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RESEARCH ARTICLE

COMPARATIVE ANALYSIS OF NUTRIENTS OF FIVE SELECTED LEAFY VEGETABLES CULTIVATED IN LAND-FILLED AND NORMAL GROUND IN THE CITY OF KOLKATA

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ABSTRACT

Dhapa, the largest open waste dumping ground of the city of Kolkata, India, is famous for "Garbage farming" all over the World. More than 40 per cent of the leafy vegetables in the Kolkata markets come from these lands. The main objective of the study is to compare the nutrient contents of selected leafy vegetables cultivated in Dhapa land-filled ground (DLG) with Normal ground (NG). Accordingly six selected samples (Red Amaranth, Green Amaranth, Bottle Gourd Leaves, Ceylon Spinach, and Spinach) were collected from both the places throughout the year and analyzed. From the analysis it is observed that there is no significant variations ($p > 0.05$) in the values of nutrient contents like moisture, total carbohydrate and soluble protein in both the categories of samples excepting ash and total protein contents, where significant variation is noted ($p < 0.05$).

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INTRODUCTION

The Wetlands play a significant role in treating the sewage and in turn convert the Municipal wastes into resources and protect the river and environment from pollution (Panicker, 2008). The East Kolkata Wetlands (EKWs) are the largest of their kind in the world, covering an approximately about of 12,500 hectors area, which were designed as a RAMSAR site in 2002 (Suutari, 2006). This multi-use wetland lies eastern part of the city which includes a garbage dump, popularly known as 'Dhapa Square Mile', where the Municipal Solid Wastes (MSW) of the city of Kolkata is dumped (The Telegraph, 2003). This disposal site has been earmarked since the middle of the 19th century for dumping MSW generated in the city. Dumping of MSW is still continuing in certain parts of Dhapa and the rest of the vast stretch of land, of about 2000 acres is used by the local farmers to grow various kinds of vegetables (Kumar *et al*., 2011; Gupta *et al*., 2007).

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The idea of using Dhapa for agricultural production had been conceived for natural recycling of garbage and sewage water. "The 'Dhapa Square Mile' was taken on lease in the 19th Century and the solid waste was used for vegetable farming and the sewage water for pisciculture (Ghosh, 1998). On the basis of a rapid assessment, this garbage farms produce more than 1,500 quintals of vegetables per acre per year, which are marketed in the City of Kolkata.

The Municipal Solid Wastes (MSW) contains lot of organic wastes which are subsequently converted to organic matters after biodegradation by various microbes present in soils. Hence land-filled ground created after dumping the Municipal Solid Wastes (MSW) containing high organic waste becomes an excellent agricultural practice. But the strongest negative factor in the use of human and animal wastes for the production of food, feed or fertilizer is the possibility of disease transmission through the growing vegetables. MSW, Sewage and industrial effluents are the rich sources of both beneficial as well as harmful elements. They may have high concentration of several heavy metals such Cd, Ni, Pb and Cr (Arora *et al*., 1985; Narwal *et al*., 1993). Their continuous disposal on agricultural soils has resulted in soil sickness (Narwal *et al*., 1988) and accumulation of some of the toxic metals in soil (Adhikari *et al*., 1993; Antil & Narwal, 2005, 2008; Antil *et al*., 2004, 2007; Gupta *et al*., 1986, 1994, 1998, 2011; Kharche *et al*., 2011; Narwal *et al*., 1993) which may seriously affect the human and animal health (Patra *et al*, 2001).

Food demands have been accelerated with the exponential human population growth resulting in marginal land resource availability for growing food crops especially vegetables. Vegetables are plants or parts of plants that are used as food. Vegetable being good sources of vitamins and minerals also termed as "Micronutrients", protect our body by acting as coenzymes & cofactors which are essential for smooth running of our biochemical reaction. Hence the edible portions must contain all the micro nutrients adequately (Srilakshmi, 2007).

Although various vegetables are grown on Dhapa land-filled ground and marketed in and around Kolkata since long back (Gupta *et al*., 2007) but there is no detailed information available about the nutrient contents of these vegetables. The present studies were done to evaluate nutritional quality of some selected leafy vegetables, grown on Dhapa Land-Filled Ground (DLG), and to compare with the same vegetables grown in Normal Ground (NG). This study may help the consumers to understand and to select the safe and healthy vegetables.

MATERIALS AND METHODS

Sample collection

All the samples were collected throughout the year from five selected fields of Dhapa land-filled ground (designated as DP1, DP2, DP3, DP4, & DP5) and also from selected Normal ground (designated as NG1, NG2, NG3, NG4, & NG5). All the samples were collected in sterile zip lock plastic bag and preserved in ice bag during transportation from land to the laboratory. For analysis leaves with small portion of adjoining stem were used. It may be further mentioned that for identification, whole plants of selected samples were collected and herbarium sheets were prepared after sun drying. These plants were identified and classified by a plant taxonomist of Botany Department, University of Calcutta, Kolkata. The details of each plant species are elaborated in Table 1.

Determination of ash content

Ash content was determined by weight difference method by using muffle furnace (Raghuramulu *et al*., 2003)

Determination of total carbohydrate content

The samples were blended and used for the estimation of total carbohydrate content by using Anthrone Method (Mc.Cready *et al*., 1950). To the 0.1gm grounded sample, 5ml 2.5(N) HCl was added and the mixture was hydrolyzed for 3 hours in a water bath. After cooling, the hydrolyzed mixture was neutralized with Na_2CO_3 and the volume was made up to 100 ml by distilled water and centrifuged at 3000 RPM for 15 minutes to remove any residues. To 1.0 ml of supernatant, 4ml of Anthrone reagent (0.2% in conc. H_2SO_4) was added and mixed thoroughly. The mixture was allowed to heat for 8 minutes in water bath and cooled. This was followed by recording absorbance in spectrophotometer (Perkin Elmer, Lambda 25, UV/VIS Spectrophotometer) at 630 nm wavelengths against a blank. The blank was prepared by taking 1.0 ml distilled water instead of sample extract.

Determination of protein content

Estimation of soluble Protein

The quantity of soluble protein can be determined by colorimetric method introduced by Lowry *et al*., (Lowry *et al*., 1951). 1gm each of the sample was smashed with 10 ml cold phosphate buffer (pH 7.5, 0.1M) using a chilled mortar and pestle. The homogenate was kept overnight in a chilled environment for complete extraction of protein and centrifuged at 5000 rpm for 30 min in a cold centrifuge (4^oC). The supernatant was then taken for protein analysis according to the method of Sawhney and Randhir (Sawhney and Randhir, 2006). In this method, 5.0 ml of alkaline copper sulfate reagent [prepared by mixing 1.0 ml of copper sulfate reagent (0.5 % $CuSO_4.5H_2O$ in 1.0% sodium potassium tartarate) with 50 ml of alkaline sodium carbonate reagent (2% Na_2CO_3 in 0.1 (N) NaOH solutions) was added in 1.0 ml of supernatant and mixed thoroughly. The mixture was then allowed to stand for ten minutes. Now 0.5 ml of Folin ciocalteu reagent (1:1v/v in distilled water) was added into it and incubate for 30 minutes at room temperature.

Table 1. Vegetables collected for the study and parts used for analysis

English name	Species name	Family name	Local name	Parts used*	Status
Red Amaranth	*Amaranthus gangeticus Linn*	Amaranthaceae	Lal Saag	Leaves and stems	Cultivated
Green Amaranth	*Amaranthus blitum Linn*	Amaranthaceae	Notey Saag	Leaves and stems	Cultivated
Bottle Gourd Leaves	*Lagenaria siceraria (Mol.) standl.syn*	Cucurbitaceae	Lau Saag	Leaves and stems	Cultivated
Ceylon Spinach	*Spinacia oleracea Linn.*	Chenopodiaceae	Pui Saag	Leaves and stems	Cultivated
Spinach	*Basella alba Linn.*	Basellacae	Palang Saag	Leaves and stems	Cultivated

**leaves with small portion of adjoining stem.*

Analysis

Determination of moisture content

Moisture content was determined by drying 10 gm of samples at 105^oC in a drying oven to a constant weight (AOAC, 1990).

The absorbance of the blue colored solution obtained was measured at 750 nm wavelengths by spectrophotometer (Perkin Elmer, Lambda 25, UV/VIS Spectrophotometer) against a blank. The blank is prepared by taking 1.0mL of 0.1 M phosphate buffer in place of sample. Standard Bovine serum albumin protein at various concentrations was used to draw a standard curve and the amount of proteins in different samples was estimated from the standard curve.

Estimation of Total Protein

The total Protein content was determined by Kjeldahl method (Bureau of Indian Standard, IS No. 7219:1973). Once the nitrogen content has been determined, it is converted to a protein content using the appropriate conversion factor (N factor i.e. 6.25).

Statistical analysis

Each experiment was repeated three times for all the samples collected from selected fields of DLG (i.e. DP1, DP2, DP3, DP4, & DP5) and NG (i.e. NG1, NG2, NG3, NG4, & NG5). The results are presented with their means, and standard deviation using Microsoft Office Excel 2007. The statistical analysis was done using repeated measures ANOVA with the help of the software SPSS 16.0. $P<0.05$ indicates significant variation exists at 95% confidence level.

RESULTS

The result of analysis of nutrients (Moisture, Ash, Total Carbohydrate, Soluble Protein and Total Protein Content) in Dhapa land filled Ground (DLG) as well as Normal Ground (NG) are given in **Table 2** and **Table 3** respectively.

Figure.1 to **Figure.5** represent comparison between the Moisture Contents, Ash Contents, total Carbohydrate Contents, Soluble Protein contents, total protein content of five selected vegetables grown in five different location (i.e. DP1, DP2, DP3, DP4, & DP5) of DLG and five different location (i.e. NG1, NG2, NG3, NG4, & NG5) of NG respectively. All the results are expressed in gm % fresh weight basis.

DISCUSSION

Leafy vegetables are a vital constituent of human diet comprising essential nutrients and micronutrients, important for human metabolism (Aliyu, 2006). The result of analysis (**Table 2** and **Table 3**) showed variation in proportions of nutrients (Moisture, Ash, Total Carbohydrate, Soluble Protein and Total Protein Content) in Dhapa land filled Ground (DLG) as well as Normal Ground (NG). It is found that (**Figure 1**) there are no significant differences in moisture contents of all vegetables grown in DLG and NG ($P>0.05$). However, the moisture contents of Red Amaranth and Bottle Gourd Leaves significantly differ ($P< 0.05$) in five different locations of DLG and the same trend is observed in case of NG for both the samples.

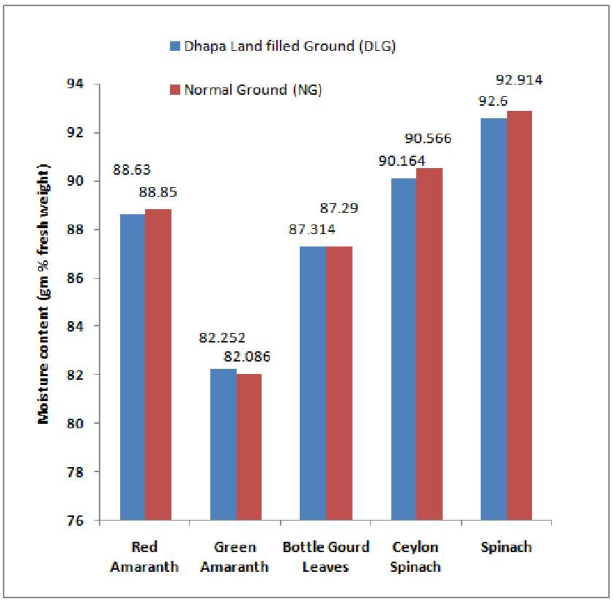

Fig. 1 Moisture content (gm % fresh weight) of different leafy vegetables grown in Dhapa land filled Ground (DLG) as well as Normal Ground (NG)

Table 2. Moisture, Ash, Total Carbohydrate, Soluble Protein, and Total Protein contents (gm % fresh weight) of five leafy vegetables grown in selected fields (designated as DP1, DP2, DP3, DP4, & DP5) of Dhapa land-filled ground (DLG)

Name of the vegetables	Moisture Content (%) Mean ± SD (n=15)	Ash Content (%) Mean ± SD (n=15)	Total Carbohydrate (gm % fresh weight) Mean ± SD (n=15)	Soluble Protein (gm % fresh weight) Mean ± SD (n=15)	Total protein (gm % fresh weight) Mean ± SD (n=15)
Red Amaranth	88.63 ± 0.86**	2.742 ± 0.02*	6.080 ± 0.06*	3.142 ± 0.01**	3.422 ± 0.02**
Green Amaranth	82.252 ± 0.31*	2.842 ± 0.03**	4.400 ± 0.06*	3.392 ± 0.03**	3.806 ± 0.01*
Bottle Gourd Leaves	87.314 ± 0.38**	1.884 ± 0.04**	6.400 ± 0.20**	2.112 ± 0.06*	2.752 ± 0.01**
Ceylon Spinach	90.164 ± 0.39*	1.288 ± 0.06**	4.080 ± 0.25**	1.994 ± 0.02*	2.440 ± 0.02**
Spinach	92.600 ± 0.44**	1.714 ± 0.09**	2.916 ± 0.05**	1.438 ± 0.03*	2.444 ± 0.01*

* P > 0.05 **P < 0.05; Here P values were calculated for each sample collected from five selected fields of DLG

Table 3. Moisture, Ash, Total Carbohydrate, Soluble Protein, and Total Protein contents (gm % fresh weight) of five leafy vegetables grown in selected fields (designated as NG1, NG2, NG3, NG4, & NG5) of Normal ground (NG)

Name of the vegetables	Moisture Content (%) Mean ± SD (n=15)	Ash Content (%) Mean ± SD (n=15)	Total Carbohydrate (gm/100gm fresh weight) Mean ± SD (n=15)	Soluble Protein (gm/100gm fresh weight) Mean ± SD (n=15)	Total protein (gm/100gm fresh weight) Mean ± SD (n=15)
Red Amaranth	88.580 ± 1.01**	2.666 ± 0.04*	6.064 ± 0.07*	3.156 ± 0.05**	3.320 ± 0.02**
Green Amaranth	82.086 ± 0.29*	2.768 ± 0.05**	4.272 ± 0.07*	3.362 ± 0.07**	3.764 ± 0.01*
Bottle Gourd Leaves	87.290 ± 0.42**	1.726 ± 0.03**	6.448 ± 0.17**	2.128 ± 0.02*	2.644 ± 0.03**
Ceylon Spinach	90.566 ± 0.58*	1.242 ± 0.05**	4.096 ± 0.43**	1.972 ± 0.02*	2.364 ± 0.01*
Spinach	92.914 ± 0.32*	1.678 ± 0.05**	2.934 ± 0.04**	1.450 ± 0.03**	2.360 ± 0.01*

* P > 0.05 **P < 0.05; Here P values were calculated for each sample collected from five selected fields of NG.

The comparative analysis of ash contents (**Figure 2)** of the selected vegetable samples grown in DLG and NG reveled that, significant differences exist ($P < 0.05$) in ash contents of all the samples collected from DLG and NG. Accordingly it is found to be high for all the samples grown in DLG as compared to NG. Moreover, the ash content in all samples significantly differs in different locations ($P < 0.05$) of DLG and NG.

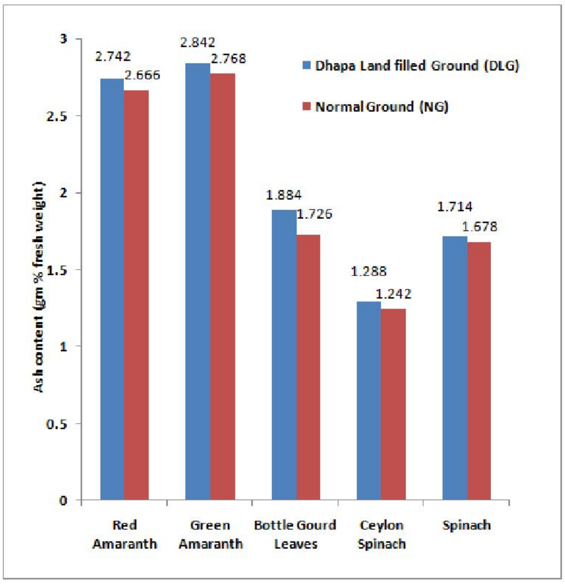

Fig. 2. Ash content (gm % fresh weight) of different leafy vegetables grown in Dhapa land filled Ground (DLG) as well as Normal Ground (NG)

The comparative studies of total carbohydrate contents (**Figure 3**) reveals that there are no significant differences in carbohydrate contents of all samples cultivated in DLG and NG ($P > 0.05$).

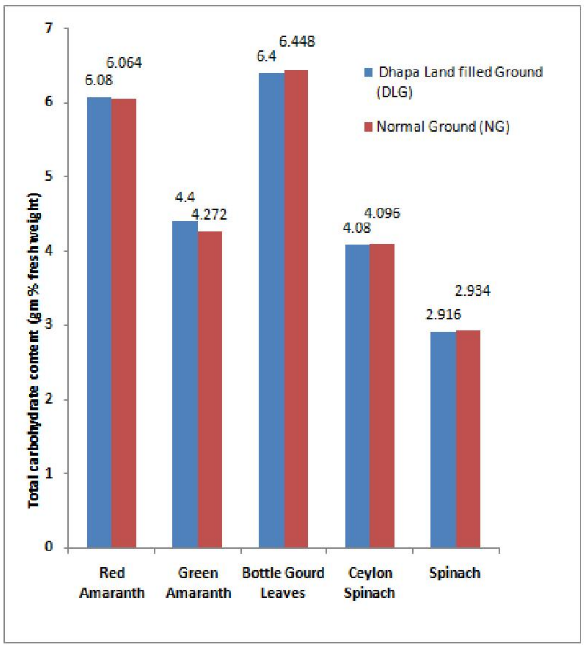

Fig.3. Total carbohydrate content (gm % fresh weight) of different leafy vegetables grown in Dhapa land filled Ground (DLG) as well as Normal Ground (NG)

Moreover carbohydrate contents of Bottle Gourd Leaves, Ceylon Spinach and Spinach differ significantly ($P < 0.05$) in five different locations of DLG and NG. The results of soluble protein analysis (**Figure 4**) of five selected vegetables of DLG and NG showed that no significant differences exist in soluble protein contents of all the samples cultivated in DLG and NG ($P > 0.05$). Moreover, soluble proteins in red amaranth, green amaranth, and spinach differ significantly ($P < 0.05$) in five different locations of DLG and NG. But the analysis of total protein contents of selected samples of DLG and NG (**Figure 5)** noted the significant differences in all samples of DLG and NG ($P < 0.05$), although the higher amounts present in all the samples grown in DLG as compared to NG.

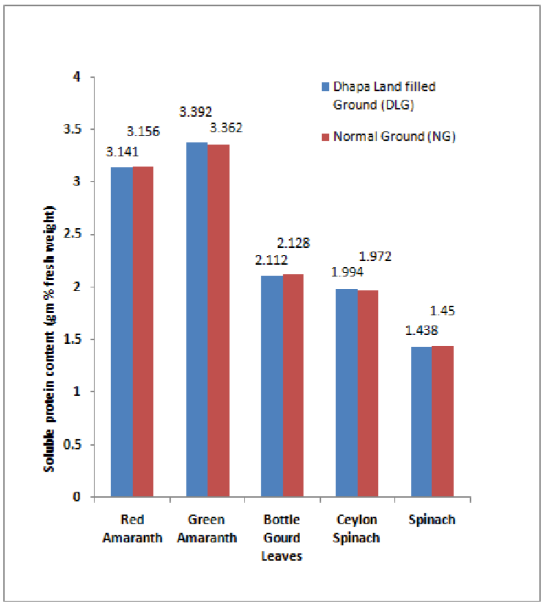

Fig.4. Soluble protein content (gm % fresh weight) of different leafy vegetables grown in Dhapa land filled Ground (DLG) as well as Normal Ground (NG)

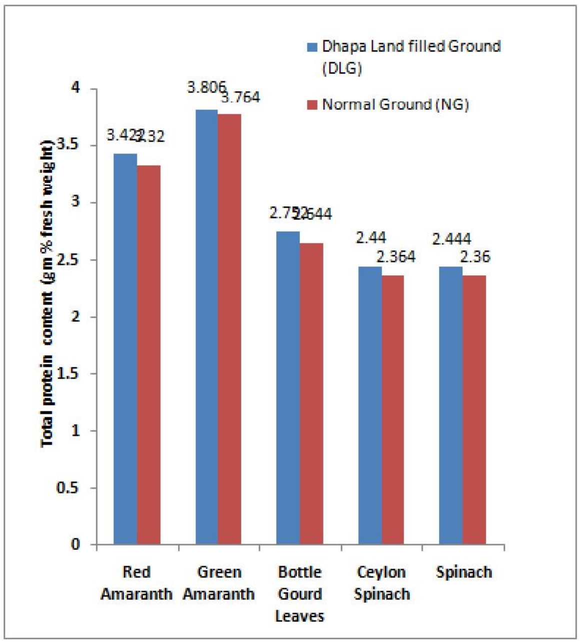

Fig.5. Total protein content (gm % fresh weight) of different leafy vegetables grown in Dhapa land filled Ground (DLG) as well as Normal Ground (NG)

Accordingly, total protein contents in red amaranth and bottle gourd leaves differ significantly in five different locations of DLG and NG ($P < 0.05$).

Conclusion

From the present data, it is observed that no significant differences exist between the selected samples viz. red amaranth, green amaranth, bottle gourd leaves, ceylon spinach and spinach, cultivated in different locations of Dhapa Land-Filled Ground (DLG) and Normal Ground (NG) in terms of moisture, carbohydrate and soluble protein contents ($p > 0.05$), where as significant variations ($p < 0.05$) exist for ash and total protein contents. It is further to be noted that ash and total protein contents of all the samples of DLG are higher than those of NG.

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