

## The effect of normal treatment methods at home in the removal of heavy metals from surface of rice distributed in Riyadh region

Hanan F. A. AL-Harbi\*, Mashaal Makki Mohammed Aljaish, Nora Hamad Saad Aljhlfi

Department of Botany and Microbiology, College of Science, King Saud University, Riyadh, Saudi Arabia

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### ABSTRACT

Cleaning of rice with water with or without prior soaking may decrease the levels of heavy metals. The current study evaluated the efficacy of ordinary treatment techniques such as water washing in expelling the heavy metals found on the rice grains. Three varieties of rice were chosen: Abu Kass and Al Walimah from Riyadh area. Assessments were performed by Scanning Electron Microscopy (SEM). The two most common treatment techniques were washing a few times or after soaking for two hours. Diverse rates of heavy metals were present on the surface of rice grains of various types. A total of 15 different types of metals were found on the surface of samples with Zn, Cu, and Pb being present in all varieties of rice. Washing several times and soaking for two hours was effective in removing heavy metals from rice. However, important elements like Zn (15.9%), Mg (23.82%), K (22.05%) and Ca (16.75%) were lost to water after washing for several times. Interestingly, the concentrations of Hg and Pb were found to be high in Abu Kass rice (Hg: 19.7%; Pb: 13.4%); this can raise serious health concerns warranting further investigations. The presence of Pt in Abu Kass rice without washing (54.5%) and after washing several times (73.7%) is also a cause of concern. The results demonstrated the effectiveness of washing for several times and soaking for two hours to help in total dilution or removal of the elements. Soaking followed by washing may be more effective in removing more elements.

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### 1. Introduction

Rice (*Oryza sativa*) is one of the most important food types in the world. It is considered an essential and almost daily meal in many countries. Rice plays an integral part of the staple diet and, any contamination with xenobiotics raises serious health concerns. More recently, possible contamination of rice with heavy metals arising from numerous sources indicates one of the disadvantages of rapid industrialization. Amongst potential xenobiotic contaminants, heavy metal pollution has always been a major cause of concern (Duffus, 2003). Heavy metals such as Cd, Pb, Hg can accumulate on rice through air, water and food. Health implications of unwanted heavy metal exposure can cause toxicity wherein serious and fatal effects can be manifested if they are obtained in large quantities and exceed the

maximum dose, especially in pregnant women, cancer patients, and young people (Qu et al., 2012). The presence of heavy metals in rice even at trace levels needs to be given special attention owing to the potential health implications (Al-Saleh and Abduljabbar, 2017; Loutfy et al., 2006).

The release and accumulation of heavy metals due to rapid industrialization and the inability of heavy metals to undergo biological degradation causes their deposition in healthy tissues. Heavy metals, for example, Cd, Cr, Ni, and Hg, from mining, and wastewater discharge are regular contaminants of arable soil (Duffus, 2003; Qu et al., 2012; Pehlivan et al., 2009). These lethal substantial metals can be ingested and amassed by plants and in the long run enter the human body through sustenance admission. Sustenance utilization is the real introduction pathway, and presentation hazard from ingestion surpasses dangers from inward breath and dermal contact (Loutfy et al., 2006). A recent review (Jaishankar et al., 2014), indicated that most of the food pollution was due to heavy metals, amongst which, lead and cadmium were shown to be the most toxic. It is important to note that rice of obtained from certain countries were observed to have a

\* Corresponding Author.

Email Address: [hhanan@ksu.edu.sa](mailto:hhanan@ksu.edu.sa) (H. F. A. AL-Harbi)

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Corresponding author's ORCID profile:

<https://orcid.org/0000-0002-4653-8717>

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record of contamination in the fields (Al-Saleh and Abduljabbar, 2017; Zhao et al., 2015).

Many plant species have varying capacities to either remove or accumulate heavy metals; therefore, there are reports indicating that certain species may accumulate specific heavy metals, causing a serious risk to human health when plant-based foodstuffs are consumed (Fytianos et al., 2001). Substantial levels of heavy metals were found in sheltered rice obtained from China (Zhao et al., 2015). This indicates that the treatment processes employed for the removal of heavy metals plays a major role in diluting their concentrations. The usual process of cleaning of rice either without or with prior soaking has not been previously investigated to decrease the levels of heavy metals. The aim of this research was to therefore to investigate the effectiveness of the methods used in our homes to wash rice in removing the heavy metals from rice.

## 2. Methods

Collection of rice samples was performed in the Riyadh region of Saudi Arabia. All rice samples were obtained within the production time period of 2015-

2016. Based on the results of the survey, 44% use Abu Kass rice and 38% use Al Walimah rice. The rice varieties were produced in India. Each sample of rice was divided into three groups:

- Group I: Left without washing,
- Group II: Washed several times,
- Group III: Rice soaked for two hours

Rice samples were air-dried in the laboratory for several days at room temperature, and examined using a scanning electron microscope (G.E.O.L 76105 field emission SEM) to estimate the levels, type and percentages of various heavy metals on the surface of the samples (Espinosa-Mendoza et al., 2012; Batista et al., 2018; Echlin, 2011; Goldstein et al., 2007).

## 3. Results

Heavy Metal Concentrations on the surface of rice surface by weight (%): Heavy metal concentrations on the surface of rice samples along with SEM images are shown in Table 1 and Figs. 1-3.

**Table 1:** Heavy metals found in Al Walimah and Abu Kass rice

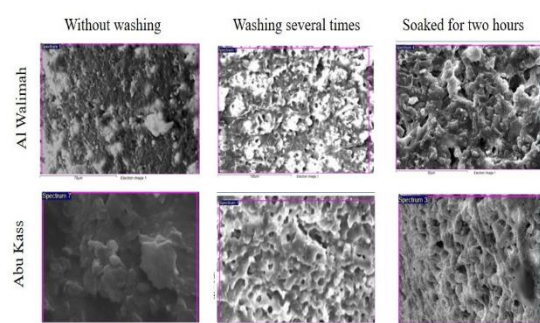
	Al Walimah			Abu Kass		
	Without washing	Washed several times	Soaked for two hours	Without washing	Washed several times	Soaked or two hours
Zn	17.8%		18.94%	3.3%	6.0%	39.45%
Mg	17.0%	11.00%	37.86%	-	-	-
Al	-	-	3.26%	0.2%	-	1.17%
P	6.0%	16.19%	7.83%	-	-	-
K	28.6%	24.54%	13.67%	-	-	-
Ca	-	-	12.61%	-	-	-
Ti	-	-	-	0.1%	-	-
Cu	30.3%	15.49%	17.34%	4.6%	7.0%	66.47%
As	-	-	-	1.9%	-	-
Cd	-	-	-	2.4%	-	1.59%
Au	-	-	-	-	-	-
Hg	-	-	-	19.7%	-	-
Pb	-	-	3.27%	13.4%	-	2.76%
S	-	32.79%	-	-	13.3%	-
Pt	-	-	-	54.5%	73.7%	-

The results showed that 15 types of metals were found at different rates on the surface of the investigated samples (Zn, Mg, Al, P, K, Ca, Ti, Cu, As, Cd, Au, Hg, Pb, S and Pt). Zn, Cu and Pb were present in all varieties of rice. Washing the rice for several times and prior soaking of rice for two hours was substantially effective in removing heavy metals. However, there was a loss in important elements like Zn (15.9%), Mg (23.82%), K (22.05%) and Ca (16.75%) after washing rice for several times. Moreover, the concentrations of Hg and Pb were found to be high in Abu Kass rice (Hg: 19.7%; Pb: 13.4%). Pt was found in Abu Kass rice without washing (54.5%) and after washing several times (73.7%).

Effective the methods washing and soaking to remove the Heavy Metals from rice surface:

Washing rice samples for several times was less effective than the soaking process for two hours for removing heavy metals. Furthermore, in Al Waleema

rice, a reduction of elements Mg K Cu was observed (prior to washing: 17.06 %, 28.67%, 30.33%; post washing: 11.00%, 24.54%, 15.49%), respectively. This process also caused the appearance of some new elements on the surface (Table 1; Figs. 2 and 3).



**Fig. 1:** Scanning electron microscopy images of Al Walimah and Abu Kass rice

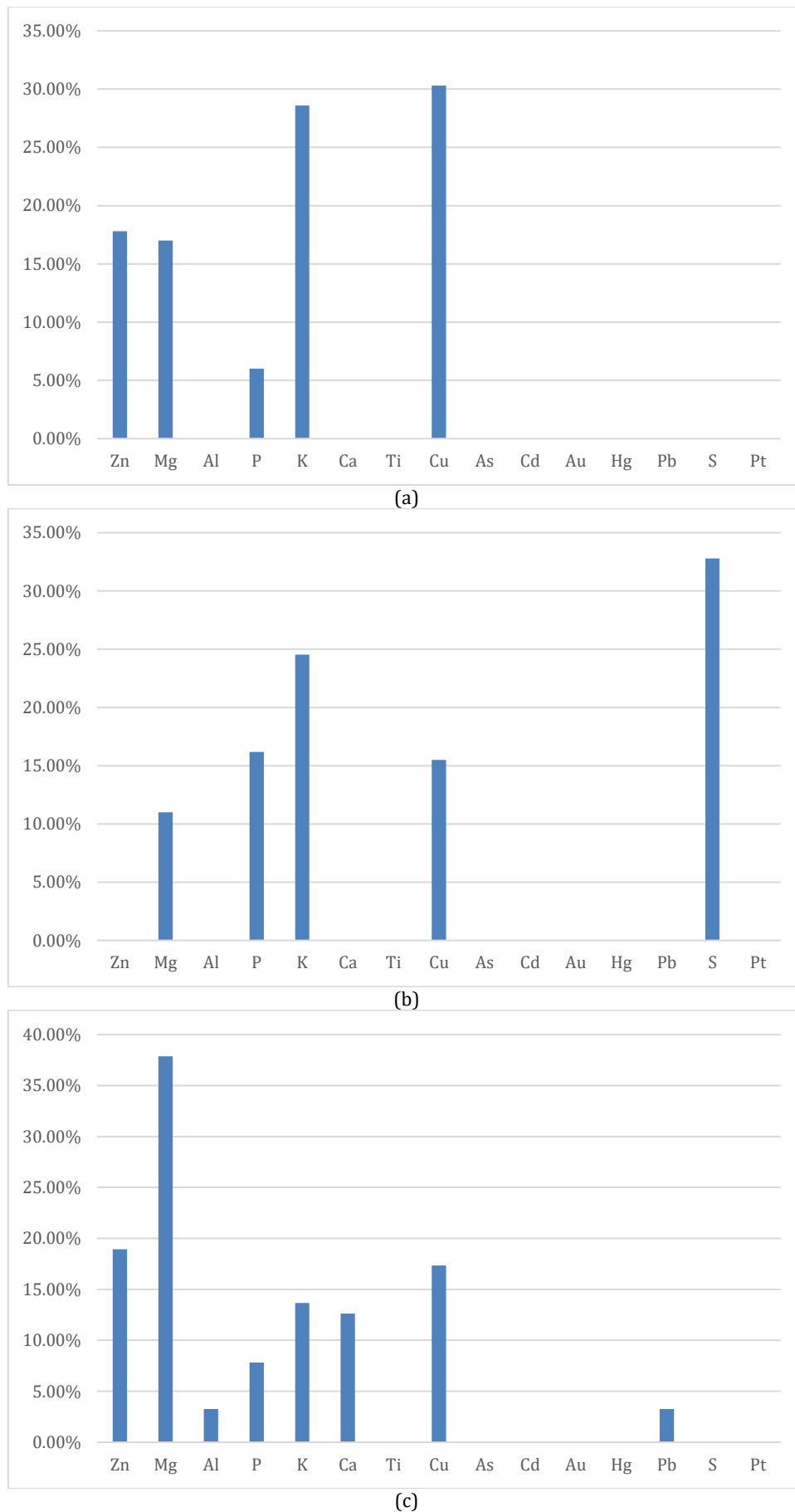


Fig. 2: Composition of heavy metals in Al Walimah rice (a) without washing, (b) after washing several times and (c) after soaking for two hours

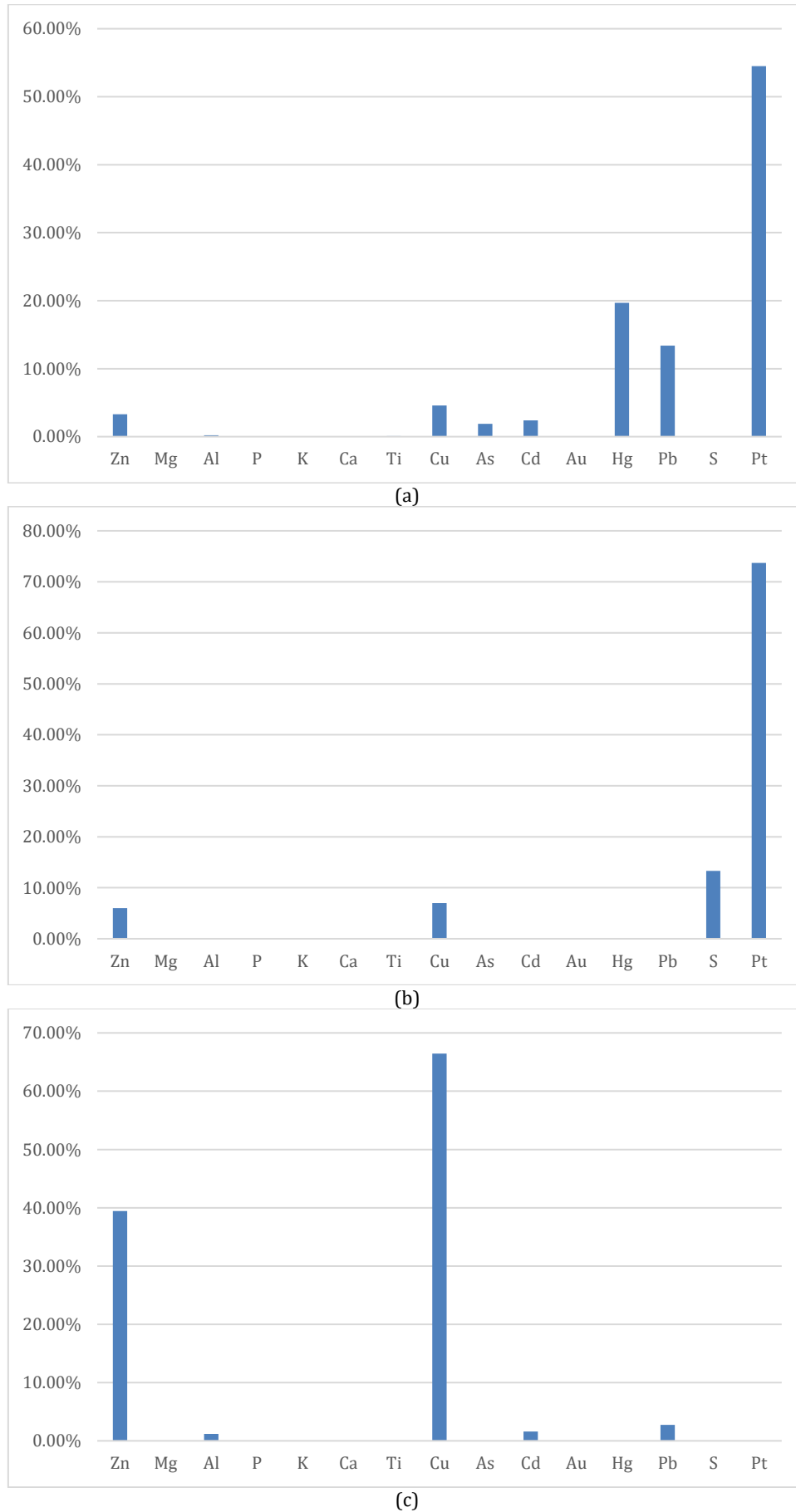


Fig. 3: Composition of heavy metals in Abu Kass rice (a) without washing, (b) after washing several times and (c) after soaking for two hours

#### 4. Discussion

In order to observe the potential health risk of pollutants in food, the route and level of exposure in target organisms needs to be estimated. While many possible pathways for xenobiotic exposure to humans exist, the food chain is the most important (Caussy et al., 2003). Owing to this, it is critical to make sure that xenobiotics such as heavy metals do not enter the food chain above a certain limit (Caussy et al., 2003; Balkhair and Ashraf, 2016).

The human hazard appraisal evaluation is of prime significance in nations, for example, Saudi Arabia, where the wastewater water system practice remains unregulated. Moreover, rice consumption has been distinguished as one of the significant sources of human exposure to poisonous heavy metals because of their aggregation in rice grains (Satpathy et al., 2014). The rice genotypes also additionally act as the main factors in influencing the transmission and bioavailability of heavy metals in the soil-rice system (Cheng et al., 2006; Zeng et al., 2008).

The current study was conducted to understand the effectiveness of routine washing procedures in removing heavy metals from the surface of three varieties of rice, viz., Abu Kass and Al Walimah. We showed that approximately 15 types of metals appeared at different rates on the surface of samples including some hazardous metals such as Hg, Pb, Cd Cu and Pt which can have potential adverse health implications on human health. Amongst all the heavy metals, we observed, Zn, Cu, Pb were found in all samples. Studies have reported that the levels of cadmium and lead in 50 different kinds of rice exceeded the contaminant limit. This could probably be related to the strong adsorption capacity for lead, which indicates the need to rethink about the currently designed control estimates (Wen-Juan et al., 2016). Cd and Pb are considered to be non-essential metals and causing many health risks, even at very low concentrations (Ikeda et al., 2000; Zhuang et al., 2009) and can cause physiological degradation such as mental retardation and impact vital functions (Mohanty et al., 2011). Interestingly, amongst the levels of basic micronutrients for plants, Cu and Zn were the most abundantly reported for wheat and rice (Asgary et al., 2017). However, the existence of Pt needs further evaluation because Pt is usually observed in many wild plant species (Vatansever et al., 2017). The use of reclaimed soils polluted with heavy metals for agricultural production may cause accumulation of Cd and Cu (Reith et al., 2014). Another point to be noted is the presence of Hg in small quantities in one sample. Since, Hg is a dangerous element even in small proportions and can act as cumulative poisons causing neurological and renal disturbances, additional studies are needed for further assessments (Li et al., 2012).

Washing of seeds after soaking and washing several times were effective in removing many heavy metals. This is the first study to investigate the

efficacy of the home washing methods to remove the heavy metals from the rice. Also, we have employed the use of the high resolution scanning electron microscope to support our findings.

#### 5. Conclusion

In the current study, the effectiveness of the home washing methods in the total dilution or removal of the heavy metals was studied. The effectiveness of soaking followed by washing was found to be more effective in removing heavy metals. In addition, some of the heavy metals appeared at different rates on the surface of samples. Further studies are needed to understand the release of elements within the grain and the possible long term implications of the released heavy metals on human health especially when staple foods are contaminated.

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#### Compliance with ethical standards

#### Conflict of interest

The authors declare that they have no conflict of interest.

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