INTERNATIONAL JOURNAL OF PHARMACY AND ANALYTICAL RESEARCH

ISSN:2320-2831

*IJPAR |Vol.8 | Issue 1 | Jan – Mar - 2019*
*Journal Home page: www.ijpar.com*

*Research article* *Open Access*

# A study on heavy metal content in black scented rice in India

**Dr Ashish Mukherjee*, Dr Manvi Sharma, Smt Savita Latkar & Smt Priya Maurya**

*Central Agmark Laboratory, North Ambazari Road, Nagpur-440010, Maharashtra, India*

***Corresponding Author: Dr Ashish Mukherjee**
**Email: cal@nic.in**

## ABSTRACT

Black Scented rice is a range of rice types of the species oryza sativa L. It is also known as purple rice, some of which are glutinous rice. Varieties include Indonesian black rice and Thai jasmine black rice. Black rice is known as *chak-hao* in Manipur which is an Indian state on the eastern border with Myanmar, where desserts made from black rice are served at major feasts. Black rice is a source of iron, vitamin E, and antioxidants (more than in blueberries). The bran hull (outermost layer) of black rice contains one of the highest levels of anthocyanins found in food, which helps in fighting against heart disease, cancer and associated diseases. The grain has similar amount of fiber to brown rice and, like brown rice, has a mild, nutty taste. It has a deep black color and when cooked, it usually turns purple. Its dark purple color is primarily a product of its anthocyanin content, which is higher by weight than that of other colored grains. It is very useful when making porridge, dessert, traditional Chinese black rice cake, bread, and noodles. Black scented rice also known as Chakhao Amubi is a type of glutinous rice. It is indigenous to northeastern regions of India. It is also called Gold rice as the rice can be exported to countries where there is high demand of sticky rice and fetch foreign exchange.

Exposure of heavy metals to human beings has risen dramatically in the last 50 years. Humans are more likely to be exposed to heavy metal contamination from the dust that adheres to edible plants than from bioaccumulation. There are no reports regarding the level of heavy metal content in Black scented Rice. The objectives of this study was to determine the concentrations of lead (Pb) and copper (Cu) in Black scented rice collected from Gauwahti and Shillong North east part of India and also to assess whether the black scented rice were safe for human consumption.

Out of 84 samples of black scented rice analysed, Lead (Pb) content ranges from 0.012 ppm to 0.419 ppm. As per FSSAI, the maximum permissible limit in "food not specified category "is 2 ppm (max.). It clearly indicates that all the samples were found to contain Lead (Pb) within the permissible limit as specified by FSSAI.

Out of 84 samples of Black scented rice samples analysed, 79 samples were found to contain low level of Copper (Cu) content ranges from 0.022 ppm to 1.826 ppm. The Copper (Cu) content was "Not detected" in 5 samples of Black scented Rice. As per FSSAI, the maximum permissible limit in "foods not specified category" for Copper (Cu) is 30 ppm. It clearly indicates that all the samples were found to contain Copper (Cu) within the permissible limit as specified by FSSAI.

The Black scented rice samples are safe for human consumption. The concentration of Lead (Pb) and Copper (Cu) in all the black scented rice samples collected from Northeastern regions of India is within the safe limits as prescribed by FSSAI.

**Keywords:** Black scented Rice; North eastern states; heavy metal; Atomic absorption spectrometry; Lead (Pb), Copper (Cu).

## INTRODUCTION

Rice, a cereal crop is the major staple food sources for half of the world population. Black scented rice (also known as purple rice) is a range of rice types of the species *Oryza sativa* L., some of which are glutinous rice. Varieties include Indonesian black rice and Thai jasmine black rice. Black rice is known as *chak-hao* in Manipur, an Indian state on the eastern border with Myanmar, where desserts made from black rice are served at major feasts. Black rice is a source of iron, vitamin E, and antioxidants (more than in blueberries). The bran hull (outermost layer) of black rice contains one of the highest levels of anthocyanins found in food. It plays a role in preventing plaque building in artery walls. It is also helpful in lowering cholesterol levels in body. The grain has a similar amount of fiber to brown rice and, like brown rice, has a mild, nutty taste. Black rice has a deep black color and usually turns deep purple when cooked. Its dark purple color is primarily due to its anthocyanin content, which is higher by weight than that of other colored grains. It is suitable for preparation of porridge, dessert, traditional Chinese black rice cake, bread, and noodles. The Chakhao Amubi is one type of sticky black rice that is indigenous to Manipur. 'Chakho' means delicious while 'Ambui' means black. In Manipur, it is generally served in special occasions and festive events. Chahaomubi may be considered as black gold of Manipur because of its scope for earning foreign exchange. The demand for good quality chahaomubi has been increasing in international market because of its organic in character. The Government of India also emphasising on the promotion of organic farming through Paramparagat krishi vikas yojana and organic value chain Development in North East India from 2016-17. The importance of chahaomubi for development of agri-business sector of Manipur includes the following facts e.g it is ornamental rice and symbol of calmness among all plants; it is top class royal food and a ritual item for Asian people; it is useful for protection of pests and diseases on friendly plants; by product has economic utility due to its aromatic character; it is farmer friendly and climate indicator for state Manipur.

Rice bran, the outer layer of rice grain is a rich source of gamma-oryzonol and vitamin E including tocopherols and tocotrienols [1]. These nutritional compounds play an important part in preventing oxidative damage in foods and have a wide range of application in biological activities. The rice bran from red and purple rice has a higher concentration of phenolic and flavonoid concentrations than the lighter rice bran colour [2]. Bran also reduces the serum cholesterol levels in blood that help in lower of bad low density lipoprotein (LDL) and increase good high density lipoprotein (HDL) levels of cardiovascular health. Antioxidants like anthocyanins in Black scented rice helps in fighting against heart disease, cancer and associated diseases. Food and Beverage industry could explore the potential of black rice bran to boost human health and provide supplementary nutrients to the human body as synthetic compounds have side effects [3].

The aromatic black glutinous rice of Manipur has been characterized with 34 morphological characters. Das et al., 2014 [3] has developed a novel rice hybrid of "Chakhao Amubi and Basmati 370" to improve yield and provide better grain quality rice having high Nutraceutical properties using anther culture development techniques of homozygous breeding lines of double haploid. The improved varieties can be exported to South east and East Asian Countries where there is a huge demand of aromatic glutinous rice.

The main sources of heavy metals in plants are their growth media, nutrients, agro inputs, soil and others factor such as pesticides and fertilizers. Heavy metals along with other pollutants are discharged to the environment through industrial activity, automobile exhaust, heavy duty electric power generators and pesticides used in agriculture etc and enter into the food chain. Heavy metals

have great significance due to their tendency to accumulate in the vital human organs over prolonged period of time. Heavy metals especially Lead (Pb) is a physiological and neurological toxin that can affect several organs in the human body. Lead can also damage kidneys and reproductive systems . Heavy metal such as Copper is essential for human body as it is an integral part of numerous enzymes including ferro-oxidase (ceruloplamin), cytochrome-c-oxidase, superoxide dismutase etc. It also plays a role in iron metabolism melanin synthesis and central nervous system function. However, chronic (long term) effects of copper exposure can damage the liver and kidneys. Acute symptoms of copper poisoning by ingestion include vomiting, hematemesis (vomiting of blood), hypotension (low blood pressure), melena (black "tarry" feces), coma, jaundice (yellowish pigmentation of skin) and gastrointestinal distress. Presence of these pollutants (Pb and Cu) in Black Scented Rice above the permissible limit may lead to severe health hazards to the people consuming it So, estimation of their levels in contaminated food is very important for the safety of human health [4,5,6].

There are no reports available in the literature about any study on the level of Heavy metals in the Black Scented Rice available in India. Therefore, it is important to study the heavy metal contamination in the black scented rice. In the present study, the concentration of these two heavy metals including Lead (Pb) and Copper (Cu) was determined in black scented rice collected from North Eastern regions of India.

## MATERIALS AND METHODS

### Sample Collection

A total of 84 samples of Black scented rice were collected from Gauwahti and Shillong.

## APPARATUS AND REAGENTS

Atomic Absorption Spectrophotometer AAS 7000SP with air-acetylene base for flame; Microwave Digestion System (Model 3000, Anton Paar), Contaminated free digestion vessels are used for digestion, Mixer – For grinding the sample, Volumetric Flask (100 ml), Pipettes, Funnels (Glass or plastic), Filter paper Watman No.4 or equivalent and Glass rods Concentrated HCl (AR Grade), Concentrated $HNO_3$ (AR Grade), Distilled water, Lead standard (99.99%) and Copper Standard (99.99%).

## SAMPLE PREPARATION AND DIGESTION

One portion of a well homogenized sample was grinded in a mixer. From this, 0.1g of ground sample (dried) was weighed into digestion Teflon vessel. 6 ml concentrated $HNO_3$ and 1 ml concentrated HCl was added in the sample in fume hood. Vessels were left aside for 5 minutes to initial vigorous reaction. Teflon vessels were closed in position in Microwave Digestion System (Model 3000, Anton Paar). Door was closed properly. After 50 minutes, digestion was over. System was cooled to room temperature. The digestion vessels were unscrewed. Cap and sides of Teflon vessel were rinsed with distilled water. Solution was filtered into 100 ml volumetric flask. Filter paper and funnel was washed properly then solution was made up to mark with distilled water. A reagent blank, sample blank, spike samples were prepared in the same manner with the same quantity of acid as for samples.

## PREPARATION OF STANDARDS

### Stock standard solution (1000 ppm)

0.10 g Pb (99.99%) / Cu (99.99%) powder was dissolved into 2 ml $HNO_3$: $H_2O$(1:1) solution. Then it was made up to 100 ml volumetric flask with distilled water.

### Intermediate standard (100 ppm)

10 ml of 1000 ppm solution was pipetted out into 100 ml volumetric flask and made up to mark with distilled water.

### Working Standards

The range of working/calibration standards were prepared such as blank (0), 0.5ppm, 1 ppm, 2 ppm, 4 ppm and 6 ppm in 100 ml volumetric flask.

## ANALYSIS OF LEAD (PB) AND COPPER (CU) BY AAS

Analysis of Lead and Copper in White pepper samples was carried out using Flame and air-

acetylene AAS 7000 SP workstation as Per AOAC Official method 999.10.

## RESULTS

A total of 84 samples of black scented rice were analysed for the presence of Lead (Pb) and Copper (Cu) on AAS 7000 at Central Agmark Laboratory, Nagpur. The samples were received from North eastern regions of India. Table 1 showed the Analytical conditions for analyzing heavy metal in black scented rice samples for AAS.

**Table 1. Analytical Conditions of AAS 7000 SP for analyzing heavy metals in White Pepper**

| Parameter | Lead | Copper |
|---|---|---|
| Wavelength (nm) | 217 | 324.7 |
| Slit width (nm) | 0.4 | 0.2 |
| Lamp current (mA) | 4.0 | 2.0 |
| Types of Flame | Air-Acetylene | Air-Acetylene |
| Fuel Gas pressure (M Pa) | 0.0 | 0.10 |
| Burner Height (mm) | 8.0 | 8.0 |
| Fuel Gas Flow rate (L/mm) | 1.70 | 1.70 |
| Combustion-supporting gas | Air | Air |
| Sampling speed | 10 | 50 |
| Integral time (s) | 1.0 | 2.0 |
| Smooth curve factor | 1 | 10 |
| Units | Ppm | ppm |

### Lead (Pb) content in Black scented rice

It has been found that out of 84 black scented rice samples, all samples were found to be positive for Lead (Pb). Table 2 indicates the level of Lead Content in ppm in black scented rice. The range of Lead (Pb) content in black scented rice is from 0.012 ppm (Minimum) to 0.419 ppm (Maximum). The results of Lead s summarized n Table-2.

**Table 2. Level of Lead (Pb) in ppm in Black scented rice samples obtained from North Eastern regions of India**

| S.No | Lead (Pb) content (ppm) | S.No | Lead (Pb) content (ppm) | S.No | Lead (Pb) content (ppm) | S.No | Lead (Pb) content (ppm) |
|---|---|---|---|---|---|---|---|
| 1 | 0.012 | 22 | 0.067 | 43 | 0.178 | 64 | 0.204 |
| 2 | 0.015 | 23 | 0.07 | 44 | 0.18 | 65 | 0.208 |
| 3 | 0.017 | 24 | 0.085 | 45 | 0.181 | 66 | 0.215 |
| 4 | 0.022 | 25 | 0.112 | 46 | 0.181 | 67 | 0.218 |
| 5 | 0.029 | 26 | 0.123 | 47 | 0.181 | 68 | 0.22 |
| 6 | 0.031 | 27 | 0.124 | 48 | 0.182 | 69 | 0.221 |
| 7 | 0.033 | 28 | 0.126 | 49 | 0.183 | 70 | 0.221 |
| 8 | 0.036 | 29 | 0.135 | 50 | 0.185 | 71 | 0.222 |
| 9 | 0.038 | 30 | 0.137 | 51 | 0.186 | 72 | 0.233 |
| 10 | 0.039 | 31 | 0.14 | 52 | 0.187 | 73 | 0.233 |
| 11 | 0.047 | 32 | 0.144 | 53 | 0.188 | 74 | 0.233 |
| 12 | 0.049 | 33 | 0.148 | 54 | 0.191 | 75 | 0.244 |
| 13 | 0.051 | 34 | 0.158 | 55 | 0.192 | 76 | 0.247 |
| 14 | 0.051 | 35 | 0.162 | 56 | 0.193 | 77 | 0.25 |
| 15 | 0.052 | 36 | 0.163 | 57 | 0.194 | 78 | 0.251 |
| 16 | 0.054 | 37 | 0.166 | 58 | 0.194 | 79 | 0.255 |
| 17 | 0.058 | 38 | 0.17 | 59 | 0.195 | 80 | 0.262 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18 | 0.06 | 39 | 0.173 | 60 | 0.196 | 81 | 0.337 |
| 19 | 0.062 | 40 | 0.173 | 61 | 0.196 | 82 | 0.348 |
| 20 | 0.063 | 41 | 0.174 | 62 | 0.197 | 83 | 0.353 |
| 21 | 0.063 | 42 | 0.174 | 63 | 0.201 | 84 | 0.419 |

### Copper (Cu) content in Black scented rice

It has been found that out of 84 black scented rice samples analysed, 79 samples were found to be positive for copper (Cu). The Copper (Cu) content has not been detected i.e '0.00' ppm in 5 samples of black scented rice. Table 3 indicates the copper concentration in ppm in black scented rice samples received from North Eastern regions of India. The Copper (Cu) content ranges from 0.022 ppm to 1.826 ppm in black scented rice samples.

**Table 3. Level of Copper (Cu) in ppm in black scented rice samples obtained from north eastern regions of India**

| S.No | Copper (Cu) content (ppm) | S.No | Copper (Cu) content (ppm) | S.No | Copper (Cu) content (ppm) | S.No | Copper (Cu) content (ppm) |
|---|---|---|---|---|---|---|---|
| 1 | ND | 22 | 0.066 | 43 | 0.377 | 64 | 1.397 |
| 2 | ND | 23 | 0.068 | 44 | 0.382 | 65 | 1.465 |
| 3 | ND | 24 | 0.075 | 45 | 0.402 | 66 | 1.469 |
| 4 | ND | 25 | 0.076 | 46 | 0.403 | 67 | 1.491 |
| 5 | ND | 26 | 0.076 | 47 | 0.416 | 68 | 1.495 |
| 6 | 0.022 | 27 | 0.077 | 48 | 0.421 | 69 | 1.508 |
| 7 | 0.028 | 28 | 0.087 | 49 | 0.519 | 70 | 1.51 |
| 8 | 0.035 | 29 | 0.088 | 50 | 0.566 | 71 | 1.574 |
| 9 | 0.037 | 30 | 0.089 | 51 | 0.641 | 72 | 1.583 |
| 10 | 0.038 | 31 | 0.097 | 52 | 0.832 | 73 | 1.601 |
| 11 | 0.041 | 32 | 0.099 | 53 | 0.832 | 74 | 1.648 |
| 12 | 0.044 | 33 | 0.114 | 54 | 0.848 | 75 | 1.682 |
| 13 | 0.049 | 34 | 0.12 | 55 | 0.932 | 76 | 1.699 |
| 14 | 0.056 | 35 | 0.127 | 56 | 1.156 | 77 | 1.704 |
| 15 | 0.057 | 36 | 0.143 | 57 | 1.187 | 78 | 1.756 |
| 16 | 0.058 | 37 | 0.151 | 58 | 1.192 | 79 | 1.761 |
| 17 | 0.058 | 38 | 0.152 | 59 | 1.234 | 80 | 1.766 |
| 18 | 0.059 | 39 | 0.157 | 60 | 1.276 | 81 | 1.787 |
| 19 | 0.06 | 40 | 0.161 | 61 | 1.357 | 82 | 1.802 |
| 20 | 0.062 | 41 | 0.168 | 62 | 1.395 | 83 | 1.821 |
| 21 | 0.065 | 42 | 0.185 | 63 | 1.397 | 84 | 1.826 |

ND- Not detected and may be taken as "0".

## DISCUSSION

### Lead

The permissible level for Lead (Pb) as per FSSAI (Food Safety and Standards Authority of India) under category "foods not specified" in India is 2 ppm (max). In black scented rice, the maximum Lead content (Pb) was 0.419 ppm which was found to be within the permissible limit. Hence all the samples of black scented rice analysed were safe for human consumption with respect to Lead (Pb) content.

Tegegne et al., 2017[7] determined the levels of selected metals in commercially available rice in Ethiopia. They reported that level of Lead (Pb) ranges from 0.8 ± 0.07 ( mean ± SD) mg/kg in Ethiopian red rice followed by 2.1 ± 0.1 (Royal rice), 3.3 ± 0.2 (Ethiopian white rice), 3.8± 0.3 (NERICA Rice), 4.2 ± 0.4 (Jasmine rice) to maximum of 5.3± 0.7 mg/kg in Basmati Rice respectively. Similarly, the Lead content level was found to be reported as "Not detected" in Saban rice from Malaysia [8], 0.01 mg/kg in Taiwan rice from Taiwan [9] and 2.95 mg/kg in Super Basmati

Rice and 2.89mg/kg in Shahee Basmati Rice from Pakistan [10] respectively. Moreover, the lead content in 50 species of rice was determined by Xie et al., 2016 [11] ranged from 0.41 ± 0.01 to 0.49 ± 0.01 mg/kg which are similar to the maximum limit of lead in present study.

The Lead (Pb) content of Black Scented Rice in the present study was within the permissible limits as defined by the Indian legislation. Hence, it does not pose a serious health risk. Black scented rice samples analysed from North Eastern regions of India may not produce health risk for human consumption, if other sources of toxic metals contaminated food are not taken.

### Copper

The permissible level of Copper (Cu) as per FSSAI under category "foods not specified" is 30 ppm (maximum) in India. In black scented rice, the maximum Copper content (Cu) was 1.826 ppm which was found to be within the permissible limit. Hence all the samples of black scented rice samples analysed were safe for human consumption with respect to Copper (Cu) content.

Tegegne et al., 2017**(7)** determined the levels of selected metals in commercially available rice in Ethiopia. They reported that level of Copper (Cu) ranges from 2.7 ± 0.09 ( mean ± SD) mg/kg in Jasmine rice followed by 3 ± 0.2 (Basmati rice), 3.3 ± 0.2 (Ethiopian red rice), 3.6± 0.01 (NERICA Rice), 4.9 ± 0.3 (Royal Rice) to maximum of 15± 1.3 mg/kg in Ethiopian red Rice respectively. Similarly, the Copper (Cu) content level was found to be reported as 0.312 mg/kg in Saban rice from Malaysia [8], 2.22 mg/kg in Taiwan rice from Taiwan [9] and 0.93 mg/kg in Super Basmati Rice and 1.08 mg/kg in Shahee Basmati Rice from Pakistan [10] respectively. Moreover, the Copper content in 50 species of rice was determined by Xie et al., 2016 [11] ranged from 3.4 ± 0.32 to 9.15 ± 0.05 mg/kg.

The copper (Cu) content in Black Scented Rice in the present study was within the permissible limits as defined by the Indian legislation. Hence, it does not pose a serious health risk. Black scented rice samples analysed from North Eastern regions of India may not produce health risk for human consumption, if other sources of toxic metals contaminated food are not taken.

## CONCLUSION

Screening of 84 samples of Black Scented Rice received from North eastern regions of India revealed that all the samples were found to contain Lead (Pb) and Copper (Cu) within the permissible limit as specified by Indian legislation. In view of this, it has been concluded that consumption of Black Scented Rice may not produce any health risk for human consumption, if other sources of toxic metals contaminated food are not taken.

### Acknowledgments

We would like to express our sincere gratitude to Shri P.K. Swain, Joint Secretary- cum-Agricultural Marketing Adviser to the Govt. of India and all the Staffs of Central Agmark Laboratory and Regional Agmark Labratories have been source of constant inspiration to us. We would like to express our gratitude to Regional Office, Gauwahi and Sub-office Shillong to collect and provide the samples of black scented rice for analysis. The views expressed in the manuscript are that of authors and not binding on the Government of India.

## REFERENCES

[1]. Godber JS, Wells JH- Rice Bran: as a viable source of high value chemicals. *Louisiana Agriculture*. 37(2), 1994, 13-17.

[2]. Min B, Gu L, McClung AM, Bergman, CJ, Chen M- Free and Bound Total Phenolics, Procyanidin and Anthocyanins Profiles and Their Antioxidant Capacities in Whole Grain Rice (*Oryza Sativa* L) of Different Bran Colors. *Food Chemistry*. 133, 2012, 715-722.

[3]. Das KR, Medhabati K, Nongalleima K and Devi HS- The potential of Dark Purple Scented Rice-From Staple Food to Nutraceutical. *Current World Environment*. 9(3), 2014, 867-876.

[4]. Gilbert J- Analysis of Food contamination. *Vol 1 Elsevier App. Sci. Puplishers, London*. 1984

[5]. Zakrzewski S F- Principal of environmental toxicology. In: ACS professional Reference Book vol 1. ACS, Washington, DC, 1991.

[6]. Kennish MJ- Ecology of Estuaries: Anthropogenic Effects. *CRC Press, Boca Raton. USA*. 1992, 494

[7]. Tegegne B, Chandravanshi BS and Zewge F- Levels of selected metals in commercially available rice in Ethiopia. *International Food Research Journal*. 24 (2), 2017, 711-719.

[8]. Yap DW, Adezrian J, Khairiah J, Ismai BS and Ahmad-Mahir R- The uptake of heavy metals by paddy plants (*Oryza sativa*) in Kota Marudu, Sabah, Malaysia. *American Eurasian Journal of Agriculture and Environmental Science.* 6, 2009, 16-19.

[9]. Lin HT, Wong SS and Li GC- Heavy metal content of rice and Shellfish in Taiwan. *Journal of Food and Drug Analysis*. 12, 2004, 167-174.

[10]. Mehdi SM, Abbas G, Sarfraz M, Abbas ST and Hassan G- Effect of industrial effluents on mineral nutrition of rice and soil health. *Pakistan Journal of Applied Science*. 3, 2003, 462-473.

[11]. Xie WJ, Lei Che, Guang YZ, Yang LN and Hu MY- The bioconcentration ability of heavy metal research for 50 kinds of rice under the same test conditions. *Environ. Monit. Assess*. 188, 2016, 675. DOI 10.1007/s10661-016-5660-1.