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Assessment of Pesticide Residue, Heavy Metal, and Nutritional Quality of Six Different Brands of Commercially Popular Noodles from Orie-Ugba Market, Umuahia, Abia State

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Abstract
The World Health Organization (WHO) opined that most health challenges in recent times is consequent upon consumption of contaminated food. This, therefore, necessitated the assessment of pesticide residues and heavy metals in instant noodles purchased from six different stores at Orie-Ugba market in Umuahia, Abia State. The different brand of noodles was analyzed for selected pesticide residues, heavy metals and nutritional quality using standard methods at the University of Nigeria Nsukka Central Laboratory. The results showed the presence of Pb, Cd, Zn, Cr and Cu in the noodles but the values of Pb (0.45 mg/kg) and Cr (6.30 mg/kg) were higher than permissible limit set by Codex Alimentarius Commission. Pesticide residues tested in this study were below the permissible limit. Notwithstanding this, the consumption of such contaminated noodles over a period of time could pose serious health risks to consumers since Pb and Cd have no positive biological function in the human body. Very strong positive relationship exists between Cd and Heptachlor ($r = 0.85$, $P<0.01$) and Carbofuran ($r = 0.692$, $P<0.01$)
Keywords: Pesticide residues, Heavy metal, nutritional quality, Orie-Ugba

Introduction

Pesticides are a class of xenobiotic compounds that have been used to destroy or repel unwanted animals, insects, and plants (such as weeds) for several decades. They consist of a wide range of compounds, including rodenticides, insecticides, herbicides, molluscicides, and nematicides, among others (Lei *et al*., 2020). The use of agrochemicals (e.g., pesticides and fertilizers) to control pests and boost crop yield, especially in the northern part of Nigeria, where a good number of farmers are involved in large-scale (i.e., commercial) production of food crops may be a route of entry of pesticide residues in plants (Ogbonna *et al*., 2023). For instance, pesticides are of great global concern because they negatively impact food safety and security and ultimately result in various health issues (Chen *et al.,* 2017; Imran *et al*., 2018). Crops tend to absorb metals from the soil solution through their roots and translocate them to their aerial parts (Ogbonna *et al.,* 2018). The exploitation of such crops at maturity and subsequent processing in food industries will result in the accumulation of pesticide residues and heavy metals in the end food product. The increasing demand for processed foods like noodles will result in the build-up of these toxic substances in the bodies of consumers.

Noodle is one of the processed foods manufactured or imported into Nigeria. It is highly consumed by pupils and students in primary and secondary schools, University students, as well as adults. It is relatively easy to prepare and most children prefer it to other types of food, such as spaghetti, macaroni, among others. They are made from wheat or rice flour, and their global consumption is second only to bread (Iniobong *et al*., 2017). It consists of carbohydrate, salt, protein, water, and a small amount of fatty acids. Additionally, substances such as flour treatment agents, anti-oxidants, preservatives, humectants, acid regulators, emulsifiers, thickeners, flavor enhancers, stabilizers, colours, and anti-caking agents were added to enhance its shelf life (World Instant Noodles Association, 2016; Shamsani *et al*., 2019). Nigeria, Africa's most populous nation, is one of the largest consumers of instant noodles. The country also occupies the 11th position in the global demand for noodles, with Indomie instant noodles being the most consumed brand in Nigeria (Adebowale and Suleiman, 2023). The astronomical demand for noodle consumption in Nigeria has culminated in the tremendous growth of the pastry industry.

Literature search shows that some research has been carried out on heavy metal contamination of instant noodles in the main market at Onitsha, Anambra State (Odidika *et al.,* 2020), in Port Harcourt, Rivers State (Iniobong *et al.,* 2017), in Nigerian markets (Onyema *et al.,* 2014), and in Malaysia (Shamsani *et al.,* 2019). To the best of my knowledge, there is no existing literature documented on pesticide residues in commercially popular food as Indomie, manufactured or purchased from any market in Nigeria. Considering the increasing trend in the consumption of noodles in Nigeria, inter alia, the recent alarming on presence of cancer-causing ethylene oxide in noodles vis-à-vis the prevalent health challenges resulting from consumption of foods contaminated with toxic substances, the quality of noodles product that is being sold in the market need to be constantly monitored to ascertain the safety of consumers. The objective of this study, therefore, is to assess the concentration of pesticide residues, heavy metal, and nutritional properties of different brands of noodles commercially sold in Umuahia market and compare the results with permissible limits of Joint Committee of Food and Agriculture Organization and World Health Organization (FAO/WHO) of the United Nations.

Materials and Methods

2.1 Description of the study area

The study was carried out in Orie-Ugba market, located in Umuahia North, Abia State of Nigeria; It lies between latitudes 5º 34' N and 5º 42' E; and Longitude 7º 24' N and 7º 34' 30" E (Ukeka, 1992) covering a land mass of 245 square kilometers and a population of 220,660 at the 2006 census with so many communities. It is bounded to the north by Isukwuato Local Government Area, to the north-east by Bende LGA, to the south-east by Ikwuano LGA, to the south by Isiala-Ngwa North LGA, and has a common boundary with Imo State to the west. The topography is undulating with a maximum elevation of 193 m above sea level. Major vegetables grown in the area include fluted pumpkin, bitter leaf, water leaf, okra, pepper, garden eggs, okra, amaranthus, and "oha". The major tree crops cultivated in the area are oil palm, kola, citrus, and rubber, while major food crops include cassava, yams, coco-yams, maize, plantains, and banana The area is located within the tropical rainforest zone of South east Nigeria and its climate is characterized by two distinct weather seasons viz; the wet and dry seasons with annual rainfall ranging between 2,500 mm to 3,100 mm (Onyeka *et al*, 2008) and the annual mean temperature is 29 ˚C.

2. 2 Noodles collection and preparation

The Noodles brands tested in this study were purchased at Orie Ugba market. The selection of noodle brands for assessment was based on the level of their demand and consumption in Umuahia. The selected noodle brands were Tummy Tummy, Indomie, Supreme, Mimee, Masters, and Golden Penny. A small carton of each of the different brands of noodles was purchased randomly from six (6) different shops at Orie-Ugba market and transported to the laboratory. In the laboratory, each of the brands (e.g., Supreme) was bulked together (about 1000 g) and placed separately in a Stomach sample bag, well-sealed, properly labeled for pre-treatment and analysis.

2.2.1 Determination of Heavy Metal/Mineral

One gram (1g) each of the samples was weighed into a digestion flask, and 30 cm^3 of aqua regia was added and digested in a fume-cupboard until a clear solution was obtained. It was cooled, filtered, and then made up to the 50 ml mark in a standard volumetric flask with de-ionized water. A blank sample was prepared to zero the instrument before running other series of samples. Standards (2 ppm, 4 ppm, and 6 ppm) were prepared from a 1000 ppm stock solution of the metals and used to plot the calibration curve. The curve was plotted automatically by the instrument Atomic Absorption Spectrometer model AA-7000 Shimadzu, Japan, ROM version 1.01, S/N A30664700709 for the metal/mineral.

2.2.2 Determination of Nitrogen/Crude Protein

The micro-Kjedahl method, as described in Pearson and Cox (1976), was used. This method involves the estimation of the total nitrogen in the sample and the conversion of the nitrogen to protein with the assumption that all the protein in the sample is present as nitrogen. Using a conversion factor of 6.25, the actual percentage of protein in the sample was calculated as;

% crude protein = % Nitrogen x 6.25.

2.2.3 Determination of Moisture Content

The A.O.A.C. method (1990) was used. Porcelain crucibles were washed and dried in an oven at 100 °C for 30 minutes and allowed to cool in a desiccator. One gramme of the sample was placed into weighed crucibles and then put inside the oven set at 105 °C for 4 hours. The samples were removed from the oven after this period and then cooled and weighed. The drying was continued, and all the samples with the crucibles were weighed until a constant weight was obtained.

% moisture = $\frac{A-B}{A} \times \frac{100}{1}$

A = Original weight of sample

B = Weight of dried sample.

2.3.4. Determination of Ash Content

Using the AOAC (1990) method, 1g of the finely ground samples was weighed into porcelain crucibles, which had been washed, dried in an oven at 100°C, cooled in a desiccator, and weighed. They were then placed inside a muffle furnace and heated at 600°C for 4 hours. After this, they were removed and cooled in a desiccator and then weighed.

% Ash = $\frac{A-B}{C} \times \frac{100}{1}$

A = Weight of crucible + ash

B = Weight of crucible

C = Weight of original sample

2.3.5. Determination of Fat Content

The Pearson and Cox (1976) method was used. This involves the use of a Soxhlet extraction apparatus, so 1g of the ground sample was accurately weighed and transferred into a rolled filter paper and then placed inside the extraction thimble. The thimble was placed inside the extractor. Some quantity of petroleum ether was poured into the extraction flask (usually three-quarters of the volume of the flask). The condenser and the flask were connected to the extractor. The whole unit was placed on a heating mantle for 4 hours, after which the petroleum ether was recovered. The oil collected in the flask was dried in an oven at 105 °C. It was then weighed, and the percentage fat calculated as shown below

$$\% \text{ fat} = \frac{C - A}{B} \times \frac{100}{1}$$

C = weight of flask +oil

A = weight of empty flask

B = weight of original sample.

2.3.6 Determination of Crude Fibre Content

The A.O.A.C. (1990) method was used. 1g of the sample was weighed (w1) into a 600ml beaker and 150ml of preheated 0.128M H_2SO_4 was added to it. This was heated for 30 minutes and filtered under suction, and washed with hot distilled water until the washings were no longer acidic. The residue was then transferred to a beaker and boiled for 30 minutes with 150ml of preheated KOH (0.223M). It was filtered and washed with hot water until the washings were no longer alkaline. The residue was washed three times with acetone and dried in an oven at 105 °C for 2 hours. It was then cooled in a desiccator, weighed (W2), and ashed in a muffle furnace (make: Vecstar, model LF3, made in the U.K.) at 500°C for 4 hours. The ash obtained was cooled in a desiccator and weighed (W3)

$$\% \text{ Crude fibre} = \frac{W_2 - W_3}{W_1} \times \frac{100}{1}$$

Where:

W_1= weight of sample

W_2= Weight of dry residue

W_3=Weight of ash.

2.4 Determination of Pesticide Residues

A 5ml of sample was pipette into a beaker containing 20ml of N-hexane, shaken very well, and poured into a separating funnel and allowed to stand for 30 minutes. The N-hexane layer was collected and stored in a sample vial for pesticide residue analysis with GC-FID. The analysis of pesticide residues was performed on a BUCK M910 Gas chromatography equipped with an FID detector. A RESTEK 15-meter MXT-1 column (15m x 250um x 0.15um) was used. The injector temperature was 280°C with splitless injection of 2ul of sample and a linear velocity of 30cms^{-1}. Helium 5.0 Pa.s was the carrier gas with a flow rate of 40ml/min. The oven operated initially at 200 °C, it was heated to 330 °C at a rate of 30 °C min^{-1} and was kept at this temperature for 5min, the detector operated at a temperature of 320 °C. 0.5ul of the extracted sample was injected into the equipment via the injector of the equipment and allowed to scan pesticide components for 45 minutes. Pesticide components were determined by the ratio between the area and mass of the internal standard and the area of the identified compounds. The concentration of the different pesticide components was expressed in µg/ml.

Temperature Condition

Initial Temp	Hold	Ramp	Final Temp
70°C	5min	10min	170°C
170°C	5min	5min	220⁰C

Results and Discussion

3.1 Concentration of Pesticide Residues in Instant Noodles

The results of the values of pesticide residues in different brands of instant noodles tested in this study are summarized in Table 1. The result show that the highest values of Heptachlor (0.16 ± 0.00 mg/kg), Carbofuran (0.35 ± 0.00 mg/kg), Dicophol (0.19 ± 0.00 mg/kg), Aldrin (0.22 ± 0.00 mg/kg), Endrin (0.04 ± 0.00 mg/kg) were recorded in Supreme instant noodles. The values of the pesticide residues in noodles (except Endrin) were higher than the permissible limits of 0.1 mg/kg recommended for food crops by the Thai Agricultural Standard (2014). Pesticides are potentially toxic to humans and have a wide range of human health hazards, ranging from short-term impacts such as headaches, nausea to chronic impacts like cancer, reproductive harm, and endocrine disruption (TAC, 2015). For instance, Aldrin, despite being an easy pesticide to apply in crop farm fields, remained characterized as a neurotoxin that will bioaccumulate and at the same time be bio-magnified (Rakhimol *et al.,* 2020).

The highest values of T-nonachlor (0.02 ± 0.00 mg/kg), G-chlordane (0.003 ± 0.00 mg/kg), Dichlorvos (0.11 ± 0.00 mg/kg), and HCB (0.002 ± 0.00 mg/kg) were observed in Indomie instant noodle. These pesticides residue enters the human body through ingestion of food as well as water. These pesticide residues function as AChE inhibitors, which can lead to various neurological side effects (Esfandian *et al.,* 2016). Children in particular are susceptible to adverse neurological, developmental, and other effects of pesticide exposure (CPDIC, 1993; Weiss *et al.,* 2004).

The highest values of Dieldrin (0.32 ± 0.00) and Biphenyl (0.01 ± 0.00 mg/kg) were obtained in Tummy Tummy instant noodles. The consumption of such contaminated noodles could cause autoimmune disorders and inhibit the functions of some biochemical processes (Navish *et al.,* 2022; Nwosu *et al.,* 2023). The highest values of Lindane (0.26±0.00 mg/kg), Tetradifon (0.30 ± 0.00 mg/kg), and Deltametrin (0.38 ± 0.00 mg/kg) were recorded in Golden Penny, Masters, and Mimee instant noodles, respectively. Prolonged consumption of these instant noodles could lead to their bioaccumulation in the body of man and animals, thus resulting in serious health challenges (Nwosu *et al.,* 2023).

Generally, the values of the pesticide residues in various brands of instant noodles followed a decreasing order: Deltametrin> Carbofuran> Diedrin> Tetradifon> Lindane> Aldrin> Dicophol> Heptachlor> Dichlorvos> Endrin> T-nonachlor 2-4-DOT, Endosulfan> Biphenyl> HCB> G-chlordane. The purpose of ranking the pesticide residue is to show their level of distribution in instant noodles in order of concentration.

3.2. Concentration of Heavy Metals in Various Brands of Instant Noodles

The results of the values of heavy metals (mg/kg) in various instant noodles tested in the study are summarized in Table 2. The highest concentration of Cd (0.11±0.00 mg/kg) and Zn (0.10 ± 0.00 mg/kg) were recorded in Supreme instant noodle, while the highest value of Cr (6.30 ± 0.00 mg/kg) was obtained in Mimee instant noodles. The high values of Cd and Zn in Supreme and Cr in Mimee instant noodles may be attributed to the application of fertilizer to crops to boost soil nutrient vis-à-vis crop yield (Ogbonna *et al.,* 2013, 2023). The concentration or values of Zn in the instant noodles increased from 0.03 ± 0.00 to 0.10± 0.00 mg/kg, which is well below the permissible limit of Zn by Codex Alimentarius Commission. Zinc is an essential element for the healthy growth and development of man (Ogbonna *et al.,* 2021). The values of Cd in various brands of instant noodles tested in this study ranged from 0.00± 0.00 to 0.11± 0.00. which is higher than 0.03 to 0.37 mg/kg obtained in instant noodles from Malaysian market (Shamsani *et al.,* 2019),0.001 to 0.008 mg/kg of Cd in common instant noodles at market in Nigeria (Onyema *et al.,* 2014), The level of Cd in this study (0.00 ± 0.00-0.11 ± 0.00 mg/kg) was relatively lower than the permissible limit of Codex Alimentarius Commission. Cadmium does not have any positive biological function in the human body and can be toxic even at trace values (Jain et al., 2007). It (Cd) causes adverse effects on the respiratory system, liver, as well as bones (ATSDR, 2012).

The highest value of Pb (0.45 ± 0.00 mg/kg) was obtained in Golden Penny. The high value of Pb in Golden Penny may be attributed to irrigation of crops with Pb-contaminated water or through the addition of flavour enhancers, stabilizers, water, emulsifiers, thickeners, colours, preservatives in the production of instant noodles (Maleki and Zarasvand, 2008; Shamsani *et al.,* 2019). The values of Pb increased from 0.00 ± 0.00 to 0.45 ± 0.00 mg/kg, which is higher than the permissible limit of the Codex Alimentarius Commission. Lead (Pb) is a non-essential element in the human biological system. Exposure to Pb affects human brain, liver, and kidney damage (ATSDR, 2007; IARC, 2006).

The highest values of Cr (6.30±0.00 mg/kg) were observed in Mimee instant noodles. The values of Cr ranged from 0.12 ± 0.00 to 6.30 ± 0.00 mg/kg, which is higher than the permissible limit of 2.30 (Cr) established for leaves of edible crops by the Codex Alimentarius Commission (FAO/WHO, 2006). Chromium (Cr) is essential for carbohydrate metabolism in mammals (Tucker *et al.,*2005), but its value in the instant noodles (eg, Mimee and Golden Penny) tested in this study poses a serious health risk to humans and animals that consume these chromium-contaminated instant noodles. Exposure to Cr could lead to allergic dermatitis in humans, bleeding of the gastrointestinal tract, cancer of the respiratory tract, and ulcers of the skin (Bhagure and Mirgane, 2010; AlHagibi *et al.,* 2018; Ogbonna *et al.,* 2021).

The highest value of Cu (0.03 ± 0.00 mg/kg) was statistically the same for Tummy Tummy, Supreme, Masters, and Golden Penny instant noodles. The values of Cu in the various brands of instant noodles sampled in this study ranged from 0.00 ± 0.00 to 0.03 ± 0.00 mg/kg, which is below the permissible limit of 73.0 mg/kg (Cu) set by the Codex Alimentarius Commission (FAO/WHO, 2011). The Recommended Dietary Allowance (RDA) of Cu for proper growth and human health of an adult ranges from 1.5 to 3 mg/day (Samira and Tawner, 2013). Copper is one of the essential micro elements, but it could cause damage to the immune system, liver, and gastrointestinal tract (ATSDR, 2004). Generally, the values of the concentration of heavy metals in different brands of instant noodles followed a decreasing order: Cr>Pb>Cd>Zn>Cu. The purpose of ranking the heavy metals is to show they're of distribution in an instant in order of concentration.

3.3 Concentration of Macro Element (Mg/Kg) in the Different Brands of Noodles

The results of the values of macro element content of various instant noodles tested in this study are presented in Table 3. The results indicate that the highest values of Mg (4.69 ± 0.00 mg/kg), Na (7.61 ± 0.00 mg/kg), Ca (41.33 ± 1.00 mg/kg), and P (45.80 ± 1.00 mg/kg) were obtained in Masters, Indomie, Mimee, and Supreme instant noodles, respectively. The highest value of Mg (4.69 mg/kg) in this study is relatively higher than 4.32 mg/kg reported in varieties of instant noodles sold in Sokoto State, Nigeria (Suleiman *et al*., 2020). The highest value of Na (7.61 mg/kg) in this study is higher than 1.176 mg/kg recorded in noodles made from *Triticum Duruma, Digitaria Exilis, Vigna Unguiculata Flour, and Moringa Oleifera Powder* (Orisa and Udofia, 2019). The highest value of Ca (41.33 mg/kg) in this study is higher than 7.6 mg/kg of Ca observed in noodles (Suleiman et al., 2020) and 5.902 mg/kg of Ca reported by Orisa and Udofia (2019). The highest value of P (45.80 mg/kg) in this study is well above 0.154 mg/kg of P reported in noodles (Orisa and Udofia, 2019). The disparity in the values of macro-elements in the instant noodles may be attributed to the different media upon which the plant species used in the production of noodles were grown. However, the presence of macro-elements in noodles is important for human health. For instance, magnesium helps regulate intracellular flow of calcium ions, but its deficiency may lead to weakness, fatigue, problems with muscle contraction, and confusion (Suleiman *et al.,* 2020). Sodium is required by the body to regulate blood pressure and blood volume. Sodium also helps to regulate the fluid balance in the body. It also helps in the proper functioning of the muscles and nerves (Payne, 1990). Calcium helps in the development of strong teeth and bones (Suleiman *et al.,* 2020). In addition, it helps in the formation of blood, intracellular, and extracellular fluids within and outside the cells of the tissues (Malan and Stump, 2004).

3.4 Correlation Between Heavy Metals and Macro-Elements in the Instant Noodles

The result of the correlation between heavy metals and macro-elements in various brands of instant noodles is summarized in Table 4. The result indicates that a very strong negative relationship exists among Pb and Mg (r=0.602, P<0.01), Pb and K (r=-0.842, P<0.01), Pb and Na (r=-0.726, P<0.01). A strong positive relationship exists between Cr and Ca (r=0.702, P<0.01). The strong positive relationship indicates that the heavy metal and macro-element were from the source, it also indicates that an increase in metal (e.g., Cr) resulted in to increase in macro-element (eg, Ca).

3.5. Correlation Between Heavy Metal and Pesticide Residue in the Instant Noodles

The result of the correlation between heavy metal and pesticide residue is presented in Table 5. The results show that a very strong positive relationship exists between Pb and Lindane (r=0.791, P< 0.01), Pb and Aldrin (r=0.705, P<0.01). Similarly, very strong positive relationships exist between Cd and Heptachlor (r=0.851, P<0.01), Cd and Carbofuran (r=0.692, P<0.01), Cd and Dicophol (r=0.880, P<0.01), and Cd and Endrin (r=0.913, P<0.01). However, very strong negative relationships exist between Pb and Dieldrin (r= - 0.708, P< 0.01), Pb and G-chlordane (r= - 0.700, P< 0,01), Pb and Dichlorvos (r=-0.783, P<0.01), and Pb and HCB (r= - 0.700, P<0.01). Additionally, a very strong negative relationship exists between Cd and Dieldrin (r= - 0.606, P<0.01), Cd and 2-4-DOT (r=- 606, P<0.01). More so, very strong negative relationships exist between Cu and G-chlordane (r = - 0.632, P<0.01) as well as Cu and Deltametrin (r = - 0.614, P< 0.01).

3.6. Correlation between macro-elements and pesticide residues in noodles

The result of the Pearson correlation coefficient between macro-elements and pesticide residues in various brands of instant noodles is presented in Table 6. A very strong negative relationship exists between Mg and Lindane (r = - 0.607, P< 0.01) while a very strong positive relationship exists between Mg and Tetradifon (r=-0.915, P<0.01). A very strong negative relationship exists between K and Lindane (r= -0.598, P<0.01) and Aldrin (r =

- 0.838, P< 0.01). Very strong positive relationship exist between K and G-chlordane (r =0.610, P < 0.01), Dichlorvos (r= 0.602, P<0.01), HCB (r =610, P< 0.01), Endosulfan(r=0.612, P<0.01), and Tetradifon (r=610,P<0.01). More so, very strong positive relationship exists between Na and Diedrin (r=0.646, P<0.01), T-nonachlor (r=661, P< 0.01), G-chlordane (r =593, P<0.01), Dichlorvos (r=0.684, P<0.01) and HCB (r = 0.593, P< 0.01). Very strong negative relationship exist between Ca and Diedrin (r=0.853, P<0.01), Biphenyl (r= -0.649, P<0.01), T-nonachlor (r=-0.918, P<0.01), Dichlorvos(r= - 0.637, P<0.01) while very strong positive relationship exist between Ca and Deltametrin (r= 0.692, P<0.01). Very strong positive relationship exists between P and Carbofuran (r= 0.610, P< 0.01), Dicophol (r = 0.629, P< 0.01), Aldrin (r= 0.676, P< 0.01), while very strong negative relationship exists between P and G-chlordane (r= - 0.649, P< 0.01), Dichlorvos (r= - 0.551, P< 0.01), HCB (r = - 0.652, P< 0.01), and Endosulfan (r = - 0.882, P < 0.01).

Conclusion

The results of the study revealed the presence of heavy metals, pesticides, and macro-elements in different brands of instant noodles tested in the study. The values of Pb and Cr recorded in the noodles (Golden Penny and Mimee) were higher than the permissible limit set by the Codex Alimentarius Commission. The presence of heavy metals (Pb, Cr, and Cd) and pesticide residues in the noodles could pose serious health risks to people who consume such contaminated foods. Therefore, it is recommended that the contaminated noodles be called back or retrieved from the market by the producers. This will reduce the continuous intake of heavy metals and pesticide residues by consumers. Additionally, there should be regular monitoring of contaminants (heavy metals and pesticide residues) in instant noodles to ensure food safety and the health of consumers. Proper precautions should be taken during the processing and production of instant noodles.

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Table 1: Concentration of Pesticide Residues on Noodle Samples

Noodles	Heptachlor	Diedrin	Carbofuran	Dicophol	Biphenyl	T-nonachlor	Lindane	Aldrin	G-chlordane	Dichlorovos	2-4-DOT	HCB	Endosulfan	Deltametrin	Endrin	Tetradifon
Tummy Tummy	0.02^{b}± 0.00	0.32^{a}± 0.00	0.01^{e} ±0.00	0.02^{c} ±0.00	0.01^{a} ±0.00	0.02^{b} ±0.00	0.01^{c} ±0.00	0.21^{b} ±0.00	0.00^{b} ±0.00	0.03^{b} ±0.00	0.02^{a} ±0.00	0.00^{b} ±0.00	0.00^{d} ±0.00	0.00^{c} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00
Indomie	0.00^{c}± 0.00	0.23^{b}± 0.00	0.00^{f} ±0.00	0.01^{d} ±0.00	0.00^{b} ±0.00	0.02^{a} ±0.00	0.00^{d} ±0.00	0.01^{f} ±0.00	0.003^{a}± 0.00	0.11^{a} ±0.00	0.00^{d} ±0.00	0.002^{a} ±0.00	0.02^{a} ±0.00	0.00^{c} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00
Supreme	0.16^{a}± 0.00	0.00e± 0.00	0.35^{a} ±0.00	0.19^{a} ±0.00	0.00^{b} ±0.00	0.00^{d} ±0.00	0.16^{b} ±0.00	0.22^{a} ±0.00	0.00^{b} ±0.00	0.00^{c} ±0.00	0.00^{d} ±0.00	0.00^{b} ±0.00	0.00^{d} ±0.00	0.03^{b} ±0.00	0.04^{a} ±0.00	0.00^{b} ±0.00
Mimee	0.00^{c}± 0.00	0.01^{d}± 0.00	0.32^{b} ±0.00	0.02^{b} ±0.00	0.00^{b} ±0.00	0.00^{e} ±0.00	0.00^{e} ±0.00	0.16^{d} ±0.00	0.00^{b} ±0.00	0.00^{c} ±0.00	0.02^{b} ±0.00	0.00^{b} ±0.00	0.00^{d} ±0.00	0.38^{a} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00
Masters	0.00^{c}± 0.00	0.03^{c}± 0.00	0.23c ±0.00	0.00^{e} ±0.00	0.00^{b} ±0.00	0.00^{e} ±0.00	0.00^{e} ±0.00	0.10^{e} ±0.00	0.00^{b} ±0.00	0.00^{c} ±0.00	0.00^{d} ±0.00	0.00^{b} ±0.00	0.02^{c} ±0.00	0.00^{c} ±0.00	0.00^{b} ±0.00	0.30^{a} ±0.00
Golden Penny	0.00^{c}± 0.00	0.00^{e}± 0.00	0.10^{d} ±0.00	0.00^{e} ±0.00	0.00^{b} ±0.00	0.01^{c} ±0.00	0.26^{a} ±0.00	0.19^{c} ±0.00	0.00^{b} ±0.00	0.00^{c} ±0.00	0.01^{c} ±0.00	0.00^{b} ±0.00	0.02^{b} ±0.00	0.00^{c} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00

Values are mean ± standard deviation of three replicates

^{abc}Means in the same column with different superscripts are significantly different (P<0.0)

Table 2: Concentration of Heavy Metals (mg/kg) in different Noodles

Noodles	Pb	Cd	Cr	Cu	Zn
Tummy Tummy	0.15^{c} ± 0.00	0.00^{c} ± 0.00	0.58^{d} ± 0.00	0.03^{a} ± 0.00	0.03^{e} ± 0.00
Indomie	0.00^{d} ± 0.00	0.04^{b} ± 0.00	0.12^{e} ± 0.00	0.00^{b} ± 0.00	0.06^{c} ± 0.00
Supreme	0.30^{b} ± 0.00	0.11^{a} ± 0.00	0.82^{c} ± 0.00	0.03^{a} ± 0.00	0.10^{a} ± 0.00
Mimee	0.30^{b} ± 0.00	0.04^{b} ± 0.00	6.30^{a} ± 0.00	0.00^{b} ± 0.00	0.07^{b} ± 0.00
Masters	0.15^{c} ± 0.00	0.04^{b} ± 0.00	0.70^{f} ± 0.00	0.03^{a} ± 0.00	0.03^{d} ± 0.00
Golden Penny	0.45^{a} ± 0.00	0.04^{b} ± 0.00	2.45^{b} ± 0.01	0.03^{a} ± 0.00	0.07^{b} ± 0.00

Values are mean ± standard deviation of three replicates

^{abc}Means in the same column with different superscripts are significantly different (P<0.05)

Table 3: Macro-Element content (mg/kg) in different Noodles

Noodles	Mg	K	Na	Ca	P
Tummy Tummy	$4.20^{c} \pm 0.00$	$0.15^{b} \pm 0.00$	$7.26^{b} \pm 0.00$	$31.33^{e} \pm 0.00$	$42.60^{b} \pm 1.00$
Indomie	$4.26^{b} \pm 0.00$	$0.31^{a} \pm 0.00$	$7.61^{a} \pm 0.00$	$33.00^{d} \pm 1.00$	$28.20^{f} \pm 1.00$
Supreme	$4.09^{d} \pm 0.00$	$0.08^{c} \pm 0.00$	$6.83^{d} \pm 0.00$	$38.00^{b} \pm 0.58$	$45.80^{a} \pm 1.00$
Mimee	$4.09^{d} \pm 0.00$	$0.08^{c} \pm 0.00$	$6.12^{f} \pm 0.00$	$41.33^{a} \pm 1.00$	$40.40^{c} \pm 1.00$
Masters	$4.69^{a} \pm 0.00$	$0.31^{a} \pm 0.00$	$7.26^{c} \pm 0.00$	$38.00^{b} \pm 1.00$	$38.00^{d} \pm 1.00$
Golden Penny	$3.97^{e} \pm 0.00$	$0.08^{c} \pm 0.00$	$6.82^{e} \pm 0.00$	$36.00^{c} \pm 1.00$	$30.20^{e} \pm 1.00$

Values are mean ± standard deviation of three replicates

[abc]Means in the same column with different superscripts are significantly different ($P<0.05$)

Table 4: Pearson correlation between Heavy Metals and Macro-Element content of different Noodles

	Pb	Cd	Cr	Cu	Zn	Mg	K	Na	Ca	P
Pb	1									
Cd	0.290	1								
Cr	.525*	-0.067	1							
Cu	0.369	0.130	-0.459	1						
Zn	0.491*	0.844**	0.278	-0.177	1					
Mg	-0.602**	-0.190	-0.401	0.124	-0.607**	1				
K	-0.842**	-0.299	-0.569*	-0.176	-0.551*	0.826**	1			
Na	-0.726**	-0.228	-0.918**	0.176	-0.473*	0.493*	0.782**	1		
Ca	0.485*	0.458	0.702**	-0.184	0.481*	-0.010	-0.350	-.780**	1	
P	0.157	0.331	0.111	0.355	0.067	0.019	-0.416	-0.375	0.285	1

*****. Correlation is significant at the 0.01 level ($P<0.01$)***

****. Correlation is significant at the 0.05 level ($P<0.05$)***

Table 5: Pearson correlation between Heavy Metals and Pesticide Residues on different Noodles

	Pb	Cd	Cr	Cu	Zn	Heptachlor	Diedrin	Carbofuran	Dicophol	Biphenyl	T-nonachlor	Lindane	Aldrin	G-chlordane	Dichlorovos	2-4-DOT	HCB	Endosulfan	Deltametrin	Endrin	Tetradifon
Pb	1																				
Cd	0.290	1																			
Cr	.525*	-0.067	1																		
Cu	0.369	0.130	-0.459	1																	
Zn	.491*	.844**	0.278	-0.177	1																
Heptachlor	0.206	.851**	-0.252	0.365	.621**	1															
Diedrin	-.708**	-.606**	-.479*	-0.130	-.614**	-0.249	1														
Carbofuran	0.451	.692**	.487*	0.038	.562*	.530*	-.791**	1													
Dicophol	0.206	.880**	-0.159	0.251	.686**	.991**	-0.289	.589*	1												
Biphenyl	-0.234	-.582*	-0.261	0.316	-.642**	-0.068	.766**	-.493*	-0.136	1											
T-nonachlor	-.469*	-.485*	-.508*	-0.111	-0.336	-0.242	.861**	-.924**	-0.286	.546*	1										
Lindane	.791**	0.427	-0.014	.500*	.565*	0.357	-.496*	0.101	0.318	-0.261	-0.070	1									
Aldrin	.705**	0.176	0.234	.601**	0.178	.481*	-0.216	0.348	0.443	0.410	-0.236	.491*	1								
G-chlordane	-.700**	-0.082	-0.359	-.632**	0.027	-0.231	.471*	-.537*	-0.196	-0.200	.605**	-0.314	-.836**	1							
Dichlorovos	-.783**	-0.263	-0.446	-.544*	-0.171	-0.255	.715**	-.698**	-0.241	0.106	.783**	-0.399	-.722**	.953**	1						
2-4-DOT	0.126	-.606**	.494*	-0.112	-0.386	-0.286	0.381	-0.133	-0.276	.707**	0.167	-0.281	.482*	-0.376	-0.163	1					
HCB	-.700**	-0.082	-0.359	-.632**	0.027	-0.231	.471*	-.537*	-0.196	-0.200	.605**	-0.313	-.835**	.997**	.952**	-0.375	1				
Endosulfan	-0.197	-0.184	-0.352	-0.057	-0.152	-.514*	-0.040	-.478*	-.540*	-0.445	0.238	0.150	-.700**	.518*	0.389	-.628**	.518*	1			
Deltametrin	0.257	-0.006	.935**	-.614**	0.259	-0.150	-0.341	.546*	-0.040	-0.220	-.497*	-0.290	0.112	-0.220	-0.291	.493*	-0.219	-.489*	1		
Endrin	0.234	.913**	-0.212	0.316	.696**	.991**	-0.347	.586*	.992**	-0.200	-0.310	0.385	0.418	-0.200	-0.265	-0.376	-0.200	-0.445	-0.118	1	
Tetradifon	-0.234	-0.082	-0.237	0.316	-.475*	-0.231	-0.236	0.183	-0.269	-0.200	-0.464	-0.318	-0.308	-0.200	-0.265	-0.376	-0.200	0.366	-0.220	-0.200	1

*****. Correlation is significant at the 0.01 level (P<0.01)***

****. Correlation is significant at the 0.05 level (P<0.05)***

Table 6: Pearson correlation between Macro-Element content and Pesticide Residues on different Noodles

	Mg	K	Na	Ca	P	Heptachlor	Diedrin	Carbofuran	Dicophol	Biphenyl	T-nonachlor	Lindane	Aldrin	G-chlordane	Dichlorovos	2-4-DOT	HCB	Endosulfan	Deltametrin	Endrin	Tetradifon
Mg	1																				
K	.826**	1																			
Na	.493*	.782**	1																		
Ca	-0.010	-0.350	-.780**	1																	
P	0.019	-0.416	-0.375	0.285	1																
Heptachlor	-0.252	-0.403	-0.110	0.142	.634**	1															
Diedrin	0.110	0.409	.646**	-.853**	-0.107	-0.249	1														
Carbofuran	-0.015	-0.432	-.708**	.882**	.610**	.530*	-.791**	1													
Dicophol	-0.284	-0.425	-0.186	0.221	.629**	.991**	-0.289	.589*	1												
Biphenyl	-0.028	-0.055	0.263	-.649**	0.352	-0.068	.766**	-.493*	-0.136	1											
T-nonachlor	-0.201	0.269	.661**	-.918**	-0.444	-0.242	.861**	-.924**	-0.286	.546*	1										
Lindane	-.607**	-.598**	-0.218	0.065	-0.135	0.357	-.496*	0.101	0.318	-0.261	-0.070	1									
Aldrin	-.502*	-.838**	-.523*	0.134	.676**	.481*	-0.216	0.348	0.443	0.410	-0.236	.491*	1								
G-chlordane	0.087	.610**	.593**	-0.431	-.649**	-0.231	.471*	-.537*	-0.196	-0.200	.605**	-0.314	-.836**	1							
Dichlorovos	0.080	.602**	.684**	-.637**	-.551*	-0.255	.715**	-.698**	-0.241	0.106	.783**	-0.399	-.722**	.953**	1						
2-4-DOT	-0.319	-0.429	-0.406	-0.099	0.349	-0.286	0.381	-0.133	-0.276	.707**	0.167	-0.281	.482*	-0.376	-0.163	1					
HCB	0.087	.610**	.593**	-0.428	-.652**	-0.231	.471*	-.537*	-0.196	-0.200	.605**	-0.313	-.835**	.997**	.952**	-0.375	1				
Endosulfan	0.325	.612**	.535*	-0.220	-.882**	-.514*	-0.040	-.478*	-.540*	-0.445	0.238	0.150	-.700**	.518*	0.389	-.628**	.518*	1			
Deltametrin	-0.268	-0.426	-.840**	.692**	0.251	-0.150	-0.341	.546*	-0.040	-0.220	-.497*	-0.290	0.112	-0.220	-0.291	.493*	-0.219	-.489*	1		
Endrin	-0.244	-0.388	-0.143	0.226	.576*	.991**	-0.347	.586*	.992**	-0.200	-0.310	0.385	0.418	-0.200	-0.265	-0.376	-0.200	-0.445	-0.118	1	
Tetradifon	.915**	.610**	0.259	0.226	0.033	-0.231	-0.236	0.183	-0.269	-0.200	-0.464	-0.318	-0.308	-0.200	-0.265	-0.376	-0.200	0.366	-0.220	-0.200	1

*****. Correlation is significant at the 0.01 level (P<0.01)***

****. Correlation is significant at the 0.05 level (P<0.05)***