THE UNIVERSITY OF MANITOBA

THE DEVELOPMENT OF PROCESSING SYSTEMS FOR MANITOBA WILD RICE

BY

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TO THE MEMORY OF MY FATHER,

WHO INSTILLED IN ME AN OVERWHELMING DESIRE

TO STUDY, AND

TO MY MOTHER,

WHO ENCOURAGED AND SUPPORTED ME THROUGHOUT

MY ACADEMIC ENDEAVORS.

ABSTRACT

Color, cleanliness and degree of breakage are the main quality criteria for acceptable wild rice. These characteristics can change drastically because of wide variations in processing procedures. Processing has not been standardized, and uniform quality standards do not exist for the industry. This study was designed to improve upon the existing processing methods and aimed at standardizing the procedures needed to produce a more uniform final product that best accords to consumer preference. The flavor characteristics of wild rice were also investigated using 18 characteristics.

Results indicated that good quality wild rice was obtained when low temperature curing, controlled humidity and controlled high temperature parching during processing were used. As curing progressed, color development increased under favorable conditions. Well controlled parching and curing systems will not affect total yield and thus ensure optimum yields.

The consumer survey conducted indicated that dark colored, whole and clean wild rice was more acceptable. However, present high prices generally limit the use of wild rice to gourmet cooking only.

Results from the flavor analysis showed that wild rice with dark brown color, straight and split kernels, bland aroma, grainy taste and slight chewiness was of good quality and was considered to be highly acceptable.

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INTRODUCTION

Wild rice, (Zizania aquatica) has long been the staple food crop of the Indians in the Northern Great Lakes Region. This crop was not cultivated but allowed to grow naturally and then harvested in large quantities from its habitat in the shallow lakes and streams of the area. Today, due to its limited supply and unique flavor and color characteristics, wild rice is considered a delicacy by most North Americans. Even with its high price, $6.00/lb in 1972 (41) as compared to 10¢/lb in 1918 (37), there appears to be a growing demand for this grain. This demand has encouraged cultivation of wild rice in paddies, along with the use of mechanical harvesting and processing techniques. Since 1968, the increase in production of paddy wild rice has been dramatic, especially in the United States. For instance, in Minnesota, it increased forty fold in five years (12, 15, 41). However in Canada, natural stand harvest supplies the largest quantity of rice with the production from paddies being very limited.

When compared to other cereal grains, (Table 1) wild rice is a nutritious food. It is relatively high in protein and low in fat content (6, 26, 38). The analysis of wild rice indicates that it contains 14.10g protein, 6.2mg niacin and 353 calories per 100g of raw parched product. Other researchers have stated that it is also rich in the B vitamins, especially thiamine, riboflavin and nicotinic acid, while being low in Vitamin A and some minerals.

Today, wild rice, although no longer used as a staple food by most of the Indians, still remains as a major supplementary food and a source of much needed income for the native people (38, 41). Due to the high price, most consumers cannot afford to use it as often as they would like to. Yet, despite the high cost, the white man has introduced successful, numerous recipes for the preparation of wild rice. Now it is used in game-bird stuffings, desserts and in various other ways. The basic method of preparation of wild

TABLE 1*. Composition of Wild Rice and Comparisons With Other Grains.

Grain Wild Rice	Water	Protein	Fat	Carbon	Ash	Calories Fuel Value per lb
Whole Grain	9.5	12.9	1.0	75.2	1.4	1,625
Ground	13.0	10.9	0.8	74.0	1.3	1,740
Parched Whole Grain	11.2	14.6	0.7	72.3	1.2	1,620
Parched & Ground	9.5	11.5	0.8	76.9	1.3	1,800
Rice, polished	12.3	8.0	0.3	79.0	0.4	1,630
Barley, pearled	11.5	8.5	1.1	77.8	1.1	1,650
Wheat, cracked	10.1	11.1	1.7	75.5	1.6	1,685
Oats, rolled	7.7	16.7	7.3	66.2	2.1	1,850
Cornmeal, unbolted	11.6	8.4	4.7	74.0	1.3	1,730
Hominy	11.8	8.3	0.6	79.0	0.3	1,650
Kafir Corn	16.8	6.6	3.8	70.6	2.2	1,595
Buckwheat Flour	13.6	6.4	1.2	77.9	0.9	1,620

*Adapted from - "Wild Rice" - Indian Food and a Modern Delicacy", by Taylor A. Steeves, Economic Botany. 1952.

rice is by boiling it in water until the rice becomes tender to one's taste. At the present time, quality standards have not been established for the final product. Consumers have therefore had to contend with whatever is available in the market regardless of its quality.

The major problems in the processing of wild rice are 1) - the industry has not become equipped for large scale operations and 2) - much of the understanding of the processing operations is based on art and not on scientific technology. This study was therefore carried out 1) - to study the effect of the curing system on wild rice quality, by varying a) temperature, b) humidity and c) storage time. 2) - to study the effect of the parching system on wild rice quality by varying (a) temperature and (b) time. 3) - to evaluate the quality of the final product obtained in (1) and (2) above by color analysis, yield analysis, sensory evaluation and consumer preference.

2. LITERATURE REVIEW

Wild rice has served the Indians both as food and revenue for many years. However, no information was ever written concerning their processing techniques until 3-5 hundred years ago (6, 7, 18, 38). Such information became available only after the white man migrated to the wild rice regions in the 18th century (19, 38). At that time, the white man was dependent on this grain as a staple and winter food. The Indians harvested the rice, processed it by hand and sold it to the white man until recent years when he began to manage the production of this grain.

Rapid growth of this new industry has resulted in the need for improved cultivation and processing techniques. The first commercial paddies were developed in Minnesota in 1964, and since then, (tables 2 & 3), commercial wild rice production and processing has expanded rapidly into Wisconsin, Manitoba, Northwestern Ontario, Saskatchewan, Alberta, and Michigan.

2.1 The Wild Rice Plant

The wild rice plant that grows in the upper Great Lakes region is known scientifically as Zizania aquatica. It is found throughout the eastern and northern United States and southern Canada (19, 38). It is also known by several other names such as Indian rice, menomen, water oats and marsh oats (8, 19, 38).

Wild rice is an annual aquatic grass. It matures indeterminately, shatters and therefore the seed has to be harvested in the immature green stage (8, 19, 25, 38).

2.2 The Wild Rice Kernel

A kernel of wild rice will range from 1-3 cm long and 2-4 mm in diameter. It is almost cylindrical with a slight indentation along the length of the kernel and tapered ends (25, 26, 35). The outer

TABLE 2. The Production of Wild Rice in Minnesota from 1973-75.

Year	Acres Natural Stands	Unprocessed Grain (lb)
1973	-	1,000,000
1974	-	550,000
1975	-	100,000
	Cultivated Fields (Paddy)	
1973	18,000	3,000,000
1974	13,000	2,700,000
1975	13,000	3,200,000

Courtesy of University of Minnesota, Department of Agronomy and Plant Genetics. April, 1976.

TABLE 3*. The Price and Supply of Green Wild Rice in Manitoba from 1966-74.

Year	Green Rice Natural Stand (kg)		Approximate price to Harvestor (kg)	
	(lb)	(kg)	(lb)	(kg)
1966	(119,126)	54,036	$ (1.10)	$ 2.43
1967	(593,000)	268,984	(1.45)	3.20
1968	(230,000)	104,328	(.64)	1.41
1969	(160,000)	72,576	(.75)	1.65
1970	(145,000)	65,772	(.70)	1.54
1971	(470,000)	213,192	(.45)	.99
1972	(678,000)	307,540	(.45)	.99
1973	(624,000)	283,046	(.50)	1.10
1974 (est.)	(102,000)	46,267	-	-

*Adapted from Wild Rice Production in Manitoba by D. Punter et. al. No. 527. 1975.

coat of the kernel is a thin, pigmented layer known as the pericarp (Figure 1). Covering the whole kernel is a thin outer sheath called the hull. One end of the hull tapers to a bristly hair-like point called the beard which is usually about as long as the kernel. The hull clings tightly to the kernel but must be removed during processing. Freshly harvested grain contains about 35-40% moisture (22, 41, 42) and has a pliable kernel that is dark-brown to black in color when fully mature. After processing, the kernel contains 7-11% moisture and the endosperm is hard and translucent due to the gelatinization of the starch.

2.3 Early Methods of Processing Wild Rice

A detailed description of the methods used by the Great Lakes Indians in processing wild rice has been reviewed thoroughly by Chung, 1975 (10).

The traditional harvesting method involved two individuals in a canoe, one maneuvering the canoe through the rice stand and the other bending wild rice stalks over the canoe and striking them with a stick, causing the mature seeds to fall into the canoe (8, 19, 38, 41). This technique is still in use today by native people but is gradually being replaced (15, 33, 41).

After harvesting rice was cured (dried) by one of three methods: (1) - rice was spread in a thin layer and exposed to the sun for several days: (2) - rice was placed on grass mats hung 3 to 4 feet above a slow-burning smokey fire for 1 to 3 days: (3) - a few pounds of rice was put into a kettle and heated at a high temperature for 15-30 minutes with constant stirring (8, 19, 28, 41). The latter method was called "parching" and produced rice with the best flavor (3, 8, 19, 38, 41). Often times rice was sun-dried for a few days and then parched.

After curing, rice kernels became hard and hulls were brittle. This permitted the hulls to be removed by a rubbing action, which was accomplished in one of three ways: (a) - putting the rice into a shallow hole and having

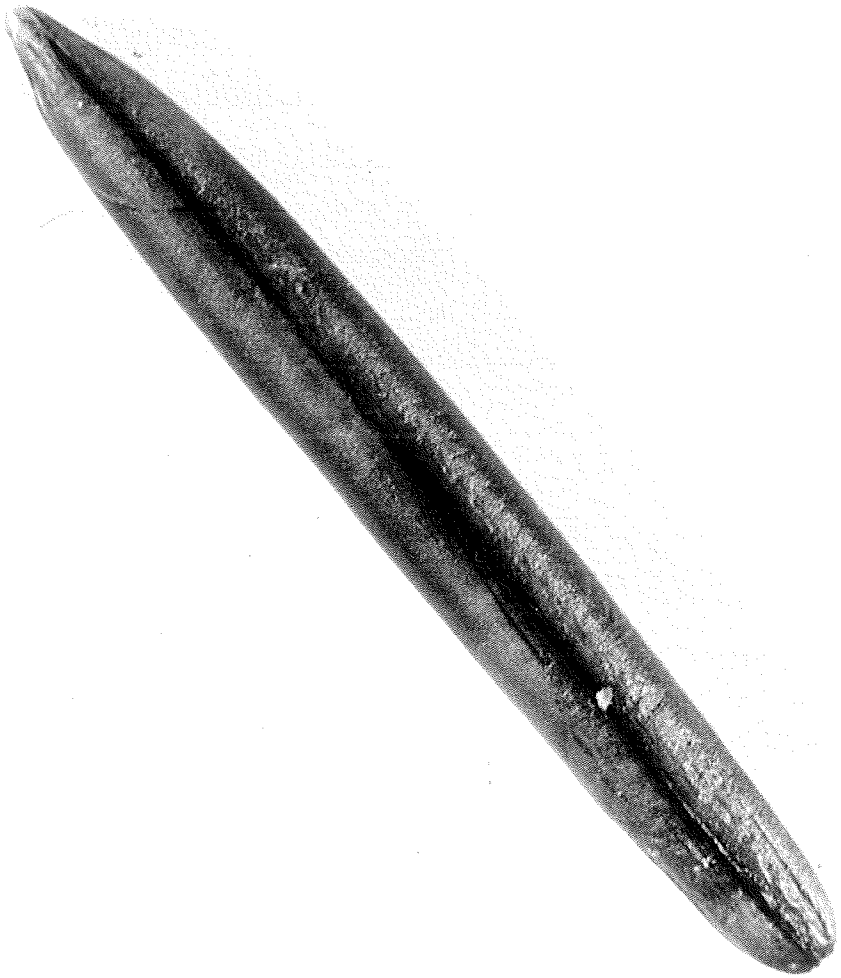

FIGURE 1. The Wild Rice Kernel.

a man tread on it; (b) - putting rice into a shallow hole and pounding it with a pole; or (c) - putting rice in a bag or on a blanket and beating it with sticks. After dehulling, chaff and kernels were separated by winnowing (19, 38). Following this operation, rice was ready for storage or to be cooked and consumed.

2.4 Modern Processing Methods

Modern wild rice processing accomplishes the same purposes as traditional methods but involves a higher degree of mechanization. Processing techniques and equipment designs vary among processes although they are similar in all respects. The basic steps of processing are: harvesting, storage (curing), parching, hulling, winnowing (cleaning), grading (size separation) and packaging (8, 10, 13, 38, 41, 42). Special machines called speedheads have been adapted to harvest natural stand wild rice (Figure 2), (13, 38). Paddy rice is harvested by rice combines after draining of the paddies (41, 42). The harvested rice is packed into cloth or plastic bags and transported by truck to the processing plant (41, 42).

The rice is usually stored (cured) from 1-5 weeks either outdoors or in sheds. The purpose for this is twofold: (a) - to mature the green rice and (b) - for storage since the equipment used in the subsequent steps is not of a size sufficient to handle the large bulk of material very quickly. The basis for this is economics, i.e. the rice harvesting season is only 4-6 weeks while the processing season has been extended to 12-14 weeks. Even under these conditions the plant and equipment lie idle for the rest of the year (8, 13, 14, 32, 38, 41, 42).

During curing, the green rice is spread out on the ground and piled up to a height of 1-3 feet (15). The rice is stirred and turned over every day and then watered when necessary, throughout the curing period (10, 15, 41). The purpose of this practice is to prevent any excess heat