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A Narrative Review on Antioxidant Potential of Locally Available Rice Varieties in Sri Lanka

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ABSTRACT

Sri Lanka is a country rich in diverse range of traditional rice varieties known for their functional properties beyond nutrition. This review paper highlights the antioxidant potential of reported grains, showing their bioactive compounds and health benefits. Traditional rice varieties (Oryza sativa L.), such as "Rath Kadha", "Sudu Heenati", and "Beheth Heenati", have shown high total phenolic content, flavonoid content, and free radical scavenging activities in 2,2-Diphenyl-1-picrylhydrazyl (DPPH) and Ferric Reducing Antioxidant Power (FRAP) assays. Reported literature showed red rice varieties namely "Kurulu Thuda" and "Pachchaperumal" as grains possessing higher antioxidant potential than that of white rice due to the presence of anthocyanins and other bioactive compounds. The bioactive compounds in reported grains, namely phenolic compounds, flavonoids, and proanthocyanidins, play a vital role in combating oxidative stress and minimizing the risks of chronic diseases such as diabetes, cardiovascular diseases, and cancer. This review summarizes that Sri Lankan rice varieties are important in promoting natural, antioxidant-rich dietary patterns for improving public health and minimizing non-communicable diseases. These research findings emphasize focus on expanding further research into investigating the antioxidant potential of local rice varieties and utilize them in functional food systems.

KEYWORDS: *Rice, Antioxidant potential, Bioactive compounds, Health benefits, Functional foods*

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1 INTRODUCTION

Rice is the staple food among the majority in South Asians. Sri Lanka is enriched with a wide variety of traditional rice which is in demand due to their nutritional and functional properties. Traditional rice varieties such as "*Kalu Heenati", "Pachchaperumal", "Rath Kadha"*, "*Sudu Heenati"*, and "*Beheth Heenati"* are valued not only due to their rich nutritional profile but also for their high levels of bioactive compounds. These compounds including phenolic compounds, flavonoids, and anthocyanins significantly contribute to antioxidant activity which result in health benefits beyond basic nutrition (Gunaratne et al., 2011).

Sri Lankan traditional rice varieties have been valued for their health benefits including strong antioxidant properties (Thushara et al., 2019). Bioactive constituents of rice contribute to antioxidant, antimicrobial, anti-inflammatory, and anticancer activities, highlighting the important nutra-pharmaceutical potential of traditional Sri Lankan rice (Gunawardana et al., 2024).

The increasing risk of chronic diseases such as diabetes, cardiovascular conditions, and cancer has driven global attention to functional foods, highlighting the necessity of natural dietary antioxidants (Nam et al., 2006). Sri Lankan traditional rice varieties have exhibited significant antioxidant properties in various studies, largely attributed to their bioactive compound profiles. These properties contribute to reduce oxidative stress-related health issues while promoting public health.

This review explores reported findings on the antioxidant potential of locally available Sri Lankan rice varieties. The paper further highlights the importance of utilizing Sri Lankan rice varieties in developing functional foods and advancing research to unlock their full potential in food industry.

2 REPORTED STUDIES ON ANTIOXIDANT POTENTIAL OF LOCAL RICE VARIETIES IN SRI LANKA

There are reported studies on Sri Lankan context providing insights about antioxidant properties of locally available rice varieties.

2.1 Antioxidant potential of traditional rice varieties

A recent study highlights nutritional and functional properties of 20 selected

traditional Sri Lankan rice varieties, showing their antioxidant capacity through the measurement of Total Phenolic Content (TPC), Total Flavonoid Content (TFC), and Total Carotenoids (TC). Among the tested rice varieties, *Rath Kadha* showed the highest TPC of 9.94 mg GAE/g per Fresh Weight (FW) and TC of 2.27 mg/g FW, while *Sudu Heenati* had the highest TFC of 16.77 mg /g FW. Antioxidant potential analyzed through DPPH radical scavenging, was highest in *Beheth Heenati* (84.93% inhibition). These key findings highlight the antioxidant properties of traditional rice varieties which are due to their bioactive compound content, proving the fact that these grains can be successfully incorporated in managing diseases related to oxidative stress (Jayadewa et al., 2023).

Another study has determined the antioxidant potential of five selected traditional Sri Lankan rice varieties namely *Kurulu Thuda, Nilkanda, Heeneti, MaaWee*, and *Suwadal.* Antioxidant capacity was assessed using the FRAP and ABTS radical scavenging activity tests based on 70% ethanolic extracts of rice bran. Significant differences ($P < 0.05$) in antioxidant potential were observed among the tested varieties. Especially, the red rice variety *Kurulu Thuda* showed the highest antioxidant activity, depicting the highest results in both FRAP and 2,2'-Azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) radical scavenging assays. In contrast, the white rice variety *Suwadal* reported the lowest antioxidant potential. Nevertheless, this study highlights the fact that antioxidant activity was significantly different between red and white rice types (Samaranayake et al., 2017).

There is another study that reviews the nutritional composition, antioxidant activity, and health benefits of selected traditional rice varieties in Sri Lanka, highlighting their significant antioxidant properties. Red rice varieties namely *Kalu heenati, Kuruluthuda, Madathawalu*, and *Pachchaperumal* are concerned for their high levels of *anthocyanins* and other bioactive compounds, which provide strong antioxidant potential to them. These antioxidants assist in combating oxidative stress while providing anti-inflammatory and anticarcinogenic benefits and minimizing the risk of chronic diseases such as diabetes and cardiovascular conditions. DPPH and FRAP assays have depicted significant free radical scavenging capabilities in these grains,

with certain varieties also showing potential for regulating cholesterol and blood sugar levels. This study highlights the traditional and medicinal value of these rice varieties, proving their potential as functional foods and their benefits in promoting health through natural antioxidant-rich diets (Ratnayake and Karunarathna, 2023).

Further studies have discussed the antioxidant properties of locally available grain varieties in Sri Lanka. A study (Waisundara, 2020) has been done on basis of identifying the presence of bioactive compounds such as phenolic compounds, flavonoids and other compounds in traditional rice and millet varieties in Sri Lanka. These compounds assist in free radical scavenging activity and protection against oxidative stress-related diseases. It is stated that these antioxidant compounds neutralize free radicals and reduce oxidative stress, thereby minimizing the risks of some Non-Communicable Diseases (NCDs) such as cardiovascular diseases, diabetes and cancer. However, this study proved the fact that these grains can be successfully utilized in preventing chronic diseases due to their rich antioxidant profile (Waisundara, 2020).

Antioxidant activity of three traditional rice varieties (*Madathawalu, Suwandel, and Handiran*) has been evaluated in 2017. The 70% ethanol extracts of the samples have been analyzed for TPC and free radical scavenging activity using DPPH assays. Organically grown rice exhibited significantly higher TPC, and free radical scavenging activity ($P<0.05$) compared to non-organically grown rice. Among the tested varieties, the *Madathawalu* variety showed high antioxidant properties, with the highest TPC and free radical scavenging activity. Results highlighted that organic cultivation enhances the antioxidant potential of traditional rice varieties, especially in *Madathawalu* (Hemanthi et al., 2017).

Antioxidant properties of six selected Sri Lankan traditional rice varieties processed in different ways such as raw, parboiled, and polished have been assessed in another study (Thennakoon and Ekanayake, 2021). They have been analyzed for their TPC and antioxidant activity. Raw rice has exhibited the highest TPC and antioxidant activity according to the ABTS, DPPH, and FRAP assays, followed by parboiled and polished rice. Rice with red bran depicted greater antioxidant potential than white bran varieties. Also, it was stated that cooking

reduced the antioxidant properties across all processing methods, with raw rice retaining the highest levels of antioxidants (Thennakoon and Ekanayake, 2021).

However, bioactive compounds in grains are found to be varying with germination. A study has been done focusing on germination period and the presence of bioactive compounds in each stage. The results indicated that rice and other grains tested in the study germinated for eight days showed a significant ($P < 0.05$) increase in total polyphenol and flavonoid content, which directly affected enhanced antioxidant activity. It was proved that germination increases the antioxidant activity of rice and it is beneficial in developing food products with health benefits beyond nutrition. (Gunathunga et al., 2024).

Composite flour formulations have been prepared from locally available grain varieties in Sri Lanka as reported in a previous study (Perera et al., 2024). Red rice (*kalu heenati*), green gram, black gram, and *meneri* have been composited in designed ratios to prepare a composite flour mixture. Antioxidant potential has been determined by employing assays such as DPPH, ABTS and FRAP. Results were interpreted in Trolox equivalent antioxidant capacity (TEAC) in all the assays. The composite flour formulations exhibited outstanding antioxidant potential which is influenced by ingredient proportions. Traditional red rice variety contributed significantly to the antioxidant potential. However, results indicated that locally available grains, especially red rice can be successfully incorporated in functional foods to enhance health benefits. Figure 1 shows percentage of DPPH inhibition of reported commonly used traditional rice varieties in Sri Lanka. Further, figure 2 shows the selected rice varieties discussed in this narrative review.

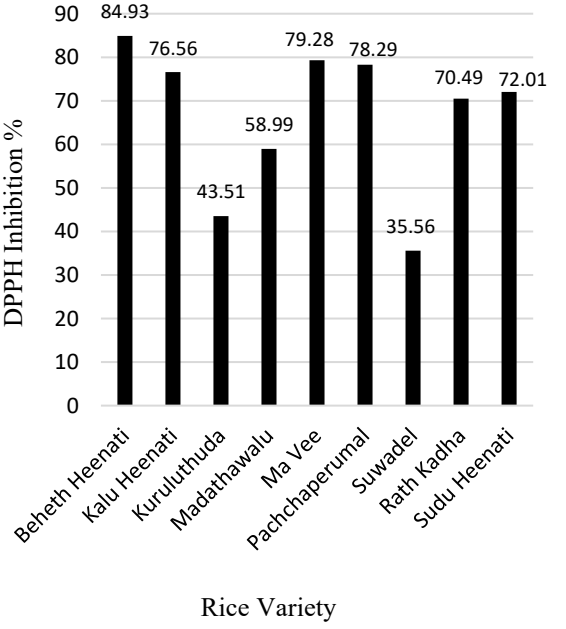

Figure 1. Antioxidant properties of selected traditional rice varieties as per Percentage DPPH inhibition

Figure 2. Some traditional rice varieties which exhibit prominent antioxidant properties in reported literature (Arachchilage and Ekanayake, 2024)

2.2. Antioxidant potential of traditional rice varieties compared to improved varieties

The antioxidant potential of rice brans of 29 selected rice varieties has been studied in another study (Abeysekera et al., 2017). Traditional, old and improved rice varieties have been considered for this. Traditional rice varieties namely Kalu heenati, Pachchaperumal and Beheth heenati exhibited significant amounts of TPC and antioxidant potential analyzed with regard to FRAP, ORAC, ABTS and DPPH assays. Black rice contained comparatively high amounts of antioxidants than that of improved rice varieties. Results revealed that red rice brans have significant antioxidant potential which assist in preventing chronic diseases. This promotes the cultivation and consumption of traditional red rice varieties.

A study done in 2011 has comparatively evaluated the antioxidant potential of traditional and improved rice varieties in Sri Lanka which resulted in proving that traditional rice varieties have significantly higher antioxidant capacity compared to improved varieties. Especially, traditional brown rice varieties had high TPC than that of improved brown rice varieties. This resulted in showing high antioxidant activity in traditional brown rice varieties. Further, it is stated that ongoing research studies are focused on antioxidant properties of brown rice varieties to promote their health benefits (Gunaratne et al., 2011).

Sri Lankan red rice varieties namely Attakkari, Bg2907, and Bg407 have been tested for their antioxidant activity using water extracts of them. Among the selected varieties, Attakkari variety exhibited the highest antioxidant activity. Key contributors which affect these properties were total phenolic content, flavonoids,

and condensed tannins contained in significant amounts in these rice varieties. These results highlight the rich antioxidant profile of Sri Lankan red rice, *Attakkari*, making it a beneficial dietary option for food systems (Priyanthi and Sivakanesan, 2021).

2.3. Antioxidant potential of Sri Lankan pigmented and non-pigmented rice varieties

Further, Sri Lankan pigmented and non-pigmented long grain rice varieties have been analyzed for their antioxidant activity (Abeysekera et al., 2020). Selected varieties included CIC Red Fragrant, CIC Black, Pakistani White Basmati and CIC White Slender of various polishing rates such as whole grains, 40% polished and fully polished. Nevertheless, the results indicated that pigmented whole grain varieties, CIC Black and CIC Red Fragrant exhibited higher levels of antioxidant capacity than that of non-pigmented rice. These rice varieties contained high TPC and antioxidant properties as per FRAP, DPPH, ABTS and ORAC assays. The polishing rate of rice was inversely proportional to the antioxidant activity which denoted that the higher the polishing rate lower the antioxidant potential. This study highlighted the fact that whole grains or minimally processed rice contained high antioxidant activity which assisted in reducing oxidative stress.

Table 01 shows the significant findings of the studies discussed in this paper.

Table 01. Key findings of the studies reported on the basis of antioxidant properties of Sri Lankan rice.

Reference	Assays employed	Key findings
Gunathunga et al., 2024	TPC, TFC, DPPH, ABTS, FRAP assays	• Germination enhanced antioxidant properties in rice and other grains • Eight-day germination increased polyphenol and flavonoid content, improving antioxidant activity and supporting the development of nutrient-dense foods
Gunawardana et al., 2024	-	• Traditional rice varieties that are minimally processed red pericarp grains, showed high antioxidant, antimicrobial, anti-inflammatory, and anticancer properties, highlighting their potential as nutraceuticals
Perera et al., 2024	DPPH, ABTS, FRAP assays	• Composite flour formulation which composed of higher percentage of *Kalu Heenati* rice exhibited the highest antioxidant activity in Trolox Equivalent Antioxidant Capacity TEAC (mg/g dw)

Jayadewa et al., 2023	DPPH, TPC, TFC assays	• *Rath* Radha had the highest TPC content of 9.94±0.01mgGAE/g FW and TC of 2.27±0.06 mg/g FW • Beheth *Heenati* had the highest DPPH% inhibition of 84.93±0.81% • *Sudu* Hennati had the highest TFC of 16.77±0.01mg RE/g among 20 selected rice varieties
Ratnayake and Karunarathna, 2023	DPPH, FRAP assays	• Red rice varieties (e.g., *Kalu Heenati, Kurulu Thuda, Pachchaperumal*) exhibited strong antioxidant properties due to anthocyanins and bioactive compounds, providing anti-inflammatory and anticarcinogenic benefits and minimizing the risk of chronic diseases
Priyanthi and Sivakanesan, 2021	DPPH, FRAP, ABTS assays	• Tested varieties included *Attakkari*, Bg 2907, Bg406 • Red rice variety *Attakkari* exhibited the highest antioxidant activity with high TPC, TFC as follows, FRAP: 0.70 ± 0.077 (mmol/100 g FW) DPPH: 26.07 ± 3.08 (IC_{50}, mg FW/mL) ABTS: 33.49 ± 4.10 (EC_{50}, mg FW/mL)
Thennakoon and Ekanayake, 2021	TPC, ABTS, DPPH, FRAP assays	• Tested varieties included Godaheenati, Batapola el, Dik wee, Dahanala, Unakola samba and, Hangimuththan • Raw rice varieties had the highest TPC and antioxidant activity followed by parboiled and polished rice • Cooking reduced antioxidant properties, with raw red bran varieties retaining the highest levels
Abeysekera et al., 2020	TPC, FRAP, ORAC, DPPH, ABTS assays	• CIC Black rice (Whole grains of 0% polishing rate had the highest antioxidant activity as follows, TPC (mg GAE g^{-1} extract): 27.67±1.26 FRAP (mg TE g^{-1} extract): 35.58±1.03 ORAC (mg TE g^{-1} extract): 107.58±4.60
Waisundara, 2020	-	• Common bioactive compounds in traditional rice include phenolics and flavonoids which neutralize free radicals and reduce oxidative stress
Abeysekera et al., 2017	TPC, FRAP, ORAC, DPPH, ABTS assays	• Selected 29 rice varieties have been tested • Red rice brans, especially from traditional varieties *Kalu Heeneti, Pachchaperumal, Beheth Heeneti* showed superior antioxidant activity compared to white rice brans
Hemanthi et al., 2017	TPC, DPPH assays	• Tested rice varieties included Madathawalu, Suwandel, and Handiran • Madathawalu rice variety had the highest TPC of 2.22±0.03 (mg gallic acid equivalents/g of rice)

		• Also, the highest DPPH radical scavenging activity of 16.89±0.78 (mg ascorbic acid equivalent /g of rice extract)
Samaranayake et al., 2017	FRAP ABTS radical scavenging assays	• Tested rice varieties included Suwadal, Heeneti, Nilkanda, Kurulu Thuda, Maa Wee • Red rice variety Kurulu Thuda exhibited the highest antioxidant activity of 6.79 ± 0.42 (mmol FeSO4/100 g bran) • Also, the highest ABTS radical scavenging activity of 13.13 ± 0.28 (mmol Trolox /100 g bran)
Gunaratne et al., 2011	TPC, ABTS assay	• Brown rice flour (BRF) from traditional varieties contained 68-86% more total phenolic content (TPC) and exhibited 86-90% greater antioxidant activity than BRF from improved varieties

4 CONCLUSION & RECOMMENDATIONS

This review highlights the antioxidant potential of locally available Sri Lankan rice varieties, especially traditional red rice varieties, due to their rich bioactive compound profiles. These bioactive compounds include phenolic compounds, flavonoids, and anthocyanins which contribute to combat oxidative stress and reduce the risk of chronic diseases such as diabetes, cardiovascular diseases, and cancer. DPPH, ABTS, FRAP were the commonly employed assays in most of the reported studies in determining the antioxidant potential of rice. ORAC assay also has been used in a few studies. The findings summarize the benefits of traditional rice varieties in promoting natural, antioxidant-rich dietary patterns and their capability for incorporating into functional foods. Further research is suggested to reveal their broader applications and to improve understanding of their health benefits for sustainable dietary and healthcare practices.

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