

37 only provides water but also contains considerable amount of organic matter and plant
38 nutrients (N, P, K, Ca, S, Cu, Mn & Zn) and has been reported to increase the crop yield
39 (Pathak et al. 1998, 1999, Siebe 1998, Ramana et al. 2001, Lubello et al. 2004, Nagajyothi et
40 al. 2009, Nath et al. 2009). Thus, its use would help in water conservation, recycling nutrients
41 (NPK) in wastewater, reducing direct fertilizer inputs and minimizing pollution loads to
42 receiving water bodies (Hylander *et al.*, 2006;Thapliyal *et al.*, 2009;Vasudevan *et al.*, 2010).

43 However, apart from plant nutrients contained in wastewater, it may contain various
44 potentially toxic elements and organic matters with highly harmful effects on human and
45 animal health. Municipal wastewater contains relatively high amounts of sodium, which can
46 be accumulated in the soil during irrigation with this wastewater and display toxic effects on
47 the plants. If this wastewater is not disinfected or treated in stabilization ponds, it is highly
48 contaminated with microorganisms. Therefore, the utilization of municipal wastewater for the
49 irrigation of crops is associated with a number of risks. Very serious risks are those of crop
50 yields reduction, crops contamination with pathogens and intestinal helminthes (Zavadil,
51 2009).

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

61 **2. Materials and Methods**

62 **2.1 Experimental Location**

63 The experiment was conducted in the screen house of the Plant Science and
64 Biotechnology Department, Adekunle Ajasin University, Akungba Akoko, Ondo State,
65 Nigeria with latitude 7° 37'N and longitude 5°44E.

66 **2.2 Planting Materials**

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

70

71 **2.3 Experimental Set up**

72 Top soil used for the experiment was collected from the experimental farm of Plant
73 Science and Biotechnology Department, Adekunle Ajasin University, Akungba Akoko. The
74 soil was air-dried and sieved through to remove stones. The beauty salon wastewater was
75 collected from a septic wastewater tank from a beauty salon in Akungba Akoko, Ondo State.
76 Concentrations of 25, 50, 75, and 100% of the wastewater were prepared in a plastic keg just
77 before each treatment by dilution with tap water to make the desired concentrations. Four
78 viable seeds of *Abelmoschus esculentus* and three viable seeds of *Telfairia occidentalis* were
79 sown in perforated polythene bags containing 3kg of top soil. Seedlings were allowed to
80 establish for three weeks and thinned to one seedling per pot. Plants were irrigated with the
81 wastewater at 0 (control), 25%, 50%, 75% and 100% concentrations. Each pot was treated
82 with 250mL (volume enough to keep the soil moist) 2 times in a week; thus each pot received
83 500mL of wastewater treatment per week. The treatment lasted for 8 weeks. The experiment
84 was carried out from July to October, 2016. Pots were laid in a completely randomized
85 design, with 6 replicates per treatments. The experiment ended in October 2016 by harvesting
86 the fruits of *Abelmoschus esculentus* with the seeds and leaves of *Telfairia occidentalis*. Their
87 fresh weight was determined after which they were oven-dried at 80°C for the dry weight
88 measurement.

89

90 **2.4 Nutritional and Phytochemical analysis**

91 **Dried seeds of *Abelmoschus esculentus* and dried leaves of *Telfairia occidentalis***
92 **were milled for chemical analyses. Total N was determined by micro-Kjeldahl method. For**
93 **P, K, Ca and Mg, samples (0.5 g) were ashed, dissolved in 10% HCl and diluted to 50 ml. P**
94 **was determined using Vanado molybdate colourimetry. Ca and Mg were determined by**
95 **EDTA titration, while Na and K was by flame photometry. Seeds and leaf were also assayed**
96 **for proximate compositions: crude protein, fat and carbohydrate, crude fiber and total ash**
97 **following the method of AOAC.**

98

99 **2.5 Statistical analysis**

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

103

104 **3. RESULTS**

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

113

114 **Table 1.**

115 **Yield of *Abelmoschus esculentus* (Okra) grown in soil irrigated with water containing**
 116 **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

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

119 Plant biomass was compared. Table 2. Shows the result of the effect of beauty salon
 120 wastewater on the root dry mass, shoot dry mass and total biomass of the two vegetables.
 121 Increase in biomass was observed at 25-75% concentrations in comparison with the control.
 122 Fig 1. Shows highest increase in the biomass of *Abelmoschus esculentus* at 50%
 123 concentration of wastewater. Fig 2. Shows that 25% concentration had the highest increase in
 124 the total biomass of *Telfairia occidentalis*.

125

126 **Table 2.**

127 **Dry mass, Root: shoot ratio and Relative growth rate of *Abelmoschus esculentus* and**
 128 ***Telfairia occidentalis* grown in soil irrigated with beauty salon wastewater under screen**
 129 **house condition**

	Vegetable species	Quantity of beauty salon wastewater applied (%)				
		0	25	50	75	100
Root dry mass (g)	<i>Telfairia occidentalis</i>	2.92 ^a	4.17 ^a	3.52 ^a	5.68 ^a	2.69 ^a
	<i>Abelmoschus esculentus</i>	2.49 ^{ab}	3.29 ^c	2.70 ^{abc}	2.88 ^{bc}	2.03 ^a
Shoot dry mass (g)	<i>Telfairia occidentalis</i>	4.3 ^b	5.06 ^a	5.75 ^a	6.17 ^a	6.63 ^a
	<i>Abelmoschus esculentus</i>	3.3 ^{bc}	4.13 ^b	5.86 ^b	7.86 ^a	7.73 ^a
Total biomass (g)	<i>Telfairia occidentalis</i>	6.43 ^b	7.29 ^{ab}	8.08 ^{ab}	8.53 ^a	9.19 ^a
	<i>Abelmoschus esculentus</i>	5.8 ^c	7.03 ^{ab}	8.89 ^{ab}	10.99 ^a	11.59 ^a
Root: shoot ratio	<i>Telfairia occidentalis</i>	0.50 ^{ab}	0.44 ^b	0.41 ^b	0.38 ^b	0.39 ^b
	<i>Abelmoschus esculentus</i>	0.76 ^b	0.70 ^b	0.52 ^c	0.4 ^c	0.50 ^c

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

132

133

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138

139 **FIGURE 1**

140 Effect of beauty salon wastewater on biomass of *Abelmoschus esculentus*.

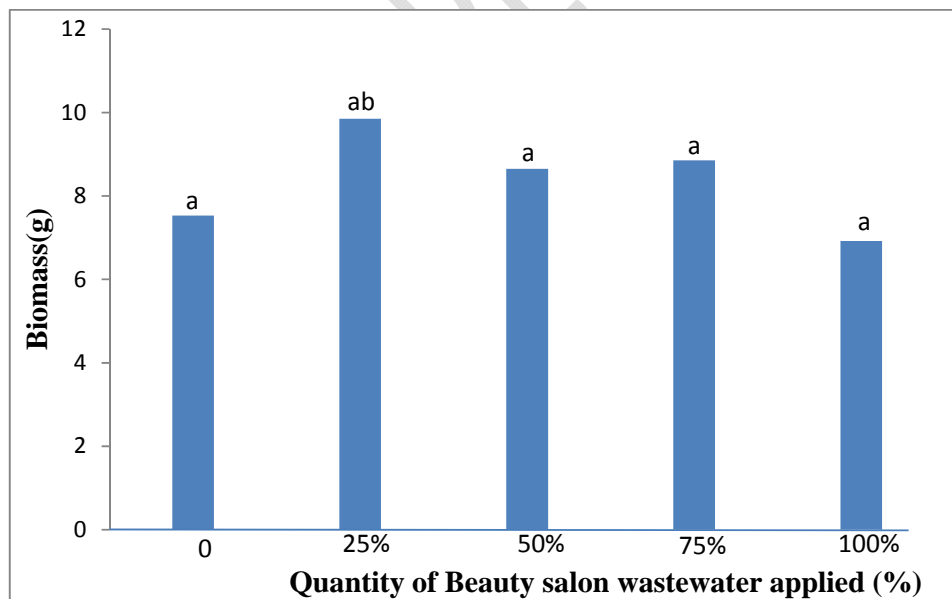


141

142

143 **FIGURE 2**

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



145

146 Beauty salon wastewater at all treatment levels(25-100%) caused an increase in the
147 nutrient composition of the fruits of *Abelmoschus esculentus* and leaves of *Telfairia*
148 *occidentalis* when compared with the control. N, K, Ca and Na composition of the two

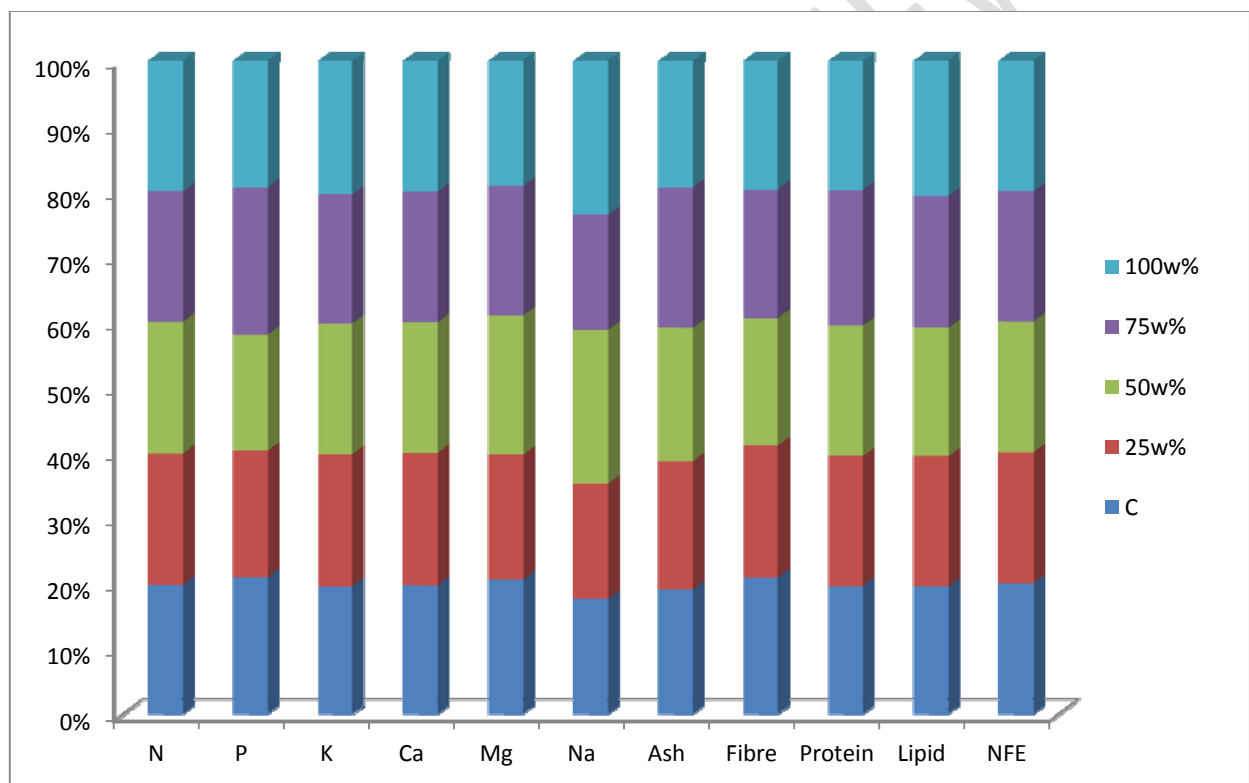
149 vegetables increased in comparison with the control. The result also shows increase in the
 150 percentage ash and protein content of the plants. Lipid content increased while the fibre
 151 content decreased in *T. occidentalis* whereas in *A. esculentus* fibre content increased while
 152 the lipid content decreased in comparison to the control.

153

154 **Figure 3:**

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

158

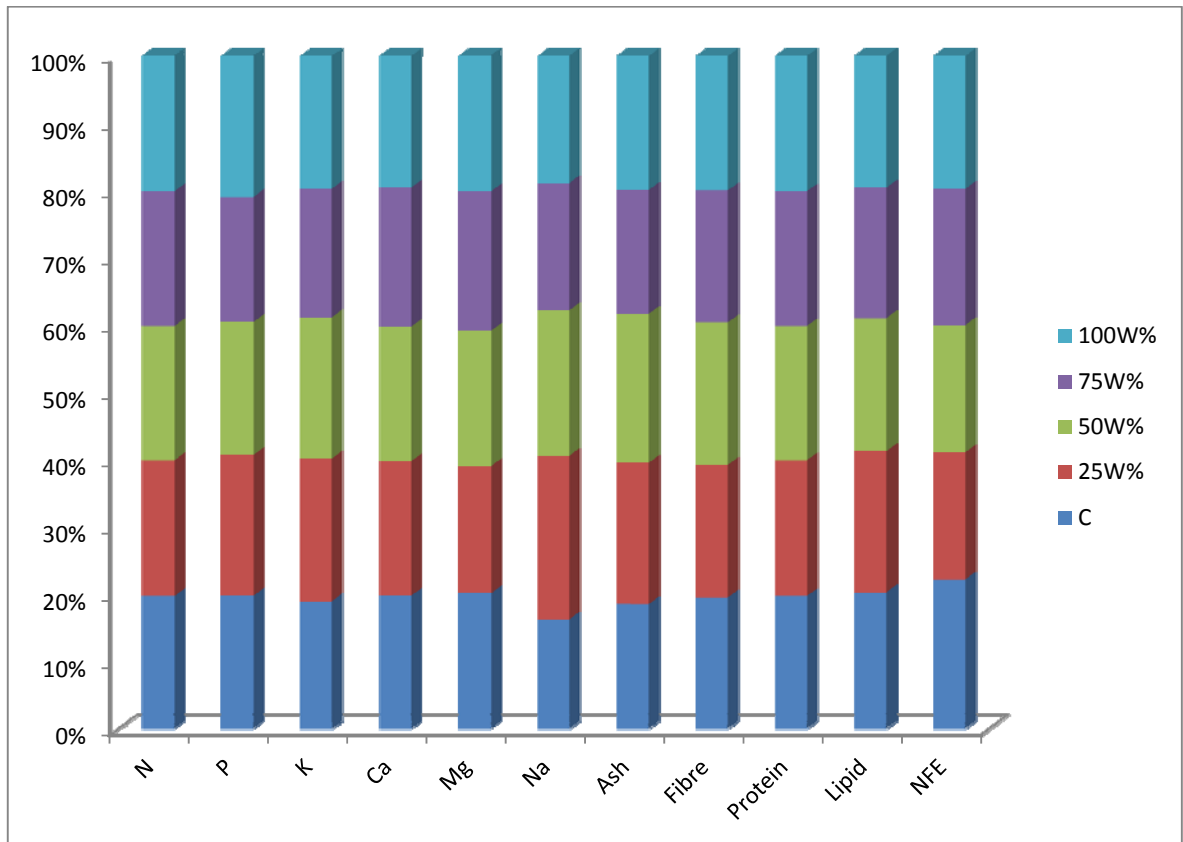


159

160

161 **Figure 4.**

162 **Nutritional and proximate composition of fruits produced by *Abelmoschus esculentus***
 163 **(Okra) grown in soil irrigated with water containing different proportions of beauty**
 164 **salon wastewater under screen house condition**



165

166

167 4. DISCUSSION.

168 The effect of wastewater on environment has been demonstrated and discussed
 169 extensively by many authors. Results of this experiment showed the effect of beauty salon
 170 wastewater on the yield and nutritional value of *Telfairia occidentalis* (Fluted Pumpkin) and
 171 *Abelmoschus esculentus* (Okra).

172 Table shows that plant irrigated with 25-75% concentrations of beauty salon
 173 wastewater had higher yield than the control. This concur with the previous finding of
 174 Kiziloglu *et al.* (2008) that wastewater irrigation treatment increased the availability of N, P,
 175 K, Ca, Mg, Na, Fe, Zn and Cu to plant which led to increase of red cabbage yields. Similarly,
 176 *Gossypium spp* yield was improved by using diluted municipal wastewater with groundwater
 177 at 50:50 mixtures when compared to groundwater alone from wells in Arizona (Day *et al.*,
 178 1981). Day *et al.* (1974) also compared the effect of irrigation with wastewater and pump
 179 water on wheat. They concluded that wastewater irrigation produced taller plants, heavier
 180 seeds and higher grain yields than pump water. Wastewater has the potential to increase plant
 181 yield than the control. Similar results were also recorded by Juwarkar *et al.* (1990) in *Arachis*
 182 *hypogea*.

183 Higher concentration of beauty salon wastewater decreased the dry weight of the root,
184 stem and leaf of *A. esculentus* and *T. occidentalis*. The reduction in the dry weight might be
185 due to the poor growth of the seedlings under effluent stress. The plant biomass of the two
186 vegetables increased at 25-75% treatment levels of the wastewater. It was reported by Misra
187 *et al.* (2009) that *Solanum lycopersicum* irrigated with greywater obtained higher nutrient
188 uptake and biomass at the flowering stage when compared to tap water.

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

204

205 CONCLUSION

206 The research has revealed that beauty salon wastewater improved seedling growth and
207 yield of *A. esculentus* and *T. occidentalis* when diluted with water at 25-75% while the
208 undiluted one reduced plant growth and yield. Besides, beauty salon wastewater did not have
209 negative effect on the nutritional quality. Consequently, beauty salon wastewater can serve as
210 an alternative liquid fertilizer in the production of *A. esculentus* and *T. occidentalis* if applied
211 to soil at levels not above 75% dilution.

212

213

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