International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page:www.iscientific.org/Journal.html

Analyzing Various Cereals Chemically to Identify Key Nutrients in Public Health

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Abstract

From ancient times, whole-grain cereals have served as the cornerstone of the human diet. They have a significant impact on human health since they are abundant in a wide range of special bioactive components. In this research, a variety of grain kinds, including parboiled rice (PBR), raw basmati rice (RBR), hybrid yellow maize (HYM), whole wheat flour (WWF), and refined wheat flour (RWF) were chosen for nutritional prediction. In comparison to WWF, their investigation revealed that RWF, which is widely used in outdoor furnaces and shops to produce bread, is lacking in practically all micro and macro minerals. This research also showed that a significant portion of the population's metabolism is malfunctioning as a result of the everyday ingestion of RWF used to make bread and other foods. RBR and PBR comparisons were made similarly. According to this investigation, both varieties of rice undergo processing that reduces important micronutrients. Combining these two varieties of rice may provide balanced nutritional needs (RBR and PBR). As it is often eaten as a cereal for breakfast and a staple meal in many nations, HYM analysis was also done. Its investigation in this research also emphasized its contrasting nutritional levels.

Keywords: Nutrition, Cereals, Minerals, Flour

Full length article **Corresponding Author*, e-mail: deepika.sharma@jnujaipur.ac.in

1. Introduction

Nutritional deficits in the general population have been linked to a variety of health issues in developing nations. Studying their daily consumption of cereal, which makes up the majority of every meal, was deemed to be necessary to understand the reasons for dietary deficiencies. A balanced and nourishing diet must include grains [1]. Yet, not all grains or grain-based products have the same nutritional value. A significant part of the prevention of many illnesses is the consumption of whole grains, which have several health advantages. According to this study, Increasing your consumption of whole grains may help you maintain a healthy weight and body mass index while lowering your chance of getting heart disease (BMI) [2]. Consuming whole grains also affects how insulin and blood sugar respond. It would aid in the fight against Type 2 diabetes. Whole grain's fiber content promotes gastrointestinal wellness. Because of these advantages, whole grains should be consumed in at least three servings daily, according to the 2010 Dietary Guidelines for Americans published by the USDA [3].The need for grains is expected to rise dramatically as the global population rises. More than three billion individuals are thought to be malnourished in terms of micronutrients right now.

Inefficient food systems that continuously fail to provide sufficient amounts of these vital elements to satisfy the nutritional needs of regular people are to blame for the current worldwide crisis in nutritional health [4]. The nutritional enrichment of main staple food crops with micronutrients using agricultural enrichment techniques is one sustainable farming strategy to minimize malnutrition among those at the greatest risk that is, elderly people, babies, and children, who are resource-poor women. In the current environment, it is necessary to raise the consciousness of the public about the dangers of consuming processed foods that are low in nutrients, especially white flour, as it is well-known that products like naan, puri, and bakery goods made from refined white bread are seriously lacking in several essential nutrients and contribute to malnourishment in the common community [5]. Many of the nutrients in grains that support health are lost during processing and other unit operations, as scientists have known for a long time. Around 75% nutrients included in these grains are lost as a result of consumer demand for processed rice and fine white flour. In the manufacturing process, protein, fiber, vitamins, minerals, and antioxidants are frequently lost [6].

Five black kinds of vinegar were profiled for their chemical contents using label-free LC-MS, GC-MS, and chemical isotope labeling LC-MS. The metabolite compositions of several vinegar varieties varied. Several diketopiperazines and linear dipeptides that contribute to various flavor impacts have been discovered [7].Worldwide, rice is a staple food that is important to the food systems of many nations. Rice contamination by fungi and mycotoxins is a significant problem for the food business since it lowers the grain's nutritional value, economic worth, and safety [8].The effects of early vs regular grain harvesting on the produced Amaranthus cruentus species' chemical makeup and secondary metabolites. Confirms the important role that amaranth grain plays in both human and animal nutrition and health as carbohydrates, fiber, vitamin E isomers, critical secondary metabolites, and unsaturated fatty acids. Amaranth grain's nutritional content and quality will vary depending on how it is harvested [9].An essential factor in the establishment of product safety assessments is determining the extent of consumer exposure to chemical pollutants. By comparing a demographic group's eating patterns with the amounts of pollutants in food, one may calculate their dietary exposure. The contemporary consumer, who is often exposed to many harmful substances via nutrition, places a high priority on food security [10].Humans depend on cereals for many of their important nutrients, and the evaluation of their quality has garnered considerable interest. The advancement of cereal quality assessment is further supported by the integration of IRS/HSI and AI. AI and the developments in IRS and HSI for the identification of grain quality. The equipment needed a stringent constant temperature and humidity environment, and the optical material was challenging to fabricate and had limited resolution [11].The phenolic components, antioxidant capacity, technical characteristics, and color features of the colored rice flours and they're corresponding extruded were studied. Black rice snacks are distinguished for their higher nutritional value, while red rice snacks are distinguished for their expansion and texture features and phenolic profiles. The higher granular starch's consistency, which made it more challenging to interrupt and improved the ultimate viscosity, is presumably what caused the reduced breakdown [12].Using tandem mass spectrometry and ultra-high efficiency liquid chromatography with a diode-array detector, the phenolic profiles of free and bound extracts were determined, as well as the antioxidant activity using ABTS and DPPH techniques [13].The steps of public health nutrition known as Assessment, Analysis, and Action include the use of food composition databases. Finding nutrients whose consumption is either too low or too excessive is a crucial action in the assessment phase. This information is unavailable for several food categories since labeling is not required [14].They are anticipated to play a constantly developing role in the food industry, increasing the population's access to healthful food. Plant breeders have already started new breeding initiatives to develop crop production cultivars with higher bioactive component concentrations in grain in response to the demand for such goods. Yet, there is still a lack of understanding of the intricate processes controlling resistance in cereal crops, making it challenging for breeders to choose resistant genotypes [15].

2. Materials and methods

2.1 Chemical and Material

The Pyrex glass equipment utilized in this investigation was carefully cleaned and oven dried, and the chemicals employed during the whole research were of effective quality management. The samples of WWF, RWF, RBR, PBR and HYM were processed via 100 mesh screens in a willy mill. Every material (500g amount) was stored for examination in polythene-lined plastic containers.

2.2 Percentage of moisture

Collecting a 5g quantity of After a uniform weight of the dried material is acquired, each flour experiment is dried in an oven at 100°C under vacuum, and the each flour sample moisture content was calculated by AOAC (934.01) (6). A Mammet-type ULM 400 forced-air circulated oven was used for dryness. Within 0.05°C, the temperature may be controlled. A thermometer called the Hart 8C 227-2562 RTD was used to assess the control accuracy of internal temperatures. The following equation (1) was used to determine the moisture content:

$$Moisture\ (\%) = \frac{Wt.of\ original\ flour\ sample - Wt.of\ dried\ flour\ sample}{Wt.of\ original\ flour\ sample} \times 100 \quad (1)$$

2.3 Percentage of Ash

A 3 g sample was charred over heat until it turned black, then placed in a muffle furnace maintained at 550 °C for five hours, or until a grey color of ash was achieved, to calculate the total ash content of the flours. The details provided in AOAC International, 2002 were followed for the estimation of the overall ash content. According to the following equation (2), the ash content was determined:

$$Ash(\%) = \frac{Wt.of\ ash}{Wt.of\ flour\ sample} \times 100 \quad (2)$$

2.4 Percentage of protein

Using the Kjeltec system 1002, the crude protein content of every flour was calculated by Kjeldahl's technique. The digesting tube was filled with a 5g sample that had been weighed. Two digestion tablets acted as catalysts, and 20 mL of concentrated H_2SO_4 (98%) was added to the digestion tube. The digestive process took three to four hours to complete before the digested materials become translucent. The digested material was concentrated to a final volume of 50 mL and then allowed to cool at room temperature. The ammonia that had been entrapped in the H2SO4 was released by adding a 40% NaOH solution by distillation. The ammonia was then collected and titrated against a standard 0.1N H2SO4 solution in a container containing 4% boric acid solution and methyl red indicator. For maize, the percent nitrogen was converted into crude protein content using a factor of 6.25, whereas rice and wheat were converted using a value of 5.7. In equation (3),

$$Nitrogen\ (\%) = \frac{Volume\ of\ 0.1\ N\ H_2SO_4 \times Volume\ of\ dilution\ made \times 0.0014}{Wegiht\ of\ sample\ (g) \times volumeof\ dilution\ take\ \ (mL)} \times 100 \quad (3)$$

2.5 Percentage of fat

Following the steps outlined, a 3g dried flour sample was put through the Soxhlet apparatus with petroleum ether as a solvent for 6-8 hours to measure the crude fat amount in every flour test. The sample is first covered in filter paper and pinned shut. The Soxhlet device was then used to hold the data and subject it to 5–6 petroleum ether washings after that. After the evaporation of the solvent, the % fat content was calculated using equation (4) below.

$$Crude\ fat(\%) = \frac{Weight\ of\ fat}{Weight\ of\ flour\ sample} \times 100 \quad (4)$$

2.6 Percentage of Fiber

The method described in AOAC Official Methods, 2002 was used to calculate the crude fiber. The experiment included obtaining 3g of each fat-free flour sample from each cereal, which was then digested twice—once with 1.25% H2SO4 solution then cleansed with distilled water, and filtered after being exposed to 1.25% NaOH solution once more. The digested samples were heated for four hours in a muffle furnace at a temperature between 550 and 650 °C to produce gray ash, which was subsequently produced by lighting the sample residue. Equation (5), which is illustrated below, was used to determine the proportion of crude fiber after burning the samples.

$$Crude\ fiber\ (\%) = \frac{Weight\ loss\ on\ ignition}{Weight\ of\ flour\ sample} \times 100 \quad (5)$$

2.7 Percentage of Starch

Weighing 2 g of each flour sample, boiling it in an open beaker with calcium chloride solution, stirring, and applying water to keep the liquid level constant allowed us to calculate the starch content of each experiment. Boil for half an hour and then add 10 ml of stannic chloride solution, let it cool to ambient temperature, and then add 100 ml of calcium chloride solution to make a volume. The Whatman filter paper was used for the filter, a 100 mm polarimeter tube was used to measure the angle of rotation, and starch was estimated using the equation below (6).

$$Starch\ \%(d.b) = \frac{Angular\ Rotation \times 100}{Weigt\ of\ sample\ d.s\%} \quad (6)$$

$$(d.s)203 \times 2dm \times 100mL\ \times 100$$

Where the value 203 denotes the angular degree at which starch is specifically rotated. d.s. represent the Dry Substance, and d.b. represent the Dry Basis.

2.8 Minerals (micro & macro elements)

Each flour sample was progressively heated until charred before being put in a muffle furnace and kept at 500°C for 4 to 5 hours to generate a light-gray residue. The dry ash residue was diluted in 100 mL of 6N HCl before being utilized to examine the mineral contents using atomic absorption spectroscopy. The air acetylene flame-equipped Atomic Absorption Spectrophotometer was used.

3. Results and Discussions

3.1 Percentage of Starch

As can be seen in table 1, processing drastically changed how much starch was present. Figure 1 uses a bar graph to illustrate the proportion of starch. Since WWF has more fiber than RWF, its starch level is much lower (70.8%), and as a result, a given cereal's starch content decreases as the fiber concentration rises. The starch content of RBR (80.4%) is greater than that of PBR (79.9%). While RBR contains less fiber than PBR does, this further confirms the findings mentioned above. Starch content in HYM is 72.4%. Due to the cereal's increased levels of fat and fiber, HYM has less starch than other brands. The contrast between WWF and RWF demonstrates that processing eliminates several essential elements, resulting in larger carbohydrate content in processed flour, i.e. RWF. Due to processing, there is little variation in rice's starch content even though both dehulling methods practically maintain the same starch level.

3.2 Percentage of Protein

The number of proteins in a sample determines its quality index since they are polymers of amino acids. The quantity of nitrogen in a sample is often evaluated to determine the crude protein. The findings of the protein content of various cereal kinds are shown in Table 1. Figure 2 bar graph used to represent the percentage of the protein shows that WWF (13.2%) has the greatest amount of protein, followed by “RWF (9.1%), HYM (9.1%), RBR (7.2%), and PBR (7.0%)”.

The results of a recent experiment revealed that the protein in grains products is lost during processing. The results of the current study are consistent with those of an earlier investigation that discovered a significant rise in the proximate composition of a number of different flours.

3.3 Percentage of Fiber

The amount of indigestible pentosans, cellulose, lignins, and other such elements that are present in non-food is quantified by the crude fiber. While crude fiber has minimal nutritional value, it offers food bulk and helps keep several physiological processes in check. Bran is an important source of dietary fiber, which research suggests may help reduce the chance of getting heart disease as well as colon cancer. Whole wheat flour is used in India’s rural regions to make flat, unleavened bread with a high bran content. The consumption of flat bread made from wheat types with greater crude fiber may help to boost the intake of fiber and lower the risk of heart disease and colon cancer.

Table 1 presents the findings on the crude fiber content of various cereal varieties, and Figure 3 bar graph illustrates the percentage of fiber. The findings showed that various varieties of cereal had considerably variable crude fiber contents. The findings clearly show that WWF's crude fiber content (2.2%) is much larger than that of “HYM (1.4%), RWF (0.48%), PBR (0.42%), and RBR (0.39%)”. These findings demonstrate that when RWF, PBR, and RBR are processed more thoroughly, there is a reduction in fiber content.

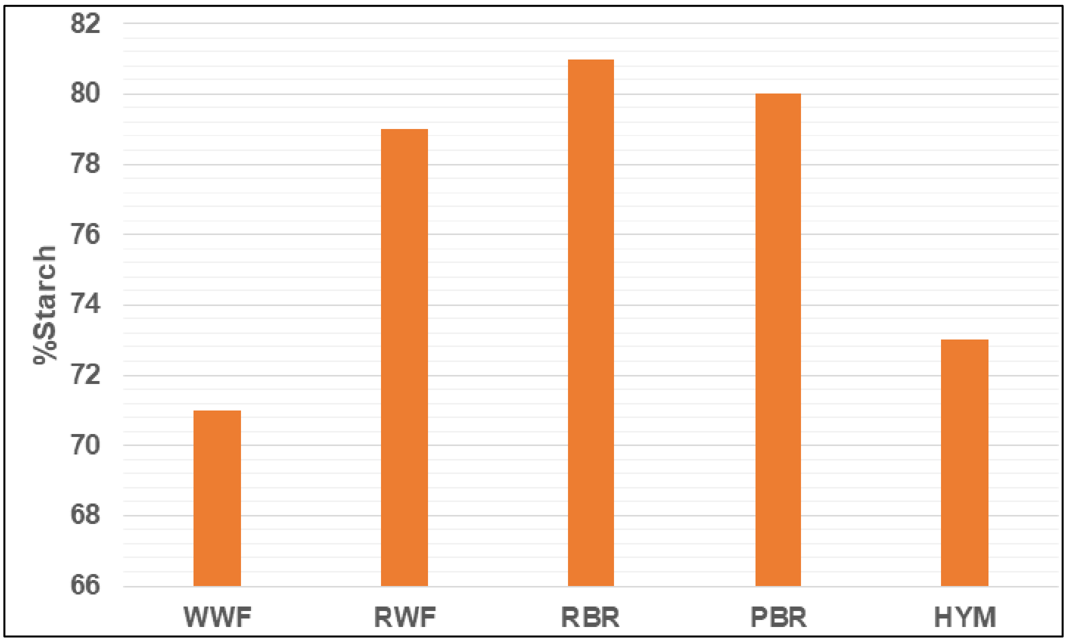

Figure 1: Several cereals compared starch values

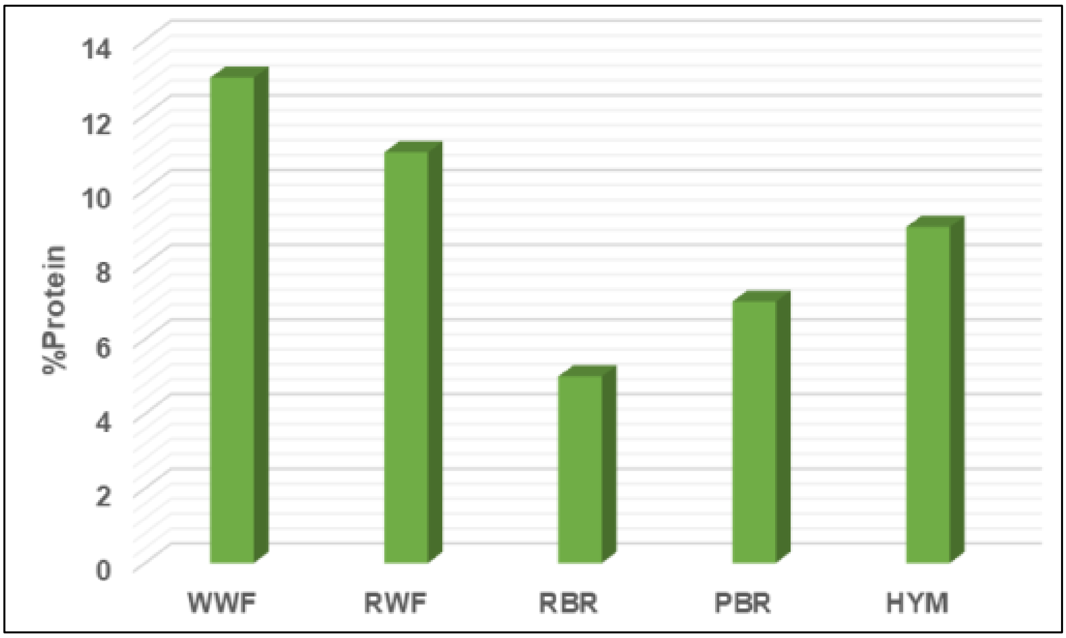

Figure 2: Several cereals compared protein values

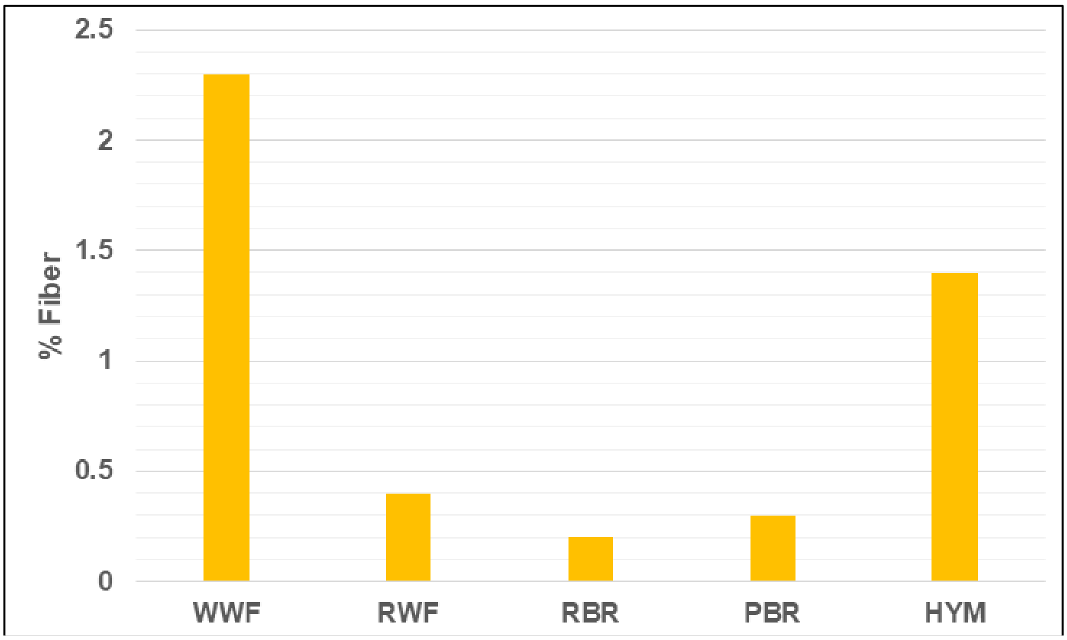

Figure 3: Several cereals compared fiber values

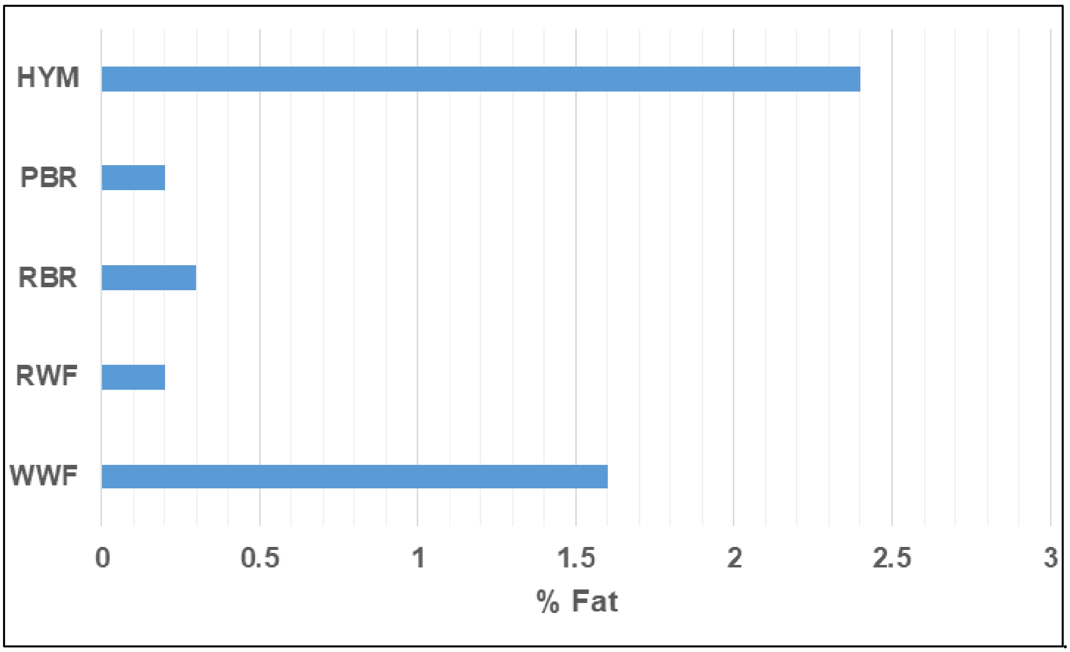

Figure 4: Several cereals compared fat values

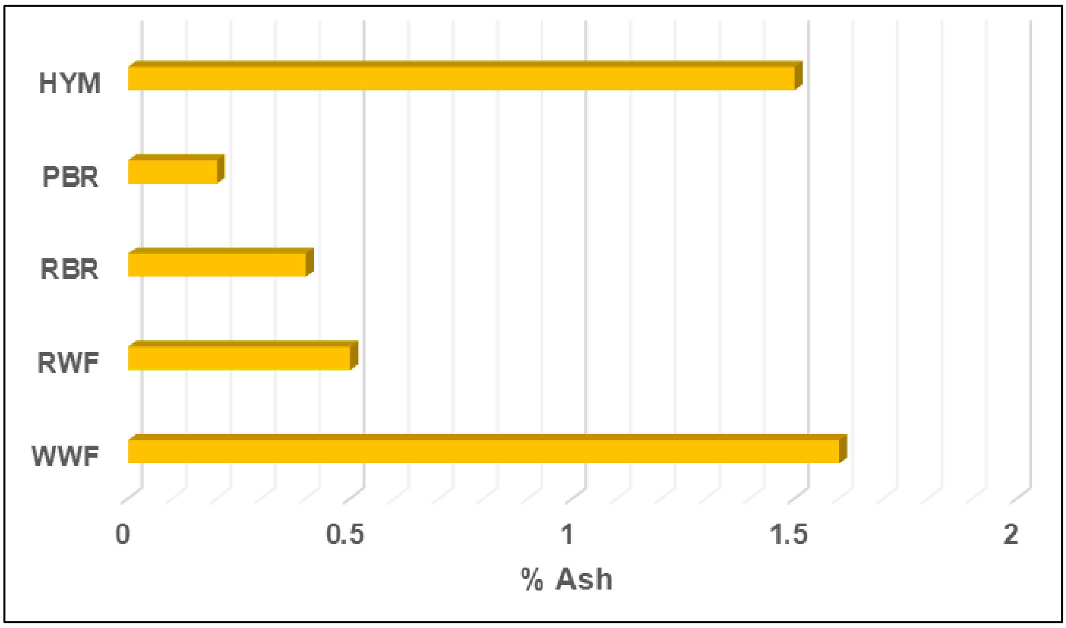

Figure 5: Several cereals compared ash values

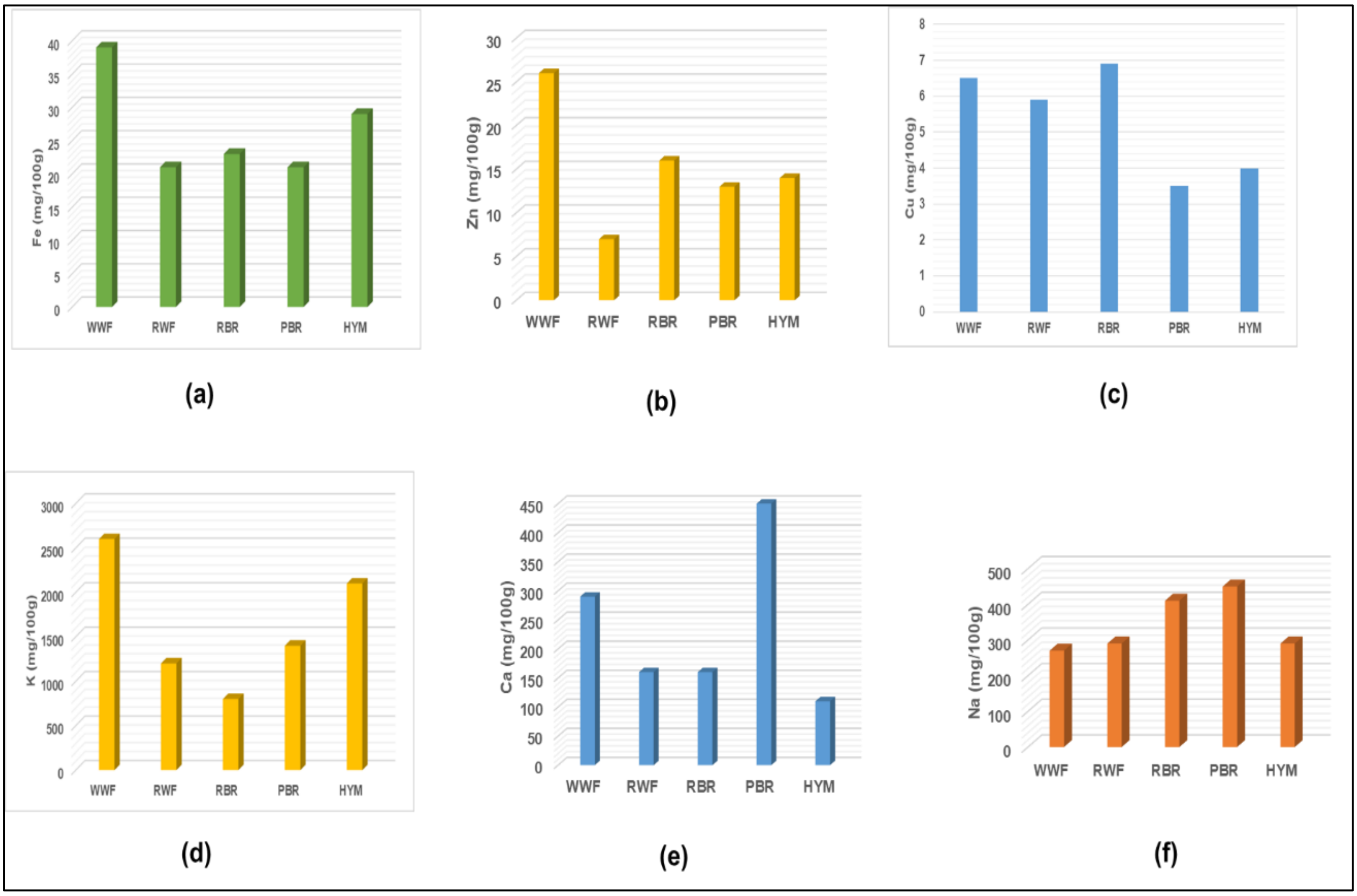

Figure 6: Values of several cereals' macro- and micro-minerals in comparison

Table 1: Dry-Basis Proximate Study of Various Cereals (d.b)

Sample	%Fat	%Protein	%Starch	%Fiber	%Ash	%Moisture
RBR	0.44	7.2	80.4	0.39	0.48	12
HYM	3.45	9.1	72.4	1.4	1.5	12.2
WWF	1.7	13.2	70.8	2.2	1.6	11.8
RWF	0.38	9.1	78.4	0.48	0.52	11.3
PBR	0.41	7	79.9	0.42	0.42	11.6

Table 2: Mineral content of various grains (mg/100g)

Sample	MicroMinerals			MacroMinerals		
	Fe	**Zn**	**Cu**	**K**	**Ca**	**Na**
HYM	26.60	17.20	4.18	2050	119.20	280
PBR	20.89	14.11	3.50	1440	451.40	455
RBR	23.33	15.58	6.91	860	173.50	418
RWF	21.34	6.42	6.05	1200	168.90	291
WWF	36.24	26.08	6.36	2600	296.91	273

3.4 Percentage of Fat

Lipids, which include fats and oils, are some of the most vital elements of food and play a crucial role in day-to-day intake for a variety of different reasons. It serves as the body's primary energy source and provides essential lipid nutrients. Lipid molecules are crucial in establishing the overall physical properties of food products, including texture, taste, appearance, and mouth-feel. Table 1 shows the impact of on fat content processing of several kinds of flour. Figure 4 shows the percentage of fat with the use of a bar graph. The HYM had the greatest fat level (3.45%), whereas "WWF (1.7%), RBR (0.44%), PBR (0.41%), and RWF (0.38%)" had the lowest fat contents. Due to the lack of processing in WWF, it has a greater fat content than RWF, RBR, and PBR, which are created by processing.

The concentration of mineral materials in a specific product is often represented by its ash content. Higher ash content is an indirect indicator of more minerals being present. The environment and the stage of malnutrition of wheat grains have a general impact on the ash content. Table 1 lists the ash content of the various types of grain flours. Figure 5's bar graph used to represent the proportion of ash shows that WWF (1.6%) has a high ash content. As a comparison to other cereals like "HYM (1.5%), RWF (0.52%), RBR (0.48%), and PBR (0.42%)", WWF has a greater ash content. The processing of these grains is what causes the RWF, RBR, and PBR's ash levels to decrease. As a result, processing makes grains less nutritious.

3.5 Mineral Analysis

The goal of this study was to identify the causes of nutritional deficiencies in common men, impoverished men, and old men. It was not feasible to study all food categories consumed by all racial, ethnic, and socioeconomic groups of individuals for this goal. The most popular cereals were taken into consideration for this reason. Cereals are regarded as the foundational food category of a balanced diet and the one that the majority of people intake regularly.

3.6 Micro Minerals

Microminerals are those that exist in little amounts yet are essential for development. For this study's cereals HYM,RWF, WWF,RBR, and PBR, microminerals including iron, copper, and zinc were examined. Table 2 displays the findings concerning the concentrations of microminerals. The bar graph in Figure 6a shows how much iron is present. Compared to other cereals like "RWF (21.34 mg/100g), RBR (23.33 mg/100g), PBR (20.89 mg/100g), and HYM (26.60 mg/100g)", iron is significantly more abundant in WWF

(36.24 mg/100g). In a similar vein, WWF (26.08 mg/100g) has more zinc (Zn) than "HYM (17.20 mg/100g), RBR (15.58 mg/100g), PBR (14.11 mg/100g), and RWF (6.42 mg/100g)". Figure 6b shows amounts of zinc using a bar graph. When compared to other processed cereals like "WWF (6.36 mg/100g), RWF (6.05 mg/100g), HYM (4.18 mg/100g), and PBR (3.50 mg/100g)", RBR has a greater copper (Cu) content (6.91 mg/100g). Figure 6c displays the copper quantities as a bar graph.

3.7 Macro Mineral

These are the minerals that are abundantly found in food. They consist of sodium (Na), calcium (Ca), and potassium (K) (Na). Table 2 displays the findings concerning the quantities of macro minerals. Potassium (K) content in several grain varieties varied considerably. As indicated in Table 2, the quantity of K in WWF (2.6 g/100g) is greater than that in "HYM (2.05 g/100g), PBR (1.44 g/100g), RWF (1.2 g/100g), and RBR (0.86 g/100g)" for all of these cereals. The findings demonstrate how processing reduced the quantity of K. When compared to PBR (1.44g/100g), RBR has a lower K content (0.86g/100g). Figure 9d shows the potassium content as a bar graph. This happened as a result of the dehulling of RBR having an impact on the rice's outer coating, which contains the majority of the K. PBR uses a method for boiling peddy that preserves the outer shell of the rice. As a result, PBR has more K than RBR.

In comparison to "WWF (296.91 mg/100g), RBR (173.5 mg/100g), RWF (168.9 mg/100g), and HYM (119.2 mg/100g)", PBR (451.4 mg/100g) has a high concentration of calcium, a necessary mineral. Figure 6e shows the calcium amounts as a bar graph. The sodium content of different varieties of cereal varies similarly. PBR (455 mg/100g) has the highest sodium concentration, followed by "RBR (418 mg/100g), RWF (291 mg/100g), HYM (280 mg/100g), and WWF (273 mg/100g)". Figure 6f shows the salt content as a bar graph.

4. Conclusions

In comparison to whole wheat flour, refined wheat flour was found to be low in practically all nutrients. RWF is often used to make bread and bakery goods. Similar to this, an examination of two rice samples revealed that uncooked basmati rice included more carbohydrates and fat and less of the macronutrients Na, K, and Ca than parboiled rice, which loses essential micronutrients like Fe, Cu, and Zn during processing. As rice is cooked, dried, and de-hulled to create a final product, this occurs. Our findings demonstrated that both mechanisms are contributing to the loss of several essential macro and micronutrients. Using both varieties of rice RBR and PBR can provide balanced nutritional needs. According to an examination of hybrid yellow maize, Fe, Cu, Ca, and Na are lower in hybrid yellow maize than in uncooked basmati rice, WWF, and RWF, whereas K, Zn, and Cu are greater in hybrid yellow maize compared to those foods. The study's findings support the idea that choosing cereals that have few processing stages would result in a diet that is higher in nutrients while also maintaining the body's need for basic nutrients like minerals.

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