

## **ANNUAL REPORT RU-3**

### **Evaluation and Improvement of Rice as a Brewers' Adjunct to Expand its Market in the Brewing Industry**

Michael J. Lewis

Department of Food Science and Technology  
University of California, Davis, Ca 95616

Level of current funding 1988/89 \$34,712

#### **Objectives:**

1. Determine the qualities of rice that make it a desirable or undesirable adjunct for brewing and compare these attributes to corn grits.
2. Develop or select tests that can be used to screen rice products and other extract sources (especially corn) for their brewing quality.
3. Evaluate rice from many sources for their brewing quality.

#### **Introduction and Summary of Research in 1988**

The brewing industry consumes approximately one quarter of the production of U.S rice growers. Some of this is the by-products of milling (grits) but, as this is insufficient to meet the demand, rice is also processed for brewing use.

Our research project seeks to understand the problems involved with processing rice in breweries, to learn how to measure and evaluate desirable and undesirable attributes, and then to seek rice varieties that, from the processing and agronomic point of view, are best suited to the brewing process. Our limited research to date has surprised us. We had expected from comments in the literature and from the oft-repeated traditional experience of brewers, to find rice a recalcitrant under-performer in certain tests. While rice does behave somewhat differently from corn, we find the differences surprisingly small and often in favor of rice. We begin to ask, therefore, whether rice has not been a victim of a brewers' myth--a firmly held conviction that has no basis in fact. While our research is only just starting, we have already learned to have a much more open mind about the relative merits of rice and corn than when we began.

The research results reported below are incomplete. Also, we have reported only those tests in which rice and corn show significantly different behavior. They reflect our initial work on developing appropriate methods for the examination of rice and corn in brewing systems (Objectives 1 and 2) not that examination itself. We shall expand considerably on this work in the remainder of the research year, with a view to adding new methods (including differential scanning calorimetry), further refining our experimental technics, and expanding the available rice samples studied.

### **Objective 1:**

#### **Research Results: Extract Yield**

One of the main standard by which brewers' adjuncts are evaluated is their yield of extract. This is the quantity of the material that dissolves, usually expressed as a percentage of the dry weight. The value of a brewing material is then measured in terms of its price per pound of extract (not weight). Small differences in extract yield have great economic importance. When we measured extract yield in several rice samples and corn grits, using standard brewing industry methods, we found rice significantly outperformed corn (Table 1). These samples were not identified by variety. We now have some samples that will allow us to make varietal comparisons.

#### **Reaction with $\alpha$ -Amylase**

When rice reacts in brewing processes it is degraded by  $\alpha$ -amylase derived from malt. The speed and extent to which is broken down in part qualify the adjunct material and help define the character of the beer. For example, some materials may be more readily broken down to fermentable sugars, than others. Generally, though not always, rapid breakdown to fermentable sugars is preferred over a high level of residual dextrins. Using many commercially available  $\alpha$ -amylase preparations (the one reported here is actually used in the brewing industry) we compared the behavior of rice and corn. In Table 2 the value for soluble solids is a measure of extract yield, the iodine color is a measure of extent of starch breakdown (pale yellow indicates extensive breakdown; brown and blue colors indicate poor breakdown) and low viscosity is preferred over high viscosity. From the data it is clear that rice and corn react differently to this enzyme. Generally in these tests rice outperformed corn by giving higher soluble solids, pale iodine color (extensive breakdown) and low viscosity.

## **Objective 2:**

### **Research Results: HPLC Analysis.**

The different reaction of corn and rice worts to iodine (reported above) indicate a different ratio of fermentable to unfermentable sugars, but give no indication of the make-up of the low molecular weight fraction of the sugar profile. This is consequential because some sugars are more easily metabolized by yeast than others. We compared the sugar profile in wort from rice and corn mashes that were treated identically with  $\alpha$ -amylase (Table 3). To our surprise we found corn worts deficient in low molecular weight sugars, especially glucose. Rice yielded almost twice as much maltose and maltotriose (fermentable sugars) as corn. This was not the result of incomplete enzyme action, because the treatment was exhaustive (one-hour boil and one-hour enzyme reaction), but reflected the quality of the materials as enzyme substrates.

### **Starch Composition**

Starch composition can be expected to influence the brewing quality and behavior of rice and corn in two ways: first, by its ease of gelatinization and second, by its reaction with amylase enzymes. Once again the results we obtained with these measurements surprised us (Table 4). The corn starch in brewers' yellow corn grits contained rather more amylose than expected by brewers' tradition and by the result we obtained in Table 3 (low yield of fermentable sugar). The rice contained a range of amylose contents, but the low level of amylose in "rice, 1<sup>st</sup> shipment" did not correlate as expected with the high level of fermentable sugar reported in Table 3. This suggests there may be unexpected variables in the behavior of rice and corn.

## General Summary and Conclusions:

To our own surprise, the rice samples we have examined so far, and the methods we have used, show rice to be at least as good as corn as an adjunct for brewing, and in some cases superior. Inferior brewing characteristics, traditionally ascribed to rice, be a myth. Technologically, rice may have been given what, in another setting, would be called a "bum rap". Initially, at least, we conclude that barriers to the use of rice in brewing are not technological ones, but may be economic or reflect perceived availability problems or a regional (mid-western) bias in the industry. To convince brewers that rice is as easy to brew with as corn, will require solid research, but it will be worthwhile if it opens up the adjunct market to rice. Our research for the moment is quite incomplete; we have not even explored the full range of methods and samples we expect to use. But the results to date are encouraging. Given these early favorable returns, we are requesting a continuation grant in a somewhat reduced amount.