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Nutritional Analysis of Leafy Vegetables Grown in Periphery of Allahabad District, UP, India

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Abstract: ***Leafy vegetables constitute an important part of the human diet since these contain carbohydrate, protein, vitamin, minerals and fibers require for human health. In recent years their consumption is increasing gradually particularly among the urban community. This is due to increased awareness on the food value of vegetables, as a result of exposure to other cultures and acquiring proper education. Periphery of Allahabad district namely Naini, Jhunsi, Fafamau and Mundera were selected purposively for the present study as they are peri- urban areas. Use of water for irrigating the vegetable crops from tanks that are part of the city drainage system and drain untreated or partially treated domestic sewage and industrial effluents from a number of small scale units. Fresh leafy vegetable samples were collected in triplicate form from four above mentioned study sites. The collected sample was including Soya leaves/dill (Anethum graveolens L.) and Fenugreek leaves (Trigonella foenum- graecum), Spinach (Spinacia oleracea). Nutrient contents were determined according to the methods described in AOAC (1980). There were found to be non- significant difference between places but it was for vegetables with regards to all nutrients except to calcium contents. The protein contents of all vegetables for all places were ranged from 2.16gm to 8.83gm, fat contents were ranged from 0.55gm to 0.97gm, CHO contents were 2.78gm. to 12.04gm, total ash contents were 1.70gm. to 3.36gm, iron contents were 1.33mg to 10.66mg and 74.83mg to 405.21mg were for calcium contents. The order of vegetables in respective to their nutrient contents along with their mean were as follows: Protein: Soya leaves (7.57gm.) > Fenugreek leaves (5.63gm) > Spinach (2.51gm). Fat: Fenugreek leaves (0.87gm) > Soya leaves (0.80gm.) > Spinach (0.63gm). Carbohydrate: Soya leaves (13.27gm) > Fenugreek leaves (8.96gm.) > Spinach (2.88gm).Total ash: Soya leaves (2.63gm.) > Spinach (2.38gm.) > Fenugreek leaves (1.80gm.). Iron: Soya leaves (9.81gm.) > Fenugreek leaves (2.21gm.) > Spinach (2.12gm). Calcium: Fenugreek leaves (367.07gm) > Soya leaves (206.27gm) > Spinach (83.64gm).***

Keywords: Allahabad District, Periphery, Leafy vegetables, Consumption, Nutritional analysis

1. Introduction

Green leafy vegetables are popular food stuffs around the world. Leafy vegetables constitute an important part of the human diet, since these contain carbohydrate, protein, vitamin, minerals and fibers require for human health. In recent years the consumption of leafy vegetables is increasing gradually, as the prevalence of non-communicable is increasing like obesity, diabetes, heart diseases and cancer particularly among the urban communities. This is due to increased awareness on the food value of vegetables, as a result of exposure to other cultures and acquiring proper education. The daily vegetables intake of 400 g to 600 g is recommended by the World Health Organization, Food and Agriculture Organization of the United Nations, and the World Cancer Research Fund.

The main aim of this study was to analyze the nutritional content of some selected leafy vegetables grown in periphery of Allahabad district, where waste water was used to watering these leafy vegetables. Comparison was also done between fresh ground water grown leafy vegetables and waste water grown leafy vegetables with their respective nutritional content.

2. Materials And Methods

Selection of study site: Allahabad is one of the south-eastern and among the largest district of Uttar Pradesh, situated at the confluence of three rivers - Ganga, Yamuna and the invisible Saraswati. The meeting point is known as Triveni and is especially sacred to Hindus. It lies between the parallels of North latitudes 24°47′ and 25°47′ and East longitudes 81°09′ and 82°21′ longitudes and is surrounded by the districts Pratapgarh and Jaunpur in north, Varanasi in east, Kaushambi in west, Mirzapur and Rewa of Madhya Pradesh on the south. The total geographical area of this district is 5482 Sq. Km. and a population of 5959798 as per 2011 census.

Periphery of Allahabad District namely Naini, Jhunsi, Phaphamau and Mundera were selected purposively for the present study as they are peri-urban areas, use of water for irrigating the vegetable crops from tanks that are part of the city drainage system that drain untreated and partially treated domestic sewage and industrial effluents from a number of small scale units. The control site was selected in Naini area where vegetable grower was using the fresh ground water but the all the environmental condition was same as other sewage irrigated study sites.

Collection of Samples

Fresh vegetable samples were collected in triplicate form from four different sites namely Naini, Jhunsi, Phaphamau, and Mundera. The collected sample includes Spinach (*Spinacia oleracea)*, Soya leaves/dill (*Anethum graveolens* L.) and Fenugreek leaves (*Trigonella foenum- graecum*).

Nutritional analysis of leafy vegetables:
Moisture, protein, fat, carbohydrates, total ash, iron and calcium were analyzed. **(AOAC, 1980).**

Statistical analysis of data

The data ascertained from the experiments on different parameter where subjected to statistical analysis using mean standard deviation, standard error and ANOVA Two way classification with r=3 observation as per cell, if significant results were obtained due to places or types of vegetables the value of C.D. was also calculated at 5% level of significance, which was used for comparing all possible combination of two vegetables at a time two places together. Tabulation method was also used to represent the obtaintain data.

3. Results and Discussion

Table 1: Moisture contents of all selected leafy vegetables/100gm.

Veg. Places	Soya leaves Mean±SE	Fenugreek leaves Mean±SE	Spinach Mean±SE
Phaphamau	88.53±4.31	89.3±0.381	90.43±3.29
Mundera	85.63±1.69	88.1±1.44	88.56±3.67
Naini	82.1±0.727	83.66±0.6	94.93±3.03
Jhunsi	96.16±1.13	88.6±1.22	89.4±1.72
Mean	88.105	87.41	90.83
Control	83±1.58	89.13±1.71	94.7±1.39
*Standard value	79.9	86.1	92.1

***Gopalan *et al.*, (2004)**

According to above table 1 the obtained data shows that the moisture content of leafy vegetables were ranged from 82.1±0.72 to 96.16 ±0.16 for soya leaves, 83.66±0.66 to 89.3±0.38 for Fenugreek leaves where as the range for Spinach were from 88.56±3.67 to 94.93+3.03. Thus the average moisture values in all the leafy vegetables for all the places were trends as follows: Spinach (90.83) > Soya leaves (88.105) > Fenugreek leaves (87.41). As reported by **Gopalan *et al.*, (2004)** moisture values for Soya leaves/dill, Fenugreek leaves and Spinach are 79.9, 86.1, & 92.1, respectively.

The ANOVA revealed that the calculated value of F due to places and due to vegetables were smaller than their respective table value of F at 5% probability level; so our null hypothesis was accepted in both the cases. Therefore no significant effect of places as well as of three types of vegetable was found as regards to moisture content i.e. effect of places and of vegetable as par (same).

Table 2: Protein contents of all selected leafy vegetables/100gm

Vegetables Places	Soya leaves Mean±SE	Fenugreek leaves Mean±SE	Spinach Mean±SE
Phaphamau	8.83±0.04	6.26±0.779	2.16±0.173
Mundera	7.13±0.31	5.13±0.254	2.5±0.531
Naini	5.63±0.11	5.61±0.398	2.33±0.092
Jhunsi	8.71±0.11	5.53±0.444	3.06±0.027
Mean	7.575	5.632	2.513
Control	7.73±0.080	5.56±0.097	3.3±0.046
*Standard value	6.0	4.4	2.0

***Gopalan *et al.*, (2004)**

According to above table 2 the obtained data shows that the Protein contents in Soya leaves were ranged from 5.63±0.11 to 8.83±0.04, for Fenugreek leaves from 4.13±0.254 to 6.26±0.779, while in Spinach protein ranged from 2.16±0.177 to 3.06±0.092. Highest protein contents were found in all the three selected leafy vegetables for Phaphamau area while the lowest contents were observed in all the leafy vegetables for Naini area. The average protein content in all the leafy vegetables for all places were trends as follows: Soya leaves/dill (7.575) > Fenugreek leaves (5.383) > Spinach (2.513). In fresh ground water grown leafy vegetables the protein content for Soya leaves, Fenugreek leaves and Spinach was 7.73+0.083, 5.56+0.97 and 3.3+.046 respectively. Protein content was found to be highest for all the leafy vegetables in comparison to sewage grown leafy vegetables. As reported by **Gopalan *et al.*, (2004)** protein contents for Soya leaves/dill, Fenugreek leaves and Spinach are 6.0, 4.4, & 2.0/100gm. respectively.

The ANOVA skeleton revealed that the calculated value of F due to vegetables were greater than the tabulated value of F on 2 and 28 d.f. and at 5% probability level; hence our null hypothesis was rejected. Therefore significant difference was found between three vegetables, but the calculated value of F due to places were smaller than its tables value at 5% level of significance, concluding thereby that no significant difference between four places occurred. Since the ANOVA showed significant result due to vegetables so to compare all possible combination of two vegetables, the value of critical difference was calculated at 5% level of significance which was obtained as 1.55; hence the comparison table is appended below:

Table 2.1 Comparison table for protein contents in leafy vegetables

	V_2= 5.633	V_3= 2.516
V_2= 5.633	3.117*	1.958*
$V_{1=}$ 7.591	5.075*	-

From the above comparison table significant difference was observed between Soya leaves and Spinach (V_1 & V_3), Soya leaves and Fenugreek leaves (V_1 & V_2) and between Fenugreek leaves and Spinach (V_2 & V_3). Since the average value of Soya leaves (V_1) was highest so it can be regarded as the best vegetables as regards to protein value. The calculated mean orders of the vegetables were trend as follows: (V_1) Soya leaves (7.591) > (V_2) Fenugreek leaves (5.633) > (V_3) Spinach (2.516).

Table 3: Fat contents of all selected leaf vegetables/100gm

Veg. Places	Soya leaves Mean±SE	Fenugreek leaves Mean±SE	Spinach Mean±SE
Phaphamau	0.86±0.05	0.74±0.086	0.74±0.043
Mundera	0.78±0.057	0.90±0.017	0.57±0.012
Naini	0.77±0.07	0.89±0.012	0.67±0.006
Jhunsi	0.8±0.069	0.97±0.002	0.55±0.004
Mean	0.803	0.875	0.632
Control	0.85±0.23	0.91±0.012	0.88±0.35
*Standard value	0.5	0.9	0.7

***Gopalan *et al.*, (2004)**

According to above table 5 the obtained data shows that fat contents in Soya leaves were ranged from 0.77±0.07to 0.86±0.05, for Fenugreek leaves from 0.74±0.086 to 0.97±0.002, while for Spinach fat contents ranged from

0.55±0.004 to 0.74±0.043. Highest fat content was found in Fenugreek leaves for Jhunsi area while lowest content was observed in Spinach also for Jhunsi area. The average fat contents in all the leafy vegetables for all the places were trends as follows: Fenugreek leaves (0.875) > Soya leaves (0.803) > Spinach (0.632). In fresh water grown leafy vegetables the fat contents for Soya leaves, Fenugreek leaves & Spinach was 0.85±0.23, 0.91±0.012, and 0.88±0.35 respectively. Fat contents were found to be highest for all the leafy vegetables except Fenugreek leaves in comparison to sewage grown leafy vegetables**.** As reported by **Gopalan *et al*., (2004)** fat values for Soya leaves, Fenugreek leaves & Spinach are 0.5, 0.9, and 0.7/100gm. respectively.

The ANOVA skeleton revealed that the calculated value of F due to vegetables were greater than the tabulated value of F on 2 and 28 d.f. and at 5% probability level; hence our null hypothesis was rejected. Therefore there were significant difference between three vegetables but the calculated value of F due to places is smaller than its table value at 5% level of significance, concluding thereby no significant difference between four places.

Since the ANOVA showed significant result due to vegetables so to compare all possible combination of two vegetables, the value of critical difference was calculated at 5% level of significance which was obtained as 0.1116; hence the comparison table is appended below:

Table 3.1: Comparison table for fat contents in leafy vegetables

	V_2= 0.88	V_3= 0.6341
$V_{1=}$ 0.8041	0.0759^{NS}	0.17^{*}
V_2= 0.88	0.2459^{*}	-

From the above comparison table significant difference was observed between (V_1 and V_3) and (V_3 and V_2) but non significant difference was found between V_2 and V_1. Since the average value of vegetable Fenugreek leaves (V_2) was highest so it can be regarded as the best vegetable as regards to fat value. The descending mean order of the leafy vegetables were trend as follows: (V_2) Fenugreek leaves (0.88) > ($V_{1)}$ Soya leaves (0.8041) > (V_3) Spinach (0.6341).

Table 4: Carbohydrate contents of all selected leafy vegetables/100gm

Vegetables / Places	Soya leaves	Fenugreek leaves	Spinach
	Mean±SE	Mean±SE	Mean±SE
Phaphamau	13.24±4.24	11.41±1.53	2.77±0.063
Mundera	12.93±1.35	8.91±0.45	2.84±0.098
Naini	9.88±0.248	7.76±0.69	3.14±0.025
Jhunsi	12.04±0.72	7.77±0.548	2.78±0.103
Mean	12.0	8.96	2.88
Control	14.73±0.924	7.6±0.046	3.23±0.014
Standard value	10.8	6.0	2.9

***Gopalan *et al.*, (2004)**

According to above table 4 the obtained data shows that the carbohydrate contents in Soya leaves/Dill was ranged from 9.88±0.248 to 13.24±4.24 for Fenugreek leaves from 7.76±0.69 to 11.41±1.53, while for Spinach carbohydrate content ranged from 2.77±0.063 to 3.14±0.025. Highest CHO content was found in Soya leaves for Phaphamau area while lowest content was observed in Spinach also for Phaphamau area. The average CHO contents in all the leafy vegetables for all the places were trends as follows: Soya leaves (12.0) > Fenugreek leaves (8.96) > Spinach (2.88). In fresh ground water grown leafy vegetables the CHO contents for Soya leaves, Fenugreek leaves & Spinach was 14.73±0.924, 7.6±0.046, and 3.23±0.014 respectively. CHO content was found to be higher in all the leafy vegetables in comparison to sewage grown leafy vegetables. As reported by **Gopalan *et al*., (2004)** CHO values for Soya leaves, Fenugreek leaves & Spinach are 10.8, 6.0, & 2.9/100gm. respectively.

The ANOVA revealed that the calculated value of F due to vegetables was greater than the tabulated value of F on 2 and 28 d.f. and at 5% probability level; hence our null hypothesis was rejected. Therefore there was significant difference between three vegetables but the calculated value of F due to places was smaller than its table value at 5% level of significance, concluding thereby no significant difference between four places.

Since the ANOVA showed significant result due to vegetables so to compare all possible combination of two vegetables, the value of critical difference was calculated at 5% level of significance which was obtained as 2.94, hence the comparison table is appended below:

Table 4.1: Comparison table for carbohydrate contents in leafy vegetables

	V_2= 8.94	V_3= 2.88
V_2= 8.94	6.06^{*}	4.33^{*}
$V_{1=}$ 13.27	10.39^{*}	-

From the above comparison table significant difference was observed between Soya leaves and Spinach (V_1 & V_3), Soya leaves and Fenugreek leaves (V_1 & V_2) and between Fenugreek leaves and Spinach (V_2 & V_3). Since the average value of Soya leaves (V_1) was highest so it can be regarded as the best vegetable as regards to carbohydrate value. The calculated mean order of the vegetables were trend as follows: (V_1) Soya leaves (13.27) > (V_2) Fenugreek leaves (8.94) > (V_3) Spinach (2.88).

Table 7: Total ash contents of all selected leafy vegetables /100gm.

Veg. / Places	Soya leaves	Fenugreek leaves	Spinach
	Mean±SE	Mean±SE	Mean±SE
Phaphamau	3.06±0.10	1.73±0.092	2.03±0.37
Mundera	3.3±0.092	1.7±0.08	2.4±0.21
Naini	3.33±0.11	1.7±0.04	2.66±0.092
Jhunsi	3.36±0.17	2.1±0.092	2.46±0.15
Mean	3.26	1.80	2.38
Control	4.5±0.13	2.53±0.18	3.4±0.26
*Standard value	3.2	1.6	2.5

***Gopalan *et al.*, (2004)**

According to the above table, obtained data shows that total ash content in soya leaves were ranged from 3.06±0.10 to 3.36±0.17, for Fenugreek leaves from 1.7±0.4 to 2.1±0.092, while for Spinach total ash content ranged from 2.03±0.37 to 2.66±0.092. Highest content was found in Soya leaves for Jhunsi area while lowest content was observed in Fenugreek leaves for Naini area. The average total ash content in all the

leafy vegetables for all places were trends as follows: Soya leaves (3.26) > Spinach (1.80) > Fenugreek leaves (2.38). In fresh water grown leafy vegetables the total ash content for Soya leaves, Fenugreek leaves & Spinach was 3.46±0.13, 1.20±0.13, and 2.30±0.26 respectively. Total ash content was found to be lower in all the leafy vegetables in comparison to sewage grown leafy vegetables**.** As reported by **Gopalan *et al*., (2004)** total ash values for Soya leaves, Fenugreek leaves and Spinach are 3.2, 1.6, and 2.5/100gm. respectively.

The ANOVA skeleton revealed that the calculated value of F due to vegetables is greater than the table of value of F on 2 and 28 d.f. and at 5% probability level; hence our null hypothesis was rejected. Therefore there were significant difference between three vegetables but the calculated value of F due to places were smaller than its table value at 5% level of significance, concluding thereby no significant difference between four places.

Since the ANOVA showed significant result due to vegetables so to compare all possible combination of two vegetables, the value of critical difference was calculated at 5% level of significance which was obtained as 0.30, hence the comparison table is appended below:

Table 5.1: Comparison table for total ash contents in leafy vegetables

	V_3= 2.39	V_2= 1.825
V_2= 1.825	0.565*	1.435*
$V_{1=}$ 3.26	0.87*	-

From the above comparison table significant difference was observed between Soya leaves and Spinach (V_1 & V_3), Soya leaves and Fenugreek leaves (V_1 & V_2) and between Fenugreek leaves and Spinach (V_2 and V_3). Since the average value of Soya leaves (V_1) was highest so it can be regarded as the best vegetable as regards to total ash value. The mean order of vegetables were trend as follows: (V_1) Soya leaves (3.26) > (V_3) Spinach (2.39) > (V_2) Fenugreek leaves (1.825).

Table 6: Iron contents of all selected leafy vegetables /100gm.

Veg. / Places	Soya leaves Mean±SE	Fenugreek leaves Mean±SE	Spinach Mean±SE
Phaphamau	10.43±0.43	2.35±0.259	1.33±0.031
Mundera	10.66±0.74	2.14±0.009	1.57±0.207
Naini	8.66±0.092	1.93±0.004	2.13±0.017
Jhunsi	9.5±0.12	2.43±0.092	3.47±0.11
Mean	9.81	2.21	2.13
Control	8.9±0.13	2.76±0.071	2.01±0.036
*Standard value	8.0	1.93	1.14

***Gopalan *et al.*, (2004)**

According to above table 8 the obtained data shows that iron content in soya leaves were ranged from 8.66±0.92 to 10.66±0.74, for Fenugreek leaves from 1.93±0.004 to 2.43+0.093, while for spinach iron content ranged from 1.33±0.031 to 3.47±0.11. Highest iron content was found in soya leaves for Mundera area while lowest content was observed in spinach for Fafamau area. The average iron content in all the leafy vegetables for all the places were trends as follows: Soya leaves (9.81) > Fenugreek leaves (2.21) > Spinach (2.13). In fresh water grown leafy vegetables the iron content for Soya leaves, Fenugreek leaves and Spinach was 8.9±0.13, 2.00±0.071 & 2.01±0.036 respectively. Iron content was found to be lower in all the leafy vegetables in comparison to sewage grown leafy vegetables. As reported by **Gopalan *et al*., (2004)** iron values for Soya leaves, Fenugreek leaves and Spinach are 8.0, 1.93, and 1.14/100gm. respectively.

The ANOVA skeleton revealed that the calculated value of F due to vegetables were greater than the table value of F on 2 and 28 d.f. and at 5% probability level; hence our null hypothesis was rejected. Therefore significant difference was found between three vegetables but the calculated value of F due to places is smaller than its table value at 5% level of significance, concluding thereby no significant difference between four places.

Since the ANOVA showed significant result due to vegetables so to compare all possible combination of two vegetables, the value of critical difference was calculated at 5% level of significance which was obtained as 1.22; hence the comparison table is appended below:

Table 6.1: Comparison table for iron contents in leafy vegetables

	V_2= 2.21	V_3= 2.127
V_2= 2.21	0.083^{NS}	7.611*
$V_{1=}$ 9.821	7.694*	-

From the above comparison table significant difference was observed between Soya leaves and Spinach (V_1 & V_3) and Soya leaves and Fenugreek leaves (V_1 & V_2) but non significant difference was found between Fenugreek leaves and Spinach (V_2 & V_3). Since the average value of vegetable (V_1) Soya leaves/dill was highest so it can be regarded as the best vegetable as regards to iron value. The mean order of vegetables were trend as follows: (V_1) Soya leaves (9.821) > (V_2) Fenugreek leaves (0.053) > (V_3) Spinach (0.076).

Table 7: Calcium content of all selected leafy vegetables/100gm

Vegetables / Places	Soya leaves Mean±SE	Fenugreek leaves Mean±SE	Spinach Mean±SE
Phaphamau	213.33±133	401.32±6.00	75.66±1.33
Mundera	227.33±24.7	405.21±3.08	89.36±0.40
Naini	201.33±3.56	277.66±1.18	94.73±1.57
Jhunsi	184±3.67	384.12±0.46	74.83±2.59
Mean	206.49	367.077	83.65
Control	189±1.69	391±2.35	79.66±0.97
*Standard value	180.00	395.00	73.00

*** Gopalan *et al.*, (2004)**

According to above table 9 the obtained data shows that calcium content in Soya leaves were ranged from 184±3.67 to 227±0.33, for Fenugreek leaves from 277±0.66 to 405.21+3.08, while for spinach calcium content ranged from 74.83±2.59 to 94.73±1.57. Highest calcium content was found in Fenugreek leaves for Mundera area while lowest content was observed in spinach for Jhunsi area. The average calcium content in all the leafy vegetables for all places were trends as follows: Fenugreek leaves (206.49) > Soya leaves (367.077) > Spinach (83.65). In fresh water

grown leafy vegetables the calcium content for Soya leaves, Fenugreek leaves & Spinach was 189±1.69, 391±2.35, and 79.66±0.97 respectively. Calcium content was found to be lower in all the leafy vegetables in comparison to sewage grown leafy vegetables. As reported by **Gopalan *et al*., (2004)** calcium values for Soya leaves, Fenugreek leaves and Spinach are 180.0, 395.0, and 73.0/100gm. respectively. The calculated value of F due to places and due to vegetable were smaller than their respective table value of F at 5% probability level, so our null hypothesis will be accepted in both the cases. Therefore it can be concluded from the above data that there was no significant effect of places as well as of three types of vegetable as regards of Calcium i.e. effect of places and of vegetable are as par (same).

4. Conclusion

This study was conducted to analyze the nutritional contents of some commonly consumed leafy vegetables i.e. Soya leaves/dill, Fenugreek leaves and Spinach grown in periphery of Allahabad district, where sewage water was used for irrigating the leafy vegetables by the vegetables growers. The obtained data revealed that the highest protein, fat, carbohydrate, total ash and iron content were found in Soya leaves while calcium content was found to be highest in Fenugreek leaves. Whereas in fresh ground water grown leafy vegetables the protein, fat and carbohydrates contents were high, total ash, iron and calcium contents were low in comparison to sewage water grown leafy vegetables.

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