



Chemical Contamination in Date Fruits Collected During Ramadan from Different Markets of Dhaka North City, Bangladesh

RAUSAN ZAMIR^{1,*}, NAZMUL ISLAM^{2,3}, SHARMIN PARVIN³, SAFIUR RAHMAN⁴, M. OMAR FARUQUE³, MD. ALI ASRAF¹ and M. ZAKARIA¹

¹Department of Chemistry, University of Rajshahi, Rajshahi, Bangladesh

²Department of General Educational Development, Daffodil International University, Dhaka, Bangladesh

³Department of Nutrition and Food Technology, Jessore University of Science and Technology, Jessore, Bangladesh

⁴Chemistry Division, Atomic Energy Commission, Dhaka, Bangladesh

*Corresponding author: E-mail: rsnzamir@gmail.com

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Assessment of toxic metals in date fruits collected during Ramadan from different market sites within Dhaka city of Bangladesh have been carried out. Detection of toxic metals like Zn (0.07-0.15 mg/100 g), Cu (0.08-0.28 mg/100 g), Mn (0.80-1.25 mg/100 g) and Fe (0.54-1.90 mg/100 g) were found within safety limit for consumption with respect to international regulatory body.

Keywords: Toxic metals, Date and Health safety.

INTRODUCTION

Date fruits are rich nutritious sources of human diet and fruits from date palm contains vitamins (C, B1 and B2), fight cancer, boost immunity against viral diseases and provide antioxidant activities [1-6]. For Muslims, dates are of religious importance and customarily used to break the day long fast with dates during the holy months of Ramadan. Several authors [7-10] reported the nutritive compositions of dates palm (*Phoenix dactylifera* L.). Along with the nutritive values (crude protein, crude fat, essential amino acids), dates have strong antioxidant [11], anticancer [12] and antiviral [13] activities.

Dates also constitute some macro-minerals [7], which are essential to human health. Trace elements are very important for cell functions at biological, chemical and molecular levels. These elements have the ability to deposit in various organs in human body, which possess a great threat to human health. As alertness of the risk of heavy metal pollution in food chain increases national and international regulations on food quality have lowered the maximum acceptable levels of toxic metals in food items has taken this issue very seriously. Therefore, monitoring and assessment of toxic metal concentrations in the date fruits from the market sites have been carried out in some developed and developing countries [14,15].

Concerns have been raised on air quality of Dhaka city. Traffic congestion and automobile exhaustion is in rise, rapid urbanization is fueling brick production and brickfields in the outskirts of Dhaka city emitting toxic metals with gases in alarming quantity and reckless housing of welding workspaces have directly injecting metal particles into surroundings [16]. In this settings, dates are sold and date consumption uplifts during Ramadan. As a result, possibility of chemical contamination due to toxic metals in date fruit selling in open air increases. Unlike, other common fruits, dates are not usually subjected to washing before consumption. So any chances of heavy metal contamination either from raw materials, processing and environment sources is highly concerning. Another investigation regarding the presence of microbial contaminations in date samples from different outlets of Dhaka city were also investigated [17]. However, no studies were carried out on heavy metal determination in date fruit in Bangladesh. Henceforth, in this work, analysis of some toxic metals with some specific macro and micromineral contents of different types of dates available in the markets of Dhaka city of Bangladesh was conducted.

EXPERIMENTAL

Samples collection: As Bangladesh is not a date producer, here year long and especially during Ramadan, date is imported

from predominantly middle-east countries. In this investigation, popular date samples were purchased from different local outlets of Dhaka city during Ramadan (May- July 2018) as during this tenure most date entered markets and outlets of Dhaka city.

Sample collection zone have been selected on the basis of date fruit selling hotspots as those places were densely populated. Open market and kitchen markets were everywhere heterogeneously distributed. Retailers selling date fruits without commercial packaging and labelling. Date of expiry was not provided. From collection points, date samples were poured in zipper bags and labeled as the collection point code and the variety of dates. Samples were directly transported to Atmospheric Chemistry Research Lab, Bangladesh Atomic Energy Commission (BAEC), Dhaka lab for toxic metal analysis.

Sample preservation: Date samples were packed into zipper bags to avoid further contamination. Additional date sample were kept in the refrigerator for further experiments. During the sampling techniques all the requisite care was exercised.

Sample preparation: X-ray fluorescence (XRF) technique was employed to determine the amount of toxic metals, macro and micro minerals in date samples. Preserved sample were deseeded and kept into the petri-dish. Further each sample was spread by spatula into the petri-dish. Then the samples were dried in an oven at 80 °C, 8 h for one week and finally ashed by muffle furnace for 8 h at 600 °C. Then the ashed samples were grinded for making powder using carbide mortar and pestle.

Considering the sensitivity of assessment, the accuracy and precision of the XRF analysis were tested by analyzing repeatedly the certified reference materials SRM 1571 (trace elements in Orchard leaves, National Bureau of Standards Certificate of Analysis, USA). Here, replication was 3 for all certified reference materials (Pb, Mn, Cu, Zn, As, K, Fe and Co) and mean value was calculated. Replication was done in same day, therefore the precision was intraday. The results for the recoveries varied between 90.60% and 103.20% (Table-1), which showed satisfactory precision of measurement between the measurement and certified values.

TABLE-1
ANALYTICAL RESULTS OBTAINED ON
CERTIFIED REFERENCE MATERIALS

Certified reference material		XRF assessment (µg/g)		
Element	Certified value	Mean measured value (n = 3, intraday)	Recovery (%)	Accuracy (%)
Pb	45	43.02	95.60	-4.40
Mn	91	85.28	93.71	-6.29
Cu	12	10.87	90.58	-9.42
Zn	25	25.8	103.20	3.20
As	10	9.06	90.60	-9.40
K	2079	2090	100.53	0.53
Fe	300	305.02	101.67	1.67
Co	0.20	0.21	105	5.00

Human health risk assessment: Human health risk assessment was done for avoiding adverse health impact poses by

date consumption in terms of toxic metals. Here we used the following self-developed formula for human health risk which is the ratio of ceiling (mg/day) to per capita date fruit consumption (g/day). Human health risk value below 1 indicates risk and possible adverse health impact with date fruit consumption and human health risk value more than 1 indicates safety and the more value, the more ease of safety from adverse effect.

$$\text{Ceiling (mg/day)} = \frac{\text{Upper intake level (mg/day)}}{\text{Max. conc. in date sample (mg/100 g)}} \quad (1)$$

$$\text{HHR} = \frac{\text{Ceiling (g/day)}}{\text{Per capita date fruit consumption (g/day)}} \quad (2)$$

where, HHR = human health risk.

RESULTS AND DISCUSSION

In this study, all the date samples contained potassium abundantly. Concentrations of potassium in all samples were higher than the other elements present in all the date fruits and the results of concentrations were compared with the Dietary Reference Intake (DRI) [18]. The DRI value for potassium is 4700 mg/day [19]. Recommended potassium diet reduces the risk of stroke and other heart diseases. On the contrary, high potassium intake can affect patients with chronic kidney diseases because their kidneys can no longer remove excess potassium (Table-2).

Among the macro-minerals, calcium was present in highest concentrations in Modina varieties and lowest concentrations in Dhapash brands. Calcium containing fruits can help patients suffering from high blood pressure, heart attack, premenstrual syndrome, colon cancer, weak bones and risks of osteoporosis in old age. The recommended DRI value for calcium is 1000 mg/day [19]. The tolerable upper intake level of calcium for adults is 2500 mg/day. However, maximum calcium containing date fruit Modina variety from Mohammadpur (2576.5 g) can be consumed daily with safety if none other sources providing calcium consumed. This estimation of upper limit was compared with per capita date consumption (100 g wet wt./person/day, whereas average body weight of a healthy person is considered 71 kg) [20]. This large ceiling of upper limit (25 times than per capita daily consumption) (eqn. 2) fits date fruits safe to consume while considering values of calcium.

In present study, the highest concentration of iron value was present in Khurma, collected from Mirpur market and lowest concentration was found in Dhapash, collected from New market. The DRI value all age groups of men and post-menopausal women is 8 mg/day and the RDA for premenopausal women is 18 mg/day. The tolerable upper intake level for adults is 45 mg/day of iron, a level based on gastrointestinal distress as an adverse effect [19]. With this estimation, 23,684 g of maximum iron containing date fruit Khurma variety from Mirpur (Table-2) can be consumed daily with safety if none other sources are providing iron the day of Fe taking from other sources. This estimation of upper limit consumption was compared with per capita date consumption (100 g wet wt./person/day) [20] and found the ceiling was 236 times higher than daily consumption of date fruits (eqn. 2). Therefore, daily consumption dates in terms of iron would definitely be safe.

TABLE-2
PRESENCE TOXIC METAL CONTENT IN DATE FRUIT SAMPLES COLLECTED
FROM DHAKA CITY, BANGLADESH (MAY-JUNE 2018)

Sampling region	Local name	Toxic metal concentration (mg/100 g)									
		K	Ca	Fe	Mn	Co	Ni	Cu	Zn	As	Pb
Uttara	Boroi	181.81	43.41	0.98	0.85	< BDL	< BDL	0.12	0.10	< BDL	< BDL
Uttara	Dhapash	106.92	29.88	0.58	0.80	< BDL	< BDL	0.10	0.10	< BDL	< BDL
Mohammadpur	Morium	274.25	49.48	0.69	0.88	< BDL	< BDL	0.15	0.10	< BDL	< BDL
Mohammadpur	Modina	311.11	97.03	1.23	1.24	< BDL	< BDL	0.08	0.11	< BDL	< BDL
Mohammadpur	Forida	300.07	80.78	1.39	1.09	< BDL	< BDL	0.18	0.12	< BDL	< BDL
Mohammadpur	LalBoroi	318.96	74.73	0.88	0.85	< BDL	< BDL	0.10	0.08	< BDL	< BDL
Mohammadpur	Teunesia	334.62	62.90	0.85	0.85	< BDL	< BDL	0.11	0.07	< BDL	< BDL
Mohammadpur	KaloBoroi	343.75	62.14	0.90	1.10	< BDL	< BDL	0.12	0.07	< BDL	< BDL
Mohammadpur	Razij	336.41	63.75	1.03	0.88	< BDL	< BDL	0.10	0.07	< BDL	< BDL
Karwan Bazar	Dhapash	212.66	42.81	0.97	1.07	< BDL	< BDL	0.11	0.07	< BDL	< BDL
Karwan Bazar	Khurma	276.45	56.93	0.91	1.25	< BDL	< BDL	0.15	0.12	< BDL	< BDL
Karwan Bazar	Morium	357.35	86.80	1.73	1.08	< BDL	< BDL	0.17	0.13	< BDL	< BDL
Mirpur	Razij	286.62	66.82	0.90	0.85	< BDL	< BDL	0.11	0.10	< BDL	< BDL
Mirpur	Dhapash	366.70	66.63	1.00	1.09	< BDL	< BDL	0.20	0.10	< BDL	< BDL
Mirpur	Khurma	416.50	96.02	1.90	1.09	< BDL	< BDL	0.28	0.15	< BDL	< BDL
Karwan Bazar	Forida	314.55	68.43	0.92	0.86	< BDL	< BDL	0.14	0.09	< BDL	< BDL
Karwan Bazar	Teunesia	313.26	57.79	1.00	0.89	< BDL	< BDL	0.20	0.09	< BDL	< BDL
Karwan Bazar	KaloBoroi	287.86	41.12	0.59	0.92	< BDL	< BDL	0.10	0.08	< BDL	< BDL
Karwan Bazar	LalBoroi	316.65	43.13	0.80	0.96	< BDL	< BDL	0.11	0.09	< BDL	< BDL
New Market	Teunesia	323.12	67.83	1.02	0.87	< BDL	< BDL	0.14	0.09	< BDL	< BDL
New Market	Dhapash	257.47	44.16	0.54	0.96	< BDL	< BDL	0.12	0.09	< BDL	< BDL
New Market	Iraqqi	350.66	82.30	1.43	1.10	< BDL	< BDL	0.20	0.13	< BDL	< BDL

BDL= Below detection limit

The highest concentration of manganese was observed in Khurma varieties, collected from Karwanbazar market and lowest concentration was present in Dhapash brand, collected from Uttara market. The DRI values of manganese for females and males are 1.8 and 2.3 mg/day, respectively [18]. The tolerable upper intake level for adults is 11 mg/day of Mn [19]. This computing states that date fruit of Khurma variety from Karwan Bazar, which contains maximum Mn (1.25 mg/100 g) can be consumed maximum 880 g (Table-2) with safety if none other sources having manganese consumed. This quantity of maximum consumption was compared with per capita date consumption (100 g wet wt./person/day) [20] and set the ceiling 88 times higher than daily consumption of date fruits (eqn. 2). As a result, daily consumption of manganese was considered safe through date fruits under investigation.

The highest concentration of zinc was observed in Khurma varieties, collected from Mirpur market and lowest concentration was present in Dhapash brand, collected from Karwan market. The recommended DRI values of zinc for males and females are 8 and 11 mg/day, respectively [19]. The tolerable upper intake level for adults is 40 mg/day for zinc [18]. The upper level value revealed that date fruit of Khurma variety from Mirpur contains maximum Zn (0.15 mg/100g) can be consumed maximum 26,666.70 g (Table-2). This consumption (26,666.70 g) was found 267 times higher than per capita date consumption (100 g wet wt./person/day) [20] (eqn. 2). Hence, daily consumption of dates was computed safe in terms of zinc.

The highest concentration of copper was found in Khurma varieties, collected from Mirpur market and lowest concentration was found in Modina varieties collected from Mohammadpur market. The tolerable upper intake level of copper for adults is 10 mg/day [19]. This value has been selected considering

protection from liver damage as the critical adverse effect. The upper limit value provides that date fruit of Khurma variety from Mirpur which contains maximum Cu (0.28 mg/100g) can be consumed maximum 3571.42 g (Table-2), 35 times higher than per capita consumption [20] with safety if date fruit was the only source of copper per day was taken (eqn. 2).

Overall findings of present investigation have been summarized in Fig. 1. Estimated amount of toxic metals have been converted into unity and safety limit per day consumption have been represented by times of respective metals. Fig. 1 revealed that in different date samples, the maximum concentrations of Ca, Fe, Mn, Zn and Cu were 25, 236, 88, 267 and 35 times below the ceiling beyond which adverse effect may developed. Presence of heavy metals viz. As, Pb, Co and Ni were not detected beyond the permissible limit in present investigation.

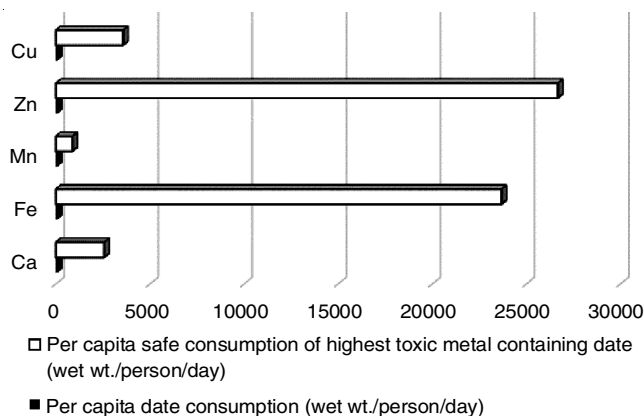


Fig. 1. Diagrammatic representation for safety consumption of date fruit in terms of toxic metals

Conclusion

Date fruits contain considerable amount of macro-minerals including potassium and calcium which have great nutritional value. It contains some micro-mineral which are also essential nutrients including iron, manganese, copper and zinc. The concentration of toxic elements including nickel, lead and arsenic present in date fruit within the safe limit for consumption. Even though the toxic metals present in date fruit within the permissible limit, consumption of the fruit after washing is recommended as human health safety measure.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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