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PROXIMATE AND MICRONUTRIENT ANALYSIS OF ORANGE FLESHED SWEET POTATO LEAVES GROWN IN SYLHET REGIONS OF BANGLADESH

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ABSTRACT

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Sweet potato leaves are the traditional indigenous vegetables and most economically efficient source of micronutrients in terms of both land required and production costs per unit. This study aimed to compare and identify one variety rich with proximate, microelements and anti-oxidants from three high yielding sweet potato varieties viz. BARI SP-04, BARI SP -11 and BARI SP-12 including one local genotype leaves that helps provide leafy vegetables as well as micronutrients to poor community in lean vegetables production period of Sylhet regions. The tested varieties and genotype showed significant variation in different nutrient contents. In case of proximate composition the highest ether extract was found in BARI SP-11 (7.33% ± 0.64 DW) and the lowest in BARI SP-04 variety (3.80% ± 0.42 DW). And the ash contents range was (12.05% ± 0.89 to 16.43% ± 1.02 DW), but the highest was recorded in BARI SP-12 and the lowest in BARI SP-04. In case of crude fiber the highest (19.99% ± 1.06 DW) was found in BARI SP-11 and the lowest (16.73% ± 0.62 DW) in local genotype. The microelements composition result revealed that BARI SP-04 reserved the highest (32.82 ± 4.5 mg 100 g⁻¹) Iron & (2.1 ± 0.5 mg 100 g⁻¹) Zinc and the lowest (19.40 ± 2.5 mg 100 g⁻¹) Iron and (1.27 ± 0.2 mg 100 g⁻¹) Zn in BARI SP-11 & local genotype respectively. However in case of phenolic compound, the highest 257.00 ± 10.3 mg TAE 100 g⁻¹ DW was found in local genotype followed BARI SP-11 and BARI SP-12 but the lowest amount 218.75 ± 7.8 mg TAE 100g⁻¹ DW was recorded in BARI SP-04. These results revealed that BARI SP-12 leaves reserved average standard proximate, microelements and anti-oxidant among the studied varieties and genotype. But all varieties leaves except local genotype contained essential nutrients which may favorably well to meet micronutrient deficiency especially lean vegetable production period for poor community in Sylhet region of Bangladesh.

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INTRODUCTION

Sylhet is a topographically diversified and rains fade north eastern area of Bangladesh. People of that area usually grow vegetables in winter than summer and in this lean period they are used to depend on imported vegetables from outside of the country. Hence the people especially women and children are suffering for hidden hunger due to minimum of vitamins and minerals. Due to micronutrient deficiency a significant number of less than two children and reproductive women suffering from chronic malnutrition and anemia, respectively. About 57% poor people of Sylhet region are living in food insecurity (Kuddus et al., 2018). The stunting rate of fewer than five children is 50% where national average about 36%, and stunting prevalence at adolescent girls is 40% while national figure is 30% (BDSH, 2014). Globally about 22% and nationally 36% children are suffering with stunting (Global Nutrition Report, 2018). Suchana is a nutrition focused programme has been working in Sylhet region to reduce chronic malnutrition of under two children through nutrition specific and nutrition sensitive intervention. Sweet potato (*Ipomoea batatas* L.) is one of the most traditional root crops in many countries like Bangladesh. It is traditionally regarded as a 'poor man's crop' as it is consumed by poor households. It gives satisfactory yield under adverse climatic and soil conditions, as well as under low or non-use of external inputs (Carey et al., 1999; Kuddus et al., 2018). The sweet potato plants are mainly planted for their storage roots. During the harvesting period, 95-98% of the leaves are discarded while the remaining 2-5% is used as animal food. So that leaves may be an important and potential nutrient sources for the poor community people in lean period of summer.

The sweet potato is one of the traditional tuber crops adaptable to wide ecological range with relatively quick growing and of high yielding potential even on infertile soil (Hahn, 1984). Ifon and Bassir, 1979 showed that sweet potato leaf contained protein and crude fiber which are important for addressing protein deficiency diseases and colon diseases. Other studies also revealed that both sweet potato tuber and leaf contain micro nutrients necessary for healthy body and in addition, it also contains anti-nutrients such as phytate, oxalate and tannin (Osagie, 1998; Fleming, 1981; Udoession and Ifon, 1990). The leaves of sweet potatoes are consumed as vegetables in tropical areas, especially in Southeast Asia (Villareal et al., 1982). Because the plants grow quickly in moist conditions, these leaves can be harvested several times a year. Bangladesh is challenged by hidden food insecurity issues, like micro-nutrient deficiency among small farming households in rural areas, in which more than 43% of preschool age children are stunted and 56% are underweight (USAID Horticulture Project, 2013). Regular consumption of vegetables and fruits reduces the risk of cardiovascular diseases (Otaki et al., 2009). In vegetables and fruits, the main constituents with antioxidant properties are polyphenols, which have a beneficial effect in contributing to the prevention of these diseases. Several studies have shown that polyphenols from various foods, such as red wine, green tea, and chocolate, can reduce bad cholesterol levels (Kalkan et al., 2004). Antioxidants reduce bad cholesterol levels and stimulate the production of good cholesterol. The sweet potato is one of the top 15 agricultural crops that can be used as raw material for many industrialized products, given its composition and agricultural potential. In addition, the young leaves can be consumed (Antonio et al., 2011). Sweet potato foliar tissues are predominantly consumed in African and Asian countries, functioning as a source of protein, essential amino acids, antioxidants, vitamins, minerals, and dietary fiber (Johnson and Pace, 2010). Sweet potato foliar tissues have shown significantly higher contents of certain water soluble vitamins compared with roots (Ishida et al., 2000). It can be harvested several times a year, the annual yield of sweet potatoes is much higher than that of many other vegetables grown for the leaves.

In addition, several studies showed that orange-fleshed sweet potato, is a potential source of vitamin A (Haskell et al., 2004), minerals (Fe, Zn, Mn), and other phytonutrients such as polyphenols and carotenoids (Haskell et al., 2004). The leaves of *Ipomoea batatas* are rich sources of Fe, and could be a good leafy vegetable for pregnant women and lactating mothers. Since women generally loss some quantity of blood during monthly menstruation, it could help in nourishing their bodies (Awol., 2014). Carotenoids in particular, likewise vitamin C, vitamin E or polyphenols, have antioxidant properties (Maruf et al., 2009) and are able of scavenging free radicals generated constantly by our body. Ingested with food, these compounds strengthen our natural defense against oxidative stress and thus prevent various chronic diseases such as cancer and cardiovascular diseases (Philpott et al., 2004). The study of antioxidant capacity in *Ipomoea batatas* leaves has been limited compared to their storage roots, and up to now little research has been conducted to determine the influence of the different varieties on the antioxidant activities in the leaves of this plant. The researcher

carried out a participatory performance study on four BARI released variety (BARISP-04, BARISP-07, BARISP-08 and BARISP-13) in Suchana working area in 2016-2017 production period. From the study it was found that BARISP-04 performance is better in terms of production and community acceptability. For the current study researcher selected two new varieties (BARISP-11, BARISP-12) & a local genotype along with BARISP-04 to compare nutrient content of leaves that may use as a sources of micronutrient to poor people especially in lean vegetable production period of Sylhet region. So the aim of the study was to find out suitable and potential variety with high micronutrient content involving women members of the marginal farming households that may plays a beneficial role for child and women health in Sylhet region of Bangladesh.

MATERIALS AND METHODS

The study was carried out at two locations of Sylhet region during 2018-19 cropping season. Vines of three BARI developed sweet potato varieties viz. BARI SP-04, BARI SP-11 & BARI SP-12 were collected from Bangladesh Agricultural Research Institute, Joydebpur, Gazipur and local variety collected from the farmer of that area. Six farmers were selected from Nilgaon and Chamurakandi villages of Sylhet Sadar Upazila of Sylhet district. The collected vines were transplanted on 19 November 2018 at both locations having plot size of 10ft x 10ft with 3 replications following RCB design. Fertilizers were applied in the experimental plots @ 70-25-90 kg/ha of N-P-K as a source of Urea, TSP, and MoP, respectively. Weeding, irrigation, earthing-up, vine lifting and other intercultural operations were done as and when necessary. For micronutrient analysis 3 twigs were picked from each plot with 3 replications and by this way 216 twigs collected from 24 plots randomly. Immediate after collection samples were packed with brown paper bag and sent to the laboratory of SRDI and SAU, Sylhet.

Analytical methods

Several analyses were carried out: Total dry matter, Ash, Crude fiber, Ether extract, phenolic compounds, Tannins, Ascorbic acid, Iron and Zinc. The quantification of proximate composition was done by Association of Official Analytical Chemist (AOAC) 2000; and Fe & Zn atomic absorption spectrophotometer method (AOAC 2000, Model 200, Germany). Dry matter content was determined using oven; ash content was determined by the dry ash method in a muffle furnace by incineration of known sample (Naberthem Trade Mark, Germany at 550 °C for 6 hours as per Ranganna (1991) and crude fiber was estimated by the gravimetric method and obtained from the loss in weight on ignition of dried residue (550 °C for 6 hours) remaining after digestion of fat free with 1.25% each of sulphuric acid and sodium hydroxide solution under specific condition. Ether extract was determined by Foss Soxtech 2046 apparatus (Soxtech Extractor) using petroleum ether (b.p. 40-60 °C) with a known weight of the sample after completing boiling, rinsing and exhaustive extraction steps. Tannins were determined according to Khan and Chaudhry (2011) by the difference between total phenolics before and after mixing about 1 ml extract with 1 ml water and 0.1g polyvinyl pyrrolidone (PVP). The mixtures were vortex mixed (Whirlimix, Fison Limited), incubated at 4°C for 30 min, centrifuged for 5 min and supernatants were collected. The supernatants were centrifuged again for 3 min to remove any remaining insoluble. About 0.1 ml aliquot of each this supernatant were mixed with 0.4 ml of water, 0.25 ml of Folin-Ciocalteu reagent and 1.25 ml of sodium carbonate solutions (20%) and the absorbance of the resultant colour was read as described earlier. Total tannins were determined by subtracting the value of total phenol after using PVP from the value of total phenol before using the PVP. Tannic acid was used as a standard and the results were expressed as mg tannic acid equivalent g of sample DM.

. The Folin-Ciocalteu method was used to determine phenolic compound (Khan and Chaudhry,2010). Extracts for the Phenolic compound determination were prepared by suspending 0.125 g samples in 6.25 ml of 75% aqueous acetone in test tubes. The contents of the test tubes were mixed at 5 minutes (min) intervals for 2 h and 20 min using a vortex mixer (Whirlimix, Fison Limited). Aliquots (1 ml) of each extract were mixed with 5 ml Folin-Ciocalteu reagent in 100 ml volumetric flasks that contained 70 ml of deionised water. After waiting for up to 8 min 15 ml of Na₂CO₃ solution (20%) were added. The volumetric flasks were then made up to volume with deionized water. After standing for 2 h at room temperature, the absorbance was read at a wavelength of 760 nm in the visible range of the spectrum using a UV/VIS-spectrophotometer (Biochrom Libra, S12). The estimation of phenolic compound in extracts was carried out in duplicate for all samples.

Tanic acid was used as a standard and the results obtained were expressed as mg tanic acid equivalent per g of sample DM.

To analyze Iron, Zn about 1 g dried and ground sample was placed into a Kjeldahl tube and 20 ml pure HNO₃ were added. The sample was digested in Kjeldahl digestion chamber at 100°C and the digested sample was diluted to the original volume of 20 ml with water. The samples were filtered through Whatman filter papers no 541 and the concentrations of selected minerals were determined with inductively coupled plasma optical emission spectroscopy (ICP-OES) with Unicam 701 ICP-OES. The machine was calibrated over the relevant concentrations using individually certified standards obtained from Sigma- Aldrich, UK. Ascorbic acid was extracted by 3% metaphosphoric acid and acetic acid solution followed by titration with 2,6 Dichlorophenol Indophenol.

The data were analyzed by using the Minitab 19 software. Experimental results were expressed as the mean \pm standard Error (SE).

RESULTS AND DISCUSSION

Dry matter content

From Table 1, it's found that the dry matter content in the twigs of the sweet potato varieties ranged 15.01% to 15.77%. And the highest amount 15.77% was recorded in BARI SP-04 and the lowest 15.01% in BARI SP-11. There was no significant difference among the variety for dry matter content. The reasons for the observed differences in dry matter content due to the climate, the type of soils and genetal factors. (Woolfe., 2008) reported that the normal dry matter content was around 30%, but differs widely depending on aspects such as variety, geographic area, climate, and amount of light, soil and cultivation practices.

Ether Extract

From Table 1 the ether extract content of 3 studied varieties and one genotype was found significantly different ($p < 0.01$). The highest ether extract was found in BARI SP-11 (7.33% \pm 0.64) and the lowest in BARI SP-04 variety (3.80% \pm 0.42) followed by BARI SP-12 variety and Local genotype (6.24% \pm 0.51) & (5.21% \pm 0.48), respectively. Awol (2014) also reported that the crude fat or ether extract content of *Ipomoea batatas* leaves was 3.80% (Ishida et al., 2000). Hossain et al. (2018) reported that ether extract may vary from cultivar to cultivar (2.05% to 3.63%).

Table 1. Proximate composition of DW

OFSP Varieties ¹	Proximate Composition (%)			
	Dry matter	Ether Extract	Ash	Crude Fiber
BARI SP 04	15.77	3.80 ^d \pm 0.42	12.05 ^b \pm 0.89	17.76 ^{ab} \pm 1.04
BARI SP 11	15.01	7.33 ^a \pm 0.64	15.32 ^{ab} \pm 0.92	19.99 ^a \pm 1.06
BARI SP 12	15.22	6.24 ^b \pm 0.51	16.43 ^a \pm 1.02	17.94 ^{ab} \pm 0.94
Local	15.36	5.21 ^c \pm 0.48	15.63 ^{ab} \pm 0.75	16.73 ^b \pm 0.62
Mean	15.34	5.65	14.86	18.11
CV (%)	0.08	1.70	2.79	1.40

Means \pm SE expressed on dry matter basis of triplicate determination. Values within columns with different letters are significantly different at DMRT ($p < 0.05$)

Ash Content

From the study the ash contents in leaves of sweet potato varieties and genotypes ranged between 12.05% \pm 0.89 to 16.43% \pm 1.02 having significant difference at ($p < 0.05$) level. The highest ash content was recorded in BARI SP-12 and the lowest in BARI SP-04. Such range of ash content (7.39–14.66 mg/100 gm DW) was also recorded by Sun *et al.*

Crude fiber

From the study found that dietary crude fiber ranged from 16.73% \pm 0.62 to 19.99% \pm 1.06 among the three varieties & one genotype and that was significantly different at ($p < 0.05$) level (Table 1). The highest crude fiber (19.99% \pm 1.06) was found in BARI SP-11 and the lowest (16.73% \pm 0.62) in local genotype and almost same in BARI SP-04 & BARI SP-12. Sun *et al.* (2014) also found crude fiber content in the same range and that was 9.15 \pm 0.49 to 14.26 \pm 0.38 g/100 g DW. FAO (2001) reported 1.2%, and Ishida *et al.* (2000) reported dietary crude fiber content of the sweet potato twigs in the range between 2.28% and 11.7%. On the other hand, based on dry weight, Oboh *et al.*, 1989 found that the crude fiber content of 49 sweet potato varieties ranged between 3.45% and 6.36%, and Senanayake *et al.* (2013) found it in the range between 2.1% and 13.6% in Sri Lankan varieties. Crude fiber in the leaf sample contributed a higher percentage and makes the leaf very important because of its role in the prevention and treatment of diseases such as obesity, diabetes, cancer and gastro intestinal disorders (Saldanha, 1995).

Microelement Composition

Table 2. Microelements, Phenolic and Tannins (mg 100g⁻¹ DW)

OFSP Varieties ¹	Microelement			Phenolic compound (mg TAE 100g ⁻¹)	Tannins (mg PEGE 100g ⁻¹)
	Iron	Zinc	Ascorbic acid		
BARI SP 04	32.82 ^a \pm 4.5	2.10 ^a \pm 0.5	13.95 ^b \pm 0.3	218.75 ^b \pm 7.8	110.3 ^c \pm 3.7
BARI SP 11	19.40 ^c \pm 2.5	1.45 ^{bc} \pm 0.3	15.98 ^d \pm 0.4	252.75 ^a \pm 9.4	144.3 ^a \pm 4.8
BARI SP 12	24.67 ^b \pm 3.7	1.35 ^{bc} \pm 0.3	15.11 ^c \pm 0.4	231.50 ^b \pm 8.6	123.0 ^b \pm 4.3
Local	24.53 ^b \pm 4.1	1.27 ^c \pm 0.2	13.02 ^a \pm 0.3	257.0 ^a \pm 10.3	148.5 ^a \pm 5.1
Mean	25.36	1.54	14.52	240.00	131.53
CV (%)	23.08	0.11	1.26	243.84	243.63

Means \pm SE expressed on dry matter basis of triplicate determination. Values within columns with different letters are significantly different at DMRT ($p < 0.05$)

Table 2 gave the idea of the Iron & Zinc composition in sweet potato samples as analyzed. The Fe and Zn contents in three varieties and one genotype were significantly different ($p < 0.05$). BARI SP-04 inhabited the highest (32.82 \pm 4.5 mg 100 g⁻¹) Fe content and BARI SP-11 reserved the lowest (19.40 \pm 2.5 mg 100g⁻¹) content. Zn content was the highest in BARI SP-04 (2.1 \pm 0.5 mg 100g⁻¹) and the lowest (1.27 \pm 0.2 mg 100 g⁻¹) in the local genotype. And in BARI SP-11 and BARI SP-12 Zn content was recorded (1.5 \pm 0.3 mg 100g⁻¹) & (1.3 \pm 0.2 mg 100g⁻¹), respectively. Fe is required for hemoglobin formation and its deficiency leads to anemia (Turan *et al.*, 2003). Hossain *et al.* (2018) stated that Fe and Zn content was influenced by the genotypes and the Fe content ranged between 19.89 to 44.39 mg 100 g⁻¹ while Zn content ranged between 2.83 to 5.11 mg 100 g⁻¹ in sweet potato twigs. The Fe content of *Ipomoea batatas* leaf was found to be 7.38 \pm 0.03 mg 100g⁻¹ which is higher than 2.80 \pm 0.7 mg 100 g⁻¹ in some cultivated vegetables such as spinach (1.6 mg 100 g⁻¹) lettuce (0.7 mg 100 g⁻¹) and cabbage (0.3 mg 100g⁻¹) (Turan *et al.*, 2003).

Ascorbic acid

The result of ascorbic acid findings was also found statistically different among three studied varieties and one genotype leaves and it ranged between 13.02 ± 0.3 to 15.98 ± 0.4 mg100 g⁻¹ DW. The highest ascorbic acid was recorded in BARI SP-11 and the lowest in local genotype. Ascorbic acid contents in BARI SP-04 & BARI SP-12 were 13.95 ± 0.3 mg 100g⁻¹ & 15.11 ± 0.4 mg100 g⁻¹ in dry weight basis respectively. Hossain *et al.* (2018) reported that ascorbic acid content may also differ from variety to variety and the range was 18.04 to 10.56 mg100 g⁻¹. From the findings found that ascorbic acid content in BARI SP-04 is lowest it may due to presence of dark purple twig than other three varieties.

Phenolic compound

The phenolic content was expressed as tannic acid equivalents (mg TAE/100g). The phenolic contents in the varieties and genotype varied significantly and ranged between 257.00 ± 10.3 to 218.75 ± 7.8 mg TAE 100g⁻¹ DW. Local genotype showed the highest amount of phenolic compound in (257.00 ± 10.3 mg TAE 100g⁻¹ DW) whereas the BARI SP-04 variety had the lowest phenolic compound (218.75 ± 7.8 mgTAE 100g⁻¹mg DW). Hossain *et al.* (2018) also recorded phenolic compound 204 to 385 mg TAE 100g⁻¹ DW in different genotype of sweet potato leaves.

Tannins

The highest amount of tannins (148.5 ± 5.1 mg 100⁻¹ g DW) was recorded in local genotype followed by 144.3 ± 4.8 & 123.0 ± 4.3 mg 100⁻¹ g DW in BARI SP-11 BARI SP-12, respectively and the lowest (110.3 ± 3.7 mg 100⁻¹ g DW) was found in BARI SP-04. The tannins contents in the leaves of different varieties were reported between 278 ± 0.11 and 535 mg100g⁻¹ DW and were significantly different from each other (Hue *et al.*, 2012). The deviation in the tannin contents might be attributed to the geographical factors as well as the different cultivation methods.

Summery and Conclusion

Among the studied varieties and genotype, according to proximate and micronutrient content characters, BARI SP-12 reserved average standard proximate matters and microelements. And this variety is able to meet the Fe and Zn of young child and reproductive women in Sylhet regions. But other varieties leaves also contained essential nutrient except local genotype and can meet micronutrient deficiency during lean vegetable production period of poor community in Sylhet region of Bangladesh.

Future Research

As the result was found from one year experiment, so for becoming a concrete decision, the experiment may be proceed adding with other nutrient content and BARI released new variety.

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