Project No. RU-2

ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
January 1, 1994 - December 31, 1994

PROJECT TITLE: Rice Utilization and Product Development

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LEVEL OF 1994 FUNDING: $25,000

PROPOSAL OBJECTIVES: To carry out research on California rices that ultimately will lead to new products for domestic and foreign markets.

RESEARCH OBJECTIVES:

1. Nutrition
2. Rice Technology
3. Extrusion Technology
4. Rice Quality Assessment

SUMMARY OF 1994 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVE:

1. **Nutrition**

Starch - Glycemic Response

The beneficial glycemic properties of rice are being evaluated in small animals as a preliminary to human nutrition studies. The rate of starch digestion and absorption into the blood stream affects the level of blood sugar and the demand for insulin. Elevated blood glucose and insulin appear to result in an increase in circulating cholesterol and triglycerides which are associated with heart disease. Previously all rice was thought to be low in glycemic response. Recently only varieties with starch containing a high proportion of linear chain starch (amylose) have been reported to have this property. The iodine binding method for measuring amylose in rice also appears to bind to long branches of branch chain starch (amylopectin) which shows up as apparent amylose. More definitive information is needed on the fine structure of starch molecules. The proportion of amylose to amylopectin as well as the length of branch chains in amylopectin are dependent on both the genetics of the rice variety and environmental conditions during grain filling. A study to relate nutritional and molecular properties of rice is being conducted. This year, long and short grain rices were compared with each other as well as to a glucose control in a rat model. Both types of rice were lower in glycemic response than the glucose control, and the long grain showed indications of slower glucose absorption. Currently, another rat model is being evaluated that may be more experimentally desirable.

A pulsed amperometric detector and HPLC column were purchased to study the molecular size and fine structure of rice starch. These accessories along with a multi-angle laser light scattering detector (MALLS) will be used to identify the genetic and environmental effects on rice starch composition and to relate starch structure to processing, texture, and nutritional properties. We have formed a collaborative research program with UC Davis to study rice starch texture and molecular properties.

Since long grain rice is usually higher in amylose than medium grain rice, results from these fundamental rice starch studies will be useful in breeding programs to combine the softer texture and slower retrogradation found in lower amylose medium grain rice with improved glycemic response. Selection for starch with longer chain amylopectin may accomplish this objective.

Antioxidants

Antioxidants found in rice bran are under investigation for their effect on atherosclerotic plaque formation in the aorta of hamsters. The purpose of the study is to determine if these antioxidants can retard the formation of foam cells, the precursors of atherosclerotic plaques, in an animal model. This is a long term study that will be completed in May 1995 and may increase the desirability of rice bran for both food and feed. In addition to the potential protection against atherosclerosis, we are currently developing animal models to test the efficacy of rice bran and its components on the prevention of colon cancer.

2. **Rice Technology**

Oxidative Stability of Rice Bran

We expect to return to the problem of off-flavors in stored rice bran upon the delivery and installation of the table top extruder early in 1995. Research in this area was not practical without a means to prepare stabilized rice bran of known processing history. We recently installed a gas chromatograph and trained a technician to evaluate typical off-flavor compounds of rice bran.

Methods

In addition to the chromatography detectors mentioned above for molecular weight and shape determination, methods have been developed to perform image analysis on the hamster aorta to determine the extent of plaque formation. Surgical techniques and enzyme assays are in development both for atherosclerosis development in the aorta and for detecting pre-cancerous lesions in the colon.

3. **Extrusion Technology**

Rice bran was processed through an extruder at two different energy levels and fed to hamsters to determine the effects of processing on cholesterol lowering properties. The experiment is complete and data analysis is in progress. Preliminary results indicate that the energy of extrusion does not affect the cholesterol lowering properties of cereal brans and that rice bran is superior to other major cereal brans.

4. **Rice Quality Assessment**

Collaboration among laboratories continued and successfully demonstrated that NIR technology could predict amylose in U.S. rices using NIR instruments in different laboratories. Through the efforts of Kent McKenzie of the CA Cooperative Rice Research Foundation at Biggs, fifty rice varieties from the 1992 crop were obtained from 5 state breeders and sent as milled rice to three laboratories: WRRC, Albany (Maura Bean and Ray Miller); the USDA Instrumentation and Sensing Laboratory at Beltsville, MD. (Steve Delwiche); and the Grain Research Laboratory in Winnipeg, Manitoba, Canada (Philip Williams). Each collaborator performed grinding to flour and scanning in their NIR instrument. Chemical amylose data were supplied by Bill D. Webb, USDA Rice Research Laboratory, Beaumont, TX and protein data were obtained on a LECO Analyzer at USDA, Beltsville, MD. A manuscript submitted for publication reports successful prediction of amylose and protein by all three laboratories. Typical results on a validation set indicated $r^2 = 0.95$ and standard error of 1.0% for amylose and $r^2 = 0.99$ and standard error of 0.11% for protein. Within-laboratory repeatability error of the NIR method was comparable to the reference chemical methods.

Since this study was completed, two rice research laboratories (Biggs, CA and Beaumont, TX) purchased the recommended NIR instrument. We are helping them develop their data bases for predicting amylose and protein on flours from milled rices. We have also helped Biggs (K.McKenzie) study the feasibility of using brown or milled rice (without grinding to flour) to develop NIR spectra for prediction of these constituents. The Biggs group is continuing this work with help from the instrument manufacturer.

PUBLICATIONS AND REPORTS:

Bean, M.M. and Miller, R.E. 1994. Rice properties important for baked and other processed food products. Temperate Rice Conference, Yanco Agricultural Institute, Yanco, NSW, Australia. February 1994. (Presentation, Abstract and Manuscript for Proceedings)

Same as above, *Proc 25th RTWG* pp.125. March 5-9 New Orleans. (Abstract)

Bean, M.M., Miller, R.E., and Chiu, M.M. 1994. NIR and DSC - New tools for rice quality evaluations. *Proc. 25th RTWG* pp. 129 March 5-9 New Orleans. (Abstract)

Delwiche, S.R., Bean, M.M., Miller, R.E., and Webb, B.D. 1994 Rice amylose determination by NIR reflectance spectrophotometry. *Proc. 25th RTWG* pp.59-60. March 5-9 New Orleans. (Abstract)

Delwiche, S.R., Bean, M.M., Miller, R.E., Webb, B.D. and Williams, P.C. Apparent amylose content of milled rice by near-infrared reflectance spectrophotometry. Submitted *Cereal Chem.*, July, 1994; revised November, 1994.

Kahlon, T. S., Chow, F.I., Hudson, C. A., and Sayre R. N. Cholesterol-lowering by rice bran and rice bran oil unsaponifiable matter. in hamsters Submitted *Cereal Chem.* 1994.

Kahlon, T. S., Chow F. I., and Sayre R. N. 1994. Cholesterol-lowering properties of rice bran. *Cereal Foods World* 39:99-103.

Marshall, W.E., Johnson, G.P., Bean, M.M., Chiu, M.M., and Webb, B.D. Comparison of starch gelatinization parameters for rice varieties in different growing areas. *Proc. 25th RTWG* pp. 127-128. March 5-9 New Orleans. (Abstract)

McKenzie, K.S., Bean, M.M., Marshall, W.E., Webb, B.D., McCaskill, D.R., Kohlwey, D.E., Linscombe, S.D., Moldenhauer, K.A.K., Gravois, K.A., and Kanter, D. 1994. Characterization of quality of U.S. rice varieties. *Proc. 25th RTWG* pp.126. March 5-9 New Orleans. (Abstract)

Sayre, R.N., Yokoyama, W. H., Knuckles, B. E., Chiu, M. M., and McKenzie, K. S. 1994. Effect of Environmental and Variety on Rice Starch Molecular Properties. *Proc. 25th RTWG* pp. 126-127, March 5-9 New Orleans. (Abstract)

Yokoyama, W. H. 1994. Glycemic properties of rice and rice products. *Cereal Foods World*, #215, 39:628. (Abstract)

Yokoyama, W. H., Hudson, C. A., and Castillo, S. 1994 Structure and glycemic properties of rice starch. *Rice Experiment Station Field Day*, pp. 6. Aug 30, Biggs, CA. (Abstract)

Yokoyama, W. H., Walzem, R., Xu, R., and German, J. B. 1994. Lipoprotein cholesterol analysis by size exclusion chromatography: Comparison with sequential equilibrium density ultracentrifugation. *FASEB J.*, 8-I:A449, #2602 (Abstract)

Xu, R., Frankel, E. N., Yokoyama, W. H., and German, J. B. 1994. A rapid method to prepare low density lipoprotein for oxidative susceptibility evaluation. *FASEB J.*, 8-I:A450, #2603 (Abstract)

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

1. Rice starch types (linear vs, branched) and degree of branching are being investigated to determine their affect on glycemic response (glucose and insulin levels in the blood) and subsequent atherosclerotic plaque formation. Initial studies have shown that both types of starch lower glycemic response, but that the longer chain starch is most effective. Another interest is the effect of starch structure on texture and rheological properties of rice based processed products. Relating molecular structure to these nutritional and processing characteristics will provide guidance to breeding programs the product rice with the most desirable qualities. Antioxidants and fiber in rice bran also are being investigated for both their effect on circulatory diseases as well as their possible effect on inhibiting colon cancer.

2. Methodology has been developed during the past year to evaluate oxidative off flavor development in rice bran. Chromatographic equipment has been obtained to evaluate starch structure. Small animal models and surgical techniques have been developed to evaluate nutritional and health promoting components in rice.

3. Rice bran and other cereal brans have been processed by extrusion cooking with various energy inputs to test the effect of processing on cholesterol lowering properties. Processing energy appears to have little effect and rice bran gave superior results compared to other cereal brans.

4. Collaborative studies have been completed to validate the use of NIR technology to predict amylose content and protein in rice. This rapid, non-destructive method allows multiple analyses on single samples. NIR machines have now been located at the Biggs Rice Research Station and at the Rice Quality Laboratory in Beaumont, TX. We are assisting in developing their data bases and in developing spectra for the use of brown or milled rice directly without grinding.