# Physicochemical characterization and nutrient composition decide harvest maturity of *Cucumis melo* varieties.


## Abstract

**Use full text not abbreviation and explain it in proper way**

*Cucumis melo* is a polymorphic taxon belonging to the family Cucurbitaceae, with a number of varieties based on ovary pubescence. Among these,*Cucumis melo* var.*momordica* and *Cucumis melo* var. *acidulus* are two popularised and highly cultivated forms in South India. The characteristics of *C.melo*var .*momordica* is its fruit cracking nature, when it is ready to harvest, that distinguishing the variety from others. So, it would be a herculean task for the farmers to harvest ripened fruits before it gets cracked. Analysis of physicochemical attributes and nutritional composition of the ripening process is inevitable to understand and establish proper harvest management for the varieties. The present investigationanalyzed fruit quality attributes of the two melon varieties (*C.melo*var. *momordica* and *C.melo*var. *acidulus*) at five developmental stages (S1: 5 days after pollination (DAP), S2: 10DAP, S3:15DAP, S4: 20DAP, S5: 25DAP). Pomological characteristics such as fruit weight and length at different developmental stages showed a tremendous peak from S3 to S5 in both varieties. However,firmness of the fruits decreased from the S4 to S5 stage in varieties whereas, reducing sugar accumulated sharply from S2 to S3 stage. Titratable acidity content in *C. melo* fruits continuously increased from the S1 to S5 stage On the other hand, the total carbohydrate, cellulose, protein, and amino acid content increased from S1 to S2 but decreased sharply in S3 and S5. Ascorbic acid, total phenolics, lipid peroxidation, and electrolyte leakage levels declined with fruit ripening in *C.melo* varieties.Results of all quality parameters mentioned above, *C.melo* fruit harvested at the S4 maturity stage was the ideal harvest maturity for long-distance transportation and higher consumer acceptability before fruit cracking. Our findings showed that the physico-biochemical properties and nutritional composition of *C.melo* varieties change dynamically during ripening .The study highlighted the significance of maturity stages for fruit quality and provide critical information for optimal harvest management of the fruits of *C.melo* varieties.



**Keywords**: Melon, *Cucumis melo* var. *acidulus*, *Cucumis melo*var. *momordica*, Physico biochemical attributes, Fruit cracking, Fruit ripening, Fruit quality.


## Introduction

**Content not proper or not arranged very well and so lengthy**

Melon (*Cucumis melo* L.) is an old-world warm-season cucurbit species that belongs to the family Cucurbitaceae. According to the FAO [1], 1.14 million ha of land produces 32 million t of melons annually. China (17.1 million tonnes) is the world's top producer of melons, followed by Turkey, Iran, and Egypt. Almost all cucurbit fruits contain significant amounts of cucurbitacin, vitamin C, provitamin A, and phenolic phytochemicals,apart from the other nutrients that are beneficial for human consumption, including fiber and minerals [2,3]. The species differ widely and numerous varieties are reportedHammer K (4), of these *C.melo*var.*momordica*(Roxb.) Duthie.&J.B.Fullerand *C.melo*var.*acidulus*L are the generally cultivated varieties in South Indiawere selected for the study.

*Cucumis melo* var. *momordica* (Roxb.) Duthie.&J.B.Fuller, commonly known as snap melon, is a native of India [5]. Snapmelon is locally known in North India as "phut," in Kerala, it is called "Pottuvellari" due to the distinct tendency of ripe fruit to produce split or crack [3].Snapmelons are popular among the poor and middle classes, and the fruit is readily available for nearly five months during the spring and rainy seasons. During World War II, snap melon fruits were used as food on two Japanese islands, Hachijo and Fukue [6].

*Cucumis melo* var. *acidulus* L. naudin, also known as sambar vellari, pickled melon, or preserving melon, is a melon used in cooking. This locally produced non-dessert melon is growing in Kerala, Karnataka, Andra Pradesh, and TamilNadu and is native to tropical, humid southern India. The variety is characterized by the orange, smooth, oval fruits with white, firm, crisp flesh with a long shelf life. The mature fruits are used to make sambar or eaten as salad.

Nutritional factors responsible for fruit quality indices of melon include biochemical characteristics such as titratable acidity [6],carbohydrate [7], protein [8],amino acids[9],electrolyte leakage [10], cellulose [11], ascorbic acid [12], reducing sugar [13] and phenol [14].

Melon fruit cracking is a major physiological problem that harms production of high-quality fruits with principal consumer and commercial value. The cracks formed on the fruit surface quickly penetrate fungal spores and decrease moisture content, leading to excessive fruit shriveling and decreasing fruit quality and shelf life—in this aspect, harvesting fruits before fruit cracking is inevitable. Pre-harvesting factor determines the final fruit quality and shelf life. Of fruits.Long-distance transportation of commercially cultivating fruits such as tomato, Litchi, cherry, and Akebia is possible only after harvesting them at semi-ripened stages [15]. Hence it is crucial to find out the physical and chemical attributes of fruits at different maturity stages and explore the suitable fruit maturity stage with the best commercial value. However, the maturity stage at harvest is likely the most critical factor in determining final fruit quality. The maturity stage at harvest influenced the physicochemical properties of winter jujube, Akebia, during fruit ripening [16-21). Nevertheless, little is known about the changes in physicochemical properties and nutritional composition of *C.melo* varieties at various stages of fruit maturity. Thus, this study aimed to look into changes in physicochemical properties and nutritional composition in the fruits of *C.melo* varieties at different stages of ripening. The findings in the present investigation can help to understand the fundamentals of dynamic fruit quality patterns and determine optimal harvest maturity stages of *C.melo* varieties with higher quality and longer marketability before fruit cracking.

## Materials and methods

### 2.1 Plant material

Fruits of two varieties of *C.melo*var. *momordica* and *C.melo* var. *acidulus*, which are free from pests, insects, and diseases, were randomly harvested at five developmental stages (S1: 5 days after pollination (DAP), S2: 10DAP, S3:15DAP, S4: 20DAP, S5: 25DAP)from the experimental farm at the Department of the Botany University of Kerala, India, which is located at 8.5°N latitude 76.9°E longitude and 29m above mean sea level (Figure 1). At the S4 time point, the fruits of var. *momordica* begin to soften to some extent with no fruit cracking. At the S5 time, the fruits begin to crack (about 90%), which was set as the fruit cracking time (Figure 1&b).Seeds of both varieties were collected and sown in different area of experimental farm by following the procedure given by the Kerala Agricultural University (KAU) package of Practices Recommendations for Organic Farming Crops (2016)for the cucurbitaceous Vegetables. Fruits pulp from three fruits was mixed into one biological replicate for Reducing sugar, Total

carbohydrate, protein, amino acid, cellulose, ascorbic acid, total phenolics, TitratabeAcidity, Electrolyte leakage, and lipid peroxidation, and the fruit pulp was stored at -80$^0$C until further analysis. At the same time, both varieties determined TotalSolubeSolids (TSS) and fruit firmness with fresh fruits collected at different developmental stages. Samples from each stage were immediately evaluated for fruit weight, length, and moisture on five fruits.

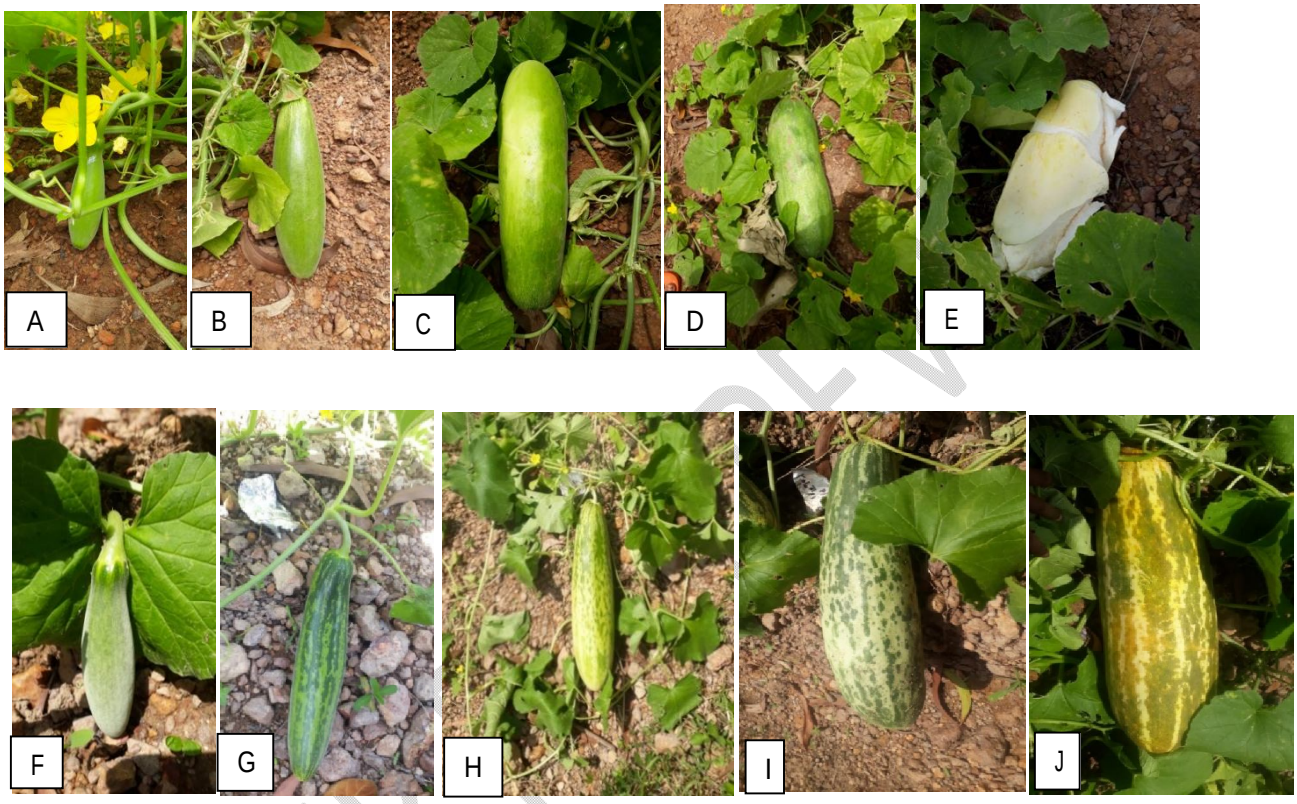



Figure 1.The fruits of *C melo* varieties at different maturity stages. (A-E) the fruit of var.*momordica* at S1,S2,S3,S4 and S5 stages ,respectively.The pericarp is whitish cream when it cracks.(F-J) the fruit of var.*acidulus* at S1,S2,S3,S4 and S5 stages,respectively.(S1: 5 days after pollination (DAP), S2: 10DAP, S3:15DAP, S4: 20DAP, S5: 25DAP).

3.2 **Physical parameters**

Five fruits from each developmental stage were collected for average weight by an electronic balance and expressed in grams. Fruit length (FL) was determined using a digital caliper with 0.01 mm accuracy. Their values were expressed in millimeters. Flesh firmness of the fruit in different developmental stages of both varieties was measured using a texture analyzer (TA) HD plus (Stable microsystems the UK) using the compression mode test, and the result was expressed in Newton (N). Moisture content in the fruit at different maturity stages was calculated by oven drying at 70$^0$ for 48 hours.

An Erma hand refractometer was used to determine each sample's total soluble solids (TSS). Few drops of the well-homogenized sample were taken from the fruit's equatorial region and put on the prism of the refractometer. Direct reading was taken by reading the scale in meters and expressed in $^{0}$ Brix. Titratable acidity (TA) was determined by titrating100g of the sample against 0.1 N NaOH solution using phenolphthalein as an indicator until reaching pH 8.1. The result was expressed in percent anhydrous citric acid.

2.3.1**Estimation of reducing sugar**

Reducing sugar in the fruit pulp of both varieties at different developmental stages was determined, as described by [21]., 2016. 100mg of the fruit pulp was weighed, and the sugars were extracted with hot 80% ethanol 5mL each time. A water bath evaporated the collected supernatant at 80°C. Then added, 10mL of distilled water and dissolved sugars. Later pipette out 0.5 3mL extracts into the test tubes and equalize the volume to 3mL with water in all the tubes. 3mL of DNS reagent was added and heated in a boiling water bath for 5min. 1mL of 40% Rochelle salt solution was added to the warm test tubes, cooled, and read the intensity of dark red color at 510nm.

2.3.2**Determination of cellulose**

Added 3 ml of acetic/ nitric reagent to 1g sample in a test tube and mixed in a vortex mixer. Later, test tubes were placed in a water bath at 1000C for 30 minutes. Cooled and centrifuged the contents for 15 – 20 minutes. Discarded the supernatant and washed the residue with distilled water. Then added, 10 ml of 67% sulphuric acid and allowed to stand for 1 hour—diluted 1ml of the above solution to 100 ml. 1 ml of this diluted solution was mixed with 10 ml of anthrone reagent. For 10 minutes, place the tubes in a boiling water bath. The color was cooled and measured at 630 nm.

2.3.4**Estimation of Total carbohydrate, protein, and amino acids**

We weighed 100mg of the sample into a boiling tube and hydrolyzed it by keeping it in a water bath for 3 hours with 5mL of 2.5 N-HCl and cooled it to room temperature. Then neutralized, it is with solid sodium carbonate until the effervescence ceases. Made the volume up to 100mL and centrifuged. Later collected, the supernatant and taken 0.5 ml and 1mL aliquots for analysis. Distilled water was added to all the test tubes, and made the volume was one mL.4mL of anthrone reagent was added and heated for eight minutes in a boiling water bath. Cooled rapidly and read the green to dark green color at 630nm.

1 g of sample homogenized with 5 ml of Phosphate buffer saline ( PBS). Now add 5 ml of diluted dye solution to all the test tubes, including the test tubes labeled 'blank' and 'unknown.' Mixed the contents of the tubes by vortexing them for 30 minutes to develop color. Then recorded, the absorbance at 595 nm against blank.

Taken 1 g of the samples in labeled test tubes. Then added, distilled water was to the test tube to make up the volume to 4 ml. Later, added 1 ml of ninhydrin reagent was to all the test tubes labeled, and mixed the contents of the tubes by shaking the tubes. Covered the mouth of the tubes with aluminum foil and placed all the test tubes in a boiling water bath for 15 minutes. Cooled the test tubes in cold water, added 1 ml of ethanol to each test tube, and mixed well. Recorded the absorbance at 570 nm using a spectrophotometer.

**2.3.5 Determination of Ascorbic acid, Total phenolics, Lipid peroxidation, and Electrolyte leakage**

Ascorbic acid estimation was carried out by Bajaj and Kaur procedure[22]. In a test tube, 1g of fresh sample was placed. 4 mL of oxalic acid-EDTA extracting solution (5 g oxalic acid + 0.75 g EDTA in 100 mL distilled water) was added. Then 1 mL of orthophosphoric acid was added,

followed by 1 mL of 5% sulphuric acid. 2 mL of 5% ammonium molybdate solution and 3 mL of water were added to this mixture. The solution was kept at room temperature for 15 minutes. After incubation, absorbance at 760nm was measured using UV-visible spectrophotometry against a blank. A standard ascorbic curve was used to calculate the concentration of ascorbic acid in the samples. After the incubation period, absorbance at 760 nm was measured, and the standard graph was created.

The rate of Lipid peroxidation was measured by following the procedure ofCarmak and Horst [23]. 1.0 g fruit sample was homogenized in 3 ml of 0.1% (w/v) TCA solution. Then centrifuged, the homogenate was for 15 minutes at 20,000 rpm. 0.5 ml of supernatant and 3ml of 0.5% TBA were added to 20% TCA. This mixture was heated at 950 degrees C in a water bath for 25 minutes. Cooled the test tubes in an ice water bath and stopped the reaction. Samples were centrifuged at 10,000rpm for 10 minutes, and the absorbance was measured at 532 and 600nm. The absorption coefficient for calculating MDA concentration was measured as the difference in absorbance at 600nm and 532nm.

The sample's total phenol content was estimated with [24]. 1mg of the fresh fruit sample was weighed and made into a paste using a mortar and pestle with 5 ml of distilled water. 3 ml was put into a test tube from the prepared extract pipetted out. Made the volume of each test tube to 3 ml with distilled water and mixed thoroughly with 0.5 ml of folin – ciocalteu reagent for 3 min. After that, 2 ml of 20% of sodium carbonate was added. Boiled the solution in a water bath for 10 minutes, cooled to room temperature, and measured absorbance at 650 nm. The results were given as mg of catechol equivalent per g fresh weight.

The percentage of electrolyte leakage was measured by [25]. Four pieces of 9mm melon cylinder from the equatorial part of the fruit were taken by a cork borer. Then added, distilled water and filtered by using Whatman filter paper. Later transferred, it was to a 50ml beaker, then added 30 ml of 500mM mannitol was and measured the conductivity. Then incubated, it for 5 hours and again measured the conductivity. Stored at 20 degrees for 24 hours, boiled for 15 minutes at 1000C, and cooled and measured the conductivity.

**Statistical analysis**

Statistical analyses were carried out using IBM SPSS Statistics 24.0 software, and significant differences between means were determined using Turkey's highest significant difference (HSD) test at $p < 0.05$. The findings were presented as means± standard error.

**Results**

2.4Changes in Physical parameters of *C.melo* fruits at different developmental stages

Influence of developmental stages on the changes in the physical parameters of *C.melo* varieties (var. *momordica* and var. *acidulus*) are shown in Table 1.It was found thatfruit weight, length, and moisture content increased significantly with increasing maturity in both varieties. In *C.melo* var. *momordica*, the fruit weight increased from 52±5.8 g to 2169.6±51.17 g at S1 to S5 stage . However, in the case of *C.melo*var. *acidulus*, showed an increase from 50±3.21 to 2524±126.15 at the S1 to S5 stages.

An increase in fruit moisture content was observed in the varieties, in *C.melo* var.*momordica*, it was 93.91±.07 % to 96.23±0.17 and 93.62±0.08% to 96.36±11% *C.melo* var. *acidulus* respectively.The fruit length in var.*momordica* increased significantly,*ie,* from 123.6±0.31mm to 253.3±3.41 mm and in var. *acidulus* it was 103.6±0.57mm to 326±0.64mm respectively. The moisture content in both varieties shows no significant difference was observed in the moisture content of both varieties from S1 to S3 stages, but from

S4 to S5 stage there was a slight increment. The fruit firmness of *C.melo* varieties was significantly affected by the harvest maturity stages during fruit development. Fruit firmness in var. *momordica* increased significantly from the S1 to S3 stage (261.73 N, 279.39 N, 350.66 N), but there was a sudden decline from S4 to S5 (260.04N, and 54.94N). Similar pattern was observed in *C.melo*var.*acidulus*from the S1 to S3 stage but from S4 to S5 stage showed increased values.This result indicates that the rate of firmness increasing in var. *momordica* goes faster than var. *acidulus* in the early maturity stages but declines when it matures.

**Table 1 Effect of harvest maturity on physical parameters of two varieties of *C.melo***

| Varieties | Maturity stages | Fruit Weight(g) | Fruit Length (mm) | Moisture content(%) | Flesh firmness (N) |
|---|---|---|---|---|---|
| *C.melo*var.*momordica* | S1 | 52±5.8 $^{e}$ | 123.6±0.31 $^{e}$ | 93.91±0.07$^{de}$ | 261.73±7.25$^{c}$ |
| | S2 | 171.33±35.19 $^{d}$ | 143±0 $^{f}$ | 93.74±0.15$^{ef}$ | 279.39±25.34$^{b}$ |
| | S3 | 894±206.03$^{c}$ | 192±0.3$^{c}$ | 93.22±0.09$^{f}$ | 350.66±29.59$^{d}$ |
| | S4 | 1141.6±83 $^{b}$ | 246±0.52 $^{bc}$ | 95.67±0.13$^{bc}$ | 260.04±16.31$^{c}$ |
| | S5 | 2169.6±51.17$^{a}$ | 253.3±3.41 $^{b}$ | 96.23±0.17$^{a}$ | 54.94±4.45$^{d}$ |
| *C.melo*var.*acidulus* | S1 | 50±3.21$^{d}$ | 103.6±0.57 $^{f}$ | 93.62±0.08$^{ef}$ | 255.96±4.45$^{c}$ |
| | S2 | 337.33±100.77 $^{d}$ | 174±0.72$^{e}$ | 93.41±0.06$^{ef}$ | 264.9±17.73$^{c}$ |
| | S3 | 587±111.44$^{c}$ | 241±0.69 $^{bc}$ | 95.25±0.07$^{c}$ | 381.02±5.1$^{a}$ |
| | S4 | 1140.33±87.6$^{b}$ | 287±0.64 $^{ab}$ | 94.43±17 $^{d}$ | 218.75±21.36$^{b}$ |

| | | | | | |
|---|---|---|---|---|---|
| | S5 | 2524±126.15 | 326±0.64$^{ab}$ | 96.36±11$^{a}$ | 287.25±3.8 $^{c}$ |

Data expressed here are the mean value of replicates of three independent analyses and SE. According to Tukey's test, means with different superscript letters in the same column are statistically different ($p < 0.05$) between varieties for each variable. (S1: 5 days after pollination (DAP), S2: 10DAP, S3:15DAP, S4: 20DAP, S5: 25DAP)

2.5**Changes in pH, Total Soluble Solids, Titratable acidity, and Ascorbic acid content during Developmental Stages**

The $P^H$ of melon varieties at different maturity stages showed decreasing trend while ripening (Table 2). Fruits of var. *acidulus* displayed lower pH during late stage of ripening than var. *momordica* as shown in table 2.There is no significant difference in the TSS value of both varieties at the S3 and S4 stages. In var *momordica*, TSS content decreases from the S4 stage to the S5 stage as 20Brix to 1.90Brix, but in var. *acidulus*, it increases from 2.530Brix to 3.70Brix.

As shown in the table 2, the Titratable acidity (TA) content of fruits *of C. melo* varieties gave an increasing range of values from the S1 to S5 stage of fruit maturity in both varieties. The S3 and S5 stages of *C.melo* var. *momordica* showed higher values than its prior stages of maturity. While var. *acidulus* displayed higher values at the S3 and S4 stages of fruit maturity. The content of ascorbic acid declined from 6.8 mg/100g to 5.7 mg/100g during the maturity stages in var. *momordica*, but there was a slight increment in the value at the S5 stage of fruit ripening. Similarly, fruits of var. *acidulus* showed a decrease in ascorbic acid content from 6.3mg/100g to 5.2mg/100g at different maturity stages. However, no significant change was observed between the S4 and S5 stages.

**Table 2 Effect of harvest maturity on chemical parameters of the two varieties of *C.melo***

| Variety | $P^H$ | TSS (°B) | TA (%) | Asa (mg/g) |
|---|---|---|---|---|
| *Cucumis melo* var *momordica* | S1 5.9±0.02$^{b}$ | 4.6±0.20$^{ab}$ | 5.5±0.02$^{bc}$ | 6.8±0.48$^{a}$ |
| | S2 5.03±00$^{e}$ | 4.06±0.08$^{bc}$ | 4.3±0.02$^{c}$ | 5.9±0.28$^{bc}$ |
| | S3 5.27±0.01$^{d}$ | 2.9±0.03$^{d}$ | 6.4±0.02$^{abc}$ | 5.5±0.02$^{c}$ |
| | S4 4.44±0.01$^{g}$ | 2±0.05 $^{e}$ | 5.4±0.04$^{bc}$ | 5.6±0.17$^{c}$ |
| | S5 4.22±00$^{h}$ | 1.9±0.01$^{e}$ | 7.4±0.05$^{ab}$ | 5.7±0.17$^{bc}$ |
| *Cucumis melo*var.*acidulus* | S1 6.01± 0.00$^{a}$ | 5.1±0.03$^{a}$ | 4.4±0.00$^{c}$ | 6.3±0.26$^{bc}$ |
| | S2 5.63±0.02$^{c}$ | 2.7±0.03$^{d}$ | 5±0.08$^{bc}$ | 5.7±0.18$^{bc}$ |

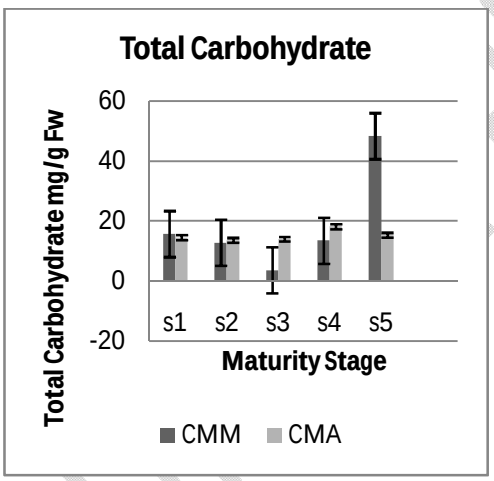
| | | | | |
|---|---|---|---|---|
| | S3 | 5.34±0.01[d] | 2.96±0.06[d] | 6.6±0.11[abc] | 6.00±0.1[bc] |
| | S4 | 4.57±00[f] | 2.53±0.028[de] | 8.2±0.02[a] | 5.2±0.2[c] |
| | S5 | 3.92±0.01[i] | 3.7±0.019[c] | 0.82±0.02[a] | 5.2±.08[c] |

Data expressed here are the mean value of replicates of three independent analyses and SE. According to Tukey's test, means with different superscript letters in the same column are statistically different ($p < 0.05$) between varieties for each variable. (S1: 5 days after pollination (DAP), S2: 10DAP, S3:15DAP, S4: 20DAP, S5: 25DAP)

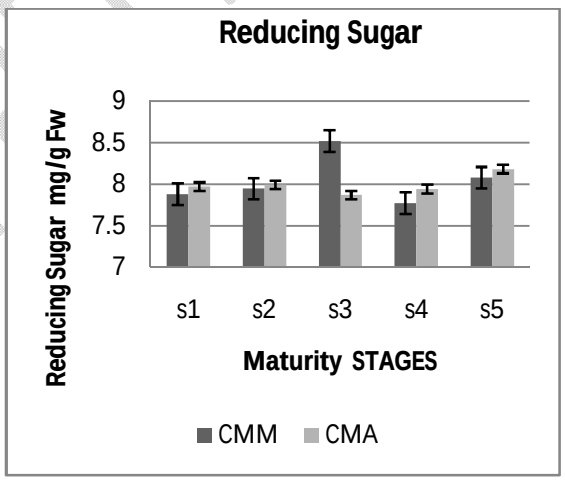
**2.6Change in Total carbohydrate, Reducing sugar and Cellulose Content during Maturity Stages**

Total carbohydrate content in the two varieties of melon showed significant changes over the different maturity stages.The observed values are given in figure 2A.The carbohydrate content was found decease from S1 to S3 stages and accumulated from S3 to S4.

(2A)




(2B)




(2C)

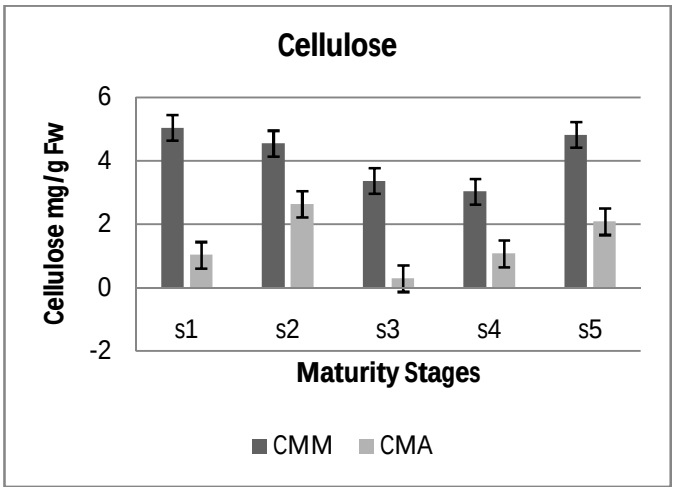


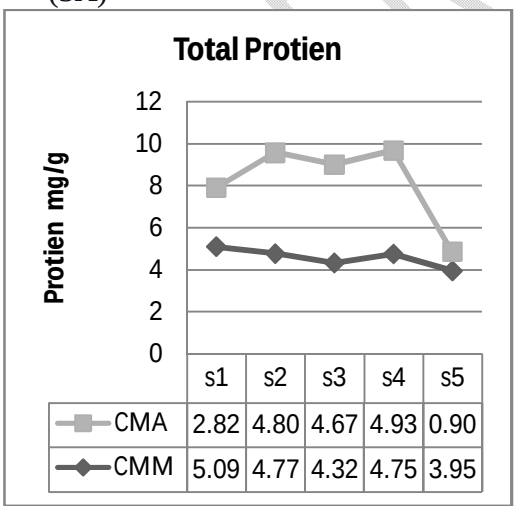

**Figure 2(A).** Total Carbohydrate, (B)Reducing Sugar, and (C) Cellulosein varieties of *C.melo* fruit at five stages of ripening.CMM: *Cucumis melo* var.*momordica*;CMA: *Cucumis melo* var.*acidulus*. S1: 5 days after pollination (DAP), S2: 10DAP, S3:15DAP, S4: 20DAP, S5: 25DAP

For var. *acidulus* the total carbohydrate content increased from S3 to S4 stage. Similarly, cellulose content also increased from S3 to the s4 stage in var. *acidulus,* whereas in var. *momordica*, it decreased slightly from S3 to the S4 stage (Figur2C). But no significant changes were noticed in the reducing sugar present in both varieties (Figure 2B).

**2.7 Change in Total protein and Amino acid Content during Maturity Stages**

The total protein content of var. *momordica* declines from S1 to S4(5.09 -4.7mg/g). It reaches a minimum value at the S5 stage (3.9 mg/g), while the total protein content of var. *acidulus* showed significant increase from the S1 to S4 stage (2.8 mg/g -4.9 mg/g), followed by a sudden decrease at the S5 stage (0.9mg/g) (Figure3A).

(3A)




(3B)

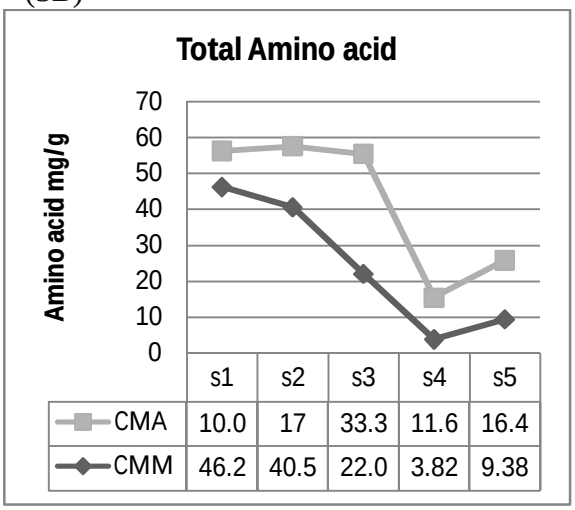


**Figure3.** (**A**) Total Proteinand (**B**) Total Amino acidin Varieties of *C.melo* fruits at five stages of ripening.CMM: *C. melo* var.*momordica*;CMA: *C.melo* var.*acidulus*. Error bars indicate standard error from 3 replicates. S1: 5 days after pollination (DAP), S2: 10DAP, S3:15DAP, S4: 20DAP, S5: 25DAP

The total amino acid content in var. *momordica* declined significantly from the S1 to S4 stage (46.23mg/g -3.8mg/g) and had a slight increment at the S5 stage (9.38mg/g).However, var. *acidulus* showed a slight increment from the S 1 to S4 stage (10.3- 11.6mg/g) with a sharp increment at the S3 stage(33.36mg/g) and the increment from S4 to the S5 stage is meager at later stage of fruit maturity Figure 3B.

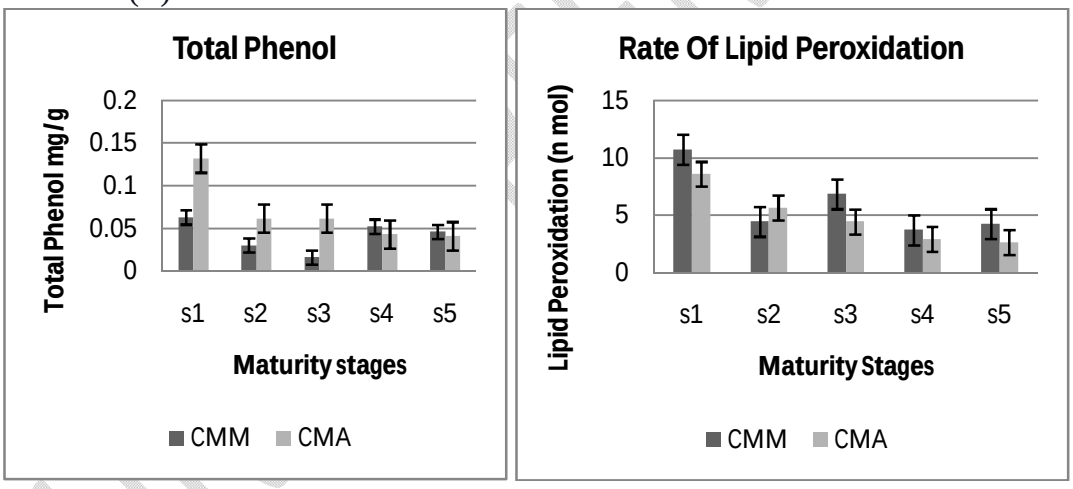
**2.8 Change in Total Phenolics, Electrolyte Leakage and Lipid peroxidation during Maturity Stages**

The total phenolic content in melon varieties at five maturity stages is shown in figure 4A. Overall, the total phenolic content declines from the S1 to S5 stage. Compared with var. *momordica*, the phenolics content in var. *acidulus* was sharply decreased (0.132- 0.041 mg/g) from the S1 to S5 stage of fruit maturity. Rate of lipid peroxidation and electrolyte leakage on both varieties decreased from the S1 stage to the S4 stage of fruit maturity (Figure 4B&C).

The value of electrolyte leakage percentage (55.4 % -75%) in var. *momordica* slightly increased from S4 to S5 stage, and in var. *acidulus*, it was (67.6%-71.4%). Whereas lipid peroxidation rate in var. *momordica* at the S4 and S5 stage is 3.7nmol and 4.2nmol respectively, whereas in var.*acidulus* a slight decrease from 2.9nmol to 2.64 nmol at the S4 to S5 stage was observed.

(A)

(B)




(C)

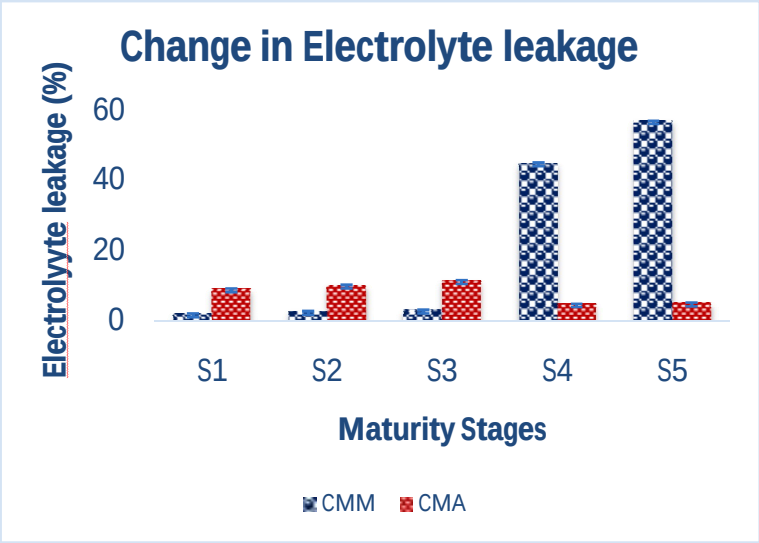



**Figure4.** TotalPhenol(**A**),(**B**)Lipidperoxidatioin and(**C**)ElectrolyteLeakage in varietiesof *C.melo* fruitsat Five stages of ripening.CMM: *Cucumis melo* var.*momordica*;CMA: *Cucumis melo* var.*acidulus*. Error bars indicate standard error from 3 replicates. S1: 5 days after pollination (DAP), S2: 10DAP, S3:15DAP, S4: 20DAP, S5: 25DAP

**Discussion**

**Write in proper way comparison between two factor not proper**

The current study found that the maturity stage significantly impacted the physicochemical and nutritional properties of *C .melo* fruits. Fruit size increased when harvest maturity was postponed (fruit weight and length). At the S3, S4, and S5 stages, the fruit weight of var. *momordica* increased by 42%, 67%, and 90%, respectively. Fruit weight increased by 42%, 48%, and 54% in the var. *acidulus*. Fruit weight increased rapidly in both varieties from S4 to S5. The fruit weight of var. *momordica* increased faster than that of var. *acidulus*. However, the fruit weight of var. *acidulus* was still more significant than that of var. *momordica* at the S5 Stage of fruit maturity. The rate of fruit length growth increased from the S3 to the S5 Stage. The highest rate of fruit length growth in var. *momordica* occurred at the S3 Stage (25.5%), followed by a gradual decline at the S4 and S5 stages (21.9% and 2.88%, respectively). Fruit length decreased from 27.8% to 11.9% in the var. *acidulus*. Both varieties rapidly increase fruit weight and length from S4 to S5. Previous research has shown that the maturity stage at harvest significantly impacts the quality of ripe fruit and storage life [26-28]. Fruit growth in both varieties followed a sigmoid curve, which was consistent with previous reports in A. trifoliata fruit [29, 15].

As a critical quality criterion, fruit firmness directly impacts fruit shelf life and consumer acceptance [30]. With fruit ripening, the fruit of *C. melo* varieties begins softening and cracking, associated with easy rotting caused by bacterial infection and mechanical damage. As a result, while melon fruit can be picked before cracking, the fruit quality degrades quickly after harvest, within 3-5 days at room temperature. As a result, harvesting fruits before they soften and crack

may be an effective way to extend the shelf life of melon varieties. In the current study, the firmness of var. *momordica* decreased with the delay of the harvest stage, whereas the firmness of var. *acidulus* increased. Fruit firmness of var. *momordica* decreased by 25.7% and 79.71%, respectively, from S4 to S5, indicating that fruit textural properties changed dramatically during the period. In *Akebia trifoliata*, [31]Niu*etal* discovered that the cell wall became thinner and looser and showed a significant breakdown in the pericarp of cracking fruit compared to noncracking fruit. The firmness of var. *momordica* decreased sharply before cracking, consistent with the pericarp structure observation results [32]. Fruit moisture content is crucial in determining flavor, storage ability, and suitability for consumption. It is worth noting that the moisture content of both varieties increased significantly from the S3 to the S5 stages. As the fruit ripens, the increase in moisture content could be attributed to starch hydrolysis to sugars. Mulberry and cherry fruit have shown a similar increasing trend in moisture content with maturity [33, 34, 15].

PH was inversely related to acidity. The ripe sample with the lowest acid content had the highest pH. Furthermore, when pineapple fruit reaches an advanced ripening stage, increased pH results in more edible fruit with less acidity. In the present study, var. *momordica* at the S4 Stage of fruit maturity was given a pH of 4.4. The pH of the different fruit fractions ranged from 4.27 to 5.29. Parveen *et al*. [35] discovered similar PH variations in the *ravi* melon variety. According to Bianchi *et al*. [36], the pH of melon varies from 5.2 to 6.5 depending on the cultivar used. TSS content in both varieties of melon fruit decreased from the S1 Stage to the S5 Stage in this study. TSS content of var. *momordica* decreased by 11.7%, 39%, 31%, and 5% at the S2, S3, S4, and S5 stages, respectively. Furthermore, the TSS content of var.*acidulus* decreased by 46.5%, 7.2%, 14%, and 46% at the S2, S3, S4, and S5 stages, respectively.

Titratable acidity indicates the fruit's acidity, which influences its flavor. Our study results show that in var. *momordica* and var. *acidulus*, the TA value decreases from the S1 to S5 Stage of maturity. This outcome is comparable to the reports of [37]. According to Woodwardand Moing, titratable acidity increased during development but was lower in ripe fruits[38,39]. Roobanetal reported thattitratable acidity of mango and cashew apple is high at the immature Stage and low at the over-ripened Stage[40]. Notably, acidity rise could be related to the fruit's low respiration rate (reducing the citric acid cycle) and accumulating organic acids from phloem unloading [41]. Titratable acidity (TA) is an essential genetic quality in peach fruit that influences both perceptions of sourness and sweetness, which vary depending on the ripening stage[42,43]. Our study noted that fruits of *C.melo* varieties have a low sweet taste due to less accumulation of Total Soluble Solids (TSS) and a high level of TA. As a result, the fruit's balance of sugars and acids may significantly impact its flavor. Other studies have documented TSS, TA, and TSS/TA changes at various maturity stages [44-46]. Firmness and TSS for *C.melo* varieties changed sharply between S3 and S4 stages in var. *momordica* than in var. *acidulus*. Then it tended to level off; firmness and TSS can be used as fruit maturity indicators for melon varieties. As a result, TSS, TA, and firmness are always regarded as the primary parameters for determining fruit quality.

Ascorbic acid is not only a necessary nutrient for humans, but it is also a potent antioxidant [47]. The AsA content in the fresh fruit weight of both varieties decreases from S1to S5 stages. The analysis of results shows a slight increment from 5.2 to 5.7 mg/100Fw in the S5 Stage of *var. momordica*, whereas, in var. *acidulus*, the value is 5.2 mg/100mgFW in both S4 and S5 stages. This result indicates that AsA is rapidly synthesized before fruit ripening. Studies conducted by [48-50] in the South Indian melon landraces show that AsA content increases up to

9.0 mg 100 g-1 FW in the varieties. Tlilietal says that the vitamin C content of many fruits (apple, mango, citrus ) is higher when they are immature and decline as the fruits reach peak ripeness as they are respired or converted to sugars [51].

Fruit ripening and cracking are complex physiological processes that involve the transcription of many genes and the synthesis of large amounts of protein [52]. The present study reveals that total protein content at different maturity stages decreases while ripening, but there is a slight increase from S3 to S4 Stage in var. *momordica*. In the same way, in var. *acidulus*, it increases from the S1 to S4 Stage, then at the S5 Stage, it declines abruptly. The protein content decline from S4 to S5 Stage is explained as ripening proteins used for the enzyme machinery [53]. Nevertheless, the increment in protein content at the S3- S4 Stage shows that these Stage fruits are metabolically stable and viable for long-term transport. Changes in amino acids indicate variations in metabolic activity during different growth phases. During the climacteric phase of many fruits, there is a decrease in free amino acids, which often reflects an increase in protein synthesis. In the present investigation, *Cucumis melo* var *momordica* shows a sudden decrease from S3 to the S4 Stage. In var. *acidulus*, it increases from S1 to S4, which includes a gradual decrease from S3 to S4 Stage.

In summary, both varieties' increased protein and decreased amino acid content from S3 to S4 favor long shelf life and harvest maturity. This result is supported by [54] because free amino acids increase during ripening as per their research. In contrast, protein content decreases due to the activity of exopeptidase and non-specific protease enzymes in the fruit.

Carbohydrates, sugar, and cellulose play a significant role in fruit physiology when the fruit is attached to the tree and after its harvest. The present study reveals that var. *momordica* got a sudden increment in the total carbohydrate content from the S3- S4 Stage of maturity. However, in the var. *acidulus*, it is a gradual change.Nunez-Paleniu*setal* [55[ have shown that the total carbohydrate content increases during the development of Cantaloupe melon fruit, ensuring the ripened fruits' quality attributes. The total cellulose content in var. *momordica* declines from the S3-S4 Stage of maturity to S4- S5 Stage. However, in var. *acidulus*, it got increased from the S3to S5 Stage of fruit maturity. A report states that the amount of fiber, consisting of cellulose, decreases during the maturation and ripening of Dates [56]. Evidence from the studies conducted in the three muskmelon cultivars shows that cellulose content decreases while attaining harvest maturity and increases at the over-ripened Stage.[57].

Numerous studies have reported sugar content in the melon fruit during fruit growth and ripening as soluble sugar accumulation, which determines fruit sweetness at harvest, an essential parameter of fruit quality [57-60]. In the present investigation reducing sugar decreases from S3 to S4 stage maturity in var. *momordica* but in var. *acidulus*, there is a slight difference in the reducing sugar at the S4 to S5 Stage in both varieties.

According toShivapriya*etal* [61], quantitative analysis of sugars in muskmelon fruit showed consistency in reducing sugar content which was high initially and decreased subsequently but increased in the pre-ripened Stage. However, reducing sugars declined when the fruit attained the fully ripe Stage. There are reports with the litchi cultivar, Gola, that the highest reducing sugars were significantly superior in quality attributes but also had the maximum fruit cracking than the rest of the others with less reducing sugars [62]. From this report, we could conclude that the S3-S4 Stage of maturity of var. *momordica* has superior fruit quality attributes than var. *acidulus*.

Phenolic compounds are important secondary metabolites in plant cells, which protect the cell from oxidative damage. Our work shows that total phenolic content decreases with the

advancement of maturity in the fruits of *C.melo* varieties. However, if we compare the quantity of the compound from S3 to S4 Stages of ripening, var. *momordica* possesses slightly more than var. *acidulus*. This fact can be considered a quality-improved criterion of melon fruits, and such variations in phenolics have also been found in many fruit crops [63,64].

Melon fruit shows a progressive increase in membrane permeability, as measured by electrolyte leakage, as the fruit matures [65]. In this study, electrolyte leakage of var. *momordica* from the S3-S4 stages there is an increase in its percentage and its reaches maximum at S5 stage whereas invar. *acidulus*, there is no prominent change in the percentage from S3 to S5 fruit maturity stage. In comparing short-and long-storage life, non-netted melons electrolyte leakage increased with ripening. It was consistently higher in the short-storage cultivar, whereas the long-storage life cultivar had little increase in membrane permeability as the fruit ripened [66]. According to Bhatt*etal*[67], electrolyte leakage is often regarded as a reliable tool to measure overall fruit quality because sometimes increased membrane permeability coincides with increased membrane viscosity.

Like electrolyte leakage, lipid peroxidation is a prominent feature of plant senescence and aging [68] and may impair membrane structure and function [69]. Studies show lipid peroxidation is an early detectable process in fruit ripening [70]. The free radicals induce lipid peroxidation, which initiates the deteriorative changes associated with fruit ripening [71, 72].In this study, we observed that both melon varieties' lipid peroxidation rates decreased by half from the S3 to S4 fruit maturity stage. So lower the rate of lipid peroxidation, the higher the fruit quality.

## 3. Conclusions

**(Give proper conclusion it's too long)**

Among the two varieties of *Cucumis melo* selected for the study, fruits of var. *momordica* are highly perishable with a short market and shelflife than the var. *acidulus*. For the two varieties, var. *acidulus* possesses bigger fruit than var. *momordica*, and there are significant differences in the biochemical and nutritional attributes of the two varieties. This study found that the maturity stages significantly affect physiochemical parameters and nutritional properties during *C.melo* fruit ripening, with dramatic changes occurring between the S3 and S4 stages. The pH, TSS, TA, firmness, ascorbic acid, total carbohydrate, protein, amino acid, reducing sugar, total phenolics, and celluloses showed remarkable changes during the transition to physiological maturity. The fruit harvested before fruit cracking, the harder the fruit is, the more suitable for long-distance transportation and the longer shelf life. Based on the investigation, the maturity stage significantly affected physiochemical parameters and nutritional properties during *C.melo*fruit ripening, with dramatic changes occurring between the S3 and S4 stageskunjuaami2016

.

**References :**

**Arranged it in proper way**

1. FAOSTAT [Internet]. Canada: Food and Agriculture Organization of the United Nations. [cited 2017 Jan]. Available from: https://www.fao.org/faostat/en/

2. Rolim PM, Seabra LM, de Macedo GR. Melon by-products: Biopotential in human health and food processing. Food Reviews International. 2020 Jan 2;36(1):15-38. https://doi.org/10.1080/87559129.2019.1613662

3. Lija M, SuharaBeevy S A review on the diversity of Melon. Plant ScienceToday. 2021 Nov 8(4): 995–1003 https://doi.org/10.14719/pst.1300

4. Hammer K, Gladis T. Notes on infraspecific nomenclature and classifications of cultivated plants in Compositae, Cruciferae, Cucurbitaceae, Gramineae (with a remark on *Triticum dicoccon*Schrank) and Leguminosae. Genetic resources and crop evolution. 2014 Dec; 61(8):1455-67.https://doi.org/10.1007/s10722-014-0148-8

5. Duthie, J. F. (1905). Flora of the upper Gangetic plain and the adjacent Sivalik and sub Himalyan tracts, vol. I Ranunculaceae to Companulaceae. *Office of the Suprintendent of Governmnet of Priniting, Calcutta*, 41-43.

6. Fujishita N. Pedigree of melon (Cucumis melo L.) in ancient Japan. InInternational Symposium on Asian Plant Diversity and Systematics, Sakura, Japan 2004 Jul 29.

7. Abd El-Rhman, I. E. (2010). Physiological studies on cracking phenomena of pomegranates. *J. Appl. Sci. Res*, *6*(6), 696-703.

8. Al-Hmadawi, A. M., Al–Numani, R. M., & Wasan, H. A. S. (2011). Effect of pruning and spraying with N, Ca and GA3 on some characters of fruits and percentage of cracking offig cv. Asowd Diala. *Euphrates J. Agric. Sci*, *3*(2), 37-44.

9. Huang, X. M., Yuan, W. Q., Wang, H. C., Li, J. G., Huang, H. B., Shi, L., & Jinhua, Y. (2004). Linking cracking resistance and fruit desiccation rate to pericarp structure in litchi (Litchi chinensis Sonn.). *The Journal of Horticultural Science and Biotechnology*, *79*(6), 897-905.

10. Mohamed, A. K., Abdel-Galil, H. A., & Galal, N. (2020). Effect of some nutrients and amino acids spraying on yield and fruit quality of Manfalouty pomegranate. *SVU-International Journal of Agricultural Sciences*, *2*(2), 18-29.

11. Tehranifar, A., & Tabar, S. M. (2009). Foliar application of potassium and boron during pomegranate (Punica granatum) fruit development can improve fruit quality. *Horticulture Environment and Biotechnology*, *50*(3), 191-196

12. Yan, G., Youting, Y., Ling, L., Xin, Z., Yuhui, B., Huiqiong, M., & Bo, X. (2021, June). Study on the Effect Difference of Two Kinds of Control Techniques on Cracking Fruit of Qingcui Plum. In *IOP Conference Series: Earth and Environmental Science* (Vol. 792, No. 1, p. 012042). IOP Publishing.

13. Jeppsson, N. (2000). The effect of cultivar and cracking on fruit quality in black chokeberry (Aronia melanocarpa) and hybrids between chokeberry and rowan (Sorbus). *Gartenbauwissenschaft*, *65*(2), 93-98

14. Haq, I. U., & Rab, A. (2012). Characterization of physico-chemical attributes of litchi fruit and its relation with fruit skin cracking. *The Journal of Animal & Plant Sciences*, *22*(1), 142-147.

15. Zou S, Gao P, Jia T, Huang H. Physicochemical Characteristics and Nutritional Composition during Fruit Ripening of Akebia trifoliata (Lardizabalaceae). Horticulturae. 2022 Apr 13;8(4):326.

16. Fawole, O.A.; Opara, U.L.; Theron, K.I. Chemical and Phytochemical Properties and Antioxidant Activities of Three Pomegranate Cultivars Grown in South Africa. Food Bioprocess Technol. **2012**, 5, 2934–2940. [CrossRef]

17. Lee, S.K.; Kader, A.A. Preharvest and postharvest factors influencing vitamin C content of horticultural crops. Postharvest Biol.Technol. **2000**, 20, 207–220. [CrossRef]

18. Opara, U.L.; Al-Ani, M.R. Antioxidant contents of pre-packed fresh-cut versus whole fruit and vegetables. Br. Food J. **2010**,112, 797–810. [CrossRef

19. Song, J.X.; Bi, J.F.; Chen, Q.Q.; Wu, X.Y.; Lyu, Y.; Meng, X.J. Assessment of sugar content, fatty acids, free amino acids, and volatile profiles in jujube fruits at different ripening stages. Food Chem. **2019**, 270, 344–352. [CrossRef] [PubMed]

20. Wang, C.T.; Cheng, D.; Cao, J.K.; Jiang,W.B. Antioxidant capacity and chemical constituents of Chinese jujube (Ziziphus jujube Mill.) at different ripening stages. Food Sci. Biotechnol. **2013**, 22, 639–644. [CrossRef]

21. Adesola, B., Ogundipe, K., Sangosanya, K.T., Akintola, B.D., Oluwa, A., Hassan, E., (2016). Comparative study on the biosorption of Pb(II), Cd(II) and Zn(II) using Lemon grass (Cymbopogon citratus): Kinetics, isotherms and thermodynamics. . *Chemistry International* 2, 89-102..

22. Bajaj, K.L.,and Kaur, G. (1981): Spectrophotometric determination of L-ascorbic acid in vegetable and fruits. *Analyst*, 106(1258): 117-20

23. Carmak, I. and J.H. Horst. (1991). Effects of aluminum on lipid peroxidation, superoxide dismutase, catalase, and peroxidase activities in root tips of soybean (Glycine max). *Physiol. Plant.*, 83: 463-468.

24. Kaur, C., & Kapoor, H. C. (2002). Anti□oxidant activity and total phenolic content of some Asian vegetables. *International Journal of Food Science & Technology*, *37*(2), 153-161.

25. Ergun, M., Jeong, J., Huber, D. J., &Cantliffe, D. J. (2005). Suppression of Ripening and Softening ofGalia'Melons by 1-Methylcyclopropene Applied at Preripe or Ripe Stages of Development. *HortScience*, *40*(1), 170-175.

26. Song, J.X.; Bi, J.F.; Chen, Q.Q.; Wu, X.Y.; Lyu, Y.; Meng, X.J. Assessment of sugar content, fatty acids, free amino acids, and volatile profiles in jujube fruits at different ripening stages. Food Chem. **2019**, 270, 344–352. [CrossRef] [PubMed]

27. Zhao, Y.T.; Zhu, X.; Hou, Y.Y.; Wang, X.Y.; Li, X.H. Postharvest nitric oxide treatment delays the senescence of winter jujube (Zizyphus jujuba Mill. cv. Dongzao) fruit during cold storage by regulating reactive oxygen species metabolism. Sci. Hortic. **2020**, 261, 109009. [CrossRef]

28. Mahmood, T.; Anwar, F.; Afzal, N.; Kausar, R.; Ilyas, S.; Shoaib, M. Influence of ripening stages and drying methods on polyphenolic content and antioxidant activities of mulberry fruits. J. Food Meas. Charact. **2017**, 11, 2171–2179. [CrossRef

29. Zhong, C.H.; Bu, F.W.;Wang, Z.Y.; Peng, D.F. Fruit development and biological characteristics of seedling progenies of Akebia trifoliata. Hunan Agric. Sci. **2006**, 1, 27–29.

30. Khodabakhshian, R.; Emadi, B.; Khojastehpour, M.; Golzarian, M.R. Determining quality and maturity of pomegranates using multispectral imaging. J. Saudi. Soc. For. Agric. Sci. **2015**, 16, 322–331. [CrossRef]

31. Niu, J.; Sun, Z.M.; Shi, Y.L.; Huang, K.Y.; Zhong, Y.C.; Chen, J.; Chen, J.H.; Luan, M.B. Comparative Analysis of Akebia trifoliataFruit Softening at Different Flesh Ripening Stages Using Tandem Mass Tag Technology. Front. Nutr. **2021**, 8, 684271. [CrossRef]

32. Niu, J.; Shi, Y.L.; Huang, K.Y.; Zhong, Y.C.; Chen, J.; Sun, Z.M.; Luan, M.B.; Chen, J.H. Integrative transcriptome and proteome analyses provide new insights into different stages of Akebia trifoliata fruit cracking during ripening. Biotechnol. Biofuels **2020**,13, 149. [CrossRef]

33. Nayab, S.; Razzaq, K.; Ullah, S.; Rajwana, I.A.; Amin, M.; Faried, H.N.; Akhtar, G.; Khan, A.S.; Asghar, Z.; Hassan, H.; et al.Genotypes and harvest maturity influence the nutritional fruit quality of mulberry. Sci. Hortic. **2020**, 266, 109311. [CrossRef]

34. Mahmood, T.; Anwar, F.; Bhatti, I.A.; Iqbal, T. Effect of maturity on proximate composition, phenolics and antioxidant attributes of cherry fruit. Pak. J. Bot. **2013**, 45, 909–914.

35. Parveen S., Ali M. A., Asghar M., Khan A. R. & Salam A.(2012). Physico-chemical changes in muskmelon (*Cucumismelo L*.) as affected by harvest maturity stage, *Journal of Agricultural Research*, 50(2), 249-250.

36. Bianchi T., Guerrero L., Gratacos-Cubarsi M., Claret A., Argyris J., Gracia-Mas J. &Hortos M. (2016). Textural properties of different melon (*Cucumis melo L*.) fruit types:Sensory and physical-chemical evaluation. *Scientia Horticulturae*, 201, 46-56.

37. Illeperuma, C. K., & Jayasuriya, P. (2002). Prolonged storage of 'Karuthacolomban'mango by modified atmosphere packaging at low temperature. *The Journal of Horticultural Science and Biotechnology*, *77*(2), 153-157.

38. Woodward, J. R. (1972). Physical and chemical changes in developing strawberry fruits. *Journal of the Science of Food and Agriculture*, *23*(4), 465-473.

39. Moing, A.; Renaud, C.; Gaudillere, M.; Raymond, P.; Roudeillac, P.; DenoyesRothan, B. (2001). Biochemical changes during fruit development of four strawberry cultivars. *Journal of the American Society for Horticultural Science*, v.126, p.394-403.

40. Rooban, R., Shanmugam, M., Venkatesan, T., & Tamilmani, C. (2016). Physiochemical changes during different stages of fruit ripening of climacteric fruit of mango (Mangifera indica L.) and non-climacteric of fruit cashew apple (Anacardium occidentale L.). *J Appl Adv Res*, *1*(2), 53-8.

41. Zhang H, Wang HS, Yi HP, Zhai WQ, Wang GZ, Fu QS (2016). Transcriptome profiling of Cucumis melo fruit development and ripening. *Horticulture Research* 3:10.

42. Dirlewanger, E., Moing, A., Rothan, C., Svanella, L., Pronier, V., Guye, A., Plomion, C., & Monet, R. (1999). Mapping QTLs controlling fruit quality in peach Prunus persica (L.) Batsch. *Theory and Applied Genetics*, 98, 18–31

43. Lobit, P., Soing, P., Génard, M., & Habib, R. (2002). Theoretical analysis of relationships between composition, pH, and titratable acidity of peach fruit. *Journal of Plant Nutrition*, *25*(12), 2775-2792.

44. Mahmood, T.; Anwar, F.; Abbas, M.; Boyce, M.C.; Saari, N. Compositional Variation in Sugars and Organic Acids at Different Maturity Stages in Selected Small Fruits from Pakistan. Int. J. Mol. Sci. **2012**, 13, 1380–1392. [CrossRef]

45. Riaz, M.; Zamir, T.; Rashid, N.; Jamil, N.; Rizwan, S.; Masood, Z.; Mushtaq, A.; Tareen, H.; Khan, M.; Ali, M. Comparative study of nutritional quality of orange (Citrus sinensis) at different maturity stages in relation to significance for human health. Am. Eur.J. Toxicol. Sci. **2015**, 7, 209–213.

46. Sanchez, E.M.; Calin-Sanchez, A.; Carbonell-Barrachina, A.A.; Melgarejo, P.; Hernandez, F.; Martinez-Nicolas, J.J. Physicochemical characterisation of eight Spanish mulberry clones: Processing and fresh market aptitudes. Int. J. Food Sci. Technol. **2014**, 49, 477–483.[CrossRef]

47. Lee, S.K.; Kader, A.A. Preharvest and postharvest factors influencing vitamin C content of horticultural crops. Postharvest Biol.Technol. **2000**, 20, 207–220. [CrossRef]

48. Dhillon, N.P.S., Ranjana, R., Singh, K., Eduardo, I., Monforte, A.J., Pitrat, M., Dhillon, N.K. & Singh, P.P. (2007).Diversity among landraces of Indian snapmelon (*Cucumis* melo var. *momordica*) *Genet. Resources Crop Evol.* 54 1267 1283

49. Fergany, M., Kaur, B., Monforte, A. J., Pitrat, M., Rys, C., Lecoq, H., ... & Dhaliwal, S. S. (2011). Variation in melon (Cucumis melo) landraces adapted to the humid tropics of southern India. *Genetic Resources and Crop Evolution*, *58*(2), 225-243.

50. Malik, A. A., Vashisht, V. K., Singh, K., Sharma, A., Singh, D. K., Singh, H., ... & Dhillon, N. P. (2014). Diversity among melon (Cucumis melo L.) landraces from the Indo-Gangetic plains of India and their genetic relationship with USA melon cultivars. *Genetic resources and crop evolution*, *61*(6), 1189-1208.

51. Tlili, I., Hdider, C., Lenucci, M. S., Ilahy, R., Jebari, H., & Dalessandro, G. (2011). Bioactive compounds and antioxidant activities during fruit ripening of watermelon cultivars. *Journal of Food Composition and Analysis*, *24*(7), 923-928.

52. Wu, J.; Xu, Z.; Zhang, Y.; Chai, L.; Yi, H.; Deng, X. An integrative analysis of the transcriptome and proteome of the pulp of a spontaneous late-ripening sweet orange mutant and its wild type improves our understanding of fruit ripening in citrus. J. Exp.Bot. **2014**, 65, 1651–1671. [CrossRef] [PubMed]

53. Frenkel, C., Klein, I. and Dilley, D.R. (1968). Protein synthesis in relation to ripening of pome fruit. *Journal of Plant Physiology*, 43: 1146-1153.

54. Sorrequieta, A., Ferraro, G., Boggio, S. B., & Valle, E. M. (2010). Free amino acid production during tomato fruit ripening: a focus on L-glutamate. *Amino acids*, *38*(5), 1523-1532.

55. Nunez-Palenius H. G., Gomez-Lim M. & Ochoa-Alejo N. (2008). Melon Fruits: Genetic Diversity, Physiology, and Biotechnology Features, Critical Reviews in Biotechnology, 28, 13-55

56. Mustafa, A. B., Harper, D. B., & Johnston, D. E. (1986). Biochemical changes during ripening of some Sudanese date varieties. *Journal of the Science of Food and Agriculture*, *37*(1), 43-53.

57. Deluc LG, Grimplet J, Wheatley MD, Tillett RL, Quilici DR, Osborne C, Schooley DA, Schlauch KA, Cushman JC, Cramer GR. (2007) Transcriptomic and metabolite analyses of Cabernet Sauvignon grape berry development. *BMC Genomics* 8: 429.

58. Lombardo, V. A., Osorio, S., Borsani, J., Lauxmann, M. A., Bustamante, C. A., Budde, C. O., &Drincovich, M. F. (2011). Metabolic profiling during peach fruit development and ripening reveals the metabolic networks that underpin each developmental stage. *Plant Physiology*, *157*(4), 1696-1710.

59. Osorio, S., Alba, R., Nikoloski, Z., Kochevenko, A., Fernie, A. R., & Giovannoni, J. J. (2012). Integrative comparative analyses of transcript and metabolite profiles from pepper and tomato ripening and development stages uncovers species-specific patterns of network regulatory behavior. *Plant Physiology*, *159*(4), 1713-1729.

60. Vallarino, J. G. (2018). e Lima FD, Soria C, Tong H, Pott DM, Willmitzer L, Fernie AR, Nikoloski Z, Osorio S. *Genetic diversity of strawberry germplasm using metabolomic biomarkers. Sci Rep*, *8*, 14386.

61. Shivapriya, M., Mamatha, S., Umesha, K., Lingaiah, H. B., & Mohankumar, S. (2021). Genetic variation in melon (Cucumis melo L.) landraces and wild relatives of Karnataka state of southern India. *Plant Genetic Resources*, *19*(5), 419-427.

62. Haq, I. U., & Rab, A. (2012). Characterization of physico-chemical attributes of litchi fruit and its relation with fruit skin cracking. *The Journal of Animal & Plant Sciences*, *22*(1), 142-147.

63. Fawole, O.A.; Opara, U.L. Changes in physical properties, chemical and elemental composition and antioxidant capacity of pomegranate (cv. Ruby) fruit at five maturity stages. Sci. Hortic. **2013**, 150, 37–46. [CrossRef]

64. Fawole, O.A.; Opara, U.L. Effects of maturity status on biochemical content, polyphenol composition and antioxidant capacity of pomegranate fruit arils (cv. 'Bhagwa'). S. Afr. J. Bot. **2013**, 85, 23–31. [CrossRef]

65. Lester, G., Dunlap, J., & Lingle, S. (1988). Effect of postharvest heating on electrolyte leakage and fresh weight loss from stored muskmelon fruit. *HortScience*, *23*(2).

66. Lacan, D. and J. Baccou. 1996. Changes in lipids and electrolyte leakage during nonnetted muskmelon ripening. *J. Amer. Hort.Sci*. 121:554-558.

67. Bhatt, D., Negi, M., Sharma, P., Saxena, S. C., Dobriyal, A. K., & Arora, S. (2011). Responses to drought induced oxidative stress in five finger millet varieties differing in their geographical distribution. *Physiology and Molecular Biology of Plants*, *17*(4), 347-353.

68. Kumar, G. M., & Knowles, N. R. (1993). Changes in lipid peroxidation and lipolytic and free-radical scavenging enzyme activities during aging and sprouting of potato (Solanum tuberosum) seed-tubers. *Plant Physiology*, *102*(1), 115-124.

69. Thompson, J., C. Froese, Y. Hong, K. Hudak and M. Smith. (1997). Membrane deterioration during senescence. *Can. J. Bot.* 75:867-869.

70. Meir, S., Philosoph-Hadas, S., Zauberman, G., Fuchs, Y., Akerman, M., & Aharoni, N. (1991). Increased formation of fluorescent lipid-peroxidation products in avocado peels precedes other signs of ripening. *Journal of the American Society for Horticultural Science*, *116*(5), 823-826

71. Dhindsa, R. S., Plumb□Dhindsa, P. L., & Reid, D. M. (1982). Leaf senescence and lipid peroxidation: Effects of some phytohormones, and scavengers of free radicals and singlet oxygen. *Physiologia Plantarum*, *56*(4), 453-457.

72. Du Z., & Bramlage, W. J. (1994). Superoxide dismutase activities in senescing apple fruit (Malus domestica Borkh.). *Journal of food science*, *59*(3), 581-584.