rice.

Further improvements in the biofortification of rice for vitamin A have been achieved. After determining that the daffodil gene encoding the phytoene synthase (*psy*) was the limiting step in ß-carotene accumulation in Golden Rice, other plant *psy*s were evaluated and a *psy* from maize was identified that can significantly increase carotenoid accumulation (Paine et al., 2005). The genetically engineered Kaybonnet with maize *psy* in combination with the Erwinia uredovora carotene desaturase (*crtI)*, which was used in developing the original Golden Rice, is called 'Golden Rice 2'. It produces up to 37 µg/g carotenoid (mostly ß-carotene at 31 µg/g), which is 23-times higher than that of the original Golden Rice. Consumption of 72 g of Golden Rice 2 enables the delivery of 50% of child's recommended daily allowance (RDA). At present, IRRI and the members of the Golden Rice Network (composed of public institutions in India, the Philippines, China, Bangladesh, Vietnam, and Indonesia) started transferring this trait into their popular varieties that can be suitable for large scale production in Asia. Initial testing of developed lines was conducted in U.S. and the first outdoor trial of Golden Rice in Asia took place in the Philippines in 2008 (Virk, 2009). The project estimated that the field trials will begin by 2010 or 2011, and it is expected Golden Rice will be released to farmers in Asia by 2012 or 2013.

A recent study on the effectiveness of Golden Rice as source of vitamin A for human indicated that the ß-carotene was absorbed in the gastrointestinal tract and four units of ß-carotene from Golden Rice were converted to one unit of vitamin A (Tang et al., 2009). This conversion rate was much better than that for spinach and carrot, which had an estimated conversion ratio ranging from 10:1 to 27:1.

In regions where rice is the staple food, it is eaten in more than one meal per day; sometimes, it is eaten during breakfast, lunch, and supper. A cup of Golden Rice if consumed daily can supply 50% of the RDA. Once Golden Rice varieties adapted to these regions are developed, grown, and consumed, it is expected that vitamin A deficiency could be alleviated.

For more information, please visit http://www.goldenrice.org and consult the following references:

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Golden Rice ...

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* Article by Dr. Stanley Omar PB. Samonte and Dr. Rodante E. Tabien, Texas AgriLife Research and Extension Center, Texas A&M System, Beaumont, TX.

Rice Education Contest ...

plant, insect pests, diseases, and weeds (including red rice) of rice, stages of processing rice, and rice grain quality. Additional preparation for the contestants is provided through a preliminary hands-on review session conducted at the Center about one to two weeks prior to the Contest. This review session is usually held in late September, just before the Texas Rice Festival in Winnie.

Contest winners are presented with awards on the main stage during the Texas Rice Festival. The awards are presented to individual students and high school chapters, and these include ribbons, plaques, certificates of participation, belt badges and buckles, and cash prizes. The Texas Rice Festival, various agrichemical donors, and the Texas AgriLife Research/Extension sponsor these awards. Many award winners make mention of their success in letters and resumes for college placement and in requests for university financial aid.

High school Vo-Ag teachers are largely responsible for coaching and transporting their students to the Center for the review sessions and exams. Special recognition goes to Ruben Stringer and Mike Broussard, who teach at Hamshire-Fannett High School. These Vo-Ag teachers were instrumental in making sure the Contest continued after the retirement of Dr. Arlen Klosterboer, who presided over the Contest for many years. Also, Daun Humphrey, Office Associate at the Center, plays a key role by helping organize the Contest and sending out announcements to the high schools.

Figures 1 and 2 show the students and Vo-Ag teachers from the 2008 top two high school FFA chapters – Hardin-Jefferson and Hamshire-Fannett. Last year's Contest was held later than normal due to Hurricane Ike and participation was a little low, but I am excited about this year's Contest and welcome more high schools to participate in this community service activity. For more details about this year's Contest, please contact me (Mo Way) at MoWay@aesrg.tamu.edu. *

* Article by Dr. Mo Way, Texas AgriLife Research and Extension Center, Texas A&M University System, Beaumont, TX.

Fig. 2. Hamshire-Fannett High School, 2nd place winners of the Rice Youth Education Contest in 2008. From left to right: Vo-Ag teacher Ruben Stringer, J. Storme Jannise, Skylar Trahan, Shelby Jordan, Shannon Duncan, Casey Garcia, Brooke Cuniff, and Kyle Fountain. (Photo by MoWay.)

From the Editor ...

is over 20 times higher than that found in the original Golden Rice. Unfortunately, both Golden Rice and these new selections produce milled rice that is more yellow in color than normal milled rice. This pushes the issue right back to one of having to change eating preferences for Golden Rice (and other rice varieties that produce unusual colored grain) to be adopted. There is no doubt that these improved varieties are better for us; but, it may take a bit of time and a lot of hard work changing peoples eating preferences.

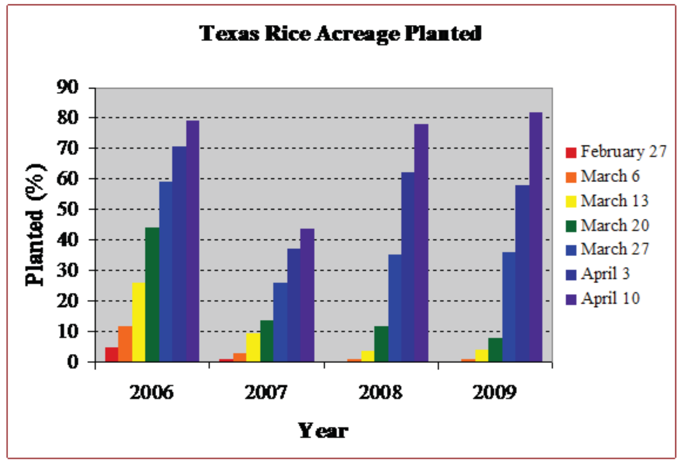
Please keep on sending me your comments and suggestions.

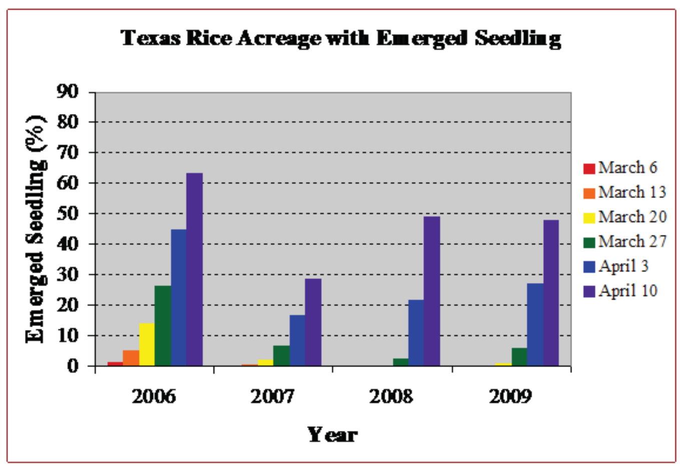
Sincerely,

L.T. Wilson
Professor & Center Director
Jack B. Wendt Endowed
Chair in Rice Research

Rice Crop Update

As of April 10, 2009, about 82% of the estimated rice acreage in Texas had already been planted, and about 48% had emerged seedlings. So far, about 2% of the rice crop acreage had reached the permanent flood stage.





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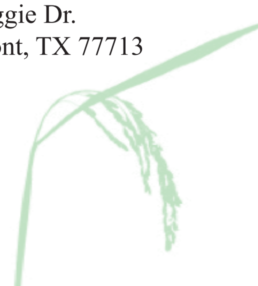

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