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RESEARCH ARTICLE

# Assessment of Antioxidant Activity and Quality Attributes in Indigenous Pran (Kashmiri Shallot) Genotypes

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## Abstract

Pran is a condiment vegetable of the Kashmir region and belongs to family Alliaceae.Indigenous landraces of Alliums represent an important reservoir of nutritional and functional diversity; however, they remain poorly characterized in many mountain agro-ecosystems. Pran also known as Kashmiri shallot (*Allium x cornutum*clementii ex vis.), is widely cultivated for its distinctive pungency and culinary value, yet comprehensive information on its biochemical attributes is not available. The present study aimed to characterize the antioxidant potential, nutritional composition, and quality traits of indigenous Pran genotypes collected from diverse agro-ecological regions of Jammu and Kashmir. Thirty Pran genotypes along with a commercial check were evaluated for antioxidant activity (DPPH radical scavenging), vitamin C, total phenols, dry matter, total soluble solids (TSS), pyruvic acid, and total sugars. Significant genotypic variation ($p \leqslant 0.05$) was observed for all traits studied. Antioxidant activity ranged from 49.57 to 71.12%, vitamin C from 2.93 to 3.51 mg 100 $g^{-1}$, and total phenolics from 3.12 to 9.12 mg 100 $g^{-1}$. Dry matter and TSS varied from 13.20 to 23.89% and 9.79 to 22.14 °Brix, respectively. Pyruvic acid content ranged from 4.34 to 5.33%, while total sugars varied between 5.71 and 8.77%. Several genotypes exhibited superior performance across multiple biochemical and quality parameters, significantly outperforming the check. The pronounced biochemical diversity observed in Kashmiri Pran highlights its potential as a valuable genetic resource for nutritional improvement, the development of functional foods, and the sustainable utilisation of Pran germplasm. The identified elite genotypes may serve as promising candidates for breeding programmes and conservation initiatives in temperate and high-altitude regions

**Keywords:** Antioxidant activity, Biochemical diversity, Indigenous germplasm, Pran

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## Introduction

Onion and shallot are among the most widely consumed vegetable crops globally and are valued not only for their culinary importance but also for their health-promoting properties. One notable species, Pran, is distinguished by its unique flavor and is widely used as a condiment in soups, meat dishes and salads (Suraya *et al.*, 2025). It holds a special place in Kashmiri cuisine, where the renowned "Wazwan" is considered incomplete without Pran. It is an important ingredient of chilli cakes commonly known as 'Wari'. These chilli cakes are sold at exorbitant prices and even exported to Middle Eastern countries by certain private companies and can be stored up to a period of two to three years under ordinary conditions (Jabeen *et al.*,2012). The simple paste, prepared from the Pran, not only enhances the taste but also holds a treasure trove of health benefits. As Pran is a type of shallot, shallots (*A. cepa* var. *aggregatum*) are rich in bioactive compounds such as phenolics, flavonoids, sulfur-containing compounds, and

vitamin C, which contribute to their antioxidant capacity and distinctive flavour (Griffiths *et al*., 2002; Slimestad *et al*., 2007). This fact led us to characterize the diverse Pran genotypes growing in parts of Jammu and Kashmir and find out their relative quality parameters. Pran is a triploid, viviparous onion with a moreslender stature than onion and more pinkish, flushed flowers. Pran is an integral component of Kashmiri cuisine (wazwan). It is typically propagated vegetatively and exhibits considerable variation in bulb size, pungency, and taste. Despite its local importance and adaptability to temperate and high-altitude conditions, Pran remains underutilized and scientifically under explored. Characterization of its biochemical and quality traits is essential for identifying nutritionally superior genotypes and for promoting its conservation and improvement. The present study aimed to study the extent of biochemical diversity among indigenous Kashmiri Pran genotypes with particular emphasis on antioxidant potential, nutritional composition, and quality attributes, and to identify elite genotypes suitable for breeding and value addition.

## Materials and Methods

### *Plant material*

Thirty indigenous diversePran genotypes were collected from different agro-ecological regions of Jammu and Kashmir. A commercially grown variety was included as a local check. The experiment was conducted at Urban Technological Park Habbak, Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir during *Rabi* 2023-2024. The experimental field of Urban Technological Park in Habbak is situated at an elevation of 1608 meters above sea level, between 34.16° N latitude and 74.83° E longitude. The single-factor experiment was set up in a Randomized Block Design (RBD) with three replications. The climate is temperate with mild summers. The bulbs were sown at depth of 3-4 cm, spacing of 20 cm × 15 cm, farmyard manure 25-30 tons per hectare and 100:80:60 Kg/ha of NPK were applied (Saleem *et al.,* 2023)

### *Biochemical analysis*

Fresh bulb samples were analyzed for biochemical and quality traits using standard procedures. Antioxidant activity was estimated using the DPPH radical scavenging assay (Brand-William *et al.,* 1995). Vitamin C content was determined by titration method and expressed as mg 100/g fresh weight (Thimmaiah 1999). Total phenolic content was measured using the Folin–Ciocalteu method and expressed as mg 100/g (Bray and Thorpe, 1954). Dry matter content was determined by oven drying. Total soluble solids (TSS) were measured using a digital refractometer (Digital Abbe Refractometer, Krusss Optroic AOAC, 1980). Pyruvic acid content, an indicator of pungency, was estimated following Schwimmer and Weston (1961). Total sugars were estimated using standard biochemical methods (A.O.A.C.1980).

### *Statistical analysis*

The experimental data obtained for different biochemical and quality traits were subjected to statistical analysis using analysis of variance (ANOVA) appropriate for the experimental design as described by Gomez and Gomez (1984). The significance of differences among genotypes was tested at 5% level of probability ($p \leqslant 0.05$).

The standard error of difference (SED) was calculated to estimate the variability among treatment means, and the critical difference (CD) values were worked out to compare the significance between genotypic means. Wherever the calculated difference between two means exceeded the CD value, the difference was considered statistically significant.

All observations were recorded on randomly selected samples, and mean values were used for statistical computation. The single-factor experiment was set up in a Randomized Block Design (RBD) with three replications.

## Results

### *Antioxidant activity and Vitamin C content*

The data presented in Table 1 revealed significant

**Table1:** Mean Performance of different genotypes of Pran withrespect toantioxidant activity and quality traits

| S.No. | Genotype | Antioxidant (% DPPH inhibit) | Vitamin-C (mg/100 g) | Phenols (mg/100 g) | Dry matter (%) | TSS (°Brix) | Pyruvic acid (mg/100 g fresh weight) | Total sugars (%) |
|---|---|---|---|---|---|---|---|---|
| 1 | SKAU-PRAN-H | 51.25 | 2.93 | 7.51 | 18.41 | 10.24 | 4.65 | 5.71 |
| 2 | SKAU-PRAN-Kup | 50.16 | 2.96 | 9.11 | 19.78 | 13.9 | 5.11 | 6.23 |

| S.No. | Genotype | Antioxidant (% DPPH inhibit) | Vitamin-C (mg/100 g) | Phenols (mg/100 g) | Dry matter (%) | TSS (°Brix) | Pyruvic acid (mg/100 g fresh weight) | Total sugars (%) |
|---|---|---|---|---|---|---|---|---|
| 3 | SKAU-PRAN-P | 67.51 | 3.12 | 7.13 | 15.11 | 16 | 4.72 | 7.31 |
| 4 | SKAU-PRAN-Gbl | 61.27 | 3.08 | 4.12 | 23.77 | 19.22 | 4.81 | 6.16 |
| 5 | SKAU-PRAN-Bo | 67.06 | 3.48 | 5.23 | 13.2 | 13.89 | 5.29 | 8.77 |
| 6 | SKAU-PRAN-K | 49.57 | 2.94 | 6.31 | 18.1 | 18.09 | 4.34 | 6.13 |
| 7 | SKAU-PRAN-Bnd | 71.12 | 3.51 | 3.12 | 23.89 | 19.77 | 5.33 | 8.57 |
| 8 | SKAU-PRAN-So | 68.25 | 3.24 | 8.422 | 2.29 | 18.9 | 5.08 | 5.89 |
| 9 | SKAU-PRAN-Q | 65.15 | 3.34 | 8.13 | 15.23 | 16.89 | 5.13 | 8.42 |
| 10 | SKAU-PRAN-So1 | 65.28 | 3.16 | 3.12 | 19.79 | 18.78 | 4.96 | 7.68 |
| 11 | SKAU-PRAN-So2 | 65.97 | 2.98 | 3.21 | 19.33 | 17.89 | 4.89 | 7.55 |
| 12 | SKAU-PRAN-L1 | 58.24 | 2.97 | 3.81 | 19.92 | 1.86 | 4.58 | 8.06 |
| 13 | SKAU-PRAN-L2 | 59.13 | 2.93 | 3.43 | 19.51 | 20.88 | 4.62 | 8.12 |
| 14 | SKAU-PRAN-L3 | 57.68 | 3.11 | 3.72 | 18.29 | 20.24 | 4.74 | 8.22 |
| 15 | SKAU-PRAN-Sh | 62.58 | 3.15 | 7.13 | 22.81 | 7.87 | 4.92 | 8.18 |
| 16 | SKAU-PRAN-A | 60.78 | 3.18 | 3.85 | 18.25 | 19.87 | 4.95 | 8.26 |
| 17 | SKAU-PRAN-Kul | 60.27 | 3.49 | 9.12 | 17.26 | 19.06 | 4.97 | 8.32 |
| 18 | SKAU-PRAN-S1 | 68.99 | 3.32 | 3.81 | 19.2 | 29.82 | 4.99 | 7.69 |
| 19 | SKAU-PRAN-Ch | 59.15 | 3.42 | 5.51 | 17.92 | 2.14 | 5.24 | 7.54 |
| 20 | SKAU-PRAN-S | 269.82 | 3.49 | 3.51 | 22.71 | 17.97 | 4.89 | 7.45 |
| 21 | SKAU-PRAN-S | 368.45 | 3.45 | 4.12 | 21.24 | 18.81 | 5.18 | 7.76 |
| 22 | SKAU-PRAN-S4 | 69.23 | 3.38 | 4.21 | 20.31 | 8.98 | 5.12 | 7.85 |
| 23 | SKAU-PRAN-S5 | 68.85 | 3.44 | 5.52 | 19.24 | 17.68 | 5.24 | 7.33 |
| 24 | SKAU-PRAN-S6 | 68.57 | 3.46 | 4.93 | 23.8 | 9.79 | 5.32 | 7.66 |
| 25 | SKAU-PRAN-Bud | 60.25 | 3.37 | 3.52 | 19.21 | 4.55 | 5.19 | 8.11 |
| 26 | SKAU-PRAN-T | 67.51 | 3.46 | 6.83 | 17.17 | 14.89 | 5.02 | 7.36 |
| 27 | SKAU-PRAN-Ko | 58.25 | 3.35 | 4.12 | 19.11 | 19.41 | 4.76 | 8.12 |
| 28 | SKAU-PRAN-Qa | 58.26 | 3.23 | 8.06 | 16.45 | 17.85 | 4.83 | 8.26 |
| 29 | SKAU-PRAN-Brl | 65.21 | 3.16 | 7.89 | 21.02 | 17.91 | 4.83 | 8.14 |
| 30 | SKAU-PRAN-S7 | 69.23 | 3.41 | 3.78 | 20.49 | 10.78 | 5.17 | 7.53 |
| | Local Check | 66.33 | 3.14 | 7.28 | 22.13 | 18.17 | 5.02 | 6.26 |
| | SED | 0.172 | 0.0045 | 0.0045 | 0.121 | 0.0025 | 0.086 | 0.172 |
| | CD | 0.345 | 0.009 | 0.009 | 0.242 | 0.005 | 0.172 | 0.345 |

differences among Pran genotypes for antioxidant activity and vitamin C content. Antioxidant activity, expressed as per cent DPPH inhibition, ranged from 49.57 to 71.12%. The highest antioxidant activity was recorded in SKAU-PRAN-Bnd (71.12%), followed by SKAU-PRAN-S2 (69.82%), SKAU-PRAN-S4 and SKAU-PRAN-S7 (69.23%), all of which were significantly superior to the check. The lowest antioxidant activity was observed in SKAU-PRAN-K (49.57%).Vitamin C content varied from 2.93 to 3.51 mg/100 g. Maximum vitamin C was recorded in SKAU-PRAN-Bnd (3.51 mg/100 g), followed by SKAU-PRAN-S2 (3.49 mg/100 g). Several genotypes showed significantly higher vitamin C content than the check, indicating substantial nutritional variability within the Pran germplasm.

### *Total phenols*

Table 1 depicts the variation in total phenol content among Pran genotypes, which ranged from 3.12 to 9.12 mg/100 g. The highest phenol content was recorded in SKAU-PRAN-Kul (9.12 mg/100 g), closely followed by SKAU-PRAN-Kup (9.11 mg/100 g) and SKAU-PRAN-So (8.42 mg/100 g). Genotypes with lower phenolic content included SKAU-PRAN-Bnd, SKAU-PRAN-So1,

and SKAU-PRAN-So2. The observed variation suggests the presence of genotypes with enhanced nutraceutical potential suitable for functional food development.

***Dry matter and total soluble solids (TSS)***

Dry matter content exhibited wide variation among the genotypes, ranging from 13.20% to 23.89% (Table 1). The highest dry matter content was recorded in SKAU-PRAN-Bnd (23.89%), followed by SKAU-PRAN-S6 (23.80%) and SKAU-PRAN-Gbl (23.77%), whereas SKAU-PRAN-Bo (13.20%) recorded the lowest value.Total soluble solids (TSS) ranged from 9.79°Brix to 22.14°Brix. The highest TSS was observed in SKAU-PRAN-Ch (22.14°Brix), followed by SKAU-PRAN-L1 (21.86°Brix) and SKAU-PRAN-L2 (20.88°Brix). Higher TSS values indicate better sweetness and suitability for processing and culinary purposes.

***Pyruvic acid and total sugar***

Pyruvic acid content, an indicator of pungency, varied significantly among the genotypes (Table 1), ranging from 4.34 to 5.33%. The highest pyruvic acid content was recorded in SKAU-PRAN-Bnd (5.33%), followed by SKAU-PRAN-S6 (5.32%) and SKAU-PRAN-Bo (5.29%), indicating their strong pungency compared to the check.Total sugar content ranged from 5.71% to 8.77%. The highest total sugars were observed in SKAU-PRAN-Bo (8.77%), followed by SKAU-PRAN-Bnd (8.57%), SKAU-PRAN-Kul (8.32%), and SKAU-PRAN-A (8.26%). Genotypes with higher sugar content are likely to possess better taste and consumer acceptability.

Genotypes such as SKAU-PRAN-Bnd, SKAU-PRAN-Bo, SKAU-PRAN-Kul, and SKAU-PRAN-S2 consistently ranked among the top performers across multiple biochemical and quality traits, making them promising candidates for conservation, varietal improvement, and value-added utilization.

## Discussion

The present investigation revealed substantial biochemical and quality-related variability among Kashmiri Pran (shallot) genotypes, highlighting the richness of indigenous germplasm and its potential for nutritional enhancement and varietal improvement. Similar wide variability for biochemical traits has been earlier reported in onion and shallot genotypes, suggesting strong genetic control influenced by environmental adaptation (Griffiths *et al*., 2002).

**Table 2:** Comparative summary of top-performing pran (Kashmiri Shallot) genotypes for biochemical and quality traits

| Trait | Range Observed | Top Performing Genotype(s) | Value |
|---|---|---|---|
| Antioxidant activity (% DPPH inhibition) | 49.57 – 71.12 | SKAU-PRAN-Bnd | 71.12% |
| | | SKAU-PRAN-S2 | 69.82% |
| | | SKAU-PRAN-S4 / S7 | 69.23% |
| Vitamin C (mg/100 g) | 2.93 – 3.51 | SKAU-PRAN-Bnd | 3.51 |
| | | SKAU-PRAN-Bo / S2 | 3.49 |
| Total phenols (mg/100 g) | 3.12 – 9.12 | SKAU-PRAN-Kul | 9.12 |
| | | SKAU-PRAN-Kup | 9.11 |
| | | SKAU-PRAN-So | 8.42 |
| Dry matter (%) | 13.20 – 23.89 | SKAU-PRAN-Bnd | 23.89 |
| | | SKAU-PRAN-S6 | 23.80 |
| | | SKAU-PRAN-Gbl | 23.77 |
| TSS (°Brix) | 9.79 – 22.14 | SKAU-PRAN-Ch | 22.14 |
| | | SKAU-PRAN-L1 | 21.86 |
| | | SKAU-PRAN-L2 | 20.88 |
| Pyruvic acid (%) – pungency | 4.34 – 5.33 | SKAU-PRAN-Bnd | 5.33 |
| | | SKAU-PRAN-S | 65.32 |
| | | SKAU-PRAN-Bo | 5.29 |
| Total sugars (%) | 5.71 – 8.77 | SKAU-PRAN-Bo | 8.77 |
| | | SKAU-PRAN-Bnd | 8.57 |
| | | SKAU-PRAN-Kul | 8.32 |

### *Antioxidant activity and vitamin C*

Antioxidant activity varied widely among the Pran genotypes, with several genotypes recording values significantly higher than the check (Table 2). High antioxidant potential in Allium species is primarily attributed to the presence of phenolics, flavonoids, vitamin C, and sulfur-containing compounds (Slimestad *et al*., 2007). Genotypes such as SKAU-PRAN-Bnd and SKAU-PRAN-S2, which exhibited superior antioxidant activity, may therefore serve as valuable sources of health-promoting compounds. Although onions are generally considered moderate sources of vitamin C, the observed variation among Pran genotypes aligns with earlier findings that genotype plays a crucial role in determining ascorbic acid content (Kumar *et al*., 2015). Higher vitamin C levels in certain genotypes enhance their dietary value and contribute synergistically to antioxidant activity.

### *Total phenolic content*

Phenolic compounds are major contributors to antioxidant capacity and are known to vary widely among onion cultivars (Lachman *et al*., 2003). In the present study, phenolic content ranged considerably, with SKAU-PRAN-Kul and SKAU-PRAN-Kup recording the highest values. These findings corroborate earlier reports by Prakash *et al*., (2007), who observed significant genotypic differences in total phenols among onion cultivars. High-phenol genotypes are particularly important for functional food development and may offer enhanced protection against oxidative stress-related disorders (Yang *et al.,* 2004).

### *Dry matter and total soluble solids (TSS)*

Dry matter content is a critical quality trait influencing storage life, processing suitability, and pungency in onions and shallots. Genotypes with higher dry matter content, such as SKAU-PRAN-Bnd and SKAU-PRAN-S6, are considered desirable for dehydration and processing purposes. Similar associations between high dry matter content and better processing quality have been reported earlier. Total soluble solids, which are closely associated with sweetness and flavour intensity, also varied significantly among genotypes. High TSS values observed in certain Pran genotypes are consistent with earlier reports that attribute such variation to differences in carbohydrate accumulation and genetic background. Genotypes combining high dry matter and high TSS may thus possess superior culinary and commercial value.

### *Pyruvic acid and total sugars*

Pyruvic acid content is widely used as an indicator of pungency in onions and shallots. The significant variation observed among Pran genotypes reflects differences in sulfur metabolism and enzymatic activity, as also reported by Schwimmer and Weston (1961). Genotypes such as SKAU-PRAN-Bnd and SKAU-PRAN-S6, which recorded higher pyruvic acid content, may be preferred for consumers favouring strong pungency and traditional flavour profiles. Total sugars contribute directly to sweetness and overall palatability. Genotypes with higher sugar content, notably SKAU-PRAN-Bo and SKAU-PRAN-Kul, are likely to be more acceptable for fresh consumption. Previous studies have demonstrated an inverse or complex relationship between sugar content and pungency, depending on genotype and environmental conditions, which may explain the observed variation among Pran genotypes.

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