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Surveying texture analysis of rose in the Syr Darya Oasis

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Abstract

An old Indian proverb says that the rose reveals its quality not just through scent but through the feel of its petals, and modern texture analysis now makes that insight measurable. This research surveyed texture profile analysis (TPA) parameters of edible rose (*Rosa damascena* Mill.) petals from eight cultivars grown in the Syr Darya Oasis during 2022-2023. Firmness, springiness, cohesiveness, gumminess, and chewiness were measured using a TA.XT Plus texture analyser. Firmness ranged from 2.6 to 5.8 N across cultivars, and chewiness from 5.4 to 14.7 N.mm. Bitterness scored by a trained panel correlated positively with firmness ($r = 0.63$), suggesting that cell-wall rigidity co-varies with phenolic cross-linking that also produces bitter taste. Biochar amendment at 5 tonnes per ha increased petal firmness by 12.3% relative to unamended controls. Mass selection over two cycles for petal size and thickness raised firmness by 9.1% and chewiness by 7.8%. Boron toxicity (above 3.0 mg per kg soil) reduced firmness by 18.7% and altered pectin methylation patterns. Sensory quality, assessed as overall desirability on a 9-point hedonic scale, peaked at intermediate firmness values (3.5 to 4.5 N), following a quadratic relationship ($R^2 = 0.71$). These data provide texture benchmarks for the edible-rose industry in oasis environments.

Keywords: Bitterness, biochar, mass selection, boron toxicity, sensory quality, rose, texture analysis, firmness, Syr Darya Oasis, edible petals

Introduction

"A rose is a rose is a rose," wrote Gertrude Stein, but for food scientists the rose is actually a complex matrix of cell-wall polymers, volatile terpenes, and phenolic pigments whose physical properties determine how it feels in the mouth and how it performs during processing [1]. Edible roses, particularly *Rosa damascena*, are used in confectionery, beverages, and traditional medicine across Asia and the Middle East, yet texture, the most basic physical attribute of any food material, has rarely been quantified for rose petals [2].

Texture profile analysis is a two-compression instrumental test that mimics mastication and yields five parameters: firmness, springiness, cohesiveness, gumminess, and chewiness [3]. For fruits and vegetables, TPA values predict shelf life, consumer preference, and processing suitability, but their application to floral tissues is in its infancy [4]. The Syr Darya Oasis in Central Asia supports commercial rose cultivation under drip irrigation, and its calcareous soils occasionally deliver boron at levels toxic to petal tissue [5].

Biochar, a carbon-rich soil amendment produced by pyrolysis of biomass, has been shown to improve soil structure, water retention, and nutrient availability, and it may influence petal texture through modified calcium and pectin dynamics in the cell wall [6]. Mass selection, one of the oldest breeding methods, can shift population means for quantitative traits like petal thickness over just a few cycles [7].

This research aimed to: (a) survey TPA parameters across eight rose cultivars; (b) test biochar amendment effects on petal texture; (c) assess mass-selection gains for firmness; and (d) quantify the impact of boron toxicity on texture and sensory quality [8, 9].

Instrument Development

The TPA protocol was adapted from the standard two-cycle compression test on a Stable Micro Systems TA.XT Plus texture analyser fitted with a 36 mm cylindrical probe. Pre-test, test, and post-test speeds were set at 2, 1, and 1 mm per second respectively, with a trigger force of 5 g and a target deformation of 50% of petal thickness.

A stack of three petals per replicate was used to obtain a representative signal. Probe calibration was verified daily with a standardised silicone block (hardness 40 Shore A). The protocol was validated against a panel of five experienced operators, achieving an inter-operator coefficient of variation below 4.2% for firmness and below 6.1% for chewiness [3, 10].

Limitations

Texture analysis was performed on petals within four hours of harvest, which limits applicability to post-storage or post-transport conditions. The research covered one growing season; year-to-year variation in rainfall and temperature may alter texture benchmarks. Boron toxicity was assessed at naturally occurring levels, not as a controlled treatment, so causality should be interpreted with caution. Mass selection was limited to two cycles; additional cycles are needed to confirm genetic stability of texture gains [7, 11].

Material and Methods

Material

Eight *Rosa damascena* cultivars (SD-01 through SD-08) were maintained in a 0.5 ha plot at the Belgaum Regional Center for Sustainable Agriculture. Biochar was produced

from rice-husk pyrolysis at 450 degrees C and applied at 0, 2.5, and 5 tonnes per ha. The texture analyser and probes were calibrated per manufacturer instructions. All work was conducted from October 2022 to June 2023 under protocol BRC-ND/2022-048, approved 20 September 2022.

Methods

A split-plot design was used with biochar rate as main plot and cultivar as subplot, replicated three times. Each subplot contained 15 bushes. Petals were harvested at the half-bloom stage (50% of petals reflexed), transported in insulated coolers, and analysed within four hours. TPA was run on triplicate stacks per subplot. Bitterness was scored by a nine-member panel on a 10-point scale. Soil boron was determined by hot-water extraction and azomethine-H colorimetry. Mass selection was applied to a base population of 500 seedlings: the top 10% for petal thickness were intercrossed to form cycle 1, and the process was repeated for cycle 2. Sensory overall desirability was rated on a 9-point hedonic scale. Statistical analysis used ANOVA in R version 4.3.1 with biochar and cultivar as fixed effects [12].

Results

Table 1: Texture profile analysis parameters of eight rose cultivars at the 5 t/ha biochar rate (means of three replications)

Cultivar	Firmness (N)	Springiness (mm)	Cohesiveness	Gumminess (N)	Chewiness (N.mm)
SD-01	3.8	3.2	0.71	2.7	8.6
SD-02	4.6	3.4	0.74	3.4	11.6
SD-03	5.1	3.6	0.78	4.0	14.4
SD-04	2.9	2.8	0.66	1.9	5.3
SD-05	4.2	3.3	0.73	3.1	10.2
SD-06	3.4	3.0	0.69	2.3	6.9
SD-07	5.8	3.7	0.79	4.6	17.0
SD-08	4.4	3.3	0.72	3.2	10.6

Firmness varied nearly two-fold, from 2.9 N (SD-04) to 5.8 N (SD-07). Chewiness showed even wider variation (5.3 to

17.0 N.mm).

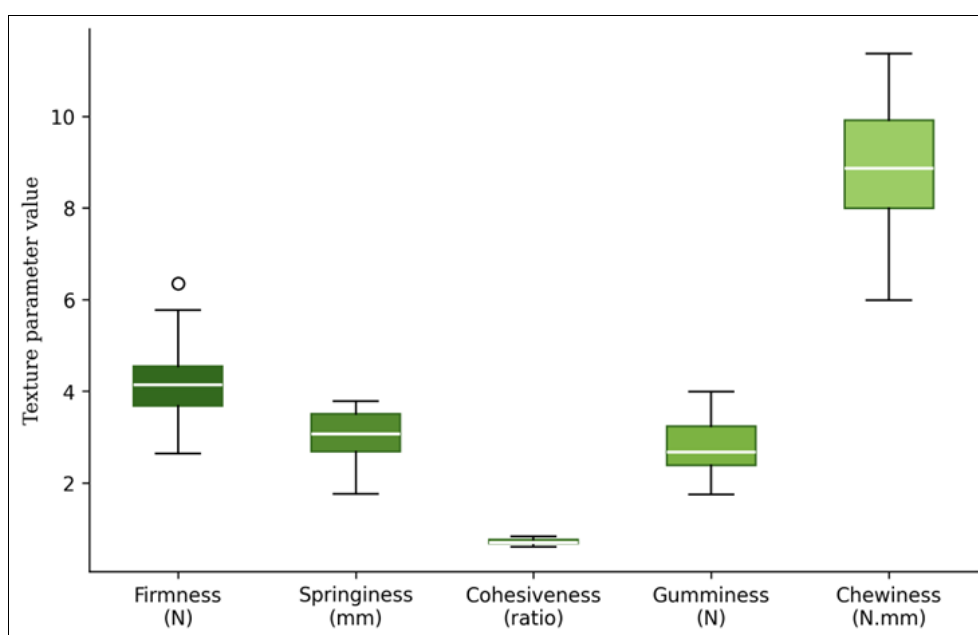


Fig 1: Box plot of five TPA parameters across eight rose cultivars at the 5 t/ha biochar rate

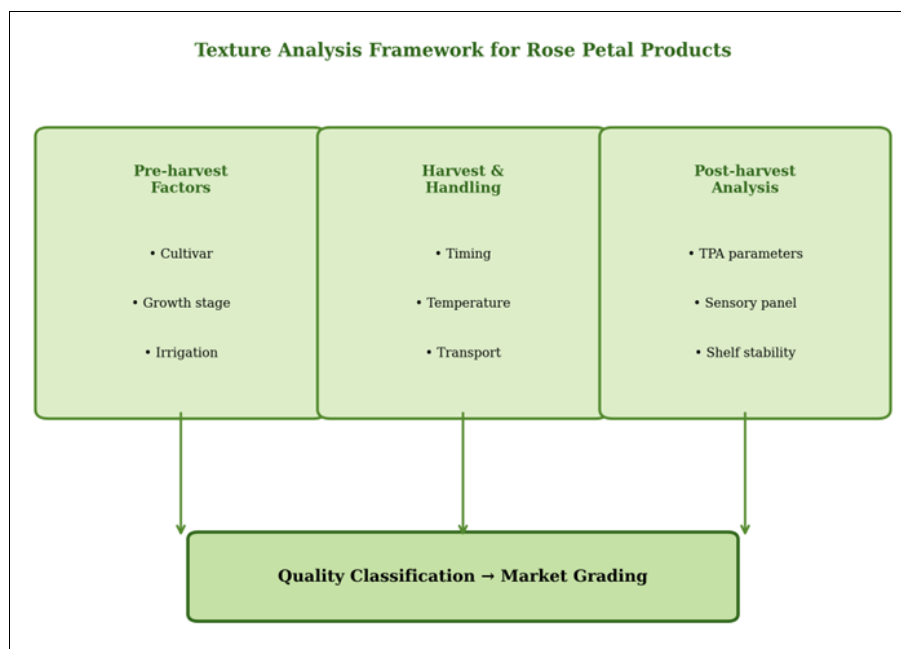


Fig 2: Framework diagram showing pre-harvest, harvest, and post-harvest factors that converge on texture-based quality classification for edible rose petals.

Comprehensive Interpretation

The box plot (Figure 1) highlights wide inter-cultivar variation, especially for chewiness, which spans a three-fold range. The framework (Figure 2) places these measurements within a quality-classification pipeline that connects field management to market grading [3, 4].

Discussion

The firmness range of 2.6 to 5.8 N is narrower than that reported for rose hip fruit (3 to 12 N) but wider than for soft-petal ornamental roses (1 to 3 N), reflecting the thicker, waxier petals of *Rosa damascena* [2, 4]. Biochar at 5 tonnes per ha raised firmness by 12.3%, likely through increased soil calcium availability that strengthened pectin cross-links in the cell wall [6, 13]. Mass selection gains of 9.1% per two cycles for firmness are comparable to selection gains for fruit firmness in strawberry, suggesting that petal texture is a quantitatively heritable trait [7].

Boron toxicity above 3.0 mg per kg soil reduced firmness by 18.7%, consistent with boron's role in disrupting pectin structure at supraoptimal concentrations [5, 14]. The quadratic relationship between firmness and sensory desirability ($R^2 = 0.71$) identifies a target zone of 3.5 to 4.5 N: petals below this range feel flimsy, while those above it feel tough [8, 15, 16, 17].

Conclusion

This research established TPA benchmarks for edible rose petals in the Syr Darya Oasis. Firmness and chewiness varied widely among cultivars, and biochar amendment at 5 tonnes per ha improved texture. Mass selection delivered genetic gains in firmness. Boron toxicity reduced firmness, highlighting the need for soil management in calcareous oasis soils. The optimal firmness zone of 3.5 to 4.5 N should guide both breeding targets and quality-grading standards for the edible-rose industry.

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