Total soluble solids (TSS), an important indicator of fruit sweetness and eating quality, differed significantly among cultivars. Shahi recorded the highest TSS, suggesting superior sugar accumulation during fruit maturation. The accumulation of soluble sugars in litchi fruit is regulated by genotype and influenced by physiological processes such as carbohydrate translocation, photosynthetic efficiency, enzyme activity, and fruit maturity at harvest. Climatic conditions during fruit development, particularly temperature and light intensity, may further influence sugar accumulation. Hussain et al. (2021) similarly reported that cultivar genetics play a dominant role in determining soluble solids, while environmental conditions modify the extent of sugar accumulation. The relatively high TSS of Shahi indicates its suitability for fresh consumption and premium fruit markets.

The observed varietal differences have important implications for commercial litchi production in Nepal. Seedless combined high fruit weight, greater aril weight, and reduced seed size, making it an attractive cultivar for consumers and the fresh fruit market. In contrast, Shahi exhibited superior sweetness, while China and Early Large Red performed well for fruit size. These findings suggest that cultivar selection should be based on the intended market, with Seedless being preferable where edible portion is prioritized and Shahi being suitable where sweetness is the primary quality attribute. Region-specific evaluation of cultivars is essential because fruit quality is influenced by genotype × environment interactions, and cultivar performance may vary under different agro-climatic conditions (Menzel, 2002).

Although the present study provides valuable baseline information on the fruit quality characteristics of major litchi cultivars grown in Sarlahi, it was conducted at a single location during one fruiting season. Consequently, seasonal variation and environmental effects could not be fully evaluated. Future studies should include multi-location and multi-year trials to assess the stability of cultivar performance under diverse agroecological conditions. In addition, integrating physiological, biochemical, molecular, and postharvest quality analyses would provide a more comprehensive understanding of varietal performance and support the development of improved litchi cultivars for commercial production in Nepal.

5 Conclusion

This study demonstrated significant variation in fruit morphological and quality characteristics among seven major litchi (*Litchi chinensis* Sonn.) cultivars grown under the agro-climatic conditions of Sarlahi, Nepal. Among the evaluated cultivars, Seedless exhibited superior commercial attributes, including higher fruit weight, greater aril weight, and smaller seed size, indicating a higher edible portion and greater consumer preference. Shahi recorded the highest total soluble solids (TSS), reflecting superior sweetness and eating quality, whereas China and Early Large Red produced comparatively larger fruits. These findings confirm that cultivar selection plays a crucial role in determining fruit quality and market value.

The results provide valuable scientific information for growers, researchers, and orchard managers in selecting cultivars according to market demand and production objectives. Based on the overall evaluation of fruit quality traits, Seedless appears to be the most promising cultivar for commercial cultivation in the Terai region of Nepal, while Shahi is particularly suitable for fresh fruit markets where sweetness is a key quality attribute.

Since the present investigation was conducted at a single location during one fruiting season, further multi-location and multi-year evaluations are recommended to validate the stability of cultivar performance under diverse agroecological conditions. Future research should also integrate physiological, biochemical, molecular, and postharvest quality assessments to support breeding programmes and the sustainable development of the litchi industry in Nepal.

Authors' contributions

AA and AP were involved in conceptualization, conducting the experiment, data curation, editing, data analysis, writing the original draft, manuscript revision and providing the final structure to the manuscript. Both authors read and approved the final manuscript.