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Evaluation and character association study for tuber yield, biochemical and antioxidant properties of sweet potato (*Ipomoea batatas*)

H D TALANG[1], A K JHA[2], M B DEVI[1]*, G T MAWLONG[1], KAMNI P BIAM[1], J MAWLEIN[1], H RYMBAI[1], V K VERMA[1], B LYNGDOH[1] and S HAZARIKA[1]

ICAR-Research Complex for North-Eastern Hill Region, Umiam, Meghalaya 793 103, India

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ABSTRACT

A study was carried out during 2022 and 2023 at ICAR-Research Complex for North-Eastern Hill Region, Umiam, Meghalaya to evaluate the yield, biochemical and antioxidant properties of 49 accessions of sweet potato [*Ipomoea batatas* (L.) Lam.] in mid hill condition of north-eastern region. The experiment was laid out in randomized block design (RBD) with 3 replications. Results indicate that Mynthlu Orange exhibited the highest tuber weight, length, diameter and yield. In terms of biochemical parameters, Meghalaya Local recorded the highest dry matter content; Col-6 recorded the highest starch content; and X-24 had the highest total sugar content. Among antioxidants, X-24 showed the highest total phenolic content, highest FRAP assay value and anthocyanin with lowest IC50 value which signified that X-24 had the highest antioxidant activity. Correlation study revealed significant positive correlation of tuber yield with tuber weight, diameter and total anthocyanin. Based on the mean performance, accessions Mynthlu Orange, X-24 and Col-6 were found promising for yield, biochemical and antioxidant parameters.

Keywords: Accessions, Antioxidant, Biochemical, Sweet potato, Yield

Sweet potato [*Ipomoea batatas* L. (Lam.)], rank as the sixth most significant food crop globally, following rice, wheat, potatoes, maize, and cassava (CIP 2020). They hold immense appeal for resource-constrained farmers due to their remarkable productivity despite minimal input requirements, resilience to adverse climates, and ability to thrive in low-fertility soils (Sivakumar 2003). Notably, they boast a rich nutritional profile, being abundant in carbohydrates, vitamins (A, B, and C), minerals (calcium, phosphorus, iron, and potassium), dietary fiber, energy and natural antioxidants (Tegeye *et al*. 2019, Paliwal *et al*. 2020). Particularly, orange, yellow-fleshed and purple-fleshed sweet potatoes are noted for their significant concentrations of phenolic acids, carotenoids and anthocyanins (Grace *et al*. 2014, Wang *et al*. 2016).

The north-eastern region contributes approximately 4.02% to the country's total production, yielding 64.27 thousand tonnes from an area covering 11.7 thousand hectares (Anonymous 2023). The tribal communities in the region have been cultivating and consuming sweet potato for generations, serving as a vital source of food and nutritional security. The region boasts a diverse range of sweet potato varieties, including those with yellow, white, orange, and purple flesh (Talang *et al*. 2023). However, despite the crop's significant importance in the region, comprehensive research on yield, biochemical attributes, and antioxidant properties of the local sweet potato accessions remain scarce. In light of this, we carried out a study on 49 sweet potato accessions collected from various parts of the region, focusing on yield, biochemical as well as antioxidant properties in mid hill condition of north-eastern region.

MATERIALS AND METHODS

A study was carried out during 2022 and 2023 at ICAR Research Complex for NEH Region, Umiam, Meghalaya. Forty-nine (49) sweet potato accessions (Supplementary Table 1) were examined for yield, biochemical, and antioxidant properties. Planting was done in August 2022 and harvested in second week of December 2022. Recommended cultivation practices as outlined by Verma *et al*. (2023), were followed to ensure optimal growth and yield. Fully matured tubers were used for analysis of biochemical and antioxidant properties. The experiment was laid out in randomized block design (RBD) with 3 replications. Each plot measured 6 m × 2.4 m, with spacing of 60 cm × 45 cm.

Yield parameters: Parameters such as weight of tuber, length, diameter and yield were recorded by taking the average of 100 tubers, following standard procedures.

[1]ICAR Research Complex for NEH Region, Umiam, Meghalaya; [2]ICAR-Directorate of Knowledge Management in Agriculture, Krishi Anusandhan Bhawan-I, Pusa, New Delhi. *Corresponding author email: bilashini1712@gmail.com

Dry matter content: Dry matter content of the samples was determined by oven-drying 100 g of freshly sliced tubers at 60°C, till a constant weight was attained and calculated as:

$$\text{Dry matter (\%)} = (\text{Dry weight/Fresh weight}) \times 100$$

Starch: Starch was estimated as described by Hedge and Hofreiter (1962).

Total sugar: This test was estimated according to DuBois *et al.* (1956).

Reducing sugar: This test was estimated as per the procedure described by Miller (1959).

Non-reducing sugar: It was estimated by subtracting reducing sugar from total sugar.

Ferric reducing antioxidant power (FRAP) Assay: The antioxidant capacity was determined as described by Benzie and Strain (1999).

DPPH radical scavenging assay: Free radical scavenging ability of the extracts was tested as described by Shen *et al.* (2010) and calculated as:

$$\text{Scavenging activity (\%)} = \{(\text{Abs control-Abs sample})\}/\text{Abs control} \times 100$$

IC_{50} was determined by using the scavenging activity to create a standard curve for each standard and sample from the linear equation y = ax+b.

$$IC_{50} = 50\text{-b/a}$$

Total phenolic content: The total phenolic content was determined as described by Keskin-Sasic *et al.* (2012).

Anthocyanin: Anthocyanin was estimated as described by Srivastava and Kumar (2002).

$$\text{Total anthocyanin (mg/100 g)} = (\text{Total OD/100 g})/98.2$$

Statistical analysis: The data were statistically analysed using SPSS software, version 14.0.

RESULTS AND DISCUSSION

Yield parameters: Significant variations were noted among different accessions for all the traits studied with Mynthlu Orange exhibited highest tuber weight, tuber length, tuber diameter and tuber yield (Table 1). Mary *et al.* (2022) also reported variations in yield parameters of sweet potato which they stated could be attributed to the genetic composition of the genotype. Yooyongwech *et al.* (2014) stated that variations in yield are inherent to cultivars since they are genetically determined traits. Similarly, Hayati *et al.* (2020) linked environmental and soil conditions, the source of propagation material, and the inherent characteristics of cultivars as major factors contributing to the observed variation in tuber yield.

Biochemical parameters: Significant variability was observed among different accessions of sweet potato in terms of biochemical parameters. Meghalaya Local exhibited the highest dry matter content, which was comparable to Shalinda-3, while the lowest dry matter content was found in Sree Bhadra and ST-14 (Table 2). Col-6 recorded the highest starch content, whereas Arunachal-1 showed the lowest. Maximum total sugar was recorded in X-24 which is however on par with Mynthlu Orange, reducing sugar in Sohmynting-1 and non-reducing sugar in S-5. These variations in quality parameters may be attributed to inherent differences among the accessions (Pavithra *et al.* 2023). Moreover, it is less likely that environmental effects influenced most of the quality parameters, as all accessions were cultivated under similar climate and soil conditions with uniform cultivation practices. Similar observations were reported by Yildirim *et al.* (2011) and Verma *et al.* (2023).

Antioxidant activity: Significant variations were noted among different accessions of sweet potato in terms of their antioxidant activity, as evaluated through the FRAP assay and the DPPH radical scavenging assay. X-24 (orange flesh) had the highest FRAP value and lowest IC50 value as compared to the other accessions (Fig. 1). This indicated that X-24 had the highest antioxidant activity. Tang *et al.* (2015) reported FRAP values of 70.18 ± 0.47 mmol $FeSO_4E/g$ with orange flesh sweet potato while white flesh sweet potato recorded a FRAP value of 61.86 ± 1.26 mmol $FeSO_4E/g$. Additionally, sweet potato demonstrated outstanding antioxidant activities surpassing those of other leafy vegetables, as reported by Truong *et al.* (2007), Gunathilake and Ranaweera (2016) and Comert *et al.* (2020).

Total phenolic content: Fig. 1 illustrates significant variations in total phenolic content among different sweet potato accessions, with X-24 recorded highest value. Similar findings were reported by Roy *et al.* (2012), who observed variation in phenolic content among sweet potato accessions. Shan *et al.* (2005) suggested that factors such as the plant part tested, maturity period, presence of diseases and pests, climate, location, soil fertility, and temperature could contribute to this significant variation in phenolic content. Moreover, the presence of different phenolic compounds in plant extracts may contribute to the variation in total phenolic content (Rajurkar and Hande 2011).

Total anthocyanin: X-24 recorded maximum anthocyanin content and Mizo-2 the minimum (Fig. 1). These variations in total anthocyanin content may be attributed to differences in flesh colour among the accessions. Rahman *et al.* (2023) reported that the anthocyanin content of sweet potato depends on the colour intensity of the tuber with purple colour sweet potato tubers exhibited the highest anthocyanin followed by orange, white and yellow colour. Similarly, Kim *et al*. (2011) and Chen *et al*. (2018) reported that orange-fleshed sweet potatoes contain higher total anthocyanin content followed by white and yellow colour tubers.

Correlation analysis: Results revealed that weight of tuber had the highest positive and significant correlation with tuber yield (r^2 = 0.716) and diameter of tuber (r^2 = 0.656) at P<0.01 (Table 3). Similar finding was reported by Islam *et al*. (2002) in potatoes. Felenji *et al*. (2011) stated that cultivars with more tuber weight have higher yield. Length of tuber had significant positive correlation with dry matter (r^2 = 0.345) and reducing sugar (r^2 = 0.303) at P<0.05 but significant negative correlation with non-reducing sugar (r^2 = -0.369) at P<0.01. Diameter of tuber had the highest

Table 1 Yield parameters of sweet potato accessions

Genotype	Weight of tuber (g)	Length (mm)	Width (mm)	Yield (t/ha)
Shalinda-3	158.50±2.12^{fgh}	166.58±3.12^{abc}	35.31±2.15^{hijklm}	17.84±0.19^{pq}
Nongrim Nongladaw	117.33±7.51^{klmnop}	179.16±0.87^{a}	22.39±1.46^{no}	20.50±0.22^{lm}
Col-6	91.67±7.64^{qrst}	149.20±5.19^{cdefghijk}	26.29±2.70^{mno}	16.30±0.13^{rs}
Meghalaya Local	94.67±5.03^{opqrs}	176.88±6.05^{ab}	34.83±2.07^{hijklm}	13.15±0.13^{uv}
TSP 12-6	173.67±4.16^{cdef}	112.34±6.95^{qrstu}	59.98±1.81^{ab}	24.84±0.06^{fg}
Lumsohpieng Orange	250.63±3.87^{a}	127.57±4.56^{lmnopqrs}	49.69±2.69^{bcde}	25.67±0.71^{ef}
Sohmynting-1	119.33±5.51^{klmn}	153.29±3.40^{cdefghi}	31.73±2.32^{jklmn}	18.75±0.26^{nop}
Shalinda-2	169.91±4.62^{defg}	132.54±3.24^{jklmnop}	44.38±3.77^{cdefghi}	23.09±0.33^{hij}
Shalinda-1	171.33±6.35^{cdefg}	146.98±3.41^{defghijkl}	53.31±3.75^{abc}	14.76±0.10^{t}
Shilliang Myntang	145.00±4.62^{hi}	157.07±0.81^{bcdefgh}	26.23±3.02^{mno}	22.25±0.25^{ij}
Sel-7	119.73±6.51^{jklmn}	167.81±7.62^{abc}	30.11±2.12^{klmn}	11.75±0.08^{w}
Mizo-5	96.12±1.12^{nopqrs}	141.11±7.18^{fghijklm}	25.80±2.91^{mno}	14.20±0.02^{tu}
Mawtneng-1	128.57±3.02^{ijkl}	138.04±4.93^{ghijklmno}	26.24±5.20^{mno}	23.79±0.28^{gh}
HDT-2	189.84±12.77^{bcde}	96.40±5.89^{uv}	49.89±4.15^{bcde}	26.45±0.49^{de}
Bhoi-1	84.64±2.83^{qrst}	153.15±6.18^{cdefghi}	43.77±4.97^{cdefghij}	18.75±0.22^{nop}
Mizo-1	79.33±5.13^{rst}	137.37±5.83^{hijklmno}	26.42±3.87^{mno}	16.16±0.12^{rs}
Mawtneng-3	117.67±7.02^{klmno}	160.80±3.99^{abcdef}	30.88±2.22^{klmn}	19.59±0.19^{mn}
Col-1	97.33±4.62^{mnopqrs}	132.12±6.36^{jklmnopq}	29.13±2.78^{klmno}	16.16±0.26^{rs}
Sel-2	92.75±1.31^{qrst}	109.88±5.14^{stu}	25.90±0.78^{mno}	14.55±0.02^{t}
S-3	193.00±7.55^{bcde}	161.34±5.75^{abcde}	39.94±4.13^{efghijkl}	27.50±0.36^{cd}
Arunachal-1	104.67±8.08^{lmnopq}	157.38±5.37^{bcdefg}	36.30±3.83^{hijklm}	15.25±0.15st
Bhoi-3	132.67±6.81^{ijk}	111.88±5.84^{rstu}	37.29±4.82^{fghijklm}	22.25±0.31^{ij}
S-2	97.89±1.87^{mnopqrs}	150.18±4.55^{cdefghij}	26.87±3.94^{mno}	20.50±0.22^{lm}
S-5	143.33±7.64^{hij}	138.46±7.64^{ghijklmn}	38.01±3.60^{efghijklm}	18.75±0.18^{nop}
Mawtneng-2	69.71±5.03^{t}	146.03±8.06^{defghijklm}	26.16±2.77^{mno}	14.20±0.17^{tu}
S-6	93.62±5.78^{pqrst}	155.45±1.40^{cdefghi}	29.14±1.99^{klmno}	17.00±0.03^{qr}
Mizo-2	98.16±3.19^{mnopqrs}	131.48±2.41^{jklmnopqr}	30.16±3.83^{klmn}	22.25±0.25^{ij}
Gauri	74.68±1.11st	137.20±5.00^{hijklmno}	31.70±3.72^{jklmn}	18.96±0.27^{nop}
Col-2	92.16±0.99^{qrst}	115.93±10.58^{pqrstu}	17.51±1.63^{o}	12.66±0.07^{vw}
Sohmynting-2	94.86±5.88^{opqrs}	136.10±5.24^{ijklmno}	26.64±3.70^{mno}	18.75±0.19^{nop}
Mawtneng-4	91.86±7.18^{qrst}	149.89±5.00^{cdefghij}	26.18±2.91^{mno}	19.08±0.62^{no}
Sel-4	96.07±0.88^{nopqrs}	104.56±4.79^{tu}	36.38±3.9^{ghijklm}	14.76±0.20^{t}
Kokrajhar Red	194.33±6.03^{bc}	146.20±8.18^{defghijklm}	35.44±4.59^{hijklm}	30.09±0.08^{b}
Lumsohpieng Red	193.49±6.06^{bcd}	143.19±3.43^{efghijklm}	41.22±5.26^{cdefghijk}	22.60±0.26^{ij}
Lumdiengan	98.32±0.72^{mnopqrs}	142.29±2.69^{efghijklm}	32.16±2.60^{ijklmn}	18.05±0.24^{opq}
Mawthei	99.20±1.82^{mnopqr}	118.52±5.08^{opqrst}	49.95±2.68^{bcde}	21.00±0.88^{kl}
Mynthlu Orange	266.67±14.43^{a}	180.43±1.76^{a}	63.35±2.89^{a}	34.95±0.57^{a}
X-24	148.33±2.89^{ghi}	179.46±1.05^{a}	44.51±3.25^{cdefgh}	24.75±0.61^{fg}
Sree Bhadra	107.13±0.88^{lmnopq}	82.51±1.25^{v}	37.19±1.89^{fghijklm}	21.00±0.30^{kl}
ST-14	104.20±5.29^{mnopq}	129.87±4.01^{klmnopqr}	48.79±5.95^{bcdef}	22.04±0.05^{jk}
Umroi-1	97.74±2.54^{mnopqrs}	126.52±5.01^{mnopqrs}	27.86±3.24^{lmno}	22.25±0.25^{ij}
Umroi-2	169.33±5.13^{efg}	127.94±3.79^{lmnopqrs}	40.71±2.87^{defghijk}	23.79±0.41^{gh}
FGSP 12-12	158.89±6.59^{fgh}	120.50±8.27^{nopqrst}	36.02±5.29^{hijklm}	24.00±0.36^{gh}
TSP 12-4	194.33±6.03^{bc}	158.41±7.25^{bcdef}	52.85±7.84^{abcd}	23.30±0.56^{hi}
TSP 12-5	120.67±7.51^{jklm}	142.88±4.22^{efghijklm}	29.36±5.21^{klmno}	27.50±0.07^{cd}
TSP 12-7	189.67±10.02^{bcde}	128.00±6.31^{lmnopqrs}	39.97±2.26^{efghijkl}	17.84±0.16^{pq}
TSP 12-9	190.00±13.23^{bcde}	163.63±13.79^{abcd}	34.75±3.04^{hijklm}	25.88±0.24^{ef}
TSP 12-11	200.00±25.00^{b}	119.71±9.66^{nopqrst}	48.62±3.17^{bcdefg}	28.00±0.71^{c}
TSP 12-12	208.33±7.40^{b}	129.58±9.46^{klmnopqrs}	32.62±3.86^{hijklmn}	24.50±0.51^{g}

Table 2 Biochemical parameters of sweet potato accessions

Genotype	Dry matter (%)	Total starch (%)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)
Shalinda-3	37.23 ± 0.19^{a}	22.53 ± 0.06^{ef}	5.85 ± 0.01^{gh}	1.57 ± 0.03^{hijk}	4.28 ± 0.04^{fgh}
Nongrim Nongladaw	37.00 ± 0.12^{ab}	19.04 ± 0.37^{klm}	5.86 ± 0.02^{fgh}	1.78 ± 0.07^{def}	4.08 ± 0.06^{jklm}
Col-6	32.99 ± 0.56^{fghijk}	25.71 ± 0.09^{a}	5.69 ± 0.02^{lm}	1.74 ± 0.07^{efg}	3.95 ± 0.06^{lmnopq}
Meghalaya Local	37.49 ± 0.03^{a}	19.17 ± 0.04^{klm}	5.18 ± 0.03^{u}	1.80 ± 0.06^{cde}	3.38 ± 0.07^{y}
TSP 12-6	30.45 ± 0.34^{lmnopq}	17.59 ± 0.57^{pq}	5.45 ± 0.01^{qr}	1.59 ± 0.03^{hijk}	3.86 ± 0.04^{pqrst}
Lumsohpieng Orange	36.47 ± 0.90^{abc}	22.78 ± 0.03^{def}	5.77 ± 0.01^{j}	1.14 ± 0.02^{qrst}	4.63 ± 0.02^{bc}
Sohmynting-1	31.67 ± 0.60^{ijkl}	15.20 ± 0.15^{vw}	5.78 ± 0.00^{ij}	2.39 ± 0.03^{a}	3.39 ± 0.03^{y}
Shalinda-2	35.62 ± 0.44^{abcde}	23.69 ± 0.12^{bc}	5.10 ± 0.00^{v}	1.51 ± 0.03^{ijkl}	3.59 ± 0.03^{wx}
Shalinda-1	31.98 ± 0.47^{hijkl}	22.46 ± 0.45^{efg}	4.64 ± 0.01^{z}	1.16 ± 0.03^{qrs}	3.48 ± 0.03^{xy}
Shilliang Myntang	37.12 ± 1.12^{a}	22.05 ± 0.02^{fghi}	5.90 ± 0.02^{de}	1.28 ± 0.03^{opq}	4.62 ± 0.05^{bc}
Sel-7	36.76 ± 0.02^{ab}	15.23 ± 0.03^{vw}	5.55 ± 0.00^{p}	1.28 ± 0.03^{opq}	4.27 ± 0.03^{fgh}
Mizo-5	28.71 ± 0.36^{opqr}	16.59 ± 0.05^{rst}	5.43 ± 0.02^{r}	1.59 ± 0.03^{hijk}	3.84 ± 0.04^{qrst}
Mawtneng-1	28.47 ± 0.93^{qr}	21.39 ± 0.24^{ij}	5.62 ± 0.01^{no}	1.59 ± 0.07^{hijk}	4.03 ± 0.06^{klmn}
HDT-2	30.99 ± 0.95^{klmn}	15.44 ± 0.03^{uvw}	5.90 ± 0.01^{def}	1.26 ± 0.03^{pq}	4.64 ± 0.03^{ab}
Bhoi-1	32.46 ± 1.05^{ghijkl}	15.36 ± 0.18^{vw}	5.85 ± 0.03^{gh}	1.45 ± 0.03^{klmn}	4.40 ± 0.02^{def}
Mizo-1	35.85 ± 0.46^{abcde}	17.73 ± 0.55^{opq}	6.03 ± 0.01^{b}	2.25 ± 0.01^{a}	3.78 ± 0.02^{stu}
Mawtneng-3	33.51 ± 0.53^{fghi}	23.48 ± 0.31^{cd}	5.06 ± 0.01^{w}	1.65 ± 0.03^{fghi}	3.41 ± 0.04^{y}
Col-1	29.03 ± 0.76^{nopqr}	25.18 ± 0.08^{a}	5.68 ± 0.00^{m}	1.45 ± 0.03^{klmn}	4.23 ± 0.03^{ghi}
Sel-2	33.24 ± 0.57^{fghij}	17.39 ± 0.06^{pq}	5.78 ± 0.01^{ij}	1.16 ± 0.03^{qrs}	4.62 ± 0.04^{bc}
S-3	35.83 ± 0.68^{abcde}	16.24 ± 0.21^{st}	5.68 ± 0.02^{m}	1.59 ± 0.03^{hijk}	4.09 ± 0.02^{jkl}
Arunachal-1	30.70 ± 0.88^{lmno}	14.96 ± 0.01^{w}	5.73 ± 0.03^{kl}	1.37 ± 0.07^{mnop}	4.36 ± 0.04^{defg}
Bhoi-3	33.91 ± 0.25^{efgh}	16.21 ± 0.09^{st}	5.65 ± 0.01^{mn}	1.59 ± 0.03^{hijk}	4.06 ± 0.04^{jklm}
S-2	35.79 ± 0.33^{abcde}	15.45 ± 0.08^{uvw}	5.31 ± 0.01^{t}	1.41 ± 0.03^{lmno}	3.90 ± 0.04^{nopqrs}
S-5	36.28 ± 1.11^{abc}	17.04 ± 0.09^{qr}	5.91 ± 0.02^{cde}	1.14 ± 0.03^{qrst}	4.77 ± 0.04^{a}
Mawtneng-2	32.51 ± 0.36^{ghijkl}	16.14 ± 0.14^{stu}	5.48 ± 0.01^{q}	1.41 ± 0.03^{lmno}	4.07 ± 0.04^{jklm}
S-6	34.15 ± 0.93^{defg}	15.38 ± 0.02^{vw}	5.61 ± 0.01^{o}	1.51 ± 0.03^{ijkl}	4.10 ± 0.04^{ijk}
Mizo-2	33.18 ± 0.93^{fghij}	15.41 ± 0.14^{uvw}	5.78 ± 0.02^{ij}	1.51 ± 0.03^{ijkl}	4.27 ± 0.04^{fgh}
Gauri	29.29 ± 0.32^{mnopqr}	19.10 ± 0.06^{klm}	5.93 ± 0.02^{cd}	1.63 ± 0.03^{ghij}	4.30 ± 0.04^{efgh}
Col-2	30.60 ± 0.01^{lmnop}	22.61 ± 0.13^{ef}	5.82 ± 0.01^{hi}	1.35 ± 0.04^{nop}	4.47 ± 0.03^{d}
Sohmynting-2	33.34 ± 0.06^{fghi}	16.34 ± 0.04^{rst}	5.59 ± 0.02^{op}	1.57 ± 0.03^{hijk}	4.02 ± 0.02^{klmn}
Mawtneng-4	28.57 ± 0.59^{pqr}	19.10 ± 0.10^{klm}	5.79 ± 0.01^{ij}	1.35 ± 0.04^{nop}	4.44 ± 0.03^{de}
Sel-4	29.00 ± 0.02^{nopqr}	24.41 ± 0.07^{b}	5.76 ± 0.02^{jk}	1.26 ± 0.03^{pq}	4.50 ± 0.04^{cd}
Kokrajhar Red	28.98 ± 0.11^{nopqr}	21.48 ± 0.04^{hi}	4.81 ± 0.01^{y}	1.05 ± 0.02^{st}	3.76 ± 0.03^{tuv}
Lumsohpieng Red	33.88 ± 0.59^{efgh}	22.95 ± 0.01^{cde}	4.96 ± 0.01^{x}	1.00 ± 0.01^{t}	3.95 ± 0.01^{lmnopq}
Lumdiengan	32.03 ± 0.47^{hijkl}	22.94 ± 0.03^{cde}	5.38 ± 0.01^{s}	1.76 ± 0.08^{efg}	3.62 ± 0.07^{vw}
Mawthei	27.53 ± 0.45^{rs}	18.75 ± 0.05^{lmn}	5.87 ± 0.01^{efg}	1.20 ± 0.03^{qr}	4.67 ± 0.04^{ab}
Mynthlu Orange	34.48 ± 0.62^{cdefg}	21.76 ± 0.64^{ghi}	6.01 ± 0.01^{b}	2.32 ± 0.04^{a}	3.69 ± 0.03^{uvw}
X-24	25.88 ± 0.55^{st}	18.01 ± 0.11^{nop}	6.12 ± 0.00^{a}	2.28 ± 0.03^{a}	3.84 ± 0.03^{qrst}
Sree Bhadra	24.63 ± 0.06^{t}	15.84 ± 0.16^{tuv}	5.95 ± 0.01^{c}	1.94 ± 0.07^{bc}	4.01 ± 0.06^{klmno}
ST-14	24.63 ± 0.44^{t}	16.62 ± 0.07^{rs}	6.01 ± 0.01^{b}	2.02 ± 0.02^{b}	3.99 ± 0.02^{klmnop}
Umroi-1	34.93 ± 0.57^{bcdef}	18.59 ± 0.20^{mn}	5.02 ± 0.01^{w}	1.08 ± 0.03^{rst}	3.94 ± 0.04^{mnopqr}
Umroi-2	36.08 ± 0.86^{abcd}	16.62 ± 0.05^{rs}	5.31 ± 0.02^{t}	1.20 ± 0.03^{qr}	4.11 ± 0.04^{ijk}
FGSP 12-12	34.65 ± 1.11^{cdef}	20.64 ± 0.07^{j}	5.46 ± 0.01^{qr}	1.65 ± 0.08^{fgh}	3.81 ± 0.08^{rstu}
TSP 12-4	28.52 ± 0.41^{pqr}	18.44 ± 0.06^{mno}	5.78 ± 0.03^{j}	1.90 ± 0.03^{bcd}	3.88 ± 0.06^{opqrst}
TSP 12-5	31.45 ± 0.32^{ijkl}	19.72 ± 0.22^{k}	5.67 ± 0.01^{m}	1.50 ± 0.00^{jklm}	4.17 ± 0.01^{hij}
TSP 12-7	30.68 ± 0.21^{lmno}	22.20 ± 0.08^{efgh}	5.79 ± 0.00^{ij}	1.04 ± 0.03^{st}	4.75 ± 0.03^{ab}
TSP 12-9	31.66 ± 0.34^{ijkl}	19.42 ± 0.41^{kl}	5.05 ± 0.01^{w}	1.86 ± 0.06^{cde}	3.19 ± 0.06^{z}
TSP 12-11	31.21 ± 0.98^{jklm}	16.31 ± 0.23^{rst}	5.79 ± 0.00^{ij}	1.84 ± 0.03^{cde}	3.95 ± 0.03^{lmnopq}
TSP 12-12	31.93 ± 0.71^{hijkl}	20.71 ± 0.56^{j}	5.86 ± 0.01^{fgh}	1.76 ± 0.03^{defg}	4.10 ± 0.04^{ijk}

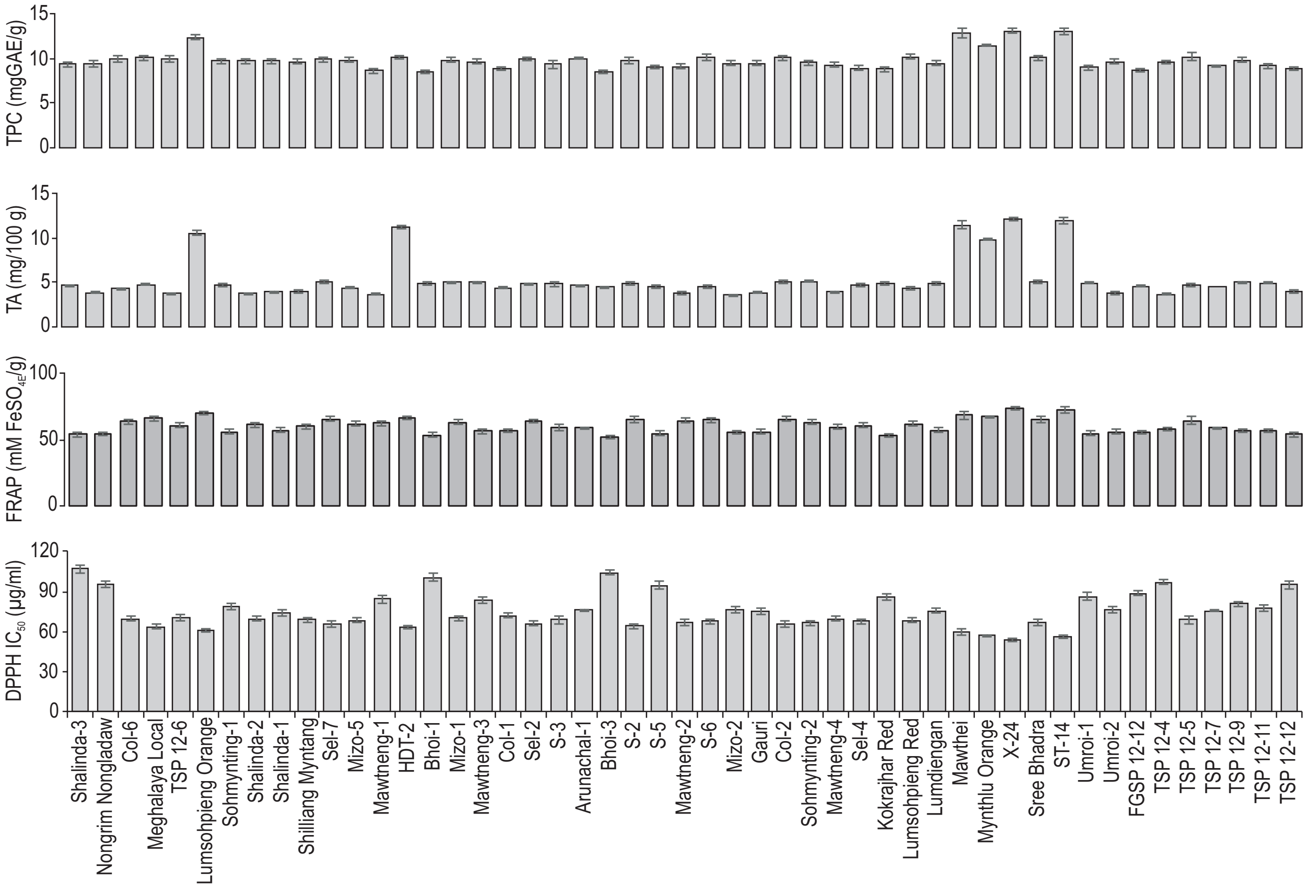

Fig. 1 Antioxidant properties of the sweet potato accessions.

positive significant correlation with tuber weight (r^2 = 0.656) followed by yield (r^2 = 0.518), total anthocyanin (r^2 = 0.484) and total phenolic content (r^2 = 0.409) at P<0.01. Yield had significant correlation with weight (r^2 = 0.716), diameter of tuber (r^2 = 0.518) at P<0.01 and total anthocyanin (r^2 = 0.326) at P<0.05 while no significant correlation was observed with other variables. Dry matter had significant positive correlation with length of tuber (r^2 = 0.345) and negative correlation with total anthocyanin (r^2 = -0.295) at P<0.05. Starch is found to be non-significant with all other traits. Total sugar had the highest significant positive correlation with non-reducing sugar (r^2 = 0.556) followed by reducing sugar (r^2 = 0.376) at P<0.01 and total anthocyanin (r^2 = 0.356) at P<0.05. Reducing sugar had the highest positive significant correlation with total sugar (r^2=0.376, P<0.01) and length of tuber (r^2=0.303, P<0.05) and significant negative correlation with non-reducing sugar (r^2 = -0.560, P<0.01). Non-reducing sugar had significant negative correlation with length of tuber (r^2=-0.369) at P<0.01. Similar finding were also reported by Islam *et al*. (2002) in potatoes. This may be attributed to the inter-conversion between the starch and sugar content in the tubers (Verma *et al.* 2023).

With regards to antioxidants parameters, total phenolic content exhibited the highest positive significant correlation with total anthocyanin (r^2 = 0.842, P<0.01) and FRAP (r^2 = 0.801, P<0.01). However, a significant negative correlation was found between total phenolic content and DPPH (r^2 = -0.654, P<0.01). FRAP had significant positive correlation with anthocyanin (r^2 = 0.674), but negative correlation with DPPH (r^2 = -0.845) at P<0.01. A significant negative correlation was observed between DPPH and anthocyanin (r^2 = -0.498, P<0.01). Makori *et al.* (2020) also reported a similar positive correlation between total phenolic content and FRAP (r^2 = 0.535, P<0.001). Previous studies have likewise reported a positive correlation between antioxidant activity and both phenolic and anthocyanin content in sweet potato (Cui *et al*. 2011, Gan *et al*. 2012). This positive correlation underscores the significant role of polyphenols in plant extracts in their antioxidant activity (Kiselova *et al*. 2006), which serves as a useful indicator of the antioxidant properties of sweet potatoes (Khurnpoon and Rungnoi 2012).

The study unveiled notable variations in yield, biochemical, and antioxidant properties among the sweet potato accessions collected from the north-eastern region. Based on the mean performance, accession Mynthlu Orange, X-24 and Col-6 was found promising for yield, biochemical and antioxidant parameters. Considering the limited research on the above aspects, these findings hold potential for further enhancements in the yield and quality of sweet potato.

Table 3 Correlation among the yield, biochemical and antioxidant parameters of sweet potato

	Weight (g)	Length (mm)	Diameter (mm)	Dry matter (%)	Starch (%)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	FRAP (mmol $FeSO_4E$/g)	DPPH IC_{50} (µg/ml)	Total phenolic content (mg GAE/g)	Total anthocyanin (mg/100 g)	Yield (t/ha)
Weight (g)	1.000^{**}	0.071^{NS}	0.656^{**}	0.150^{NS}	0.224^{NS}	-0.107^{NS}	-0.003^{NS}	-0.094^{NS}	-0.049^{NS}	0.084^{NS}	0.141^{NS}	0.239^{NS}	0.716^{**}
Length (mm)		1.000^{**}	-0.080^{NS}	0.345^{*}	0.050^{NS}	-0.109^{NS}	0.303^{*}	-0.369^{**}	-0.007^{NS}	0.079^{NS}	0.102^{NS}	-0.042^{NS}	0.001^{NS}
Diameter (mm)			1.000^{**}	-0.173^{NS}	-0.018^{NS}	0.016^{NS}	0.104^{NS}	-0.079^{NS}	0.166^{NS}	-0.113^{NS}	0.409^{**}	0.484^{**}	0.518^{**}
Dry matter (%)				1.000^{**}	0.036^{NS}	-0.216^{NS}	-0.183^{NS}	-0.029^{NS}	-0.243^{NS}	0.227^{NS}	-0.266^{NS}	-0.295^{*}	-0.056^{NS}
Starch (%)					1.000^{**}	-0.240^{NS}	-0.156^{NS}	-0.075^{NS}	-0.068^{NS}	0.020^{NS}	-0.038^{NS}	-0.077^{NS}	0.009^{NS}
Total sugar (%)						1.000^{**}	0.376^{**}	0.556^{**}	0.278^{NS}	-0.092^{NS}	0.278^{NS}	0.356^{*}	0.025^{NS}
Reducing sugar (%)							1.000^{**}	-0.560^{**}	0.161^{NS}	-0.050^{NS}	0.243^{NS}	0.185^{NS}	0.193^{NS}
Non-reducing sugar (%)								1.000^{**}	0.104^{NS}	-0.037^{NS}	0.030^{NS}	0.152^{NS}	-0.152^{NS}
FRAP (mmol $FeSO_4E$/g)									1.000^{**}	-0.845^{**}	0.801^{**}	0.674^{**}	-0.026^{NS}
DPPH IC50 (µg/ml)										1.000^{**}	-0.654^{**}	-0.498^{**}	0.044^{NS}
Total phenolic content (mg GAE/g)											1.000^{**}	0.842^{**}	0.177^{NS}
Total anthocyanin (mg/100 g)												1.000^{**}	0.326^{*}

*, Significant at 5%; **, Significant at 1%; NS, Non-significant.

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