

# Arsenic Concentration of Rice in Bangladesh

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## **Abstract**

*The total arsenic concentration of rice produced during 1998 winter to 1999 spring in arsenic contaminated village of Samta in Jessore and other uncontaminated areas in Bangladesh was measured. The arsenic concentration of rice produced in arsenic-contaminated area is 2 to 3 times higher than that produced in unaffected districts. The values of arsenic content of rice produced in Bangladesh and Japan were almost similar (0.1 to 0.3 ppm). It was concluded that the risk of chronic arsenic poisoning by the arsenic ingestion from rice is low.*

## **INTRODUCTION**

In Bangladesh, large-scale use of groundwater for irrigation began with the "green revolution", which was initiated 20 years ago. The production of rice increased significantly and this was mainly due to the increase in rice production during dry season with the use of groundwater irrigation. In recent years, groundwater in Bangladesh has been found to be contaminated by arsenic. The chronic arsenic poisoning by drinking tubewell water has become a national problem in Bangladesh. In the arsenic pollution areas, the possible presence of high concentration of arsenic in crops produced by arsenic contaminated irrigation water is a great concern.

The arsenic content of 67 samples of rice from Bangladesh and 30 rice samples produced in Japan were measured at the Fukuoka Institute of Hygiene and Environment under technical Cooperation on arsenic mitigation in Bangladesh with support from JICA. The rice samples were collected from both contaminated and uncontaminated areas of Bangladesh. The samples collected from uncontaminated areas were used as control.

## **METHODOLOGY**

### **Sampling Method**

A total of 21 samples (cleaned rice) were collected from Samta village of Jessore district, which is a highly arsenic contaminated area. Another 24 threshed rice samples were collected from around Rajshahi, Rangpur, Gaibandha and Tangail. The remaining 12 samples were collected from the Kitchen and markets of Dhaka and Rajshahi. A total of 30 rice samples were collected from the Fukuoka city by the Food Inspector during annual inspection.

### **Method of Analysis**

Threshed rice was cleaned with the home rice-cleaning machine for 5 minutes. 5ml of concentrated nitric acid and two boil stones are added and it is heated at aluminium block heater at 130°C and digested by wet method. If the liquid shows color, nitric acid is added further in small quantity and decomposition is continued.

If liquid becomes almost transparent, 1ml of sulfuric acid (conc.) is added, and the liquid is heated several hours to 16 hour at 160°C. Heating is continued until the liquid becomes transparent completely and white smoke arises, with the addition of nitric acid a little if needed. It is heated after cooling until white smoke arises again, in order to add 2ml of distilled water and to remove nitric acid completely. When digestion is complete, the sample is adjusted to 10 ml by adding distilled water for analysis by FIAS-AA.

### **Reagent**

60-62% dark nitric-acid: detrimental metal analysis grade(wako)  
95+% dark sulfuric-acid:detrimental metal analysis grade(wako)  
Arsenic Standard Liquid: As1000ppm (JCSS)  
NaBH<sub>4</sub>: Hydrogenation boron sodium: reagent grade  
35-37% HCl: Hydrochloric Acid: Arsenic analysis grade

**FIAS-AA Analysis Conditions**

Instrument: Perkin Elmer AAnalyst-100 +FIAS-100

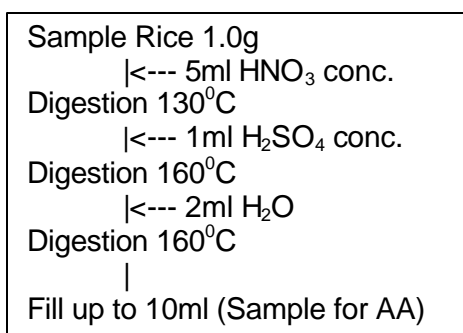
HCL: As 193.7 nm, 2nm Width

Carrier gas: Nitrogen

Expansion: x2

Recorder 500mv/ Fs

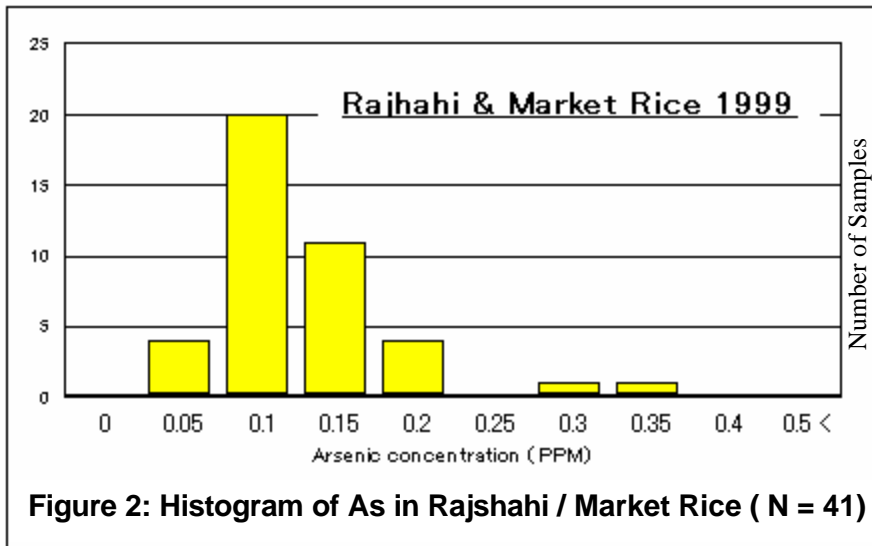
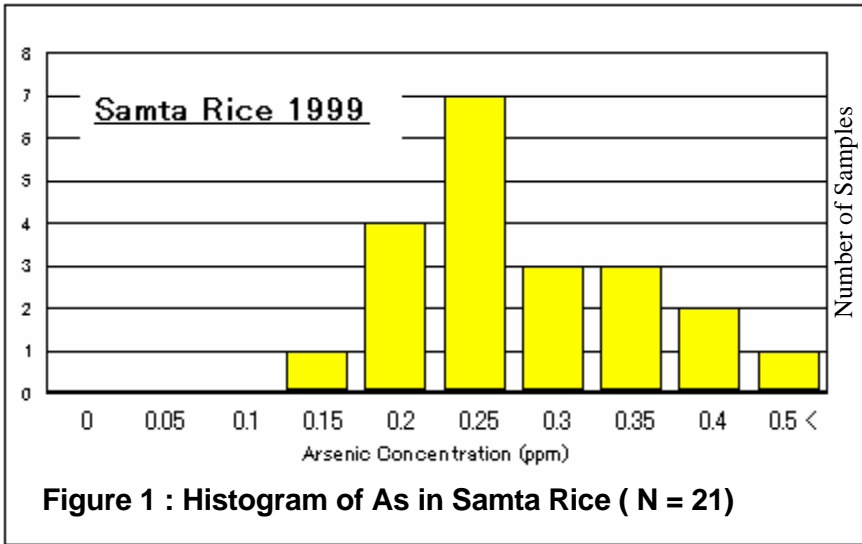
Carrier A: 10% (V/V) HCl

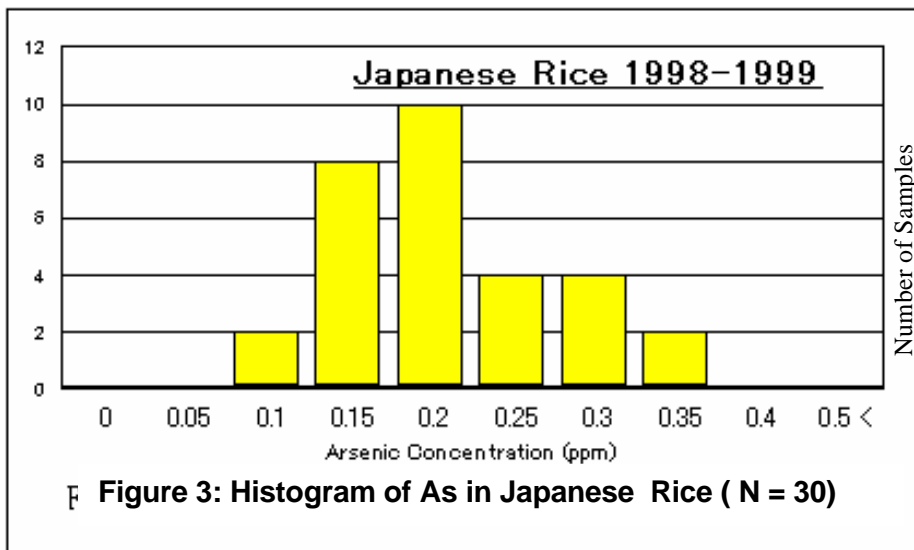
Carrier B: 0.5% NaBH<sub>4</sub> in 0.05% NaOH**Flow chart of As analysis of Rice****RESULTS AND DISCUSSION**

Arsenic concentration of rice produced in 1999 in Samta village, an arsenic contaminated area of Bangladesh is shown by histogram in Figures 1. Similarly arsenic content of rice collected from uncontaminated areas and market in Bangladesh is shown in Fig. 2. Arsenic Concentration of rice produced in Japan is shown in Fig. 3. No significant difference was found between average arsenic content of rice produced in Samta village and the rice produced in Japan. The arsenic concentration of rice of the arsenic contaminated soil was 2 to 2.5 times higher than average value of arsenic content in other areas of Bangladesh. One sample of rice produced in Samta village showed arsenic content as high as 0.94 ppm.

In order to understand the form of arsenic in rice, two samples (SM-16 and SM-17) were digested with the 2N-HCl after cooking with water and soluble Arsenic was measured. The residue was then digested with nitric-acid-sulphuric acid and total Arsenic were measured. This study indicated the proportion of soluble form of arsenic (inorganic arsenic) present in rice,

which is decomposed by acid present in stomach. The readily decomposed arsenic is absorbed within the stomach and intestines and the arsenic present in stable organic form is discharged with stool. About 40% - 50% of the total arsenic present in rice was found soluble.





**Table 1: Arsenic concentration of Rice produced in Samta, Jessore**

No.	As (ppm)	Producer Name	Type	Harvested	Area	THANA-Dist.	TW Use
SM01	0.16	Faruk Hassan	Amon	Oct.99	Northwest	Samta, Jessore	N/A
SM02	0.34	Babur Ali	IRRI	April 99	Northwest	Samta, Jessore	E
SM03	0.11	GolamMostofa	IRRI	April 99	Northwest	Samta, Jessore	Unknown
SM04	0.23	Sirajul Islam	IRRI	April 99	Southwest	Samta, Jessore	Unknown
SM05	0.22	Fazlul Karim	Amon	Nov. 98	Southwest	Samta, Jessore	N/A
SM06	0.18	Fazlul Karim	IRRI	April 99	Southwest	Samta, Jessore	F
SM07	0.36	Bazrul Rahma	Amon	Oct.99	South	Samta, Jessore	N/A
SM08	0.27	Bazrul Rahma	IRRI	April 99	South	Samta, Jessore	G
SM09	0.27	Md.Azizul Huq	IRRI	April 99	South	Samta, Jessore	F
SM10	0.19	Md.Azizul Huq	Amon	Oct.99	South	Samta, Jessore	N/A
SM11	0.24	Lutfur Rahma	Amon	Oct.99	Southwest	Samta, Jessore	N/A
SM12	0.21	Lutfur Rahma	IRRI	April 99	South	Samta, Jessore	F
SM13	0.22	Akbar Ali	IRRI	April 99	West	Samta, Jessore	A
SM14	0.32	Md.Sar Ali	IRRI	April 99	South	Samta, Jessore	H
SM15	0.18	Md.Solaiman	IRRI	April 99	South	Samta, Jessore	F
SM16	0.40	Faruk Hassan	IRRI	May 99	Northwest	Samta, Jessore	A
SM17	0.21	Tutul Mondol	IRRI	April 99	North	Samta, Jessore	C or D
SM18	0.31	Md.Ayubu Ali	IRRI	April 99	South	Samta, Jessore	Unknown
SM19	0.21	Md.Aynal Huq	IRRI	April 99	South	Samta, Jessore	F?
SM20	0.30	Daud Gazi	Amon	Dec. 98	Northwest	Samta, Jessore	N/A
SM21	0.94	Wazed Ali	IRRI	April 99	Samta bazar	Samta, Jessore	N/A

**Table 2a: Arsenic concentration of Rice produced in Rajshahi, Bangladesh(1999)**

No.	As ppm	Name of Farmer	Rice	Village Postoffice Thana District
RS01	0.13	Abdul jaliil	BR11	Teherpur Gopigram Sadullapur Gaibandha
RS02	0.08	Aminul Islan	BR11	Dashmowas Jahingar Pironj Rangpur
RS03	0.10	Gurudas	BR11	Turakamal Sandiapur Sadullapur Gaibandha
RS04	0.03	Md Shofikul Islam	Puragini	Shaigarigobindopur Dhaperhart Sadullapur
RS05	0.12	Nilatan	Paijam	Dulamitipur Panbazar Pironj Rangpur
RS06	0.11	Bablu Mija	BR11	Junidpur Sandiapur Sadullapur Gaibandha
RS07	0.14	Ohab Miah	BR11	Baradaudpur Gopigram Sadullapur Gaibandha
RS08	0.11	Ohab Miah	BR11	Baradaudpur Gopigram Sadullapur Gaibandha
RS09	0.09	GobindaChandraSarker	BR11	RowshanpurGopigram Pironj Rangpur
RS10	0.07	Md.Harum Miah	BR11	Mohenshapur Gagarbazar Sadullapur Gaibandha
RS11	0.10	Aauu Miah	BR11	Gobarkutubpur Panbazar Pironj Rangpur
RS12	0.07	Shar Afroz Alam	BR11	Mokimpur Fathapur-Laldhigi Pironj Rangpur
RS13	0.09	Rafiqul Alam	BR11	Monoharpur Jamalpur Sadullahpur Gaibanda
RS14	0.10	Sunil Chandra	Paijam	Amodpur Jahingirabad Pirgonji Rangpur
RS15	0.09	Matab Ali	Aman	DhanMojompur Ghatail Tangaik Ghatail Tangail
RS16	0.08	Md Nazrullslam Kharn	Paijam	Jhakai Chaithatta Chatail Tangail
RS17	0.08	Shobhan Sharkar	BR11	Dampara Modhupur Modhupur Tangail
RS18	0.07	Hazi Sakwat Hossain	Binni	Chaithatta Chaithatta Chatail Tangail
RS19	0.34	Tafsir Uddin	Chaina	Chaithatta Chaithatta Chatail Tangail
RS20	0.06	Halimuzzaman Khan	Biroi	Junkail Ghatail Tangaik Ghatail Tangail
RS21	0.14	Hasan Ali Toroxxx	Paijam	Rassulpu Chaithatta Chatail Tangail
RS22	0.10	Khalikur Rahman	BR11	Kharghata Shonkhola Ghatail Tangail
RS23	0.06	Mohammad Ali	Chapali	Chaithatta Chaithatta Chatail Tangail
RS24	0.05	Rafiqul Islam	Kalizira	Panzanal Porabari Nagbari Ghatail Tangail

**Table 2b: Arsenic concentration of market rice from Rajshahi and Dhaka (1999)**

No.	As ppm	Sample name	Rice	note	Market
HT01	0.09	motel Rajatan	long grain	white	Rajhahi
HT02	0.03	Hotel Abokasi	long grain	1999/04/18	Dhaka
HT03	0.05	No01 Hotel Abokashi	small grain	Dhaka	Dhaka
HT04	0.16	No01A Akhra Kitchin	white middle	long grain	Dhaka
HT05	0.06	No02A Akthar house	long grain	long grain	Dhaka
HT06	0.16	No02B Akthar Kitchin	small white	small white	Rajhahi
HT07	0.11	No02 Ralans Hamindarl	long grain	Prof.Hamidur	Rajhahi
HT08	0.12	No03 pavjam	long grain	Rajahi	Rajhahi
HT09	0.09	No04 katari	china?	rashahi	Rajhahi
HT10	0.28	No05 Market rice	long grain	long brwn	Rajhahi
HT11	0.13	No06 pari	Middle grain	Rajhahi	Rajhahi
HT12	0.15	No07 india	Middle grain	from india	Rajhahi
HT13	0.05	No08 RARUNI	Small White	Rajhahi	Rajhahi
HT14	0.10	No09 ratni	long grain	rashahi	Rajhahi
HT15	0.05	No10 Kalo	Short white	Rajhaahi K	Rajhahi
HT16	0.12	Pacc-kitcin	long grain	Hotel	Rajhahi
HT17	0.19	Dhinighura	long grain	Rajhahi	Rajhahi

The results of analysis of total arsenic concentration of 21 rice samples of Samta village are shown in Table-1, which represent rice from high-concentration arsenic pollution district. The results of analysis of the total arsenic concentration of 41 rice samples, collected from the market of Rajhahi and Dhaka are shown in Table 2a and Table 2b respectively. The result of arsenic analysis of 29 rice samples produced in Japan in 1998 and 1999 and one sample of California rice are shown in Table 3.

**Table 3: Arsenic concentration of Rice produced in JAPAN (1988-99)**

No.	As (ppm)	Sampling	Spices	Pref. / Province	
J98-E1	0.12	1999/07	hitomebore	akita	honsho-si
J98-E2	0.16	1999/07	hitomebore	iwate	ichinoseki-si
J98-E3	0.17	1999/07	hohoemi	fukuoka	yame hosino-mura
J98-E4	0.17	1999/07	yumetukusi	fukuoka	asakura
J98-E5	0.10	1999/07	akitakomachi	akita	yamamoto-gun
J98-H1	0.15	1999/07	hohoemi	fukuoka	kuroki
J98-H2	0.18	1999/07	hinohikari	kagosima	isa
J98-H3	0.27	1999/07	hinohikari	yamaguchi	kikukawa
J98-H4	0.12	1999/07	kirara397	hokkaido	kitaryuu
J98-H5	0.07	1999/07	kosihikari	kumamoto	aso
J98-S1	0.14	1999/07	hinohikari	fukuoka	fukuokacity motooka
J98-S2	0.13	1999/07	Shonaimai-haenuki	yamagata	tsuruoka city
J98-T1	0.32	1999/07	aigamo-genmai	kumamoto	kuma-gun
J99-E1	0.25	1999/11	hitomebore	miyagi	tunoda-si
J99-E2	0.31	1999/11	kosihikari	shimane	izumo
J99-E3	0.20	1999/11	akitakomachi	akita	oogata-mura
J99-E4	0.16	1999/11	yumetsukusi	fukuoka	tagawa
J99-E5	0.21	1999/11	akitakomachi	akita	yamamotogun81machi
J99-E6	0.15	1999/11	hitomebore	miyagi	furukawa
J99-H1	0.26	1999/11	akitakomachi-2nd	akita	senhoku-gun
J99-H2	0.20	1999/11	kosihikari-2nd	niigata	kashiwazaki
J99-H3	0.21	1999/11	kosihikari-1st	toyama	toyama-si
J99-H4	0.19	1999/11	kosihikari-2nd	shimane	iishi gun kakeai-cho
J99-H5	0.23	1999/11	yumetsukusi-1st	fukuoka	kaho
J99-J1	0.18	1999/11	akitakomachigenmai	akita	akita
J99-J2	0.26	1999/11	yumetsukusi	fukuoka	buzen-si
J99-M1	0.08	1999/11	akitakomachi	akita	akita
J99-M2	0.14	1999/11	hitomebore	miyagi	N/A
J99-M3	0.11	1999/11	california	USA	california
J99-M4	0.19	1999/11	neo-genmai	chiba	nodashi
MO-1	0.08	RS01-Abdull Jalil		shell	Rajhahi
MO-2	0.05	RS12-br11		shell	Rajhahi
MO-3	0.04	RS22-Khalikur Rahman		shell	Rajhahi

## **CONCLUSIONS**

The arsenic concentration of rice produced in polluted area of Bangladesh was about 0.3 mg/l, which is 2 to 3 times higher than the arsenic content of rice produced in a non-polluting district. There was no difference in As concentration of rice produced in Japan and in polluted area of Bangladesh. The arsenic content of rice of Bangladesh is not considered to be the concentration of greater health concern. Although one rice sample produced in contaminated Samta village showed high arsenic content (0.94 ppm), which need further investigation. This rice of higher arsenic content can be blended with rice of lower arsenic content to reduce arsenic ingestion.