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RESEARCH ARTICLE

Preliminary Characterization of Wild *Actinidia Callosa* Var. *Strigillosa* as Potential Genetic Resources from North Sikkim, India

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Abstract

A preliminary morpho-biochemical characterisation of fruit sampled from 81 wild kiwifruit (*Actinidia callosa* var. *strigillosa*) female vines distributed across the Lachung and Lachen territorial regions of North Sikkim district of Sikkim in Northeast India during 2021-2023 resulted in the identification of nine promising female accessions as potential genetic resources. Among these, SKNLC-18 and SKNLC-14 recorded the highest fruit weight, while SKNFF-05 and SKNLA-16 exhibited the highest vitamin C content, SKNLA-15 and SKNLC-16 resulted in the highest sugar: acid ratio, SKNZM-09 and SKNLC-10 produced the highest yield per vine, whereas SKNFF-07 exhibited greenish-yellow flesh colour. Sensory evaluation (9-point hedonic scale) of these nine superior accessions together revealed the highest overall acceptability in SKNLC-18 and SKNLA-16. The present preliminary assessment identified these nine accessions as promising plant genetic resources (PGRs) for breeding cold-hardy kiwifruit cultivars and expanding cultivation in the high-altitude Himalayan region.

Keywords: *Actinidia callosa* var. *strigillosa*, Cold-hardy, Genetic resources, North Sikkim, Vitamin C

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Introduction

Kiwifruit (*Actinidia* spp.), a deciduous vine of the family *Actinidiaceae* and genus *Actinidia*, is predominantly cultivated in major kiwifruit-producing regions such as New Zealand, Chile, and China (Lee *et al.,* 2020). It is well known for its high vitamin C content and natural laxative properties, making it a nutritious and effective fruit for relieving constipation in people of all ages (Nishiyama *et al.*, 2004; Kim *et al.,* 2011). It is an excellent natural source of dietary folate (Vitamin B9), containing approximately 31-38 µg per 100 g of fresh fruit (Richardson *et al.*, 2018). Before the late 1990s, kiwifruit cultivation was largely focused on the New Zealand origin 'Hayward' cultivar (*A. deliciosa*), known for its green flesh and commercial reliability (Kwack *et al.*, 2010). The kiwifruit cultivars 'Hayward' and 'Allison' (*A. deliciosa*), introduced to India in the early 1960s, perform well between 300 and 2000 m above mean sea level (AMSL) in the Indian Himalayan region. However, their subtropical origin limits cultivation above 2000 m AMSL, where harsh winter conditions lead to leaf wilting, flower and fruit drop, delayed phenology, reduced fruit quality, and frequent vine mortality (Joshi, 1998; Jhalegar *et al.*, 2011). In addition, the high acidity of 'Hayward' and difficulties associated with uniform ripening under household conditions have reduced its consumer acceptability in recent years (Wi *et al.*, 2019; Kwack *et al.*, 2022). Of the 56 recognized species within the genus *Actinidia*, 52 are native to China (Henare, 2016), while India harbours three species, *viz. A. callosa*, *A. strigosa* (Mao & Dash, 2020) and *A. indica*, a recent documentation from Arunachal Pradesh in Northeast India (Maity *et al.*, 2026). Among these, *A. callosa* is particularly noteworthy due to its strong frost tolerance and cold-hardy traits (Padhan *et al.*, 2023), making it a valuable genetic resource for the introgression of cold tolerance into *A. deliciosa* through interspecific hybridization (Arora, 2014). Recent explorations in the forested regions of North Sikkim, India, have for the first time in the country, documented the natural occurrence of *A. callosa* var. *strigillosa* C.F. Liang, with female wild kiwifruit selections thriving at elevations of 2441-2843 m AMSL, underscoring their value as cold-hardy genetic resources for expanding kiwifruit cultivation and breeding in high-altitude Himalayan environments (Padhan *et al.*, 2023; Padhan & Thakur, 2025a).

Since the early 20th century, kiwifruit breeding programmes have primarily focused on improving fruit weight, vitamin C content, sweetness, yield potential, and flesh colour. With the development of numerous new cultivars, consumer preferences, particularly among younger populations, have shifted toward hairless, sweeter fruits with diverse flesh colours (Latocha & Krupa, 2007). Nowadays, growers too are increasingly adopting fruit cultivars with intense skin and flesh colour to receive greater consumer preference and higher market value (Kumar *et al.*, 2026). The cultivars, *viz.* 'Tsechelidis', 'Hayward', and 'Jinyan' (JY) are among the kiwifruit varieties routinely selected for their consistently larger fruit size in commercial production and breeding initiatives (Zhong *et al.*, 2011). Considering vitamin C as a key selection criterion, *A. kolomikta* ranks as the species with the greatest ascorbic acid accumulation, while among widely cultivated germplasm, the *A. chinensis* cultivar 'Zespri Sun Gold' is distinguished for its comparatively high vitamin C concentration (Latocha, 2017). Evidence from multiple research reports demonstrates that yellow-fleshed and certain red-fleshed *A. chinensis* var. *chinensis* genotypes consistently show higher TSS and overall sugar accumulation compared with traditional green-fleshed *A. deliciosa* cultivars such as 'Hayward' (Zhang *et al.*, 2020). For enhanced yield potential, the principal parental resources comprise the commercially dominant cultivar 'Hayward', advanced high-yielding germplasm such as 'Zesy002' (Zespri Sun Gold), and diverse wild *Actinidia* taxa (Feng & Huang, 2025). Traditionally, the green-fleshed cultivar *A. deliciosa* 'Hayward' has served as the predominant female parent in kiwifruit breeding programmes. In contrast, the development of yellow-fleshed cultivars has primarily utilised elite *A. chinensis* var. *chinensis* germplasms, *viz.* 'Hort-16A' (Zespri Gold), 'Gold3' (Zespri Sun Gold), 'Jintao' (Jin gold), 'Jinyan', and 'Jinshi 1' as key female progenitors. For the breeding of red-fleshed kiwifruit, cultivars including 'Hongyang', 'Donghong' (Oriental Red), and 'Zespri Ruby Red' have been widely adopted as principal parental lines due to their stable red pigmentation, high anthocyanin concentration, and favourable horticultural performance (Liu *et al.*, 2017). By strategically crossing these parental lines, breeders can introgress complementary traits, including yield potential, flavour quality, disease resistance, and distinct flesh-colour phenotypes to generate novel, commercially attractive kiwifruit cultivars (Hanley, 2018).

Under prolonged evolutionary pressures and natural selection, *Actinidia* species have developed extensive phenotypic and genetic diversity both within and among species, enabling them to adapt and survive across diverse environments. Leveraging this extensive genetic diversity, kiwifruit breeding programs worldwide have developed a wide range of improved cultivars (Lee *et al.*, 2020). The wild kiwifruit (*A. callosa* var. *strigillosa*) populations of North Sikkim exhibit substantial genetic diversity. Based on key fruit-quality attributes for table purposes, viz. TSS and Total sugars, six superior female accessions have been identified (Padhan & Thakur, 2025a), along with two promising male accessions selected for their superior pollinating traits, *viz.* higher average stamens count and longer flowering duration (Padhan & Thakur, 2025b).

Although the mid-hill regions (500-2000 m AMSL) of the Indian Himalayan states offer favourable agroclimatic conditions for the cultivation of kiwifruit (*A. deliciosa*), there remains a considerable scope for expanding its cultivation into higher altitude areas (2000-3000 m AMSL). Diversification in existing varieties by bringing wild and underutilized species into commercial cultivation may help in increasing the total kiwifruit production to meet the growing consumer demand and reduce imports. These naturally evolved populations possess several desirable traits, including variation in fruit size, flesh colour, sugar-acid balance, ascorbic acid content and may serve as potential rootstocks to improve cold and drought tolerance in commercial *Actinidia* spp. Despite their potential importance as genetic resources and rootstocks, limited efforts have been made to systematically explore and characterize the superior wild kiwifruit accessions.

Therefore, the present investigation was undertaken to assess the nature and magnitude of morpho-biochemical variability among the wild kiwifruit populations growing in their natural habitats and to select and conserve superior accessions possessing horticulturally desirable traits, *viz.* fruit size, flesh colour, sugar-acid balance, ascorbic acid content and vine yield, which may be utilized as parental breeding lines for future crossing and hybridisation programmes.

Materials and Methods

Study location

The present study was carried out during 2021-2023 in the Lachung and Lachen valleys of the North Sikkim district of the Northeastern Himalayan state of Sikkim, India. According to the Koppen-Geiger climatic classification, the study area comprises a warm temperate climate (Cfb) in Lachen, gradually transitioning to a sub-alpine climate (ET) in Lachung. A preliminary survey identified 81 female vines of wild kiwifruit (*Actinidia callosa* var. *strigillosa*) distributed across 15 locations. Of these, eight sub-locations in the Lachung region, *viz.* Katao Road (LA1), Sarchowk (LA2), Shanti Nagar (LA3), New Cutting Road (LA4), Lanka (LA5), Fakha Farey (FF), Bitchu (BC), and Teeling (TL) and seven sub-locations in the Lachen region, *viz.* Check Post (LC1), Hotel Panghen Metok (LC2), Puchi (LC3), Near Chaten (LC4), Zemu Chu Bridge (LC5), Chaten (CH), and Zeema (ZM), were included for morpho-biochemical evaluation (Fig. 1). Based on field observations and preliminary assessment, nine superior accessions were selected from five sub-locations, *viz.* Shanti Nagar (LA3) and Fakha Farey (FF) in the Lachung region, and Puchi (LC3), Zemu Chu Bridge (LC5), and Zeema (ZM) in the Lachen region (Table 1; Fig. 1). The geographical distribution of these superior accessions ranged from 27°41'41.244'' N to 27°45'33.840'' N latitude and 88°32'18.636'' E to 88°45'00.972'' E longitude, at elevations between 2632 and 2829 m AMSL (Table 1;

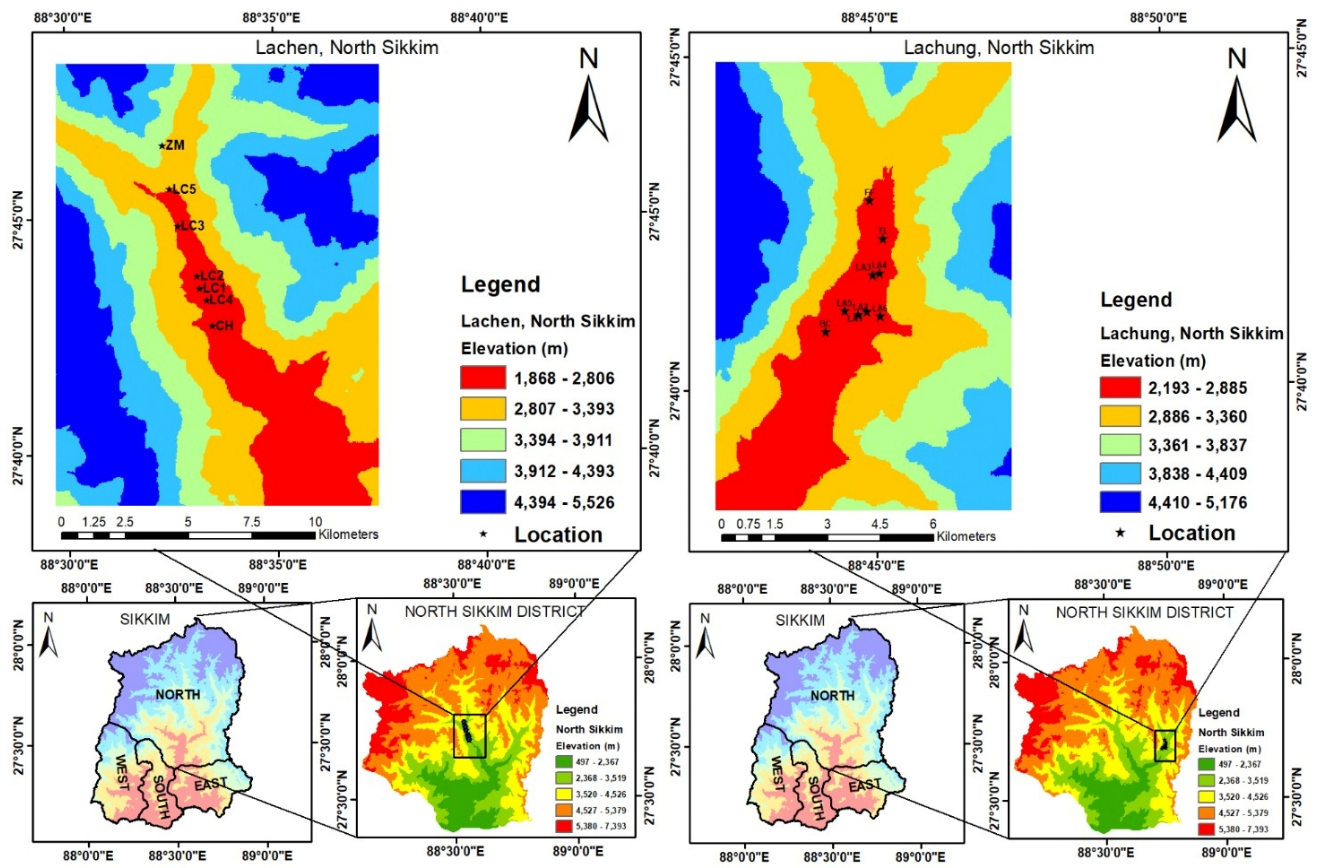

Fig. 1: Location details of selected wild- kiwifruit female accessions from various sub-locations under Lachen and Lachung territorial regions in North Sikkim district of Sikkim.
Out of 15 locations, 8 sub locations under Lachung area, i.e: LA1 – Katao Road, LA2 – Sarchok, LA3 – Shanti Nagar, LA4 – New Cutting Road, LA5 – Lanka, FF – Fakha Farey, BC – Bitchu, TL – Teeling, 7 sub locations under Lachen area, i.e: LC1 – Check Post, LC2 – Hotel Panghen Metok, LC3 – Puchi, LC4- Near Chaten, LC5 – Zemu Chu Bridge, CH – Chaten, ZM-Zeema.

Fig. 1). Field experiments were approved by the Department of Forest, Environment and Wildlife Management, Government of Sikkim (F.No:78/GOS/ FEWMD/ BD-R-2015/191).

Plant material

At the beginning of 2021, a preliminary survey was conducted in the North Sikkim district to document wild kiwifruit accessions in their natural habitats. The survey led to the identification of 81 healthy and regular fruit-bearing female vines across 15 different sub-locations in the Lachung and Lachen valleys of North Sikkim (Supplementary Excel Sheet 1). Subsequently, during the following year, fruit samples were systematically collected from the selected vines during the peak fruiting period in September 2022 (Table 1). Scion wood from the nine promising female selections was collected from 5 different sub-locations under the North Sikkim district as described in Table 1, during the first week of March 2023 and tongue-grafted onto seedling rootstocks of kiwifruit (*A. deliciosa*) for field conservation and subsequent utilization.

Morphological observations

Twenty fruits were randomly sampled from each vine and analysed at the Centre for Agricultural Engineering and Post-Harvest Technology (CAEPHT), Gangtok, Sikkim. Average fruit yield per vine was estimated by multiplying the mean fruit weight of 20 fruits collected from random branches by the total number of fruits per vine recorded during the field survey. The average value of 10 randomly selected fruits from each vine was taken into calculations for measuring fruit weight, fruit size and stalk length. Fruit weight was recorded using an electronic weighing balance (Model BT-224S), while fruit length, diameter, and stalk length were measured using Vernier Calipers (Model CD-6' CS, Mitutoyo Corp., Japan). Fruit size was calculated as the product of fruit length and diameter, and the length-to-diameter ratio was also determined.

Fruit's flesh colour was assessed visually following the DUS test guidelines of UPOV (2019) using Royal Horticultural Society (RHS), London colour charts. Fruit's skin and flesh colour traits, including colour of the outer pericarp, locule, and core, were recorded in accordance with the DUS guidelines for *Actinidia* (Kiwifruit) as prescribed by UPOV (2019) and compared with the RHS colour charts. Sensory evaluation of only selected superior nine accessions was conducted by a panel of four judges, who assessed fruit samples for flavour, texture, aroma, taste, and overall acceptability using a nine-point hedonic scale (Lawless & Heymann, 2010). Harvest maturity was determined by monitoring TSS levels, with fruits harvested upon reaching the

Table 1: Location details and morphological non-metric characters of selected wild- kiwifruit female accessions from North Sikkim district of Sikkim

Sl.	Accessions	Sub locations & Major Locations under North Sikkim District	Denoted in the Map (refer Figure 1)	Latitude	Longitude	Altitude (metres above mean sea level)	Estimated Age	Fruit shape	Conspicuousness of lenticels on fruit's skin	Hairiness of fruit's skin	Fruit skin colour	Fruit's flesh colour			Width of core relative to fruit	General shape of core in cross section	Date of full bloom	Anticipated date of harvest	Harvesting period (days)
												Colour of outer pericarp	Colour of locule	Colour of core					
1	SKNLC-14	Puchi, Lachen	LC3	27° 44' 44.448" N	88° 32' 40.812" E	2710	35	Oblong	Medium	Absent	Medium green	Dark green	Dark green	White	Small	Circular	27-06-2022	12-09-2022	78
2	SKNLC-18	Zemu Chu Bridge, Lachen	LC5	27° 45' 20.268" N	88° 32' 18.636" E	2734	43	Obovate	Medium	Absent	Light green	Dark green	Light green	White	Medium	Oblate	25-06-2022	28-09-2022	96
3	SKNLA-16	Shanti Nagar, Lachung	LA3	27° 41' 41.244" N	88° 45' 0.972" E	2638	48	Obovate	Strong	Absent	Medium green	Medium green	Light green	White	Medium	Transverse elliptic	25-06-2022	15-09-2022	83
4	SKNFF-05	Faka Farey, Lachung	FF	27° 42' 45.864" N	88° 44' 59.208" E	2807	29	Oblong	Medium	Absent	Light green	Medium green	Light green	White	Small	Oblate	03-07-2022	20-09-2022	80
5	SKNLA-15	Shanti Nagar, Lachung	LA3	27° 41' 41.424" N	88° 45' 0" E	2632	32	Oblong	Medium	Absent	Medium green	Medium green	Medium green	White	Medium	Oblate	30-06-2022	14-09-2022	77
6	SKNLC-16	Puchi, Lachen	LC3	27° 44' 44.808" N	88° 32' 40.488" E	2713	63	Obovate	Medium	Absent	Light green	Medium green	Light green	White	Small to medium	Circular	27-06-2022	10-09-2022	76
7	SKNZM-09	Zeema, Lachen	ZM	27° 45' 33.84" N	88° 32' 19.5" E	2781	58	Oblong	Strong	Absent	Medium green	Dark green	Medium green	White	Medium	Oblate	05-07-2022	26-09-2022	84
8	SKNLC-10	Puchi, Lachen	LC3	27° 44' 49.56" N	88° 32' 39.048" E	2740	41	Oblong	Medium	Absent	Light green	Dark green	Dark green	White	Small to medium	Transverse elliptic	04-07-2022	13-09-2022	72
9	SKNFF-07	Fakha Farey, Lachung	FF	27° 42' 48.78" N	88° 44' 56.94" E	2829	17	Oblong	Medium	Absent	Medium green	Greenish yellow	Greenish yellow	Yellow white	Medium	Transverse elliptic	08-07-2022	24-09-2022	89

[i.e. Comparison with RHS Colour Charts :Colour of outer pericarp (Dark green: Yellow Green group 144 A, Medium green: Yellow Green group 144 B, Greenish yellow: Yellow Green group 154 B), Colour of locule (Greenish Yellow: Yellow Green group 154 B, Dark green: Green Group 143 A, Medium Green: Green Group 143 B, Light Green: Green Group 143 C), Colour of core (White: Green-White group 157 D, Yellow white: Yellow- White group 158 A), Fruit skin colour: (Light green: Yellow Green group 151 A); (Medium green: Yellow Green group 152 B)] optimum stage (TSS >6.5 °Brix) as suggested by Beever and Hopkirk (1990). The harvesting period for each selected accession was calculated as the duration from full bloom to the anticipated harvest date.

Biochemical observations

TSS: Total soluble solids (TSS) were measured using a digital Erma hand refractometer (0-32 °Brix). The instrument was calibrated with distilled water before analysis. A few drops of fruit juice were placed on the prism surface, and the readings were recorded after applying temperature correction whenever the temperature deviated from 20°C (A.O.A.C., 1970). The TSS content was expressed as °Brix. For each accession, observations were recorded from five randomly collected fruits per vine, and the mean value was considered for analysis.

Titratable acidity (%): The titratable acidity (%) was obtained by using the procedure given by Ranganna (2009). For the estimation of titratable acidity, 25 g of fruit pulp from each sample was crushed, and the volume was made up to 250 ml with distilled water in a volumetric flask. From this extract, a 50 ml aliquot was used for acidity estimation, while the remaining extract was utilized for the determination of total and reducing sugars. An aliquot of 10 ml juice extract was titrated against N/10 NaOH solution using phenolphthalein as an indicator until the appearance of a faint pink endpoint. The titratable acidity was expressed as per cent malic acid, considering that 1 ml of N/10 NaOH is equivalent to 0.0067 g of anhydrous malic acid. The acidity percentage was calculated using the following formula:

$$\text{Titratable acidity (\%)} = \frac{\text{Titre value} \times \text{Normality of Alkali} \times \text{Volume-madeup} \times \text{Equivalent weight of acid} \times 100}{\text{Volume of sample taken for estimation} \times \text{Volume of aliquot taken} \times 1000}$$

Total sugars (%): Total sugars were estimated by the Lane and Eynon volumetric method (A.O.A.C., 1970). The remaining 200 ml of juice extract obtained after acidity estimation was clarified by adding 10 ml of saturated lead acetate solution. The contents were shaken thoroughly and filtered into a flask containing 10 ml of potassium oxalate solution to remove excess lead. After shaking and allowing the precipitate to settle, the solution was filtered again. An aliquot of 50 ml filtrate was transferred to a 250 ml volumetric flask, mixed with 5 ml concentrated HCl, and kept overnight at room temperature for hydrolysis of non-reducing sugars. The excess acid was neutralized using a saturated NaOH solution. The hydrolysed extract was then titrated against a boiling mixture of 5 ml each of Fehling's solution A and B using methylene blue as an indicator. The endpoint was marked by the disappearance of blue colour and the formation of a brick-red precipitate. The total sugar content was expressed as a percentage on a fresh pulp weight basis as:

$$\text{Total sugars (\%)} = \frac{\text{Factor} \times \text{Dilution}}{\text{Titre value} \times \text{Weight or volume of sample taken}} \times 100$$

*Factor=0.05

Reducing sugars (%): The reducing sugars (%) were obtained by using the procedure given by Ranganna (2009). For the estimation of reducing sugars, 5 ml each of Fehling's solution A and Fehling's solution B were mixed with 50 ml of distilled water in a beaker and boiled for about 10 minutes. Subsequently, 2-3 drops of methylene blue indicator were added, and the solution was titrated against the prepared filtrate. The contents were continuously shaken during titration, and the endpoint was indicated by the appearance of a brick-red precipitate. The reducing sugar content was expressed as a percentage on a fresh pulp weight basis and calculated using the following formula:

$$\text{Reducing sugars (\%)} = \frac{\text{Factor} \times \text{Dilution}}{\text{Titre value} \times \text{Weight or volume of sample}} \times 100$$

*Factor=0.05

Non-reducing sugars (%): The non-reducing sugars (%) were obtained by using the procedure given by Ranganna (2009). The non-reducing sugar content was calculated by subtracting the reducing sugars from the total sugars and multiplying the difference by the standard factor 0.95. The non-reducing sugars were expressed as a percentage on a fresh pulp weight basis using the following formula:

$$\text{Non-reducing sugars} = (\text{Total sugars} - \text{Reducing sugars}) \times 0.95$$

Sugar/acid ratio: It was calculated by dividing the percentage of total sugars by the percentage of titratable acidity.

$$\text{Sugar/acid ratio} = \frac{\text{Total sugars (\%)}}{\text{Acidity (\%)}}$$

Total phenols (mg GAE/100 g): Total phenol content was determined by the Folin-Ciocalteu method described by Singleton & Rossi (1965), and absorbance was recorded at 650 nm using a spectrophotometer. In alkaline medium, phenolic compounds react with phosphomolybdic acid present in the Folin- Ciocalteu reagent to form a dark blue coloured complex (molybdenum blue). The intensity of the developed colour was measured at 650 nm. A standard calibration curve was prepared using different concentrations of gallic acid, and the total phenol content of the samples was estimated from the standard curve and expressed as mg/g of sample.

Ascorbic acid (mg/100 g): Quantitative estimation of ascorbic acid was carried out following the A.O.A.C. (1980) method using 2,6-dichlorophenol indophenol dye. Five grams of the fruit sample were homogenised in 3% metaphosphoric acid (extraction solution), and the volume was made up to 50 ml. An aliquot of the extract was then titrated against the dye solution until the appearance of a light pink colour endpoint. The ascorbic acid content was calculated using the following formula:

$$\text{Ascorbic acid (mg/100 g)} = \text{Dye factor} \times \frac{\text{Titration reading}}{\text{Weight of fruit taken}} \times \frac{\text{Volume made}}{\text{Volume taken for estimation}} \times 100$$

Statistical analysis

The data generated from the evaluation of nine promising wild kiwifruit accessions for various morphological, biochemical, and sensory traits were subjected to statistical analysis using Analysis of Variance (ANOVA) in Microsoft Excel. The significance of differences among accessions was tested using the F-test, and treatment means were compared using the Critical Difference (CD) test at the 5% level of significance. Standard Error of Mean (SEm (±)), coefficient of variation (CV%), overall mean, and range were computed for each morphological and biochemical metric character to assess the extent of variability among the accessions. The statistical parameters, including mean, range, SEm (±), CD (0.05), CV (%), and F-test significance levels, are presented for all evaluated traits to facilitate comparison of accession performance and identification of superior accessions.

Results and Discussion

In 2022, fruit samples obtained from 81 female wild kiwifruit vines were subjected to detailed morphological and biochemical evaluations (Supplementary Excel Sheet 1). Based on overall performance and their potential value as genetic resources, nine accessions, *viz.* SKNLC-14, SKNLC-18, SKNLA-16, SKNFF-05, SKNLA-15, SKNLC-16, SKNZM-09, SKNLC-10, and SKNFF-07, were identified as superior. These accessions exhibited superior performance for key economically and nutritionally important traits, including higher fruit weight, elevated ascorbic acid content, superior sugar-acid ratio, greater yield per vine, and a desirable greenish-yellow flesh colour. The morphological characteristics of these selected accessions are illustrated in Tables 1-4 & Fig. 1-10. The selection criteria emphasized traits critical for genetic improvement and utilization in breeding programmes. Consequently, these nine accessions represent valuable genetic resources with significant potential for incorporation into kiwifruit breeding efforts aimed at developing improved cultivars that meet market requirements and consumer preferences.

Morphological and biochemical metric characters as selection criteria

Fruit weight: Among the 81 wild kiwifruit accessions, SKNLC-18 exhibited the highest mean fruit weight (9.16 g), followed by SKNLC-14 (8.07 g), whereas the fruit weight ranged between 2.94 and 9.16 g among the selected 9 accessions (Table 2). These values exceed or are comparable to those reported in earlier studies,

Table 2: Morphological metric characters of selected wild kiwifruit female accessions from North Sikkim district of Sikkim

Accessions	Fruit weight (g)	Fruit length (mm)	Fruit diameter (mm)	Fruit size (Length *Diameter) (mm^2)	Fruit (length to diameter ratio)	Length of fruit stalk (mm)	Yield (kg/vine)
SKNLC-14	8.07	23.26	19.94	463.80	1.17	15.93	9.00
SKNLC-18	9.16	32.21	22.42	722.15	1.44	17.33	9.00
SKNLA-16	5.18	25.34	19.04	482.47	1.34	16.32	4.50
SKNFF-05	2.98	23.62	19.11	451.38	1.24	17.14	18.50
SKNLA-15	4.62	22.85	19.26	440.09	1.20	17.85	5.50

SKNLC-16	4.14	23.38	16.66	389.51	1.40	16.43	10.50
SKNZM-09	4.25	18.86	17.14	323.26	1.10	11.94	28.50
SKNLC-10	3.83	24.82	16.08	399.11	1.56	11.18	26.50
SKNFF-07	2.94	18.34	16.32	299.31	1.13	15.14	2.50
Range	2.94-9.16	18.34-32.21	16.08-22.42	299.31-722.15	1.10-1.56	11.18-17.85	2.50-28.50
Mean	5.02	23.63	18.44	441.23	1.29	15.47	12.72
SEm (±)	0.09	0.44	0.26	8.88	0.02	0.27	0.13
CD (P = 0.05)	0.27	1.30	0.77	26.63	0.05	0.80	0.39
CV (%)	3.13	3.19	2.41	3.49	2.28	3.00	1.78
F -test	**	**	**	**	**	**	**

I.e.: SEm (±) = Standard Error of Mean; CD = Critical Difference; CV = Coefficient of Variation; ** = Significant at $P \leqslant 0.01$

where average fruit weights of 6.9 g were recorded in the hardy kiwifruit cultivar 'Ananasnaya' (*Actinidia arguta*) grown in Oregon, USA (Pescie & Strik, 2004), 8.1 g average weight in Bingo, a F_1 hybrid between *A. purpurea* 'Purpurna Sadova' and *A. arguta* (Latocha, 2012), 4.8 g in *Actinidia callosa* var. *strigillosa* from China (Hongwen, 2014), 6.71 g in *A. melanandra* (4x), and 4.85 g in *A. arguta* var. *arguta* (4x) from Northwest China (Zhang *et al.*, 2017). The comparatively higher fruit weight observed in SKNLC-18 (Fig 3a, b, c) and SKNLC-14 (Fig 2a, b, c) underscores substantial intra-specific variability within wild germplasm and highlights the

SKNLC-14

Fig. 2 (SKNLC-14): Depicting wild kiwifruit (*A. callosa* var. *strigillosa*). (2a) fruit's flesh with outer pericarp, locule and inner core; (2b) length and diameter of fruit with measuring scale; (2c) vine during the fruiting period in North Sikkim, India.

SKNLC-18

Fig. 3 (SKNLC-18): Depicting wild kiwifruit (*A. callosa* var. *strigillosa*). (3a) fruit's flesh with outer pericarp, locule and inner core; (3b) length and diameter of fruit with measuring scale; (3c) vine during the fruiting period in North Sikkim, India.

potential of these accessions as valuable genetic resources for breeding programmes aimed at fruit size improvement.

Vitamin C level: The accessions SKNFF-05 (106.60 mg 100/g) and SKNLA-16 (91.00 mg/ 100 g) exhibited the highest vitamin C among the 81 wild kiwifruit female accessions, with a range of 28.60-106.60 mg/100 g Vit. C among the selected 9 accessions (Table 3), reflecting substantial variability for ascorbic acid accumulation in Himalayan *Actinidia* resources. These values are comparable to those reported for the green kiwifruit cultivar 'Hayward' (80-120 mg/100 g fresh weight (Beever & Hopkirk, 1990), though lower than gold kiwifruit cultivars such as *A. chinensis* cv. 'Zespri Sun Gold', which contains approximately 161.3 mg/ 100 g (USDA, 2016; Richardson *et al.*, 2018). Wild and semi-domesticated *Actinidia* species from the Himalayan region are recognised for their superior nutraceutical traits, with *A. kolomikta* reported to possess the highest ascorbic acid concentration among the genus (Latocha, 2017). The comparatively high vitamin C levels observed in SKNFF-05 (Fig 5a, b, c) and SKNLA-16 (Fig 4a, b, c) highlight its potential as a promising donor accession for biofortification-oriented breeding programmes and for broadening the nutritional base of cultivated kiwifruit under temperate Himalayan conditions.

Table 3: Biochemical characters of wild kiwifruit female accessions from North Sikkim district of Sikkim

Accessions	TSS (°B)	Titratable acidity (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	Sugar: acid ratio	Vit. C (mg /100 g)	Total Phenols (mg GAE /100g)
SKNLC-14	16.40	0.77	8.57	6.67	1.80	11.13	54.60	39.30
SKNLC-18	15.46	1.05	7.55	5.55	1.90	7.19	46.80	57.15
SKNLA-16	16.76	0.77	8.33	5.88	2.32	10.82	91.00	86.11
SKNFF-05	14.40	0.56	6.81	5.55	1.19	12.16	106.60	75.94
SKNLA-15	15.36	0.49	7.22	5.68	1.46	14.73	65.00	30.92
SKNLC-16	13.80	0.49	6.81	5.26	1.47	13.90	33.80	34.67
SKNZM-09	12.35	0.56	5.26	3.90	1.29	9.39	28.60	71.17
SKNLC-10	12.70	0.70	5.35	4.16	1.13	7.64	33.80	81.20
SKNFF-07	15.60	0.6	37.50	5.88	1.53	11.90	36.40	27.60
Range	12.35-16.76	0.49-1.05	5.26-8.57	3.90-6.67	1.13-2.32	7.19-14.73	28.60-106.60	27.60-86.11
Mean	14.76	0.67	7.04	5.39	1.56	10.98	55.18	56.01
SEm (±)	0.26	0.01	0.12	0.08	0.13	0.15	0.95	1.22
CD (P = 0.05)	0.79	0.03	0.36	0.23	0.02	0.44	2.84	3.67
CV (%)	3.08	2.59	2.98	2.49	2.54	2.31	2.97	3.79
F -test	**	**	**	**	**	**	**	**

I.e.: SEm (±) = Standard Error of Mean; CD = Critical Difference; CV = Coefficient of Variation; ** = Significant at P⩽0.01

SKNLA-16

Fig. 4 (SKNLA-16): Depicting wild kiwifruit (*A. callosa* var. *strigillosa*). (4a) fruit's flesh with outer pericarp, locule and inner core; (4b) length and diameter of fruit with measuring scale; (4c) vine during the fruiting period in North Sikkim, India.

SKNFF-05

Fig. 5 (SKNFF-05): Depicting wild kiwifruit (*A. callosa* var. *strigillosa*). (5a) fruit's flesh with outer pericarp, locule and inner core; (5b) length and diameter of fruit with measuring scale; (5c) vine during the fruiting period in North Sikkim, India.

SKNLA-15

Fig. 6 (SKNLA-15): Depicting wild kiwifruit (*A. callosa* var. *strigillosa*). (6a) fruit's flesh with outer pericarp, locule and inner core; (6b) length and diameter of fruit with measuring scale; (6c) vine during the fruiting period in North Sikkim, India.

SKNLC-16

Fig. 7 (SKNLC-16): Depicting wild kiwifruit (*A. callosa* var. *strigillosa*). (7a) fruit's flesh with outer pericarp, locule and inner core; (7b) length and diameter of fruit with measuring scale; (7c) vine during the fruiting period in North Sikkim, India.

Highest sugar: acid ratio: The accessions SKNLA-15 (14.73) and SKNLC-16 (13.90) recorded the highest sugar: acid ratio among the 81 accessions, whereas it ranged between 7.19-14.73 among the selected 9 accessions under present investigation (Table 3), indicating superior sweetness perception and overall fruit palatability. Earlier studies have reported comparatively lower sugar-acid ratios across different

SKNZM-09

Fig. 8 (SKNZM-09): Depicting wild kiwifruit (*A. callosa* var. *strigillosa*). (8a) fruit's flesh with outer pericarp, locule and inner core; (8b) length and diameter of fruit with measuring scale; (8c) vine during the fruiting period in North Sikkim, India.

SKNLC-10

Fig. 9 (SKNLC-10): Depicting wild kiwifruit (*A. callosa* var. *strigillosa*). (9a) fruit's flesh with outer pericarp, locule and inner core; (9b) length and diameter of fruit with measuring scale; (9c) vine during the fruiting period in North Sikkim, India.

SKNFF-07

Fig. 10 (SKNFF-07): Depicting wild kiwifruit (*A. callosa* var. *strigillosa*). (10a) fruit's flesh (Greenish yellow) with outer pericarp, locule and inner core; (10b) length and diameter of fruit with measuring scale; (10c) vine during the fruiting period in North Sikkim, India.

Actinidia species. Wang *et al.,* (2018) observed ratios ranging from 5.33 to 8.05 in *A. kolomikta*, *A. arguta*, and *A. chinensis* cultivars, with Hayward (*A. chinensis* var. *deliciosa*) exhibiting a ratio of 6.50. Similarly, Liang *et al.,* (2021) reported sugar: acid ratios between 5.91 and 10.39 in 15 cultivars of *A. chinensis* and *A. chinensis* var. *deliciosa*, with only a few cultivars (Hongyang, Yate, Jinyan, Cuiyu) exceeding a ratio of 10.0. These values fall at the upper end of the range (5.39-14.17) reported by Wen *et al.,* (2023) for hardy kiwifruit (*A. arguta*) cultivars at the soft-ripe stage, suggesting that the present accessions, *viz.* SKNLA-15 (Fig. 6a, b, c) and SKNLC-16

(Fig. 7a, b, c) possess a favourable biochemical balance comparable to advanced commercial cultivars, indicating their potential as suitable donor parents for enhancing fruit sweetness in kiwifruit breeding programmes in the Himalayan region.

Fruit yield: Among the 81 evaluated accessions, SKNZM-09 (28.50 kg/vine) and SKNLC-10 (26.50 kg/vine) recorded the highest yield per vine, with a range of 2.50-28.50 kg/vine fruit yield among the 9 selected accessions (Table 2), demonstrating outstanding yield potential. These values are substantially higher than those reported for several hardy kiwifruit cultivars, where average yields typically range from 4.2 to 6.2 kg /vine, as documented for 'HORTGEM TORU' and 'HORTGEM WHA' in New Zealand (McNeilage *et al.*, 2003a, b, c) and 'Vip Green' and 'Vip Red' in Romania (Stanica *et al.*, 2022). While higher cumulative yields have been reported in certain European cultivars under long-term cultivation (Latocha *et al.*, 2023), the superior per-vine productivity observed in SKNZM-09 (Fig. 8a, b, c) and SKNLC-10 (Fig. 9a, b. c) underscores the wider yield variability inherent in wild hardy kiwifruit germplasm. These accessions therefore represent promising elite selections for yield improvement and domestication-oriented breeding programmes in Himalayan regions.

Morphological non-metric character as a selection criterion

Greenish yellow flesh: The single accessions 'SKNFF-07' (Fig. 10a, b, c) exhibited a distinct greenish-yellow flesh colour, a trait of significant commercial and breeding relevance in kiwifruit among the evaluated 81 accessions. In this single accession, the outer pericarp and locular tissues were characterized by a greenish-yellow hue (Yellow-Green Group 154B), while the core region displayed a yellow-white colouration (Yellow-White Group 158A) (Table 1). Yellow-fleshed kiwifruit gained global prominence following the release of *Actinidia chinensis* 'Hort-16A', the first cultivar developed through a systematic breeding programme to be successfully commercialized internationally (Asadi *et al.*, 2024). Since then, substantial progress has been made worldwide, with yellow-fleshed cultivars developed both through direct selection from wild germplasm in China and through structured breeding programmes in other kiwifruit-growing regions. Notable examples include 'Dori' and 'Soreli' from Italy (Testolin & Cipriani, 2008; Costa *et al.*, 2014), 'Goldrush', 'Haegeum', 'Halla Gold', and 'Jecy Gold' from Korea (Kim *et al.*, 2007; Cho *et al.*, 2011; Kwack *et al.*, 2011; Kim *et al.*, 2012), 'Sanuki Gold' from Japan (Fukuda *et al.*, 2007), and 'Y368' from New Zealand (US Plant Patent, 2010). The occurrence of greenish-yellow flesh in the present accession highlights the potential of indigenous germplasm as a valuable genetic resource for developing novel yellow-fleshed kiwifruit cultivars adapted to Himalayan agro-climatic conditions, thereby reducing dependence on imported cultivars and broadening the genetic base of kiwifruit improvement programmes.

Other morphological and biochemical metric characters of selected accessions

In the present study, significant variation was observed among the nine accessions with respect to fruit size and biochemical attributes. Fruit length ranged from 18.34 mm in SKNFF-07 (Fig. 10b) to 32.21 mm in SKNLC-18 (Fig. 3b), while fruit diameter varied from 16.08 mm in SKNLC-10 (Fig. 9 b) to 19.94 mm in SKNLC-14 (Fig. 2b) (Table 2). The superior fruit length recorded in SKNLC-18 exceeded the values reported by Zhang *et al.,* (2017) for kiwi berry species in Northwest China, where fruit length ranged from 27.44 mm in *A. arguta* var. *arguta* (4x) to 29.49 mm in *A. arguta* var. *giraldii* (8x and 10x). Similarly, fruit diameter in the present study was comparable to that reported for *A. melanandra* (4x), which ranged from 19.66 to 21.36 mm, but higher than values reported for *A. arguta* var. *giraldii*.

Total soluble solids (TSS) content among the accessions varied from 12.35 °Brix in SKNZM-09 to 16.76 °Brix in SKNLA-16, with a mean value of 14.76 °Brix in the present study (Table 3). The higher TSS observed in SKNLA-16 (16.76 °B) was comparable to the post-ripening TSS values reported by Jung *et al.,* (2016) in *A. arguta* cultivars 'Mansu' (16.5 °B) and 'Chiak' (16.9 °B), indicating favourable sweetness levels. In contrast, TSS values reported at harvest by Jung *et al.,* (2016) and by Kishor *et al.,* (2017) in *A. chinensis* var. *deliciosa* cultivars were notably lower, suggesting species- and genotype-specific differences in sugar accumulation.

Total sugar content varied significantly among the accessions, ranging from 5.26 % in SKNZM-09 to 8.57% in SKNLC-14 (Table 3). The higher sugar content observed in SKNLC-14 (8.5%) was comparable to that reported by Kishor *et al.,* (2017), who recorded maximum total sugars of 8.31% in cv. Monty, followed by Allison (6.88%) and other commercial cultivars. These findings highlight the promising biochemical attributes of certain wild kiwifruit accessions, particularly SKNLC-14 and SKNLA-16, which exhibited fruit quality traits comparable to or exceeding those of cultivated kiwifruit (*A. chinensis*) varieties.

Other morphological non-metric characters of selected accessions

Considerable variation was observed in non-metric fruit characters among the selected accessions. Fruit shape ranged from oblong in six accessions (SKNLC-14 (Fig. 2b), SKNFF-05 (Fig. 5b), SKNLA-15 (Fig. 6b), SKNZM-09 (Fig 8b), SKNLC-10 (Fig. 9b), and SKNFF-07 (Fig. 10b) to obovate in three accessions (SKNLC-18 (Fig. 3b), SKNLA-16 (Fig. 4b) and SKNLC-16 (Fig. 7b)), indicating substantial morphological diversity in the present study (Table 1). Similar cultivar-dependent variation in fruit shape has been reported earlier, with ovate fruits in hardy kiwifruit cvs. Mansu and Chiak (*A. arguta*) (Jung *et al.*, 2016) and oblong, elliptical and ovoid fruits in *A. chinensis* cv.s Goldone, Hayward, Goldrush and Hort16A (Kwack *et al.*, 2017). The conspicuousness of lenticels on the fruit skin varied from medium in seven accessions to strong in two accessions *viz.* SKNLA-16 (Fig. 4b) and SKNZM-09 (Fig. 8b) (Table 1). In contrast, Rodriguez (2019) reported a high density of conspicuous lenticels with the absence of skin hairs in cv. CRISTAL (*A. chinensis* var. *deliciosa*), suggesting genotype-specific expression of this trait. Fruit skin colour also differed among accessions, ranging from light green (Yellow Green group 151 A) in four accessions to medium green (Yellow Green group 152 B) in five accessions in the present investigation (Table 1), whereas a greenish-brown skin colour was reported in cv. Hongyang (*A. chinensis*) under China agroclimatic conditions (Mingzhang & Mingzhong, 2008).

The harvesting period among the nine accessions ranged from 72 to 96 days, reflecting differences in maturity behaviour (Table 1). Comparable variation in harvest maturity has been documented in hardy kiwifruit, with harvesting at 81-84 days after flowering in cv. Issai (Lei *et al.*, 2022) and 100-110 days after flowering in cv. Ananasnaya (Strik & Hummer, 2006). Overall, the observed variability in non-metric traits underscores the genetic diversity of the evaluated germplasm and its potential relevance for selection and breeding programmes.

Sensory analysis

Consumer acceptance and purchase decisions for new kiwifruit cultivars are strongly influenced by the fruit's aroma and flavour. Cultivars that fail to meet consumer sensory expectations are unlikely to achieve sustained market success (Latocha & Krupa, 2007). Sensory evaluation of fruit samples from selected wild kiwifruit female accessions was carried out using a nine-point hedonic rating scale (Table 4). The attributes assessed included flavour, texture, aroma, taste, and overall acceptability. Scores were assigned to identify the most consumer-preferred accessions based on sensory perception. Hedonic scales have a well-established and robust history in consumer research and are widely used to effectively assess consumer preferences and satisfaction (Stone & Siddel, 2004). The

Table 4: Sensory evaluation of selected wild- kiwifruit female accessions from North Sikkim district of Sikkim

Genotypes	Flavour	Texture	Aroma	Taste	Overall acceptability
SKNLC-14	7.00	7.00	6.50	7.00	6.88
SKNLC-18	8.00	9.00	8.00	8.00	8.25
SKNLA-16	8.00	8.00	7.50	8.00	7.88
SKNFF-05	7.00	6.50	7.00	6.50	6.75
SKNLA-15	6.00	5.00	5.00	7.00	5.75
SKNLC-16	6.00	6.00	7.00	6.00	6.25
SKNZM-09	7.00	7.00	6.00	7.00	6.75
SKNLC-10	5.00	5.00	6.00	6.00	5.50
SKNFF-07	5.00	6.50	5.00	4.00	5.13
Range	5-8	5-9	5-8	4-8	5.13-8.25
Mean	6.55	6.67	6.44	6.61	6.57
SEm (±)	0.11	0.15	0.11	0.10	0.07
CD (P = 0.05)	0.34	0.44	0.31	0.31	0.22
CV (%)	2.96	3.83	2.82	2.69	1.95
F -test	**	**	**	**	**

I.e.: SEm (±) = Standard Error of Mean; CD = Critical Difference; CV = Coefficient of Variation; ** = Significant at $P \leqslant 0.01$

nine-point hedonic scale, with ratings ranging from 1 to 9, is widely employed to capture consumer preferences. The scale assumes that participants' sensory responses lie along a continuum of liking and disliking, where 1 represents 'dislike extremely', 2 'dislike very much', 3 'dislike moderately', 4 'dislike slightly', 5 'neither like nor dislike', 6 'like slightly', 7 'like moderately', 8 'like very much', and 9 'like extremely'. These ratings collectively reflect graded variations in consumer liking or disliking (Lawless & Heymann, 2010).

The flavour was rated excellent in SKNLC-18 and SKNLA-16, both receiving an 8-point hedonic scale, while the remaining selections were assessed as good. Pulp texture was outstanding in SKNLC-18 (9), followed by SKNLA-16 (8), whereas the other accessions exhibited acceptable to fair texture. Aroma was exceptional in SKNLC-18 (8) and SKNLA-16 (7.5); the remaining selections were generally rated as fair, except SKNFF-07, which recorded a comparatively low score (5.0). Taste was rated excellent in SKNLC-18 and SKNLA-16 (8), while SKNFF-07 was evaluated as poor. Overall, based on overall acceptability, SKNLC-18 and SKNLA-16 clearly outperformed all other accessions (Table 4).

Sensory attributes such as flavour, texture, aroma, and taste are key determinants of consumer acceptability in wild kiwifruit, with overall flavour perception representing an integrated response of taste sensations and aroma-active volatiles. Considerable variation in sensory quality has been reported among *Actinidia* species. Hongwen (2014) described *A. callosa* var. *strigillosa* as slightly acidic, astringent, and tart, with low juiciness and a mildly crispy texture, indicating limited sensory appeal. In contrast, Stanica *et al.,* (2022) reported a fine, distinctive, and predominantly sweet flavour in *A. arguta* cultivars 'Vip Green' and 'Vip Red'. In the present study, SKNLC-18 and SKNLA-16 exhibited superior sensory profiles, characterised by high scores for flavour, texture, aroma, and taste (Table 4), closely resembling the favourable attributes reported for sweet-tasting *A. arguta* cultivars. These results underscore the potential of SKNLC-18 and SKNLA-16 as promising accessions for consumer acceptance and gene source for future varietal development.

Conclusions and future prospective

Among the 81 evaluated wild kiwifruit vines, nine elite accessions based on superior fruit weight, vitamin C content, sugar: acid ratio, yield potential, and yellow flesh colour were identified, of which SKNLC-18 and SKNLA-16 emerged as outstanding accessions with superior fruit size, while SKNFF-07 was distinguished by its greenish-yellow flesh colour. The occurrence of greenish-yellow flesh in wild Himalayan kiwifruit is of particular significance, as it represents a rare and valuable trait with high commercial and breeding relevance. The present study confirms a significant level of variation among the nine superior accessions that harbour immense untapped genetic potential and constitute an important reservoir of traits, especially for cold as well as drought tolerance, yield improvement, nutritional quality and consumer-preferred fruit attributes. These accessions also hold potential as parental lines for breeding and development of climate-resilient cold-hardy cultivars suited for the high-altitude areas of the Himalayan region.

These nine superior accessions have been established in the field gene bank of the researcher's institute. Their stability, adaptability, and horticultural performance will be validated through multi-location evaluations across high-altitude environments (2000-3000 m AMSL) in the Indian Himalayan region under homogenous conditions. In addition, comparative transcriptomic analyses involving cultivated kiwifruit (*Actinidia* spp.) groups will be undertaken to identify cold-responsive genes and gain insights into the genetic basis of cold tolerance, thereby facilitating their potential utilization in kiwifruit breeding programmes and expanding cultivation into the higher altitude regions of the Himalayan Mountains.

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Mean values of traits for selection of nine supeiror accesssions

Serial Number	Accession name	Fruit weight (g)	Titratable acidity (%)	Total sugars (%)	Sugar: acid ratio	Ascorbic acid/ Vitamin C (mg/100g)	Fruit yield (kg/vine)	Colour of Outer Pericarp	Colour of Locule	Colour of Core
1	SKNLA-01	7.55	0.77	8.57	11.13	39.00	3.00	Dark green	Light green	White
2	SKNLA-02	7.23	0.70	6.60	9.43	31.20	2.50	Dark green	Light green	White
3	SKNLA-03	7.71	1.05	7.89	7.51	65.00	5.50	Dark green	Light green	White
4	SKNLA-04	7.13	0.91	7.69	8.45	33.80	4.50	Dark green	Light green	White
5	SKNLA-05	7.84	0.98	8.82	9.00	36.40	3.50	Dark green	Medium green	Yellow white
6	SKNLA-06	4.19	0.63	7.79	12.37	31.20	6.50	Dark green	Light green	White
7	SKNLA-07	3.81	0.84	7.61	9.06	41.60	8.00	Dark green	Light green	White
8	SKNLA-08	3.93	0.63	6.25	10.42	44.20	2.50	Dark green	Dark green	White
9	SKNLA-09	3.12	0.49	5.88	12.00	36.40	1.80	Light green	Light green	White
10	SKNLA-10	4.63	0.91	6.86	7.54	39.00	6.50	Dark green	Light green	White
11	SKNLA-11	3.69	1.05	10.52	10.02	41.60	8.50	Dark green	Dark green	White
12	SKNLA-12	3.51	0.77	8.10	10.52	44.20	10.50	Dark green	Light green	White
13	SKNLA-15	4.62	0.49	7.22	14.73	65.00	5.50	Medium green	Medium green	White
14	SKNLA-16	5.18	0.77	8.33	10.82	91.00	4.50	Medium green	Light green	White
15	SKNLA-17	5.43	0.63	6.66	10.57	59.80	7.50	Dark green	Light green	White
16	SKNLA-18	3.74	1.05	8.21	7.82	33.80	11.00	Medium green	Light green	White
17	SKNLA-19	4.85	0.91	7.05	7.75	46.80	3.50	Dark green	Light green	White
18	SKNLA-20	5.48	0.84	6.97	8.30	31.20	2.00	Dark green	Medium green	White
19	SKNLA-21	6.34	0.56	6.52	11.64	62.40	2.50	Dark green	Light green	White
20	SKNLA-22	5.85	0.77	8.47	11.00	70.20	4.50	Dark green	Light green	White
21	SKNLA-23	5.32	0.63	5.45	8.65	85.80	5.50	Dark green	Light green	White
22	SKNLA-24	3.27	0.84	6.25	7.44	46.80	6.50	Dark green	Light green	White
23	SKNLA-25	4.75	0.98	6.67	6.81	57.20	9.50	Dark green	Medium green	White
24	SKNLA-26	4.66	0.63	7.50	11.90	41.60	8.50	Dark green	Light green	White
25	SKNLA-27	4.08	0.70	7.69	10.99	39.00	5.50	Dark green	Light green	White
26	SKNLA-28	5.34	0.56	5.26	9.39	62.40	6.50	Dark green	Light green	White
27	SKNLA-29	6.31	0.49	5.76	11.76	75.40	8.17	Dark green	Light green	White
28	SKNLA-30	6.92	0.56	6.74	12.04	33.80	2.50	Medium green	Light green	White
29	SKNLA-31	5.95	0.98	7.89	8.05	46.80	11.00	Dark green	Light green	White
30	SKNLA-32	5.97	0.49	4.68	9.55	44.20	19.00	Dark green	Light green	White
31	SKNLA-33	4.37	0.63	6.38	10.13	31.20	14.50	Light green	Light green	White
32	SKNLA-34	4.86	0.77	6.74	8.75	44.20	12.50	Dark green	Light green	White
33	SKNLA-35	5.15	0.91	7.31	8.03	52.00	15.50	Dark green	Light green	White
34	SKNLA-36	5.31	1.05	10.34	9.85	41.60	14.50	Light green	Light green	White
35	SKNFF-01	5.28	0.56	6.25	11.16	33.80	2.00	Light green	Light green	White
36	SKNFF-03	3.06	0.49	6.52	13.31	31.20	9.00	Light green	Light green	White
37	SKNFF-05	2.98	0.56	6.81	12.16	106.60	18.50	Medium green	Light green	White
38	SKNFF-07	2.94	0.63	7.50	11.90	36.40	2.50	Greenish yellow	Greenish yellow	Yellow white

39	SKNFF-08	3.46	0.56	5.17	9.23	39.00	2.50	Dark green	Light green	White
40	SKNBC-01	6.33	0.91	9.83	10.80	31.20	3.50	Light green	Light green	White
41	SKNBC-02	3.92	1.05	9.90	9.43	33.80	5.50	Dark green	Dark green	White
42	SKNBC-03	6.56	0.91	6.67	7.33	31.20	2.00	Dark green	Light green	White
43	SKNBC-04	4.07	0.84	6.38	7.60	54.60	6.50	Medium green	Light green	White
44	SKNBC-05	8.05	0.56	4.61	8.23	41.60	20.50	Light green	Light green	White
45	SKNTL-01	3.52	0.70	6.60	9.43	67.60	2.50	Dark green	Light green	White
46	SKNLC-01	2.94	0.56	6.89	12.30	39.00	7.50	Dark green	Dark green	White
47	SKNLC-02	3.71	0.84	9.52	11.33	33.80	2.50	Dark green	Dark green	White
48	SKNLC-03	2.92	0.70	6.38	9.11	44.20	5.50	Dark green	Medium green	White
49	SKNLC-04	2.69	0.63	6.25	9.92	36.40	22.50	Dark green	Light green	White
50	SKNLC-05	1.76	0.91	8.57	9.42	44.20	4.50	Dark green	Light green	White
51	SKNLC-06	1.57	0.84	8.33	9.92	41.60	22.50	Dark green	Light green	White
52	SKNLC-07	5.28	1.19	9.83	8.26	31.20	3.50	Medium green	Light green	Greenish white
53	SKNLC-08	4.36	0.49	6.67	13.61	26.00	4.50	Light green	Light green	White
54	SKNLC-09	2.64	0.77	8.57	11.13	59.80	7.60	Dark green	Light green	White
55	SKNLC-10	3.83	0.70	5.35	7.64	33.80	26.50	Dark green	Dark green	White
56	SKNLC-11	6.28	0.56	4.68	8.36	49.40	7.50	Medium green	Light green	White
57	SKNLC-12	6.02	0.63	6.25	9.92	36.40	9.50	Dark green	Medium green	White
58	SKNLC-14	8.07	0.77	8.57	11.13	54.60	9.00	Dark green	Dark green	White
59	SKNLC-15	6.37	0.63	8.45	13.41	31.20	4.50	Dark green	Dark green	Yellow white
60	SKNLC-16	4.14	0.49	6.81	13.90	33.80	10.50	Medium green	Light green	White
61	SKNLC-17	2.96	1.26	9.37	7.44	41.60	8.50	Dark green	Light green	White
62	SKNLC-18	9.16	1.05	7.55	7.19	46.80	9.00	Dark green	Light green	White
63	SKNLC-19	3.49	0.56	5.76	10.29	36.40	6.50	Medium green	Light green	White
64	SKNLC-20	5.22	0.63	6.38	10.13	44.20	14.50	Medium green	Light green	White
65	SKNCH-01	4.71	0.49	6.59	13.45	70.20	9.50	Dark green	Light green	White
66	SKNCH-02	5.62	0.77	6.81	8.84	52.00	3.50	Medium green	Light green	White
67	SKNCH-03	6.68	0.84	7.14	8.50	80.60	4.50	Dark green	Dark green	Greenish white
68	SKNCH-04	6.51	0.91	8.33	9.15	36.40	5.50	Dark green	Light green	White
69	SKNZM-01	6.34	0.77	8.04	10.44	59.80	4.50	Dark green	Light green	White
70	SKNZM-02	5.82	1.05	10.60	10.10	31.20	7.50	Dark green	Light green	White
71	SKNZM-03	4.32	0.77	7.63	9.91	44.20	4.50	Dark green	Medium green	White
72	SKNZM-04	4.71	0.56	6.67	11.24	31.20	5.50	Light green	Dark green	White
73	SKNZM-05	2.24	0.49	5.26	10.73	46.80	3.50	Dark green	Light green	White
74	SKNZM-06	6.25	0.56	6.25	11.16	41.60	1.80	Dark green	Dark green	White
75	SKNZM-07	6.77	0.42	5.17	12.31	33.80	3.00	Medium green	Light green	White
76	SKNZM-08	5.29	0.77	6.25	8.12	39.00	14.50	Dark green	Medium green	Yellow white
77	SKNZM-09	4.25	0.56	5.26	9.39	28.60	28.50	Dark green	Medium green	White
78	SKNZM-10	5.32	0.91	6.81	7.48	46.80	16.00	Dark green	Light green	White
79	SKNZM-11	5.76	0.84	5.45	6.49	33.80	12.50	Dark green	Light green	White
80	SKNZM-12	4.49	0.98	7.50	7.65	39.00	4.50	Medium green	Dark green	White
81	SKNZM-13	6.63	0.49	5.45	11.12	33.80	14.60	Medium green	Light green	Yellow white