

A Study on Heavy Metal Content In Rice Flour In India

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Abstract- Rice flour, a staple in Asian diets, offers health benefits like high fiber content and gluten-free nature. However, fungal contamination can lead to aflatoxin formation, posing health risks. Heavy metal exposure has surged, primarily through dust adhering to edible plants. Despite rice flour's importance, research on aflatoxin and heavy metal content is scarce. This study evaluated lead (Pb) and copper (Cu) concentrations in 35 rice flour samples from diverse Indian regions. Lead (Pb) content ranged from 0.0522 ppm to 2.4385 ppm, with 33 samples within FSSAI's permissible limits but two exceeding them. Copper (Cu) content varied from 0.0242 ppm to 6.9843 ppm, all within FSSAI's specified limits. The findings confirm rice flour's safety for consumption, with lead (Pb) and copper (Cu) concentrations within FSSAI's prescribed safe limits across all sampled regions in India.

Key words: Rice flour; heavy metal; Atomic absorption spectrometry; Lead (Pb), Copper (Cu).

1.INTRODUCTION:

Rice flour is made by grinding whole kernels and or broken rice kernels recovered from the milling process into a powder. Rice flour may be made from either white rice or brown rice. Rice is the main staple food in Southeast and Northeast Asia. China, India, Indonesia, and Bangladesh have the highest levels of rice consumption and use of its flour. In the 1980's, it was introduced to the Western world, and they used it as a primary ingredient in many processed foods in the baking industry. Of the world's total rice production, 90% is grown and consumed in Asia [1]. Rice flour is used as an alternative to wheat flour in gluten-free baked goods. Bread produced from it may have lower loaf volume, harder texture, and shorter shelf life [2]. It is important to use it in combination with other flours, starches, gums, and enzymes to help mimic the gluten matrix. Using rice flour with these ingredients will improve water absorption. It has a water absorption of 42.9–60.7% based on dough weight [2]. Higher water absorption levels indicate a dough that is more elastic. Adding hydrocolloids at 2% to a rice flour formulation has shown an increase in water absorption to the 63.4–67% range [4].

Rice flour is high in fiber, gluten-free, and low in saturated fat, cholesterol, and sodium. It has less nutritional value than whole-grain rice or whole grain brown rice flour but is a significant source of manganese [3]. It has around 7–10% protein, 75–82% carbohydrates, and 0.7–1% fat [1]. Rice flour is enriched with vitamins and minerals to meet nutrient requirements. Rice flour is an important commercial commodity and used for preparation of various types of traditional home products such as cakes, idli, noodles, etc. It is now required for production of baby foods, extruded breakfast cereals and snack foods, as also pet foods. Besides, it is used in baking of breads, pan breads, waffles, pizza, muffins, biscuits and cookies wherever wheat cannot be used. It is also used as dusting flour for separating dough pieces, for pan release and to impart crispness [5]. One important reason for such use of rice flour is its non allergenic nature. There is a small proportion of the population who are allergic to wheat gluten. Rice is widely used in baking for such wheat-intolerant people, i.e., those suffering from coeliac disorder. Its non allergenic property also makes rice as one of the first cereals to be used in infant feeding [6].

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 (ceruloplatin), 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 Rice flour 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 [7,8,9].

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

2. MATERIALS AND METHODS:

2.1 Sample Collection

A total of 35 samples of rice flour were collected from various regions of India.

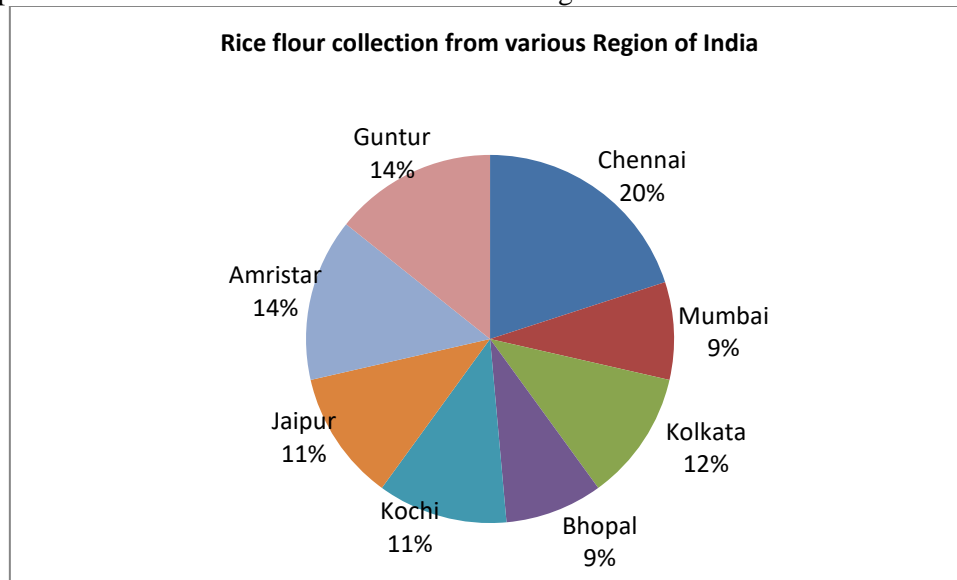


Figure-1 Rice Flour Collection from Various Region of India

2.2 APPARATUS AND REAGENTS

Atomic Absorption Spectrophotometer (Model AAS 7000SP), Microwave Digestion System (Model 3000, Anton Paar), Volumetric Flask (100 ml), Pipettes, Glass Funnels, Filter paper Whatman No.4 and Glass rods Concentrated HCl (AR Grade), Concentrated HNO₃ (AR Grade), Distilled water, Lead standard (99.99%) and Copper Standard (99.99%) were employed in the study.

2.3. SAMPLE PREPARATION AND DIGESTION:

0.1 g of homogenized rice flour sample was weighed and kept for digestion in Teflon vessel of microwave digester. 6 ml concentrated HNO₃ and 1 ml concentrated HCl was added to the sample. Vessels were left aside for 5 minutes to initial vigorous reaction. Teflon vessels were closed in position in Microwave Digestion System. Total 35 samples were digested in batches and made up as filtered solution in 100 ml volumetric flask. A reagent blank, sample blank, spike samples were prepared in the same manner as samples preparation and the solutions are properly labelled.

2.4 PREPARATION OF STANDARDS:

0.10 g of standards of lead (99.99%) and Copper (99.99%) powder was dissolved into 2 ml HNO₃: H₂O(1:1) solution dissolved separately in a 100 ml volumetric flask with distilled water for making stock standards of 1000ppm. Intermediate standard solutions of 100ppm and 5 nos. working standards were prepared along with the blank separately for both standards in a 100 ml volumetric flask.

2.5 ANALYSIS OF LEAD (PB) AND COPPER (CU) BY AAS:

The analytical conditions followed are indicated in Table -1

Table 1. Analytical Conditions of AAS 7000 SP for analyzing heavy metals in Rice flour

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

3 RESULTS AND DISCUSSION:

A total of 35 samples of Rice flour were analysed for the presence of Lead (Pb) and Copper (Cu) on AAS 7000 at Central Agmark Laboratory, Nagpur. The samples were received from various regions of India. Table 2 indicates Level of Lead (Pb) and Copper (Cu) in ppm respectively in Rice flour samples obtained from various regions of India.

3.1 Lead (Pb) content in Rice flour

The outcome of the analysis in 35 Rice flour samples indicated that 40 per cent (14 samples) were found contaminated with lead and 60% were not detected for lead as 3% (0.121 ppm) and 17.2 % ND from Chennai, 8.5 % (0.2855 to 0.4334 ppm) from Mumbai, 8.5% (0.1157 to 0.2408ppm) and 5.7% ND from Amristar, 5.7% (0.2095 to 1.2101) and 5.7% ND from Jaipur, 14.3%(0.1782 to 0.0532) and 8.6% ND from Guntur, 11.4% each from Kolkata and Kochi were not detected. The Lead (Pb) content of other 14 analysed Rice flour samples ranged from 0.0522 ppm to 2.4385 ppm.

3.2 Copper (Cu) content in Rice flour

It has been found that out of 35 Rice flour samples analysed, 25 samples were found positive for Copper (Cu) which ranged from 0.0242 ppm at Guntur region to 6.9843 ppm at Kochi region and rest of 10 samples were not detected as they read the values '0.0 ppm'. The percentage distribution of Copper contamination is 11.4 % (0.8395 to 1.4446 ppm) and 8.6 % ND from Chennai region, 8.6%(0.8229 to 1.6912 ppm) from Mumbai region, 11.4%(4.3594 to 6.9843ppm) from Kochi, 11.4%(2.9684 to 3.8462) from Kolkata, 8.6% (0.8114 to 1.0658 ppm) and 3% ND from Jaipur, 5.7%(0.1696 to 2.5540 ppm) and 8.6% ND from Amristar, 5.7% (0.0969 to 0.242 ppm) and 8.6% ND from Guntur.

Table 2. Level of Lead (Pb) and copper (Cu) in ppm in Rice flour samples obtained from various regions of India

S.No	Region	Lead (Pb) content (ppm)	Copper (Cu) content (ppm)
1	Chennai	ND	1.4446
2	Chennai	ND	1.0077
3	Chennai	ND	0.8395
4	Chennai	0.1210	0.8798
5	Chennai	ND	ND
6	Chennai	ND	ND
7	Chennai	ND	ND
8	Mumbai	0.4334	0.8229
9	Mumbai	0.3515	1.1234
10	Mumbai	0.2855	1.6912
11	Kolkata	ND	3.3042
12	Kolkata	ND	3.1513
13	Kolkata	ND	2.9684
14	Kolkata	ND	3.8462
15	Kochi	ND	6.9843
16	Kochi	ND	6.1704
17	Kochi	ND	6.4316
18	Kochi	ND	4.3594
19	Jaipur	ND	ND
20	Jaipur	1.2101	1.0658
21	Jaipur	ND	0.8114
22	Jaipur	0.2095	1.0052
23	Bhopal	2.4385	1.2072

24	Bhopal	0.5222	1.0173
25	Bhopal	0.2408	ND
26	Amristar	ND	ND
27	Amristar	0.2408	0.1696
28	Amristar	ND	ND
29	Amristar	2.0231	ND
30	Amristar	0.1157	2.5540
31	Guntur	0.1782	0.0969
32	Guntur	ND	0.1211
33	Guntur	ND	ND
34	Guntur	ND	ND
35	Guntur	0.0532	0.0242

ND- Not detected and may be taken as “0”.

5. CONCLUSION

The present study shows that all the samples for copper and 34 samples for lead are within the permissible limit as per FSSAI (Food Safety and Standards Authority of India) under category “foods not specified”, wherein 2 ppm (max) and 30 ppm (maximum) respectively in India. In Rice flour, the maximum Lead content (Pb) was 2.4385 ppm and Copper was 6.9843 ppm.

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