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DETERMINATION OF THE CONCENTRATION OF METALS IN NOODLES FROM A MAJOR MARKET IN NIGERIA: A HEALTH RISK ASSESSMENT

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ABSTRACT

This study evaluated the levels of Na, Ca, Fe, Cr, Cd and Pb in five different brands of instant noodles sold in a major market in Ogun State, Nigeria using Atomic Absorption Spectrophotometer after acid digestion. The associated non-carcinogenic risk of toxic metals in these noodles when ingested was estimated by calculating Chronic Daily Intake (CDI), Target Hazard Quotient (THQ) and Total Target Hazard Quotient (TTHQ). The results of the metals concentrations in the noodle samples were (in mg/kg) Na $\leq 13.8 \pm 0.9$, Ca $\leq 40.3 \pm 1.2$, Cr $\leq 1.58 \pm 0.01$, Fe $\leq 1.51 \pm 0.02$, Cd $\leq 0.082 \pm 0.001$ and Pb $\leq 0.001 \pm 0.000$, while in seasoning samples, Na $\leq 18.2 \pm 1.4$, Ca $\leq 38.7 \pm 2.1$, Cr $\leq 1.18 \pm 0.02$, Fe $\leq 1.58 \pm 0.01$, Cd $\leq 0.041 \pm 0.001$ and Pb was below the detection limit of the instrument. The concentration of all the metals was below the WHO permissible standard in foods except for Cr in some brands. The level of Na in all the noodles and seasoning samples were less than the set targets by United Kingdom and South Africa for Na in foods. Chronic Daily Intake, THQ and TTHQ obtained for all the metals were less than unity but values for children were higher than that for adults. This result revealed that noodles consumption has no adverse non-cancer health effects over a lifetime; however, instant noodles should not be served alone as children meal but be supplemented.

Keywords: Instant noodles, metals, sodium, health risk, seasoning

INTRODUCTION

Noodles are widely consumed throughout the world and their consumption is second only to bread. Its sales have grown tremendously with the introduction of different brands in the market. This is because instant noodles are convenient, tasty, nutritious, of low cost and have relatively long shelf-life (Gulia *et al.,* 2014). It is a popular meal commonly taken by both young and old oftentimes, and it is given as a complete meal to growing children (Ezekiel and Sombie, 2014). Instant noodles are dried or precooked fused with oil and often sold with a packet of flavoring including seasoning oil. Dried noodles are usually eaten after being cooked or soaked in boiling water, while precooked noodles can be reheated or eaten directly from the packet.

Instant noodles are often criticized as unhealthy or junk food, the monosodium glutamate (MSG) in the flavor packets usually contains high concentration of sodium which is added as flavor enhancer (Farrand *et al.,* 2017). Allergy to MSG has been reported to produce burning sensations, chest and facial flushing, or pain and headaches. High sodium level is attributed as a key contributor to ill health across the world (Farrand *et al.,* 2017). It is a major risk factor for cardiovascular and non-communicable diseases (NCDs). The global target of 30% relative reduction in mean population of salt intake by 2025 has been recommended by WHO as less than 5 g/day (WHO, 2013; Mozaffarian *et al.,* 2014).

Salt is added during the production of instant noodles at concentrations of 1–3% of flour weight; it is a major component of the seasoning included in the packaging of instant noodles. Salt is added to reduce cooking time, enhance flavour, provide a softer and more elastic texture, and inhibit enzyme activities and growth of microorganisms (Fu, 2007). The United Kingdom (UK) has set an average target between 200 and 350 mg of sodium per 100 g of instant noodles (PHRD, 2014) while South Africa (SA) set its targets at 800 mg of sodium per 100 g by 2019 (Government Gazette, 2013).

Contamination of food products by heavy metals is becoming an unavoidable problem these days. Air, land and water pollution are contributing to the presence of these harmful elements in food stuff including instant noodles (Onyema *et al.,* 2014, Pirsaheb *et al.,* 2016). Food processing equipment, containers, additives and packaging materials are some of the possible channels through which noodles can be contaminated with heavy metals (Jothi and Uddin, 2014, Omuku *et al.,* 2014, Charles *et al.,* 2018). Soil irrigation with contaminated water, fertilizer and pesticides application, industrial emissions, storage container, and road traffic with leaded petrol are some of the possible sources of heavy metals in wheat which serves as the main raw material for noodles production (Gholam and Jahead, 2005; Ihedioha, *et al.,* 2018).

Human exposure to heavy metals, a group of non-biodegradable and persistent environmental contaminants, from food has increased in recent years. Ingestion and bio-accumulation of high concentrations of heavy metals through food products can cause damages to the heart, nervous system, liver, kidney, blood, lungs, bone, and spleen (Ghasemidehkordi *et al.,* 2018, Fathabad *et al.,* 2018). Cadmium has been reported to interfere with some essential functions of Zn, inhibiting enzyme reactions and nutrient utilization (Afiukwa, 2013). Lead affects the peripheral and central nervous systems, renal functions and blood cells. High level of lead has been associated with hypertension, reproductive, developmental and neurological disorders (Jarup, 2003). Higher levels of some of these heavy metals in noodles have been reported in literature. For example, high levels of arsenic, lead and copper have been reported in noodles from Taiwan, high levels of lead in Maggi noodles from India, (Ihedioha *et al.,* 2018) and also in Bangladesh (Jothi and Uddin, 2014).

Heavy metal concentrations in food products need to be continuously monitored for quality assurance and safety. Information on the levels of these in commercially available noodles is significant to evaluate the possible health risks associated with their consumption. This study therefore, was undertaken to determine the levels of some essential (Na, Ca, Fe) and non-essential metals (Cr, Cd and Pb) in noodles, their seasoning pack and to evaluate the health risks due to their regular and unguarded consumption.

MATERIALS AND METHODS

Sample Collection and Digestion

The samples collected consist of five different brands of instant noodles (coded A, B, C, D, E) commonly consumed in Ogun State. Samples of noodles were randomly selected from the composite, ground into powder and kept for further analysis. The seasoning packed with each selected noodle sample was labeled as samples Sa to Se. In each case, 1 g of the sample (noodles and seasoning) was weighed in duplicate into separate Teflon beakers using analytical weighing balance. Thereafter, 10 mL of Nitric acid (HNO_3) was added, covered with a watch glass and the mixture was heated over a hot plate at a temperature of 120 – 150°C in a fume cupboard until digestion was complete. The digested solution was made up to mark in a 50 mL volumetric flask. The concentrations of Na, Ca, Cr, Fe, Cd and Pb in the filtrate were determined using Atomic Absorption Spectrophotometer (Buck Model 205). In order to correct chemical and ionization interference in Na determination, 1 mL of Cesium Chloride solution was added to each of the standard and sample solutions (Julshamn *et al.*, 2005).

Quality Assurance

Quality assurance and quality control protocols used include: procurement of analytical grade Nitric acid from Sigma Aldrich; recovery studies (spiking), and blank determination. Appropriate standard solutions prepared from analar grade salts were used to calibrate the Atomic Absorption Spectrophotometer prior to measurement of metal concentrations. The detection limit of the instrument was evaluated using blank signal plus three times the standard deviation of the blank signal for each metal.

Health risk assessment

The health risk assessment of consuming toxic metals (Cr and Cd) in instant noodles considered in this study was evaluated by calculating the Chronic Daily Intake (CDI) and Target Hazard Quotient (THQ). Pb was not included because its concentration was below the detection limit for most of the samples. The Chronic Daily Intake (CDI) (mg/kg/day) of Cr and Cd in instant noodles was estimated using Equation 1 (Heshmati *et al.,* 2018; Keramati *et al.,* 2018).

$$CDI = \frac{C \times EDi \times IRi \times EFi}{BW \times ATn} \quad (1)$$

where C = concentration of heavy metals mg/kg, IRi (Ingestion rate, kg/n-day) = 0.0027 (WINA 2018), EFi (Exposure frequency, days/year) = 350, Edi (Exposure duration, years): Adults = 30; and children = 6 (EPA, 2011), BWi (Body weight, kg): Adults = 70 and children = 20, ATn (Average time exposure, days): Adults = 10550 and children = 2100 (EPA 2011).

The non-carcinogenic risk of Cr and Cd due to direct ingestion of instant noodle was estimated using Target Hazard Quotient (THQ) according to Equation 2 (EPA, 2011; Fakhri *et al.,* 2018).

$$THQ = \frac{CDI}{RFd} \quad (2)$$

If THQ > 1 value, potentially adverse health effect is likely; while THQ ≤ 1 value, adverse health effect is not likely (EPA, 2011; Abtahi *et al.,* 2017, Fakhri *et al.,* 2017).

The health risk of multiple heavy metals in the instant noodle and the seasoning was calculated. This was done by summing THQ for individual heavy metal using Equation 3 (EPA 2011, Razzaghi *et al.,* 2018)

$$TTHQ = THQ_1 + THQ_2 + \ldots + HQn \quad (3)$$

RESULTS AND DISCUSSION

The results of the quality assurance in terms of calibration curves, detection limits of instrument and percentage recovery were presented in table 1. Correlation values (r^2) of the calibration curves for metals showed high linearity ranges from 0.829 to 0.983. Na has the highest detection limit while Cd has the lowest. The % recoveries of all the studied metals are higher than 80 % with Na having the lowest and Cr the highest. The correlation values (r^2), the detection limits and % recoveries of all the metals are within the acceptable range indicating that the results are reliable and accurate.

Table 1: AAS calibration, detection limit and % recovery of the metals in noodles samples

Metal	Calibration Curve, r^2	Calculated DL (mg/kg)	% Recovery
Na	0.829	0.231	81.9 ± 2.1
Ca	0.892	0.017	90.3 ± 3.2
Cr	0.982	0.014	95.2 ± 3.3
Fe	0.983	0.013	93.4 ± 3.1
Cd	0.894	0.004	92.7 ± 4.2

DL - Detection Limit

Table 2: Concentrations of the metals (mg/kg) in the noodle samples

Sample	Na	Ca	Cr	Fe	Cd	Pb
A	11.7±0.9	7.89±0.12	1.65±0.03	0.74±0.00	0.043±0.001	BDL
B	12.3±0.8	8.01±0.32	BDL	0.60±0.00	0.072±0.001	BDL
C	12.1±0.6	9.55±0.31	1.58±0.01	1.01±0.01	0.077±0.002	0.001±0.000
D	12.2±0.7	11.30±0.60	0.61±0.00	1.29±0.01	0.038±0.001	BDL
E	13.8±0.9	40.30±1.20	0.02±0.00	1.51±0.02	0.082±0.001	BDL
Mean	12.4±0.8	15.40±1.10	0.77±0.00	1.03±0.01	0.062±0.001	0.000±0.000
WHO Std	<35*, <80**		0.05	10.0	0.03	0.50

*WHO std- World Health Organization standard; **Set targets by the United Kingdom and South Africa.

Table 3: The concentration of the metals in the noodles seasoning

Sample	Na (mg/kg)	Ca (mg/kg)	Cr (mg/kg)	Fe (mg/kg)	Cd (mg/kg)	Pb (mg/kg)
Sa	17.6±1.3	8.58±0.1	0.081±0.002	0.467±0.001	0.021±0.000	BDL
Sb	16.8±0.8	10.7±0.8	0.035±0.001	0.406±0.001	0.014±0.000	BDL
Sc	16.9±1.0	15.2±1.1	0.759±0.021	0.896±0.002	0.041±0.001	BDL
Sd	18.2±1.4	17.1±0.9	0.653±0.015	0.775±0.002	0.031±0.000	BDL
Se	17.5±0.9	38.7±2.1	1.180±0.020	1.580±0.010	0.037±0.000	BDL
Mean	17.4±0.8	18.1±0.9	0.602±0.014	0.824±0.001	0.029±0.000	BDL

Mean Standard Deviation

The results of the analysis of metals in noodles and seasoning samples sold in commercial market were presented in tables 2 and 3 respectively. From the results presented in Table 2 for metal content in the noodles, Na had the highest concentration while the concentration of Pb in most samples was below the detection limit of the instrument. Sample E contained the highest concentrations of Na, Ca, Fe and Cd while sample A contained the lowest concentration of Na and Ca. In the analyzed seasoning samples, sample Sd had the highest Na content while Pb was found to be below the detection limit of the instrument for all the seasoning samples. Calcium level in seasoning sample Se was found to be the highest, similar to the content in noodle sample E. The concentration of Na in all the seasoning samples was higher than the content in the noodle samples but all are less than the set targets by the United Kingdom (PHRD, 2014) and South Africa (Government Gazette2013) (Tables 2 and 3). The concentrations of all the analysed metals in both noodles and seasonings were compared with permissible limits set by WHO (2011) and were all found to be significantly below the set standard except some for Cr in some of the samples (Table 3). Calcium and Fe are two of the essential metals required by the body and, to a lesser extent Cr, but Cd and Pb are toxic to the body (Charles *et al.,* 2018).

The level of Cd recorded in both noodle and seasoning samples was ⩽ 0.082 mg/kg and all were found to exceed the permissible levels set by WHO (0.003 ìg/g) and FDA (0.005 mg/kg) for Cd (WHO, 2011; Tomori and Onibon, 2015) except seasoning samples Sa and Sb, but less than Codex Alimentarius standard for Cd in cereals (0.1 mg/kg) (Codex Alimentarius, 2008). Cadmium level in this study was higher than the level reported by Onyema *et al.* (2014) and Ihedioha *et al.* (2018) in instant noodles from Nigeria but less than the level reported by Tajdar-oranj *et al.* (2018) and Jothi and Uddin (2014) in noodles from Iran and Bangladesh.

The levels of Pb in most of the noodles and seasoning samples were below detection limit; this is not in accordance with the report of earlier workers who reported detectable levels in their findings (Onyema *et al.*, 2014; Charles *et al.*, 2018; Ihedioha *et al.*, 2018; Tajdar-oranj *et al.*, 2018). The recommended maximum level for Pb in noodles is 2 (mg/kg) according to the Bangladesh Standards and Testing Institution (BSTI), (Jothi and Uddin, 2014). Permissible limits set by the Codex Alimentarius and WHO for the Pb in cereals and food products are 0.2 and 0.025 (mg/kg) respectively (Codex Alimentarius, 2008, Charles *et al.,* 2018).

The concentration of Cr in instant noodle samples ranged from 0.023 to 1.650 (mg/kg) while in seasoning samples the values ranged from 0.081 to 1.180 (mg/kg). Chromium concentration in noodle samples B, E and seasoning sample B were below the defined limit by WHO, while all others were above the standard (0.05 mg/kg). This result is higher than the result reported by Onyema *et al.* (2014), Ihedioha *et al.* (2018) and Tajdar-oranj *et al.* (2018), but fell within the range of the result reported by Charles *et al.* (2018) in noodles sold in Port Harcourt market.

Although, little amount of Na is required by the body for proper functioning, but if the daily intake is exceeded, this could result into high blood pressure, kidney diseases and the body may even experience inability to properly absorb the sodium consumed (WHO, 2011). On the other hand, if the required sodium is not enough per day, low sodium could result into the body's inability to maintain healthy fluid levels and could also have a negative impact on the way the muscles expand and contract, especially during exercise (WHO, 1996).

Health risk assessment

The health risk assessment of the two toxic metals (Cr and Cd) determined in this study were evaluated by calculating the Chronic Daily Intake (CDI), Target Hazard Quotient (THQ) and Total Target Hazard Quotient (TTHQ). The results of the calculated CDI, THQ and TTHQ were presented in Tables 4 and 5 respectively. The CDI for Cr is a bit higher than that of Cd for both noodle and seasoning samples and all were less than 1.0. THQ values (i.e. the ratio between the measured concentrations and the oral reference dose) were calculated for Cr and Cd in the noodle and seasoning samples. The total hazard Quotient (TTHQ) is a sum of the individual hazard quotients of each metal. The THQ for Cd is higher than that of Cr for both noodle and seasoning samples and both THQ and TTHQ obtained for all the metals were less than 1.0. TTHQ for children is more than that for adults. This is not in accordance with the findings of Tajdar-oranj *et al.* (2018) and Charles *et al.* (2018) who recorded higher TTHQ for adult consumers. THQ and TTHQ exposures below 1.0 have been reported not to result in adverse non-cancer health effects over a lifetime of exposure (Charles *et al.,* 2018; Ihedioha *et al.,* 2018, Tajdar-oranj *et al.,* 2018).

Table 4. Estimated Chronic Daily Intake (CDI) (mg/kg/day) of heavy metals in the samples

	Metals	Metals (mg/kg)	Children	Adult
Noodles	Cr	0.774±0.001	$1.05x10^{-4}$	$2.97x10^{-5}$
	Cd	0.062±0.001	$8.37x10^{-6}$	$2.38x10^{-6}$
Seasoning	Cr	0.602±0.014	$8.13x10^{-5}$	$2.31x10^{-5}$
	Cd	0.029±0.000	$3.92x10^{-6}$	$1.11x10^{-6}$

Table 5. Target Hazard Quotient and Total Target Hazard Quotient of Cr and Cd in the samples

	metals	Children	Adult
Noodles	Cr	$7.00x10^{-5}$	$1.98x10^{-5}$
	Cd	$8.37x10^{-3}$	$2.38x10^{-3}$
Seasoning	Cr	$5.42x10^{-5}$	$1.54x10^{-5}$
	Cd	$3.92x10^{-3}$	$1.11x10^{-3}$
	TTHQ	$1.24x10^{-2}$	$3.53x10^{-3}$

However, a TTHQ greater than 1.0 does not necessarily suggest a likelihood of adverse effects. This is based on the fact that ingested dose is not equal to the absorbed pollutant dose because a fraction of the ingested toxicant may be excreted, leaving a smaller portion to accumulate in the body tissues (Horiguchi *et al.,* 2004, Zhuang *et al.,* 2009).

CONCLUSION

The concentrations of some essential and non-essential metals were determined in commonly consumed instant noodles and seasoning samples. The study revealed that most of these metals were below the permissible levels set by WHO in food. The Na level in all the noodles and seasoning samples were less than the set targets by United Kingdom and South Africa for Na in food. The health risk assessment indicated that eaten any of the noodles brands cannot result in adverse non-cancer health effects. Though, the levels of the metal contamination and the health risk assessment is low, instant noodles should not be served as a wholesome meal to children and there should be continuous monitoring of possible contaminants for food quality assurance and safety.

REFERENCES

Abtahi, M., Fakhri, Y., Oliveri Conti, G., Keramati, H., Zandsalimi, Y., Bahmani, Z., Hosseini Pouya, R., Sarkhosh, M., Moradi, B. and Amanidaz, N. 2017. Heavy metals (As, Cr, Pb, Cd and Ni) concentrations in rice (Oryza sativa) from Iran and associated risk assessment: a systematic review. *Toxin Rev.* 36, 331–341.

Afiukwa, J. N. 2013. Evaluation and correlation study of heavy metals load in drinking water and update of water-related disease cases in Ebonyi State from 2001 – 2011. *Amer J Sci Ind Res.* 4, 221-225.

Charles, I. A., Ogbolosingha, A. J. and Afia, I. U. 2018. Health risk assessment of instant noodles commonly consumed in Port Harcourt, Nigeria. *Environ Sci Pollut Res.* 25, 2580–2587.

Codex Alimentarius. 2008. Codex General Standard for contaminants and toxins in food and feed. Codex Stan 9, 193-1995.

EPA. 2011. Exposure Factors Handbook, 2011 edition, EPA/600/r-09

Ezekiel, C. N. and Sombie, J. I. 2014. Survey of aflatoxins and fungi in some commercial breakfast cereals and pasta retailed in Ogun State, Nigeria. *Nat Sci.* 12, 27 – 32.

Fakhri, Y., Mohseni-Bandpei, A, Conti, G. O., Keramati, H., Zandsalimi, Y., Amanidaz, N., Hosseini Pouya, R., Moradi, B., Bahmani, Z. and Rasouli Amirhajeloo, L. 2017. Health risk assessment induced by chloroform content of the drinking water in Iran: systematic review. *Toxin Rev.* 36, 342–351.

Fakhri, Y., Mohseni-Bandpei, A., Conti, G. O., Ferrante, M., Cristaldi, A., Jeihooni, A. K., Dehkordi, M. K., Alinejad, A., Rasoulzadeh, H. and Mohseni, S. M. 2018. Systematic review and health risk assessment of arsenic and lead in the fished shrimps from the Persian gulf. *Food Chem Toxicol.* 113, 278–286.

Farrand, C., Charlton, K., Crino, M., Santos, J., Rodriguez-Fernandez, R., Ni Mhurchu, C. and Webster, J. 2017. Know Your Noodles! Assessing Variations in Sodium Content of Instant Noodles across Countries. . 9, 612. doi: 10.3390/nu9060612

Fathabad, A. E., Shariatifar, N., Moazzen, M., Nazmara, S., Fakhri, Y., Alimohammadi, M., Azari, A. and Khaneghah, A. M. 2018. Determination of heavy metal content of processed fruit products from Tehran's market using ICP-OES: a risk assessment study. *Food Chem Toxicol.* 115, 436–446.

Fu, B. X. 2007. Asian noodles: History, classification, raw materials and processing. *Food Res. Int.* 41, 888–902.

Ghasemidehkordi, B., Malekirad, A. A., Nazem, H., Fazilati, M., Salavati, H., Shariatifar, N., Rezaei, M., Fakhri, Y. and Khaneghah, A. M. 2018. Concentration of lead and mercury in collected vegetables and herbs from Markazi province, Iran: a non-carcinogenic risk assessment. *Food Chem Toxicol.* 113, 204–210

Gholam, R. and Jahead, K. 2005. Determination of Zinc contents in Iranian Breads. *Pakistan J Nutr.* 4, 294-297.

Government Gazette. 2013. No. R. 214 Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act 54 of 1972) Regulations Relating to the Reduction of Sodium in Certain Foodstuffs and Related Matters The Heart and Stroke Foundation South Africa. South Africa Government, Pretoria, South Africa.

Gulia, N., Dhaka, V. and Khatkar, B. 2014. Instant noodles: processing, quality, and nutritional aspects. *Crit Rev Food Sci Nutr.* 54, 1386–1399.

Heshmati, A., Ghadimi, S., Mousavi Khaneghah, A., Barba, F. J., Lorenzo, J. M., Nazemi, F. and Fakhri, Y. 2018. Risk assessment of benzene in food samples of Iran's market. *Food Chem Toxicol.* 114, 278–284.

Horiguchi, H., Oguma, E., Sasaki, S., Miyamoto, K., Ikeda, Y., Machida, M. and Kayama, F. 2004. Dietary exposure to cadmium at close to the current provisional tolerable weekly intake does not affect renal function among female Japanese farmers. *Environ Res*. 95, 20–31.

Ihedioha, J. N., Atiatah, I. M., Ekere, N. R. and Asegbeloyin, J. N. 2018. Levels of Heavy Metals in Pasta Available in the Nigerian Market: Assessing the Human Health Implications. *Journal of Chemical Health Risks,* 8, 95-105.

Jarup, L. 2003. Hazards of heavy metal contamination. British Med Bull. 68, 167 - 182.

Jothi, J. S. and Uddin, M. B. 2014. Detection of heavy metals in some commercial brands of noodles. *Eur Acad Res.* 2, 10667 – 10677.

Julshamn, K., Lea, P. and Sloth, J. J. 2005. Determination of Sodium in Foods by Flame Atomic Absorption Spectrometry after Microwave Digestion: NMKL Interlaboratory Study. *Journal of AOAC International* 88, 1212-1216.

Keramati, H., Miri, A., Baghaei, M., Rahimizadeh, A., Ghorbani, R., Fakhri, Y., Bay, A., Moradi, M., Bahmani, Z., Ghaderpoori, M. and Khaneghah, A. M. 2018. Fluoride in Iranian drinking water resources: a systematic review, Meta-analysis and Non-carcinogenic Risk Assessment. *Biol Trace Elem Res*. 1–13.

Mozaffarian, D., Fahimi, S., Singh, G.M., Micha, R., Khatibzadeh, S., Engell, R.E., Lim, S., Danaei, G., Ezzati, M. and Powles, J. 2014. Global sodium consumption and death from cardiovascular causes. *N. Engl. J. Med.* 371, 624–634.

Omuku, P. E., Onwumelu, H. A. and Alisa, C. O. 2014. Comparative analysis of selected heavy metals in green leafy vegetables and instant noodles sold in Eke-Awka market, Awka, Anambra state. *Journal of Environmental Science and Water Resources* 3, 209 – 213.

Onyema, C. T., Ekpunobi, U.E., Edowube, A. A., Odinma, S. and Sokwaibe, C. E. 2014. Quality Assessment of Common Instant Noodles Sold in Nigeria Markets. *American Journal of Analytical Chemistry,* 5, 1174-1177.

PHRD. 2014. Public Health Responsibility Deal: UK Salt Reduction Targets for 2017. UK Department of Health; London, UK.

Pirsaheb, M., Fattahi, N., Sharafi, K., Khamotian, R. and Atafar, Z. 2016. Essential and toxic heavy metals in cereals and agricultural products marketed in Kermanshah, Iran, and human health risk assessment. *Food Addit Contam.* Part B 9, 15–20.

Razzaghi, N., Ziarati, P., Rastegar, H., Shoeibi, S., Amirahmadi, M., Conti, G.O., Ferrante, M., Fakhri, Y. and Khaneghah, A. M. (2018). The concentration and probabilistic health risk assessment of pesticide residues in commercially available olive oils in Iran. *Food Chem Toxicol.* 120, 32–40.

Tajdar-oranj, B., Shariatifar, N., Alimohammadi, M., Peivasteh-roudsari, L., Khaniki, G. J., Fakhri, Y. and Khaneghah, A. M. 2018. The concentration of heavy metals in noodle samples from Iran's market: probabilistic health risk assessment. *Environ Sci Pollut Res*. https://doi.org/10.1007/s11356-018-3030-y

Tomori, W.B. and Onibon, V.O. 2015. Health risk assessment of metal content in wheat based snacks from three different kitchen types in Akure metropolis. FUTA J Res Sci. 1, 157 – 170.

WHO. 2011. Evaluation of certain contaminants in food: seventy-second report of the Joint FAO/WHO Expert Committee on Food Additives. World Health Organization.

WHO. 2013. Global Action Plan for the Prevention and Control of Non-communicable Diseases 2013–2020. World Health Organization; Geneva, Switzerland.

Zhuang, P., McBride, M. B., Xia, H., Li, N. and Li, Z. 2009. Health risk from heavy metals via consumption of food crops in the vicinity of Dabaoshan mine, South China. *Sci Total Environ.* 407, 1551–1561.