World Journal of Medical Sciences 6 (2): 68-73, 2011
ISSN 1817-3055

Effect of Processing on Nutritional Value of Rice (*Oryza sativa*)

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Abstract: This research work was concerned with the loss of nutrients during the processing of rice using three different varieties such as Kernel, KSE and 86 rice. Rice samples were used for proximate analysis of nutritional factors of rice, like moisture, ash, fat, fiber and protein respectively. Concentration of minerals was determined by using Atomic Absorption Spectroscopy (AAS) and Flame Emission Spectroscopy (FES) techniques. For mineral concentration rice samples were burnt and decomposed with concentrated nitric acid and absorbance of each sample and standards was noted. From graphs concentration of minerals (K, Na, Ca, Zn, Fe, Mn, Cd, Ni, Cr) was determined.

Key words: Nutritional value · Processing · Minerals · Standards

INTRODUCTION

Rice (*Oryza sativa*) is one of the most important foods in world supplying as much as half of the daily calories of the world population.It is most important staple food after wheat in Pakistan and is known as queen among cereals. The main varities which are present in Pakistan are IRRI-6, IRRI9, sarshar and Dr-83 [1]. Rice considered as third major crop after wheat and cotton in 2007-08 and cultivated on area of 2594 thousand hectares with a production of 5720 thousand ton [2] Off times rice is categorized by its size as being short grain, medium grain or large grain [3]. The genus *Oryza* comprise about 25 species, distributed in tropical and sub-tropical regions of Asia, Africa, South America, China and Northern Australia. Rice can be grown in a wide range of environmental and soil conditions and is produced in over 100 countries except Antarctica. About 95% of world's rice is produced in developing countries, 92% of it in Asia. Irrigated lands account for 2/3 of the total rice production while about 20-25% is from less favorable environment. Of the major rice producers, only Pakistan, United States and Egypt had 100% irrigated rice. The types of soil suitable for paddy cultivation depends more on the conditions under which the crop is grown [4]. The rice is classified according to the degree of milling that is undergoes. This is what makes one type different from the other. They may be classified as brown rice, white rice, Arborio, Basmati, Sweet rice; Jasmine, Bhutanese red rice and Forbidden rice [5]. Few of the world's grain are available in as many forms as rice. These include Rough rice, brown rice, parboiled rice, regular-milled white rice, precooked rice, individually quick frozen rice and crisped/puffed/expanded rice [6]. Effect of poor nutritional value of rice rates short expectation of life, the prevalence of disease and poor physical development and working capacity. One effect is the incidence of the disease beri-beri and number of deficiency diseases less spectacular but none the less insidious in undermining. When higher calories requirements have to be met, it is usual to meet these additional needs by increasing the consumption of rice. As a result, dependence on the rice for the provision of the requisite amount of vitamin B becomes even more marked. If it is highly milled, the deficiency becomes more pronounced. Only rice providing 0.5mg or more per 10,000 non-fat calories could act as an adequate safeguard against the occurrence of beri-beri under these conditions [7]. When considering dietary refinement, it is important to consider not only the total amount of each delivered but also its chemical forms and their interaction with other compounds in food. Bioavailability of minerals and trace elements have increasing inters in field of nutrition. Elements which are required in trace amount are Ca, Fe, Zn, Cu, K, Cr, Mn, Na etc b/c higher concentrations can be harmful. All these elements are essential for normal growth and development because, they play important role in nerve functioning, sugar metabolism, activity of numerous enzymes and in cardiac function [8]. The composition of rice differs with variety. It is also said to vary according to soil in which it is grown and with manuring. Losses of nutrients in milling, storage and cooking so for, out weight in

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importance any advantage that might assure by increasing the nutrients in varieties. The amount of fat, soluble vitamins A and D in rice is negligible, but vitamin E content of whole rice is considerable. Husked rice has a high content of vitamin B, at least 1/10th of dried feast. The riboflavin content is low and vitamin C is absent. Early workers realizing that, high milling of rice result in incidence of beri-beri assumed that thiamine content of the rice is mainly present in the aleuronic layer and the embryo of the rice grain. In views of these reports it can ve concluded that milling should be design to remove the pericarp but to retain the scutellut and as much of the aleurone layer as possible [9].

MATERIALS AND METHODS

The fat content of rice is low and much of fat is lost in the process of milling. Protein content of mill rice is low in comparison with other cereals, although whole grain contain about same quantity as is found in wheat. The low content of lysine is the most serious amino acid deficiency [8].

Rice Mills Processing: The basic role of industrial rice milling is transforming paddy rice into white rice, while giving it a good appearance and selecting the best quality grain for human consumption [9]. Cleaning of white rice removes foreign objects such as hay, stone, tree stump from the paddy [10]. Hulling rubs excessive husk off cleaned paddy. On removed, brown rice is separated from husk through ventilation process and mechanical equipment leaving pure brown rice available for milling [11]. The milling or whitening stage removes the bran layer from brown rice. The modern multi-break vertical whiteners use both abrasion and friction to gently and efficiently convert brown rice to mill which kernels. The bran layers are removed by ventilation process which usually takes 2-3 cycles depending on the required milling degree [12]. Polishing Smooths and brightening a surface of rice grain by roll or series of rolls [13]. Grading separates milled rice (mixture of different size, whole grain, head grain rice and broken rice) by e sieve grader includes several sizing techniques [14]. Sorting removes rice defects such as decoloration yellows, immature (green), chalky, peck, seeds, red rice and glass stones. Add value to white rice and parboiled rice to ensure that only cleanest rice is passed [15]. In packing/storage the finished rice will be packed and stored in individual bags according to its grades and the rice is ready for delivery to customers [16].

Effect of Milling on Nutritive Value of Rice: Losses occur in the fields especially during harvesting, storage, transport and processing and by improper drying or milling. Loss of nutrients resulting from milling and polished rice is very considerable. The degree of milling and polishing determines the amount of nutrients removed. Drying methods are generally capable of improvement, but improvements are difficult to implement at village level. Loss in milling is often due to the misuse of machinery etc which often leads to high breakage of kernels. This however may not result in total loss but produce rice of lower quality which is then sold at lower price.

Proteins, fats, vitamins and minerals are present in greater quantities in the germ and outer layer than in the starchy endosperm, the removal of the protecting pericarp also facilitate the extraction of the soluble substances from aleurone layer during washing immediately before cooking the grain.

Milled or white rice represents 40-7-% extraction of rough rice. The B vitamin and iron are found primarily in the germ and bran layers and are therefore removed in the milling process. It hand been estimated that in the course of milling brown rice to white rice approximately 80% to the thiamin is removed. Other nutrients contained in the bran layer are also lost, including niacin, iron and riboflavin.

Losses on Polishing: Losses on polishing are 29% of the protein, 79% of the fat, 84% of the time and 67% of the iron. The difference in the protein content between the two rice which is about 2g/100g may not at first right appear to be large, but a calculation shows that it may be very important. Comparison of mineral composition of husked and polished rice showed that the mineral content decreased in the polished rice.

Husked Rice: It has high content of vitamin B while polished rice has little or none and that the iodine value of polished rice is 11.5 as compared with (3.6%) in husked rice and 85.16% in rice polishing. A normal diet of husked rice will supply about half the requirement of iodine and the required amount of lime.

Deficiencies of Rice Diets: The rice is subjected to a series of conditions and treatments from the time it is harvested to the time it is consumed, which seriously depletes it of nutrients, proteins, fat, carbohydrates, minerals and vitamins. The rice eaters consume a product of satisfactory appearance from which the most of the nutrients have been removed. Some of the losses of nutrients are inevitable. Milling is essential but faulty or over milling caused frequently by mills in need of repair and replacement result in high %age of breakage and consequent loss of vitamins.

Experimental Work: Proximate analysis of rice's nutritional factors

The %age of all the contents was calculated as:

$$Content\ \%\ age\ =\ \frac{wt.\ of\ nutritional\ contents\ (g)}{wt.\ of\ fresh\ sample\ (g)}\ \times 100$$

Moisture, Fiber and Ash: Moisture content, fiber and ash were estimated by A.O.A.C (2005) method. 3-5gms of the each sample was taken. Moisture kept at 100-105°C in oven for 20-24 hours and ash first incinerated at low flame and then kept at 450-500°C in a muffle furnace for a period of 4-6 hours. Sodium hydroxide (1.25%) and sulphuric acid (1.25%) were used as reagents for fiber estimation. 2g of ground fiber samples were taken in 1L capacity quick fit flask respectively. Added 20 ml of (1.25%) hot sulfuric acid and refluxed for half an hour. Filtered and washed with 200ml boiled water. Took the residues and added 200ml of (1.25%) hot NaOH soln and again refluxed for half an hour. Washed with 200ml of hot boiled water and again washed with 15ml of dilute HCl followed by alcohol and finally with ether. Dried in an oven at 100°C for 24 hours.

Fat: Few grams of each ground and dried sample of rice was taken in weighed thimbers and the first was extracted using soxhelt apparatus contained n-Hexane as solvent. Then thimbers were air dried and put them in oven todry and then weighed, the loss in weight used to determine the %age fat.

Protein: Protein was estimated by Kjeldal method. 100gm of the samples were taken in long neck flask and added approximately 100g of the catalyst along with 10ml of conc. sulfuric acid. Heated the mixture at temperature till it become clear digestion, its volume was adjusted upto 100ml. 5ml of each sample was added into the Murkham apparatus and 10ml or more of the 0.5 NaOH was added. Heated the mixture in the distillation flask, all the nitrogen released in the form of ammonia, it was absorbed at the receiving end by 5ml boric acid (2%) containing a drop of methyl red as an indicator.

Titrated against N/70 HCl and recorded the volume used to restore the pink color. The 'N' and crude protein content was determined as follow:

Volume of N/70 HCl used = X.c.c

I.c.c of N/70 HCl = 0.2g of nitrogen
X.c.c of N/70 HCl = xX = Ygm of nitrogen
Total protein = Yx6.25 = Z

Mineral Determination: The moisture value and various minerals were determined in the kernel, KSE and 86 rice varieties.

Experiment # 1: Few grams of kernel, KSE and 86 rice varieties were put in the 3 chine crucibles. Then these china crucibles were demoisturized and weighed and determined moisture value of kernel, KSE and 86rice. The crucibles were immediately put in the desiccators after removing from the oven.

Experiment # 2
Formation of Ash: Ashes of kernel, KSE and 86 rice were made in muffle furnace at 550°C.

Preparation of Stock Solution: 1g of ash decomposed by conc nitric acid. Added distilled water to it and boiled for 10 minutes, it was then filtered and filtrate was diluted to 100ml by distilled water. AAS and FES was used to determine minerals in sample and standardsoln.

Determination of Fe, Zn,Ni, Mn, Ca, Cr and Cd by AAS

Step1
Preparation of Standard Solution: Solution of Fe, Zn, Ni, Mn, Ca, Cr and Cd was prepared and then diluted to a total volume of 100ml to get 100ppm and then 2-10ppm. For Zn and Mn standard solutions of 0.4ppm to 2ppm were prepared, 10-50ppm of Ca, 3-12ppm of Ni, 2-20ppm of Cr were also prepared.

Step 2:
Preparation of Sample Solution: 10ml of the stock solution of each variety was diluted up to 100ml. so the dilution factor = 10.

Procedure: Absorbance of standard solutions as well as sample solutions was taken by atomic absorption spectrophotometer using their respective cathode lamp like Fe-cathode lamp etc. Concentration of sample was determined by the graph between concentration along X-axis and absorbance along Y-axis.

Determination of Na and K by FES
Preparation of Standard Solution: Solution of Na and K was prepared. 10ml of each solution was diluted to a total

volume of 100ml to get 100ppm solution. 20-100ppm of 'Na' and 'K' were prepared by taking 20ml to 100ml of the stock solution of the 100ppm.

Step 2:

Preparation of Sample Solution: 10ml of the stock solution of each variety was diluted up to 100ml. so the dilution factor = 10.

Procedure: Flame photometer was turned on and set for sodium. All the standards and sample was subjected to the flame photometer and emission from photo cell was measured from digital read out system. Concentration of sample was determined by the graph between concentration along X-axis and absorbance along Y-

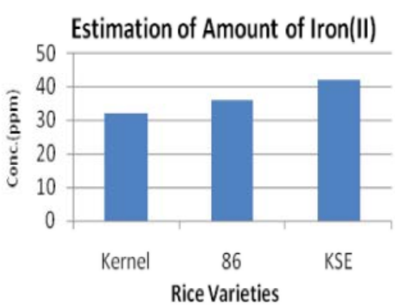
RESULTS AND DISCUSSION

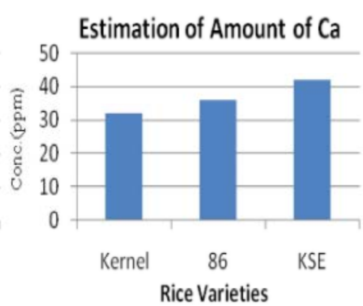
Losses occur in the fields especially during harvesting, storage, transport and processing and by improper drying or milling. During milling decrease in minerals take place [19]. The effect of processing on vitamin and mineral content of rice are shown in Table 1. Comparison of composition of husked and polished rice showed that the mineral content is decreased in polished rice. Table 2 shows the concentration of minerals in various rice varieties. Proximate composition of different varieties of rice is given in Table 3.

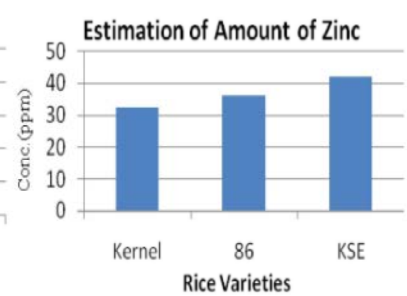
Table 1: Effect of milling on vitamin and mineral content of rice

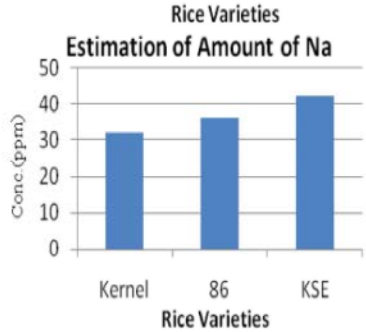
Extraction Rate%	100 Rough	82 Brown rice	72 Milling rice
Mineral content			
Calcium (mg/g)	0.3	0.1	0.1
Phosphorus (mg/g)	3.1	3.2	1.5
Zinc (ppm)	2.4	3.3	18.0
Iron (ppm)	38.0	8.8	4.1
Copper (ppm)	2.8	2.7	2.2
Vitamin Content			
Thiamine (µg/g)	2.8	2.4	1.6
Riboflavin (µg/g)	0.5	0.3	0.2
Niacin (µg/g)	29.6	29.0	6.0
Pyridoxine (µg/g)	5.1	5.1	1.9
Biotin (µg/g)	91.0	48.0	43.0

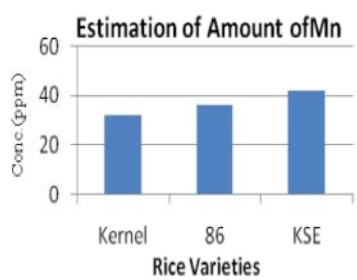
The result obtained by FES showed that the concentration of Na ranges from 20ppm to 100ppm and among 86 rice, Kernel and KSE, it is maximum for 86 rice which is 58ppm. Results obtained by AAS for Ca revealed that the concentration of Ca ranges from 0.010ppm to 0.090ppm. It is maximum for KSE i.e 0.026ppm among the three under discussion types. The AAS study of Fe showd that the concentraion ranges from 0.030ppm to 0.10ppm. The value is greater for 86 rice i.e 0.080. For Zn the range is from 0.040ppm to 0.12ppm and the value is higher form Kerenl i.e 0.11ppm. K is estimated by FES.

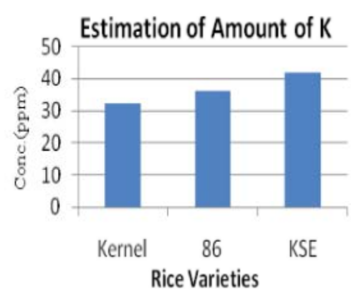




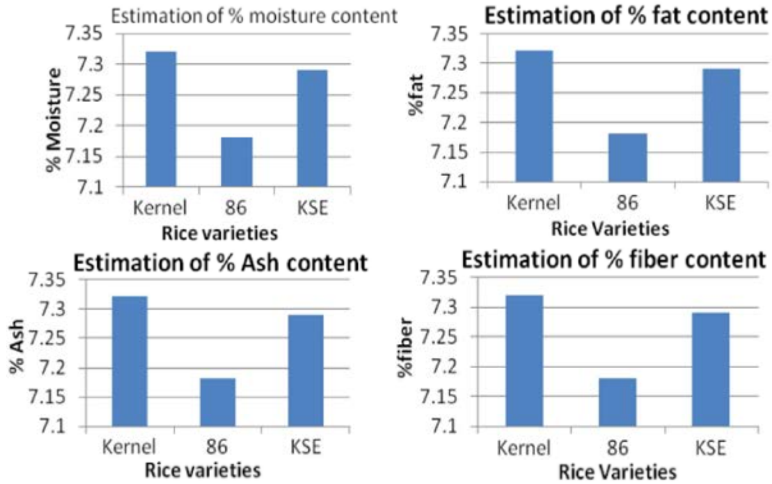








Note:
The results for Ni, Cd, Cr in kernel rice are negative by AAS. So, the Ni, Cd, Cr minerals are not present in kernel rice. The results for Ni, Cd, Cr in 86 rice are negative by AAS. So, the Ni, Cd, Cr minerals are not present in it. The results for Ni, Cd, Cr in KSE rice are negative by AAS. So, the Ni, Cd, Cr minerals are not present in it



Its concentration ranges from 20ppm to 100ppm and the value is at top for KSE i.e 44ppm. AAS stude of Mn showed that it ranges from 0.015ppm to 0.061ppm. Kernel rice has the greater value i.e 0.030ppm. In views of these conclusions it follows that milling should be design to remove the pericarp but to retain the other contents and as much of the aleurone layer as possible.

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