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Research Article

EFFECT OF MUNICIPAL WASTEWATER ON THE NUTRITIONAL AND PROXIMATE COMPOSITION OF SELECTED VEGETABLES GROWN AT SILANWALI ROAD SARGODHA

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ABSTRACT
The present study was conducted in the fields of Sargodha city along Silanwali municipal channel to evaluate the effect of canal water and wastewater irrigation on *Spinacia oleracea* and *Brassica oleracea.* The ash, carbohydrate, protein, moisture, fat, fiber contents, energy values and nutrient composition of two vegetables' *Spinacia oleracea* and *Brassica oleracea* were determined. Micro nutrients composition was also determined in these vegetables by using atomic absorption spectrophotometer.

Keywords: *Spinacia Oleracea Brassica Oleracea, Proximate, Heavy Metal, Micro Nutrients, Waste Water*

INTRODUCTION
The amounts of heavy metals into surface and ground water soils and to the biosphere have been increased due to human activities such as mining, agriculture, transportation industrial production. Now days, a great concern is the accumulation of heavy metals in crop due to which there is great chances of the food contamination through the soil root interface. The heavy metals such as Cd, Pb and Ni are readily taken up and accumulated by plants in toxic levels (Mussarat & Bhatti, 2005; Qadir *et al*., 1999; Bhatti & Perveen, 2005).
In Pakistan, annual production of fruits and vegetables is about 12854.6 thousand tons. Annual vegetables production from it consists of5675.8 thousand tons (Government of Pakistan, 2008). Vegetables the chief component of human diet, have marked health effects and constitute important food components including proteins, vitamins, calcium and iron (Arai, 2002). They are mostly consumed due to their nutritional benefits. Vegetable crops as minor crops in the country are usually preferred because of their low cost of production, higher yield potential, higher nutritional value and economic benefit and are the most frequently irrigated crops with municipal water due to high cost in the adjacent metropolitan marketplaces (Ensink *et al*., 2004).
Disposal of municipal water containing sewage effluents is of great concern in Pakistan. Thus, the use of disposed wastewater for agriculture is a usual and widespread exercise in 50 out of 60 major cities of Pakistan (Khalil and Kakar, 2011). In developing countries, it is estimated that 20 million crops are irrigated with waste water (Dreschsel *et al.*, 2002). However, it is reported that in proper environmental planning, rapid urbanization and industrialization has resulted in discharge of industrial and sewage effluents in water bodies rendering them unhealthy for intake in agricultural field (Sheikh and Irshad, 1980; Wahid *et al.*, 1999, 2000).
Sargodha, Pakistan's eleventh largest city with geographical area of 5,864 km^2 is located northwest of Pakistan and is an agricultural trade center having various industries. Importance of environmental quality of Sargodha in recent times have taken great attention and interest. Wastewater irrigated vegetable production is the dominant agricultural practice in Sargodha. This practice of untreated wastewater irrigation has been going on from past 20 years. Industrial effluents, domestic and municipal wastes are

the main source of pollution in Sargodha. Silanwali road municipal channel is of great concern, as it irrigates ten acres agricultural field along silanwali road Sargodha where five to six species of vegetables are grown. The primary crops grown are lettuce, tomatoes, onions, Spinach and cabbage. Most of the vegetables are brought to Sargodha from silanwali road, directly irrigated with municipal waste water. These toxicants accumulate in plant body at very high concentration. They reach to humans through food chain and cause health risks.

A wide range leafy vegetable, currently distributed throughout temperate world is Spinach (*Spinacea Olearacea L*) whose origin can be traced back to Iran (Russel, 1988). It is a regularly grown vegetable in the fields of Sargodha.70% of its tissue contains water and cultivars require sufficient water for growth so as to maintain balance, resilience and to attain turgidity (Kelvin *et al.*, 1995).

The plant species require high organic content and can tolerate a fairly high range of temperature (22-30°C) and pH between 5.5-7.5 (Kelvin *et al.*, 1995) and can be grown during dry and wet seasons (Tindal, 1986). However, the growth and development of spinach cultivar is affected if wastewater is used (Mairiga *et al.*, 2009).

The current study was thus undertaken to determine the impact of polluted municipal water on biochemical, physiological and growth parameters of leafy vegetable spinach (*Spinacea oleracea*) grown in suburban area of Sargodha having short term irrigation of wastewater.

MATERIALS AND METHODS

Vegetables and Soil Samples

Plant samples of *Spinacia oleracea and Brassica oleracea* were collected randomly from municipal wastewater areas. Samples of soil from the depth of 0-15 cm were collected from similar location. Kraft paper was used for the packing of collected vegetables. Physico-chemical characteristics of soil samples were analyzed using the protocol illustrated by hand book No. 60 (USAD Laboratory, 1954).

Collection of Sewage Water

Sewage water was collected from municipal channel in polyethylene cans and transported to Department of Botany, University of Sargodha, Sargodha, Punjab, Pakistan for analysis.

Proximate Composition Analysis

The proximate composition of plant consists of carbohydrates, fats, protein, moisture and ash. AOAC method was used for the determination of proximate composition. The protein contents were obtained by multiplying nitrogen to a factor of 6.25. Carbohydrates were determined by difference method. [100-(proteins+fats+moisture+ash)]. The lipid contents were determined by Soxhlet direct solvent extraction method. Kjeldhal apparatus was used for the estimation of total nitrogen.

Heavy Metal Detection

Shoots and roots of plants at maturity were handed for chemical analysis. Root and shoot samples were collected and dried in oven at 70ºC for 72 hours. They were then minced in a Wiley micro mill, so that it may pass through a sieve of 2 mm. The material (0.2 g) was processed with 5 ml HNO_3 and incubated at room temperature overnight. Test tubes were placed in digestion block and heated up to 250ºC up until fumes were formed. After 60 minutes the tubes were removed and cooled. 2ml of hydrogen peroxide (H_2O_2) was then added slowly in the test tubes and tubes were positioned again indigestion block. The procedure was repeated until the contents became clear and colorless. Solution was filtered after adding 50 ml of distilled water in each test tube. Atomic absorption spectrophotometer was used to determine heavy metals in the extracts.

For each metal 1000 ppm concentration stock solution was prepared by the given formula:

$$= \frac{\boldsymbol{molecular\ weight\ of\ salt}}{\boldsymbol{molar\ weight\ of\ metal}} \times \mathbf{0.1} = \boldsymbol{X}$$

x grams of the salt were dissolved in 100 ml dH_2O to make 1000 ppm solution that was further diluted to 100 ppm solution for preparation of solutions for preparation of the standard curve. For calibration of instrument, 1 ppm to 10 ppm diluted solution was used. Following formula was used to make dilutions;

$$\mathbf{C_1V_1= C_2V_2}$$

Statistical Analysis

In order to reach a definite conclusion data was subjected to statistical analysis using ANOVA to compare the means and test was used to note the significant and non-significant values. Two factors (species & treatments) completely randomized design (CRD) was applied for treatment and species. For significant factors, least significant difference (LSD) test at 5% level of significance was applied.

RESULTS AND DISCUSSION

Characteristics of Canal Water

Characteristics of canal and sewage water are summarized in Table 1. Electrical conductivity (EC) was considerably elevated in wastewater as compared to canal water. The EC of wastewater was 1860 µscm^{-1} while of canal water was 240 µs cm^{-1}(Table 1). According to National environmental quality standards maximum permissible limit for EC is 1.5 µs /l (EPA, 2007). Higher Electrical conductivity is usually termed as an indicator of high salt content of the water.

Characteristics	Unit	Canal Water	Waste Water
Electrical Conductivity (EC)	µscm^{-1}	240	1860
Sodium Absorption Ratio (SAR)		0.1	3.4
Calcium + Magnesium (Ca^{2+} + Mg^{2+})	meqL^{-1}	2.3	5.2
Sodium (Na^{+})	meqL^{-1}	0.1	5.6
Bicarbonate (HCO_3)	meqL^{-1}	2.0	5.6
Chloride (Cl^{1-})	meqL^{-1}	0.1	5.2
Residual Sodium Carbonate (RSC)	meqL^{-1}	Nil	0.4

Proximate Composition

In the present study, the Ash content of selected vegetables at site irrigated with waste water. Statistically highest values of ash content of *Spinacia oleracea* and *Brassica oleracea were* 1.720% and 1.800% respectively. Lowest values of ash contents were found in *Spinacia oleracea* and *Brassica oleracea* 0.058% and 0.089% respectively (Table 1).

Moisture contents were higher (5.72%) in *Spinacia oleracea* whereas in *Brassica oleracea*, moisture contents was (3.68%) at wastewater site (Table1). While comparing both selected vegetables, *Spinacia oleracea* has higher moisture contents as compared to *Brassica oleracea.*

Statistically crude fat percentage found in *Spinacia oleracea* and *Brassica oleracea* were 2.14% and 5.54% respectively (Table 1). Proteins content of *Spinacia oleracea* irrigated with wastewater was 12.60% and in *Brassica oleracea* 13.100% (Table 1).

Carbohydrate contents of *Spinacia oleracea* and *Brassica oleracea* at wastewater irrigated site were 2.32% and 2.69% respectively. Hussain *et al.*, (2011) studied the proximate composition of different vegetables including *Brassica oleracea*. The moisture content, ash, fat, protein and carbohydrate percentages were 14.70%, 12.34%, 2.87%, 22.34% and 47.72% respectively.

Many researchers have reported that in green leafy vegetables protein content range from 20.48% to 41.66%. Its deficiency may cause nutritional pathology (Roger *et al.*, 2005). Pearson (1976) have reported that vegetables providing more than its 12% caloric value are considered as good source of protein. In the present study the protein content of *Spinacia oleracea* and *Brassica oleracea* is enough to fulfill nutritional requirement of human beings.

Similarly, the fat content in the present study have also increased in both selected vegetables at wastewater irrigated site. However, the fat content was higher as compared to reports of Hussain *et al.*, (2011) in *Brassica oleracea* and Hussain *et al.*, (2010) in *Spinacia oleracea.* In contrast to this study Emebu and Anyika (2011) reported lower fat contents (0.26%) in *Brassica oleracea.*

In any Biota, ash content is an index of mineral content. Ash content in the present study is low (1.72%) in the *Spinacia oleracea* and higher in *Brassica oleracea* (1.80%) at wastewater irrigated site (Table 1). However the ash content in biota is relatively very low as compared to the reports of other researchers (Ifon and Bassir, 1979; Ladan *et al.*, 1996; Hussain *et al.*, 2010c; Hussain *et al.*, 2011). However, low ash content is usually an indicator of high nutrient quality of the selected vegetable (Ukam, 2008).

Table 1: Proximate Composition of *Spinacia Oleracea and Brassica Oleracea* Irrigated with Waste Water (%)

Species	Moisture	Ash	Protein	Carbohydrate	Fat
Spinacia oleracea	5.720±0.166	1.720 ± 0.058	12.600±0.195	2.232±0.195	2.142±0.175
Brassica oleracea	3.680±0.058	1.800±0.089	13.100±0.190	2.692±0.032	5.54±0.117

Table 2: Micronutrient Composition of the Selected Plants Species (the Concentration is Given in ppm)

Species	Cu	Ni	Zn	Pb	Fe	Mn
Spinacia oleracea	2.421±0.644	4.406± 0.746	10.266± 0.860	0.442± 0.110	16.44±2.068	3.069±0.425
Brassica oleracea	2.118± 0.486	6.141±0.116	11.690± 2.108	0.314±0.061	14.22 ± 1.903	5.504 ± 1.064

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