Estimation of Some Trace Metals Contamination in Waste Newspapers

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Abstract

In the current study, different types of waste newspapers in the Middle East and Asia were analyzed qualitatively and quantitatively by Inductively Coupled Plasma and Optical Emission Spectrometry (ICP OES) for trace metals contamination. 11 samples from different newspapers collected by the researchers from local markets were analyzed for arsenic (As), cadmium (Cd), chromium (Cr), nickel (Ni), lead (Pb), aluminum (Al), and zinc (Zn). Trace metals concentrations in the samples were compared with those established by the various specialized councils. Digestion solution for samples digested in this study included 10 ml of 69% nitric acid and 2 ml of 30% hydrogen peroxide. Based on the results for light fonts, the average content of As, Cd, Cr, Ni, and Pb was (2.8, 1.5, 6.9, 5.6, and 5.0 μg^{L-1}), while was (3.4 and 0.18 mg^{L-1}) for Al, and Zn, respectively. In bold fonts, the content of As, Cd, Cr, Ni, and Pb was (4.9, 2.4, 9.1, 7.9, and 7.0 μg^{L-1}, respectively), while Al and Zn were (5.7 mg/l and 0.32 mg^{L-1}) respectively. In the pictures, the levels of As, Cd, Cr, Ni, and Pb were (6.1, 2.99, 11.2, 9.4, and 8.99 μg^{L-1}), while Al and Zn were (8.2, and 0.39 mg^{L-1}), respectively. The results showed that all levels of trace metals under study were within the specialized global councils' permitted limits, but the presence of trace metals in waste newspapers, even within the permitted limits, remains a source of great concern, as exposure to these elements has a significant impact on consumer health.

Introduction

Trace metal levels in newspapers have been a source of concern in the past, but environmental organizations now believe that this is unlikely to be an issue. However, there is a scarcity of scientific studies of trace metal concentrations reported in actual newspapers that may be used to back up these statements [1].

The use of newspapers and journals in food packaging has become a major issue in recent years. Street food is frequently produced by the roadway in severely unsanitary conditions, and it is also marketed and given to clients wrapped in discarded newspapers. Furthermore, it is well acknowledged that the quality of paper used in newspapers is of poor quality [2].

Today, street food trading is a burgeoning industry in many developing countries, including Pakistan, India, Bangladesh, Nigeria, Egypt, the Philippines, and nearly all African countries. Its growth is linked to urbanization and the desire for job and food among city dwellers. Nonetheless, the significance of street foods in meeting the nutritional needs of city dwellers has gotten little official consideration, and more emphasis has been paid to the potential hazards associated with their intake rather than the potential advantages. However, much of the prejudice against street cuisine is erroneous and based on prejudice rather than empirical evidence [3].

The reason for utilizing a substandard newspaper's quality is to cut its cost, as the average reader cannot afford to pay the newspaper's high price, and as a result, all types of newspapers and magazines must eventually go to waste [4]. While all discarded newspapers and magazines are recycled and utilized as packing material in rich countries, recycling is not widely performed in developing countries. This service is only available in developed countries [5].

It is a well-known truth that the ink used to print newspapers and magazines may not be of acceptable quality, and that it may contain dangerous metals in high or low amounts [6]. So, when common street food eaters consume street food wrapped in used newspapers or magazines, they may consume low or high concentrations of harmful trace metals, especially when the food wrapped in used newspapers or magazines is moistened or fried in cooking oil [7].

Ingesting trace metals on a regular basis can be detrimental to people [8, 9]. When trace metals like chromium, copper, manganese, and zinc are present in food at levels above safe levels, they can cause noncarcinogenic risks like neurological disorders and liver disease [10], while cadmium contamination has been linked to an increased risk of menopausal breast cancer [11].

Food wrapped in soiled newspapers or magazines is unhealthy, and eating it is harmful to one's health, even if the food has been cooked safely. The elderly, adolescents, children, and people with compromised vital organs and immune systems are at a higher risk of developing cancer-related health complications if they are exposed to foods packed with soiled newspapers or magazines [12].

According to Shukla, printing inks in used newspapers may contain harmful colors, pigments, binders, additives, preservatives, chemical contaminants, and pathogenic microorganisms. These "contaminations" pose a risk to human health, such as phthalate, which can cause digestive problems and severe toxicity [12].

Aside from the existence of low or high amounts of trace metals in the newspaper printing ink, other hazardous compounds such as 2-naphthylamine and 4-aminobiphenyl have been documented. At least among newspaper printing workers, some studies have connected the presence of ink to bladder and lung malignancies [13, 14].

In recent research, the Commissioner of Food Safety in Chennai (one of India's cities) urged the public and street food vendors not to use newspaper trash, including magazine garbage, to sell food items packaged in printed newspapers. Eatables such as "vada, bonda, pakoda, bajji," cooked fish, and meat products, according to Bhowmik, become hazardous when packed in newspapers and plastic coverings, and should not be ingested for obvious reasons [15].

Migration refers to the movement of chemical compounds from the skeletal body of newspapers to food. This means that pollutants can migrate from newspapers that come into direct contact with food. In this sort of migration, ink chemicals transfer from newspapers to food accidentally, increasing food contamination as color intensity (or saturation) increases [16].

Many techniques, such as ICP OES, ICP-MS (inductively coupled plasma mass spectrometry), and ET AAS (electrothermal vaporization atomic absorption spectrometry), provide appropriate analytical detection power for such applications. In this regard, Kim et al [17]. Bakircioglu *et al* investigated the influence of metal migration in cheese samples packaged in tins using ICP OES for element quantification [18]. Perring *et al*. assessed various analytical techniques for the measurement of Cd, Cr, Hg, and Pb in paper materials, including ICP-MS, ICP OES, and CVG-AAS (atomic absorption spectrometry with chemical vapor generation) [19].

The goal of this study was to assess the amounts of trace metals As, Pb, Cd, Ni, Al, Zn, and Cr in newspapers, which is a frequent practice in developing and poor countries alike. It also determined whether the newspapers were compliant with relevant legislation.

Results

Waste newspapers and journals are used in a variety of ways, such as recycled cardboard and packaging for goods that come into indirect contact with food [20]. Twelve samples were chosen from a total of three newspapers for analyzing residual trace metals in waste contact paper. The samples were chosen from discarded newspapers that had either light, bold fonts, or pictures.

1.1. Method validation

The validation of the method was carried out in accordance with FDA's validation guidelines and protocol, which were published in 2018. Linearity was tested to see if the method was reliable, as well as, precision, sensitivity, limit of detection (LOD), and limit of quantification (LOQ) [21].

1.1.1. Linearity

Linearity was proved with the correlation coefficient R^2 of the calibration curves was calculated in duplicate with standard solutions at concentrations of Cd, Pb, Cr, Ni, and As (5, 10, 15, 20, 25, and 30 μg^{L-1}), with Al and Zn (2, 6, 10, 14, 18, and 25 mg $^{L-1}$) for a linear graph. Cd, Pb, Zn, Cr, and As had correlation coefficients of (0.9997, 0.9965, 0.9997, 0.9998, and 0.9992, respectively, whereas Al and Zn had correlation coefficients of (0.9997 and 0.9997). All the elements under examination had good linearity. All the correlation coefficients (r^2) were within the national standards' limit (r^2 0.999). Table 1 shows the findings of linear calibration curves for chosen metals, whereas Table 2 shows the specific results of the researched metals of interest.

Table 1
The findings of method validation for a variety of trace metals.

Metal	Wavelength (nm)	Intensity	Correlation coefficient	%RSD	LOD	LOQ
As	188.980	1.288	0.9992	3.35	1.5 μg L^{-1}	4.49 μg L^{-1}
Cd	214.439	28.098	0.9997	2.43	0.5 μg L^{-1}	1.48 μg L^{-1}
Cr	267.716	36.416	0.9998	5.25	4.1 μg L^{-1}	12.28 μg L^{-1}
Ni	231.604	4.172	0.9991	6.22	2.5 μg L^{-1}	7.49 μg L^{-1}
Pb	353	2.472	0.9965	7.50	2.1 μg L^{-1}	6.29 μg L^{-1}
Al	396.153	6836.308	0.9997	4.23	2.3 mg L^{-1}	6.89 mg L^{-1}
Zn	213.850	9133.029	0.9997	5.33	0.1 mg L^{-1}	0.28 mg L^{-1}

Table 2
Detailed results of metals of interest that were studied

Newspapers	Samples	As	Cd	Cr	Ni	Pb	Al	Zn
		μg^{Kg-1}	μg^{Kg-1}	μg^{Kg-1}	μg^{Kg-1}	μg^{Kg-1}	mg^{Kg-1}	mg^{Kg-1}
Al-Ahram (Egyptian)	Blank	0.06	0.04	0.04	0.02	0.05	0.02	0.01
Al-Ahram (Egypt)	Photo	6.42	4.30	10.35	12.98	6.65	7.36	0.28
Al-Ahram (Egypt)	Light fonts	1.94	2.31	7.93	8.47	3.90	2.68	0.16
Al-Ahram (Egypt)	Bold fonts	3.03	3.40	8.59	10.94	5.67	5.52	0.68
Sharooq (Egypt)	Blank	0.09	0.06	0.09	0.09	0.08	0.05	0.27
Sharooq (Egypt)	Photo	5.33	3.21	10.83	9.18	7.40	8.63	0.45
Sharooq (Egypt)	Light fonts	2.11	1.17	6.47	6.21	4.49	2.53	0.14
Sharooq (Egypt)	Bold fonts	4.20	2.25	8.77	8.36	6.61	5.07	0.21
Al-Akhbar (Egypt)	Blank	0.04	0.05	0.03	0.09	0.09	0.04	0.05
Al-Akhbar (Egypt)	Photo	8.56	1.36	18.57	15.70	10.03	6.60	0.48
Al-Akhbar (Egypt)	Light fonts	3.15	1.24	12.84	10.71	5.32	2.92	0.11
Al-Akhbar (Egypt)	Bold fonts	5.75	1.67	15.75	13.05	9.84	4.06	0.24
Al-Dastoor (Egypt)	Blank	0.07	0.06	0.10	0.02	0.05	0.07	0.02
Al-Dastoor (Egypt)	Photo	5.16	3.79	18.76	14.52	15.20	7.05	0.18
Al-Dastoor (Egypt)	Light fonts	3.25	1.24	13.21	9.08	10.21	4.22	0.14
Al-Dastoor (Egypt)	Bold fonts	4.85	2.67	15.28	11.04	13.42	8.56	0.15
Akhbar-Al-Youm (Egypt)	Blank	0.04	0.06	0.10	0.04	0.06	0.08	0.05

Newspapers	Samples	As	Cd	Cr	Ni	Pb	Al	Zn
		μg^{Kg-1}	μg^{Kg-1}	μg^{Kg-1}	μg^{Kg-1}	μg^{Kg-1}	mg^{Kg-1}	mg^{Kg-1}
Akhbar-Al-Youm (Egypt)	Photo	5.26	1.89	12.06	6.06	18.28	8.94	0.28
Akhbar-Al-Youm (Egypt)	Small writing	2.37	1.56	5.64	3.46	5.88	3.89	0.15
Akhbar-Al-Youm (Egypt)	Bold fonts	4.60	1.68	8.28	5.67	9.17	5.88	0.19
Sharaq-Al-Aqsah (Egypt)	Blank	0.07	0.10	0.08	0.03	0.04	0.04	0.07
Sharaq-Al-Aqsah (Egypt)	Photo	5.10	4.92	9.57	5.82	6.02	8.98	0.27
Sharaq-Al-Aqsah (Egypt)	Small writing	2.73	1.88	4.25	3.39	4.84	4.37	0.15
Sharaq-Al-Aqsah (Egypt)	Bold fonts	3.73	2.93	7.26	4.64	5.66	6.28	0.18
Al-Watan (Egypt)	Blank	0.05	0.03	0.04	0.021	0.06	0.08	0.04
Al-Watan (Egypt)	Photo	4.60	3.35	10.79	8.93	6.92	8.90	0.26
Al-Watan (Egypt)	Light fonts	3.23	1.44	5.38	4.53	2.96	3.10	0.15
Al-Watan (Egypt)	Bold fonts	6.28	2.79	8.55	6.17	4.27	5.34	0.20
Arab News (Saudi)	Blank	0.03	0.04	0.07	0.09	0.06	0.05	0.05
Arab News (Saudi)	Photo	7.00	5.59	8.22	10.32	8.77	9.59	0.44
Arab News (Saudi)	Light fonts	4.01	3.55	5.50	4.75	4.56	4.65	0.24
Arab News (Saudi)	Bold fonts	5.94	4.76	7.10	7.59	6.55	6.26	0.34
Al-Madinah (Saudi)	Blank	0.10	0.03	0.02	0.03	0.03	0.09	0.02
Al-Madinah (Saudi)	Photo	6.72	2.02	6.87	4.54	6.24	8.29	0.66
Al-Madinah (Saudi)	Light fonts	2.41	1.08	4.66	2.79	3.38	2.37	0.33

Newspapers	Samples	As	Cd	Cr	Ni	Pb	Al	Zn
		μg^{Kg-1}	μg^{Kg-1}	μg^{Kg-1}	μg^{Kg-1}	μg^{Kg-1}	mg^{Kg-1}	mg^{Kg-1}
Al-Madinah (Saudi)	Bold fonts	5.72	1.52	5.25	3.65	5.04	4.70	0.46
Urdu News (Saudi)	Blank	0.02	0.09	0.07	0.08	0.04	0.06	0.04
Urdu News (Saudi)	Photo	6.93	1.17	10.26	6.34	6.07	9.00	0.23
Urdu News (Saudi)	Light fonts	2.01	0.98	5.21	2.99	4.51	3.04	0.13
Urdu News (Saudi)	Bold fonts	4.25	1.65	8.74	7.69	5.54	5.63	0.27
News Paper (India)	Blank	0.05	0.09	0.01	0.07	0.03	0.05	0.07
News Paper (India)	Photo	6.05	1.19	7.08	8.69	7.35	6.51	0.74
News Paper (India)	Light fonts	3.97	0.54	4.35	4.67	5.01	4.03	0.33
News Paper (India)	Bold fonts	5.30	0.88	6.85	7.62	6.03	5.67	0.57

1.1.2. Precision

The degree to which measurements are close to one another, expressed as a percentage of relative standard deviation, is known as precision (%RSD). This should not exceed 15% at any concentration level. It was calculated using the average and standard deviation equations:

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

$$SD = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \overline{X})}{n-1}}$$

$$RSD = \frac{SD}{\overline{\overline{X}}}$$

Where X\ and SD were average and standard deviation

The method's precision was determined using the same process that was used to determine linearity. At various levels of the spike, the mean SD and %RSD were computed for each metal. The highest %RSD was recorded in Pb at 7.50%, and the lowest %RSD was observed in Cd at 2.43%, both of which were consistent and commensurate with national and international standards [21]. All results for %RSD in all trace metal constituents with national and international standards are listed in the Table 1.

1.1.3. Sensitivity

The sensitivity of the instrument was assessed by measuring the target trace metals' limit of detection LOD and limit of quantification LOQ as 3.3/S and 10/S, respectively. LOD was computed using the equation LOD = (3.3)/S, where S is the slope of each calibration curve and is the standard deviation of the peak intensity for the blank of a material.

LOQ was determined using the same formula: LOQ = (10)/S. Cd, Pb, Ni, Cr, and As had LODs of (0.5, 2.1, 2.5, 4.1, and 1.5 µg $^{L-1}$), while Al and Zn had LODs of (2.3 and 0.1 mg $^{L-1}$), respectively. (1.48, 6.29, 7.49, 12.28, and 4.49 µg $^{L-1}$) were the LOQs for Cd, Pb, Ni, Cr, and As, respectively. While the LOQs for Al and Zn, which were (6.89 and 0.28 mg $^{L-1}$), respectively Table 1. The values are acceptable according to national criteria because the LOD and LOQ are specific to the approach [22, 23].

Methods

5.1. Materials

Three newspapers from Egypt, Saudi Arabia, and India were collected for this study. As a result, a total of 12 samples were chosen for this project from the newspapers of the three countries mentioned above. (1) Al-Ahram, (2) Sharooq, (3) Al-Akhbar, (4) Al-Watan, (5) Al-Akhbar-Al-Youm, (6) Al-Dastoor, and (7) Al-Sharq-Al-Aqsa were the Egyptian newspapers. In the same way, three newspapers were obtained from a small shop in Riyadh, Saudi Arabia: (1) Arab News (2) Al-Medina (3) Urdu News (a local Urdu newspaper published in Riyadh, Saudi Arabia) and only one Indian newspaper were sent by one of our colleagues from India.

5.2. Chemical and reagents

Fisher Scientific, Riyadh, Saudi Arabia, provided ICP grade nitric acid 69% w/w and ICP grade hydrochloric acid 37% in H_2O, both 99.999 % Sigma Aldrich. The local agent of Sigma Aldrich, Riyadh, Saudi Arabia, provided ultra-pure hydrogen peroxide 35% w/w and ICP grade elemental stock standards of choice of 1000 mg $^{L-1}$. For ultrapure water grade 18.2MΩ·cm, the pure lab alga state-of-the-art water deionizer was utilized for all purposes, including diluting the digested samples, preparing the working standards of stock standards, and so on.

5.3. Instrumentation

The Agilent ICP OES Instrument (model: 5110 VDV, Agilent Technologies, USA) features a vertical torch and a high-speed, zero-gas-consumption Vista-Chip II CCD detector, as well as a unique Dichroic Spectral Combiner (DSC) technology that permits simultaneous radial and axial measurements. The equipment was used in proper settings, including selecting the appropriate wavelength for each element (Cd: 214.439, Pb: 220.353, Cr: 267.716, As: 188.980, Ni: 231.604, Al: 396.153, and Zn: 213.850). This wavelength was chosen since no assumptions could be drawn from these emission lines, and a better baseline was detected than at other wavelengths. The plasma argon flow rate was 12 L/min, the auxiliary argon flow rate was 1 L/min, the nebulizer argon flow rate was 0.7 L/min, the integration time was 100 seconds, the read delay was 20 seconds, and the peristaltic pump flow rate was 1 ml/min. Milestones Ethos-One high-performance microwave digestion system is state-of-the-art technology that provides high efficacy for soft and hard sample digestion. The samples were properly weighed using a Mettler Analytical Balance-A-166. Filtration for digested samples was done with PTFE-0.45m Syringe Filters.

5.4. Sample preparation

For the digestive and elemental investigations, four types of samples were chosen from each collected newspaper sample.

A-Blank, the blank samples were cut and collected from the newspaper's borderline, which was not printed with any form of printing. A section of small readable writing was trimmed and picked from each paper using B-Light fonts. C-Bold typefaces: For acid digestion, the piece of newspaper with bold characters (in black or colorful ink) was carefully trimmed. D- samples of colorful and black pictures. The collected blanks, light fonts, bold fonts, and pictures were cut into little pieces with clean stainless-steel scissors, tagged, and stored for further processing. Gloves were utilized during the operation to avoid cross contamination.

5.4.1 Prepare samples before digestion

The PTFE microwave vessels were cleansed with deionized distilled water and soaked overnight in 10% nitric acid before being used in the microwave digestion process. To avoid cross contamination, the digested sample storage PTFE bottles were rinsed with distilled water (18.2 Ohms) and soaked in 10% HNO_3. To eliminate cross-contamination, all the glassware was cleaned 2-3 times with distilled water (18.2 Ohms) and steeped in 10% HNO_3.

5.4.2. Microwave digestion method

On an analytical balance, half a gram 500 mg of all samples, blanks, light fonts, bold fonts, and pictures were weighed and transferred to PTFE microwave containers 20 ml. Then, according to EPA approved method 3052, 10 mL 69% HNO_3 was added to each vessel, followed by 2.0 mL 30% H_2O_2 [24].

To finish the reaction, the containers were placed in a fume hood for 10 minutes. The vessels were now tightly closed and inserted into the microwave, where they would be fully digested as part of the digestion program.

5.4.3. Microwave digestion program

The digested clear solution of samples was transferred to acid-washed 50 ml volumetric flasks after the microwave digestion process was completed, and the final volume of 50 ml was prepared using 2% ICP grade nitric acid. The samples were filtered using 0.45 m PTFE filters, transported to bottles, and kept at room temperature until they were injected into the ICP OES for the elemental analysis indicated.

Time (Minutes)	Power (Watts)	Temperature (°C)
15	1500	200
45(Hold Time)	1500	200

5.5 The ICP-OES investigated results of newspapers for described metals

After adequate dilution of stock standards of 1000 mg $^{L-1}$ according to the following range, multi-elemental working standard solutions were created for linear calibration graph: As, Cd, Cr, Ni, and Pb levels of interest were explored in μg $^{L-1}$ units, while Zn and Al levels of interest were investigated in mg^{L-1} units.

5.6 Statistical Analysis

The mean, standard deviation, and coefficient of variation are all displayed. For analysis and chart creation, Microsoft Office (Excel-2003) was used. The statistical analyses were performed using SPSS Statistics for Windows Version 17.0 (SPSS Inc., Chicago, IL, USA).

Discussion

6.1 Concentrations of Metals in Waste Newspapers

Arsenic is naturally present in the plants that were used to produce the paper, which has trace amounts of it [25]. Arsenic has cutaneous, developmental, hematological, reproductive, and vascular consequences when it is consumed [26]. The SML (Singapore Ministry of Health) advised a concentration of As of 0.1 mg^{Kg-1} as suggested by Korean regulations," the authors noted [27]. In the waste newspapers used for this investigation, the As concentration ranged from 1.94 to 4.01 μg^{Kg-1} in Al-Ahram (Egypt) and Arab News (Saudi), with a mean value of 2.83 μg^{Kg-1} in a light font. The mean concentration of bold font was 4.88 μg^{Kg-1}, whereas the maximum and minimum concentrations of As were 3.03 and 6.28 μg^{Kg-1}, respectively, in Al-Ahram (Egypt) and Al-Watan (Egypt). In Al-Watan (Egypt) and Al-Akhbar (Egypt), however, the concentration of As in newspaper pictures ranged from 4.60 to 8.56 μg^{Kg-1}, with an average concentration of 6.10 μg^{Kg-1} (Table 2) Figure (1, 2, 3). The As acquired values were "much lower than the SML" (Singapore Ministry of Health). Human safety as established in this investigation reveals that human exposure was within acceptable limits when compared to the allowable weekly timed consumption for As of 15 μg^{Kg-1} of body weight, as shown in (Table 2) [27].

The basic structure of cadmium red and cadmium yellow, which are frequently used in newspapers because they include brighter color pigments than other dyes, and it is highly chosen for printing inks and has already been employed in a variety of other applications [28].

According to the findings, the maximum and minimum concentrations of cadmium for light fonts were found in Urdu News (Saudi Arabia) and Indian newspapers, respectively 0.54 and 3.55 μg^{Kg-1}, with an average 1.59 μg^{Kg-1}, Table 2. These concentrations are substantially lower than the limit values 2 and 0.5 mg^{Kg-1} and are consistent with the 94/62/EC Directive (2015) and the safety limit proposed by the Council of the European Communities (1993) [20, 29–31].

The average concentration of Cd in bold fonts was 1.59 μg^{Kg-1}, while the maximum and minimum concentrations were 0.88 and 13.42 μg^{Kg-1}, respectively, in Indian newspapers and Arab News (Saudi). These concentrations are substantially lower than the permitted values 2 and 0.5 mg^{Kg-1}, according to the EPCD, 2015 and the safety limit established by the European Council (1993). As demonstrated in Table 2, Figure 1,2,3, the level of Cd in all newspaper samples was within normal limits, however it was substantially high in strong fonts compared to light fonts [29, 32].

The concentration of Cd in pictures in the Urdu News (Saudi) and Arab News (Saudi) was 1.17 and 5.59 μg^{Kg-1}, respectively, with the average concentration 2.98 μg^{Kg-1}. When compared to other newspapers, the concentration of Cd in Arab News (Saudi) was high, although it was lower than the recommendation value provided by the EPCD, 2015 and the safety level proposed by the European Council (1993) 2 and 0.5 μg^{Kg-1}, respectively. The high concentrations of Cd in several newspaper pictures confirm Zalewski's point of view [28]. This variance was related to the wide range of pigment and paint quality. The concentrations in this group of samples were lower than those found in other literature surveys [33, 34, 30]. As demonstrated in Table 2, Figure 1, 2, 3 [29, 35], the levels of Cd in all newspapers did not exceed the Cd concentration limit set by the 94/62/EC Directive (2015) [31].

The cadmium level in this study confirms that human exposure was within safe limits based on contact newspaper compared to the permissible temporary weekly intake of Pb of 7 μg^{Kg-1} body weight, but it should be considered that these newspapers are being used in fields where they are not intended (Table 2) Figure (1, 2, 3) [36].

Chromium is toxic to humans since it is carcinogenic and mutagenic in nature [34], and it is primarily found in printing inks [37]. According to Skrzydlewska *et al*. 2003, the optimum chromium level is 0.25 to

0.64 mg^{Kg-1}. The chromium levels in the trash newspapers utilized for this study ranged from 4.25 to 13.21 μg^{Kg-1} in Sharaq-Al-Aqsah (Egypt) and Al-Dastoor (Egypt), with a mean concentration of 6.86 μg^{Kg-1} in light fonts in Sharaq-Al-Aqsah (Egypt) and Al-Dastoor (Egypt), in the case of bold fonts, the mean value was 9.75 μg^{Kg-1} in Sharaq-Al-Aqsah (Egypt), while the maximum and minimum chromium concentrations were 5.25 and 15.75 μg^{Kg-1} in Al-Madinah (Saudi) and Sharaq-Al-Aqsah (Egypt), respectively.

In Al-Madinah (Saudi Arabia) and Al-Dastoor (Egypt), however, the concentration of chromium in pictures ranged from 6.87 to 18.76 μg^{Kg-1}, with an average of 11.21 μg^{Kg-1}. The results of this investigation showed that the concentration of chromium in all trash newspapers was lower than Skrzydlewska *et al.* recommendations although not by much (Table 2) Figure (1, 2, 3) [32].

The presence of nickel in waste newspapers has been attributed to the use of green dyes and inks in the sources of the waste newspaper when recycled paper is used as a raw material, as well as the use of green components in the coloring of new recycled paper products, and it is considered an important human toxin with cancer-causing potential [38, 39].

According to the findings of this study, nickel concentration for light fonts ranged from 2.79 to 10.71 μg^{Kg-1} in Al-Akhbar (Egypt) and Al-Madinah (Saudi), with an average concentration of 5.55 μg^{Kg-1} (Table 2). While the maximum and minimum concentrations nickel concentrations in bold fonts for Al-Madinah (Saudi) and Al-Akhbar (Egypt), respectively, ranged from 3.65 to 13.05 μg^{Kg-1}, with the average 7.86 μg^{Kg-1}, In Al-Madinah (Saudi Arabia) and Al-Akhbar (Egypt), on the other hand, the concentration of nickel in pictures ranged from 4.54 to 15.70 μg^{Kg-1}, with an average concentration of(9.40 μg^{Kg-1} (Table 2).There is no information available in previous literature about the maximum permissible levels of nickel. However, the World Health Organization (WHO) recommends a maximum daily dose of 100-300 µg for nickel, so, according to WHO, the level of nickel present in the samples is considered not harmful for health [40, 36].

The nickel contents found in this investigation are lower than the suggested limit levels in food legislation and certain published studies [29, 30, 33]. As a result, the presence of nickel in newspapers could be related to the presence of several colorants in the wastepaper pulp (Table 2) Fingers (1, 2, 3) [28].

Pb in newspapers could come from white inks, red pigments, yellow, and green hue [41, 42]. According to the current findings, the maximum and minimum concentrations of lead for light fonts were found in the Al-Watan (Egypt) and Al-Dastoor (Egypt) newspapers, 2.96 and 10.21 μg^{Kg-1} respectively, with the average concentration 5.01 μg^{Kg-1}, as indicated in Table 2. The readings were typically lower than the permissible levels 3 mg^{Kg-1}, according to 94/62/EC (European Parliament and Council Directive 2015), and they were consistent with the literature [30, 31].

For bold fonts, the average lead concentration was 5.01 and 7.07 μg^{Kg-1}, with the maximum and minimum concentrations 4.27 and 13.42 μg^{Kg-1} in Al-Watan (Egypt) and Al-Dastoor (Egypt). The level of lead in all newspapers was within permissible limits, according to Directive 94/62/EC (European Parliament and Council Directive 2015), but it was rather high in bold fonts compared to light fonts [30].

As indicated in Table 2, the level of lead in pictures in the Akhbar-Al-Youm (Egypt) and Sharq-Al-Aqsah (Egypt) newspapers ranged from 18.28 to 6.02 μg^{Kg-1}, with an average concentration of (5.42 μg^{Kg-1}). When compared to other newspapers, the content of lead in Akhbar-Al-Youm (Egypt) was high, but less than the maximum 3 mg μg^{Kg-1} set by Directive 94/62/EC [31]. The elevated amounts of lead were thought to be due to the pigments and coating components employed in the coating and similar coloring methods to achieve these color values [42]. All samples are below the cutoff limits 3 $^{Kg-1}$, according to Table 2. Based on contact paper and the authorized temporary weekly intake of lead of 25 μg^{Kg-1} body weight [27] lead migration demonstrates that human exposure was within safe levels (Table 2) Figure (1, 2, 3).

Aluminum in waste newspapers comes from aluminum sulfate, aluminum chloride hydroxide, aluminum format, aluminum nitrate, and sodium aluminum components used as precipitants, stabilizers, and paper production chemicals to improve the paper's and paperboard's overall product and surface attributes [43].

Aluminum concentration in light font newspapers samples ranged from 2.37 to 4.65 mg^{Kg-1} in Al-Madinah (Saudi) and Arab News (Saudi), with an average concentration of 3.44 mg^{Kg-1}, according to Table 2. While the maximum and minimum aluminum concentration in bold fonts for Al-Akhbar (Egypt) and Al-Dastoor (Egypt), respectively, ranged from 4.06 to 8.56 mg^{Kg-1}, with the average 5.73 mg^{Kg-1}.

On the other hand, in Indian newspapers and Arab News (Saudi), the concentration of aluminum in pictures ranged from 6.51 to 9.59 mg^{Kg-1}, with an average concentration of 8.17 mg^{Kg-1}, according to Table 2. The amount of aluminum generated in waste newspapers under test is smaller than the structural ones, according to Directive 2005/20/EC environmental management standard, Table 2, Figure (1, 2, 3) [44].

Zinc oxide or zinc sulfate compounds are sometimes used in paper manufacture, with zinc sulfate being used to boost the opacity of sheets and zinc oxide being used to make copying paper [45]. Zinc is also utilized in fine art, and when using white pigments to achieve good luminosity in other colors and to apply metallic hues, the amount of zinc can be increased. Metal embroidery, along with copper and aluminum, has other applications, such as engraving on various packaging [28].

The maximum and minimum zinc concentrations, as well as the average zinc concentrations in newspaper samples, were 0.11, 0.33, and 0.19 mg^{Kg-1} for Al-Akhbar (Egypt), Al-Madinah (Saudi), and Indian newspapers, respectively. Zinc concentrations did not above the maximum limit amount 50 mg^{Kg-1} set by Irvine [46].

In bold fonts, the average zinc concentration was 0.19 and 0.27 mg^{Kg-1}, with the maximum and minimum 0.15 and 0.68 mg^{Kg-1} in Al-Ahram (Egypt) and Al-Dastoor (Egypt), respectively. Zinc concentrations did not above the maximum restriction level 50 mg^{Kg-1} set by the European paper and board food packaging chain. Table 2 shows that zinc levels in all newspaper samples were within normal ranges, but that bold fonts had higher zinc levels than light fonts [46].

The zinc concentration in the Al-Dastoor (Egypt) newspaper photo and the India newspaper photo was 0.18 and 0.74 mg^{Kg-1}, respectively, with an average 0.39 mg^{Kg-1}. When compared to other newspapers, Indian newspapers had a high zinc concentration, but it was lower than the recommended limit suggested by the (EPA, 1996) legislation 50 mg^{Kg-1} [24]. Although zinc contains fluorescence and many other comparable sources in filler and coloring materials, many of these additions do not appear to be present in the wastepaper that makes up paper pulp.

6.2 Correlation between residual concentrations

The correlation of residual concentrations between Cd and Ni, 0.966 ($p < 0.01$), indicates that the strength of association between the variables is very strong ($r = 0.909$), and the correlation coefficient is very significantly different from zero (P 0.001) in all different newspapers for light fonts, bold fonts, and pictures. The correlation is moderately different from zero ($P<0.05$) in all different newspapers for light fonts, bold fonts, and pictures, with 0.653 and 0.670 ($p<0.01$) of residual concentrations observed between (As and Al) and (Pb and Cr) respectively. The strength of association between the variables is moderate, and the correlation is moderately different from zero ($P<0.05$). (Table 3). These metals may come from the same sources, according to Musoke *et al*, such as colorants and additives used in the creation of food contact paper [47].

Table 3
Pearson Correlation between light fonts, bold fonts, and pictures in all newspaper samples

		As	**Cd**	**Cr**	**Ni**	**Pb**	**Al**	**Zn**
As	Pearson Correlation	1	0.192	0.082	0.106	0.211	0.653*	0.396
	Sig. (2-tailed)		0.571	0.811	0.756	0.533	0.029	0.228
	N	11	11	11	11	11	11	11
Cd	Pearson Correlation	0.192	1	-0.068	0.032	-0.130	0.393	-0.072
	Sig. (2-tailed)	0.571		0.842	0.926	0.703	0.232	0.834
	N	11	11	11	11	11	11	11
Cr	Pearson Correlation	0.082	-0.068	1	0.909**	0.670*	-0.046	-0.483
	Sig. (2-tailed)	0.811	0.842		0.000	0.024	0.893	0.132
	N	11	11	11	11	11	11	11
Ni	Pearson Correlation	0.106	0.032	0.909**	1	0.445	-0.130	-0.418
	Sig. (2-tailed)	0.756	0.926	0.000		0.170	0.703	0.200
	N	11	11	11	11	11	11	11
Pb	Pearson Correlation	0.211	-0.130	0.670*	0.445	1	0.485	-0.260
	Sig. (2-tailed)	0.533	0.703	0.024	0.170		0.131	0.440
	N	11	11	11	11	11	11	11
Al	Pearson Correlation	0.653*	0.393	-0.046	-0.130	0.485	1	0.073
	Sig. (2-tailed)	0.029	0.232	0.893	0.703	0.131		0.832
	N	11	11	11	11	11	11	11
Zn	Pearson Correlation	0.396	-0.072	-0.483	-0.418	-0.260	0.073	1
	Sig. (2-tailed)	0.228	0.834	0.132	0.200	0.440	0.832	
	N	11	11	11	11	11	11	11
*. Correlation is significant at the 0.05 level (2-tailed).								
**. Correlation is significant at the 0.01 level (2-tailed).								

Conclusion

In conclusion, this is a thorough investigation on the presence of a wide spectrum of trace metals in diverse newspaper samples. The newspapers under examination were found to be safe when measured trace metal concentrations were compared to permissible standards, but humans should not be exposed to any of the numerous uses of newspapers to prevent harming public health. Future research and regulatory efforts should concentrate on tight monitoring of printing newspapers at all phases, from raw material selection to storage and paper manufacture, and all the way to the customer.

Even though our goal is to raise awareness among common street food consumers not to accept street food wrapped in used newspapers, it is also a good idea not to wrap vegetables in used newspapers for storage if refrigeration is not available. The reason behind this is that if the veggies are wrapped in newspaper, printing ink may transfer to the surface of the vegetables, which is difficult to notice with the human eye. Long-term exposure to certain chemicals and hazardous metals could endanger human health. As a result, wrapping veggies in newspapers to keep them "fresh" is not a good idea" [48].

Declarations

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Authors’ contributions

Hatem A Ahmed and Ahmed Saad Johar conceived and designed the research, interpreted, analyzed, and discussed the obtained data. Muhammad Naeem Janjua, Nada Alhafez conducted the determination of heavy metals in samples. Hatem A Ahmed and Ahmed Saad Johar collected the samples. Hatem A Ahmed wrote the manuscript, and all authors commented on previous versions of the manuscript. Finally, all authors read and approved the manuscript.

Data availability

All data and materials are included in the submitted article.

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Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval

Not applicable.

Consent to participate

Not applicable.

Consent to publish

Not applicable.

Code availability

Not applicable.

Conflicts of Interest

The authors state that they have no conflicts of interest in the publication of this research.

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Figures

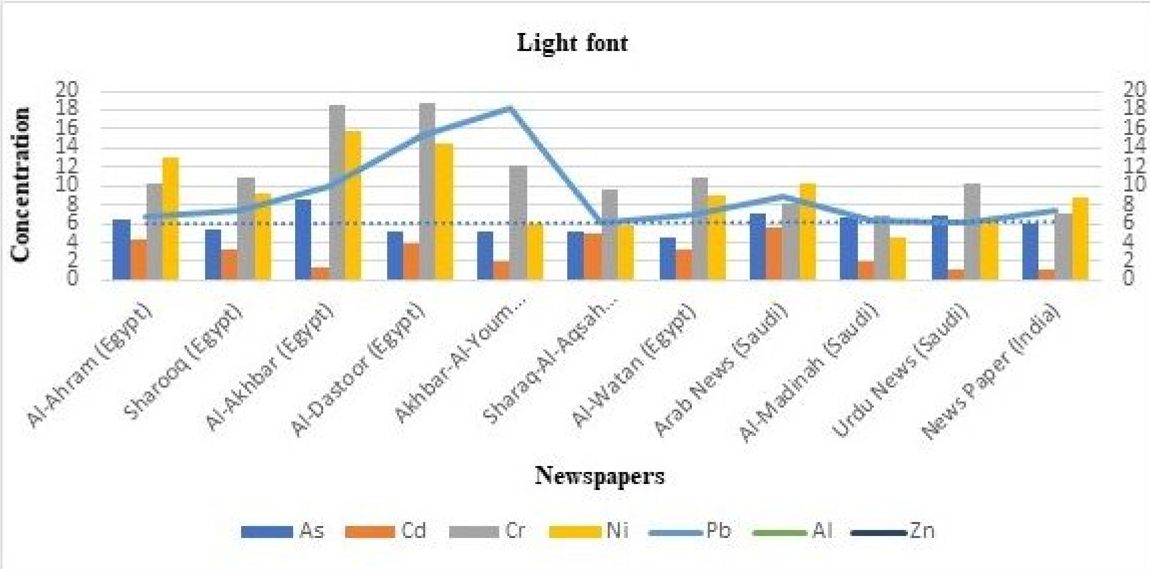

Figure 1

Different levels of trace metals in newspaper samples for light fonts.

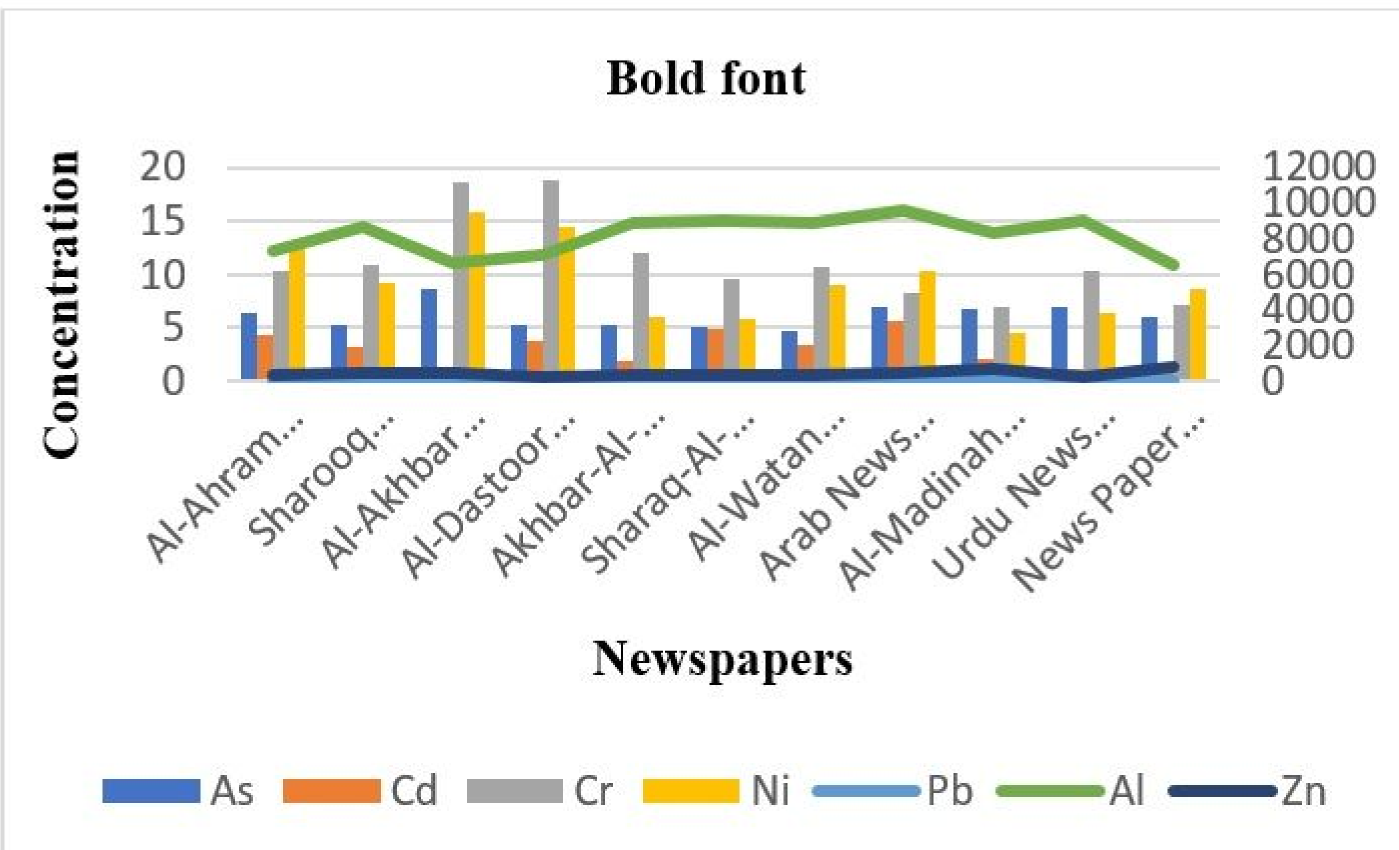

Figure 2

Different levels of trace metals in newspaper samples for bold fonts.

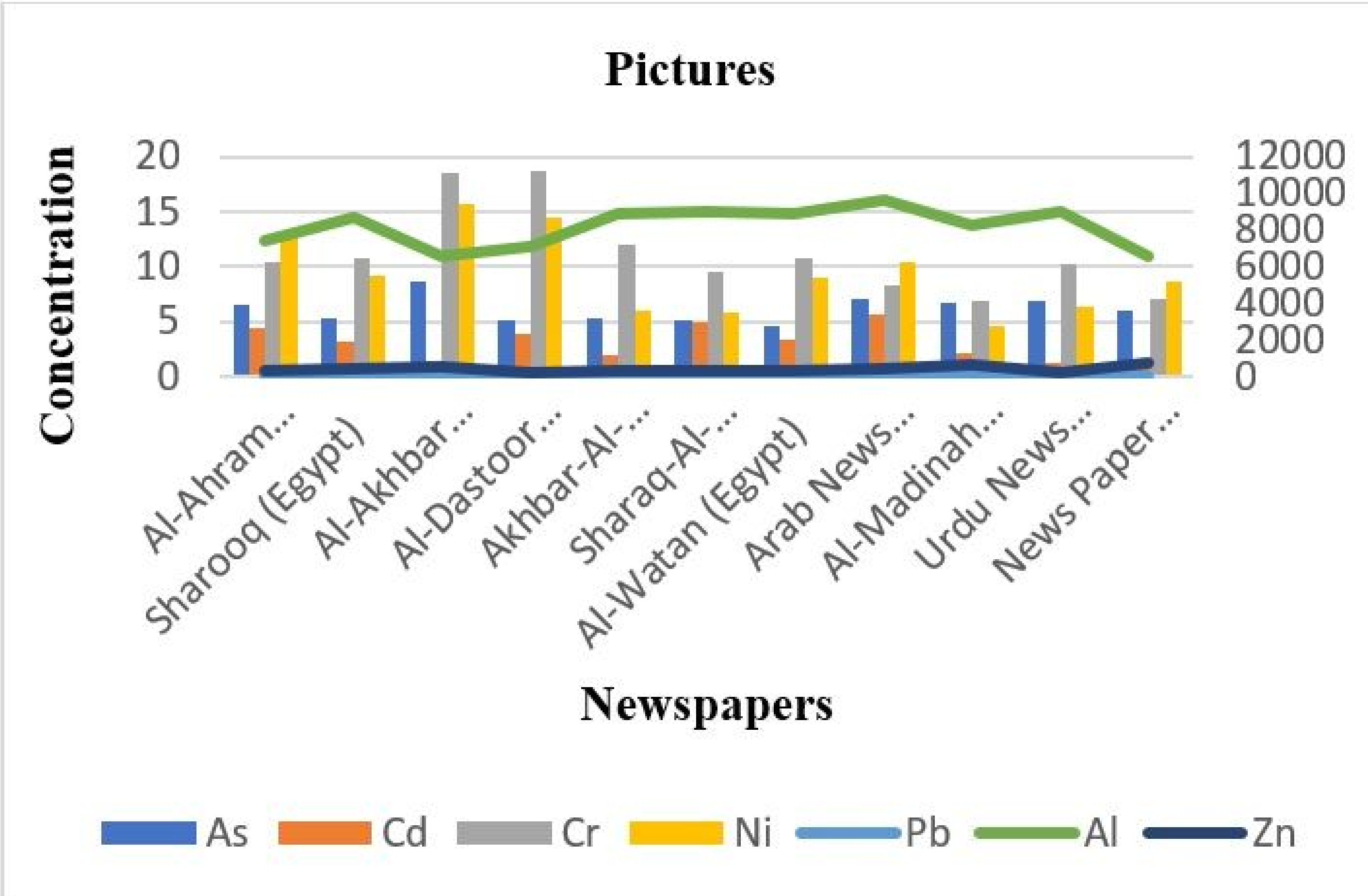

Figure 3

Different levels of trace metals in newspaper samples for pictures.