1944

Rice and the vitamin B complex

Virginia R. Williams

Recommended Citation

Williams, Virginia R., "Rice and the vitamin B complex" (1944). *LSU Agricultural Experiment Station Reports*. 515.
http://digitalcommons.lsu.edu/agexp/515

Louisiana Bulletin No. 381 July, 1944

RICE AND THE VITAMIN B COMPLEX

by

Virginia R. Williams and E. A. Fieger

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATION
W. G. Taggart, *Director*

RICE AND THE VITAMIN B COMPLEX

By VIRGINIA R. WILLIAMS AND E. A. FIEGER

The cereals—botanically, those grains and seeds of the grass family—have been the chief food of mankind for centuries. As late as the Roman era the goddess Ceres, for whom "cereals" were named, was deeply revered as the special guardian and benefactress of the grain. Each civilization has been characterized by the cultivation of one particular grain crop—wheat having become the "staff of life" of the Western world, just as rice has been the mainstay of Oriental peoples. In this hemisphere a like esteem for rice has been shown by the populations of Louisiana and neighboring states as well as Cuba and Puerto Rico, where large quantities of rice are consumed annually.

Since the germ and bran layers are removed by customary milling operations, rice is usually consumed in the "polished" state, although scientists have known for the last quarter-century that the better recognized B vitamins were located principally in these removed portions. The findings of vitamin research have prompted many endeavors to discover dietary uses for rice polish and rice bran as well as aroused questions with regard to the influence of variety and milling on the content of the newer B vitamins. In the attempt to answer some of these questions, this investigation was undertaken.

At the present time at least eleven substances are recognized as B vitamins: thiamine or B_1; riboflavin or B_2; niacin or nicotinic acid; pantothenic acid; pyridoxine or B_6; biotin; inositol; choline; para aminobenzoic acid; and two folic acid factors, B_{10} and B_{11}. Although only the first three of these eleven compounds are definitely known to be needed for human nutrition, the analyses undertaken here included also pantothenic acid, pyridoxine, biotin, and inositol in the event that later work might prove these vitamins necessary to man. The functions of the B vitamins as far as they are now known are given below.

Thiamine or Vitamin B_1 was the first B vitamin to be recognized and isolated and, for that reason, the clinical picture of functions and deficiency symptoms is now practically complete. Thiamine is needed by the body in its use of starch and sugars derived from the diet or made in the body. When an individual lacks thiamine, the emotions are affected first —and later, the nervous system. Loss of appetite, a feeling of fatigue, digestive disturbances, muscular weakness, pains in arms and legs, swelling in ankles and face, and lowering of blood pressure indicate the onset of B_1 deficiency. In more severe cases, the entire nervous system is affected, resulting in what is called "polyneuritis" and "neuralgia." Frequently the muscles in the calves of the legs will cramp and at a later stage, loss of use may occur. "Beri-beri," the name applied to conditions of severe lack of thiamine, is recognized by such symptoms as lameness, lack of muscle coordination, disturbance of the nervous system followed by labored breathing, overgrowth of the right side of the heart, and finally, death from heart failure.

Riboflavin, or B_2, regulates the speed of certain chemical reactions of the body, assists in the body use of starch and sugar, and functions in the seeing mechanism of the eyes. Individuals who consume diets inadequate in riboflavin develop a condition known as "cheilosis," characterized by sores on the lips and in the corners of the mouth, a scaly greasy condition around the folds of the nose, and inflammation of the tongue. Roughness, itching, and burning of the eyes as well as a sensitivity to light may also occur.

Niacin or nicotinic acid, like riboflavin, assists in the body's chemical reactions and helps to transport hydrogen through the system. Unlike thiamine, slight niacin deficiency cannot be recognized by any characteristic symptoms. After long deprivation, a drop in the blood level of niacin as well as the onset of "pellagra" are the first indications of niacin hunger. A definite type of sores appear in the mouth and on the skin over the nose, forehead, hands, wrists, elbows, knees—in fact any part of the body exposed to sunlight and friction. Many persons suffering from pellagra experience digestive disturbances, loss of appetite, and diarrhea. Continuance of the illness results in mental disorders—clouding of the mind, uncontrollable grasping of the hands, rigidities, and finally death. Persons developing pellagra are ordinarily on such poor diets that they lack vitamins other than niacin, but niacin appears to be the principal deficiency.

Recent work indicates that *pyridoxine* may be needed in the diet of human beings since it appears to help in curing some cases of muscular weakness, nervous disorders, acne, and nausea of pregnancy. Pyridoxine deficiency produces "rat pellagra" in rats, and results in convulsions in dogs, chicks, and pigs. *Pantothenic acid* is needed by chicks for normal feathering and good skin condition. It prevents gray hair in rats, but so far has not been shown to exercise the same function in human beings. Rats and mice need *inositol* for normal growth and production of hair, as well as for the maintenance of normal liver condition. Graying of hair in rats results from lack of *para aminobenzoic acid,* but there is no conclusive evidence that it serves the same purpose in human beings. *Biotin* hunger produces in rats a characteristic skin trouble, graying of the fur, and loss of hair around the eyes, resulting in "spectacled eye." The bottoms of the feet of chicks that are biotin deficient become rough and calloused and may in more severe cases become encrusted and bleed. A human being on a diet containing large quantities of raw egg-white develops symptoms known as "raw egg-white injury" which are relieved by feeding foods containing biotin. Biotin is sometimes helpful in curing cases of acne and skin eruptions in human beings. *Choline* is undoubtedly used by animal bodies as a building unit and may help regulate the body use of fats. It is definitely needed by rats, dogs, rabbits, guinea pigs, chicks and other animals, but human needs have not yet been investigated. *Vitamins* B_{10} and B_{11} are needed for normal feathering in chicks and for the prevention of anemia.

Experimental Work

In September of the 1942-43 milling season, laboratory workers collected one hundred rice samples from 13 Louisiana mills and one Arkansas mill. The collection of samples from many mills rather than one mill was held desirable in order to obtain data representative of milled samples in general. Samples of rice were collected and examined during the 1941-42 milling season, but the results of those anlyses were used for preliminary study only. The samples were divided into two main groups: (1) samples of brown rice of six outstanding Louisiana varieties (Blue Rose, Fortuna, Early Prolific, Nira, Rexoro, and American Pearl) collected for the purpose of studying differences among varieties, and (2) samples of milled fractions of three typical varieties (Blue Rose, Early Prolific, and Fortuna) for the purpose of studying differences in vitamin content of the different milled fractions.

These milled fractions consist of the products obtained through the different operations in the milling process, as more and more of the outer coats of the rice grain are removed and the rice progresses from the original rough state to the finished product. In Louisiana, the fractions usually consist of: (1) brown rice, (2) first break rice, (3) second break rice, (4) brushed rice, and (5) finished rice. The by-products of the milling process are (6) rice polish and (7) rice bran, which may also be considered milled fractions and consist of the removed outer coats of the grains.

The samples were analyzed by a combination of chemical and microbiological methods. Thiamine, riboflavin, and pyridoxine were determined chemically; and the other vitamins, microbiologically. Further information on these methods will be furnished on request by the Department of Agricultural Chemistry and Biochemistry, Louisiana State University.

The influence of variety on vitamin content is shown in Table I and that of milling in Table II. As may be seen, no outstanding differences

TABLE I

Comparison of the Vitamin Content of Several Varieties of Brown Rice

Variety	Vitamin Content in micro-ounces per pound*						
	B_1 Thiamine	Niacin	Pantothenic acid	Pyridoxine	B_2 Riboflavin	Biotin	Inositol
Blue Rose	64.0	788.8	264.0	150.4	12.1	1.8	61,184.0
Early Prolific	67.2	728.0	254.4	164.8	9.0	2.0	50,224.0
Nira	83.2	966.4	276.8	163.2	8.4	2.0	46,496.0
Rexoro	68.8	668.8	246.4	171.2	8.7	2.1	40,848.0
American Pearl	57.6	625.6	233.6	166.4	7.9	1.9	38,496.0
Fortuna	70.4	750.4	297.6	179.2	8.3	2.0	65,840.0
Composite average	68.5	754.7	259.1	165.9	9.1	2.0	50,514.7

Daily allowances for moderately active man recommended by Nat'l Research Council } B_1—63.49 micro-ounces. Niacin—634.92 micro-ounces. B_2—95.24 micro-ounces.

*Micro-ounces = one millionth of an ounce = $\left(\frac{1}{1{,}000{,}000}\text{ ounce}\right)$ = 1/16 microgram or $\frac{1}{16{,}000{,}000}$ gram.

TABLE II

Comparison of the Vitamin Content of the Milled Fractions of Several Varieties of Rice[1]

Vitamin	Variety	Milled Fractions						
		Micro-ounces per pound‡						
		Brown rice	1st Break	2nd Break	Brushed	Finished	Bran	Polish
Thiamine	Blue Rose	64.0	19.2	19.2	14.4	12.8	430.4	414.4
	Fortuna	70.4	25.6	14.4	8.0	9.6	425.6	456.0
	Early Prolific	67.2	36.8	22.4	16.0	19.2	481.6	249.6
	Average†	67.2	27.2	18.7	12.8	13.9	445.9	373.3
Niacin	Blue Rose	788.8	379.2	291.2	219.2	196.8	6,457.6	6,449.6
	Fortuna	750.4	326.4	272.0	148.8	153.6	7,798.4	6,876.8
	Early Prolific	728.0	531.2	478.4	224.0	257.6	5,356.8	5,139.2
	Average†	755.7	412.3	347.2	197.3	202.7	6,537.6	6,155.2
Pantothenic acid	Blue Rose	264.0	129.6	120.0	112.0	104.0	1,054.4	1,629.5
	Fortuna	297.6	137.6	123.2	97.6	100.8	1,300.8	1,769.6
	Early Prolific	254.4	168.0	128.0	153.6	104.0	1,068.8	1,152.0
	Average†	272.0	145.1	123.7	121.1	102.9	1,141.3	1,517.0
Pyridoxine	Blue Rose	150.4	68.8	41.6	41.6	32.0	380.8	473.2
	Fortuna	179.2	121.6	78.4	83.2	84.8	540.8	499.2
	Early Prolific	164.8	140.8	123.3	116.5	99.2	617.6	513.6
	Average†	164.8	110.4	81.1	80.4	72.0	513.1	495.3

TABLE II—Continued

VITAMIN	VARIETY	MILLED FRACTIONS						
		MICRO-OUNCES PER POUND‡						
		Brown rice	1st Break	2nd Break	Brushed	Finished	Bran	Polish
Riboflavin	Blue Rose	12.1	7.7	7.8	6.4	4.6	33.9	26.4
	Fortuna	8.3	7.3	4.7	4.1	3.6	29.3	30.7
	Early Prolific	9.0	5.5	3.2	2.9	3.2	39.7	28.3
	AVERAGE†	9.8	6.8	5.2	4.5	3.8	34.3	28.5
Biotin	Blue Rose	1.8	1.0	0.9	0.8	0.8	8.7	8.7
	Fortuna	2.0	0.9	0.8	0.8	0.5	7.8	13.3
	Early Prolific	2.0	1.2	0.9	0.7	0.7	6.0	9.5
	AVERAGE†	1.9	1.0	0.9	0.8	0.7	7.5	10.5
Inositol	Blue Rose	61,184.0	45,104.0	37,328.0	17,600.0	14,320.0	73,392.0	79,631.0
	Fortuna	65,840.0	47,936.0	36,240.0	27,824.0	20,224.0	65,805.4	75,600.0
	Ealy Prolific	50,224.0	35,328.0	22,704.0	22,364.0	18,208.0	46,576.0	51,472.0
	AVERAGE†	59,082.0	42,789.3	32,090.7	22,596.0	17,584.0	61,924.4	68,901.0

*All figures represent averages of a number of samples.

†Composite average.

‡Micro-ounces per pound $= \frac{1}{1{,}000{,}000}$ ounce per pound or one millionth of an ounce per pound = $^{1}/_{16}$ microgram per pound or $\frac{1}{16{,}000{,}000}$ per pound.

in the vitamin content of the several varieties was demonstrated. Some slight differences were apparent when individual values were compared with averages or when a simple rank number was assigned to each variety for the different vitamins and the ranking scores totaled. After such a procedure, the long-grain rice, such as Nira and Fortuna, were highest in vitamin content. The Rexoro, Blue Rose, and Early Prolific varieties occupied an intermediate position, and the shortest-grain variety of them all, American Pearl, was lowest. This finding seemed reasonable since, in general, the long-grain varieties have more surface per volume and hence more area of bran layers.

As is shown in Table II, without exception the vitamin content of the rice samples was found to decrease with increased milling, i.e., as the rice proceeded from the brown to the polished form. This conclusion agrees with data obtained for other grains and demonstrates that for rice, also, the members of the B complex are located principally in the bran coats and germ of the grain. Since approximately 50-70 per cent of the vitamins were removed in the first milling operation (from brown to first break rice) and the remaining three operations removed only an additional ten per cent, even an undermilled rice is not an outstanding source of B vitamins.

Rice polish and rice bran proved themselves excellent sources, and brown rice a good source, of all the vitamins studied except riboflavin. White cornmeal and hominy grits contained as much riboflavin per unit weight as did brown rice, even though the former products are not whole grain ones. Polished rice contained no important amounts of any of the B vitamins with the possible exception of pyridoxine and inositol. Since human requirements for these vitamins have not been established, however, their dietary value in rice cannot be judged. From Table II it may be seen that brown rice generally loses from 66-87 per cent of its vitamin content in the milling process, and polished rice contains only eight per cent of the vitamin content of rice polish.

The daily consumption of rice in southern Louisiana is approximately one-third to one-fourth pound per person, and on such a basis represents a sizeable portion of the daily food intake and furnishes the major part of the individual's carbohydrate requirement. Although this quantity is almost entirely polished rice, it supplies one-twenty-fifth of the person's thiamine need and one-seventeenth of his niacin requirement. The same amount of brown rice would supply one-quarter to one-fifth of an individual's thiamine and niacine requirement, and, therefore, it is obvious that diets containing such sizeable quantities of polished rice must be balanced with other foods which are rich in B vitamins. The potentialities of brown rice as a food cannot be overemphasized, not to mention those of rice polish and rice bran. Every opportunity to use these whole grain products should be taken. When the function of other B vitamins is fully understood, brown rice, rice polish, rice bran, and perhaps polished rice also may assume added importance as food sources of the B complex.