

# STUDY OF HEAVY METALS IN VEGETABLES, *TOMATOES (Lycopersicon esculentum), CHILLY PEPPER (Capsicum annuum )* and *RADISH (Raphanus sativus)* IN MASTUNG, BALOCHISTAN, PAKISTAN. (A REVIEW)

Manzoor Iqbal Khattak<sup>1</sup>, Mahmood Iqbal Khattak<sup>2</sup>, Rukhsana Jabeen<sup>3</sup> and Fahad Saeed<sup>1</sup>

<sup>1</sup>Chemistry Department, Balochistan Uiversity, Quetta.

<sup>2</sup>PCSIR Laboratories, Peshawar.

<sup>3</sup>Sardar Bahdur Khan Women University, Quetta.

Email: manzoor\_iqbal@yahoo.com

**ABSTRACT:** The primary target of this work presents to call attention to the aggregation substance of lethal follow elements, for example, Cd, Cr, Cu, Pb and Zn in vegetables (Tomatoes, Chilly pepper and Radish) gathered from Mastung in the district of Balochistan. The samples were investigated, and the information was collected. Further, the grouping of overwhelming metals in the examples gathered of vegetables substantiated that these vegetables might be checked before utilizing reference to the contamination of harmful metals. Additionally, these contemplated vegetables are likewise utilized for ecological contamination purposes as well.

**Keywords:** Vegetables, Heavy Metals, Toxicity, Atomic Absorption Spectrometry.

## 1. INTRODUCTION

Balochistan is situated in the north focal piece of the region. It has a mainland semi-bone-dry atmosphere with sweltering summers and cold winters. The most restricting variable for yield generation in downpour nourished zones of the good countries is the low precipitation and its slanted dissemination both as far as existence. Yearly precipitation ranges from 175 to 200 mm in the southern areas of Khuzdar, Mastung and Kalat and 300 to 350 mm in the northern locale of Loralai, Killa Saifullah, Pishin and Zhob. Yield creation in non-flooded zones is reliant on precipitation while the principle wellspring of water system water in the valley floor is tube-wells, and mountain springs. Organic product plantations and vegetables are the significant money yields developing of watered terrains. Vegetables not just give protein, nutrients, starches, and roughage to the human eating regimen as a sustenance source but at the same time are significant wellspring of homestead salary. Its protein generation is higher than that of the other oat crops. By the by, the per section of land yield is low principally as a result of non-accessibility of value seed of high yielding assortments and legitimate promoting component. Vegetable harvests can wind up alluring venture if appropriate consideration is given to create generation and promoting framework. Business vegetable developing gives prompt to come back to cultivators in this way it possesses a significant position in the economy of the nation. In Balochistan, particularly in good countries because of an exceptional sort of atmosphere, vegetable developing is being advanced by the ranchers. The territory under vegetable creation has been expanding and at present, vegetable development is being considered as "thrive cultivating".

Vegetables give higher net incomes than other crops in the region because of the low expenses of generation and high costs of yield. Vegetable harvests can end up alluring endeavor if legitimate consideration is given to water system water, spare the downpour run-off water through the development of little dams all through the territory particularly in good countries of the region to raise the underground water table. Besides, the aimless establishment of a cylinder well should be limited to maintain a strategic distance from the complete debacle. Plant sicknesses and bugs are causing tremendous yield misfortunes; endeavors in such matters are expected to

carry out proper plant security measures and control these issues. Create generation and promoting the foundation to improve the productivity of the advertising framework for the vegetable industry. Ultimately the ranchers need appropriate augmentation administrations at their doorsteps with the goal that the exploration discoveries could contact them and be connected in the field for higher returns.

The tomato is the palatable, frequently red berry-type product of the nightshade *Solanum Lycopersicum*, ordinarily known as a tomato plant. The tomato is devoured in assorted ways, including crude, as a fixing in numerous dishes, sauces, servings of mixed greens, and beverages. The English word tomato originates from the Spanish word, tomate, inferred Nahuatl (Aztecan linguistic) expression, tomat [1]. It previously showed up in pattern in 1595[2]. This general picture of the plant of Tomato (disambiguation) is given underneath in Figure-1:



**Figure-1. The general image of the plant of *Tomato* (disambiguation).**

The tomato has a place with the nightshade family, Solanaceae[3]. The species started in the South American Andes [4] and its utilization as nourishment began in Mexico and spread all through the world after the Spanish colonization of the Americas. Its numerous assortments are presently generally developed, some of the time in nurseries in cooler atmospheres. The plants normally develop to 1–3 meters (3–10 ft) in tallness and have a powerless stem that regularly spreads over the ground and vines over different plants. It is lasting in its local living space, albeit regularly developed outside in mild

atmospheres as a yearly. A normal regular tomato weighs roughly 100 grams (4 oz) [5-6].

The bean stew pepper (additionally chile pepper or stew pepper, from Nahuatlchilli, is the product of plants from the genus capsicum, individuals from the nightshade family, Solanaceae [7]. In Britain, Australia, Ireland, New Zealand, South Africa, Pakistan, India, [8] and other Asian nations, it is generally referred to just as the bean stew.

The materials which stretch into stew sprinkles whose power after ingestion or connected topicality are capsaicin (8-methyl-N-vanillyl-6-on enamide) and a few related synthetic substances, altogether called capsaicinoids. The general picture of the plant of bean stew pepper is given below in Figure-2.



**Figure-2. The general image of the plant of chili pepper**

Bean stew peppers have been a piece of the human eating regimen in the Americas since at any rate 7500 BCE. The latest research demonstrates that bean stew peppers were trained over 6000 years back in Mexico, in the area that stretches out crosswise over southern Puebla and northern Oaxaca to southeastern Veracruz, [9] and were one of the principal self-pollinating harvests developed in Mexico, Central and parts of South America [10].



**Figure-3. The general image of the plant of radish.**

The radish (*Raphanus sativus*) is a consumable root vegetable of the Brassicaceae family that was trained in Europe in pre-Roman occasions. Radishes are developed and expended all through the world, being generally eaten crude as a crunchy salad vegetable, which has various assortments, shifting in dimensions, taste, shading, and

period they take to develop. Radishes of zesty assortments owe their sharp flavor to the different synthetic mixes created by the vegetations, together with glucosinolate, myrosinase, and isothiocyanate, which are some of the time developed as sidekick plants and experience the ill effects of a couple of irritations and sicknesses.

They sprout rapidly and develop quickly, littler assortments being prepared for utilization inside a month, while bigger daikon varieties take a while. Another utilization of radishes is as spread or clasp harvest in midwinter[11] or as a scrounge harvest[12]. A few radishes are developed for their seeds; daikon, for example, might be developed for fat creation. Few are utilized for growing and the two roots and leaves are at times obliged baked. The general picture of the plant of radish is given underneath in Figure-3.

Varieties of radish are currently extensively disseminated the world over, yet nope archeologically chronicles are accessible to aid decide their initial history and taming [13]. Be that as it may, researchers likely find the starting point of radish (*R. sativus*) in southeast Asian regions, which is the main locale where rough structures are being found in Indian Chines, and central Asian regions seem to be optional focuses where varying structures were created. Radishes enter the verifiable records in the 3rd era BC [14].

Greek and Roman agriculturalists of the principal century AD gave subtleties of little, huge, rounded, lengthy, mellow, and shrill assortments. The reddish appears to be one of the primary Europe yields acquainted with the Americans. A Germanane plant expert announced radishes of 45 kg (100lb) and about three feet long in 1544, even though the main assortment of the size today is the Japanese Sakurajima radish [15]. The enormous, gentle, and snowy Eastern Asian structure was created in Chines regions, yet is, for the most part, related in the West with the Japanese daikon, inferable from Japan farming improvement and greater charges.

In Pakistan, mechanical gushing & raw sewage are released into exterior aquatic physiquess. The aqua insufficiency in the nation, powers the ranchers to utilize contaminated water for an aquatic system of harvests and root vegetable fields. Mess aquatic transfer in of Pakistanis huge urban areas and its dangerous impacts are exacerbate with the progression of time because untreated sewage water is utilized for developing harvests in the environments of municipal regions [16]. Manure and modern waste aqua comprise the abnormal state of natural issues and supplements alongside substantial metallics vis Fe, Mn, Cu, Zn, Pb, Cr, Ni, Cd, and Co. Florae having a higher limit concerning amassing of the overwhelming metal substance, a few species collect explicit substantial metals while another aggregate every single overwhelming metal, which causes hindering consequences for human wellbeing. Verdant vegetables collect more grouping of overwhelming metallics when developed in polluted topsoil and aqua [17]. Which is being generally revealed that medical issues happened because of overwhelming metals tainting of soil [18]. Metals, for example, Fe, Cu, Zn, and Mn are fundamental metallics however they may create lethal impacts when its dimensions surpass sure breaking points in living beings. Abnormal state of copper may create harmful impacts, for example, dramatics and haptic cancer when devoured in inordinate sums in nourishments [19]. The targets of its examination are to appraise

overwhelming metal fixation in vegetables gathered from  
Mastung, Balochistan.

### 3. EXPERIMENTAL

Tests of tomatoes, crisp (red paper) and radish were gathered from Mastung in Balochistan. The examples were arbitrarily gathered at each site to get delegate tests. They were enveloped by cleaned Al-foil, gathered in polyethylene sacks and ecstatic to the Department of Chemistry, UoB, Quetta.

#### Test Preparation

##### Herbal Samples

Gathering of herbal samples, the technique utilized by Chove *et al* [20] was pursued by slight changes. The gathered herbs washed away completely by crisp outlet aqua and flushed multiple spells with refined aqua to expel superficial toxins & holding fast to the exteriors. Trials were cut in little fragments and outdoors dehydrated on rough paper for around two hrs to take out abundance dampness. Each example was gauged, dried in a stove at 353K for a few hrs and reweighted to consistent mass. The dehydrated samples were crushed until it might go over a 2 mm work strainer and put away in perfect & dry polyethylenes packs.

##### Dry Ashing (Test Breakdown)

Around 2.5 g of pulverized herbal samples put in a perfect ceramic pot and held in a cold stiffler heater. The example was then ashed at 450 - 500°C medium-term (10 hrs). The ashes test was chilled to room temperature in a desiccator. The fiery debris was then disintegrated in 5 mL of 20% (v/v) HCl corrosive. The arrangement was heated gradually to break down any deposits. Sifting of arrangement was brought into corrosive was washed away Whatman No 42 into a 50 mL volumetric decanter. The filter paper was washed with refined water and washings gathered in the volumetric cup. Subsequently, arrangements were weakened to the imprint by refined aqua, very much blended & utilized for assurance of the substantial metallics in herbal samples [21].

##### Assurance of Heavy Metals:

Assurance of overwhelming metallics from the filtrate of vegetables and soil tests were completed by utilizing the GFAAS (Analytik Jena AG/Konrad-Zuse-Straße 1/07745/Germany) for Cu and ICP-OES (Ultma2, HORIBA Jobin Yvon S.A.S, variant 3, 2001, France) for Cd, Cr, Cu, Pb and Zn. The scientific methodology is as portrayed in [21].

##### Quality Assurance

QC (Quality control) tests were led on topsoil and herbal examples to assess the test methodology and proficiency of the GFAAS and ICP-OES strategies. The excellence of affirmations were finished by spiking each of the pre-processed examples of herbs & topsoil with weakened arrangement of overwhelming metallics typical arrangement (20 µg/kg of Cd, Cr, Cu, Pb, and Zn) arranged from a few weakening of the 1000 ppm stock standard arrangement. The spikey examples were processed & separated utilizing a similar strategy as that of soil and vegetable examples.

##### Factual Analysis

Unpaired understudy's t-test was utilized to decide and think about the measurable contrasts b/w the mean convergences of 2 gatherings of tests. A likelihood dimension of  $P < 0.05$  was measured factually noteworthy. The examination was achieved by encouraging the crude information into an exceptional program for

unpaired understudy's t-test assurance as portrayed by Kothari [22].

### 3. RESULTS AND DISCUSSION

Confession of overwhelming metallics are related by the extensive scope of foundations, for example, block ovens, little dimension businesses (metal refining, metal items, battery creation, link covering enterprises), suspended street dirt, vehicle release, diesel generators and coal burning. India's coals have low superiority and higher convergence of substantial metallics. Which is the exceedingly significant donor of substantial metallics present-day in vegetation? Additional wellspring of substantial metallics sully in vegetations is the waste aqua delivered of local and modern zones and utilized by water system reason. This waste aqua taints topsoil as well as defile yields & vegetations developed in these regions comprising polluted topsoil. Different resources incorporate intemperate utilization of insecticides, manures & manure ooze. Modern waste aqua utilized for the water system would be a real cause of substantial metallics gathering in vegetations. Cd may undoubtedly be used by the sustenance harvests, particularly verdant vegetations. Distinctive vegetal kind comprises diverse overwhelming metallics fixation relying upon ecological conditions, for example, plant accessibility, metallic types and kind of water system exercise. Substantial metallics groupings of florae are straightforwardly connected by its focuses in topsoils, yet their dimensions essentially contrast with, Heavy metals are of incredible centrality in eco chemistry and ecotoxicology as a result of their poisonous quality at low dimensions and propensity to collect in human organs [16].

Pb is poisonous and can be destructive to plants, however, the plants, for the most part, show the capacity to collect huge measures of Pb without obvious changes in their appearance or yield. In numerous plants, Pb collection can surpass a few times the limit of most extreme dimensions reasonable for humans [23]. From this present investigation, a high estimation of Pb was watched for radish and carrot. Because of its nearness with the interstate, produced Pb from vehicular depletes gets kept on the uncovered vegetables. Pb contamination has been demonstrated to be proportionate with the populace and vehicular thickness, and this in one way or another clarifies why occupants devouring Pb swarmed vegetables are inclined to poisonous quality.

The utilization of such vegetables will surely result in medical issues. The greater part of the collected Pb is sequestered in the bone and teeth [24]. This can cause fragile bones and shortcoming in the wrists and fingers. Pb that is put away in bones can reemerge the circulation system during times of expanded bone mineral reusing (i.e., pregnancy, lactation, menopause, propelling age, and so on.). Assembled Pb can be re-saved in the delicate tissues of the body and can cause musculoskeletal, renal, visual, immunological, neurological, conceptive, and formative impacts [25].

Perceptions from this investigation indicated a height of Pb in every one of the vegetables. Because of the estimations of Pb in ten distinct vegetables, it very well may be expected that if 80 gm of any of these is devoured each day, the week by week admission would surpass the

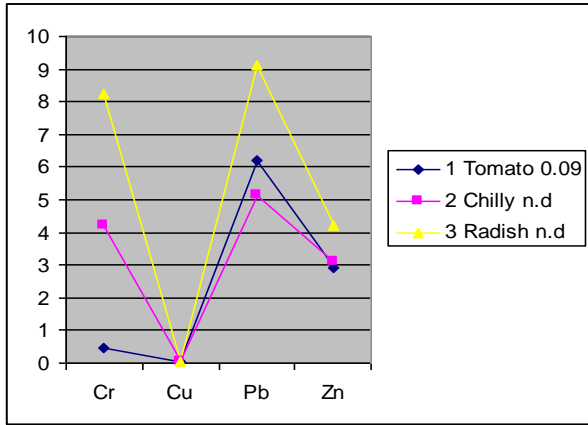


mediocre furthest reaches of 6 mg/kg suggested by CAP 132V benchmarks [26].  
The aftereffects of the examination uncovered that nonstop utilization of these vegetables will unavoidably result in risky outcomes. There ought to be a standard for normal

assessment of Pb load in vegetables from danger inclined regions and dependent on metal burdens, examined plants can be utilized for natural checking. The general information as appeared Table-1 and Figure-4

**Table-1. The concentration of heavy metals (ug/g) in vegetables collected from Mastung (Balochistan).**

S. NO	Name of Vegetable	Cd	Cr	Cu	Pb	Zn
1	Tomato	0.09	0.44	0.04	6.19	2.9
2	Chilly	n.d	4.22	0.03	5.14	3.1
3	Radish	n.d	8.22	0.029	9.12	4.2



**Figure-4. The concentration of heavy metals (ug/g) in vegetables collected from Mastung (Balochistan).**

**Cd (Cadmium)**

This is being accounted for the increments in topsoil Cd substance would produce expanded take-up by vegetations [27]. Cd take-up by vegetations of topsoil is likewise higher at a low pH of the soil [27-28].

The groupings of Cd in vegetal recorded at beneath identification limit in practically all examples and in tomatoes it was documented at over the FAO/WHO [29] admissible utmost of 0.05 ppm. Compact disc debased vegetations are identified to outcome in the bony crack, the runs, gastrointestinal torments and extreme retching, regenerative disappointment, the harm of focal sensory system and DNA, notwithstanding malignant growth improvement [30]. As indicated by before study, in the dirt,

Cd was documented at beneath the TZS [31] passable point of confinement of 1.0 ug/g in all tested areas. This is because Cd is a versatile component, effectively consumed by roots and transported to shoots where it is consistently dispersed in plants [32].

Studies [20, 33] likewise documented convergence of Copper at underneath the FAO/WHO passable farthest point in cold. The accessibility of Cu<sup>2+</sup> in topsoil relates to soil pH. Malik et al.[34] has discovered that expanded topsoil pH may likewise diminish the accessibility of Cu<sup>2+</sup> to vegetations by expanded adsorption at cation trade locales.

**Cr (Chromium)**

Groupings of Cr in the tomatoes were 0.44 ppm. The mean focus in cold and radish was,22 ug/g-dw inside FAO/WHO [35] allowable breaking point of 0.05 ppm. Utilization of influenced vegetations would be positive outcomes to wellbeing outcomes that incorporate renal and hepatic harm, derma rashes, abdominal distresses, sore,

respirational issues & lung disease and change of hereditary ingredients. The examples of vegetables indicated dimensions of Cr b/w 0.02 ppm and (0.35 ppm), standards beneath the TZS [31] allowable point of confinement of 100 ppm by an average focus documented of 0.074 ppm. Unpaired t-trial of convergence of Cr in vegetal demonstrated no huge contrasts ( t=1.62, P = 0.121 ). A variety of topsoil pH somewhere in the range of 5.65 and 7.21 might have encouraged Cr dissolvability & accessibility of assimilation by vegetals [28, 36].

Concentrates by Al-Amin et al., [37] showed high Cr focuses in radish is not exactly in cold in Pakistan. Banerjee et al. [38] directed investigations in dirtied and non-contaminated territories and recorded high groupings of Cr in tomato, nippy and radish.

Results for Cd from the present investigation were like outcomes announced after revisions led in no-contaminated zones which documented Cd after no-distinguished dimensions to 1.10 ppm in tomatoes, nippy & radish by separate focus in vegetables [39].

Al-Charani et al., [27] discovered Cd stages in cauliflowers (0.0559 - 0.6185 pp) cabbages (0.04010 - 0.43720 ppm), tomatoes (0.17310 - 0.819 ppm) & carrots (0.05940 - 0.27980 ppm. Abbas et al., [39] announced average dimensions of 0.0790 ppm “Cd in onions and 0.0490 ppm Cd to 0.0750 ppm.

**Cu (Copper)**

Convergences of Cu in vegetations by various destinations of Mastung are exhibited in Figure-4. The convergence of Cu in all vegetal and tomatoes ran b/w 0.040 ppm in radish and 3.70 ppm in cold by average fixation 0.7940 ppm. All vegetables and tomatoes documented Cr stages underneath the allowable furthest reaches of 5.0 ppm [29] in this way falling inside as far as possible. The utilization of these vegetables won't result in Cu linked medical issues. Topsoil dimensions of Copper went b/w 1.690 ppm &0.050 ppm. Average focus documented (0.8 ± 0.6730 ppm) was well underneath TZS [31] admissible point of confinement (200.0 ppm).t-test demonstrated focus in vegetal and topsoil factually not indicating critical contrasts (t = |-0.154|, P = 0.988).

**Pb (Lead)**

The amount of lead (Pb) in vegetal documented at underneath location limits in all examples. The mean focus of the mentioned vegetal was 6.190 ppm, a dimension over the FAO/WHO [35] reasonable point of confinement of 0.30 ppm. The utilization of vegetal mentioned might unquestionably outcome in medical issues. Lead (Pb) levels in vegetables after separate areas were documented inside point of confinement at Mastung. All Pb levels were beneath the TZS [31] reasonable farthest

point of 200 µg/g-dw. Sharma et al. [40] recorded a higher convergence of 1.96: g/g of cadmium in tomatoes more than that acquired in the present investigation. High centralization of substantial metal, for example, cadmium in vegetables like tomatoes.

#### Zn (Zinc)

In this examination, large amounts of Zinc were being documented inside vegetal & tomatoes at all areas. This is the admissible farthest point of the FAO/WHO passable utmost of 5.0 ppm [35]. This high fixation documented 4.20 ppm. Studies [41-42] additionally announced dimensions of Zinc in vegetal & tomatoes over the allowable dimensions of FAO/WHO. Amongst every single substantial metal, Zn is the least dangerous and is a basic component in the human eating routine as it is required to keep up the best possible working of the invulnerable framework, typical mind action and is major in the development and improvement of the baby. Over the top Zn in the eating routine for example delayed everyday admission of Zn extending 150.0 – 450.0 mg /day, likewise unfavorable to humanoid wellbeing [43-44].

No significant industrial examination zones, this was accepted that wellsprings for Zinc presumably of elastic engine automobile exhausts intensified by deprived street exteriors in region & the waste-greasing up oily in this Zinc is present as a component of numerous added substances, for example, zinc dithiophosphates [45].

#### 4. CONCLUSION

This examination was led to measure the overwhelming metals fixation in Pakistani and Indian vegetables. Tests were gathered from Mastung. Substantial metals were examined in vegetables by utilizing a nuclear ingestion spectrophotometer. Be that as it may, the grouping of these metals was not higher than WHO/FAO benchmarks limits. As the long haul utilization of these polluted vegetables may cause their amassing in the human body which can cause unsafe impacts later in their lives. It was noted from the outcomes that substantial metal substance was identified to be comparative with both dry powder and wet techniques aside from few in which fixation was distinguished to be more by dry fiery remains strategy. The discoveries demonstrated that the contemplated tests were dirtied with the previously mentioned overwhelming metals. This is because the outcome uncovered that the grouping of these metals was over as far as possible stipulated by WHO/FAO [46] Alimentarius. Along these lines, utilization of tomatoes from the examination regions may act wellbeing dangers to human-like at the season of this investigation.

#### 5. RECOMMENDATIONS

- Therefore, the utilization of tomatoes from the examination regions may act wellbeing perils to human-like at the season of this investigation.
- It is prescribed that mindfulness is expected to abstain from the exchanging of consumable foods grown from the ground in and around spots that have a heavier climatic lead focus (i.e. industrial environment or vigorously traffic-clogged streets).
- Also, there ought to be a standard for normal assessment of Pb load in vegetables from lethality inclined zones and dependent on metal burdens, examined plants can be utilized for natural observing and its ability to cause dangerous results.

- As the different substance parameters either expanded or diminished with developing period of plant and occasional changes. It is thusly prescribed that reaping of these plants may be progressively gainful at the legitimate stage to get the most extreme therapeutic advantages.

#### REFERENCES

1. Foolad, M.R. (2007). Genome mapping and molecular breeding of tomato. *Int. J. Plant Genomics*. 45: 64-58.
2. Darwin, S.C., Knapp, S. and Peralta, I.E. (2003). Taxonomy of tomatoes in the Galapagos Islands: Native and introduced species of Solanum section Lycopersicon (Solanaceae). *Syst. Biodivers*. 12: 29–53.
3. Filippone, P.T. (2014). Tomato History- the history of tomatoes as food. Once considered poisonous. The tomato is now a favourite food. Home Cooking Expert.(<http://homecooking.about.com/od/foodhistory/tomatohistory.htm>).
4. Farzaneh, A., Nemati, H., Arouiee, H. and Kakhki, A.M. (2013). Genetic analysis of traits associated with yield and earliness in nine tomato (*Lycopersicon esculentum* Mill.) lines using diallel crossing method. *J. Seed Pl. Improv.* 29(4): 693-710.
5. "Tomaat september 2010, RZ Seeds & Services" (PDF). Het gemiddeld vruchtgewicht ligt tussen de 102 en 105 gram en de kwaliteit is goed. 2010
6. "Enza Zaden – Teeltnieuws". Het gemiddelde vruchtgewicht van Ingar ligt tussen 100–110 gram. 6 August 2009 .
- 7."HORT410. Peppers – Notes". Purdue University Department of Horticulture and Landscape Architecture.Retrieved 20 October 2009. Common name: pepper. Latin name: *Capsicum annum* L. ... Harvested organ: fruit. Fruit varies substantially in shape, pericarp thickness, color and pungency.
8. Dasgupta, Reshmi R (8 May 2011). "Indian chilli displacing jalapenos in global cuisine – The Economic Times". *The Times Of India*.
9. "Birthplace of the domesticated chili pepper identified in Mexico" *EurekaAlert* April 21, 2014.
- 10."Bosland, P.W. 1998. Capsicums: Innovative uses of an ancient crop. "p. 479–487. In: J. Janick (ed.), *Progress in new crops*. ASHS Press, Arlington, VA."". *Hort.purdue.edu*. 22 August 1997. Retrieved 23 December 2010.
11. Andrew J. Price and Jason. K. Norsworthy. (2013) Cover Crops for Weed Management in Southern Reduced-Tillage Vegetable Cropping Systems. . *Weed Technology* 27(1):212-217. <http://dx.doi.org/10.1614/WT-D-12-00056.1>.
12. J. J. Fitzgerald and W. J. M. Black. (1984) Finishing Store Lambs on Green Forage Crops: 1. A Comparison of Rape, Kale and Fodder Radish as Sources of Feed for Finishing Store Lambs in Autumn. *Irish Journal of Agricultural Research*. Vol. 23, No. 2/3, pp. 127-136. <http://www.jstor.org/stable/25556085>.
13. Zohary, Daniel; Hopf, Maria (2000). *Domestication of plants in the Old World* (3rd ed.). Oxford: Oxford University Press. p. 139.
14. Lewis-Jones, L.J.; Thorpe, J.P.; Wallis, G.P. (1982). "Genetic divergence in four species of the genus *Raphanus*: Implications for the ancestry of the

- domestic radish *R. sativus*". *Biological Journal of the Linnean Society* **18** (1): 35–48. doi:10.1111/j.1095-8312.1982.tb02032.x.
15. "Raphanus sativus". *Plant Finder*. St. Louis: Missouri Botanical Garden. 2014. Retrieved 22 June 2014.
  16. Yamin M T, Ahmed N (2007). Influence of hudiara drain water irrigation on trace elements load in soil and uptake by vegetables. *Journal of Applied Science Environmental Management* **11**(2): 169-172
  17. Farooq M, Anwar F, Rashid U (2008). Appraisal of heavy metal contents in different vegetables grown in the vicinity of an industrial area. *Pakistan Journal of Botany* **40**(5): 2099-2106
  18. Singh A, Sharma R K, Agrawal M, Marshall F M (2010). Risk assessment of heavy metal toxicity through contaminated vegetables from waste water irrigated area of Varanasi, India. *Tropical Ecology* **51**: 375-387
  19. Aktan N, Tekin-Özan S (2012). Levels of some heavy metals in water and tissues of chub mackerel (*Scomberjaponicus*) compared with physico-chemical parameters, seasons and size of the fish. *The Journal of Animal & Plant Science* **22**(3): 605-613
  20. Chove, B. E., Ballegu, W.R., and Chove, L.M., (2006) Copper and lead levels in two popular leafy vegetables grown around Morogoro Municipality, Tanzania. *Tanz. Health Res. Bull.* **8**, p. 1.
  21. Othman, O.C., (2001), Heavy metals in green vegetables and soils from vegetable gardens in Dar es Salaam, Tanzania. *Tanz. J. Sci.* **27**, p. 37-48.
  22. Kothari, C.R., (2004) *Research methodology, method and techniques*. 2nd Edn, New age international (P) Ltd, New Delhi Vikas, India.
  23. Rahman A K M R, Hossain S M, Akramuzzaman M M (2010). Distribution of heavy metals in rice plant cultivated in industrial effluent receiving soil. *Environment Asia* **3**(2): 15-19
  24. Todd GC. (1996) Vegetables grown in mine wastes. *Environmental Toxicology and Chemistry* **19** (3) :600–607.
  25. Agency for Toxic Substances and Disease Registry (ATSDR) 1999 Toxicological Profile for Lead. Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services, *Public Health service*, 205–93–0606.
  26. Wei M, Yanwen Q, Binghui Z, Lei Z (2008). Heavy metal pollution in Tianjin Bohai Bay. *Journal of Environmental Science* **20**: 814-819
  27. Al-Chaarani, N., El-Nakat, J.H., Obeid, P.J., and Aouad S., (2009) Measurement of levels of heavy metal contamination in vegetables grown and sold in selected areas in Lebanon. *Jordan J. of Chem.* **4**, p. 303-315.
  28. Akinola, M.O., Njoku, K.L., and Ekeifo, B.E., (2008) Determination of lead, cadmium and chromium in the tissue of an economically important plant grown around a textile industry at Ibeshe, Ikorodu Area of Lagos State, Nigeria. *Advances in Environmental Biology* **2**, p. 25-30.
  29. FAO/WHO, CODEX ALIMENTARIUS International Food Standards *CODEX STAN-193*. Codex Alimentarius commission, WHO/FAO, 1995.
  30. Oti, W.J.O. and Nwabue, F.I. (2013) Heavy metals effect due to contamination of vegetables from Enyigba lead mine in Ebonyi state, Nigeria. *Environment and Pollution* **2**(1), p. 19-26.
  31. TZS 972:2007 *Soil quality - Limits for soil contaminants in habitat and agriculture*. 2007, Tanzania Bureau of Standards (TBS), Dar es Salaam.
  32. Sêkara, A., Poniedziaek, M., Ciura, J., and Jêdrszczyk, E., Cadmium and Lead Accumulation and Distribution in the Organs of Nine Crops: Implications for Phytoremediation. *Polish Journal of Environmental Studies* **14**(4), 2005, p. 509 -516.
  33. Farooq, M., Anwar, F. and Rashid, U., (2008) Appraisal of heavy metal contents in different vegetables grown in the vicinity of an industrial area. *Pakistan J. Bot.* **40**, p. 2099-2106.
  34. Malik, R.N., Husain, S.Z., and Nazir, I., (2010) Heavy metal contamination and accumulation in soil and wild plant species from industrial area of Islamabad. *Pakistan J. of Bot.* **42**(1), p. 291-301.
  35. FAO/WHO, CODEX ALIMENTARIUS International Food Standards *CODEX STAN-179*. Codex Alimentarius commission, WHO/FAO, 2003.
  36. Akan, J.C., Abdulrahman, F.I., Sodipo, O.A., and Lange, A.G., (2010) Physicochemical parameters in soil and vegetable samples from Gongulon Agricopperltural Site, Maiduguri, Borno State, Nigeria. *Journal of American Science* **6**, p. 7-12.
  37. Alamin, M.B., Mhapes, A.A., Bejey, A.M., Sadek, A., Atweer, R.H., Dubali, K., and Saad, D.M., (2007) Determination of essential and toxic elements in Libyan foodstuff using instrumental neutron activation analysis (INAA). *Journal of Radioanalytical and Nuclear Chemistry* **271**, p. 247-250.
  38. Banerjee, D., Bairagi, H., Mukhopadhyay, S., Pal, A., Bera, D., and Ray, L., (2010) Heavy metal contamination in fruits and vegetables in two districts of West Bengal, India. *Electronic J. Environmental, Agricultural and Food Chemistry* **9**(9), p. 1423-1432.
  39. Abbas, M., Parveen, Z., Iqbal, M., Riazuddin, M., Iqbal, S., Ahmed, M. and Bhutto, R., (2010) Monitoring of toxic metals (cadmium, lead, arsenic and mercury) in vegetables of Sindh, Pakistan. *Kathmandu University Journal of Science, Engineering and Technology* **6**, p. 60-65.
  40. Sharma, R.K., M. Agrawal and F.M. Mashall, (2009). Heavy metals in vegetables collected from production and market site of a tropical urban area of India. *J. food chem. Toxicol.*, **47**: 583-591.
  41. Bosiacki, M., and Tyksiński, W., (2009) Lead, zinc, iron and manganese content in edible parts of some fresh vegetables sold on markets in Pozinañ. *Journal of Elementol.* **14**, p. 13-22.
  42. Kirmani, M.Z., Sheikh, M., Farah, N., Iftikhar, I.N., and Erum, Z., (2011) *Determination of some toxic and essential trace metals in some medicinal and edible plants of karachi city*. *Journal of Basic and Applied Sciences.* **7**, p. 89-95.

43. Lee, M. and Media, D. (2014). Do tomatoes have more vitamin C than oranges? (healthy eating.sfgate.com/tomatoes-vitamin-c-oranges-3711.html).
44. Johnson, A.R., Munoz, A., Gottlieb, J.L. and Jarrard, D.F. *High dose zinc increases hospital admissions due to genitourinary complications*. J Urol 177, 2007, p.639-643.
45. Qasem, M., Kamal, A., and Moman, I. Contamination of roadside soil, plants, and air with heavy metals in Jordan, A comparative Study. *Turk. J. Chem.* 23, 1999, p. 209-220.
46. WHO/FAO, 2007. Joint FAO/WHO Food Standard Programme Codex Alimentarius Commission 13 Session. Report of the thirty eight session of the codes committee on food hygiene. Houston, United State of America, ALNORM 07/03/13.