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Research Article

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Effect of Maturity Stages on Physiological Properties of Banana Fruits

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Abstract

This study was conducted to understand changes of physicochemical properties of fruits of two apple cultivars (red and yellow) as influenced by stage of maturity and physiological properties of banana fruits. Results indicated that maturity stage at harvest significantly (P<0.05) affected quality of apple cultivars and banana fruits. The result of study showed red apple cultivar has higher TSS, diameter, weight and a-value while the yellow cultivar apple has higher firmness, b and L*-values. Apple red cultivar showed higher diameter (65.9 mm), higher TSS (14.6%), L* (46) and a* (22) values and yellow apple cultivar depicted higher firmness 10.04 N and b* values (26.7). The study also depicted that, ripe banana exhibited higher intensity respiration CO_2 and ethylene production compare to green banana. However, during storage conditions, the cold storage exhibited lower intensity respiration CO_2 and ethylene production. Ripe banana showed maximum intensity respiration 7.6 CO_2 (LCO_2/kg/h) and ethylene 7.4 μLC_2H4/kg*h. However, during room temperature at 32°C and cold storage at 13oC temperature, bananas stored at room temperature revealed higher respiration 1.2 CO_2 (LCO_2/kg/h) and 1.64 μLC_2H_4/kg*h ethylene compared with cold storage 0.9 CO_2 (LCO_2/kg/h) and 1.1 μLC_2H_4/kg*h respectively. Thus, it can be concluded that the choice of fruit picking time (maturity stage) plays a key role in influencing the quality attributes of apple cultivar fruits. Further research is recommended on more quality parameters with different types of apple and banana varieties.*

Keywords: Apple Cultivars, Banana, Maturity Stages

1. Introduction

Banana is one of globally consumed fruit and the most important crop in the world. Maturity stage of banana fruit is an important factor that affects the fruit quality during ripening and marketability after ripening. The ability to identify maturity of banana fruit will be a great support for farmers to optimize harvesting phase which helps to avoid harvesting either under-matured or over-matured banana. This fruit is climacteric fruits which produce ethylene and short shelf life [1]. If banana is not harvested at optimum stage of maturity, it's physicochemical properties will be affected by different factors. Particularly physiological factor like respiration is one of the most factor reduce the quality and shelf life of banana because of temperature. Temperature is also one of external (extrinsic) factor encourage respiration rate and reduce quality of fruits. Therefore, it is an important to harvest fruit at the right maturity stage to maintain the general quality and to avoid problem come from respiration and temperature because of ethylene.

Therefore, the objective of this experiment was to determine effect of stage of maturity of banana fruit on respiration rate and ethylene production as well to determine effect of storage condition on respiration rate and ethylene production of banana fruit.

2. Materials and Methods

2.1. Materials

During laboratory experiment a lot of materials were used for measuring respiration rate and ethylene production. Some were:

Green and ripe Bananas fruit……… as sample
Electronic balance…………………. .to measure samples weight
Black Jar………………… ………..to contain/hold/ sample
Graduate cylinder………………….… to measure volume
Gases analyzer……………………...to measure respiration rate
Ethylene Analyzer……………..….to measure concentration of ethylene gases in banana

Thermometer……………….……….to measure temperature
Cold storage /fridge) ………………. for storage purpose through reduce temperature

2.2. Methodology

The physiological properties (intensity respiration rate in terms of CO2 production and ethylene) produces of both banana fruits (green and yellow) were measured according to [2]. This physiological property banana fruits (ripe and green) were measured in terms production of CO2 concentration by using the closed system method in which samples were placed in airtight 5 L volume black jar container, and CO2 concentration was analyzed after 1 hour and expressed as LCO2 /kg.h.

To measure respiration rates in terms of CO2 production, we have used different methods and protocols. At the first step, the prepared green and ripe banana fruits five in number were weighed by using balance and put in black jar and sealed with grease and store at room temperature at 32oc and waited for one hour. The volume of jar was determined by using water and it was 5 liters. The volume of samples was determined by using liquid displacement method or by adding water into jar and put sample into it. The overflowed water was measure and consider as volume of sample. That means the volume of sample was obtained by subtraction of volume of samples from volume of jar. After one hours, Gases analyzer was used and directly we have placed and inserted the syringe to the hole of black Jar and the value of CO2 produced directly recorded from Gases analyzer and replicated three times. The same procedure was followed to measure carbon dioxide after storage in cold storage at 13^{o}c for one-hour. Then, the below formula was applied for calculation of CO2.

$$IR\ Co2 = \frac{\%\mathrm{CO2\ Max} - \%\ \mathrm{CO2\ (initial)} * (\mathrm{Vjar} - \mathrm{Vfruit})}{W * T}$$

Weight = weight of sample in kg and T time in hour, volume in liter

To measure ethylene produced, the weight and volume were measure by following the same above procedure used in carbon dioxide measurement. After that, ethylene analyzer syringe was placed inside of black jar and the value of ethylene produced was directly taken from it and repeated three time. After that, below formula was applied. Ethylene was also determined after cold storage at 13^{o}c for one-hour by following the same procedure done for bananas storage at room temperature.

$$\text{Ethylene production } \frac{\mu\mathrm{lC2H4}}{\mathrm{kg} * \mathrm{h}} = \frac{\mathrm{E} * (\mathrm{Vjar} - \mathrm{Vfruit})}{W * T}$$

Weight = weight of sample in kg and T time in hour

The effect of storage temperatures (room temperature, 32oc) and cold storage,13oc for one hour with inside jar 26oc) on respiration rate and ethylene production also done and compared. The banana fruits used looks like below.

Green banana Ripe banana

Figure 1: Green and Ripe Banana

3. Results and Discussions

Data recorded for determination of respiration rate (CO2) and ethylene.

Parameter's	Replication	Initial	Final	CO_2 produced (LCO_2/kg*h)	Mass (kg)	Sample Volume (L)	Jar volume (L)	Time (hr)
CO2	R1	0	0.94	**6.2**	0.66081	0.65	5	1
	R2	0	0.71	**4.7**				
	R3	0	0.61	**4**				
		Average		**4.97**				
Ethylene	Replication	Initial	Final	μLC_2H_4/kg*h	0.66081	0.65	5	1
	R1	0.1	1.1	**6.5**				
	R2	0.1	1.1	**6.5**				
	R3	0.1	1.1	**6.5**				
		Average		**6.5**				

Table 1: Ripe Banana in Jar One

parameter's	Replication	Initial	Final	CO_2 produced (LCO_2/kg*h)	Mass (kg)	Volume sample (L)	Volume Jar(L)	Time (hr)
CO2	R1	0	1.43	**9.4**	0.66172	0.650	5	1
	R2	0	1.43	**9.4**				
	R3	0	1.4	**9.2**				
		Average		**9.33**				
Ethylene	Replication	Initial	Final	μLC_2H_4/kg*h	0.66172	0.650	5	1
	R1	0.3	1.6	**8.5**				
	R2	0.3	1.6	**8.5**				
	R3	0.3	1.6	**8.5**				
		Average		**8.5**				

Table 2: Ripe Banana in Jar Two

Parameter	Replication	Initial	Final	CO2 produced (LCO2/kg*h)	Weight (kg)	Volume sample(L)	Volume jar (L)	Time (hr)
CO2	R1	0	1.68	**9.9**	0.73982	0.6	5	1
	R2	0	1.42	**8.4**				
	R3	0	1.19	**7.1**				
			Average	**8.5**				
Ethylene	Replication	Initial	Final	$\mu L C_2H_4$/kg*h	0.73982	0.6	5	1
	R1	0.3	1.6	**7.7**				
	R2	0.3	1.5	**7.14**				
	R3	0.3	1.4	**6.5**				
			Average	**7.13**				

Table 3: Ripe Banana in Jar 3

parameter's	Replication	Initial	Final	CO2 produced (LCO2/kg*h)	Mass (kg)	Sample Volume (L)	Jar Volume (L)	Time (hr)
CO2	R1	0	0.22	**1.2**	0.80607	0.6	5	1
	R2	0	0.19	**1.03**				
	R3	0	0.15	**8.2**				
		Average		**1.02**				
Ethylene	Replication	Initial	Final	$\mu L C_2H_4$/kg*h	0.80607	0.6	5	1
	R1	0.1	0.4	**1.64**				
	R2	0.1	0.4	**1.64**				
	R3	0.1	0.4	**1.64**				
		Average		**1.64**				

Table 4: Green Banana in Jar 1

Parameter	Replication	Initial	Final	CO2 produced (LCO2/kg*h)	Weight (kg)	Sample volume (L)	Jar volume (L)	Time (hr)
CO2	R1	0	0.25	**1.4**	0.77987	0.6	5	1
	R2	0	0.25	**1.4**				
	R3	0	0.24	**1.4**				
		Average		**1.4**				
Ethylene	Replication	Initial	Final	μLC_2H_4/kg*h				
	R1	0.3	0.5	**1.13**	0.77987	0.6	5	1
	R2	0.3	0.4	**0.56**				
	R3	0.3	0.5	**1.13**				
		Average		**0.94**				

Table 5: Green Banana in Jar 2

Parameters	Replications	Initial	Final	CO2 produced (LCO2/kg*h)	Mass	Samle Volume (L)	Jar.Volume (L)	Time (hr)
CO2	R1	0	0.33	**1.89**	0.78033	0.54	5	1
	R2	0	0.34	**1.94**				
	R3	0	0.35	**2**				
		Average		**1.97**				
Ethylene	Replication	Initial	Final	μLC_2H_4/kg*h	0.78033	0.54	5	1
	R1	0.3	0.5	**1.14**				
	R2	0.3	0.4	**0.57**				
	R3	0.3	0.4	**0.57**				
		Average		**0.76**				

Table 6: Green Banana in Jar 3

Storage condition	Replication	Initial	Final	CO_2 LCO_2/kg.hr produced	Weight (kg)	Sample Volume(L)	Jar Volume(L)	Time (hr)
Cold storage	R1	0	0.88	**5.8**				
	R2	0	0.68	**4.5**				
	R3	0	0.5	**3.3**	0.6608	0.65	5	1
		Average		**4.5**				
Room temperature	Replication	Initial	Final	CO_2 LCO_2/kg.hr produced	Weight (kg)	Sample Volume(L)	Jar Volume(L)	Time (hr)
	R1	0	0.94	**6.2**				
	R2	0	0.71	**4.7**	0.6608	0.65	5	1
	R3	0	0.61	**4**				
		Av		**4.97**				

Table 7: Co_2 of Ripe Banana After Stored in Cold Storage At 13°c and 32°c at Room Temperature

Storage condition	Replications	Initial	Final	μLC_2H_4/kg*h	Weight (kg)	Sample Volume(L)	Jar Volume(L)	Time (hr)
Cold storage	R1	0.3	1.2	**5.9**				
	R2	0.3	1.2	**5.9**				
	R3	0.3	1.2	**5.9**	0.6608	0.65	5	1
		Average		**5.9**				
Room temperature	Replications	Initial	Final	μLC_2H_4/kg*h	Weight (kg)	Sample Volume(L)	Jar Volume(L)	Time (hr)
	R1	0.1	1.1	**6.5**				
	R2	0.1	1.1	**6.5**	0.6608	0.65	5	1
	R3	0.1	1.1	**6.5**				
		Average		**6.5**				

Table 8: C_2H_4 of Ripe Banana After Stored in Cold Storage At 13°c and 32°c at Room Temperature

Storage condition	Replication	Initial	Final	LCO_2 /kg.hr produced	Weight (kg)	Volume Sample (L)	Volume Jar (L)	Time (hr)
Room temperature	R1	0	0.22	**1.2**	0.80607	0.6	5	1
	R2	0	0.19	**1.04**				
	R3	0	0.15	**0.82**				
		Average		**1.02**				
Cold storage	Replication	Initial	Final	LCO_2 /kg.hr produced	Weight (kg)	Volume Sample (L)	Volume Jar (L)	Time (hr)
	R1	0	0.19	**1.01**	0.80607	0.6	5	1
	R2	0	0.16	**8.7**				
	R3	0	0.15	**8.2**				
		Average		**5.97**				

Table 9: CO_2 of Green Banana After Stored in Cold Storage At 13°c and 32°c at Room Temperature

Storage condition	Replication	Initial	Final	μLC_2H_4/kg*h	Weight (kg)	Volume Sample m(L)	Volume Jar (mL)	Time (hr)
Room temperature	R1	0.1	0.4	**1.64**	0.80607	6000	5	1
	R2	0.1	0.4	**1.64**				
	R3	0.1	0.4	**1.64**				
		Average		**1.64**				
Cold storage	Replication	Initial	Final	μLC_2H_4/kg*h	0.80607	6000	5	1
	R1	0.1	0.3	**1.1**				
	R2	0.1	0.3	**1.1**				
	R3	0.1	0.3	**1.1**				
		Average		**1.1**				

Table 10: C_2H_4 of Green Banana After Stored in Cold Storage at 13°c and 32°c at Room Temperature

Based on the above tables, recorded data and information, below results which are average was obtained. That means stage of maturity and temperature used as factors. The below figures were drawn by using averages for both ripe and green banana including both storage conditions room temperature and cold storage.

According to Fig.2 below implied, the higher intensity of respiration CO_2 (7.6 L/kg*h) and lower (1.5L /kg*h) and Ethylene $(7.4\frac{\mu L}{kg*h})$ production recorded for ripe banana and the lower value for green banana $(1.1\frac{\mu L}{kg*h})$ at room temperature. This was due to the fact that, ripe fruits show a large increase in ethylene production that makes higher respiration rate during ripening. The higher ethylene production recorded for ripe banana $(7.4\frac{\mu L}{kg*h})$ and the lower for green banana $(1.1\frac{\mu L}{kg*h})$ is happened because of ethylene production increased as the maturity stage advanced. This work agrees with the work of [3].

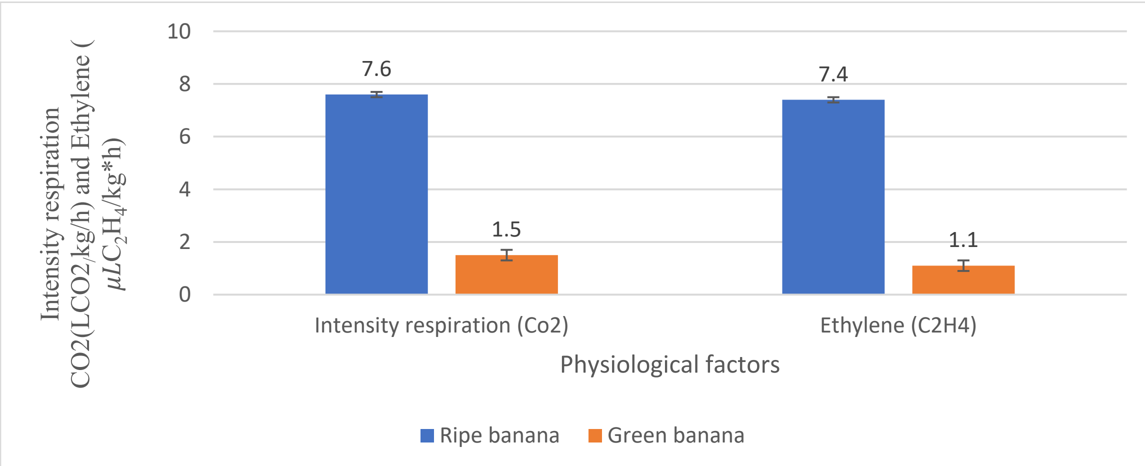

Figure 2: Effect of Stage of Maturity on Intensity Respiration (Co_2) and Ethylene Production.

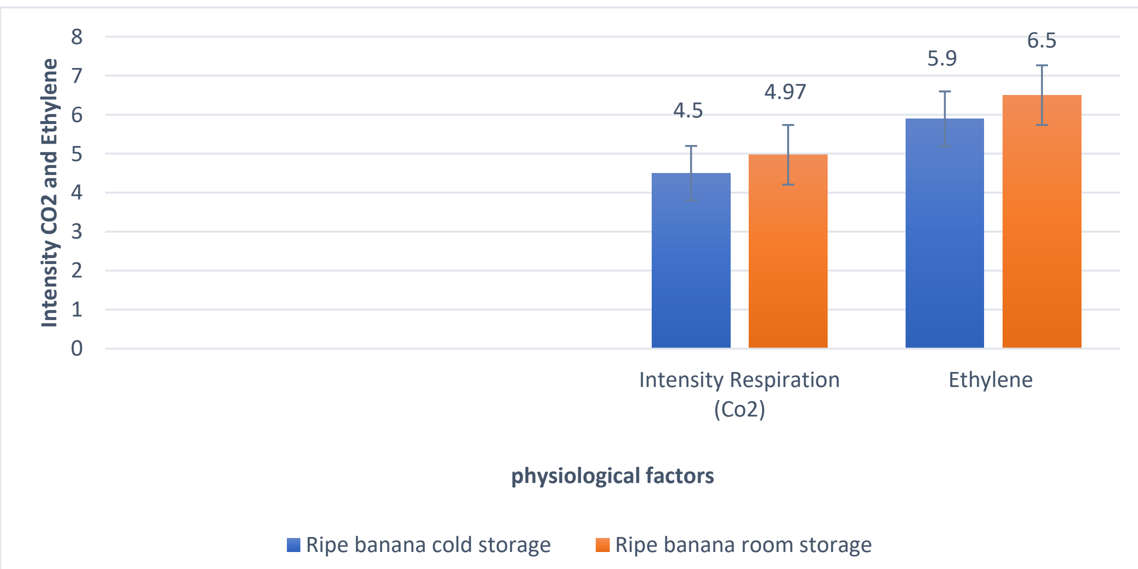

Figure 3: Effect of Storage Conditions on Intensity Respiration Co_2 And Ethylene of Ripe Banana

This above fig.3 depicted, effect of storage condition room temperature (32^{o}C) and cold storage (13^{o}c) for one hour and inside of jar 26oc on maturity stage of banana fruits. According to the Fig.3 above implied, the respiration and Ethylene data corresponding to cold and room temperatures indicated that as the temperature increased the respiration progressed at a faster rate. Our results exhibited, the higher and lower intensity respiration CO_2 (4.97 and 4.5 L/kg*h) respectively and higher and lower Ethylene $(6.5 \text{ and } 5.9\frac{\mu L}{kg*h})$ were recorded respectively.

Therefore, ripe banana fruits stored at room temperatures (32^{o}c) implied higher intensity respiration CO_2 and ethylene compare to the ripe banana stored at cold storage 13oc. This is might due to the fact that, at higher temperatures an increase in respiration rate could occur due to the increase in metabolic activities. In other way due to low temperatures slow down plant metabolic processes such as respiration, ethylene production and, in general, enzyme activity. This work witness with the work of [4,2].

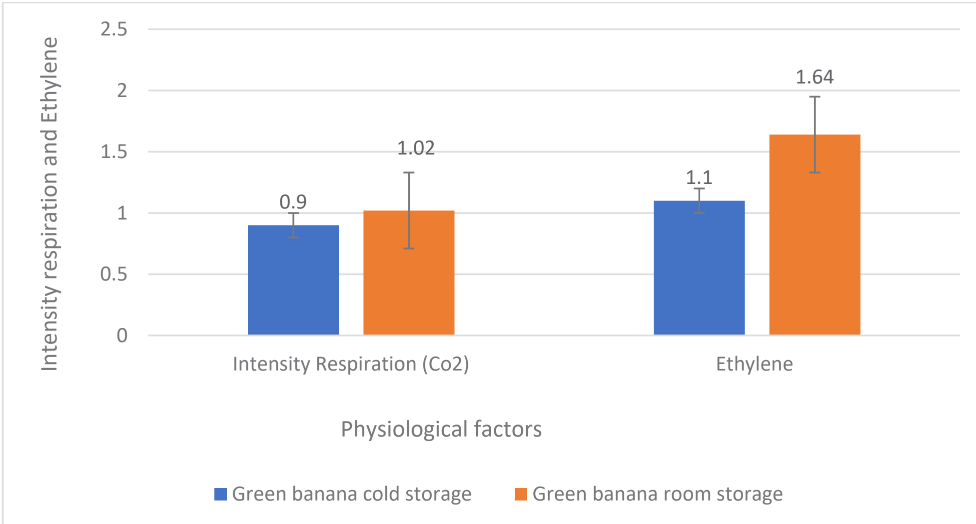

Figure 4: Effect of Storage Condition on Intensity Respiration and Ethylene of Green Banana

Figure 4 above showed, effect of storage conditions (room temperature 32ºc) and cold storage (13ºc) for one hour and 26ºc in jar on intensity respiration CO_2 and ethylene production of green bananas.

The recorded data showed, green banana stored at room temperature and cold storage produce Intensity respiration CO_2 1.02 and 0.9 L/kg*h respectively and produced ethylene 1.54 and 1.1 $\frac{\mu L}{kg*h}$ respectively. The result exhibited that, the green banana stored in room temperature produce higher intensity respiration CO_2 and ethylene than green banana stored at cold storage. This is due to the fact that, lower temperature reduces respiration and Ethylene production including other physiological factors. This is because of as storage temperature increased and respiration rates increased and vice versa [5]. This idea supported with the work of who worked on effects of maturity on physicochemical properties of Gac fruit [6].

4. Conclusion

Based on the obtained results, intensity respiration CO2 and ethylene production of banana fruits were affected by stage of maturity and storage conditions. The ripe banana exhibited higher intensity respiration CO2 and ethylene production compare to green banana. However, during storage conditions, the cold storage exhibited lower intensity respiration CO2 and ethylene production. Therefore, to maintain quality of agriculture products like banana appropriate and optimum stage of maturity and application of cold storage are very important.

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