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# Comparative Studies of Malic Acid and Citric Acid Contents in three varieties of Mango (*Mangifera indica*) Pulp.

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**Abstract**

Mango (*Mangifera indica L*) is the most flavoured delicious fruits of the tropical and subtropical regions. It has an excellent flavour, antioxidant properties, attractive fragrance, delicious taste and high nutritional value that have made it one of the much loved fruit. The analysis was selected from three varieties of mango i.e. Amrapali, Langra and Chausa. All these samples were collected from village Dhaulri, Ghaziabad district, Uttar Pradesh. The environmental conditions are so suitable to produce the peculiar characters. We found that the analysis of malic and citric acid content helps to preserve the ripped mango pulp. Langra had the highest citric acid and lowest in Amrapali variety. The highest malic acid was found in Amrapali whereas Langra had the lowest content. The objective of the present study is to scrutinize the malic acid and citric acid content changes during the unripe to ripened stage of the fruit. What kind of changes are seen in these conditions and try to know whether there are some important roles in the preservation after ripening. Keeping these facts in mind also experiments were performed. The Langra variety has more citric acid ,malic acid and citric malic acid ratio resulting in more preserving time for pulp but amrapali is a hybrid variety. It is also a specialty due to an excellent flavor which depends upon organic acid composition. In *Amrapali* variety citric acid decrease 390.2 to 78.4 mg % and malic acid 64.0 to 48.8 mg % decreases and the citric acid malic acid ratio 6.09 to 1.61 decrease unripe to ripe stage (0 to 8 days after harvest ) similarly in the *Langra* variety citric acid decrease 502.2 to 122.7 mg % and malic acid 80 to 48.0 mg % decreases and the citric acid malic acid ratio 6.09 to 1.61 decrease unripe to ripe stage (0 to 8 days after harvest ) and in the *Chausa* variety citric acid decrease 278.7 to 102.0 mg % and malic acid 70.0 to 46.0 mg % decreases and the citric acid malic acid ratio 2.56 to 2.22 (0 to 8 days after harvest )

**Keywords:** Mango, Citric acid, Malic acid, Preservative, Langra. Chausa, Amrapali.

**Introduction**

Mango (*Mangifera Indica*) is a popular fruit among the people around the world. It is an indigenous tree of India. It covers an area of 1.23 million hectares ((Knight R.J. 1997, Negi, 2000). (Knight R.J. 1997) The Indian subcontinent is very rich in mango flora.

**Review of Literature**

Most of the mango cultivars were originated as superior to natural crossing or gene mutation (Maldonado-Celis 2019 ). The variations in sensorial characteristics depend on the specific cultivars. (Knight, 1997). It has a wide variety of varieties in terms of colour, shape, smell and taste (Lauricella, M. 2017, Vallarino, J.G.; Osorio,2019). At the harvesting stage, it has a very low total soluble sugar content with a high acidic value. The fruit ripening process involves a series of physiological, biochemical, and organoleptic changes that lead to the development of soft, edible, ripe fruits with desirable quality (Drzikova B. 2005, Krishnamurty S. 1971 , Panday R.M. 1974 , Fuchs Y 1980 , Tandon D K 1983 , Medlicott A.P. 1985 ). India is a leading producer of mango with an area of 1.23 million hectares with high production (Negi SS 2000) and has ranked first among the world's mango producing countries. Each mango cultivars on the ripening stage have distinguishing characteristics and flavor. (Tyagi D.N. 1986 , Lodhi S.B. Subramanyam 1974) . The Present studies were made in the Ghaziabad district. It is located in the extreme part of western Uttar Pradesh State of India. It covers an area of 2590 km $^2$ . With a population of almost 30 laces ; Ghaziabad lies between 280 26‟ and 280 59‟ north latitude and 770 12‟ and 780 13‟ east longitude. It is bordered by Meerut in the North and Gautam Budh Nagar as well as Bulandshahr district in the South. River Ganga forms the natural boundary in the east, separating it from Moradabad

district. River Yamuna forms a part of the western boundary.

The studied area is more favourable for growing this crop. The sampleswere taken from this region for the experiments. Fig.1(a) depicts the sampling location.

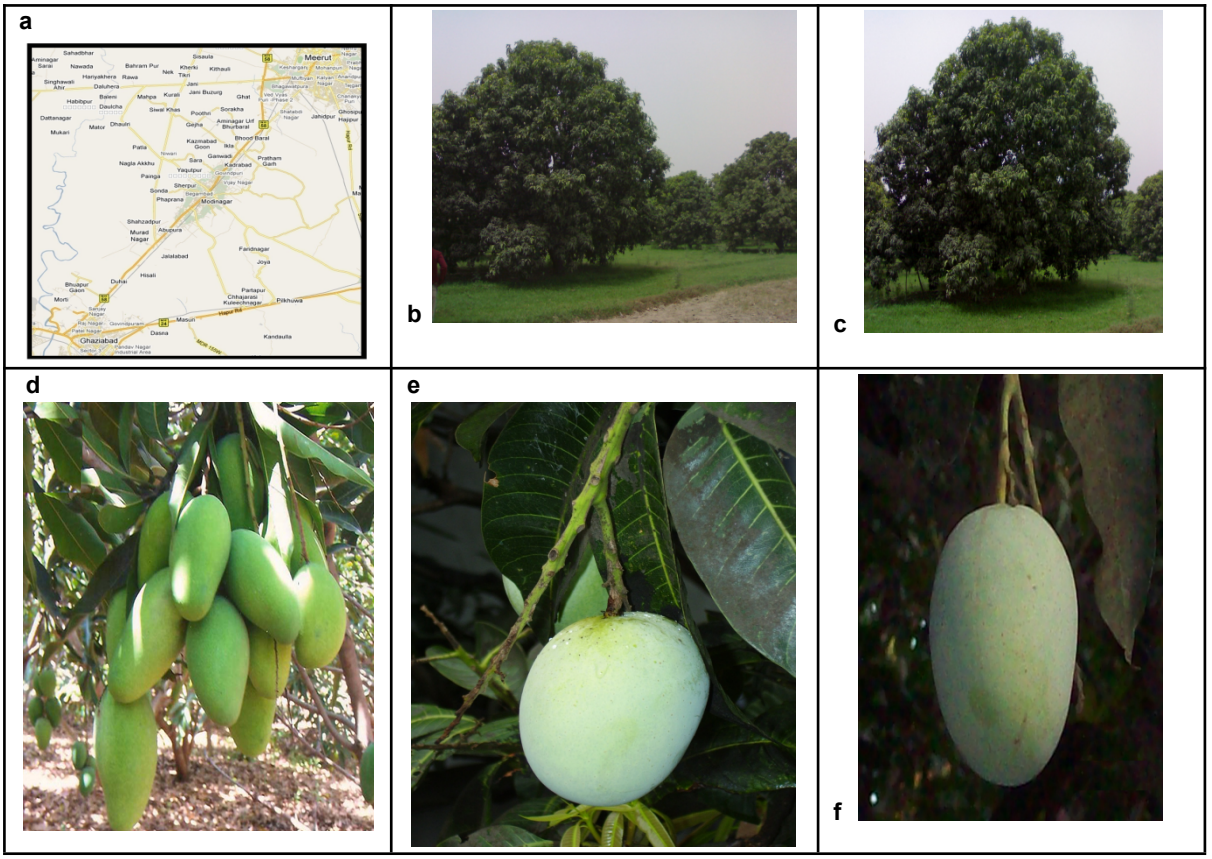


**Fig-1-(a) Mango sampling place (b) and (c):-Photos of trees taken from Mango orchard (d) Amarpali variety (e) Langra variety (f ) Chausa variety**

One of the main varieties grown in this region out of which three varieties amrapali ,langra and chausa are selected

The Amarpali variety was the first mango hybrid of the world, released by IARI, New Delhi in 1979. It is a cross between Dasheari, the popular cultivar of North India and Neelum, and the famous cultivar of South India. The plants are distinctly dwarf, regular and prolific in bearing. Due to dwarf stature it has been recommended for high density planting with a planting density of 1,600 plants /ha at 2.5 x 2.5 m planting distance. The fruits are small to medium (130 gm).55 Fruit has 75 % pulp content and very high carotenoid content. Fruit quality is excellent, good for table purpose and nectar development. It matures by 3rd week of July under North Indian conditions.

Langra is the most popular variety grown in India. Widely adapted and dominant. It originated as a chance seeding in a Langra village of Muzaffarpur district in Bihar. This name was given to the fruit because a lamb (Langra) hermit (beggar) used to survive at the foot of the huge seeding tree from which the present day cultivar Langra was multiplied. The tree is tall, vigorous and spreading. The three bears biennial fruiting. Its fruits are oblong with lime green in colour. Pulp is lemon yellow with scanty fibre. Fruit quality is good. Flavour is mild with sweet melting character aroma and sweet taste. It is a mid-season variety under north Indian conditions.

Chausa Originated as a chance seeding at Chousa village, Malihabad (UP). Tree is medium in height, moderately vigorous and spreading. Bearing medium to heavy and inclined to alternate bearing. Fruits medium; peel medium thick; pulp from umber yellow, fibreless. Fruit quality is good. Flavour of the fruit is mild and pleasant. It tastes sweet with some insipid after taste. It is one of the most delicious fruits available late in the season.

The characteristics smell and taste result from the organic acids and free sugar content of the fruit, varying from almost bland to distinctly turpentine or sweet. Cultivar development and selection depends on these chemical profiles and along with other genetically determined traits such as fibrousness, colour and shape (Lavi et. al., 1997).

Citric acid and malic acid are two types of antioxidants that are also safe additives, which are widely used in food, medicine, daily chemical, and health product industries. These preservatives help in increasing the shelf life of food items and also maintain the flavor of food for a long time. Natural preservatives which are used to preserve food are not harmful to your health. Citric and malic acid

were the major organic acids in mango which are more responsible for flavour and preservation.

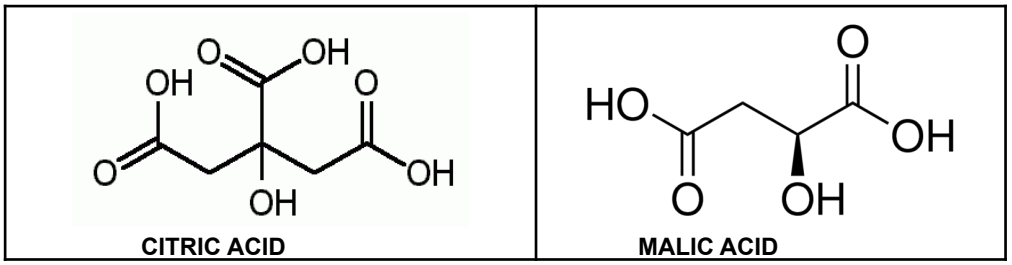


**Fig.2-structure of citric and Malic Acid ( After Virendra Kumar, 2017 )**

**Aim of the Study**

The aim of the present study is to find out the natural character of storage and preservative components in the studied *Mangifera indica* cultivars whether its due to Citric acid or malic acids or any other factor or chemical compounds.

**Materials and Methods**

The present study is performed after the selection of high quality fruits. Mango fruits were harvested at maturity and kept at ambient temperature (25±2 ºC). Each cultivar was analyzed at two ripening stages (i) at harvest maturity (0 days) and (ii) 2 eating ripe stages (6 to 8 days after harvest depending on the cultivars).

Samples at each defined maturity stage were taken from a three-mango cultivar for estimation of malic and citric acid and citric acid malic acid ratio by using titration method. Phenolphthalein: is a coloured indicator 1% w/v solution of phenolphthalein in 95% v/v ethanol which is flammable and toxic if ingested. The pH was determined using a digital pH meter (EI-top, Punjab Electronics Corporation limited) after standardizing with a buffer (pH -4.0) at 20 0C if. Sodium Hydroxide (NaOH): The Standard Laboratory solution of 0.1M which is used in the actual titration is considered to be dilute, and can readily be purchased in this form. Standard reagents and glassware are used during experiments (Rangana, 1986).

**Table-1 Composition of Citric Acid and Malic Acids of the studied varieties at ripe mango stage:**

| Cultivar | Citric acid (mg /100 g) | Malic acid (mg /100 g) | Citric acid malic acid ratio |
|---|---|---|---|
| **Amrapali** | 78.4 | 48.8 | 1.61 |
| **Langra** | 122.7 | 48.6 | 2.52 |
| **Chausa** | 102.0 | 48.0 | 2.13 |

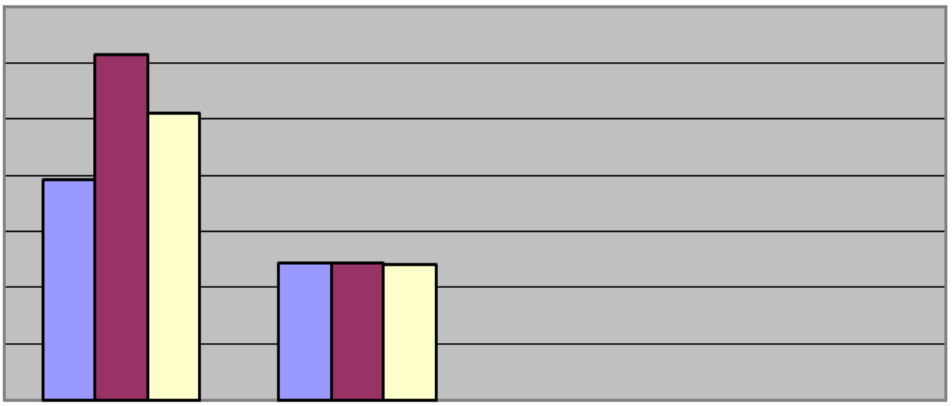


**Fig.3-Graphical Representation of Citric & Malic acid in studied varieties**

**Result**

Mango (*Mangifera Indica L.*) has an exceptionally long list of benefits that have been established through more than 4000 years of use ( Candole, 1984 ).In general fruits are the only energy alternative with enhanced blend of antioxidant energy and powerful nutrition. Fruits provide natural energy to our body needs, enhances metabolism, unlocks energy at the cellular levels and provides the vital nutrients often deficient in typical daily diet. Fruits act as a vital survival mechanism and therefore matured with chemical and structural methods, taking into consideration its excessive demand. Citric acid and malic acid were the major organic acids identified and decrease in citric malic acids was observed during ripening. Malic acid concentration changed marginally and the trend varied depending on the

cultivar. Malic acid concentration increased during ripening the fruit cultivar. The large decrease in citric acid concentration observed was responsible for the reduction in citric, malic acid ratio in ripe mango fruits. Ethylene play a important role in fruit ripening, ethylene a simple olefin, is a plant hormone, specifically a fruit-ripening hormone that exists in the gaseous state under normal physiological conditions and regulates many aspects of plant growth, development and cell metabolism including initiation of ripening and senescence, particularly in climacteric fruits. It is biologically active in trace amounts and its effects are physiologically very important. Ethylene regulates its own biosynthesis in various plant organs (Yang, S.F et al 1984).

**ACC synthase and ACC oxidase**

Ethylene biosynthesis was obeyed in this investigation. The pathway of ethylene biosynthesis was first established in apple fruit. (Adams D.O., Yang 1979) since then it has been shown to operate in other climacteric fruits such as banana, tomato and mango. The two key enzymes in the pathway are those catalyzing the conversion of S Adenosyl Adenosylmethionine (SAM) to 1-aminocyclopropane-1-carboxylic acid (ACC) and ACC to ethylene, called ACC syntheses and ACC oxidase (ethylene-forming enzyme, EFE), respectively. At the onset of fruit ripening, expression of multiple ACC syntheses genes are activated, resulting in increased production of ACC. ACC is then oxidized to ethylene by ACC oxidase. In most cases, it is the ACC syntheses activity that determines the rate of ethylene biosynthesis. Inhibition of ethylene biosynthesis by antisense RNA to ACC syntheses and ACC oxidase was very well established in tomato fruit. (Oeller P.W., Min-Wong 1991), (Hamilton A.J., Lycett 1990) . The resulting transgenic fruit do not over-ripen as normal controls, though some colour change occurs and a mere ethylene boost triggers back all the ripening related biochemical changes in similar way as normal fruit. Deamination of ACC to α-ketobutyrate by over-expressing ACC deaminase enzyme also suppressed ethylene formation and fruit ripening. (Klee H.J., Hayford M.B., Kretzmer 1991) Recently, the cDNA encoding for ACC oxidase enzyme has been isolated and characterized from mango. (Zainal Z., Tucker 1999). The mango ACC syntheses and ACC oxidase genes are being used for transgenic work in mango, for the extension of shelf life. (Zainal, ZTucker 1999) besides ethylene, abscisic acid is known to enhance fruit ripening, while indole acetic acid (auxin), gibberellic acid and cytokinin delay ripening by antagonizing the stimulatory effect of ethylene. (Shewfelt, R.L 1986). Thus, the crucial role of ethylene in fruit ripening is clear.

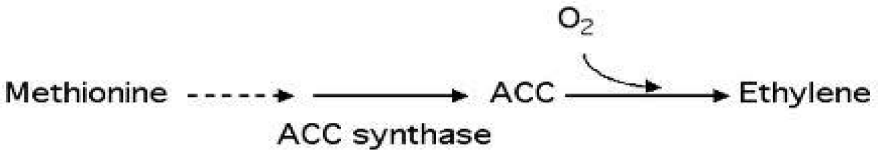


Fig- **4-ACC synthase and ACC oxidase (** After Virendra Kumar, 2017 )

The chemical composition of mango pulp varies with the location of cultivation, variety and stage of maturity. The major constituents of the pulp are water, carbohydrates, organic acid, fats, minerals, pigments, tannins, vitamins and flavor compounds.

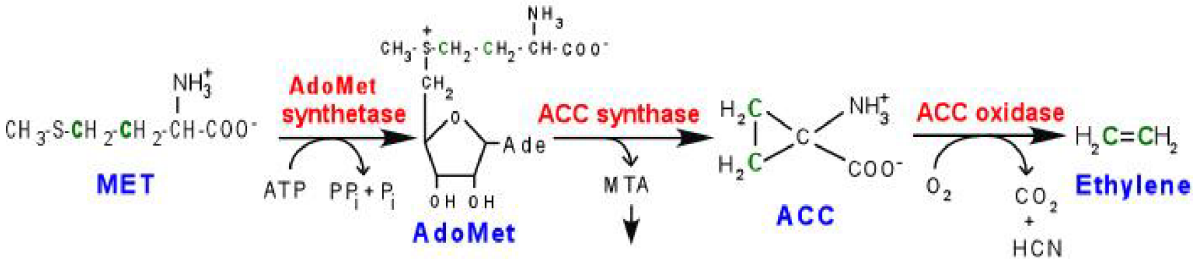


**Fig-5-Pathway of changes reaction in sample (** After Virendra Kumar, 2017 **)**

During growth and maturation of mangoes, the period of rapid growth is characterized by an increase in alcohol-insoluble solid; principally starch accumulation in the main chemical changes in the pulp-tissue. The rate of starch accumulation is rapid at the beginning of the fruit growth and slows down later but it continues to increase up to maturity.

**Table -2- Result of the citric and malic acids composition of the studied cultivars at different maturity time:**

| Cultivar | Days after harvest | Citric acid (mg %) | Malic acid (mg %) | Citric acid malic acid ratio |
|---|---|---|---|---|
| **Amrapali** | 0 | 390.2 | 64.0 | 6.09 |
| | 2 | 290.0 | 52.0 | 3.46 |
| | 6 | 191.2 | 50.0 | 1.82 |
| | 8 | 78.4 | 48.8 | 1.61 |
| **Langra** | 0 | 502.2 | 80.0 | 6.28 |
| | 2 | 422.4 | 68.2 | 6.19 |
| | 6 | 160.9 | 54.0 | 3.11 |

| | | | | |
|---|---|---|---|---|
| | 8 | 122.7 | 48.0 | 2.56 |
| **Chausa** | 0 | 278.7 | 70.0 | 2.55 |
| | 2 | 126.0 | 66.0 | 2.21 |
| | 6 | 118.0 | 52.0 | 2.27 |
| | 8 | 102.0 | 46.0 | 2.22 |

0 = at harvest maturity, 2 = ½ ripe store 6 = ¾ at eating ripe stage 8 = eating ripe

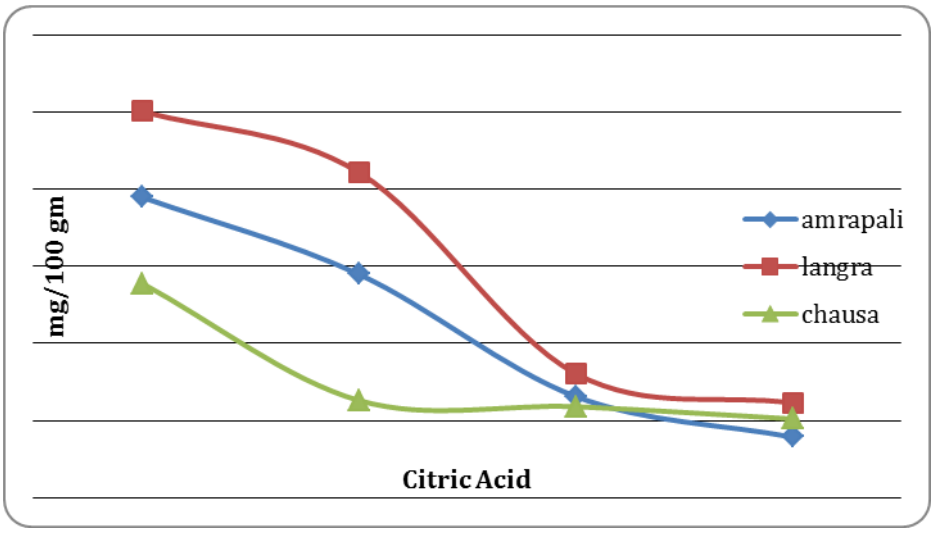


**Fig.6. Citric acid decreased from unripe to ripe stage in cultivars of *Mangifera Indica***

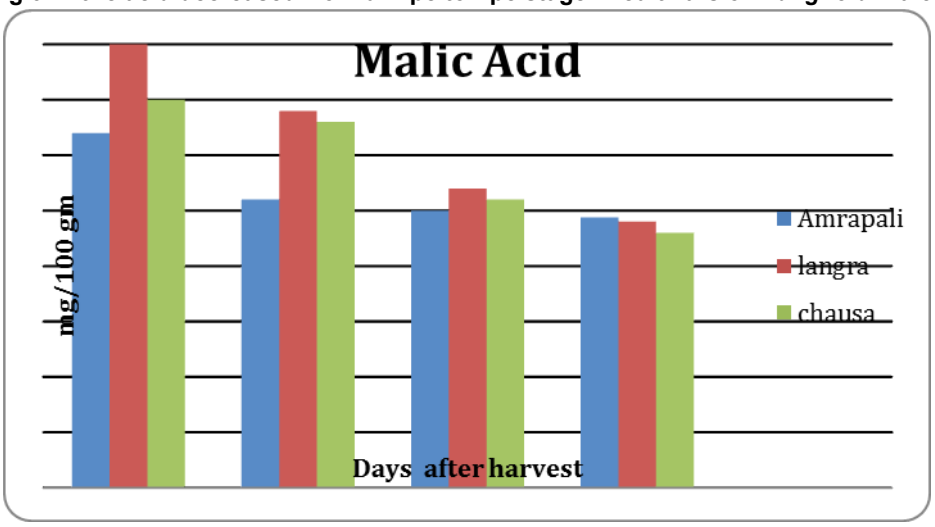


**Fig.7- Malic acid decreased to unripe to ripe stage in the studied varieties of *Mangifera Indica***

**Conclusions**

In the present study, we have majorly investigated citric acid , malic acid and citric malic acid ratio woho responsible for flavour preservation of food in mango pulp .

In *Amrapali* variety citric acid decrease 390.2 to 78.4 mg % and malic acid 64.0 to 48.8 mg % decreases and the citric acid malic acid ratio 6.09 to 1.61 decrease unripe to ripe stage (0 to 8 days after harvest ) similarly in the *Langra* variety citric acid decrease 502.2 to 122.7 mg % and malic acid 80 to 48.0 mg % decreases and the citric acid malic acid ratio 6.09 to 1.61 decrease unripe to ripe stage (0 to 8 days after harvest ) and in the *Chausa* variety citric acid decrease 278.7 to 102.0 mg % and malic acid 70.0 to 46.0 mg % decreases and the citric acid malic acid ratio 2.56 to 2.22 (0 to 8 days after harvest ) finding are shown in table -2.

Malic acid has a higher relative sourness than citric acid, even though its pH is higher. This is because malic acid has a more prolonged sour sensation in the mouth than citric acid. It also protects the ripe fruit from rotting during preservation or storage conditions. It is concluded that the fruits which have only more malic and citric acid contents are long lasting during preservation. That means their preservation capacity has increased and it is acting like a natural preservative in mango**.** The selected variety of mango Langra have high citric acid and citric acid and malic acid ratio that is more naturally preserved compared to other varieties of mango selected in the experiment. The malic acid decreases slowly unripe to ripe condition. Citric acid gradually decreases in all selected varieties but both the varieties have different flavour, pulp preservation time due to the

presence of quantity of citric acid and malic acid their ratio.

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**References**

1. *Adams D.O., Yang S.F. Ethylene biosynthesis: identification of 1 aminocyclopropane-1-carboxylic acid as an intermediate in the conversion of methionine to ethylene. Proc. Natl. Acad. Sci. 1979, 76: 170–174.*
2. *Burton-Freeman, B.M.; Sandhu, A.K.; Edirisinghe, I. Mangos and their bioactive components: Adding variety to the fruit plate for health. Food Funct. 2017, 8, 3010–3032.*
3. *Candole A.D., Origin of cultivated plants. Vegal. Paul Trench and Co., London, 1984 pp: 1-67.*
4. *Drzikova B., Dongowsky G., Gebhardt E., Habel A., Food Chem. 90, 181–192 (2005).*
5. *Fuchs Y, Peris E, Zauberman G,changes in amylase activity, starch and sugar in mango fruit pulp.ScientlaHorti.,13, 155, (1980).*
6. *Gill P. P. S., Jawandha S. K., Navdeep Kau, Navpreet Sing, J. Food Sci. Technol 54(7), 1964–1970 (2017).*
7. *Hamilton A.J., Lycett G.W., Grierson D. Antisense gene that inhibits synthesis of the hormone ethylene in transgenic plants. Nature. 1990, 346, 284–287.*
8. *Knight R. J. Jr. Important mango cultivars and their descriptors. In The mango; The Botany, Production and uses; litz, R.E.; CAB International: Boca Raton, Florida 1997. 545-565.*
9. *Krishnamurthy S, Patwardhan M V, and Subramanyam, Biochemical changes during ripening of mango fruit. Phytochem., 1971, 10, 2577.*
10. *Kumar V. Studies on analytical structural and chemical characterization of Mangifera indica Linn. (PhD Thesis) 2012)*
11. *Lauricella, M.; Emanuele, S.; Calvaruso, G.; Giuliano, M.; D'Anneo, A. Multifaceted health benefits of Mangifera indica L. (Mango): The inestimable value of orchards recently planted in Sicilian rural areas. Nutrients ( 2017), 9, 525. . [CrossRef] [PubMed]*
12. *Lavi U., Kaufman D.,Sharon D., Adato A.,Tomer E.,Gazit S.&Hillel,.J., Mango breeding and genetics-review. Acta Hort., 1997, 455:268-27*
13. *Lee H. S. Characterisation of carotenoids in juice of red navel orange (Cara cara). J. Agric. Food Chem. 2001, 49, 2563-2568.*
14. *Lodh S.B.Subramanyam M D and Divakar N.G., Biochemical studies on some mango varieties .Indian Hort, 1974 p-31 160, .*
15. *Maldonado-Celis, M.E.; Yahia, E.M.; Bedoya, R.; Landázuri, P.; Loango, N.; Aguillón, J.; Restrepo, B.; Ospina, J.C.G. Chemical composition of mango (Mangifera indica L.) fruit: Nutritional and phytochemical compounds. Front. Plant Sci. 2019, 10*
16. *Maria Elena Maldonado, Elhadi M. Yahia, Ramiro Bedoya, Patricia Landazuri, Nelsy Loango, Johanny Aguil, Beatriz Restrepo and Juan Camilo Guerrero Ospina, Frontiers in Plant Science, 2019. 10, 1073,*
17. *Marianna Lauricella, Sonia Emanuele, Giuseppe Calvaruso, Michela Giuliano Antonella D'Anneo, Nutrients, 2017.,9, 525*
18. *Medlicott A.P. and Thompson A K, analysis of sugar and organic acid in ripening mango fruit by high-performance liquid chromatography, J Sci. Fd. Agric, 1985, 36 561, ().*
19. *National Mango Database. Indian Status of Mango: Area, Production and Productivity-Growth Pattern; National Mango Database. Available online: https://mangifera.res.in/ (accessed on 6 September 2020)*
20. *Negi S.S. agro techniques, cultivars, export, mango, postharvest management, production, India ISHS Acta Horticulturae. 2000 , 509.*
21. *Oeller P.W., Min-Wong L., Taylor L.P., Pike D.A., A. Reversible inhibition of tomato fruit senescence by antisense RNA. Theol. Science 1991, pp. 437–439*
22. *Panday R.M., Rao M. M. and Singh R N Biochemical changes in the developing mango fruit (Mangifera Indica L) cv. Dasheri. Progr.hort., 1974 , 547, .*
23. *Rangana, S. Handbook of analysis and quality Control of fruit and Vegetable products. 1986, Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.*
24. *Rui Hai Liu, American Society for Clinical Nutrition, 2003, 78, 517S, .*
25. *Shang, H.S.; Chen, C.J.; Shih, Y.L.; Peng, S.F.; Chen, Y.L.; Liu, K.C.; Huang, H.C.; Hsueh, S.C.; Chen, K.W.; Lu, H.F. Mangiferin induces immune responses and evaluates the survival rate in WEHI-3 cell generated mouse leukemia in vivo. Environ. Toxicol. 36, 77–85. (2021)*
26. *Shewfelt R. L. Postharvest treatment for extending the shelf life of fruits and vegetables. Food Technol., 1986, 40: 70–80.*
27. *Tandon D K , and Kalra S K changes in sugar ,starch amylase activity during development of mango fruit cv. Dasheri. J Hortic Sci. 1986 , 58, 449,.*
28. *Tyagi D.N. and Medhabati Devi T., Morphological and compositional variation in ripe fruits of four cultivars of mango, J plant Physiol., 1986 , 29 113-117.*
29. *Vallarino, J.G.; Osorio, S. Chapter 10: Organic Acids. In Postharvest Physiology and Biochemistry of Fruits and Vegetables; Yahia, E., Carrillo-López, A., Eds.; Elsevier: Amsterdam, The Netherlands,2019 ; pp. 207–224*
30. *Yang S.F., Hoffman N.E. Ethylene biosynthesis and its regulation in higher plants. Ann. Rev. Plant Physiol., 1984, 35, 155–189.*
31. *Zainal, Z., Tucker, G.A., Lycett, G.W. Isolation and characterization of cDNA encoding ACC*

*oxidase from mango (Mangifera indica. L). Asia Pacific J. Mol. Biol. Biotechnol. 1999, 7: 53–59.*