

WESTERN REGIONAL RESEARCH CENTER

COMPREHENSIVE RESEARCH ON RICE

ANNUAL REPORT

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PROJECT TITLE: Rice Utilization and Product Development RU-2

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

RESEARCH OBJECTIVES: 1. Rice Flour.
2. High-protein Rice Flour and Liquid Sugars.
3. Rice Test Mill.
4. Rice Bran Oil and Stabilized Rice Bran.
5. Formulated Rice

SUMMARY OF 1982 RESEARCH

1. Rice Flour

Rice Flour Modifications for Baking Applications.

Previous studies from this laboratory have shown the importance of certain physicochemical properties and flour milling methods for producing rice flours for use in baking applications. Studies completed suggest rice flour treatment just prior to use can enhance its functionality. Hydration and intense mixing improved eating quality, volume, and appearance of layer cakes made from 100% rice flour. Limited results suggest an

an alternative (but more expensive) procedure comprising wet milling, drying, and grinding to a flour will also yield a rice flour with improved properties for baking applications. Development of reducing sugars during long hydration account for color improvement in cakes, but it is assumed changes in protein and/or other components may be involved in functional improvements. Baked products from rice flour are especially acceptable for those on allergy-restrictive diets when wheat products are not permitted (Bean et al, 1982; Patent Application: Bean et al, 1982).

Collaborative Rice Flour Tests

Amylograph tests have been completed on four rice flours having distinctly different gelatinization behaviors. These were obtained from Dr. Bienvenido Juliano (IRRI) as part of a collaborative study on rice that he has undertaken for the International Association of Cereal Chemists. The collaborators include several rice research laboratories throughout the world. (U.S. participants are B. Webb, USDA, Beaumont, Texas, and WRRRC, Albany, California.)

The samples tested were four milled rice flours, ground to flours at IRRI, in a Udy mill with 0.4 mm (40-mesh) sieve.

IR32 - High amylose, soft gel consistency, intermediate gelatinization temp.

IR42 - High amylose, hard gel consistency, low gelatinization temp.

IR43 - Low amylose, low gelatinization temp.

Malagkit Sungsong - Waxy, low gelatinization temp.

In addition to the flours, samples of the parent milled rice were received by four laboratories, including WRRRC, for testing after grinding to flours in their own mills. Results of this part of the study will expand the information originally developed in our rice to flour grinding studies. These indicated variations exist in gelatinization behavior, as measured by the amylograph, due to type of flour mill used. The gelatinization (pasting) variations become important in optimizing end-use properties of the flour. (Nishita and Bean, 1982).

At the specific request of the Rice Research Board in December 1981, investigations were carried out on California waxy rice varieties. Results to date are summarized below.

California Waxy Rice Varieties

Physicochemical properties of three California waxy rice varieties have been studied. The three varieties are:

Koda Brothers - Mochigome

Farmers Rice Coop "Honen" - Cal Mochi 201

Pacific International Rice Mills, Inc. - Amylopec

Results. In most of the physical measurements, Amylopec and Mochigome were not distinctly different from each other while Cal Mochi 201 exhibited many differences from the other two. Some of these differences were

- higher amylose content (1.6% vs. less than 0.1%)
- higher amylograph peak viscosity
- lower amylograph setback
- significantly thicker gels with gel consistency measurements
- significantly lower 24-hr gel strength (20% slurry)
- slightly lower H and Tmax measured with DSC

No differences were found between Cal Mochi 201 and Mochigome in gel stability after 17 weeks of freeze-thaw storage or between x-ray diffraction patterns of the two rices. Amylopec was not tested but no differences would be anticipated in these two characteristics.

Results from incorporation of waxy rice into food products.

Incorporation of waxy rice flour into pizza crusts caused the crusts to become thinner and lighter in color. A 30% substitution of waxy rice flour for wheat was the maximum acceptable substitution level. Higher levels of waxy rice caused the crust to be gummy.

The traditional Japanese food, Mochi, was made using either Mochigome or Cal Mochi waxy rice. The Mochigome mochi was smoother and more extensible than the mochi made from Cal Mochi.

Conclusions. The freeze-thaw stability of waxy rice gels is superior to the stability of medium and long grain rice gels.

High levels of substitution of waxy rice flour for wheat flour increases the stickiness and gumminess of the product.

At low levels of substitution (low enough to mask stickiness), varietal differences between the waxy rices cannot be seen and no other textural or flavor improvements have been detected.

2. High-protein Rice Flour and Liquid Sugars

A high-protein rice flour (25% protein) was produced by a rapid enzymatic digestion of rice flour with alpha-amylase thereby decreasing the starch fraction and increasing the protein concentration of the rice flour. The process produces a rice sirup containing maltose-type sugars, as well as the high-protein rice flour.

The growth rates of young weanling rats fed rice flour, high-protein rice flour, and casein at various protein concentrations were determined. At the 20% protein concentration level in the diet, high-protein rice flour was the equivalent of casein with respect to growth. That is to say, a nutritionally-superior protein source for infants (Hansen and You, 1982).

As part of developing economic justification of production of high-protein rice flour, investigations this past year focused on testing the sugar sirup as a substrate for yeast production. Yeast cell count, cell weight, ethanol concentration, and pH have been followed as a function of cell growth, using the rice sirup medium at the 5% sugar level (Hansen and Nayyar, 1982). Results are encouraging, but not yet complete.

3. Rice Test Mill

Method for assaying milling quality on small sample of brown rice.

Use is made of the WRRRC Laboratory Decortivating Mill. Milling conditions were fixed using 10 gram subsamples of brown rice and a decortivating time of one minute. Triplicate determinations were made for whole milled rice determined by visual inspection. This method was applied to a selection of twelve short- and twelve medium-grain paddy rice samples provided by the Butte County Rice Growers Mill, Richvale, California, for which the official total and head yields were known. The twelve samples consisted of four each representing high, medium and low head yield.

Very high correlation coefficients, R, were obtained between our measure, whole milled rice, and the official head yields. Reasonable correlation coefficients, R, were also obtained with official total yields. In each case the R's for short grain were somewhat better for short grain than for medium.

To perform this assay the paddy was first dehulled (100g) in a Satake Testing Husker (THU-35A). Brown rice from the large receiver requires cleaning by screening and blowing and returning the separated paddy kernels for a second time. As a matter of interest the brown rice was inspected and the brokens determined. R for this measure, brokens in brown rice, was very well correlated with official head yield for short grain, less well for medium; versus official total yield it is good for short grain and not acceptable for medium grain.

CORRELATION COEFFICIENTS, R

<u>MCGILL MILL</u>	<u>WRRC MILL</u>	<u>GRAIN TYPE</u>	
		<u>SHORT</u>	<u>MEDIUM</u>
HEAD YIELD VS. WHOLE MILLED RICE		.981	.939
TOTAL YIELD VS. WHOLE MILLED RICE		.775	.726
HEAD YIELD VS. BROKENS IN BROWN RICE		-.959	-.793
TOTAL YIELD VS. BROKENS IN BROWN RICE		-.726	-.463

We find that the assay proposed for whole milled rice probably requires too much time to be useful as a routine screening method by plant breeders. Even the method of measuring brokens in the brown rice, while shorter, still is too time consuming. However, the correlation versus official head yield is so extremely high and the sample size required so small, there may be a use for it on rice where the time element is not as critical as it is for plant breeders.

It is recognized that a machine for dehulling small samples of paddy quickly would serve a definite need and it might then be possible to measure only the brokens in brown rice to provide the desired assay method.

4. Rice Bran Oil and Stabilized Rice Bran

Effective stabilization of rice bran has been accomplished (1981 Annual Report). During 1982 about 150 tons of bran were stabilized in a commercial-sized operation to derive operational cost figures, maintenance requirements, etc.

The parameters for crude rice bran oil processing have been investigated. Optimum oil yield from alkali refining was found to result from using 16° Be' (11%) NaOH with 0.5% excess. Bleaching refined rice bran oil with the addition of 6% acid activated clay (Filtrol #105 FAC) at 120°C for 15 min produced a light golden color. Addition of charcoal did not yield a significantly lighter color. Deodorization and filtration of the bleached oil resulted in a bright, pale colored, odorless low viscosity oil.

Chick feeding trials were conducted using raw and stabilized bran, both full fat and solvent extracted. Four replicate experiments were run at six week intervals with rice bran stored at 32°C from the beginning of the first experiment. Chicks fed stabilized rice bran at 60% of the ration had lower pancreas weight, higher weight gain, and improved feed efficiency compared to chicks fed the same level of raw bran in the ration. After six weeks of high temperature storage, the oil in raw rice bran contained 63% free fatty acids (FFA) and the FFA level increased to 81% after 18 weeks of storage. Feed palatability, as indicated by the amount of feed consumed, decreased after the first experiment for rations containing either full fat bran or fat free bran, thus indicating that factors other than oil deterioration may be affecting palatability.

A swine metabolism study was conducted using raw, stabilized, and extracted stabilized rice bran. Metabolizable energy and nitrogen were not significantly different among the three types of bran. Growth studies with swine have been inconclusive to date. However, there are indications that stabilized rice bran may bind zinc in the ration thus causing deficiency symptoms in the animals. There are also indications that the kind of basal grain in the ration, in combination with stabilized rice bran, may influence zinc availability.

These experiments are intended to optimize the improvement in bran feed efficiency, brought about by the WRRRC stabilizing process. The result to the rice industry will be superior stable feeds suitable for domestic and export markets at a better selling price. (Archer-Daniels - Midland is presently extracting oil from parboiled bran in Mississippi. The defatted bran brings a price premium- the same premium would be expected for defatted stabilized bran).

Requests by food manufacturers for samples of stabilized rice bran have been extensive this past year and this interest is expected to continue. See publications by Enochian et al, Nayyar and Sayre, Saunders et al, Sayre et al, 1982.

5. Formulated Rice

In cooperation with the Pillsbury Company, WRRRC carried out consumer appraisal tests on formulated rices which had been "restructured" in a patented extrusion process. Pillsbury made such rices from California short and medium brokens supplied by RGA through WRRRC. Consumer tests showed that both reformulated rices scored well against a commercial quick-cooking long-grain rice, with the short-grain reformulated rice performing the better of the two California varieties. The reformulated rices are not sticky after cooking. Since second-heads can be used, a competitive price can be anticipated. Pillsbury proposed marketing demonstrations etc. in California, and WRRRC alerted the Rice Board, RGA and PIRMI. Unfortunately, in a year of surplus, there is little need for a formulated rice. Nevertheless these formulated rices had properties (and price?) deemed by WRRRC and Pillsbury to be marketable, and should not be forgotten.

Other Results

Three papers on measurement and reduction of stickiness in California rices through processing were submitted for publication. This work is a result of research funded by the Rice Board during 1977-79 period. While stickiness could be reduced substantially, negative effects were observed (and have not been resolved) on gloss, whiteness, flavor and storage stability (Fellers et al; Mossman et al, 1982). A book chapter on rice utilization in the tropics was written (Mossman, 1982).

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Sayre, R. N., Saunders, R. M., Enochian, R. V., Schultz, W. G., and Beagle, E. C. Review of rice bran stabilization systems with emphasis on extrusion cooking. Cereal Foods World, 27:317 (1982).

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS

1. Short and medium rice flours are superior to long grain rice flours in baking applications. The method of grinding rice flour markedly influences its properties in subsequent food applications. Speciality uses and properties of California waxy rices are described.
2. High-protein rice flour is analogous to casein in feeding trials at the protein level (20%) anticipated in infant feeding. The sirup byproduct resulting from manufacture of high protein rice flour promises to be a good substrate for yeast growth.
3. WRRRC rice mill tests show that total head yield may be predicted from a simple analysis of brokens content of dehulled paddy, without a further polishing test.
4. Stabilized rice bran and extracted stabilized bran are superior feeds than raw bran for chicks. This added value could be reflected in domestic least-cost formulated rations, and export markets. Rice bran oil may become a source of edible oil, thus increasing the value of bran.
5. Short and medium grain California second heads rice can be reformulated using a commercial extrusion process into non-sticky "whole grain rice". This "rice" compared favorably to a commercial quick-cooking rice in (statistical) consumer evaluation tests.