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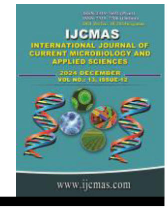

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Nutritional Profiling of Two Wild Edible Mushrooms Collected from Dulte, Khawzawl, Mizoram, India

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A B S T R A C T

With improvements in quality of life and the corresponding increase in the prevalence of life-threatening diseases, there is an irrefutable perception of food not only as a source of nutrition but also as a means to deliver functional benefits. In the present study, two wild edible mushrooms collected from Dulte, Khawzawl District were analysed for their nutritional composition and mineral content. The results showed that these mushrooms have a high protein (16.53% - 23.03%) and carbohydrate content (59.65% - 65.21%) while being low in fats (2.05% - 2.46%). Additionally, they are rich in essential minerals such as potassium, sodium, iron, zinc, calcium and magnesium that play a crucial role in promoting human health.

Introduction

Edible mushrooms have been consumed by humans for centuries, are valued for both their nutritional and medicinal properties (Lakhanpal and Rana, 2005; Cheung, 2010) and remain an important food source in many countries, especially in rural or economically disadvantaged communities (Ullah *et al.,* 2022; Khumlianlal *et al.,* 2024).

Moreover, harvesting wild edible mushrooms not only provides rural dwellers with nutritious food but also creates economic opportunities for unemployed individuals in marginalized areas (Tibuhwa, 2013; Zothanzama *et al.,* 2018; Thachunglura *et al.,* 2023a). Edible mushrooms are recognized for their high protein, fibre, and carbohydrate contents and low fat and caloric contents (Wang and Zhao, 2023). They are a rich source of essential nutrients, including vitamins such as B and D, and key minerals such as potassium, copper, and iron, along with other bioactive compounds such as antioxidants (Zeb and Lee, 2021; Demirtas *et al.,* 2024).

These components are crucial for promoting overall health, supporting immune function, and contributing to various physiological processes, making mushrooms an ideal component of a nutritious diet.

In recent years, interest in mushroom cultivation has increased across the globe, driven by its nutritional benefits, economic potential, and sustainable farming practices (Ferreira *et al.,* 2009). This trend highlights the increasing awareness of the important role that mushrooms can play in enhancing food security and providing livelihoods for farmers, and China is one of the largest producers and exporters of edible fungi, accounting for ca. 80% of mushroom production worldwide (Bakratas *et al.,* 2021). Fermented food and beverage products derived from fungi are experiencing significant growth in the market, generating billions of USD in revenue (Li and Xu, 2022). This surge in popularity can be attributed to heightened consumer interest in unique flavours, health benefits, and diverse culinary experiences.

In Mizoram, over 264 taxa of wild mushrooms have been documented (Thachunglura *et al.,* 2024a). While the diversity of wood-rotting fungi has been extensively studied across the state in the past decade (Zothanzama, 2011; Ralte and Vanlalhluna, 2016; Vabeikhokhei *et al.,* 2019; Chawngthu *et al.,* 2023; Vanlalhluna *et al.,* 2024), research on edible mushrooms remains limited.

Previous studies have identified more than 40 species of wild edible mushrooms in Mizoram (Lalrinawmi *et al.,* 2017; Zothanzama *et al.,* 2018; Thachunglura *et al.,* 2024b). However, data on their nutritional properties and mineral content are still lacking. To address this gap, the present study aimed to analyse the nutritional profile of two common wild edible mushrooms collected from Dulte village, Mizoram.

Materials and Methods

Study site, collection and identification of samples

The samples were collected from Dulte village in 2022. Dulte village is located between 23°64' N and 93°06' E in the eastern region of Mizoram, at an elevation of 981 asl (Figure 1). In summer, the temperature is moderately warm, ranging from 20°C to 30°C, while in winter, it drops to between 11°C and 21°C.

The collected specimens were carefully identified on the basis of their morphological characteristics and compared with the available literature (Olariaga and Salcedo, 2013; Zothanzama *et al.,* 2018; Verma and Pandro, 2018).

The edibility of these wild edible mushrooms was also confirmed on the basis of traditional knowledge and later verified in the published literature (Lalrinawmi, 2019). Following identification of the samples, the fleshy collected mushroom samples were oven dried at 45° C for 3 days for obtaining a consistent weight and ground into a fine powder for proximate analysis.

Proximate Analysis

For the determination of proximate composition of the samples, following AOAC (2000) moisture was determined using hot air oven; crude protein content (N × 4.38) was estimated using the macro-Kjeldahl method. Crude fat was determined by extracting a known sample weight with petroleum ether using a Soxhlet apparatus.

Ash content was measured through calcination at 600 ± 15 °C. Crude fibre content was determined using a fibre digester and carbohydrate content was calculated by subtracting the sum of the percentages of crude protein, ash, fat, and crude fiber from 100. Micro nutritional properties such as calcium (Ca), iron (Fe), magnesium (Mg), potassium (K), sodium (Na) and zinc (Zn) were assessed using Flame atomic absorption spectrophotometer.

The powder samples were pass through a 40 mesh sieve and 1 g of the sample was weighed using an electronic balance and placed in a porcelain crucible and ashed at 450 ºC for 18 h.

The ash was then dissolved in 1 mL of concentrated nitric acid, evaporated to dryness, and mixed with 1 mL of sulphuric acid, nitric acid and 1 mL of hydrogen peroxide. The mixture was then diluted with double deionized water to a final volume of 10 mL (Isildak *et al.,* 2004).

Statistical Analysis

All the results obtained in this study are expressed as standard error of the mean (SEM). The results were analyzed using one-way analysis of variance (ANOVA) followed by Tukey's HSD Test with α = 0.05. This analysis was carried out using GraphPad Prism 5.0 (GraphPad Software, Inc., USA).

Results and Discussion

The collected specimens were identified as *Ramariopsis kunzei* (Fr.) Corner and *Russula rosea* Pers. Coral mushrooms are recognized for their health-promoting properties, making them increasingly relevant in both nutritional and medicinal contexts. In the local community, *Ra. kunzei* (Local name: Far Pa var) is not well known within the Mizo community, especially at relatively low altitudes in the state. However, in recent decades, with increased interaction along the India–Burma border, knowledge from the Burmese side eventually confirmed their edibility among the Mizo people, who were later consumed by the local communities in Champhai District of Mizoram.

Russulaceae exhibit significant diversity in both lower and higher altitudes of Mizoram. *R. rosea* (Local name: Pa Lengsen) has also been reported from Aizawl and Mamit districts.

Past studies described these two species based on their morphological characteristics, and their occurrence was confirmed in Mizoram (Lalrinawmi *et al.,* 2017; Thachunglura *et al.,* 2023b).

Both species were classified as E1 (Edible: confirmed) based on the Global List of Edible Mushrooms by Li *et al.,* (2021) and their fruiting bodies were presented in Figure 2.

Nutritional composition (macro-nutrients) and mineral contents (micro-nutrients) of *Ra. kunzei* and *R. rosea* were presented in Table 1. Carbohydrate was the highest fraction in both samples, followed by protein, while both species were low in fat, which aligned with the previous studies (Agrahar-Murugkar and Subbulakshmi, 2005).

For the macro nutritional content, *Ra. kunzei* was found to be higher in moisture (11.54 %), protein (23.03 %) and fibre content (8.12 %) whereas *R. rosea* was found to be higher in crude fat (2.46 %), ash (8.32 %), and carbohydrate (65.21 %).

The studied mushrooms contained considerable amounts of potassium, with the mineral content following the order: K > Na > Fe > Zn > Ca > Mg. *Ra. kunzei* was observed to be contained higher iron (173.73 mg/kg) content, magnesium (53.89 mg/kg), and sodium (207.91 mg/kg) whereas *R. rosea* was found to be higher in calcium (63.01 mg/kg), potassium (1404.65 mg/kg) and zinc (145 mg/kg).

Minerals are essential for human health as they play a crucial role in various bodily functions, including maintaining strong bones, supporting the immune system, and regulating muscle and nerve function. The minerals found in mushrooms, such as potassium, calcium, magnesium, iron, sodium, and zinc, contribute significantly to overall nutrition, making mushrooms a valuable dietary component (Weyh *et al.,* 2022). The average nutritional values of both species were 10.81% for moisture, 19.78% for protein, 2.26% for crude fat, 7.74% for ash, 7.80% for fibre, and 62.43% for carbohydrate.

The mineral content was as follows: calcium (69.80 mg/kg), iron (160.21 mg/kg), magnesium (48.54 mg/kg), potassium (1380.23 mg/kg), sodium (191.36 mg/kg), and zinc (141.96 mg/100g). These results indicate that the studied mushrooms are high in essential nutrients, making them beneficial for human health, and are in line with the findings of several other studies (Sharma and Gautam, 2017; Nadjombé *et al.,* 2022; Renthlei *et al.,* 2024).

The nutrient content in wild mushrooms of the same species is influenced by factors such as species, growing area, fruiting body growth duration, genetic factors, substrate type, and proximity to pollution sources (Thachunglura *et al.,* 2023a). Mushrooms grown in areas free from pollution and contaminants are likely to be richer in nutrients and safer for consumption.

However, many mushrooms can accumulate elevated levels of heavy metals, which may pose serious health risks, including severe illness or even death, upon consumption (Huang *et al.,* 2017; Chawngthu *et al.,* 2024). Despite these risks, wild edible mushrooms remain a valuable source of nutrients, offering high levels of essential vitamins, minerals, and bioactive compounds that contribute to their therapeutic and nutritional importance.

The nutritional properties of wild edible mushrooms is often not well known by local communities, yet these wild edible mushrooms provides a rich source of essential nutrients that can serve as valuable dietary supplements for improving human health. With many species still widely available in Dulte village and other regions of Mizoram, there is great potential to explore their use as a sustainable and accessible source of nutrition.

Future studies could focus on the broader health benefits of these mushrooms, promoting their inclusion in local diets in rural areas. Moreover, further research into their ecological roles, cultivation, and sustainable harvesting could pave the way for utilizing wild mushrooms as a regular part of balanced diets in the future.

Table.1 Proximate composition and mineral contents of wild edible mushroom in dried weight basis (g/100g for macronutrients & mg/kg for micro-nutrients)

	Specimen	***Ra. kunzei***	***R. rosea***
Macro-nutrients	Moisture	11.54 ± 0.38^{a}	10.08 ± 0.12^{b}
	Protein	23.03 ± 0.32^{a}	16.53 ± 0.26^{b}
	Crude fat	2.05 ± 0.07^{b}	2.46 ± 0.13^{a}
	Ash	7.15 ± 0.09^{b}	8.32 ± 0.09^{a}
	Fibre	8.12 ± 0.21^{a}	7.48 ± 0.17^{b}
	Carbohydrate	59.65 ± 0.26^{b}	65.21 ± 0.14^{a}
Micro-nutrients/Minerals	Calcium	63.01 ± 0.38^{b}	76.59 ± 0.35^{a}
	Iron	173.72 ± 1.63^{a}	146.695 ± 0.388^{b}
	Magnesium	53.89 ± 0.466^{a}	43.195 ± 0.784^{b}
	Potassium	1355.8 ± 1.24^{b}	1404.65 ± 1.53^{a}
	Sodium	207.91 ± 0.42^{a}	174.8 ± 0.34^{b}
	Zinc	137.92 ± 0.66^{a}	145 ± 1.03^{b}

Each value is expressed in mean ± SEM, (n = 3)
In each row, different letters mean significant differences between species ($p < 0.05$)

Figure.1 Map indicating the study site (Dulte village).

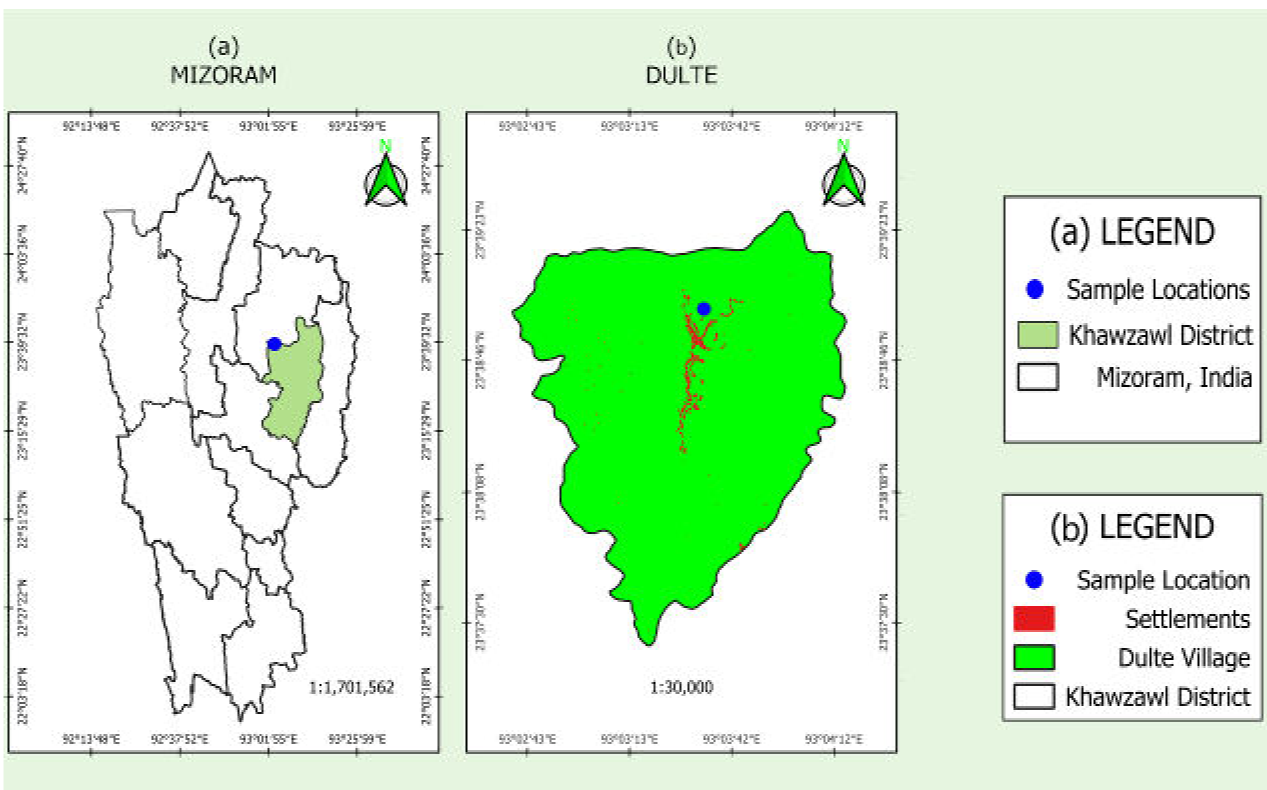

Figure.2 Fruiting bodies of the collected specimen (A. *Russula rosea*; B. *Ramariopsis kunzei*)

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Author Contributions

P. C. Vanlalhluna: Investigation, formal analysis, writing—original draft.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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