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A STUDY ON HEAVY METAL CONTENT IN MAIZE FLOUR IN INDIA

Agriculture

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ABSTRACT

Maize flour, a key cereal grain, lacks comprehensive reports on heavy metal content. This study assessed lead (Pb) and copper (Cu) concentrations in maize flour from diverse Indian regions. Among 31 samples, lead ranged from 0.0219 ppm to 1.8102 ppm, with 26 samples below detectable levels. Five samples met permissible limits set by the Food Safety and Standards Authority of India (FSSAI). Copper ranged from 0.0158 ppm to 8.0121 ppm, with 14 samples below detectable levels. All samples complied with FSSAI's permissible copper limit. Overall, the study concludes that maize flour from various Indian regions is safe for human consumption regarding lead and copper content, aligning with FSSAI guidelines.

KEYWORDS

Maize Flour; Heavy Metal; Atomic Absorption Spectrometry; Lead (Pb), Copper(Cu)

INTRODUCTION

Maize flour or Maize corn flour is a white free-flowing powder produced by wet milling of maize, followed by washing, concentrating, centrifuging, drying, milling and sifting to give a natural maize starch [1]. Maize is a domesticated grass that originated approximately 7000 years ago. Worldwide, 60–70% of maize production is used domestically as livestock feed, and the remaining 30–40% is used for production of items for human consumption [2]. Maize cultivation in india is widespread across several states in India, including Karnataka, Andhra Pradesh, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Bihar, and Telangana[3].

The production of maize is escalating as it was only 1.7 MT during 1950-51 to 14.7 MT during 2003-04 and it rose to 33.62 MT in 2021-22[4,5].

Maize, the third most consumed cereal after rice and wheat, serves as a vital source of food, forage, and industrial products globally. It is utilized in various forms like corn starch, syrup, oil, dextrose, flakes, gluten, grain cake, lactic acid, and acetone across industries such as textile, foundry, fermentation, and food. Its consumption has significantly risen in the poultry and livestock feed industries[6].

The annual maize consumption of the country was 29.33 MT[7] Maize meals and flours have smaller granulation than grits and are popular products because of their long shelf life, freedom from black specks, and bright color [8]. Corn flour made from the whole grain has about 13.4 g of dietary fiber per 100 g of flour [9]. Corn protein can form a viscoelastic dough, although it is not extensively connected. Corn flour has 9–10% protein, mostly as a series of zein proteins. These relatively low molecular weight proteins have a fair amount of α-helical and β-sheet secondary structure [10].

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) inMaize 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[11,12,13].

Therefore, it is necessary to study the heavy metal contamination in theMaize flour. The present study at Central Agmark Laboratory, Nagpur aims to identify the concentration of two heavy metals- lead and copper at maize flour collected from various regions of India.

2. METHODOLOGY:

2.1 Sample Collection:

31 maize flour samples from diverse Indian regions were collected. Samples collected from various region are indicated in figure-1

2.2 Apparatus And Reagents:

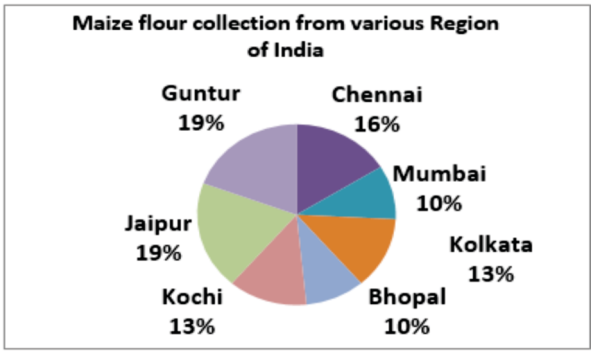
Analysis employed an Atomic Absorption Spectrophotometer (Model AAS 7000SP) and a Microwave Digestion System (Model 3000). Reagents included concentrated hydrochloric acid, nitric acid, lead standard (99.99%), and copper standard (99.99%).

2.3 Sample Preparation:

0.1g of each sample was weighed into Teflon vessels of the microwave digestion system. After adding concentrated nitric acid and hydrochloric acid, samples underwent a 50-minute digestion process. Solutions were cooled, filtered, and diluted to 100ml with distilled water.

2.4 Preparation Of Standards:

Stock standard solutions of 1000ppm for lead and copper were prepared, followed by intermediate solutions of 100ppm. Working standards with concentrations ranging from 0 to 6 ppm were prepared in 100 ml volumetric flasks.



2.5 Analysis Of Lead (pb) And Copper (cu) By Aas:

Maize flour samples underwent lead and copper analysis using Flame and air-acetylene AAS 7000 SP at the Central Agmark Laboratory, Nagpur.

Table 1 indicates the Equipment/Analytical conditions followed during the analysis of heavy metal contaminants like Lead and copper.

Table 1. Equipment/ Analytical Conditions of AAS 7000 SP for analyzing heavy metals contaminants in Maize 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:

The results of lead and copper contamination is indicated in Table-2

3.1 Lead (Pb) content in Maize flour

The lead contamination werenot detected in 83.2 % sample i.e. 26 out of 31 total analysed maize flour samples whichwere being collected from 16.1 % at Chennai , 3.2 % at Mumbai, 12.9 % at Kolkata, 3.2 % at Bhopal, 12.9 % at Kochi, 19.4 % at Jaipur and 16.1% at Guntur and rest 7 samples that is 16.2 per cent of maize flour samples contaminated with lead ranged between 0.0219ppm(Guntur region) and 1.8102ppm(Bhopal region).

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 the analysedMaize flour samples, the maximum Lead content (Pb) was 1.8102 ppm which was found to be in the permissible limit. Similar studies conducted atBairelly city, UP, India indicated lead contamination of 0.300±0.010ppm [14]. The study conducted at Mbrara city, Uganda showed lead contamination of maize milled through metallic mortar machines was 10.20± 0.000mg/kgand wooden mortarswere 0.55±0.01mg/kg[15]and at Tolon district, Ghana showed contamination of lead at milled maize samples 2.2177±1.1377mg/kg[16].

3.2 Copper (Cu) content in Maize flour

The copper contamination were not detected 45.2 % samplei.e. 14 out of 31 samples which were being collected from 9.7% at Chennai, 3.2 % at Mumbai, 6.5 % at Bhopal, 19.4 % at Jaipur, 3.2 % at Guntur. The 17 nos. (54.8%) samplesof maize flour contaminated with copper ranged between 0.0158ppm (Chennai region) and 8.0121ppm(Kochi region).

The permissible level of Copper (Cu) as per FSSAI under category "foods not specified" is 30 ppm (maximum) in India[18]. In Maize flour, the maximum Copper content (Cu) was 8.0121ppm which was found within the permissible limit. The study conducted at Mbrara city, Uganda showed copper contamination of maize milled through metallic mortar machines was 8.10±0.07mg/kg and wooden mortars were 0.50±0.07mg/kg[15] .

Table 2. Contamination of Lead and copper in ppm in maize flour samples from various regions of India

sample code No.	Region	Lead (Pb) content (ppm)	Copper (Cu) contant (ppm)
1	Chennai	ND	0.0158
2	Chennai	ND	ND
3	Chennai	ND	ND
4	Chennai	ND	0.3456
5	Chennai	ND	ND
6	Mumbai	ND	0.5178
7	Mumbai	0.1372	ND
8	Mumbai	0.1782	ND
9	Kolkata	ND	2.5763
10	Kolkata	ND	2.7908
11	Kolkata	ND	2.7441
12	Kolkata	ND	2.4535
13	Bhopal	1.8102	1.6993
14	Bhopal	0.0532	ND
15	Bhopal	ND	ND
16	Kochi	ND	8.0121
17	Kochi	ND	1.9787
18	Kochi	ND	5.1859
19	kochi	ND	6.5182
20	Jaipur	ND	ND
21	Jaipur	ND	ND
22	Jaipur	ND	ND
23	Jaipur	ND	ND
24	Jaipur	ND	ND
25	Jaipur	ND	ND
26	Guntur	ND	0.1211
27	Guntur	ND	0.4723
28	Guntur	ND	0.5571
29	Guntur	ND	0.2907
30	Guntur	0.0219	0.218
31	Guntur	ND	ND
*ND-Not Detected -0 ppm			

4. CONCLUSION:

The study found that lead and copper contamination in all maize flour samples collected from various Indian regions was within permissible limits set by FSSAI. According to Codex standards, the maximum lead level in cereal grains is 0.2 mg/kg[17]. Similarly, copper levels also met FSSAI standards. Indian food composition tables from the National Institute of Nutrition indicated no lead detection in dry maize, with copper levels within 0.45±0.23 mg/kg[19]. Thus, the study concludes that there is likely no contamination of lead and copper in maize flour samples, posing no health risks unless there is a threat of bioaccumulation.

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