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**Assessment of Cr, Cu, Ni, Cd, and Ca in an Aromatic
Beverage of Cured Leaves of the Tea Plant,
*Camellia sinensis***

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Abstract

Tea is the most common beverage used in everyday life by everyone. Tea contains a large number of possibly bioactive chemicals, including flavonoids, amino acids, vitamins, caffeine and several polysaccharides. It has been suggested that green and black tea may protect against cancer, though the catechins found in green tea are thought to be more effective in preventing certain obesity-related cancers such as liver and colorectal cancer, while both green and black teas may protect against cardiovascular disease. Negative effects of tea drinking are centered around the consumption of sugar used to sweeten the tea. Those who consume very large quantities of brick tea may experience fluorosis. Numerous recent epidemiological studies have been conducted to investigate the effects of green tea consumption on the incidence of human cancers. These studies suggest significant protective effects of green tea against oral, pharyngeal, oesophageal, prostate, digestive, urinary tract, pancreatic, bladder, skin, lung, colon, breast, and liver cancers, and lower risk for cancer metastasis and recurrence and a variety of health effects have been proposed and investigated. In present study six tea samples of different brands (Broke Bond Taza, Dhadkan, Patakha, Razana, Red label and Tata tea) were analysed for Cu, Ni, Pb, Cd, Cr and Ca. Trace metals like Cu, Ni, Pb, Cd, Cr and Ca were found to be within the permissible limit given by WHO.

Keywords: Tea, bioactive chemicals, Trace metals, human cancers.

Introduction

Tea is an aromatic beverage commonly prepared by pouring hot or boiling water over cured leaves of the tea plant, *Camellia sinensis*. After water, tea is the most widely consumed beverage in the world. It has a cooling, slightly bitter, and astringent flavour that many people enjoy. Tea originated in China as a medicinal drink. It was first introduced to Portuguese priests and merchants in China during the 16th century. Drinking tea became popular in Britain

during the 17th century. The British introduced it to India, in order to compete with the Chinese monopoly on the product, tea has long been promoted for having a variety of positive health benefits. Recent studies suggest that green tea may help reduce the risk of cardiovascular disease and some forms of cancer, promote oral health, reduce blood pressure, help with weight control, improve antibacterial and antiviral activity, provide protection from solar

ultraviolet light, and increase bone mineral density. Green tea is also said to have "anti-fibrotic properties, and neuroprotective power." Additional research is needed to "fully understand its contributions to human health, and advise its regular consumption. Tea catechins have known anti-inflammatory and neuroprotective properties, help regulate food intake, and have an affinity for cannabinoid receptors, which may suppress pain and nausea and provide calming effects. Consumption of green tea is associated with a lower risk of diseases that cause functional disability, such as "stroke, cognitive impairment, and osteoporosis" in the elderly. Tea contains L-theanine, an amino acid whose consumption is mildly associated with a calm but alert and focused, relatively productive (alpha wave-dominant) mental state in humans. This mental state is also common to meditative practice.

The phrase herbal tea usually refers to infusions of fruit or herbs made without the tea plant, such as rosehip tea, chamomile tea, or rooibos tea. Alternative phrases for this are tisane or herbal infusion, both bearing an implied contrast with "tea" as it is construed here.

Ba gel et al (2005) reported the daily mineral intake by consuming herbal teas for a 70 kg person per day are 500 mg Ca, 300 mg Mg, 15 mg Fe, 5 mg Al, 2.8 mg Mn, 15 mg Zn, 2.5 mg Cu, 1.6 mg Sr, 1.1 mg Ba, 0.025 mg Ni, 0.05-0.2mg Cr, 0.04 mg Co, 0.415 mg Pb and 0.057 mg Cd. This shows that heavy metals are present in herbal tea. Most of slimming tea products consists of tea (*Camellia sinensis*) which is either green tea or black tea. Ansari et al (2007) stated that tea (*Camellia sinensis*) is the most popular beverage in the world and contains several essential nutrients, which are beneficial for human health. The contamination of tea leaves by heavy metals may pose a serious threat to human, because they are not biodegradable and remain in environment and pass to food chain. The concentration of heavy metals of Cd, Pb, Ni, and Al and macro elements of Fe, Zn, Cu and Mn were determined by atomic absorption spectrometry on 30 samples of black tea cultivated in Iran and compared with the results for 30 samples of imported black tea in 2006. The results of analysis showed that the mean level of Al was 699.2 ± 172.7 mg/kg for Iranian and 388.3 ± 98.3 mg/kg for imported black tea. However, the values for Cd, Pb, and Ni were non-detectable. The most abundant nutritive metal was manganese with 155.2-214.2 mg/kg and 96.7-332.9 mg/kg in Iranian and imported black tea, respectively. (K. F. Fung, et al 2001). Metal determination in tea, wheat, and wheat flour using diluted nitric Acid, high-efficiency nebulizer, and axially viewed ICP OES also carried out by Martin, et al (2015).

Materials and Methods

Tea samples were collected from Rajamandi, the main market of Agra. Sampling was done at random from different retailers and vendors of this market. A total of six (6) varieties Broke Bond, Taza, Dhadkan, Patakha, Razana, Red label and Tata tea were collected. The tea samples were then analyzed for Cd, Cr, Cu, Ni, Pb, and Ca. Transferred 1gm of sample to a beaker and added 5ml conc. HNO₃. Partially covered the beaker with a watch glass to minimize contaminations. Took the container under a fume hood and heated slowly on a hot plate to boiling and evaporated to dryness. The solution at this state was clear having a light colour. If not continue heating by adding conc. HNO₃ till the digestion is completed i.e., a clear or light coloured solution is obtained. All metal salts dissolved in tea are adsorbed on some materials present as impurities in tea. Therefore, the sample is digested rigidly under controlled condition. Maintained constant sample volume, acid strength and contact time. Used the least rigorous digestion method to provide acceptable and consistent recovery compatible to analytical method and metal being analyzed. Heavy metal analysis had done by AA100-Perkin Elmer Atomic Absorption Spectrometer.

Results and Discussion

Nickel is a compound that occurs in the environment only at very low levels. Humans use nickel for many different applications. Plants are known to accumulate nickel and as a result the nickel uptake from vegetables will be eminent. Smokers have a higher nickel uptake through their lungs. Finally, nickel can be found in detergents. Humans may be exposed to nickel by breathing air, drinking water, eating food, beverages and smoking cigarettes. Skin contact with nickel-contaminated soil or water may also result in nickel exposure. In small quantities nickel is essential, but when the uptake is too high it can be a dangerous to human health. An uptake of too large quantities of nickel has the following consequences: - Higher chances of development of lung cancer, nose cancer, larynx cancer and prostate cancer - Sickness and dizziness after exposure to nickel gas - Lung embolism - Respiratory failure - Birth defects - Asthma and chronic bronchitis - Allergic reactions such as skin rashes, mainly from jewelry - Heart disorders. Nickel fumes are respiratory irritants and may cause pneumonitis. Exposure to nickel and its compounds may result in the development of a dermatitis known as "nickel itch" in sensitized individuals. The first symptom is usually itching, which occurs up to 7 days before skin eruption occurs. The primary skin eruption is erythematous, or follicular, which may be followed by skin ulceration. Nickel sensitivity, once acquired, appears to persist indefinitely. Carcinogenicity- Nickel

and certain nickel compounds have been listed by the National Toxicology Program (NTP) as being reasonably anticipated to be carcinogens. The International Agency for Research on Cancer (IARC) has listed nickel compounds within group 1 (there is sufficient evidence for carcinogenicity in humans) and nickel within group 2B (agents which are possibly carcinogenic to humans. (J.Y. Ruan and M. H. Wong, 2001).

There was not much variation in the concentration of nickel in all samples. The concentration of Ni in Broke Bond 1,0121mg/kg, Taza Dhadkan 1.125mg/kg, Pataka 0.893mg/km, Razana 0.792mg/kg, Red Label 0.962mg/kg and Taza tea 0.786mg/kg, slightly above than the permissible limit given by WHO.

People can be exposed to chromium through breathing, eating or drinking and through skin contact with chromium or chromium compounds. The level of chromium in air and water is generally low. In drinking water the level of chromium is usually low as well, but contaminated well water may contain the dangerous chromium(IV); hexavalent chromium. For most people eating food that contains chromium(III) is the main route of chromium uptake, as chromium(III) occurs naturally in many vegetables, fruits, meats, yeasts and grains. Various ways of food preparation and storage may alter the chromium contents of food. When food is stored in steel tanks or cans chromium concentrations may rise. Chromium(III) is an essential nutrient for humans and shortages may cause heart conditions, disruptions of metabolisms and diabetes. But the uptake of too much chromium(III) can cause health effects as well, for instance skin rashes. Chromium (VI) is a danger to human health, mainly for people who work in the steel and textile industry. People who smoke tobacco also have a higher chance of exposure to chromium. Chromium (VI) is known to cause various health effects. When it is a compound in leather products, it can cause allergic reactions, such as skin rash. After breathing it in chromium (VI) can cause nose irritations and nosebleeds. Other health problems that are caused by chromium(VI) are: - Skin rashes - Upset stomachs and ulcers - Respiratory problems - Weakened immune systems - Kidney and liver damage - Alteration of genetic material - Lung cancer - Death. The health hazards associated with exposure to chromium are dependent on its oxidation state. But of course, chromium level was found to be extremely high in Dhadkan sample. The concentration of Cr in Broke Bond 4.683mg/kg, Taza Dhadkan 6.914mg/kg, Pataka 3.717mg/kg, Razana 4.703mg/kg, Red Label 3.708mg/kg and Taza tea 2.307mg/kg, is above than the permissible limit given by WHO.

Copper can be found in many kinds of food, in drinking water and in air. Because of that we absorb eminent quantities of copper each day by eating, drinking and breathing. The absorption of copper is necessary, because copper is a trace element that is essential for human health. Although humans can handle proportionally large concentrations of copper, too much copper can still cause eminent health problems. Copper concentrations in air are usually quite low, so that exposure to copper through breathing is negligible. But people that live near smelters that process copper ore into metal, do experience this kind of exposure. People that live in houses that still have copper plumbing are exposed to higher levels of copper than most people, because copper is released into their drinking (C. Steinhäuser, et al, 2004) "water through corrosion of pipes. Occupational exposure to copper often occurs. In the working environment, copper contagion can lead to a flu-like condition known as metal fever. This condition will pass after two days and is caused by over sensitivity. Long-term exposure to copper can cause irritation of the nose, mouth and eyes and it causes headaches, stomachaches, dizziness, vomiting and diarrhea. Intentionally high uptakes of copper may cause liver and kidney damage and even death. Whether copper is carcinogenic has not been determined yet. There are scientific articles that indicate a link between long-term exposure to high concentrations of copper and a decline in intelligence with young adolescents. Whether this should be of concern is a topic for further investigation. Industrial exposure to copper fumes, dusts, or mists may result in metal fume fever with atrophic changes in nasal mucous membranes. Chronic copper poisoning results in Wilson's Disease, characterized by a hepatic cirrhosis, brain damage, demyelization, renal disease, and copper deposition in the cornea (J. R. J. Sorenson et al, 1974). The concentration of Cu in Broke Bond is 0.923mg/kg, Taza Dhadkan 0.481mg/kg, Pataka 0.8083mg/kg, Razana 0.7429mg/kg, Red Label 0.2392mg/kg and Taza tea 0.7350mg/kg, all within the permissible limit given by WHO.

Lead is one out of four metals that have the most damaging effects on human health. It can enter the human body through uptake of food (65%), water (20%) and air (15%). Foods such as fruit, vegetables, meats, grains, seafood, soft drinks and wine may contain significant amounts of lead. Cigarette smoke also contains small amounts of lead. Lead can enter (drinking) water through corrosion of pipes. This is more likely to happen when the water is slightly acidic. That is why public water treatment systems are now required to carry out pH- adjustments in water that will serve drinking purposes. For as far as we know, lead fulfills no essential function in the human body, it can merely do harm after uptake from food, air or water. Lead can cause several unwanted

effects, such as: - Disruption of the biosynthesis of haemoglobin and anaemia - A rise in blood pressure - Kidney damage - Miscarriages and subtle abortions - Disruption of nervous systems – Brain damage etc (J. R. J. Sorenson et al 1974). Table 1 presents the concentrations of metals found in the teas considered. These concentrations

agree with literature data reported by other researchers. The maximum lead concentration was found in the Broke Bond sample and the lowest lead concentration was in Red Label. However, these values were higher than UL approved by WHO.

TABLE – 1. Metal concentration in mg/kg studied in Tea samples

Name of the Tea Brand	Copper	Nickel	Lead	Cadmium	Chromium	Calcium
Broke bond	0.923	1.0121	1.151	0.080	4.683	70
Taza Dhadkan	0.481	1.125	0.755	0.029	6.914	70
Patakha	0.8083	0.893	0.958	0.122	3.717	66
Razana	0.7429	0.792	0.835	0.046	4.703	60
Red label	0.2392	0.962	0.899	0.051	3.708	66
Tata tea	0.7350	0.786	0.650	0.084	2.3072	100
Permissible Limit (WHO) Al (mg/d)	1-3	0.0010	0.0150	N D	0.035-0.045	1-2.5

Human uptake of cadmium takes place mainly through food. Foodstuffs that are rich in cadmium can greatly increase the cadmium concentration in human bodies. Examples are liver, mushrooms, shellfish, mussels, cocoa powder and dried seaweed. An exposure to significantly higher cadmium levels occurs when people smoke. Tobacco smoke transports cadmium into the lungs. Blood will transport it through the rest of the body where it can increase effects by potentiating cadmium that is present from cadmium-rich food. Other high exposures can occur with people who live near hazardous waste sites or factories that release cadmium into the air and people that work in the metal refinery industry. When people breathe in cadmium it can severely damage the lungs. This may even cause death. Cadmium is first transported to the liver through the blood. There, it is bound to proteins to form complexes that are transported to the kidneys. Cadmium accumulates in kidneys, where it damages filtering mechanisms. This causes the excretion of essential proteins and sugars from the body and further kidney damage. It takes a very long time before cadmium that has accumulated in kidneys is excreted from a human body. Other health effects that can be caused by cadmium are: - Diarrhoea, stomach pains and severe vomiting - Bone fracture - Reproductive failure and possibly even infertility - Damage to the central nervous system - Damage to the immune system - Psychological disorders - Possibly DNA damage or cancer development. Table 1 presents the concentrations of metals found in the teas considered. These contents agree with literature

data reported by other researchers. The maximum cadmium concentration was found in the Patakha sample and the lowest cadmium concentration was in Taza Dhadkan, these values were found to be in accordance with UL approved by WHO.

Calcium is the most abundant metal in the human body: is the main constituent of bones and teeth and it has key metabolic functions. Calcium is sometimes referred to as lime. It is most commonly found in milk and milk products, but also in vegetables, nuts and beans. It is an essential component for the preservation of the human skeleton and teeth. It also assists the functions of nerves and muscles. The use of more than 2,5 grams of calcium per day without a medical necessity can lead to the development of kidney stones and sclerosis of kidneys and blood vessels. A lack of calcium is one of the main causes of osteoporosis. Osteoporosis is a disease in which the bones become extremely porous, are subject to fracture, and heal slowly, occurring especially in women following menopause and often leading to curvature of the spine from vertebral collapse. Unlike most of the people think, there is an intense biological activity inside our bones. They are being renewed constantly by new tissue replacing the old one. During childhood and adolescence, there's more production of new tissue than destruction of the old one (J. R. J. Sorenson et al 1974).

The calcium level in all tea samples were more than the WHO standards.

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