Nutritional Profile of Asian Wild Rice from North-East India

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Abstract

Asian wild rice, a paramount cereal habitually grown in the wetlands of Manipur Valley (North-East India), is a dynamic source of carbohydrates for the Meitei ethnic group. The present work attempts to estimate a comparative evaluation of the proximate, mineral and phytochemical analyses on two Asian wild rice- *O. rufipgon* Griff. and *O. nivara* (Sharma et Shastry). Of the two wild rice populations, *O. nivara* contains a superior ratioof carbohydrates, protein, moisture, fat, nitrogen, phosphorus, potassium, manganese, iron, and zinc to that of *O. rufipogon*. The qualitative phytochemical study shows high indications of phenolic, flavonoid, tannin, carbohydrate, triterpenoids, terpenoids, saponins, and steroids in both specimens. At the same time, *O. rufipogon* indicates a higher total phenolic content (TPC) and total flavonoid content (TFC) than *O. nivara*. Based on the chemical analysis conducted, despite differences in quantitativevalues, the present study discloses that Asian wild rice is an excellent, highly nutritious cereal compared to other rice varieties.

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Introduction

Rice is well-known as the 'queen of cereals' because of its high nutritional value, excellent digestibility, prominent biological attributes, and potential effects on human health (Anjum *et al.,* 2007). It is a predominant cereal in Asian countries, and India is the second-largest rice production nation globally (USDA, 2025). This genus, which is accredited as a C3 plant with a chromosome-based number 24 (2n=24, 48), represents twenty-four recognised species, of which Asian *Oryza sativa* (Linnaeus) and African *Oryza glaberrima* (Steudel) species are the cultivated rice (Morishima, 1984; Vaughan, 1994; Brar and Khush, 2018). The *Sativa* complex includes six wild varieties, two of which are Asian wild rice and African wild rice, which are closely related to domesticated/cultivated rice. The Asian wild rice, on the other hand, can be sub-alienated into two categories- a swampy type (*O. rufipogon* Griff.) and an upland type {*O. nivara* (Sharma et Shastry)}, (Vaughan and Tomooka, 2008).

Rice scientists have classified rice into many groups based on different qualities. Owing to the coloration of grains, rice can be grouped into red type, black type, and white type, which is due to the varying quantity of anthocyanin presence in the bran layer. Red rice can alsobe again sub-classified into three forms- wild red rice, weedy red rice, and cultivated red rice (Ahuja *et al.,* 2007). Henceforth, Asian wild rice, *O. rufipogon* and *O. nivara* come under this wild red rice category (Siswanti *et al.,* 2019). Quite a lot of considerable studies have reported that pigmented rice has more nutritional status (Priya *et al.,* 2019), a higher concentration of phytochemicals such as phenolics and flavonoids (Ghasemzadeh, 2018), more anthocyanin, and anti-oxidative content (Pengkumsri *et al.,* 2011; Ravichanthiran *et al.,* 2018) than that generally consumed white rice. The sporadic studies on nutritional studies revealed higher amylose, protein, phenolic, ferric, and vitamins in Asian wild rice (Fasahat *et al.,* 2012). After considering the properties of water content, ash, fat, protein, carbohydrates, etc., in the *O. nivara* species, Siswanti *et al.,* (2019) have shown the occurrence of phenolic compounds, anti-oxidative properties, and free fatty acids.

The growth of Asian wild rice is recorded in different lands of India (Singh *et al.,* 2012; Tripathy *et al.,* 2018; Samal *et al.,* 2018), including Manipur Valley (Medhabati *et al.,* 2013; Huidrom *et al.,* 2021), particularly in the wetland ecology. The wetlands zones of Manipur are favourable habitats for the two wild rice species, namely *wainu chara* (*O. rufipogon* Griff.) and *murshi* {*O. nivara* (Sharma et Shastry)}. The Meitei people, settled in and around such lakeshores, occasionally harvested the aquatic and wild plant species (incorporating grains of wild rice) that could go with a heritable adaptive consequence of subsistence pattern.

The primary objective of the present study is 1) to estimate the comparative evaluation of the proximate content, mineral content, and qualitative analysis and quantitative analysis of the phytochemical compounds of the two Asian wild rice species, i.e., *O. rufipogon* Griff. and *O. nivara* (Sharma et Shastry) and 2). To provide health efficacy present in them.

Materials and Methods

Collection of rice grains and preparation of crude extract

The grains of wild rice were collected from the two study sites- 1) Loktak Lake (25º24'40" N 93º04'54" E), Bishnupur District and 2) Yaralpat Lake (24º49'3" N 94º0'21" E), Imphal East District. The collected grains are husked and crushed into powder form (Crushed in the electric grinder, and no sieve is used). Each 100 gm of the powdery form is taken separately to examine the proximate and mineral contents. And half a kilogram of wild rice grains of each specimen gets dissolved separately in one liter of methanol (HPLC grade methanol) for 60 consecutive days to inspect the phytochemicals. The concentrated solution is then allowed to evaporate in the Rota-vapor (Bucchi R-100), setting at a temperature below 45°C to isolate the methanolic extract. Finally, the wet extract is dried in the Concentrator Plus (Eppendorf) at the set temperature of 45°C and kept for 6 hours 23 minutes (Harborne, 1984).

Determination of grain classification

The quantification of length, width, and thickness of the two specimens are measured using a digital vernier caliper (Mitutoyo brand), and the grain weight is measured with an electronic sensitive balance instrument (Shimadzu brand). Rice grain size, in this case, is the measurement of rice kernel in its extreme dimension, and shape is the ratio of length and width. The grain of two specimens is classified using a standardized classification developed by Cruz and Khush (2000).

Determination of proximate, food energy, and minerals

The standard experiment protocol was conducted on the powdered specimen in order to determine the proximate composition, including the ash (Park, 1996), moisture (Shimadzu-MOC63u instrument), carbohydrate (Sadasivam and Manickam, 2018), protein (AOAC, 1990), and fat (AOAC, 2000). Gross food energy was estimated using the equation: Food energy (kCal/g) = $(CP \times 4) + (F \times 9) + (CHO \times 4)$, where CP means crude protein(%), F means fat (%), and CHO means carbohydrate content (Osborn and Voogt, 1978). The mineral compositions of nitrogen (Sadasivam and Manickam, 2018), phosphorus (Olsen, 1954), potassium (Chapman and Pratt, 1961), manganese, iron, copper, and zinc (AOAC, 2019) areexamined and quantified. The protein content is calculated using the formula

$$\text{Protein (\%)} = \text{N (\%)} \times \text{conversion factor.}$$

The conversion factor is usually 6.25, based on the assumption that most proteins contain 16% N. However, this conversion factor can overestimate protein content because not all N in a sample comes from protein.

The fat content and the Ash content are calculated using the formula, According to AOAC (2000):

$$\text{Fat (\%)} = \frac{\text{Weigh of the fat}}{\text{Weight of sample}} \times 100$$

$$\text{And Ash (\%)} = [(\text{ashed weight}) - (\text{crucible weight})] \times \frac{100}{\{(\text{crucible and sample weight}) - \text{c(rucible weight)}\}}$$

Determination of phytochemicals

Preliminary screening of phytochemical compounds was done by following the stereotyped procedures (Harborne, 1984; Sofowora, 1993; Trease and Evans, 2002; Mir *et al.,* 2013; Hossain *et al.,* 2013). Furthermore, the quantification of total phenolic content(TPC) and total flavonoid content (TFC) was estimated using a standard method (Sadasivam and Manickam, 2018; Chandra *et al.,* 2014).

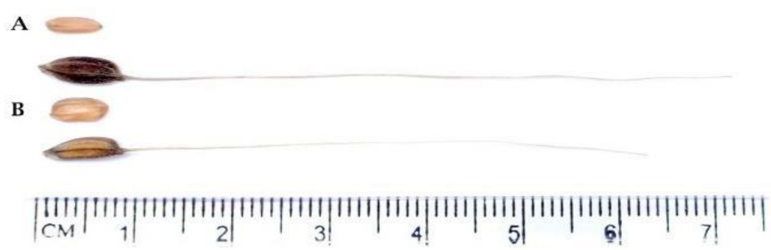

Figure 1. Unhusked seed and grain of (A) *O. rufipogon,* and (B) *O. nivara*

Results and Discussion

Grain classification

One hundred whole rice grains (unbroken) from each wild rice specimen are randomly screened and selected from two samples (Figure 1). The gross weight of 100 grains of *O. rufipogon* is 1.231g (an average of 0.01231g per grain), and that of *O. nivara* is 1.845g (an average of 0.01845g per grain), (Table 1).

The length, width, and thickness of 100 whole grains of each species showed 5.87±0.24 cm, 1.97±0.14 cm, and 1.39±0.08 cm, respectively, in *O. rufipogon*, and 5.67±0.29 cm, 2.53±0.13cm, and 1.71±0.10 cm in *O. nivara.* (Table 1).

Table 1. Morphological Feature and Appearance of *O. rufipogon* Griff. and *O. nivara* Sharma *et* Shastry

Specimen	Average weight (g)	Average lengths (cm)	Average width (cm)	Average Thickness (cm)	Appearances	Size and shape classifications
R	0.01231	5.87±0.24	1.97±0.14	1.39±0.08	Reddish incolour and slender seed	5.87 mm (medium) & 2.98 (medium)
N	0.01845	5.67±0.29	2.53±0.13	1.71±0.10	Reddish in colour and slender seedbut larger in size than *O. rufipogon*	5.67 mm (medium) & 2.24 (medium)

R=*O. rufipogon*, N=*O. nivara.* Mean values±standard error of length, width, and thickness. Size classification=length, shape classification=l/w. (Based on the classification formulated by Cruz and Khush (2000).

Proximate composition

Table 2 shows the proximate contents in the two rice species and reveals that carbohydrates and protein contents in *O. nivara* (86.49% and 10.16%, respectively) showed higher than that of *O. rufipogon* (82.31 and 6.83 %, respectively). Regarding the moisture and fat content, the two species show almost similarity (7.62% and 3% respectively in O. *nivara*, 7.58% and 2.75% respectively in O. *rufipogon*). However, both specimens show equal ash content.

Food energy

The total calorific content in a food is referred to as its energy value. The present study reveals a considerable variation in the food energy value (Table 2) between the two specimens. *O. nivara* (413.6 kcal/100g) has a higher food energy value than *O. rufipogon* (381.27 kcal/100). As a result, the former will undoubtedly give consumers more energy.

Mineral content

The present study reveals that *O. nivara* has a significantly higher micro-nutrient availability of nitrogen (1710mg), phosphorus (260mg), potassium (1860mg), manganese (1.61mg), iron (4.55mg), and zinc (6.7mg) than *O. rufipogon* (Table 2). Both specimens have an exact value of 0.12 mg in the case of Cu. As a consequence, K happens to be the dominant mineral, and Cu is the minor mineral.

Table 2. Proximate analysis and mineral contents of *O. rufipogon and O. nivara* species

Sample	Ash	Mos	Car	Pro	Fat	F.E.	N	P	K	Mn	Fe	Cu	Zn
R	1.4	7.58	82.31	6.83	2.75	381.27	1150	230	1780	1.58	2.65	0.12	3.7
N	1.3	7.62	86.49	10.16	3.00	413.6	1710	260	1860	1.61	4.55	0.12	6.7

R=O. rufipogon, N=O. nivara, Mos=moisture, Car=Carbohydrate, Pro=Protein, F.E.=Food Energy. (The unit is %/100 gram for proximate values and milligram/100 gram for mineral values. Correlation coefficient ofproximate content=1 & Correlation coefficient of mineral content=0.9).

Table 3. Preliminary tests of the phytochemical compounds

Phytochemica lcompounds	Tests Performed	Observations	Results	
			O. rufipogon	*O. nivara*
Phenolics	*Ferric Chloride test*	A dark green color is observed.	+++	+++
	Lead Acetate test	Bulky precipitation is formed.	+++	+++
Tannins	*Lead Acetate test*	A white precipitate is developed.	+++	+++
Carbohydrate	*Fehling's test*	Red color in the bottom ofthe test tube indicated the presence of carbohydrates.	+++	+++
Triterpenoids	*Liebermann-Burchard's test*	Two rings of deep red colourare observed.	+++	++
Flavonoids	*Alkaline Reagent test*	No result	+++	+++
	Ferric Chloride test	No result	-	-
Terpenoids	*Salkowski's test*	An interface of reddish-brown or pink-colored is formed.	++	++
Steroids	*Liebermann-Burchard's test*	A light yellow with green fluorescence is developed.	+	+
Saponins	*Foam test*	Two-layered foams are formedbut quickly disappear within 1 minute.	+	+
Alkaloids	*Mayer's test*	No result	-	-
	Wagner's test	No result	-	-

'+' Sign = presence of the phytochemical compounds and - Sign = no compound detected.

Correlation in proximate and mineral contents

The proximate content in the two rice specimens has a perfect positive correlation coefficient of 1, signifying that they share the equivalent proximate content. Similarly, the mineral contents of the two specimens also have a positive correlation coefficient of 0.9, indicating that they have approximately the same mineral content.

Phytochemical indications

The presence of high phytochemical compounds of phenolics, flavonoids, tannins, carbohydrates, and triterpenoids are seen in both specimens (Table 3), though the presence of other compounds like terpenoids, saponins, and steroids is less detected. It is also noticed that the total phenolic content (TPC) and flavonoid content (TFC) in *O. rufipogon* specimen (0.347g GAE/100g and 1.615 gQE) demonstrate higher concentration than *O. nivara,* showing 0.141g GAE/100g and 1.122 gQE/100g, correspondingly, (Figure 2).

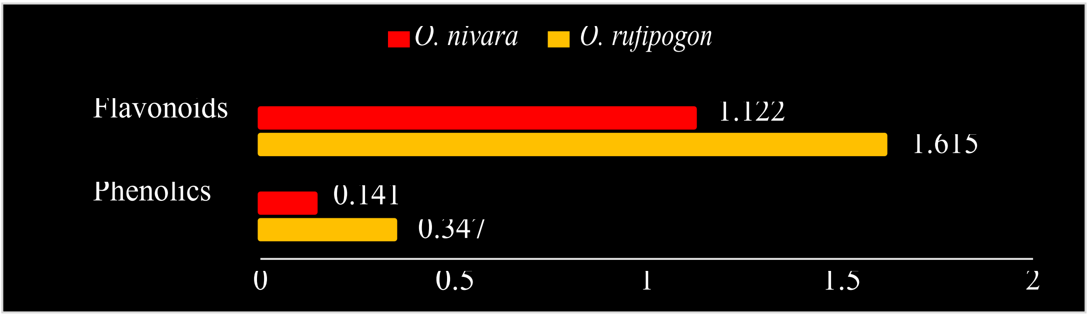

Figure 2. Total phenolic (gGAE/100g) and total flavonoid content (gQE/100g) in the two wild rice (*O.nivara and O.rufipogon)*

The primary objective of our study is to determine the nutritional values and to provide health efficacy present in whole grains of two Asian wild rice. Pertaining to grain size, two wild rice samples fall under the medium category, which is comparatively similar to earlier reports (Fasahat *et al.,* 2012; Kasem *et al.,* 2010); however, the grain of *O. rufipogon* is somewhat longer than that of *O. nivara.* It is seen that the ash content of the two specimens shows a higher concentration when compared with rice accessions (Shayo *et al.,* 2009; Rasool *et al.,* 2015; Henrita *et al.,* 2015; Verma and Srivastav,2020; Zhao *et al.,* 2020), but slightly equivalent to brown rice (Wireko-Manu and Amamoo, 2017) different wild rice species (Anderson, 1975; Watts, 1980; Umar *et al.,* 2013; Melini and Acquistucci, 2017), red and black rice (Sompong *et al.,* 2011; Petroni *et al.,* 2017; Reddy *et al.,* 2017), and some of the uncommon rice varieties (Kariyawasam *et al.,* 2016). While the value of ash content in rice accessions is influenced by the constituents of minerals in the soil and also by genetic factors (Oko *et al.,* 2012), its content reflects the value of inorganic remains after either combustion or complete oxidation in cereals and obviously helps in determining their nutritional assessment (Ismail, 2017).

Moisture content

Moisture invariably influences rice's physical and mechanical qualities (Kibar, 2010). The result shows the inferior moisture content under the tolerable perimeter, affecting grain storage for a long period. It is also noted that two specimens contain lesser moisture levels than raw and milled rice (Reddy *et al.,* 2017), different wild rice types

(Fasahat *et al.,* 2012; Anderson, 1975; Umar *et al.,* 2013; Melini and Acquistucci, 2017), aromatic and non-aromatic rice (Anjum *et al.,* 2007; Rasool *et al.,* 2015; Verma and Srivastav, 2017; Wireko-Manu and Amamoo, 2017; Sompong *et al.,* 2011; Reddy *et al.,* 2017; Kariyawasam *et al.,* 2016), etc. According to a review article, foods with low moisture content have high grinding efficiency, affecting the plasticity and powder flow characteristics (Jung and Yoon, 2018); therefore, the studied wild rice is more brittle when compared to other kinds of rice.

Carbohydrate content

Carbohydrates are the prime element in rice, dominating 80% (Juliano, 1993) of the overall proportion of ingredients and are chiefly made up of amylopectin and amylose in rice (Verma and Srivastav, 2017). The studied wild rice species show higher carbohydrate content than other categories of wild rice (Anderson, 1975; Umar *et al.,* 2013), raw black rice (Reddy *et al.,* 2017), aromatic rice (Verma and Srivasta, 2020), and different rice accessions (Henrita, 2015; Wireko-Manu and Amamoo, 2017; Sompong *et al.,* 2011; Petroni *et al.,* 2017; Reddy *et al.,* 2017). This data strongly suggests the possession of higher stickiness qualities in the studied wild rice, as it was stated in a study that a high degree of starch binds the grains collectively, and a low amount of starch has low stickiness after cooking (Mbatchou and Dawda, 2013).

Protein content

Proteins are clusters of polymer amino acids abundantly available in living organisms.They are the second dominant rice element after carbohydrates, inducing the eating quality and nutritional quality (Priya *et al.,* 2019), partaking in around 7% (Juliano, 1993) of essential albumin, globulin, prolamin, and glutelin (Juliano, 1985). Proteins form the basic building blocks in cells and tissues (Mbatchou and Dawda, 2013). This study found that *O. rufipogon* has a lesser protein content than *O. nivara,* comparable to a prior examination (Fasahat *et al.,* 2012). Then again, *O. nivara* has more excellent protein content than other varieties of wild rice (Mahmoud, 2008), regular rice, black rice (Sompong *et al.,* 2011; Petroni *et al.,* 2017), and aromatic and non-aromatic rice (Priya *et al.,* 2019; Shayo *et al.,* 2009; Verma and Srivastav, 2017; Wireko-Manu and Amamoo, 2017; Reddy *et al.,* 2017; Mbatchou and Dawda, 2013; Oko and Ugwu, 2011). Though the protein content of rice is inferior to wheat and oats (Harborne, 1984), its protein is highly excellent owing to the presence of eight different amino acids, which gives a unique benefit (Ahmed *et al.,* 1998). The differences in protein content between rice accessions could be due to a variety of factors, including water supply, handling, fertiliser application (soil nitrogen availability), environmental stress (such as salinity and alkalinity, temperatures, and diseases), growing area location, growing conditions, and time (Buresova *et al.,* 2010).

Fat content

Fat is an organic compound comprising triglycerides, glycerol, and several fatty acids, delivering a chief energy source and essential building blocks to living organisms. Rice is a vital fat supplier with linoleic acid, fatty acids, and zero cholesterol (Mbatchou and Dawda, 2013; Eggum *et al.,* 1982; Hirokadzu et al.,1979), and this portion is confined to rice bran (Priya *et al.,* 2019). The present work reveals the presence of high-fat content in the two specimens under study. Fat content in these specimens excels more than the other reported data on wild rice (Fasahat *et al.,* 2012; Anderson, 1975), scented rice (Verma and Srivasta, 2020) and white rice (Shayo *et al.,* 2009; Rasool *et* *al.,* 2015; Henrita *et al.,* 2015; Mbatchou and Dawda, 2013). The value offat content in red and black rice (Sompong *et al.,* 2011) and traditional local cultivars (Kariyawasam *et al.,* 2016) is somewhat similarto the present study. The differences in fat value in rice accessions may be attributed to fat oxidation since most fats in rice grains are unsaturated and easily oxidised by ambient oxygen.

Food energy

Food energy is the total value present in the body as a fuel. The food energy value of wild rice is relatively higher than that of conventional rice-scented (Verma and Srivasta, 2020; Rao, 2003) or red and black rice (Sompong *et al.,* 2011). The two wild rice specimens understudy also show higher energy value against other foodstuffs like cereals, millets, pulses, legumes, roots, tubers, fruits, and vegetables, except for nuts and oilseeds (Rao, 2003).

Mineral composition

Minerals are vital micronutrients needed in minute amounts in humans. They are clustered into two classes - macro-minerals and micro-minerals. Elements such as calcium, magnesium, potassium, sodium, chloride, phosphorus, and sulfur are grouped under the macro-minerals. At the same time, microminerals embrace zinc, selenium, iron, manganese, copper, cobalt molybdenum, fluoride, chromium, and boron (Gharibzahedi and Jafari, 2017).

Phosphorus (P) and Potassium (K) are two essential macro-minerals examined in the current study. Phosphorus is found in every human cell, supporting protein production for cell growth, maintenance, and reparation. It also helps in sustaining healthy bones, teeth, andacid-base balance. In association with Vitamin B, phosphorus helps in kidney performance, muscle contractions, regular heartbeat, and nerve signalling (Gharibzahedi and Jafari, 2017). Here, the two wild rice specimens understudy show low phosphorus content as compared to the prior studies of wildrice (Jiang *et al.,* 2009) and black rice (Reddy *et al.,* 2007), but are higher than white rice (Anderson, 1975). Potassium is essential for fluid equilibrium, nerve transmission, muscle contraction, blood pressure, and waste elimination. Rice is a rich potassium source. Potassium in the two wild rice specimens under study is higher than that of other rice specimens (Verma and Srivastav, 2017; Anderson, 1975). At the same time, the two wild rice specimens show relatively higher potassium content than that of white rice, brownrice, oats, wheat, and corn (Anderson, 1975).

In wild rice accessions, zinc (Zn) and iron (Fe) are accredited to be vital micro-nutrients and indispensable in children's normal growth and development (Swamy, 2018). Adding zincto dietary food helps to modulate some physiological functions. Zinc usually protects againstviral diseases such as COVID-19, influenzas, rhinoviruses, etc., by improving the total anti-oxidant capacity in the immunological effects (Oyagbemi *et al.,* 2021). Zinc deficiency regularly leads to public health complications (failure in immune systems and chronic conditions) in children and women (Askary *et al.,* 2011). In the present study, *O. rufipogon* contains lesser zinc content than previouslyreported wild rice (Reddy *et al.,* 2017; Swamy *et al.,* 2018), whereas *O. nivara* type had higher zinc content compared to otherrice types (Umar *et al.,* 2013; Reddy *et al.,* 2017; Jiang *et al.,* 2009; Swamy *et al.,* 2018: Watts and Dronzek, 1981).

Iron in food supplements is necessary during the early stages of brain development in children to reduce the risks of poor cognition, motor, social-emotional, and neurophysiologic development in the short- and long-term outcomes (Lozoff, 2007), hemoglobin formation in red blood cells, and energy metabolism in humans (Gharibzahedi and Jafari, 2017). The value of iron content in the two samples under study shows a slightly fluctuated nature but higher than previously reported wild rice (Jiang, 2009; Watts and Dronzek, 1981) aromatic and non-aromatic varieties (Verma and Srivasta, 2020).

Manganese (Mn) has a central function in the normal functioning of the brain and nervous system, the growth of human bone structure, and averting osteoporosis (Gharibzahedi and Jafari, 2017). The manganese content in the two specimens is less than that of black rice (Reddy *et al.,* 2017; Jiang *et al.,* 2009). Copper (Cu) content in two specimens (0.12 mg) is relatively low as compared to reported wild rice (Umar *et al*., 2013; Jiang *et al.,* 2009), aromatic and non-aromatic (Verma and Srivasta, 2020). Incorporating copper in daily food supplements regulates iron and protein metabolism, stimulates the immune system to combat infections, maintains injured cells and tissues, and neutralises free radicals that trigger intense cell injuries (Gharibzahedi and Jafari, 2017).

Genetic and environmental factors influence mineral content in rice (Zimmermann and Hurrell, 2002), and the quantity of minerals is lost during rice processing. Inappropriate handling in the drying and milling of grains invariably affects the mineral contents. Whole grains usually have a higher mineral content than milled rice (Abbas *et al.,* 2011). Consequently, the studied wild rice revealed more mineral content *(ibid)*. Plant breeders have recently tried to fortify foods by adding essential minerals. This agricultural approach is known as biofortification (Hotz, 2009), and it has already been applied to enhance micro-minerals like zinc *(ibid),* iron (Masuda *et al.,* 2013), and selenium (D'Amato *et al.,* 2018) lately. The same approach can be used in hybridising new rice cultivars by incorporating the minerals needed to attain the recommended daily intake.

Total phenolic and flavonoid contents

Phenolic and flavonoids are large classes of secondary compounds in plants, offering an excellent dietary anti-oxidant for humans. A good source of unique free phenolic compounds and glycosides is accumulated in cereal grains (Miller *et al.,* 2000). Our study disclosed that the examined specimen of *O. rufipogon* has a higher value of total phenolic content (TPC) than the same species in Australia (Fasahat *et al.,* 2012). When compared with the prior studies of wild rice accessions, both the studied specimens have comparatively reduced total phenolic content (Melini and Acquistucci, 2017; Yu *et al.,*2020) and pigmented rice (Ghasemzadeh *et al.,* 2018; Reddy *et al.,* 2017). In terms of total flavonoid content (TFC), the two wild rice under examination exceeds more than other rice accessions (Ghasemzadeh *et al.,* 2018; Reddy *et al.,* 2017; Yu *et al.,* 2020; Hansakul *et al.,* 2011; Yafang *et al.,* 2011).

Conclusions

Grains of the present landraces of Asian wild rice belong to the medium-size category, having the physical characteristics of slender, elongated, and reddish or brown in colour. The present study primarily shows the higher content of proximate, mineral, total phenolic content (TPC), and total flavonoid content (TFC), befalling to be an admirable food cereal of nutritional worth containing high anti-oxidant properties. The anti-oxidant can counteract undesirable harmful toxic compounds, enhance body activities and make it beneficial through breeding programs to enhance nutritional qualities in rice. Hence, our study sheds a substantial spotlight on the pertinence of wild rice in Manipur.

Conflict of Interest

All the Authors have no conflict of interest in this publication.

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