

Research Article

Mineral profile and proximate analysis of fresh and waste water irrigated cabbage from Quetta Balochistan

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Abstract

In developing countries especially in Pakistan due to insufficient fresh water resources, wastewater is largely used for irrigation purposes. The wastewater cultivated vegetables due to presence of toxic material might be injurious to human health. The present study was designed to interpret the effect of waste and fresh water on the nutritional value of Cabbage (*Brassica oleracea*). For the purpose of macro and micro nutrients along with proximate contents of the randomly selected cabbage samples from both irrigation types were analysed. The cabbage harvested from wastewater plots showed more accumulation of heavy metals than that of fresh water. The macro and micro nutrients (mg/g) in waste and fresh water cabbage were Calcium (Ca) (395.00, 399.60), Magnesium (Mg) (226.82, 234.00), Iron (Fe) (1.01, 1.06), Chromium (Cr) (0.74, 0.83), Nickel (Ni) (0.86, 0.91), Cadmium (Cd) (0.15, 0.14), Lead (Pb) (0.72, 0.07), Copper (Cu) (1.32, 1.85) and Zinc (Zn) (0.24, 0.38), respectively. Whereas, the macro and micro minerals contents of the fresh and wastewater mg/l were Ca (35.61, 37.39), Mg (23.62, 24.97), Fe (0.16, 0.18), Cr (0.05, 0.06), Ni (0.006, 0.007), Cd (0.16, 0.18), Pb (0.019, 0.07), Cu (0.007, 0.02) and Zn (0.28, 0.57), respectively. The result for the proximate composition of freshly harvested (g/100g) revealed Crude fibre (3.24 and 3.24 %), Crude protein (1.80 and 1.58 %), Ether extract (6.42 and 6.22 %), Dry matter (6.94 and 7.18 %), Moisture contents (93.02 and 92.8 %) and Ash (0.67 and 0.61 %). The study showed that cabbage is rich in appreciable amount of macro and micro nutrients, therefore possess high nutritional values in human consumption but continuous accumulation of these metals can pose severe threats to health of people.

Keywords: *Brassica Oleracea*; Heavy metals; Proximate analysis; Wastewater; Vegetables; Atomic absorption spectroscopy

Introduction

Vegetables; the herbaceous fresh portions of plants contain certain ingredients which play

vital role in different metabolic pathways and physiological functions [1, 2]. They offer the prompt and least expensive source

of fibres, minerals and vitamins to the majority of population of developing countries [3]. These are helpful for the maintenance of health, repair and build-up of the body and prevention of various diseases [4]. Vegetables contain minerals, which take part to maintain body pH, regulate osmotic pressure and act as coenzymes. These minerals neutralize the acidity formed by other foods, particularly those of animal sources and helpful in providing alkaline effects [2]. The well represented composition of minerals include Ca, Fe, Cu, P, Zn, Cl, and Na . It is recommended that adults should consume at least 400 g (or five servings a day) of fruits and vegetables [5].

Cabbage (*Brassica oleracea* var. capitata L) is a green leafy vegetable belongs to the genus *Brassica*, of family *Brassicaceae* [6]. It is an excellent source of vitamins, minerals and dietary fibre [7]. Cabbage has been used in ancient times both as food and medicine. It is helpful in the management and/or treatment of several ailments and disease conditions including yeast infections, gout and rheumatism, relieving of gastric pain and hyperacidity, short-term rapid weight loss, reduction of painful breast engorgement in breast feeding women, hangover remedy, urine retention, menstrual pain or irregularities, scurvy, immune stimulant, constipation and as a poultice to clean infected wounds [8].

Good quality water is scarce in developing countries because of overwhelmed population. Use of sewage water (wastewater) in agriculture is centuries old practice and now a days got more attention in many parts of the world due to increasing water demand [9]. In Pakistan, about 25% of the total vegetables are irrigated with wastewater that increases the risk of heavy metal toxicity [10]. Leafy vegetables including cabbage grow quite well with sewage water irrigation. However,

vegetables grown in the presence of sewage water may accumulate heavy metals that could be transferred through food chain to human and animals and may cause serious health hazards [11].

The evaluation of nutrients of vegetables is of great nutritional importance [12] and is the trend of the day throughout the world. Presently there is very little or no data is available about Quetta, regarding the use of waste and fresh water. Pakistan pertaining to the concentration of sewage water contents and their accumulation in vegetable receiving irrigation using municipal sewage water. Therefore the current study was designed to examine the effect of irrigation of fresh water (tube well) and municipal wastewater on the nutritional quality of cabbage regarding mineral profile and proximate analysis components.

Materials and methods

Cabbage samples (n=10, each 1kg) were randomly collected from the fields irrigated with fresh (tube-well) and wastewater sources, located near Samungli, Spini and Sabzal roads, Quetta where both (sources and their cultivated cabbage plants) were available. The collected samples were transferred to Toxicology laboratory of Centre for Advanced Studies in Vaccinology and Biotechnology (CASVAB), university of Balochistan for further processing and analysis to determine mineral (macro and micro) profile and proximate contents.

Sample processing

The samples were washed with distilled water, dried in hot air oven at 35°C, grinded (40 mesh) and stored in the polyethylene bags at 4°C until used for further analysis.

Mineral profile

Mineral contents were determined following the method previously adopted [13]. Briefly; 0.5 gram powdered sample (in duplicate) was placed in a crucible and added a few drops of concentrated nitric acid. Dry ashing was supported with a muffle furnace by

stepwise rise of temperature up to 550°C and then left to ash at this temperature for 6 hours. Then kept in a desiccator, rinsed with 3 Molar hydrochloric acid (3N HCL), filtered with Whatman No. 1 filter paper, poured into a 50 ml volumetric flask and made the final volume 50 ml by adding 3N hydrochloric acid. The minerals including Ca, Mg, Fe, Cr, Ni, Cd, Pb, Cu and Zn were determined by atomic absorption spectrophotometer (M series AA Spectrometer, Thermo Electron Corporation) results were expressed in mg/100g.

The Proximate composition including crude protein, dry matter, moisture, ash, crude fibre and ether extract contents were analysed adopting the methodology of [14] briefly

Crude fibre

Two grams of moisture and fat free sample was subjected to acid (1.25% H₂SO₄) and alkali (NaOH) digestion for 30 minutes. The contents were dried at a 100 °C using hot air oven till constant weight. The dried residue was ignited in muffle furnace at 550°C for 20 minutes. Loss in weight was reported as crude fibre.

$$\text{Crude fibre} = \frac{\text{Loss in weight on ignition} \times 100}{\text{Weight of sample}}$$

Crude protein

Cabbage samples were digested in presence of catalyst i.e. Mercuric sulfate (HgSO₄) and Potassium sulfate (K₂SO₄) with concentrated sulfuric acid till it become clear. The digested material was cooled and diluted with distilled water. An aliquot was transferred to Kjeldhal distillation apparatus for distillation in the presence of 40% NaOH solution and Zinc dust. The ammonia formed was trapped with 2% boric acid solution added with indicator. The distillate was titrated to light pink against 0.1 N sulfuric acid. The nitrogen percentage was calculated by using the following formula.

$$\text{Nitrogen \%} = \frac{\text{ml } 0.1 \text{ N H}_2\text{SO}_4 \times 0.0014 \times 250 \times 100}{\text{W1} \times 10}$$

Where Conversion factor = 100/N (N% in fruit products).

Ether extract

The ether extract was determined by extraction with petroleum ether (PE) using a Soxhlet system (boiling point range of 40–60°C). Extraction was carried out with 25 ml PE and 1g of dried sample with for 3-4 hours. At 105 °C PE extract was evaporated to dryness. Percentage of crude fat was known by calculating and weighing residue on dry weight basis.

$$\text{Ether extract} = \frac{\text{W}_2 - \text{W}_1 \times 100}{\text{W}_3}$$

Where W1 = Weight of empty flask, W2 = Weight of flask + fat and W3 = Weight of sample taken.

Moisture

5gm sample was placed in hot air oven at 80°C up to constant weight and recorded the moisture %age

$$\text{Moisture \%} = \frac{\text{Weight of fresh sample} - \text{weight of dried sample} \times 100}{\text{Weight of fresh sample}}$$

Ash

The 10 gram sample was placed in crucible and kept in Muffle furnace at 550°C for 6 hours, desiccated and recorded the weight.

$$\text{Ash \%} = \frac{\text{weight of sample after washing} \times 100}{\text{Total weight of sample}}$$

Data analysis

The data was statistically analysed with the help of computer software SPSS 16 for windows using independent sample student's t-test. Excel 2010 was used where needed.

Result

The mineral profile (mg/100g) of cabbage irrigated with fresh and wastewater sources (Table 1) were Ca (395.00, 399.60), Mg (226.82, 234.00), Fe (1.01, 1.06), Cr (0.74, 0.83), Ni (0.86, 0.91), Cd (0.15, 0.14), Pb (0.72, 0.07), Cu (1.32, 1.85) and Zn (0.24, 0.38). Whereas the mineral contents (mg/100l) of the water types (fresh and waste) presented in Table 2 were Ca (35.61, 37.39), Mg (23.62, 24.97), Fe (0.16, 0.18), Cr (0.05, 0.06), Ni (0.006, 0.007), Cd (0.16,

0.18), Pb (0.019, 0.07), Cu (0.007, 0.02) and Zn (0.28, 0.57). Comparison and analyses of results showed non-significant ($P>0.05$) difference in minerals viz. Ca, Mg, Fe, Cr, Ni and Cd and significant difference between Pb, Cu and Zn in both the wastewater and fresh water cabbage with their respective water cultivated.

The proximate analysis of cabbage samples (Table 3) Crude fibre contents (3.24 and 3.24 %), Crude protein (1.80 and 1.58 %), Ether extract (6.42 and 6.22 %), Dry matter (6.94 and 7.18 %), Moisture contents (93.02 and 92.8 %) and Ash (0.67 and 0.61 %). Result shows there is non-significant ($P>0.05$) difference between fresh and wastewater grown cabbage.

Table 1. Minerals in fresh and wastewater irrigated cabbage (mg/g)

S.No	Minerals	Fresh water irrigated cabbage (Mean \pm SD)	Waste water irrigated cabbage (Mean \pm SD)
1	Ca	395.00 ^a \pm 4.00	399.60 ^a \pm 5.02
2	Mg	226.82 ^a \pm 5.46	234.00 ^a \pm 5.47
3	Fe	1.01 ^a \pm 0.03	1.06 ^a \pm 0.05
4	Cr	0.74 ^a \pm 0.093	0.83 ^a \pm 0.091
5	Ni	0.86 ^a \pm 0.037	0.91 ^a \pm 0.051
6	Cd	0.15 ^a \pm 0.037	0.14 \pm 0.039
7	Pb	0.72 ^a \pm 0.071	0.07 ^b \pm 0.007
8	Cu	1.32 ^a \pm 0.12	1.85 ^b \pm 0.09
9	Zn	0.24 ^a \pm 0.08	0.38 ^b \pm 0.07

Means followed by different letters in the same row are significantly different at ($P<0.05$)

Table 2. Fresh and wastewater minerals composition (mg/l)

S. No	Minerals	Fresh water (Mean \pm SD)	Waste water (Mean \pm SD)
1	Ca	35.61 ^a \pm 2.16	37.39 ^a \pm 1.68
2	Mg	23.62 ^a \pm 0.7	24.97 ^a \pm 2.09
3	Fe	0.16 ^a \pm 0.03	0.18 ^a \pm 0.04
4	Cr	0.05 ^a \pm 0.01	0.06 ^a \pm 0.01
5	Ni	0.006 ^a \pm 0.002	0.007 ^a \pm 0.002
6	Cd	0.16 ^a \pm 0.029	0.18 ^a \pm 0.021
7	Pb	0.019 ^a \pm 0.003	0.07 ^b \pm 0.007
8	Cu	0.007 ^a \pm 0.001	0.02 ^b \pm 0.008
9	Zn	0.28 ^a \pm 0.04	0.57 ^b \pm 0.08

Means followed by different letters in the same row are significantly different at ($P<0.05$)

Table 3. Proximate composition on dry matter basis (gm/100gm)

S. No	Proximate contents (%)	Fresh water irrigated cabbage (Mean \pm SD)	Waste water irrigated cabbage (Mean \pm SD)
1	Fibre	3.42 \pm 1.12 ^a	3.42 \pm 0.67 ^a
2	Protein	1.80 \pm 0.51 ^a	1.58 \pm 0.54 ^a
3	Ether Extract	6.42 \pm 1.35 ^a	6.22 \pm 1.00 ^a
4	Dry Matter	6.94 \pm 0.67 ^a	7.18 \pm 0.53 ^a
5	Moisture	93.02 \pm 0.63 ^a	92.8 \pm 0.54 ^a
6	Ash	0.67 \pm 0.19 ^a	0.61 \pm 0.08 ^a

Means followed by different letters in the same row are significantly different at ($P<0.05$)

Discussion

Vegetables are integral part of balanced diet and play a vital role in the maintenance of good health [2]. Cabbage is a good source of minerals like Ca, Fe, P, Na and K. Nutrients are helpful in forming a strong immune system, thus assisting body to absorb, digest and utilize nutrients [2]. Minerals are needed for vital body functions i.e. acid base and water balance etc. Na and K are used as electron carrier in the body [2]. Fe being part of hemoglobin is important in the hemoglobin formation, recommended for anaemic patients [15]. Ca and P are found in the body especially in bones. Ca is necessary for nails, hair, teeth and bones [16]. Whereas in diseases like osteoporosis, renal damage, kidney stones, stroke, hypertension, hypercalciuria, and cardiac dysfunctions P have a protective role [17]. Zn is essential in cofactor of many enzymatic activities and in cellular growths [18]. Cr is involved in various metabolic reactions [4]. Cu is required for erythropoiesis and necessary for the survival of red blood cells. However in high concentrations causes diarrhea, vomiting and liver damage [19].

The heavy metals found in both fresh and wastewater samples and in cabbage irrigated with both the water were below the critical limits of wastewater by world and health organization (WHO) and food and agriculture organization (FAO) found in safe limits although the wastewater sample was a bit higher in both the water and cabbage. Major source of heavy metals accumulation in plants are due to humans and natural. Human sources include mining extraction, nuclear power, metal finishing and electroplating and nuclear power plants whereas natural sources are aerosol particles, soil erosion and urban run offs [20]. Extensive use of domestic and industrial effluents for irrigation purpose causes accumulation of heavy metals in soil, lead to their raised levels in plants through

bioaccumulation. Ingestion of such plants pose a potential threat to human and animal health [21].

The fibre contents in cabbage were similar [22]. It helps to reduce hypertension, coronary heart disease and serum cholesterol level [22]. Moisture content was in line with [2-4]. Moisture present in food items is a good source of water and it is deliberated, 20% to 30% of total water consumption should come from food [23]. Moisture in leafy vegetables is indicative of its perishability and freshness. However, elevated levels of moisture in leafy vegetables causes spoilage hence susceptible to microbes [24]. Protein contents were in agreement with [4-25]. Protein being the structural material of the body necessary for the formation of muscles, blood and body fluids etc. One gram of protein is known to supply the body with about 4 Kcal. Fats are important in terms of their important functions like sterol hormones, nervous system activities, enzymatic reactions and cell membrane structure. Energy provided by 1 gram of fat is more than double the energy given by carbohydrate or protein per unit weight i.e. 9 kcal [25]. Ash content which is a measure of the inorganic matter [26]. Ash contents identified were in line with [4-25].

Conclusion and recommendations

Present study revealed a number of positive effects of cabbage such as presence of minerals and proximate contents, which are beneficial for the health. It is concluded that the comparative nutritional analysis of cabbage irrigated with sewage water contain higher values of some heavy metals as compared to that grown with tube well (fresh) water. Use of sewage water for irrigation purposes poses a high risk of heavy metals accumulation in vegetables that may lead to several health problems.

Authors' contributions

Conceived and designed the experiments: M Tayyeb & N Rashid, Performed the Experiments: M Tayyeb & N Rashid, Analyzed the Data: N Rashid & K Baseer, Contributed reagents/ materials/ analysis tools: SK Achakzai, S Rehman & Akhtar, Wrote the paper: M Tayyeb & M Sabir.

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