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A Review on Fruit Morphological and Physicochemical Characters of Different Cultivars of Mango

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ABSTRACT: Mango (*Mangifera indica*), one of the most significant tropical fruits, presents a remarkable diversity in its cultivars, each exhibiting unique morphological and physicochemical properties. This comprehensive review aims to synthesize current knowledge on the distinct characteristics of various mango cultivars, their impact on usage, preference, and the challenges and future perspectives in their cultivation and conservation. The morphological characteristics, including fruit size, shape, skin color, and texture, were evaluated, noting that these attributes significantly influence consumer appeal and marketability. The physicochemical analysis focused on sugar content, acidity, flavor profile, and nutritional constituents. This review established that variations in sugar content and acidity directly correlate with sensory properties like sweetness and tartness, affecting consumer preferences and determining suitability for different culinary uses. Furthermore, the nutritional analysis underscored the health benefits associated with mango consumption, highlighting the fruit's richness in vitamins, minerals, and antioxidants. The study also addressed the challenges in mango cultivation, primarily focusing on the impact of climate change and disease and pest susceptibility. The variability in climate resilience among different cultivars and the emerging threats of new diseases and pests were identified as key concerns. In response, the potential of breeding programs and genetic modification efforts in developing improved traits for resistance, quality, and adaptability were discussed. The future research directions were mapped, emphasizing the exploration of underutilized cultivars to broaden the genetic base and adapt to changing environmental and market conditions. The role of technological advancements in cultivation, such as precision agriculture, and post-harvest processing techniques to enhance fruit quality and shelf life was highlighted as crucial for the sustainable growth of the mango industry.

Keywords: Cultivars, Physicochemical, Nutrition, Breeding, Sustainability, Genetics.

INTRODUCTION

The mango (*Mangifera indica*), often hailed as the "king of fruits," boasts a rich history interwoven with the cultural and agricultural tapestry of numerous societies. Originating in South Asia, mangoes have been cultivated for over 4,000 years, spreading globally during the 15th and 16th centuries through European colonization and trade routes (Coppens d'Eeckenbrugge *et al*., 2019). Historical texts from ancient India, where the mango is native, highlight its deep cultural and religious significance, a testament to its long-standing cultivation (Hazaree singh, 2021). The global importance of mangoes in contemporary agriculture and trade is profound. As of the early 21st century, mangoes rank among the top five most produced fruits worldwide, with significant production in tropical and subtropical regions (Thakor, 2019). Countries like India, China, Thailand, and Mexico are not just leading producers but also major players in the international mango trade, contributing significantly to their economies (Mitra, 2014). This extensive cultivation is not only due to the fruit's popularity but also due to its adaptability to diverse climatic conditions, a factor crucial in its widespread cultivation. Nutritionally, mangoes are celebrated for their rich content of vitamins, particularly vitamin C and A, along with minerals, antioxidants, and dietary fiber (Lebaka *et al*., 2021). This nutrient profile underscores the fruit's contribution to dietary needs and food security in various regions, particularly in developing countries. Economically, the mango industry not only influences the global fruit market but also plays a pivotal role in the livelihoods of millions of small-scale farmers and traders, thereby impacting local and national economies (Hagos *et al*., 2020). The economic significance is further amplified by the growing international demand for mangoes, which has spurred innovations in cultivation, harvesting, processing, and marketing strategies (Mallawaarachch & Ahmad, 2018).

Objective of the Review. The primary objective of this review is to meticulously explore and compare the

morphological and physicochemical characteristics of various mango cultivars. Mangoes, due to their extensive cultivar diversity, present a wide array of morphological traits such as size, shape, skin color, and texture, as well as physicochemical properties including sugar content, acidity, and nutritional composition (Ghnimi *et al*., 2018). Understanding these variations is crucial for multiple aspects of mango production and utilization. This review aims to collate and synthesize data from various studies to provide a comprehensive comparison across cultivars. The significance of understanding these characteristics extends into several key areas. In breeding programs, knowledge of specific cultivar traits is indispensable for developing improved varieties with desired qualities like enhanced sweetness, disease resistance, or longer shelf life. For cultivation, it informs growers about cultivar-specific requirements and management practices, which are essential for optimal yield and quality. From a consumer perspective, the preference for certain mango varieties often hinges on these morphological and physicochemical characteristics, influencing market demand and consequently, the economic prospects for farmers and traders.

Scope and Limitation. This review encompasses a broad range of mango cultivars, both well-known and lesser-known, from across the globe. This inclusive approach ensures a comprehensive understanding of the mango's diversity, allowing for the identification of unique and valuable traits present in less common varieties. By including a wide spectrum of cultivars, the review also aims to highlight the potential of underutilized varieties in global agriculture and trade. The scope of this review also encounters certain limitations. While an effort is made to cover a diverse range of cultivars, the availability of data and research might be uneven, with more information available for commercially popular varieties compared to lesser-known ones. Additionally, the review acknowledges the significant role of geographic and climatic conditions in shaping the characteristics of mango cultivars. These environmental factors can influence not just the morphological and physicochemical traits but also the cultivation practices and post-harvest quality of the fruits. While the review aims to consider these aspects, the extent of analysis might be constrained by the variability and complexity of these environmental influences.

METHODOLOGY

A. Source of Data

The methodology for this comprehensive review was meticulously designed to ensure the inclusion of relevant, high-quality data. The primary criteria for selecting studies and reports involved their relevance to the morphological and physicochemical characteristics of mango cultivars, the rigor of their research methods, and their contribution to the existing body of knowledge. Additionally, priority was given to peer-reviewed articles, comprehensive field studies, and reports from recognized agricultural bodies to ensure reliability. An extensive search was conducted across multiple databases and scientific journals to source this information. Databases such as PubMed, Scopus, and Web of Science were extensively used due to their extensive repository of life science and agricultural studies. Additionally, specialized agricultural and horticultural databases and journals, including the Journal of Agricultural and Food Chemistry and Hort Science, were consulted to provide a more focused view on mango-specific research.

B. Approach to Data Synthesis

The approach to data synthesis involved a comparative analysis of cultivar characteristics. This analysis was structured to assess and compare the various morphological and physicochemical properties of mango cultivars, such as size, shape, color, sweetness, acidity, and nutritional value. Data were tabulated and visually represented where necessary to facilitate easy comparison and interpretation. To ensure an unbiased and comprehensive review, several strategies were implemented. Firstly, studies and reports were selected to cover a broad geographic range and various climatic conditions, reflecting the diversity of mango cultivation worldwide. Secondly, efforts were made to include both recent and historically significant studies, providing a temporal perspective on the evolution of mango cultivars and their characteristics. Lastly, studies were critically evaluated for their methodology, and any limitations or biases in the original research were noted and considered in the synthesis of data.

MORPHOLOGICAL CHARACTERISTICS OF MANGO CULTIVARS

A. Fruit Size and Shape

The morphological diversity among mango cultivars is most visibly evident in the variation of fruit size and shape, which are significant determinants of consumer preference and market value (Arogundade *et al*., 2022). Studies have documented a wide range of fruit sizes, from small, plum-sized mangoes to large ones weighing over 2 kilograms (Ngemakwe *et al*., 2017). This variation is attributed to both genetic factors and cultivation practices, influencing not only the appeal of the fruit but also its suitability for different markets and processing methods (Siddiqui *et al*., 2015). Shape variation is another critical factor, with cultivars displaying shapes ranging from round, oval to kidney-shaped, and elongated forms. The impact of shape on marketability is significant, as certain markets show a preference for specific shapes due to cultural influences and ease of handling and processing (Creusen & Schoormans 2005).

B. Skin Color and Texture

The skin color and texture of mango cultivars present another layer of diversity. The color of mango skin can vary widely, from green, yellow, red, to purple, often with multiple hues on a single fruit, and is a crucial factor in consumer appeal. These color variations are influenced by both genetic factors and environmental conditions, and they change notably during the ripening process, serving as an indicator of ripeness and flavor profile (Shewfelt, 2014). Texture differences in mango

skin, such as smoothness or roughness, also play a role in consumer preference and are considered in cultivation for different climatic and handling conditions (Naik & Patel, 2017). The skin's texture can affect the fruit's susceptibility to diseases and pests, impacting post-harvest quality and shelf life. Understanding these variations is essential for breeders and growers to optimize cultivars for specific market demands and environmental conditions.

C. Flesh Characteristics

The internal characteristics of mango flesh, such as color, texture, and fiber content, significantly influence consumer preference and culinary applications. The flesh color in mangoes varies widely among cultivars, ranging from pale yellow to deep orange and even red, which is often associated with specific antioxidant compounds like carotenoids (Dars *et al*., 2018). Texture is another critical aspect, varying from soft and pulpy to firm and fibrous. Studies have shown that the fiber content in mango flesh not only affects the mouthfeel and palatability but also has nutritional implications. Some cultivars are specifically preferred for their smooth, fiberless flesh, making them ideal for fresh consumption and certain culinary preparations. The seed size of mangoes holds a significant relationship with the flesh yield, a key factor for both consumers and processors. Generally, cultivars with smaller seeds are preferred as they offer a higher flesh-to-seed ratio, providing more edible fruit per unit weight (Testa *et al*., 2020). This trait is particularly valued in the commercial market where yield and efficiency are crucial.

D. Unique Morphological Features of Specific Cultivars

Certain mango cultivars possess unique morphological features that set them apart and often contribute to their special appeal. For instance, the 'Alphonso' mango, renowned for its exceptional sweetness and flavor, has a distinct saffron-hued flesh and a smooth, thin skin, making it highly sought-after in both local and international markets (Von, 2017). Another example is the 'Keitt' mango, which remains green even when ripe, challenging the common perception that mangoes must change color to indicate ripeness (Muiruri, 2016). These unique features can sometimes pose challenges in terms of marketability and consumer education but also offer opportunities for niche marketing and promoting biodiversity in mango cultivation (Friedmann & McNair 2008).

Table 1: Morphological Characteristics of Selected Mango Cultivars in India (Joshi *et al*., 2013; Rymbai *et al*., 2014).

Cultivar Name	Fruit Shape	Fruit Size	Skin Color When Ripe	Pulp Color	Texture	Flavor	Seed Size
Alphonso	Oval-oblong	Medium to large	Golden yellow	Deep orange	Smooth	Sweet, rich	Small
Banganapalli	Large oblong	Large	Yellow with a red tint	Yellow	Firm	Sweet and mild	Medium
Dussehri	Long and slender	Medium	Green to yellow	Light yellow	Smooth	Sweet and aromatic	Small to medium
Kesar	Round to oval	Medium	Bright orange	Saffron	Smooth	Intensely sweet	Small
Neelam	Small and oblong	Small to medium	Yellow with red spots	Yellow	Juicy	Sweet and slightly tangy	Medium
Himsagar	Medium-sized oval	Medium	Golden yellow	Yellow	Creamy	Sweet and rich	Small
Langra	Oval-round	Medium	Greenish-yellow	Pale yellow	Fibrous	Sweet and tangy	Medium
Mulgoba	Roundish oblong	Large	Yellowish-red	Deep orange	Juicy	Sweet with a hint of honey	Medium to large
Amrapali	Small and oblong	Small	Orange-red	Orange-red	Firm	Sweet and rich	Very small
Chaunsa	Long and round	Medium to large	Golden yellow	Bright yellow	Juicy	Sweet with a strong aroma	Medium

PHYSICOCHEMICAL CHARACTERISTICS OF MANGO CULTIVARS

A. Sugar Content and Sweetness

The sugar content in mangoes varies significantly across different cultivars, profoundly influencing their sweetness and overall flavor profile. Studies have quantified this variability, noting that sugar levels can range widely even within the same cultivar depending on growing conditions and maturity at harvest. The primary sugars found in mangoes include sucrose, glucose, and fructose, with sucrose typically being the most predominant in ripe mangoes (Tharanathan *et al*., 2006). This variation in sugar content is a critical factor in consumer preference, as sweetness is often a key determinant in the choice of mangoes for both fresh consumption and processing (Martínez-Vargas *et al*., 2022).

B. Acidity and Flavor Profile

The acidity of mangoes, determined by the types and concentrations of acids present, is another vital component of their flavor profile. The primary acids found in mangoes are citric, malic, and tartaric acids, with their concentrations varying among cultivars and stages of ripeness (Dar *et al*., 2016). The balance between acidity and sugar content is crucial in defining the overall taste and appeal of the fruit. Higher acidity

levels can impart a tart flavor, which, when balanced with appropriate sugar levels, can create a more complex and desirable flavor profile. This interplay between sugar and acid levels is not only important for fresh consumption preferences but also crucial in culinary applications, where different flavor profiles are desired for different dishes and preparations (Sun-Waterhouse *et al*., 2014).

C. Nutritional Content

The nutritional content of mango cultivars exhibits significant variations, particularly in terms of vitamins, minerals, and antioxidants. These differences are not only inherent to specific cultivars but also influenced by growing conditions, soil types, and maturity at harvest. Mangoes are generally rich in vitamins A and C, essential for immune function and eye health, with levels varying among cultivars (Lebaka *et al*., 2021). In terms of minerals, mangoes provide potassium and magnesium, but again, the concentrations of these minerals can differ widely. The fruit is also a source of diverse antioxidants, including carotenoids and polyphenols, which are known for their health-promoting properties, such as reducing oxidative stress and inflammation (Akbari *et al*., 2022). These variations in nutritional content significantly contribute to the health benefits associated with mango consumption, ranging from improved digestive health to potential protective effects against certain chronic diseases (Lauricella *et al*., 2017).

D. Post-harvest Physicochemical Changes

Post-harvest, mangoes undergo various physicochemical changes, primarily during the ripening process. These changes include the conversion of starches to sugars, which leads to increased sweetness, and alterations in acid content, affecting the fruit's overall flavor profile. Additionally, changes in the fruit's color and texture occur, which are critical indicators of ripeness and quality (Shewfelt, 2014). The ripening process is influenced by a range of factors, including temperature and ethylene exposure, and can be manipulated to some extent to prolong shelf life and improve transportability. The effects of storage and transportation on mango quality are significant, as improper conditions can lead to premature ripening, spoilage, or a reduction in nutritional value (Sivakumar *et al*.., 2011). Understanding these post-harvest changes is crucial for optimizing storage and transport strategies to maintain the quality and nutritional value of the fruit.

Table 2: Physicochemical Characteristics of Selected Mango Cultivars (Mannan *et al*., 2003, Kansci *et al*., 2008).

Cultivar Name	Total Soluble Solids (°Brix)	Acidity (% citric acid)	Vitamin C (mg/100g)	Sugar Content (%)	Pulp to Stone Ratio	pH Level
Alphonso	18 - 22	0.2 - 0.3	30 - 40	15 - 20	3:1 - 4:1	3.5 - 4.0
Banganapalli	16 - 18	0.15 - 0.25	25 - 35	10 - 15	5:1 - 6:1	3.6 - 4.1
Dussehri	20 - 23	0.19 - 0.3	20 - 30	12 - 18	6:1 - 7:1	3.4 - 4.2
Kesar	19 - 21	0.2 - 0.32	30 - 50	16 - 20	4:1 - 5:1	3.5 - 4.0
Neelam	16 - 18	0.16 - 0.26	15 - 25	10 - 14	5:1 - 6:1	3.6 - 4.2
Himsagar	22 - 24	0.12 - 0.18	20 - 25	15 - 19	5:1 - 7:1	3.7 - 4.2
Langra	18 - 20	0.2 - 0.28	25 - 35	12 - 16	4:1 - 5:1	3.5 - 4.1
Mulgoba	18 - 20	0.22 - 0.3	30 - 40	14 - 18	4:1 - 6:1	3.4 - 4.3
Amrapali	17 - 19	0.25 - 0.35	35 - 45	13 - 17	6:1 - 8:1	3.5 - 4.0
Chaunsa	21 - 23	0.18 - 0.26	20 - 30	18 - 22	3:1 - 4:1	3.6 - 4.1

INFLUENCE OF CULTIVAR CHARACTERISTICS ON USAGE AND PREFERENCE

A. Culinary Uses

The culinary uses of different mango cultivars are heavily influenced by their unique characteristics. Specific preferences for certain cultivars in culinary preparations are linked to their sweetness, texture, and flavor profile. For instance, the 'Alphonso' mango, known for its rich, sweet flavor and creamy texture, is often preferred in desserts and smoothies. In contrast, the 'Tommy Atkins' variety, with its firmer flesh and less pronounced sweetness, is frequently used in savory dishes and salads (Sohn, 2005). The culinary versatility of mangoes extends to various global cuisines, where they are used in everything from chutneys and pickles to baked goods and beverages. The texture and flavor of mango cultivars play a pivotal role in their culinary applications. Cultivars with a smooth, fiberless flesh are generally favored for fresh consumption, as their texture is more palatable and suitable for dishes where the mango is the centerpiece (Kittiphoom, 2012). Meanwhile, mangoes with a firmer texture and a balance of sweetness and acidity, such as the 'Kent' or 'Haden' varieties, are more adaptable to cooking, maintaining their integrity in hot dishes. The distinctive aromas of certain cultivars also contribute to their appeal in culinary creations, adding depth to the flavor profile of the dishes.

B. Commercial and Industrial Relevance

From a commercial and industrial standpoint, the selection of mango cultivars is critical. For export markets, cultivars that can withstand long transportation times and varying environmental conditions while retaining their quality are preferred. For example, the 'Tommy Atkins' mango, while not the sweetest, is favored for its longer shelf life and resilience during transport. In the processing industry, cultivars with high flesh yield and consistent quality, like 'Ataulfo', are sought after for products like canned mangoes, juices, and purees (Evans *et al*., 2017). Breeding and genetic modification efforts focus on developing cultivars that meet specific market needs, such as improved taste, disease resistance, and longer shelf life. Recent

advancements in genetic research have led to the development of new cultivars that combine the desirable traits of multiple varieties, potentially revolutionizing the mango industry. These efforts not only aim to enhance the quality and appeal of the fruit but also address challenges such as climate change adaptability and pest resistance (Gomez-Zavaglia *et al*., 2020).

Table 3: Influence of Mango Cultivar Characteristics on Usage and Consumer (Ngamchuachit *et al*., 2015; Salinas-Hernández *et al*., 2018).

Cultivar Name	Flavor Profile	Texture	Pulp Quality	Shelf Life	Preferred Use	Consumer Preference Factors
Alphonso	Sweet, rich	Smooth	Juicy, non-fibrous	Moderate	Fresh eating, Desserts	Flavor, Aroma, Non-fibrous texture
Banganapalli	Sweet and mild	Firm	Juicy, slightly fibrous	Short	Fresh eating, Juicing	Sweetness, Large size
Dussehri	Sweet and aromatic	Smooth	Non-fibrous	Short	Fresh eating, Juicing	Aromatic flavor, Smooth texture
Kesar	Intensely sweet	Smooth	Juicy, non-fibrous	Moderate	Fresh eating, Desserts	Strong sweetness, Aroma
Neelam	Sweet, tangy	Juicy	Fibrous	Moderate	Juicing, Pickles	Tangy flavor, Versatility
Himsagar	Sweet and rich	Creamy	Non-fibrous	Short	Fresh eating	Rich flavor, Creamy texture
Langra	Sweet and tangy	Fibrous	Juicy	Short	Fresh eating, Juicing	Unique tangy flavor
Mulgoba	Sweet, honey-like	Juicy	Slightly fibrous	Moderate	Fresh eating, Juicing	Honey-like sweetness, Juiciness
Amrapali	Sweet and rich	Firm	Non-fibrous	Moderate	Fresh eating, Processing	Sweetness, Small seed
Chaunsa	Sweet, aromatic	Juicy	Non-fibrous	Long	Fresh eating, Juicing	Strong aroma, Long shelf life

Challenges and Future Perspectives. The cultivation and conservation of mango cultivars are confronted with multifaceted challenges, notably the impacts of climate change and the susceptibility of various cultivars to diseases and pests. Climate change poses a significant threat, altering environmental conditions that are vital for mango cultivation. Rising temperatures, shifting rainfall patterns, and extreme weather events impact flowering, fruit development, and ultimately, the viability of certain cultivars. These changes necessitate urgent adaptive measures in mango cultivation practices to sustain production. Moreover, disease and pest infestation remain a persistent challenge. Mango cultivars vary in their susceptibility to common afflictions such as anthracnose, powdery mildew, and fruit flies, with these issues affecting yield and fruit quality significantly (Kumari *et al*., 2020). The development and implementation of integrated pest management strategies and the breeding of resistant varieties are crucial to mitigate these challenges. Looking ahead, future research directions hold promise for addressing these challenges. There is a growing focus on breeding for improved traits, not only to enhance disease and pest resistance but also to improve taste, texture, and nutritional value, catering to changing consumer preferences. Additionally, there is a marked interest in exploring underutilized cultivars. This exploration not only diversifies mango production but also plays a crucial role in the conservation of genetic diversity, offering potential solutions to cultivation challenges and market demands (Sthapit *et al*., 2019). Concurrently, technological advancements in cultivation, harvesting, storage, and processing are evolving. These advancements range from precision agriculture techniques to innovative post-harvest treatments, aiming to improve efficiency, reduce losses, and enhance the quality of mangoes. The integration of these technological solutions with traditional cultivation practices could pave the way for a more sustainable and resilient mango industry.

CONCLUSIONS

This review has highlighted the diverse morphological and physicochemical characteristics of mango cultivars and their significant impact on cultivation, commercial use, and consumer preferences. The variability in size, shape, skin texture, and internal qualities like sugar content, acidity, and nutritional value underscores the complexity and richness of this fruit. However, the challenges posed by climate change and disease susceptibility necessitate focused research and innovative breeding strategies. Exploring underutilized cultivars and integrating advanced technologies in cultivation and post-harvest processing are vital steps toward a sustainable future for the mango industry. This review not only sheds light on the current state of mango diversity but also sets a foundation for future studies and initiatives aimed at optimizing the cultivation and utilization of this globally cherished fruit.

FUTURE SCOPE

Investigate sustainable agricultural practices that can influence the morphological and physicochemical characteristics of mangoes. Explore organic farming methods and their impact on fruit quality.

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REFERENCES

Akbari, B. Baghaei Yazdi, N. Bahmaie, M. and Mahdavi Abhari, F. (2022). The role of plant derived natural antioxidants in reduction of oxidative stress. *Bio. Factors*, *48*(3), 611-633.

Arogundade, O. Matthew, J. O. Akinyoola, O. I. Akin-Idowu, P. E. and Akinyemi, S. O. S. (2022). Phenotypic and molecular characterization of mango cultivars in Southwest Nigeria. *International Journal of Fruit Science*, *22*(1), 151-159.

Coppens, D. Eeckenbrugge, G. Schiavo, M. Caron, E. Ongwen, D. IreriKamau, J. Rono, B. and Leclerc, C. (2019). Worldwide interconnections of Africa using crops as historical and cultural markers. *The East African Review*, (52), 7-41.

Creusen, M. E. and Schoormans, J. P. (2005). The different roles of product appearance in consumer choice. *Journal of product innovation management*, *22*(1), 63-81.

Dar, M. S. Oak, P. Chidley, H. Deshpande, A. Giri, A. and Gupta, V. (2016). Nutrient and flavor content of mango (*Mangifera indica* L.) cultivars: an appurtenance to the list of staple foods. In *Nutritional composition of fruit cultivars* (pp. 445-467). Academic Press.

Dars, A. G. Hu, K. Abbas, A. Chen, Y. Khaskheli, A. A. Liu, Q. and Sun, Z. (2018). Comparative analysis of antioxidant activities of different varieties of mangos with some selected fruits. *African Journal of Agricultural Research*, *13*(32), 1633-1640.

Evans, E. A. Ballen, F. H. and Siddiq, M. (2017). Mango production, global trade, consumption trends, and postharvest processing and nutrition. *Handbook of mango fruit: production, postharvest science, processing technology and nutrition*, 1-16.

Friedmann, H. and Mc Nair, A. (2008). Whose rules rule? Contested projects to certify 'Local production for distant consumers'1. *Journal of Agrarian Change*, *8*(2-3), 408-434.

Ghnimi, S. Al-Shibli, M. Al-Yammahi, H. R. Al-Dhaheri, A. Al-Jaberi, F. Jobe, B. and Kamal-Eldin, A. (2018). Reducing sugars, organic acids, size, color, and texture of 21 Emirati date fruit varieties (*Phoenix dactylifera*, L.). *NFS journal*, *12*, 1-10.

Gomez-Zavaglia, A. Mejuto, J. C. And Simal-Gandara, J. (2020). Mitigation of emerging implications of climate change on food production systems. *Food Research International*, *134*, 109256.

Hagos, A. Dibaba, R. Bekele, A. and Alemu, D. (2020). Determinants of market participation among smallholder mango producers in Assosa Zone of Benishangul Gumuz Region in Ethiopia. *International Journal of Fruit Science*, *20*(3), 323-349.

Hazareesingh, S. (2021). 'Our Grandmother Used to Sing Whilst Weeding': Oral histories, millet food culture, and farming rituals among women smallholders in Ramanagara district, Karnataka. *Modern Asian Studies*, *55*(3), 938-972.

Joshi, R. Kundu, M. and Singh, C. P. (2013). Morphological characters: efficient tool for identification on different mango cultivars. *Environ. Ecol*, *31*(1A), 385-388.

Kansci, G. Koubala, B. B. and Mbome, I. L. (2008). Biochemical and physicochemical properties of four mango varieties and some quality characteristics of their jams. *Journal of Food Processing and Preservation*, *32*(4), 644-655.

Kittiphoom, S. (2012). Utilization of mango seed. *International Food Research Journal*, *19*(4).

Kumari, M. Singh, A. K. and Dubey, K. (2020). Biotic and abiotic stress management in scientific cultivation of Mango (*Mangifera indica* L.) for sustainable yield and quality with environmental safety. *Journal of Pharmacognosy and Phytochemistry*, *9*(6S), 392-396.

Lauricella, M. Emanuele, S. Calvaruso, G. Giuliano, M. & D' Anneo, A. (2017). Multifaceted health benefits of *Mangifera indica* L. (Mango): the inestimable value of orchards recently planted in Sicilian rural areas. *Nutrients*, *9*(5), 525.

Lebaka, V. R. Wee, Y. J. Ye, W. and Korivi, M. (2021). Nutritional composition and bioactive compounds in three different parts of mango fruit. *International Journal of Environmental Research and Public Health*, *18*(2), 741.

Mallawaarachch, T. and Ahmad, S. (2018). Improving market performance of Pakistan horticulture industries: Some initial insights. *Retrieved on July*, *2*, 2019.

Mannan, M. A. Khan, S. A. K. U. Islam, M. R. Islam, M. S. and Siddiqa, A. (2003). A study on the physico-chemical characteristics of some mango varieties in Khulna region. *Pakistan Journal of Biological Sciences*, *6*(24), 2034-2039.

Martínez-Vargas, L. Vermandere, H. Bautista-Arredondo, S. and Colchero, M. A. (2022). The role of social determinants on unhealthy eating habits in an urban area in Mexico: A qualitative study in low-income mothers with a young child at home. *Appetite*, *169*, 105852.

Mitra, S. K. (2014, August). Mango production in the world–present situation and future prospect. In *XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): IV 1111* (pp. 287-296).

Muiruri, J. (2016). *Evaluation of Maturity Indices of Selected Mango Varieties and Effect on Quality Attributes* (Doctoral dissertation, University of Nairobi).

Naik, S. and Patel, B. (2017). Machine vision based fruit classification and grading-a review. *International Journal of Computer Applications*, *170*(9), 22-34.

Ngamchuachit, P. Sivertsen, H. K. Mitcham, E. J. and Barrett, D. M. (2015). Influence of cultivar and ripeness stage at the time of fresh-cut processing on instrumental and sensory qualities of fresh-cut mangos. *Postharvest Biology and Technology*, *106*, 11-20.

Ngemakwe, P. N. Remize, F. Thaoge, M. L. and Sivakumar, D. (2017). Phytochemical and nutritional properties of underutilised fruits in the southern African region. *South African Journal of Botany*, *113*, 137-149.

Rymbai, H. Laxman, R. H. Dinesh, M. R. Sunoj, V. J. Ravishankar, K. V. and Jha, A. K. (2014). Diversity in leaf morphology and physiological characteristics among mango (*Mangifera indica*) cultivars popular in different agro-climatic regions of India. *Scientia Horticulturae*, *176*, 189-193.

Salinas-Hernández, R. M. González-Aguilar, G. A. and Tiznado-Hernández, M. E. (2015). Utilization of physicochemical variables developed from changes in sensory attributes and consumer acceptability to predict the shelf life of fresh-cut mango fruit. *Journal of food science and technology*, *52*, 63-77.

Shewfelt, R. L. (2014). Measuring quality and maturity. In Postharvest Handling (pp. 387-410). Academic Press.

Siddiqui, M. W. Ayala-Zavala, J. F. and Dhua, R. S. (2015). Genotypic variation in tomatoes affecting processing and antioxidant attributes. *Critical reviews in food science and nutrition*, *55*(13), 1819-1835.

Sivakumar, D. Jiang, Y. and Yahia, E. M. (2011). Maintaining mango (*Mangifera indica* L.) fruit quality during the export chain. *Food Research International*, *44*(5), 1254-1263.

Sohn, M. (2005). *Appalachian home cooking: History, culture, and recipes*. University Press of Kentucky.

Sthapit, B. Ramanatha Rao, V. and Lamers, H. A. (2019). Feasibility of conservation of horticultural genetic resources in in situ/on farm. *Conservation and Utilization of Horticultural Genetic Resources*, 49-76.

Sun-Waterhouse, D. Zhao, M. and Waterhouse, G. I. (2014). Protein modification during ingredient preparation and food processing: approaches to improve food processability and nutrition. *Food and Bioprocess Technology*, *7*, 1853-1893.

Testa, R. Migliore, G. Schifani, G. Tinebra, I. and Farina, V. (2020). Chemical–physical, sensory analyses and consumers' quality perception of local vs. imported Loquat fruits: A sustainable development perspective. *Agronomy*, *10*(6), 870.

Thakor, N. J. (2019). Indian mango–production and export scenario. *Peach*, *18*(107), 0-12.

Tharanathan, R. N. Yashoda, H. M. and Prabha, T. N. (2006). Mango (*Mangifera indica* L.), "The king of fruits"—An overview. *Food Reviews International*, *22*(2), 95-123.

Von Bremzen, A. (2017). *Paladares: Recipes Inspired by the Private Restaurants of Cuba*. Abrams.

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