Yield and Nutritional Value of *Abelmoshus esculentus* L. (Okra) and *Telfairia occidentalis* Hook, F. (Fluted pumpkin) as Influence by Beauty Salon Wastewater

Abstract

The effect of beauty salon wastewater on yield and nutritional quality of *Abelmoschus esculentus* L. *and Telfairia occidentalis* F. was investigated. Plants were grown in perforated polythene bags filled with 3kg of top soil and irrigated with 0 (control), 25, 50, 75 and 100% of the wastewater. Plants were laid out in a completely randomized design (CRD) consisting of 5 treatments with 6 replicates per treatment. Results showed that the yield parameters of *Abelmoschus esculentus* including number of fruits/plant, fruit fresh weight and dry weight increased at 25-75% concentrations but decreased at highest concentration of 100% wastewater in comparison with the control. Similarly, the total biomass of *Telfairia occidentalis* and *Abelmoschus esculentus* increased at 25-75% concentrations of wastewater. The N, K, Ca and Na composition of the leaf of *T. occidentalis* and fruits of *A. esculentus* increased at all wastewater treatment levels. The percentage ash and protein increased in both plants treated with the wastewater. Lipid content increased while the fibre content decreased in *T. occidentalis* whereas in *A. esculentus* fibre content increased while the lipid content decreased in comparison to the control. Percentage carbohydrate increased in both plants treated with the wastewater. The use of beauty salon wastewater in irrigation of vegetables would not only reduce environmental pollution but also serve as an alternative source of fertilizer for vegetable production.

Keywords: Beauty Salon wastewater, *Telfairia occidentalis, Abelmoschus esculentus,* pollution, fertilizer.

1. Introduction

The use of wastewater for irrigation is widely seen in many cities of developing countries where urban wastewater becomes the irrigation source for farmers in urban and semi-urban areas (Raschid-Sally and Jayakody, 2008). Wastewater use for agriculture is an important management strategy in areas with limited freshwater resources, yielding potential economic and environmental benefits. The practice has manifold benefits in the form of water conservation, nutrient recycling and prevention of surface and ground water pollution (Farahat and Linderholm, 2015). The reuse of wastewaters for purposes such as agricultural irrigation can reduce the amount of water that needs to be extracted from environmental water sources (Heidarpour *et al.,* 2007). The reuse of wastewater for irrigation purposes gives it a different fate as agricultural crops can make use of the extra water and nutrients.

Wastewater has a potential to supply carbon nutrients (NPK) and micro nutrients to support crop/plant growth (Singh *et al.,* 2011). It serves as a valuable source of plant nutrients and organic matter needed for maintaining fertility and productivity levels of the soil (Rusan *et al.,* 2007). Wastewater can have a positive effect on soil and eventually plant growth, due to its being rich in organic matter and nutrients (Ghanbari *et al.,* 2007; Mohammad and Ayadi, 2004). Application of wastewater to cropland and forested lands is an attractive option for disposal because it can improve physical properties and nutrient contents of soils (Kiziloglu *et al.,* 2007). Wastewater irrigation not only provides water, N, and P but also organic matter (OM) to the soils (Siebe, 1998). The results of Aghtape *et al.* (2011) and Tavassoli *et al.* (2010) experiments showed that irrigation with wastewater significantly increased the fresh and dry forage yield of corn than that of irrigation with well water. Abu Nada (2009) undertook study to assess the long term impacts of wastewater irrigation on different parameters of soil and crop. Long term wastewater irrigation increased salt, organic matter and plant nutrients in both soil layers. Khurana and Singh (2012) summarized the available data on chemical composition of different wastewaters and their effects on soil fertility, soil heavy-metal content, crop yield and quality. Field application of all types of wastewaters significantly increased soil OC percentage and cation exchange capacity (CEC). *Nadav et al.* (2013) indicated that the physico-chemical properties of soils were altered by wastewater irrigation, as a result of long-term accumulation of organic matter in the soil profiles. High level of organic matter in wastewater acts as cement for the building up of soil aggregates.

However, apart from plant nutrients contained in wastewater, it may contain various potentially toxic elements and organic matters with highly harmful effects on human and animal health. Municipal wastewater contains relatively high amounts of sodium, which can be accumulated in the soil during irrigation with this wastewater and display toxic effects on the plants. If this wastewater is not disinfected or treated in stabilization ponds, it is highly contaminated with microorganisms. Therefore, the utilization of municipal wastewater for the irrigation of crops is associated with a number of risks. Very serious risks are those of crop yields reduction, crops contamination with pathogens and intestinal helminthes (Zavadil, 2009).

Vegetables play important role in meeting the food requirements of people world-wide, because they are important source of various essential components i.e. minerals, dietary fibers and vitamins (Ogle *et al., 2001*). They are also potential sources of essential nutrients, constitutes functional food components by providing protein, iron and calcium which have noticeable health effects (Arai, 2002). The continuous demand for vegetables has increased the need to cultivate these crops all year round. This in effect leads to the dependence on wastewater during the dry seasons or during periods of drought. Also, due to the light water requirement of some crops, the use of wastewater to supplement the freshwater, if any, becomes inevitable.

Okra and fluted pumpkin constitute a major part of the commonly consumed vegetables which are widely grown on the field and in home gardens where there is high tendency of contact with beauty salon wastewater. The study is therefore aimed at investigating the impact of beauty salon wastewater on okra and fluted pumpkin growth.

2. Materials and Methods

2.1 Experimental Location

The experiment was conducted in the screen house of the Plant Science and Biotechnology Department, Adekunle Ajasin University, Akungba Akoko, Ondo State, Nigeria with latitude 7^0 28^iN and longitude $5^0$44E.

2.2 Planting Materials

Matured seeds of *Abelmoschus esculentus* were obtained from the Premier Seed Company Ibadan, Oyo State, Nigeria, while that of *Telfairia occidentalis* were obtained from a local market at Oka-Akoko, Ondo State, Nigeria.

2.3 Experimental Set up

Top soil used for the experiment was collected from the experimental farm of Plant Science and Biotechnology Department, Adekunle Ajasin University, Akungba Akoko. The soil was air-dried and sieved through to remove stones. The beauty salon wastewater was collected from a septic wastewater tank from a beauty salon in Akungba Akoko, Ondo State. Concentrations of 25, 50, 75, and 100% of the wastewater were prepared in a plastic keg just before each treatment by dilution with tap water to make the desired concentrations. Four viable seeds of *Abelmoschus esculentus* and three viable seeds of *Telfairia occidentalis* were sown in perforated polythene bags containing 3kg of top soil. Seedlings were allowed to establish for three weeks and thinned to one seedling per pot. Plants were irrigated with the wastewater at 0 (control), 25%, 50%,75% and 100% concentrations. Each pot was treated with 250mL (volume enough to keep the soil moist) 2 times in a week; thus each pot received 500mL of wastewater treatment per week. The treatment lasted for 8 weeks. The experiment was carried out from July to October, 2016. Pots were laid in a completely randomized design, with 6 replicates per treatments. The experiment ended in October 2016 by harvesting the fruits of *Abelmoschus esculentus* with the seeds and leaves of *Telfairia occidentalis.* Their fresh weight was determined after which they were oven-dried at 80^oC for the dry weight measurement.

2.4 Measurement of Yield

Measurement of yield of *Abelmoschus esculentus* and of *Telfairia occidentalis* irrigated with different concentrations of beauty salon wastewater was done. The parameters studied include: Number of fruits/plant, total fresh weight of fruits/plant, total dry weight of fruits/plant.

2.5 Chlorophyll content analysis

The total chlorophyll content of leaves of *Abelmoschus esculentus* and *Telfairia occidentalis* was determined using the (Arnon, 1949) method. One gram of fresh leaves was ground with acid leached sand, (sand washed with concentrated sulphuric acid (H_2SO_4) and thoroughly rinsed with distilled water to remove all nutrients). The chlorophyll content was extracted using 10ml of 80% acetone and centrifuged at 2000rpm for 15minutes. The clear supernatant liquid was decanted and the absorbance read with photo spectrophotometer at 663nm and 645nm respectively. The 80% acetone served as reference blank. The total chlorophyll content was calculated using the formula:

Total chlorophyll content= $\{20.2 \text{ x } D_{645} + 8.02 \text{ x } D_{663}\}$ x {(50/100 x (100/5) x1/2}

2.6 Fresh and dry weight determination

Plants were carefully uprooted at the end of experiment by soaking the soil with water for easy uprooting without any damage to the root. The roots were washed and each plant was separated into stems, roots and leaves. The parts were taken to the laboratory for weighing to determine the fresh weight. Dry weight was also determined after drying in an oven at 80^0C to constant weight. The weight was measured using sensitive weighing balance. Also, fruits of plant were harvested and weighed in the laboratory to determine the fresh weight. The fruits dry weight was determined after drying in an oven at 80^0C.

2.7 Plant Analysis

Dried seeds of *Abelmoschus esculentues* and dried leaves and stems of *Telfairia occidentalis* were ashed and dissolved with 10ml of 20% sulphuric acid. The Solution was placed on a hot plate preset at 30^0C to falcilitate its dissolution. It was removed from hot plate, filtered into 10ml capacity volumentric flask and marked to volume with distilled water. This filtrate was used for Ca2+, Mg2+, Na+, K+. Na+ and K+ analysis by flame photometer, and Mg2 and Ca2+ analysis by EDTA. Seeds and leaves were also assayed for proximate compositions: crude protein, fat and carbohydrate, crude fiber and total ash following the method of AOAC.

2.7.1 Sodium and potassium determination

A 2.54g and 1.9067g of pure oven dried NaCl and KCl respectively were dissolved in water to make 1litre. 10ml each of the reagent was then pipette to make 100ml with ammonia acetate to have 100ppm solution from the 100ppm, 0,2,4,6,8 and 10ml were pipette into 100ml flask and made each to mark, to have 0,2,4,6,8,10ppm working standard for two stocks. The ammonium acetate extract was employed for the determination. The flame photometer was adjusted according its instruction manual. The standards were aspirated to obtain reliable curves before aspirating the samples. The blank (ppm) is the ammonium acetate.

2.7.2 Calcium and magnesium determination

A 10ml aliquot of the plant samples was carefully transferred in duplicate into 150ml conical flask capacity. A drop of potassium cyanide and hydrochloride were introduced to both beakers. To one set of the beaker, 5ml of ammonium buffer, three drops of erichrome black, and indicator were added and titrated against 0.05M EDTA solution. The titre value obtained gave a combine result for calcium and magnesium while to the second set of beaker; 5ml of 8M of NaOH and a pinch of cal-red indicator were added and titrated against 0.05mDTA solution. The titre value obtained gave directly the result of calcium concentration. The difference between the first and the second value obtained gave the amount of magnesium.

2.7.3 Determination of crude protein

The estimation of crude protein involves the determination of total nitrogen usually by kjedahl procedure. The amount of crude protein is obtained by multiplying the nitrogen content by 6.25. This factor is based on the assumption that all the nitrogen in the tissue is present as protein.

2.7.4 Crude fibre determination

About 0.50-2.0g of the milled sample was measured into 1 litre conical flask (W_0). 200ml of boiling 1.25% H_2SO_4 was added and boiled gently for 30 minutes using cooling fingers to maintain a constant volume, this was filtered through muslin cloth or poplin material stretched over 9cm Buchner funnel. It was rinse well with hot distilled water added and the material was scraped back into flask with spatula. About 20ml of boiling 1.25% NaOH was added and boiled gently for 30 minutes using cooling fingers to maintain a constant volume. This was filtered through poplin cloth and residues washes with10% HCl and twice with industrial methylated spirit, acetone or ethanol. This was allowed to drain, dry and the residue scraped into a crucible or silica dish. This was dried overnight at 105^0C in the oven and then cooled in a desiccator. The sample was weighed (W), ashed at 550^0C for 90 minutes in a muffle furnace, cooled in a desiccators and weighed again (W_2).

Calculation

$$\%\ \text{crude fibre} = \frac{W_1 - W_2}{W_0} \times 100$$

2.7.5 Determination of soluble carbohydrate (nitrogen free extract)

The nitrogen- free extractive (NFE) referred to as soluble carbohydrate is not determined directly but obtained as a difference between crude protein and the sum of ash, protein, crude fat and crude fibre.

NFE= 100-(%ash + % crude fibre +% crude fat + % crude protein)

2.8 Statistical analysis

The data obtained were subjected to one-way analysis of variance (ANOVA) and means were separated with Tukey HSD Multiple Range tests at 5% level of probability using SPSS 21.0.

3. Results

Table 1. shows the effect of beauty salon wastewater on the yield of *Abelmoschus esculentus.* Beauty salon wastewater at 25-75% concentrations increased the yield of *Abelmoschus esculentus.* But the yield reduced at 100% concentration in comparison with the control. Plants irrigated with 75% concentration of the wastewater yielded an average of 4.00 fruits per plant compared to average of 3.85 fruits per plant in control and average of 3.67 fruits per plant in higher concentration of 100% of the wastewater. Similarly, the fruits fresh and dry weight increased at 75% concentration and reduced at 100% concentration of the wastewater in comparison with the control.

Table 1. Yield of *Abelmoschus esculentus* (Okra) grown in soil irrigated with water containing different proportions of beauty salon wastewater under screen house condition

Yield parameters	**Quantity of beauty salon wastewater applied (%)**				
	0	**25**	**50**	**75**	**100**
Number of fruits/plant	3.85^{a}	4.00^{a}	3.87^{a}	4.00^{a}	3.67^{a}
Fruit fresh weight/plant (g)	31.64^{a}	36.41^{a}	34.04^{a}	41.48^{a}	31.56^{a}
Fruit dry weight/plant (g)	4.31^{a}	4.76^{a}	4.66^{a}	6.36^{a}	3.81^{a}

Each value is a mean± S.E of 6 replicates. For each value, means with the same letter(s) in superscript on the same row are not significantly different at P≥0.05 (Tukey HSD test)

This present experiment shows significant effects of beauty salon wastewater on fresh and dry weight of Plants parts. Table 2 and 3. illustrate the impact of beauty salon wastewater on the fresh and dry weights of roots, stems and leaves of *Abelmoschus esculentus* and *Telfairia occidentalis* irrigated with beauty salon wastewater. Fresh and dry weights parts of *Abelmoschus esculentus* increased with a significant different (p>0.05) at 25-75% concentrations of the beauty salon wastewater but decreased at highest concentrations of 100% when compared with the control(Table 2). Similarly, the fresh weights of the different parts of *Telfairia occidentalis* increased at 25-75% concentrations of beauty salon wastewater compared with the control (Table 3).

Table 2. Effect of beauty salon wastewater on the fresh and dry weight (g) of plant parts in *Abelmoschus esculentus*.

Parameter	**Plant part**	**Concentration of beauty salon wastewater applied(%)**				
		0	25	50	75	100
Fresh weight (g)	Root fresh weight	12.53^{a}	15.10^{b}	13.63^{b}	13.85^{b}	11.41^{a}
	Leaf fresh weight	5.62^{ab}	5.56^{ab}	9.08^{b}	5.82^{ab}	3.56^{a}
	Stem fresh weight	11.67^{a}	14.90^{a}	13.23^{a}	15.85^{a}	8.72^{a}
Dry weight (g)	Root dry weight	2.49^{ab}	3.29^{c}	2.70^{abc}	2.88^{bc}	2.03^{a}
	Leaf dry weight	1.38^{a}	1.41^{a}	2.49^{b}	1.44^{a}	0.98^{a}
	Stem dry weight	2.26^{a}	2.60^{a}	2.58^{a}	2.99^{a}	1.59^{a}

Each value is a mean± S.E of 6 replicates. For each value, means with the same letter(s) in superscript on the same row are not significantly different at P≥0.05 (Tukey HSD test)

Table 3. Effect of beauty salon wastewater on the fresh and dry weight (g) of plant parts in *Telfairia occidentalis*

Parameter	Plant part	Concentration of beauty salon wastewater applied (%)				
		0	25	50	75	100
Fresh weight (g)	Root fresh weight	18.80^{ab}	18.96^{ab}	19.91^{b}	26.55^{c}	14.83^{a}
	Leaf fresh weight	13.75^{a}	13.85^{a}	13.97^{a}	13.32^{a}	12.73^{a}
	Stem fresh weight	14.20^{a}	16.93a	15.27^{a}	19.68^{b}	13.53^{a}
Dry weight (g)	Root dry weight	2.92^{a}	4.17^{a}	3.52^{a}	5.68^{b}	2.69^{a}
	Leaf dry weight	2.20^{a}	2.45^{a}	2.46^{a}	2.42^{a}	1.88^{a}
	Stem dry weight	2.41^{a}	3.23^{ab}	2.73^{ab}	3.75^{b}	2.22^{a}

Each value is a mean± S.E of 6 replicates. For each value, means with the same letter(s) in superscript on the same row are not significantly different at P≥0.05 (Tukey HSD test)

Table 4. shows the effect of beauty salon wastewater on the total biomass of the two vegetables. The total biomass is the total sum of the root and shoot dry mass. The total biomass increased upon irrigation with beauty salon waste water in comparison with the control. (Also see Figures 1 and 2).

Table 4. Dry mass, Root: shoot ratio of *Abelmoschus esculentus* and *Telfairiaoccidentalis* grown in soil irrigated with beauty salon wastewater.

	Vegetable species	**Concentration of beauty salon wastewater applied (%)**				
		0	**25**	**50**	**75**	**100**
Root dry mass (g)	***Telfairiaoccidentalis***	2.92^{a}	4.17^{a}	3.52^{a}	5.68^{a}	2.69^{a}
	Abelmoschusesculentus	2.49^{ab}	3.29^{c}	2.70^{abc}	2.88^{bc}	2.03^{a}
Shoot dry mass (g)	***Telfairiaoccidentalis***	4.3^{b}	5.06^{a}	5.75^{a}	6.17^{a}	6.63^{a}
	Abelmoschusesculentus	3.3^{bc}	4.13^{b}	5.86^{b}	7.86^{a}	7.73^{a}
Total biomass (g)	***Telfairiaoccidentalis***	6.43^{b}	7.29^{ab}	8.08^{ab}	8.53^{a}	9.19^{a}
	Abelmoschusesculentus	5.8^{c}	7.03^{ab}	8.89^{ab}	10.99^{a}	9.59^{a}

Each value is a mean± S.E of 6 replicates. For each value, means with the same letter(s) in superscript on the same row are not significantly different at P≥0.05 (Tukey HSD test)

FIGURE 1. Effect of beauty salon wastewater on biomass of *Abelmoschus esculentus.*

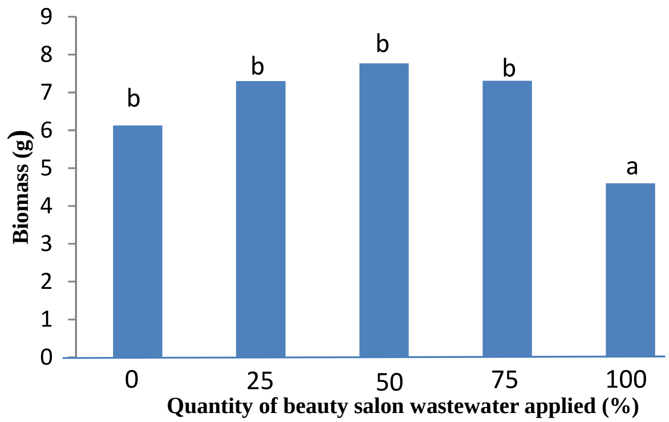


FIGURE 2. Effect of beauty salon wastewater on the biomass of *Telfairia occidentalis.*

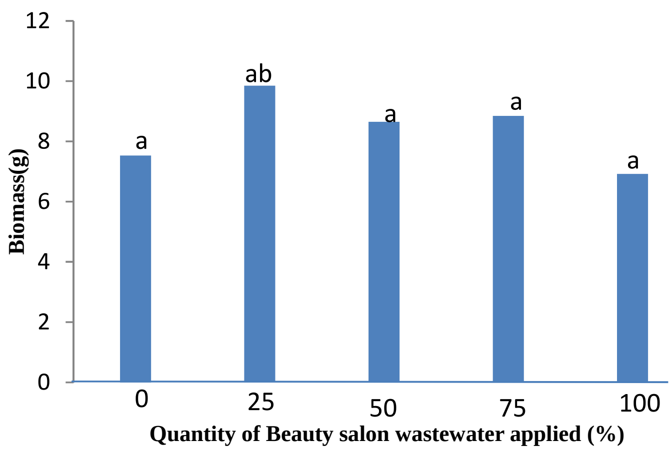


Figure 3. Effect of beauty salon wastewater on the chlorophyll content of *Telfairia occidentalis*

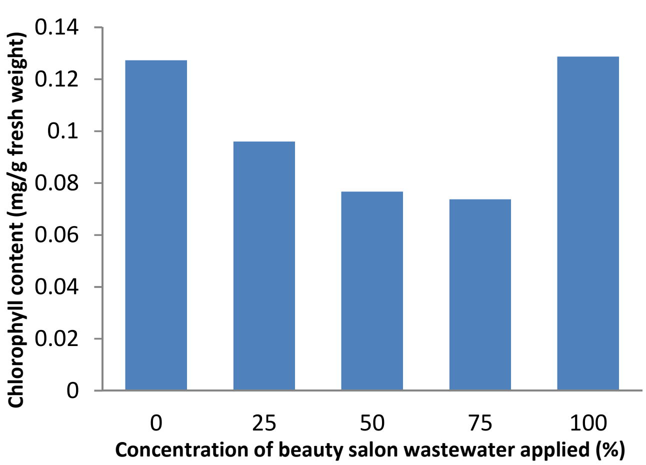
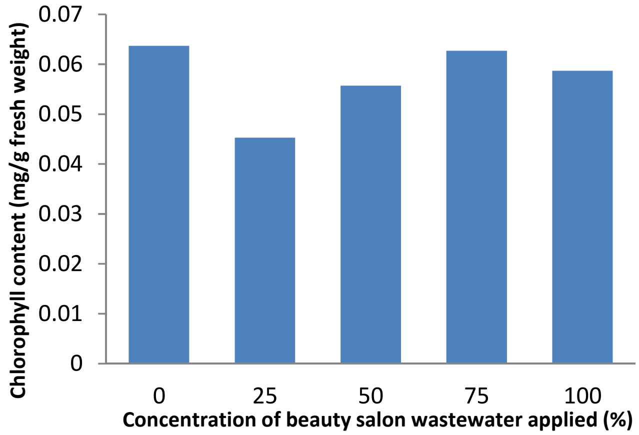


Figure 4. Effect of beauty salon wastewater on the chlorophyll content of *Abelmoschus esculentus.*



Beauty salon wastewater at all treatment levels (25-100%) caused an increase in the nutrient composition of the fruits of *Abelmoschus esculentus* and leaves of *Telfairia occidentalis* when compared with the control. N, K, Ca and Na composition of the two vegetables increased in comparison with the control. The result also shows increase in the percentage ash and protein content of the plants. Lipid content increased while the fibre content decreased in *T. occidentalis* whereas in *A. esculentus* fibre content increased while the lipid content decreased in comparison to the control.

Figure 5: Nutritional and proximate composition of leaves produced by *Telfairia occidentalis* (Fluted pumpkin) grown in soil irrigated with water containing different proportions of beauty salon wastewater under screen house condition

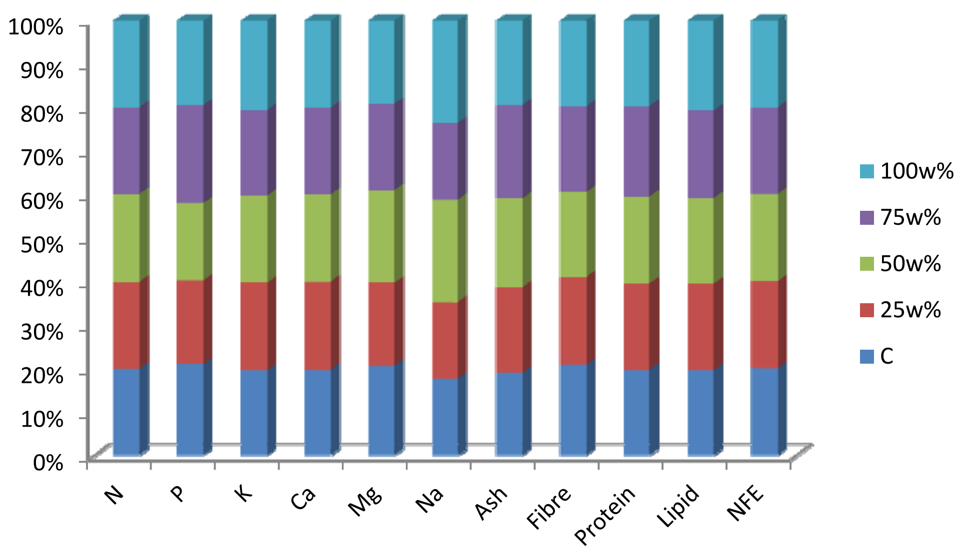


Table 5: proximate and nutritional composition of *Telfairia occidentalis*

	Quantity of Beauty Salon wastewater applied (%)				
Nutritional and Proximate Composition	0	25	50	75	100
N (%)	1.64	1.66	1.67	1.65	1.65
P (%)	0.13	0.12	0.11	0.14	0.12
K (%)	0.85	0.88	0.87	0.86	0.89
Ca (%)	0.67	0.69	0.68	0.68	0.68
Mg (%)	0.28	0.26	0.29	0.27	0.26
Na (%)	0.03	0.03	0.04	0.03	0.04
Ash (%)	4.43	4.57	4.75	5.00	4.50
Fibre (%)	9.37	9.10	8.78	8.88	8.86
Protein (%)	10.25	10.38	10.44	10.86	[illegible]
Lipid (%)	1.56	1.59	1.57	1.61	1.65
NFE (%)	74.39	74.36	74.35	73.95	73.98

Figure 6. Nutritional and proximate composition of fruits produced by *Abelmoschus esculentus* (Okra) grown in soil irrigated with water containing different proportions of beaauty salon wastewater under screen house condition

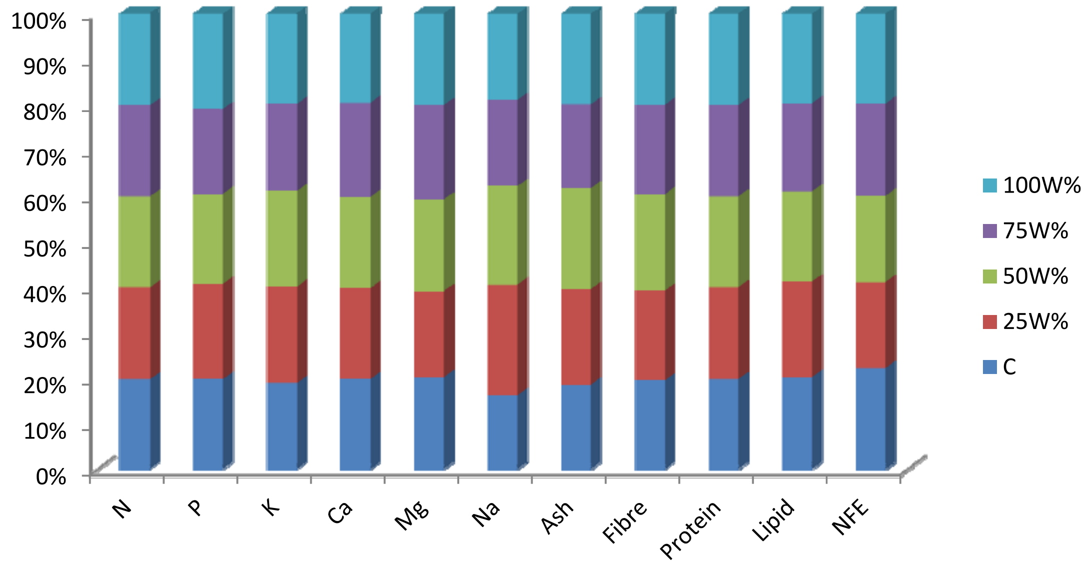


Table 6: Proximate and nutritional composition of *Abelmoschus esculentus*

	Concentration of Beauty Salon wastewater applied (%)				
Nutritional and Proximate Composition	0	25	50	75	100
N (%)	2.46	2.52	2.49	2.50	2.51
P (%)	0.17	0.18	0.17	0.16	0.18
K (%)	0.91	1.02	1.01	0.92	0.95
Ca (%)	0.86	0.87	0.87	0.90	0.85
Mg (%)	0.33	0.31	0.33	0.34	0.33
Na (%)	0.06	0.09	0.08	0.07	0.07
Ash (%)	7.90	8.96	9.45	7.86	8.50
Fibre (%)	17.74	17.94	19.27	17.86	18.19
Protein (%)	15.38	15.75	15.56	15.63	15.69
Lipid (%)	11.33	11.74	11.07	10.85	10.97
NFE (%)	52.35	44.61	44.65	47.80	46.65

4. Discussion

The effect of wastewater on yield and nutritional value of crops has been demonstrated and discussed extensively by many authors. (Day *et al*., 1981) reported that using municipal wastewater diluted with groundwater at 50:50 mixtures improved *Gossypium spp* yield when compared to groundwater alone from wells in Arizona. Kiziloglu *et al.* (2008) showed that wastewater irrigation treatments increased the availability of N, P, K, Ca, Mg, Na, Fe, Mn, Zn and Cu, to plant which led to increase of red cabbage yields. Gatta *et al.* (2015) observed that the source of irrigation water did not affect significantly tomato yield traits except tomato quality. Results of this experiment show the effect of beauty salon wastewater on the yield and nutritional value of *Telfairia occidentalis*(Fluted Pumpkin)and *Abelmoschus esculentus* (Okra).

Table 1. shows that plant irrigated with 25-75% concentrations of beauty salon wastewater had higher yield than the control. This concur with the previous finding of Bedbabis *et al.* (2015) that found that wastewater irrigation of olive trees resulted in significant yield increase when compared to yields from plot using well water. Qaryouti *et al.* (2015) concluded that, raw wastewater irrigation increased significantly tomato crop parameters, cucumber plant height and fruit yield and average fruit weight, and tomato leaf area and plant dry weight. Day *et al*. (1974) also compared the effect of irrigation with wastewater and pump water on wheat. They concluded that wastewater irrigation produced taller plants, heavier seeds and higher grain yields than pump water. Wastewater has the potential to increase plant yield than the control. Similar results were also recorded by Juwarkar *et al.* (1990) in *Arachis hypogea*. Nissim *et al.* (2015), showed that, irrigation with wastewater had a positive effect on willow growth and biomass yield. Jiménez *et al.* (1999) concluded that, reuse wastewater increased significantly crop productivity to five crops/year of alfalfa, fodder oats, tomato, barley and maize and the yield was higher than those obtained with rain. Golchin *et al.* (2013) indicated that use of wastewater could improve morphological characters, yield and yield components of alfalfa as compared to control treatment. Increasing wastewater concentration more than 45 % caused poisoning effects on plants which decreased biological yield.

Higher concentration of beauty salon wastewater decreased the dry weight of the root, stem and leaf of *A.esculentus* and *T. occidentalis*. The reduction in the dry weight might be due to the poor growth of the seedlings under effluent stress. According to El Youssfi *et al.* (2012) studied the effect of wastewater irrigation on three varieties of quinoa. The salinity caused the depression of plant's height, and reduced fresh and dry weights of different parts of three varieties of plants tested. The plant biomass of the two vegetables increased at 25-75% treatment levels of the wastewater. It was reported by Misra *et al*. (2009) that *Solanum lycoperscum* irrigated with greywater obtained higher nutrient uptake and biomass at the flowering stage when compared to tap water. Also, Gupta *et al.* (2015) reported that plant irrigated with wastewater resulted in significant increase in plant height, number of leaves per plant, leaf area index, leaf to stem (green and dry) biomass and green fodder yield of fodder sorghum and significant decrease in dry matter content as compared to well water. Zema *et al.* (2012) investigated the biomass yield of *T. latifolia* which increased by irrigation with wastewater. Ntzala *et al.* (2015) found that the treated wastewater affected significantly the dry matter yield and non-significantly the plant height on *Lactuca sativa* L. crop.

The proximate analysis of *Telfairia occidentalis* shows that Beauty salon wastewater increased leaf N, K, and Ca while other nutrients were not affected. Similarly, percentage ash, lipid and protein increased in the leaves of beauty salon waste treated plants (Figure 3). This finding is in accordance with Babyshakila *et al.*(2009) that biochemical content of lipid, ash and protein increased at 50 and 75% concentrations of wastewater in the leaf samples of Vigna radiate. The Fibre and carbohydrate contents decreased relative to the control. The proximate analysis of *Abelmoschus esculentus* shows that Beauty salon wastewater increased the composition of N, K, Ca and Na at all treatment levels in the fruits of *Abelmoschus esculentus* in comparison to the control (Figure 4). Al-Jaloud *et al.(*1995) reported elevated concentration of N, Ca, Mg, and Na in leaves of Sorghum when the crop was irrigated with wastewater. Moreover, Vazquez-Montieletal.(1996) found that irrigation of maize (Zea mays. L.) with treated wastewater resulted in increase in N, P, K and Mg concentration in leaves. Fonseca *et al.(*2005a) also obtained similar results in a greenhouse experiment with maize. Also, there was an increase in the percentage ash, fibre and protein at all treatment levels whereas the lipid and carbohydrate contents decreased in comparison to the control.

Figure (3 and 4) show the effects of beauty salon wastewater on the chlorophyll content of *T. occidentalis* and *A. esculentus.* Beauty salon wastewater treatments reduced the chlorophyll content of *Abelmoschus esculentus* but at non-significant level when compared to the control. The Chlorophyll content of *Telfairia occidentalis* reduced significantly with a significance difference at 25-75% concentrations when compared to the control upon treatment with beauty salon wastewater. Sahai and Singh (1977), Benergi and Kumar (1979) and Singh and Srivastava (1984) have reported adverse effect of wastewater on chlorophyll content and metabolism. Agrawal *et al.* (1961), suggested that heavy metals can inhibit chlorophyll formation by preventing magnesium uptake.

5. Conclusion

The use of beauty salon wastewater improved yields and nutritional values of *A. esculentus* and *T. occidentals* when diluted with water at 25-75%. Consequently, beauty salon wastewater can serve as an alternative liquid fertilizer in the production of *A. esculentus* and *T. occidentalis* if applied to soil at levels not above 75% concentration of the wastewater. This study cofirrms that high concentration (>75% concentration) of beauty salon wastewater can have negative impact on soil make it unfavourable for plant yields. Therefore, wastewater should not be used directly on crops without sufficient treatment or dilution with water. There is however the need for further evaluation or assessment of environmental health challenges associated with beauty salon waste disposal.

Ethical approval and consent are not applicable.

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