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Comparative analysis of biochemical traits in healthy and Anthracnose-infected mango fruits

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Anthracnose caused by *Colletotrichum gloeosporioides* is one of the most destructive post-harvest diseases of mango, leading to severe quality deterioration and economic losses. Although biochemical changes during mango ripening have been widely studied, information on pathogen-induced biochemical alterations under post-harvest storage conditions remains limited. The present study evaluated the effect of anthracnose infection on total soluble solids (TSS), total soluble sugars, true protein content, and titratable acidity in mango fruits during storage. Healthy fruits exhibited a progressive increase in TSS (20.80°Brix to 21.48°Brix) and total soluble sugars (8.10% to 8.52%), whereas infected fruits recorded significantly lower values, increasing only from 18.40°Brix to 19.27°Brix and 7.20% to 7.81%, respectively. In contrast, true protein content and titratable acidity remained consistently higher in diseased fruits (0.83% to 0.75% and 0.28% to 0.22%) compared to healthy fruits, which declined to 0.77% and 0.19%, respectively. These biochemical alterations indicate disruption of normal ripening processes and accumulation of acid and nitrogenous compounds associated with fungal activity. Overall, anthracnose infection markedly reduces mango fruit quality, and the evaluated biochemical parameters serve as reliable indicators of disease severity.

Keywords : Anthracnose,titratable acidity, total soluble solids, total soluble sugars, true protein

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important tropical fruit crops globally, valued for its high nutritional content, pleasant flavor, and economic significance. India is the largest producer of mango, cultivating several commercial varieties, among which cv. Dasheri holds a prominent position due to its superior taste, aroma, and consumer preference. Being a climacteric fruit, mango undergoes rapid biochemical and physiological changes during ripening, including increased sugar content, reduced acidity, and development of characteristic flavor compounds.

Despite its commercial importance, mango is highly susceptible to post-harvest diseases, which significantly reduce its shelf life and market value. Among these, anthracnose caused by *Colletotrichum gloeosporioides* is considered the most destructive disease worldwide. The pathogen infects fruits during flowering and early fruit development and remains quiescent until ripening, when favorable conditions trigger rapid lesion development, resulting in extensive decay (Arauz, 2000; Prusky *et al*. 2016).

While biochemical changes during mango ripening have been extensively studied, limited information is available on variety-specific biochemical responses of Dasheri mango to anthracnose infection under post-harvest conditions. Recent studies have highlighted that postharvest infection by *C. gloeosporioides* induces complex biochemical and molecular changes in mango fruits, including alterations in carbohydrate metabolism, organic acid balance, protein turnover, and host defense responses (Alkan and Fortes, 2015; Prusky *et al*.,2016; Deng *et al*. 2022). Advances in understanding host–pathogen interactions further indicate that resistance or susceptibility of mango cultivars is closely associated with reactive oxygen species regulation, phenylpropanoid metabolism, and structural barriers such as epicuticular wax composition (Wu *et al*. 2023; García-Sánchez *et al*. 2024). Sustainable and non-chemical

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approaches, including biocontrol agents and natural compounds, are increasingly being explored to manage postharvest anthracnose while maintaining fruit quality (Droby *et al*. 2021; Sivakumar and Bautista-Baños, 2022; Li *et al*. 2024).

MATERIALS AND METHODS

Plant Material

Mature, uniform, and disease-free mango fruits cv. 'Dasheri' were procured from a local orchard in the study region. Fruits were selected based on uniform size, colour, and physiological maturity. Healthy fruits were separated, while diseased fruits showing typical anthracnose symptoms caused by *Colletotrichum gloeosporioides* were used for comparative biochemical analysis during storage.

Estimation of Total Soluble Solids

The total soluble solid of the infected and healthy pulp of mango fruit was recorded using hand Refractometer (range 0 - 32 Brix at 20 ^{o}C). A drop of homogenized pulp was used to measure the TSS and values were expressed as ^{o}Brix in each treatment. The readings were taken and their value was considered as results.

Total Soluble Sugar

Total soluble sugar from the mango both inoculated with pathogen and uninoculated was determined by phenol sulphuric acid method as described by Dubois *et al.* (1956).One gram of pulp was macerated in 5 mL of 80 per cent alcohol and transferred into 30 mL test tubes. The total volume was then adjusted to 10 mL with 80 per cent alcohol. The test tubes were left to stand overnight. The next day, 1 mL of supernatant from each test tube was taken and evaporated to dryness in a water bath. After evaporation, the residue was reconstituted with 25 mL of distilled water in a beaker. From this 25 mL solution, 1 mL was used for the assay. To this, 1 mL of freshly prepared 5 per cent phenol solution was added, followed immediately by the addition of 5 mL of concentrated sulfuric acid. The test tubes were kept for 10 minutes at room temperature for colour development. After mixing, the solution was placed in a cold water bath for an additional 15 minutes.

The intensity of the stable yellow color formed was measured at an optical density of 490 nm using a spectrophotometer using glucose as standard. The sugar content was determined using the following formula:

Total soluble sugar (g/100g) = Sample O.D x Graph factor (mg sugar) x 250/1000

True Protein

Protein content was determined by the method developed by Lowry *et al.* (1951). One g of pulp was homogenized in 5 mL of 0.1 N NaOH, and the mixture was filtered using Whatman No. 1 filter paper. From the filtered sample, 1 mL was transferred into a 10 mL volumetric flask and diluted with distilled water. The reactions were then carried out as per the method and absorbance at 750 nm was measured. The protein content was then calculated using bovine serum albumin as a standard with a concentration range of 50-300 μg. The result was expressed as a percentage.

$$\text{True protein (\%)} = \text{Graphfactor} \times \frac{\text{Sample reading}}{\text{weight of sample}} \times \frac{\text{Total volume}}{\text{Taken volume}} \times 10^{-4}$$

Titratable Acidity

Titratable Acidity was determined by the method developed by Rangana (1986). A known quantity of pulp (5 g) was taken and titrated against standard 0.1 N NaOH using phenolphthalein indicator. The end point of the titration was determined by taking the amount of NaOH required to reach pH 8.1 (appearance of pink colour). The value was expressed in terms of citric acid as per cent titratable acidity.

$$\text{Acidity (\%)} = \frac{\text{Titre value} \times \text{Normality of NaOH} \times \text{Volume made up} \times \text{Eq. wt. of acid} \times 100}{\text{Volume of sample taken} \times \text{weight of sample (g)} \times 1000}$$

Table 1. Biochemical changes in mango fruits following anthracnose infection

Sr. No.	Days	Total soluble solids		Total soluble sugar (%)		True protein (%)		Titratable acidity (%)	
		Healthy	Diseased	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
1	1	20.80	18.40	8.10	7.20	0.87	0.83	0.25	0.28
2	2	20.89	18.54	8.28	7.45	0.84	0.81	0.23	0.27
3	3	21.20	18.78	8.38	7.69	0.80	0.76	0.22	0.25
4	4	21.48	19.27	8.52	7.81	0.77	0.75	0.19	0.22
5	Control	21.8	21.3	8.44	8.33	0.76	0.74	0.20	0.19
S.Em ±		0.33	0.42	0.26	0.32	0.02	0.02	0.01	0.01
C.D. at 5%		1.02	1.28	0.79	0.97	0.07	0.05	0.03	0.02
C.V. (%)		2.25	3.14	4.36	5.81	4.35	3.12	6.32	4.07

RESULTS AND DISCUSSION

Total Soluble Solids

Healthy Dasheri mango fruits showed a gradual increase in TSS from 20.80 °Brix on Day 1 to 21.48 °Brix on Day 4, consistent with normal ripening. In contrast, anthracnose-infected fruits exhibited significantly lower TSS values, increasing only from 18.40 to 19.27 °Brix. The reduced accumulation of soluble solids in diseased fruits indicates impaired carbohydrate metabolism due to pathogen activity, which diverts sugars for fungal growth and respiration (Chen *et al*. 2021; Luo *et al*. 2022).

Total Soluble Sugars

A similar trend was observed for total soluble sugars. Healthy fruits recorded an increase from 8.10% to 8.52%, while diseased fruits showed significantly lower sugar content (7.20 to 7.81%). Reduced sugar accumulation in infected fruits may result from fungal utilization of simple carbohydrates and disruption of starch-to-sugar conversion during ripening (Chen *et al*. 2021; Luo *et al*. 2022).

True Protein Content

Diseased fruits exhibited higher protein content throughout storage compared to healthy fruits. Protein content in infected fruits ranged from 0.83% to 0.75%, whereas healthy fruits declined from 0.87% to 0.77%. Elevated protein content in diseased fruits may reflect accumulation of fungal biomass and induction of host defense-related proteins (Alkan and Fortes, 2015; Zhang *et al*.2023).

Titratable Acidity

Titratable acidity declined steadily in healthy fruits from 0.25% to 0.19%, reflecting normal ripening. In contrast, diseased fruits maintained higher acidity levels (0.28 to 0.22%). Higher acidity in infected fruits could be attributed to delayed organic acid metabolism and accumulation of fungal metabolic by-products (Wills *et al*., 2007; Meng *et al*., 2022).

Comparison with previous mango studies Similar biochemical deterioration of mango fruits infected with *C. gloeosporioides* has been reported earlier, including reduced sugar content, increased acidity, and compromised fruit quality (Arauz, 2000; Chaudhari, 2013; Tandel, 2017; Ramakrishna, 2021). Recent reviews further emphasize

that anthracnose remains a major challenge in mango postharvest management, necessitating integrated and sustainable control strategies (Jeevanantham *et al*. 2024; Palou *et al*. 2023).

Emerging technologies Emerging technologies such as hyperspectral imaging and combined physical–botanical treatments have shown promise in early detection and management of mango anthracnose while preserving biochemical quality (Velásquez *et al*. 2024; Wang *et al*. 2025; Xie *et al*. 2024).

CONCLUSION

The present study demonstrates that anthracnose caused by *Colletotrichum gloeosporioides* significantly disrupts the biochemical composition and ripening behavior of mango fruits. Healthy fruits followed normal ripening patterns characterized by increased total soluble solids and sugars and decreased protein content and titratable acidity. In contrast, infected fruits exhibited suppressed carbohydrate accumulation, elevated protein levels, and higher acidity, indicating impaired ripening and enhanced fungal metabolic activity. These biochemical alterations adversely affect fruit quality, flavor, and marketability, ultimately shortening shelf life. The evaluated biochemical parameters can serve as effective indicators of disease severity and may be useful in screening resistant genotypes and developing improved post-harvest disease management strategies.

DECLARATION

Conflict of Interest.Authors declare no conflict of interest.

REFERENCES

Alkan, N., Fortes, A. M. 2015. Insights into molecular and metabolic changes associated with fungal fruit pathogens during postharvest decay. *Mol. Plant Pathol.***16**: 613–624.

Arauz, L. F. 2000. Mango anthracnose: Economic impact and current options for integrated management. *Plant Dis.* **84**: 600–611.

Chaudhari, K. A. 2013. *Studies on anthracnose of mango*. Ph.D. Thesis, Junagadh Agricultural University, Gujarat, India.

Chen, Y., Jiang, Y., Duan, X.,Li, J. 2021. Fungal infection alters carbohydrate metabolism and organic acid profiles in postharvest fruit tissues. *Food Chem.* **352**: 129357.

Deng, L., Zhang, M., Yang, S.,Jiang, Y. 2022. Postharvest diseases of mango: Etiology, mechanisms and control strategies. *Postharvest Biol. Technol.* 189: 111938.

Droby, S., Wisniewski, M., Teixidó, N., Jijakli, M. H. 2021. The science, development, and commercialization of postharvest biocontrol products. *Annu. Rev. Phytopathol.***59**: 93–118.

Dubois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. A.,Smith, F. 1956. Colorimetric method for determination of sugars and related substances. *Analyt. Chem.***28**: 350–356.

García-Sánchez, F., Pérez-Pérez, J. G., Rubio, F.,Martínez, V. 2024. Improving resistance of mango to *Colletotrichum gloeosporioides* by activating reactive oxygen species and phenylpropanoid metabolism. *Metabolites***14**: 417.

Jeevanantham, S., Praveen, A., Livitha, R.,Balamurugan, K. 2024. Post-harvest anthracnose of mango caused by *Colletotrichum gloeosporioides*: A review. *Arch. Curr.Res. Inter.***24**: 106–115.

Li, J., Wang, T., Zhou, Y.,Chen, X. 2024. Mitigating postharvest quantitative and qualitative losses in mango fruits through biocontrol agents. *Heliyon* 10: e28758.

Lowry, O. H., Rosebrough, N. J., Farr, A. L., Randall, R. J. 1951. Protein measurement with Folin phenol reagent. *J. Biologic. Chem.***193**: 265–275.

Luo, Z., Xu, X., Xie, J. 2022. Regulation of sugar and organic acid metabolism in fruit during pathogen infection. *Trends in Food Sci. Technol.***120**: 44–55.

Meng, X., Zhang, S.,Li, G. 2022. Role of reactive oxygen species and antioxidant enzymes in fruit resistance to postharvest fungal pathogens. *Plant Physiol. Biochem.***182**: 88–97.

Palou, L., Ali, A., Droby, S. 2023. Alternatives to conventional fungicides for the control of postharvest diseases in tropical fruits. *Crit. Rev. Food Sci. Nutrit.***63**: 3121–3145.

Prusky, D., Alkan, N., Mengiste, T., Fluhr, R.2016. Quiescent infections in postharvest diseases. *Annu. Rev. Phytopathol.***54**: 55–84.

Ramakrishna, A. 2021. *Biological management of postharvest diseases of grapes and mango*. M.Sc. Thesis, MPKV, Rahuri, Maharashtra, India.

Ranganna, S. 1986. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products* (2nd ed.). Tata McGraw-Hill.

Sivakumar, D., Bautista-Baños, S. 2022. A review on the use of natural compounds to control postharvest diseases of tropical fruits. *Food Res. Inter.***156**:111178.

Tandel, D. H. 2017. *Prevalence, loss assessment and management of mango post-harvest fungal diseases*. Ph.D. Thesis, Navsari Agricultural University, Gujarat, India.

Wang, Z., Liu, Y., Chen, J.,Huang, X.2025. Combining plant extracts and hot water treatments for managing postharvest mango anthracnose and preserving fruit quality. *Scient. Reports***15**: 89587.

Wills, R. B. H., Golding, J. B., & McGlasson, W. B. 2007. *Postharvest: An Introduction to the Physiology and Handling of Fruit, Vegetables and Ornamentals*. UNSW Press.

Wu, J., You, Y., Wu, X., Liu, F., Li, G., Yin, H.,Zhang, S. 2023. Dynamic changes of mango epicuticular wax and its effect on *Colletotrichum gloeosporioides* invasion. *Front. Plant Sci.* 14: 1264660.

Xie, Y., Zhang, L., Chen, Q., Liu, H., Wang, Y. 2024. Dimethyl trisulfide reduces post-harvest anthracnose and enhances mango quality by controlling *Colletotrichum gloeosporioides*. *Food Contr.* 156: 110109.

Zhang, H., Li, W., Chen, H.,Wang, Y. 2023. Host defense responses and metabolic reprogramming during *Colletotrichum*-fruit interactions. *Mol. Plant Pathol.* 24: 987–1001.

Zhang, Z., Huber, D. J., Rao, J.,Jiang, Y. 2020. Changes in cell wall metabolism and fruit softening in response to fungal infection. *Postharvest Biol. Technol.***164**: 111–121.