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Assessment of Some Heavy Metals Contamination in Some Vegetables (Tomato, Lettuce and Onion) in Ethiopia: A Review

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Abstract

Heavy metals in soil have a variety of chemical forms linked to their solubility, which has an impact on their mobility and biological availability. Heavy metals can be absorbed by plants and deposited on their tissues after they absorb them from the soil. The goal of this review paper is to assess the levels of heavy metals in some vegetables cultivated in Ethiopia (lettuce, tomato and onion). Due to their high consumption rate, these vegetables are staple and common vegetables consumed by Ethiopians of all social strata. Vegetables are crucial in human diets because they include critical nutrients such as carbohydrates, proteins, vitamins, minerals, and trace elements. Heavy metals enter the food chain through the consumption of vegetables such as tomato, lettuce and onion. According to several research in Ethiopia, heavy metal concentrations in vegetables have been compared to the WHO/FAO recommended standard value, and other organizations have reported comparative average values and some of heavy metal concentrations are above the recommended limit. Industrialization and agricultural activities may be to blame for the greater content of heavy metal in vegetables. We recommend that the competent official body adopt the required precautions for agricultural operations, contaminated manufacturing effluents, gasses and solid wastes, and other heavy metal sources based on data acquired from various investigations.

Keywords: Heavy Metals, Vegetables, Contamination, WHO

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1.0 Introduction

Heavy metals are defined as elements in the periodic table having high atomic number, atomic weight, specific gravity greater than 5 and atomic densities of more than 5 g/cm^3 (Pb, Cd, Zn, Hg, As, Ag, Cr, Cu, Fe, Pt, Mn, Ni, Co and others) generally excluding alkali metals and alkaline earth metals (Bahiru 2021) The environmental problems associated with heavy metals are that they as elements are undestroyable and most of them have toxic effects on living organism when exceeding their limited concentration. Furthermore, some heavy metals are being subjected to bioaccumulation, geo-accumulation and may pose a risk to human health when transferred to the food chain (Bahiru 2021).

Environmental pollution is posing significant public health risks worldwide, becoming a major concern in developing countries because of rapid economic activities and poor waste management. It is challenging to establish an association between environmental pollution and health effects because of the nature of pathways to exposure, limited data availability and the absence of a monitoring system (Amare 2021).

Heavy metal environmental pollution is matter of big concern and has accepted as a global world, problem, because of its effect on human and animal health. Among those metals Pb, Cd, Zn, Hg, As, Ag, Cr, Cu, Fe, Pt and others (Bahiru and Yegrem 2021). Heavy metals (HM) among the most serious environmental pollutants due to their high toxicity, abundance and ease of accumulation by various animal, humans, and plant organs (Dagne and Endale 2019). Some are micronutrients essential for plant growth, such as Zn, Cu, Mn, Ni, and Co, while others, such as Cd, Pb, and Hg, have no recognized biological role (Bahiru and Yegrem 2021).

Fruits, tubers, vegetables, and nuts, for example, that are grown on contaminated farmland can collect dangerous heavy metals (HMs). Humans are exposed to hazardous HMs through dust inhalation, contaminated water, and food crops. HM accumulates in several organs through diet, producing abnormal metabolism in the liver and kidneys, as well as cardiovascular, neurological, and bone diseases (Mahmood 2014)

Vegetables are common diet taken by populations throughout the world, being sources of essential nutrients, antioxidants and metabolites. They also act as buffering agents for acid substance obtained during the digestion process. However, both essential and toxic elements are present in vegetables over a wide range of concentrations as they are said to be good absorber of metals from the soil (Abrham, F. and Gholap 2021). Vegetables grown in heavy metal-rich soils are similarly affected, according to reports (Kawatra and Bakhetia 2008).

Vegetables take these metals through their roots from contaminated soils and polluted environmental deposits, incorporating them into the edible component of plant tissues or depositing them on the surface of vegetables (Nwajei 2011). It accumulates in varying concentrations in various plants. Some accumulate more than others (Kanya et al. 2013). Metal-carrying vegetables are swallowed by humans. Because the human body lacks a powerful elimination system, heavy metals can be extremely dangerous even at low amounts (Bahiru 2021). As a result, the current review was carried out with the aim of assessing the toxic metals accumulation potential on tomato, lettuce, cabbage, and onion in Ethiopia, as well as its sources also reviewed.

2.0 Sources of Heavy Metals

HMs are one of the constituent of the earth's crust and present as environmental contaminants; they are not biodegradable and thermally degradable and enter the human body through food, air and water and bioaccumulate over a period of time (Gezahegn et al. 2017b). Heavy metals are discharged into the environment from both natural and man-made sources. Agricultural activities such as pesticide and herbicide application, wastewater irrigation, and municipal waste used as fertilizer are examples of anthropogenic sources of heavy metal contamination (Alloway and Jackson 1991). Heavy metals are nonbiodegradable and persistent in the environment, accumulating in soil or being absorbed into vegetable tissue.

Soil

Heavy metals naturally occur in the soil environment as a result of pedogenetic weathering processes of parent materials at quantities that are considered trace (1000mg kg1) and rarely hazardous. Most soils in rural and urban environments may accumulate one or more heavy metals above defined background values high enough to pose a risk to human health, plants, animals, ecosystems, or other media as a result of man's disruption and acceleration of nature's slowly occurring geochemical cycle of metals (Wuana and Okieimen 2011). A simple mass balance of the heavy metals in the soil can be expressed as follows (Lombi and Gerzabek 1998).

$$M_{total} = (M_p + M_a + M_f + M_{ag} + M_{ow} + M_{ip}) - (M_{cr} + M_l), \quad \ldots\ldots\ldots\ldots\ldots(1)$$

Where

"M" is the heavy metal,

"p" is the parent material,

"a" is the atmospheric deposition,

" f" is the fertilizer sources,

"ag" are the agrochemical sources,

"ow" are the organic waste sources,

"ip" are other inorganic pollutants,

"cr" is crop re- moval, and

"l" is the losses by leaching, volatilization, and so forth.

It is projected that the anthropogenic emission into the atmosphere, for several heavy metals, is one-to-three orders of magnitude higher than natural fluxes (Yeasmin N. Jolly and ; Ahsanul Kabir, MD, MSc; Akter Shirin, MSc (Engineer); A.M. Sarwaruddin Chowdhury 2019)

Heavy metals in soil are found in a variety of chemical forms based on their solubility, which has a direct impact on their mobility and biological availability. Vegetable and other crops can absorb heavy metals from soil and, deposited on the part of their tissues (Fite Duressa and Leta 2015). Heavy metal toxicity can directly affect plant physiology, growth, and many case of toxicity from heavy metals have been reported. Jorgensen group show that intensive horticultural systems in urban areas may be threatened by soil toxicity through trace elements such as Zn, Cu, As and Pb (Yeshiwas 2017). Heavy metals are in soluble form, have high relation to their uptake by plants. Plants take up heavy metals by absorbing them from airborne deposits on the parts of the plants exposed to the air from the polluted environments as well as from contaminated soils through root systems (Dagne and Endale 2019).

Soils may become contaminated by the accumulation of heavy metals and metalloids through emissions from the rapidly expanding industrial areas, mine tailings, disposal of high metal wastes, leaded gasoline and paints, land application of fertilizers, sewage sludge pesticides, wastewater irrigation, coal combustion residues, spillage of petrochemicals, and atmospheric deposition (Khan et al. 2008). Heavy metal contamination in agricultural soils may lead to the disorder of soil functionality and retardation of plant growth, and influence human health through a contaminated food chain (Khan et al. 2008). Soil contamination which results in the underground water pollution has become a very important topic worldwide in environmental protection as it is difficult in remedial compared to air contamination (PALLANGYO 2019).

Country	Number of pollution sites	% Of heavy metal(loid)s pollution
Global	>10000000	>50
USA	>100000	>70
European Union	>80000	37
Australia	>50000	>60
China	1.0 million km^2	>80

Table 2.1. Soil pollution in the world (EEC, 2007; ADEC, 2010; EPMC, 2014; USEPA, 2014) (He et al. 2015).

Wastewater

Industrial, municipal wastewater, and other wastes are commonly applied to agricultural lands in many parts of the world, particularly in underdeveloped countries (Gernaey et al. 2011). In general, worldwide estimated that 20 million hectares of arable lands are irrigated with different wastewater (Bjuhr 2007). In some regions, water has been contaminated by harmful heavy metals as a result of natural processes and manmade activity. Heavy metal that is toxic Contamination of agricultural land by wastewater irrigation is a serious issue because it has health implications. The extent of absorption of heavy metals by the plant depends on the nature of the plant and the chemical constitution of the pollutant. Many studies have been shows that wastewater irrigation has increase the levels of heavy metals in the receiving (Yeshiwas 2017),(Dagne and Endale 2019),(Dagne et al. 2019),(Ghosh, Bhatt, and Agrawal 2012),(Sharma, Agrawal, and Marshall 2006),(Lombi and Gerzabek 1998).

The accumulation of toxic heavy metals in vegetables has serious adverse effects on human health and plants (Dagne and Endale 2019). The Ethiopian metal tools industry, according to Fisseha (2003), is the main cause of pollution in rivers that used to irrigate part of vegetable farmland. Furthermore, the author reported that wastewater discharged onto farm area near that park by the eastern industry zone of Dukem Ethiopia above FAO/WHO approved limits in the vegetables grown by irrigating these contaminated waters (Dagne 2020).

Fertilizer

Uncontrolled agricultural activities have historically been the most significant human influence on agricultural soils. Plants require not only macronutrients but also necessary micronutrients to grow and complete the life cycle. Heavy metals such as Co, Cu, Fe, Mn, Mo, Ni, and Zn, which are essential for plant growth, are insufficient in some agricultural soils (Bahiru and Yegrem 2021), and crops may be supplied with these as an addition to the soil or as a foliar spray. Cereal crops grown on Cu- deficient soils are occasionally treated with Cu as an addition to the soil, and Mn may similarly be supplied to cereal and root crops.

Large amount of fertilizers are regularly added to agricultural soil in order to provide adequate N, P and K necessary for crop growth and yield increment. Therefore, the application of certain fertilizers inadvertently adds potentially toxic heavy metals to the soil. Fertilizer production contains trace amount of heavy metals (e.g., Cd, Pb, Hg, As, Ni, Cu, Mn, V) as impurities, after continuous chemical fertilizer application may fertilizer application may significantly increase heavy metal content in the agricultural soil and then transferred to food chain (Mortvedt 1996),(Sankhla et al. 2016).

Pesticides

Several common pesticides, which were historically widely used in agriculture and horticulture, contain high levels of metals. For particular, almost 10% of the chemicals licensed for use as insecticides and fungicides in the UK in recent years were based on compounds containing Cu, Hg, Mn, Pb, or Zn. Copper-containing fungicidal sprays, such as Bordeaux mixture (copper sulphate) and copper oxychloride, are examples of such pesticides (Shakhila and Mohan 2013). Lead arsenate was used in fruit orchards for many years to control some parasitic insects. Arsenic- containing compounds were also used extensively to control cattle ticks and to control pests in banana in New Zealand and Australia, timbers have been preserved with formulations of Cu, Cr, and As (CCA), and there are now many derelict sites where soil concentrations of these elements greatly exceed background concentrations. Such contamination has the potential to cause problems, particularly if sites are redeveloped for other agricultural or nonagricultural purposes. Compared with fertilizers, the use of such mate- rials has been more localized, being restricted to particular sites or crops (McLaughlin et al. 2000).

Bio-solids and Manures

Inadvertently, the application of numerous biosolids (e.g., livestock manures, composts, and municipal sewage sludge) to land causes in the accumulation of heavy metals such as As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Mo, Zn, Tl, Sb, and others in the soil (Mahmood 2014). Different animal wastes, such as chicken, cattle, and pig manure, are routinely applied as fertilizer to crops and fields as solids or slurries in livestock farms. Although most manure are seen as valuable fertilizers, in the pig and poultry industry, the Cu and Zn added to diets as growth promoters and as contained in poultry health products may also have the potential to cause contamination of the soil by heavy metals. The manures produced from different animals on such diets contain high concentrations of As, Cu, Zn, etc (Mortvedt 1996),(Sumner 2000). The manures produced from animals on such diets contain high concentrations of As, Cu, and Zn and, if repeatedly applied to restricted areas of land, can cause considerable buildup of these metals in the soil in the long run (Wuana and Okieimen 2011).

Biosolids (sewage sludge) are largely organic solid products that are created during wastewater treatment and can be recycled (USEPA 1994). Many countries employ land application of biosolids materials to enable for the reuse of biosolids produced by urban populations (Weggler, McLaughlin, and Graham 2004a). Because of its widespread familiarity and regulatory definition, the phrase sewage sludge is frequently used. However, the term biosolids is increasingly being used to replace sewage sludge since it is regarded to better appropriately describe the beneficial qualities of sewage sludge (Wuana and Okieimen 2011). It is estimated that in the United States, more than half of approximately 5.6 million dry tons of sewage sludge used or disposed of annually is land applied, and agricultural utilization of biosolids occurs in every region of the country. In the European community, over 30% of the sewage sludge is used as fertilizer in agriculture (Wuana and Okieimen 2011).

Heavy metals most commonly found in biosolids are Pb, Ni, Cd, Cr, Cu, and Zn, and the metal concentrations are governed by the nature and the intensity of the industrial activity, as well as the type of process employed during the biosolids treatment (Gomah 2016).Under certain conditions, metals added to soils in applications of biosolids can be leached downwards through the soil profile and can have the potential to contaminate groundwater (Gomah 2016).

Industrial waste

In sectors such as chemical, textile, tanning leather, petrochemical, metallurgy, and metal processing, various industrial waste products containing heavy metals originate. HMs in the soil also can be origin from accidental oil spills or the use of petroleum and pharmaceutical products and utilization waste from these industries. These toxic metals may be, fully or partially transferred to the food chain (He et al. 2015). Although some are disposed of on land, few have benefits to agriculture or forestry. In addition, many are potentially hazardous because of their contents of heavy metals (Cr, Pb, and Zn) or toxic organic compounds and are seldom, if ever, applied to land (Wuana and Okieimen 2011).

Air borne source

Toxic heavy metals can be found in the air through stack or dust emissions of gas or vapor streams. During high-temperature processing, some harmful heavy metals such as arsenic, cadmium, and lead volatilize. Unless a reducing environment is maintained, the above-mentioned dangerous heavy metals will change to oxides and condense as fine particles. Stack emissions can be distributed over a wide area by natural air currents until dry/or wet precipitation mechanisms remove them from gas stream (Sankhla et al. 2016). All solid particles in smoke from fires and in other emissions from factory chimneys are eventually deposited on land or sea; most forms of fossil fuels contain some heavy metals and this is, therefore, a form of contamination which has been continuing on a large scale since the industrial revolution began.

heavy metals Sources	**Sources of some selected heavy metals in Agricultural soils and crops**
Arsenic	Use of arsenic in herbicides, cattle and sheep dips and insecticides. Also, as a desiccant for cotton crop to facilitate the mechanical harvesting of the crop.
Cadmium	Addition of phosphatic fertilizers (Containing 2-200 mg Cd/kg), domestic and sewage sludge, wear of automobile tyres, lubricants and mining and metallurgical activities. Emissions from mining and smelting operations, atmospheric fallout from the combustion of fossil fuels.
Chromium	Wastewater and sludge from dyeing and tanning industries are the major sources of chromium pollution.
Lead	Exhaust gases of petrol engines, which account for nearly 80% of the total Pb in the air. Pesticides, fertilizer impurities, emissions from mining and smelting operations, atmospheric fallout from the combustion of fossil fuels. Soils located near Pb mines may contain high as 0.5% Pb content.
Mercury	Hg based fungicides. Sewerage sludge and atmospheric fall out resulting from combustion of fossil fuels and industrial processes.
Nickel	Fertilizer, Manures, Metal refining, smelting, burning of coal and industrial sewage sludge. Emissions from mining and smelting operations, atmospheric fallout from the combustion of fossil fuels.

Zinc	Fertilizer, Manures, Pesticide. Mining, metal refining, smelting, electroplating and Sewerage sludge.
Copper	Manures, Fertilizer, Pesticide, Sewerage sludge and atmospheric fall out resulting from combustion of fossil fuels and industrial processes.

Table 2.2Sources of some selected heavy metals in Agricultural soils (Bahiru and Yegrem 2021).

3.0 Potential Health Hazards of Some Selected Heavy Metals

The most common heavy metals found at contaminated sites, in order of abundance are Pb, Cr, As, Zn, Cd, Cu, and Hg (E.P.A. 1997). These metals are significant because they have the potential to reduce crop production due to bioaccumulation and biomagnification in the food chain. There's also the possibility of contamination of the surface and groundwater. Understanding their speciation, bioavailability, and treatment alternatives requires knowledge of their basic chemistry, environmental consequences, and associated health implications. The chemical form and speciation of a heavy metal have a substantial impact on its fate and transit in soil. Heavy metals are absorbed in the soil by initial quick reactions (minutes, hours), followed by delayed reactions (days, years), and are therefore redistributed into multiple chemical forms with varied bioavailability, mobility, and toxicity (Shiowatana et al. 2001).

Lead

Lead is a metal with atomic number 82, atomic mass 207.2, density 11.4 g cm3, melting point 327.4°C, and boiling point 1725°C that belongs to group IV and period 6 of the periodic table. It is a naturally occurring, bluish-gray metal that is commonly found as a mineral in combination with other elements such as Sulphur (i.e., PbS, $PbSO_4$) or oxygen ($PbCO_3$). Its concentration in the earth's crust ranges from 10 to 30 mg /kg^{-1} (Abadin et al. 2020). Lead (II) compounds are predominantly ionic (e.g., Pb^{2+} SO4 $^{2-}$), whereas Pb (IV) compounds tend to be covalent (e.g., tetraethyl lead, $Pb(C_2H_5)_4$). Some Pb (IV) compounds, such as PbO_2, are strong oxidants. Lead forms several basic salts, such as Pb $(OH)_2 \cdot 2PbCO_3$, which was once the most widely used white paint pigment and the source of considerable chronic lead poisoning to children who ate peeling white paint. Many compounds of Pb (II) and a few Pb (IV) compounds are useful. The two most common of these are lead dioxide and lead sulphate, which are participants in the reversible reaction that occurs during the charge and discharge of lead storage battery.

Pb accumulates in the body's organs (such as the brain), causing poisoning (plumbism) and even death. The presence of lead has an impact on the gastrointestinal tract, kidneys, and central nervous system. Children exposed to lead have a higher risk of developmental problems, lower IQ, shortened attention spans, hyperactivity, and mental deterioration, with children under the age of six having a higher risk. Lead is not an essential element. It is well known to be toxic and its effects have been more extensively reviewed than the effects of other trace metals. Lead can cause serious injury to the brain, nervous system, red blood cells, and kidneys (Baldwin and Marshall 1999). Studies have shown that lead does not readily accumulate in the fruiting parts of vegetable and fruit crops (e.g., corn, beans, squash, tomatoes, strawberries, and apples). Higher concentrations are more likely to be found in leafy vegetables (e.g., lettuce) and on the surface of root crops (e.g., carrots). Since plants do not take up large quantities of soil lead, the lead levels in soil considered safe for plants will be much higher than soil lead levels where eating of soil is a concern (pica). Generally, it has been considered safe to use garden produce grown in soils with total lead levels less than 300ppm. Even at soil levels above 300ppm, most of the risk is from lead contaminated soil or dust deposits on the plants rather than from uptake of lead by the plant (Rosen 2002).

Chromium

Chromium is a first-row d-block transition metal with the following properties in the periodic table: atomic number 24, atomic mass 52, density 7.19 g cm^3, melting point 1875°C, and boiling point 2665°C. It is one among the less frequent elements, and it only occurs in compounds rather than in its elemental form. Chromium, in the form of the mineral chromite ($FeCr_2O_4$), is mined as a major ore product. Electroplating process discharges and the disposal of Cr-containing wastes are two major sources of Cr- pollution (Wuana and Okieimen 2011). Chromium (VI) is the form of Cr commonly found at contaminated sites. Chromium can also occur in the +III oxidation state, depending on pH and redox conditions. Chromium (VI) is the dominant form of Cr in shallow aquifers where aerobic conditions exist. Chromium (VI) can be reduced to Cr (III) by soil organic matter, S^{2-} and Fe^{2+} ions under anaerobic conditions often encountered in deeper groundwater. Major Cr (VI) species include chromate ($CrO_4{}^{2-}$) and dichromate ($Cr_2O_7{}^{2-}$) which precipitate readily in the presence of metal cations (especially Ba^{2+},

Pb^{2+}, and Ag+). The sorption characteristics of the soil, such as clay concentration, iron oxide content, and the amount of organic matter present, influence chromium mobility. Surface runoff can transfer chromium in soluble or precipitated form to surface waterways. Chromium complexes, both soluble and non-adsorbed, can leak into groundwater. As the pH of the soil rises, so does the leachability of Cr (VI). Chromium is associated with allergic dermatitis in humans (Nkwunonwo, Odika, and Onyia 2020).

Zinc

Zinc is a transition metal with the following characteristics: period 4, group IIB, atomic number 30, atomic mass 65.4, density 7.14 g cm^{-3}, melting point 419.5◦C, and boiling point 906◦C. Zinc occurs naturally in soil (about 70mg kg^{-1} in crustal rocks) (Wuana and Okieimen 2011). Zinc is an essential trace element with typical threshold values of 0.01 and 0.05 g/l in surface and groundwater, respectively (Vinodhini and Narayanan 2009). However, concentrations in tap water can be much higher as a result of dissolution of zinc from pipes. It should be noted that drinking water containing zinc levels above 3 µg/l may not be acceptable for consumers (Sayato 1989). Industrial sources or toxic waste sites may cause the concentrations of Zn in drinking water to reach levels that can cause health problems. Zinc is a trace element that is essential for human health. Zinc shortages can cause birth defects. The world's Zn production is still on the rise which means that more and more Zn ends up in the environment. Water is polluted with Zn, due to the presence of large quantities present in the wastewater of industrial plants. A consequence is that Zn- polluted sludge is continually being deposited by rivers on their banks. Zinc may also increase the acidity of waters. Some fish can accumulate Zn in their bodies, when they live in Zn-contaminated waterways. When Zn enters the bodies of these fish, it is able to biomagnified up the food chain. Water-soluble zinc that is located in soils can contaminate groundwater (Wuana and Okieimen 2011).

Cadmium

Cadmium has an atomic number of 48, an atomic weight of 112.4, a density of 8.65 gcm3, a melting point of 320.9°C, and a boiling point of 765°C. It is found at the end of the second row of transition elements. Cd is one of the major three heavy metal toxins, along with Hg and Pb, and it has no known biological role. The most significant use of Cd is in Ni/Cd batteries, as rechargeable or secondary power sources exhibiting high output, long life, low maintenance, and high tolerance to physical and electrical stress. Cadmium coatings provide good corrosion resistance coating to vessels and other vehicles, particularly in high-stress environments such as marine and aerospace. Other uses of cadmium are as pigments, stabilizers for polyvinyl chloride (PVC), in alloys and electronic compounds. The application of agricultural inputs such as fertilizers, pesticides, and biosolids (sewage sludge), the disposal of industrial wastes or the deposition of atmospheric contaminants increases the total concentration of Cd in soils, and the bioavailability of this Cd determines whether plant Cd uptake occurs to a significant degree (Weggler, McLaughlin, and Graham 2004b).

Copper

Copper is a transition metal which belongs to period 4 and group IB of the periodic table with atomic number 29, atomic weight 63.5, density 8.96 g cm^{-3}, melting point 1083◦C and boiling point 2595°C. These are important essential elements but when consumed in excess, they cause toxicity (McDowell, Catto, and Orchiston 2015). Copper deficiency results in kinky and steely hair syndrome in humans and abnormal wool in sheep, while excessive Cu intake results to hepatolenticular degeneration with progressive impairment of Cu-laden tissues until death results (He et al. 2015). Copper and zinc are critical elements for plants, microbes, animals, and humans. Many chemical and physical soil variables, as well as the physiological features of the crops, influence the connection between soil and water contamination and metal uptake by plants. Trace metal-contaminated soils can provide both direct and indirect concerns: direct threats, such as harmful effects of metals on crop growth and yield, and indirect threats, such as metals entering the human food chain and potentially harming human health (Wuana and Okieimen 2011).

Nickel

Nickel is a trace element that is required by all species. Fibrosis, chronic bronchitis, reduced lung function, and emphysema are some of the health risks. Allergic contact dermatitis is the most prevalent effect of toxicity of nickel in the general population. However, it is suspected to be an essential element for some plants and animals (Health et al. 2000). Ni deficiency causes decreased plasma cholesterol, increased hepatic cholesterol, ultrastructural abnormalities in the liver, rough hair, impaired reproduction, and poor offspring growth, according to Plant Carla (Yulchiyeva 2020). Ni deficiency results in decreased plasma cholesterol, increased liver cholesterol, ultrastructural changes in the liver calls, rough hair, impaired reproduction, and poor growth of the offspring (Nkwunonwo, Odika, and Onyia 2020).

4.0. Heavy Metal and Consumer Health

Heavy metals accumulate in the human body in significant amounts, causing damage to the body's system due to heavy metals' non-biodegradable characteristics. They also have a stronger affinity for the organ functions, allowing them to stay in the body for longer periods of time. Oral exposure is the most compelling way for those heavy metals to enter the human body and cause disruption (Seidal et al. 1993). Heavy metals are transferred into crops through polluted soil, water, and air, which then end up in food chains, causing harm to consumers (Budroe n.d.). Heavy metals enter the human body via a variety of pathways (Figure 1), including dust and air pollution, as well as the conception of vegetables produced in polluted soils (Tabande and Taheri 2016),(Brhane and Dargo 2014). Accordingly, assessment of heavy metals health risk give the impression necessary (Brhane and Dargo 2014),(Tabande and Taheri 2016),(Liu et al. 2013), therefor remediation heavy metals levels is useful method for safeguard of human health (Yi, Yang, and Zhang 2011).

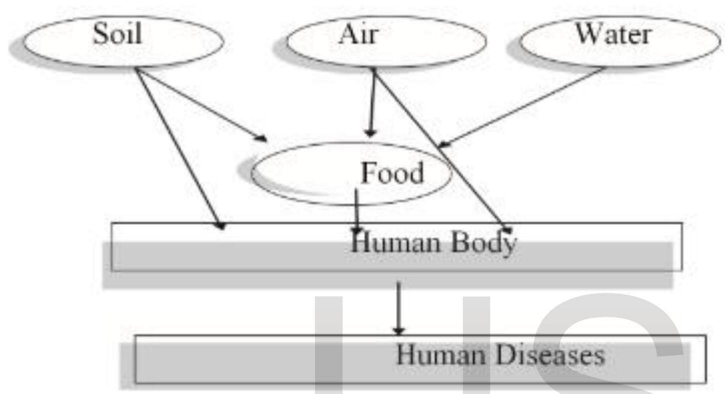

Figure 4.1. Different pathways of heavy metals entrance into human body.(Bahiru 2021)

5.0. Heavy Metal Contamination and Vegetables in Ethiopia

Vegetables are one of the diets by contributing Fe, Ca, and other nutrients. Vegetables are human diet as they contain needed by human bogs like carbohydrates, proteins, vitamins, minerals and trace elements. Their use has gradually increased in recent years, notably among the metropolitan population. This is due to a growing understanding of the nutritional value of vegetables as a result of exposure to various cultures and adequate education. Vegetables, on the other hand, contain both essential and harmful components in varying amounts (Bigdeli and Seilsepour 2008). Humans are advised to eat more fruits and vegetables, which are high in vitamins, minerals, and fiber and are also good for their health. These plants, on the other hand, contain both essential and harmful metals in varying amounts. Plants take up metals through absorbing them from contaminated soils and deposits on plant parts exposed to polluted environments' air. The public's worry and fear about the existence of heavy metal residues in their everyday diet has been fueled by the public's awareness of the high level of heavy metals in the environment. The public is confused and concerned about food safety (Radwan and Salama 2006). The transmission of trace metals from vegetables to humans through the food chain is a major concern in urban agriculture. For example, it's been estimated that this route accounts for up to 70% of dietary Cd exposure. In polluted air settings, vegetables may absorb trace metals from contaminated soil and are also exposed to surface deposition onto their shoots (Brhane and Dargo 2014). However, little is known about human exposure to pollutants in developing cities due to urban agriculture. In many developing-world cities, garbage collection is insufficient or non-existent, traffic is fast expanding, and industrial pollution is virtually unregulated. As a result, urban agriculture confronts significant challenges in balancing population growth against possible risks emerging from the eating of vegetables grown in contaminated urban areas, which is one of the routes through which heavy metals enter the food chain (Brhane and Dargo 2014). Differences in heavy metal concertation in vegetables tend to confirm differences in vegetable species. Heavy metal absorption capacity is determined by the composition of the vegetables, with some having a greater ability to collect larger quantities of heavy metals than others. The edible section of lettuce is said to acquire more heavy metals in people (Selassie 2013). Plants are known to respond to the amount of readily transportable metals in soil, notwithstanding element uptake by roots. Depending on environmental conditions, metal species, and plant accessible forms of heavy metals, different vegetable species acquired varied harmful heavy metal amounts and types (Lokeshwari and Chandrappa 2006).

According to a report on heavy metals levels in vegetables from the Addis Ababa market, lettuce had the greatest Cd content, while cabbage had the lowest (Marschner 1995),(Rahlenbeck, Burberg, and Zimmermann 1999). In vegetables from Akaki farm, which was irrigated with industrial effluent, similar tendencies of higher metal accumulation in Swiss chard and low accumulation in cabbage were detected (Itanna 1998b).

Furthermore, Bahiru and Bahiru and teju (Dagne and Endale 2019),(Dagne et al. 2019) reported that heavy metal accumulation in several vegetables above the recommended levels set by various organizations such as the FAO and WHO and in addition to those, other several studies reports in similar way as example , Awash River Cu in the lower stream the soil samples studied were below and in the vegetable samples were above the recommended safe limits of heavy metals by (WHO/FAO;

CAC; 2001) (Belay and Tizazu 2019).

Table 5.1 Maximum permissible concentration (mg/kg) of some heavy metals in vegetables (Elbagermi, Edwards, and Alajtal 2012).

Elements	Cu	Mn	Pb	Fe	Zn	Cr	Ni	Cd	As	Co
FAO/WHO	73.3	500	0.3	425.5	99.4	2.3	66.9	0.2	0.03	50

Table 5.2 Mean Concentration of heavy metal in different area of Ethiopia.

Vegetable	Study area	Name of Heavy metals	Value of heavy metals in crops (mg/kg)	Authors	Remark
Tomato **Lettuce**	Eastern Industrial Zone in Dukem	Cr, Cd and Pb	2.97, 2.20 and 4.60 respectively 3.77, 3.68 and 5.50 respectively	(Dagne et al. 2019)	Above the recommended limit of both WHO
Tomato	Eastern Industrial Zone in Dukem	Zn, Fe and Cu	45.63, 358.17and 10.20 respectively	(Dagne and Endale 2019)	Above the recommended limit of both WHO
Tomato	Gonder City	Pb, Cr, Cd, Cu, Ni, Mn and Zn	5.95,2.43,5.8,2.01 24.61,13.88 & 2.42 respectively 2.38,0.23,6.66,1.61	(Amare 2021)	Cr, Cd & Pb are above safe limit

Lettuce			64.55,48.1 & 41.52 Respectively		Pb & Cd are above safe limit
Onion			ND,3.93,6.66,2.15 19.15,9.25 &3.94 Respectively		Cr & Cd are above safe limit
Onion	Akaki	Cd, Cr, Cu, Zn& Ni	0.018,2.81,5.24, 15.4 &0.44 respectively	(Itanna 1998a)	Cr is Above safe limit
Lettuce	Kera	Zn, Cu, Ni, Co, Fe, Mn, Cr, As & Pb	48.9,7.0,1.2,0.46,132.5, 23.7,6.1,0.1 & 1.07 Respectively	(Gezahegn et al. 2017a)	Cr, As & Pb Above limit
Lettuce	Debre Birhan		84.9,9.9,5.3,0.47,115.3, 299.5,2.6,0.04 &0.46 Respectively		Cr, As &Pb Above limit
Lettuce	Melka Hida Wonji Gefersa farms	Pb,Cr &Cd	0.65, 2.4& 0.4 Respectively 0.4,1.33 &0.32 Respectively	(Length 2014)	Above Safe Limit by WHO
Tomato	Arbamnich(KRA)	Cd, Cr, Pb, Zn, Cu & Ni	0.43,1.84,0.28,13.65, 24.23&26.89 Respectively	(Abrham, F. and Gholap 2021)	Cd is Above safe limit
Lettuce			0.25.1.82,0.31, 22.45, 16.42 &17.70 Respectively		Cd & Pb Above safe limit
Tomato	Arbaminch(ATSHCA)		0.27,1.52,0.16,10.23, 19.56&24.45 Respectively		Cd is Above safe limit

lettuce			0.18,1.45,0.15,18.56, 13.89 &15.86 Respectively		All are below safe Limit
Tomato	Ziway	Cd, Cr, Pb &Cu	0.025,0.32,0.48 & 0.39 Respectively	(Anagaw, Zereffa, and Firmechale n.d.)	Pb is above safe limit
Lettuce	Bahir Dar	Fe, Zn, Mn, Co &Ni	935, ND, 110,10 & ND	(Selassie 2013)	All below safe limit
Onion	Mojo	Cr, Cu, Zn, Pb, Cd, Mn& Fe	4.87, 3.93, 12.42, 0.33, 0.05, 8.20 & 20.87 Respectively	[65]	Cr & Pb are above safe limit
	Meki		0.43,1.33,7.71, ND,0.03,13.24 &24.33 Respectively		All are below safe limit
	Ziway		3.33,0.87,13.47, ND, 0.06,7.53 &0.8 Respectively		Cr is above safe limit

6.0 Conclusion

Because of their non-biodegradable nature, extended biological half-lives, and ability to collect in many bodily parts, heavy metals are extremely dangerous. Vegetables are crucial in the human diet because they include necessary nutrients such as carbohydrates, proteins, vitamins, minerals, and trace elements. Vegetable consumption is one of the routes through which heavy metals enter the food chain. Different researchers recently assessed heavy metal concentrations in vegetables in many parts of Ethiopia, and they found that the concentrations of different heavy metals in tomato, lettuce and onion were over the FAO, WHO, UNEPA, CMH, and other organizations' recommended limits. These are the result of industrialization, home activities, and agricultural activities such as fertilizer, pesticide, and the overuse of organic fertilizer ingredients in the production of vegetables. As a result, the concerned body should focus on heavy metal contamination in vegetables, and researchers should focus on heavy metal remediation strategies.

Declaration

Assessment of Some Heavy Metals Contamination in Some Vegetables (Tomato, Lettuce and Onion) in Ethiopia: A Review

Availability of data

The data that support the findings of this review paper are openly available in google scholar and we are listed in the reference number [1-65].

Competing interests

I confirm that all authors of the manuscript have no conflict of interests to declare.

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Authors' contributions

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