

ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
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PROJECT TITLE: Rice Utilization and Product Development

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OBJECTIVES AND EXPERIMENTS CONDUCTED BY LOCATION TO ACCOMPLISH
OBJECTIVES:

1. PHYSICOCHEMICAL PROPERTIES: The objective of these experiments was to characterize and compare the textural properties of California waxy rice, Calmochi 101 (CM101) with waxy rices collected from Japan, China and Thailand using instrumental methods developed from RRB supported research in prior years. Research to understand the textural properties of crisp baked products will help to increase utilization of California waxy rice. Incorporation of waxy rice flours in breakfast cereals and other baked goods adds crispness but not hardness. Most of these processed products require extrusion or power mixing so that the energy required to mix the swollen gelatinized starch and the temperature of cooking become economically important. The textural properties are also important to consumers and to breeders. Many cultivars of waxy rices are grown throughout the world. Samples obtained were evaluated for: cooking viscosity and gelatinization (viscoamylographic profile, Fig. 1), hardness, stickiness, stringiness, toughness, and adhesiveness, and starch molecular weight.

Preliminary studies were also conducted to develop methods to evaluate rice starch quality in fluid food products such as baby foods where rice starch is used as a thickening agent as well as a hypoallergenic source of food energy. The results suggest that true amylose content of rice varies considerably due to environmental factors and result in undesirable variation in processed products.

2. Nutrition

Rice has a healthful image and research has demonstrated that particular components of rice can help to reduce risk factors of chronic diseases such as atherosclerosis and colon cancer. Studies of the health promoting properties of rice and rice fractions help to maintain a healthful image.

Research on the hypocholesterolemic properties of rice bran has been mixed. Some studies have indicated that rice bran and/or rice bran oil reduce plasma cholesterol in test animals while others have shown no effect. The discrepancies between these published reports may be due the need to properly prepare the diet that may include precomplexation and/or providing phytosterols in a soluble form. Oryzanols, a mixture of mainly three different phytosterols esterified to phenolic acids, have been the main focus of cholesterol lowering properties. The focus on oryzanols is due to the similarity in structure of plant sterols to cholesterol, an animal sterol, and the fact that some plant sterols have been known to complex with or reduce plasma cholesterol. In the last two years plant sterols have been incorporated into margarine to reduce plasma cholesterol. The phytosterols in margarines are usually esterified to some form of plant derived acid that increases its solubility.

We have developed an animal model that can be induced to carry most of its cholesterol in the form of low density lipoprotein (LD) cholesterol. Humans transport cholesterol in blood plasma by LDL whereas most rodents transport cholesterol in high density lipoprotein (HDL) particles. Rodents with HDL particles as principal cholesterol carriers seem to be less sensitive. Recently, the Japanese have reported that the combination of oryzanol with cholesterol containing foods such as butter or eggs is necessary prior to feeding. We evaluated this method in the high LDL hamster model by evaluating modest levels of oryzanol combined with the fat fraction of the animal diets that contained all the dietary cholesterol.

SUMMARY OF 1998 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVE:

1. PHYSICOCHEMICAL PROPERTIES:

The waxy rice from Japan (Hakuchomochi, Hiyokumochi, Himenomochi) were different from CM101 as well as the waxy rices from China and Thailand. The Japanese waxy rices had lower gelatinization temperatures, peak viscosity and setback viscosity (Fig. 1). Peak viscosity of Japanese waxy rice were about 0.3 Pas whereas rice from China, Thailand and California had peak viscosity of about 0.45 Pas. Peak viscosity is due to the swelling and absorption of water during heating and a resistance to breakdown of the swollen starch granule. Lower gelatinization temperature may be desirable in some processes where lower cooking temperatures increase processing efficiencies. All the samples were low in the amylose form of starch when analyzed for true amylose content. The molecular weight of the amylopectin form of starch was lower in the Japanese waxy rices than in the other rices (Fig. 2). The molecular weight of CM101 was most similar to the Indica waxy rice.

2. Nutrition

A greater understanding of the physical form of the rice bran phytosterols led to successful lowering of plasma cholesterol in hamsters fed at a level acceptable for human intake. Two oryzanol preparations, designated OZ3 and OZ5, from commercial sources were fed to hamsters on a high fat (15%), high saturated fat diet. Cholesterol was fed at 0.1% or about five times normal human intake, but at a level considered moderate for an animal model. Oryzanol was fed at 0.09% of diet. As a reference a phytosterol similar to sterols used in cholesterol reducing

margarines were also fed at a level of 0.2% of diet. This level is estimated to provide hamsters with a phytosterol sterol intake similar to humans on a body weight basis. Low density lipoprotein cholesterol decreased 24% in hamsters fed either oryzanol preparation from 369 ± 32 in the control group to 284 ± 13 and 281 ± 17 mg/dL, in the OZ3 and OZ5 fed groups, respectively (Fig. 3). High density lipoprotein cholesterol remained the same, 186 ± 13 , 212 ± 7 and 197 ± 13 mg/dL, in the control, OZ3 and OZ5 groups, respectively. The reference phytosterol group had reduced LDL cholesterol levels, 264 ± 18 mg/dL, without changes in the HDL cholesterol level, 202 ± 9 mg/dL. The ratio of LDL/HDL is also a risk factor for atherosclerosis. The LDL/HDL ratio for the control, OZ3, OZ5 and phytosterol fed groups were 2.15 ± 0.33 , 1.36 ± 0.09 , 1.52 ± 0.21 and 1.32 ± 0.10 . The LDL/HDL ratio improves after oryzanol feeding comparable to the ratio of phytosterol feeding. In conclusion, oryzanol dissolved in the cholesterol containing fat fraction of the diet reduced plasma LDL cholesterol without decreasing HDL cholesterol in hamsters fed at levels less than currently consumed by humans eating cholesterol lowering margarines. The correlation between a known cholesterol reducing agent in humans suggests that under the proper conditions oryzanol may be as good or better than currently available cholesterol reducing phytosterol agents.

Figure 1.

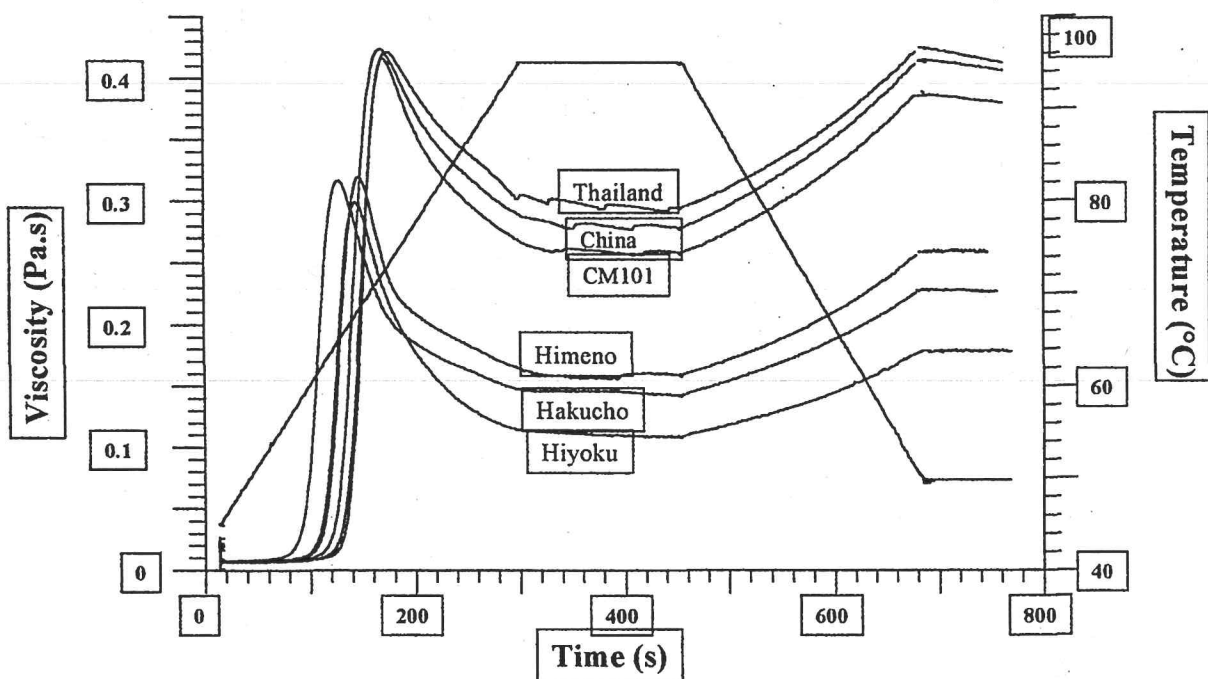


Figure 2.

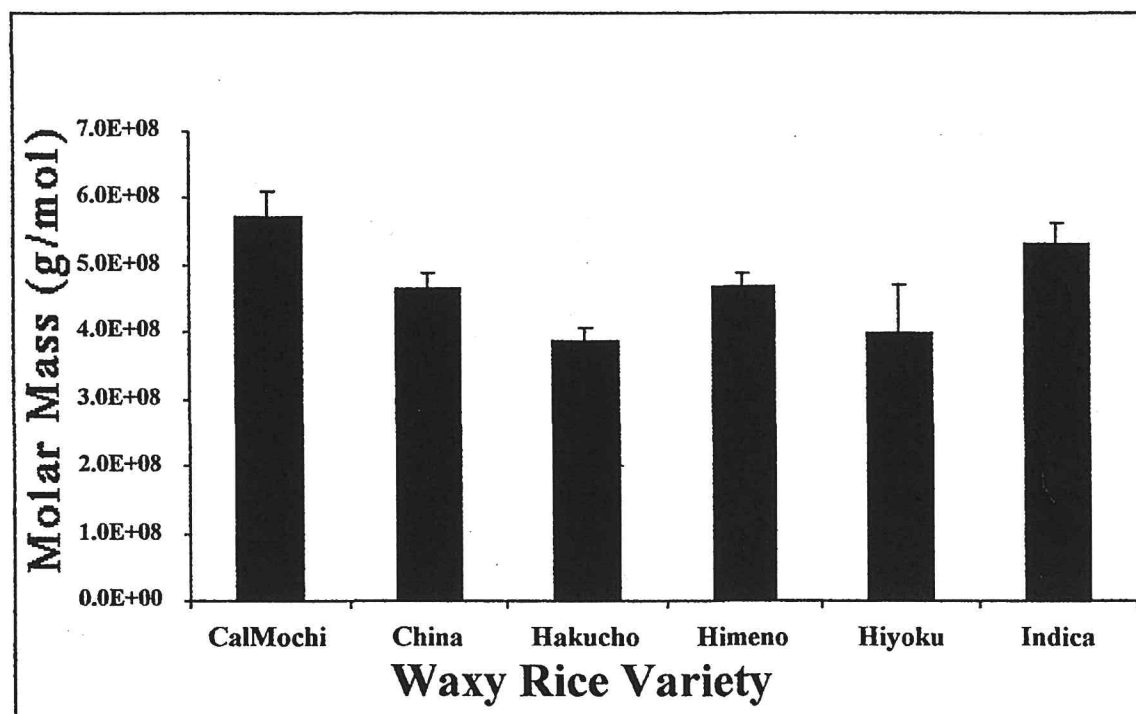
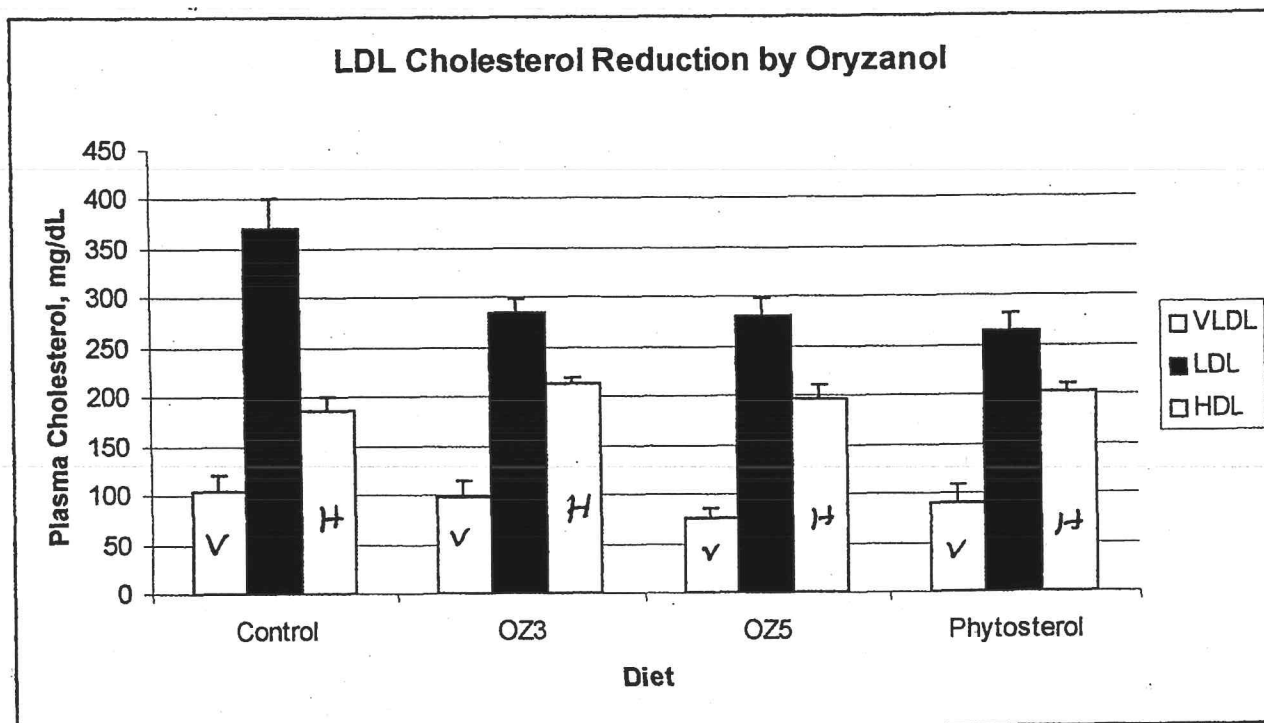


Figure 3.



Plasma LDL cholesterol was lowered 24% in hamsters fed oryzanol, a component of rice bran. The effects of oryzanol feeding are compared to control animals and a group fed phytosterols used in margarines that reduce plasma cholesterol in humans. The phytosterol was fed at about twice the amount of oryzanol.

PUBLICATIONS OR REPORTS:

1. Yokoyama, W. H., Mochizuki, Y. and Shoemaker, C. F. Starch structure and cooked rice texture. Rice Utilization Workshop, Little Rock, AK, Mar 10-12, 1999.. (Abstract)
2. Ibáñez-Carranza, A. M., Mochizuki, Y., Yokoyama, W. H., McKenzie, K.S. and C.F. Shoemaker. New instrumental methods: microviscoamylograph and single kernel texture analyzer. Rice Utilization Workshop, Little Rock, AK, Mar 10-12, 1999. (Abstract)
3. Yokoyama, W. H. Rice Research. Invited Panelist. ARS rice research planning session. Beaumont, TX. Feb 17-18, 1999.
4. Yokoyama, W. H. Rice nutrition. Invited Panelist. USA Rice Foundation, Houston, TX. April 14, 1999.
5. Mochizuki, Y., Yokoyama, W. H. and Shoemaker, C. Textural differences among cooked Koshihikari harvested from different countries. Temperate Climate Rice Meeting, Davis, CA. June 13-16. (Abstract).
6. Ibanez-Carranza, A. M., Renner-Nantz, J. J., Yokoyama, W. H., McKenzie, K.S. and Shoemaker, C. F. Viscoamylographic and Chromatographic Profiles of Waxy Rice Flour. National Meeting of the American Association of Cereal Chemists, Seattle, WA. Oct 31-Nov 3, 1999.
7. Mochizuki, Y., Yokoyama, W. H. and Shoemaker, C. F. Textural properties of six varieties of cooked waxy rice. National Meeting of the American Association of Cereal Chemists, Seattle, WA. Oct 31-Nov 3, 1999.
8. Shoemaker, C. F. Effect of shear rate on the viscoamylographic profile of rice flours and starches. National Meeting of the American Association of Cereal Chemists, Seattle, WA. Oct 31-Nov 3, 1999.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

Waxy rice varies in cooking properties that are important to high speed food processing methods. Although there is the opinion that waxy rice has a range of cooking properties, our sample of six varieties indicate that they fall into two classes. Waxy rice from California is similar to waxy rice from China and Thailand, but different from waxy rice varieties samples from Japan. The cooking properties of waxy rice may be due to differences in molecular weight of the amylopectin form of starch. There is potential for a new waxy rice in California more similar to the Japanese waxy rice based on this study.

Plant phytosterols are currently used in margarine to reduce plasma cholesterol. Oryzanol, a rice bran phytosterol, has shown promise but mixed results have reduced interest in its use. This study shows that properly prepared and use of a animal model more similar to humans can

produce results similar to phytosterols already in use. Oryzanol decreased plasma low density lipoprotein cholesterol in test animals by about 24% when fed at levels that could be reasonably consumed by humans. The LDL/HDL cholesterol ratio also improved by 37%. Reductions in plasma cholesterol were similar to those of test animals fed the active ingredient of margarines used by humans to reduce plasma cholesterol. This study indicates that under the proper conditions oryzanol may be as good or better than current phytosterols in reducing plasma cholesterol.