International Journal of Scientific Research in Multidisciplinary Studies
Vol.6, Issue.2, pp.14-20, February (2020)

Research Paper
E-ISSN: 2454-9312
P-ISSN: 2454-6143

Discarded desiccant silica gel: As agent in prolonging the shelf life of lakatan banana *(Musa acuminata)*

Reynante I. Enriquez

Talon-Talon Central School SPED Center Zamboanga City, Philippines

Author's Mail id: www.rheynrain7@gmail.com

Available online at: www.isroset.org

Received: 25/Jan/2020, Accepted: 14/Feb/2020, Online: 28/Feb/2020

Abstract- Shelf life extension is the holy grail for the fruit and vegetable industry. Extension of shelf life of fruits and vegetables has several advantages, it improves the quality, taste and texture of the food, it reduces food waste. The aim of this study is to determine the potential of discarded desiccant silica gel as agent in prolonging the shelf life of lakatan banana. The experiment was laid out in completely randomized design and replicated thrice. The lakatan banana stored with ethylene absorbent (10 grams silica gel) and in conventional way without ethylene absorbent. The physiological loss of lakatan banana, in terms of the pulp to peel ratio, set up without ethylene absorbent documented minimum weight loss of (1.65g) recorded with spoilage at the end of 7 days storage. The banana with ethylene absorbent (10 grams silica gel) documented with (1.57g) recorded no spoilage respectively up to 7 days storage. In terms of Peel color banana without ethylene absorbent data shows most evident change in peel color and some of the banana turns black which shows that the banana is overripe and already in decaying process compared to set up with ethylene absorbent (10 grams silica gel) shows the peel color of the banana are still good recorded with no spoilage. Total soluble content remained high in set up with ethylene absorbent (10 grams silica gel) with (17.37%) compared to the set up without ethylene absorbent (15%). Hence, It was concluded that silica gel can successfully prolong the shelf life of lakatan banana.

Keywords- discarded, desiccant, silica gel, lakatan banana, shelf life, ethylene absorbent, storage

I. INTRODUCTION

A major concern with ripened fruit is that it does not last very long before it begins to spoil. The loss of firmness and the production of sugars associated with ripening can also make the fruit susceptible to bacteria and spoilage. Over-softening of fruit is a major cause of spoilage during transportation, particularly for tropical fruits, such as mangoes and bananas. Spoilage can be reduced by rapid transportation of fresh fruits, or by slowing down fruit ripening. A huge amount of food is wasted as it goes off before it is eaten. If we can add a few more days to the shelf life, we could reduce the amount of food waste and significantly reduce cost. Fruit and vegetable processors can also reduce costs by extending shelf life. At the moment , they have to pick their crops quickly and ship them by the fastest route possible. This is expensive and labour intensive usage better. Postharvest treatments are used to minimize the loss of fresh produce as well as to maintain the quality, thereby increase the shelf life. Chemical treatments include usage of hydrogen peroxide, chlorine-based solutions, peroxyacetic acid, organic acids, nitric oxide and Sulphur dioxide to retard browning reactions, inhibit ethylene bio synthesis , reduce respiration rate and water loss and reduce the incidence of postharvest diseases. But these methods or treatments are too expensive to our farmers and may cause harm to our health.

Ethylene is a chemically simple, ubiquitous chemical that has diverse and profound effects on the physiology of plants. Ethylene has so many different effects on plants, is effective in such low concentration, and its effects are so dose-dependent. The increase in ethylene triggers an increase in the fruit's metabolism and causes the changes to the fruit that occur during ripening. Removing or absorbing the ethylene may slow the ripening process and may extend the shelf life of fruits. Using ethylene absorbent agent is a method use for slowing down ripening. And also to prolong the shelf life of fruits. A number of catalytic oxidizers have been combined with absorbents to remove ethylene from air. Examples include potassium dichromate , $KMnO_4$,iodine pentoxide, and silver nitrate, each respectively on silica gel (Eastwell et al.,1978). In other words , silica gel can be use as an agent in absorbing the ethylene in fruits.

Thus, discarded desiccant silica gel in sachets were used in lakatan banana (*Musa acuminata*) which is considered to be one of many agent in absorbing ethylene. Silica gel is an amorphous and porous form of silicon dioxide (silica), consisting of an irregular tridimensional framework of alternating silicon and oxygen atoms with nanometer-scale voids and pores. Silica gel is often described as "*absorbing*" moisture , which may be appropriate when the gel's microscopic structure is

ignored, as in silica gel packs or other products. Silica gel , also referred to as silica aerogel or hydrated silica, is listed by the DFA in the United States, Generally Recognized As Safe (GRAS), meaning it can be added to food products or fruits and vegetables.

Studies conducted in proving that silica gel can be an agent in absorbing ethylene. In the study of Jayarajan,S.,et al.,2018 entitled "***Impact of Ethylene absorbents on Fruits Firmness and Quality of Nectarine (Prunus persica var. nectarina) Fruits during storage at super market conditions"*** the result revealed that various ethylene absorbents sachets such as the silica gel is very effective in controlling the Physiological Loss in Weight (PLW), firmness and significantly influenced the anthocyanin content. Hence , in package use of ethylene absorbents, especially $KMnO_4$ sachets, can be recommended to enhance the shelf life of nectarine up to 12 days under supermarket condition without compromising the quality attribute.

Another study conducted by Bhattacharjee, D.,et al., 2017 entitled "***Influence of Ethylene Absorbents on Shelf Life of Bitter gourd (Momordica charantia L.) Fruits during Storage"*** the results revealed that removal of ethylene with ethylene absorbent such Silica gel-permanganate is beneficial for preserving postharvest quality of bitter gourd fruits. The effect of ethylene absorbents on the incidence of diseases in bitter gourd fruits revealed that application of silica gel-$KmnO_4$ mixture recorded no diseases up to 2 days in storage.

The study regarding the utilization of silica gel as an agent in prolonging the shelf life of lakatan banana *(Musa acuminata)* is based on study conducted by Suweesha Amarakoon and Senevirathne Navaratne , their study entitled "***Evaluation of the effectiveness of Silica Gel Desiccant in Improving the keeping quality of Rice Crackers"***, the results revealed that the 5g silica gel in sachet was the best amount to control moisture ingress into 100g rice cracker packet. Variation of pH values and total plate counts of rice crackers did not show any relationship with the silica gel amount used. The 5g silica gel in sachet was able to control the development of FFA in the rice crackers by retarding the hydrolytic rancidity Based on the texture profile analysis, 5g silica gel was able to impart lower hardness in crackers which implies a good crispiness. Therefore, 5g silica gel should be used in the 100g rice cracker packets as the desiccant because it was capable to impart favorable properties on the physical and chemical properties of the product throughout its shelf life.

To test the effectiveness of discarded desiccant silica gel as agent in prolonging the shelf life of lakatan banana (*Musa acuminata*), three different parameters were used. These parameters are pulp to peel ratio , peel color and total soluble content (sugar content). The first parameter is the pulp to peel ratio. This parameter used in analyzing the maturity of banana for its physical property. They determined the ratio of pulp and peel of the banana by dividing the weight of the pulp by peel weight. As banana ripens the weight of the peel decreases while the weight of the pulp increases. The second parameter is the peel color. The use of this different parameter in this study is based on the several studies conducted to evaluate and predict the quality of banana during the ripening stage. The study of Tarpe A.R and Jain R.K of the Department of Food Processing and Technology, A.D Patel Institute of Technology , entitle, " Study of Advanced Maturity Stages of Banana". They were able to analyse the physical , chemical and mechanical properties of banana (Musa sp var 'Robusta') of the three advanced stages of maturity, stage 5, 6 and 7. The third parameter is the Total solid content used to determine the ripening of banana. The major soluble solids in fruit juice are sugars. Other soluble materials include organic and amino acids , soluble pectins , etc. soluble solids concentration (SSC%Brix) can be determined in a small samle juice or extract using a hand held refractometer. This instrument measures the refactive index , which indicates how much a light beam is "bent" when it passes through the fruit juice (D. Garner, C.H Crisosto , P. Wiley and G.M Crisosto)

In this study discarded desiccant silica gel in packed were utilized as agent in as prolonging the shelf life of Lakatan banana (*Musa Acuminata*).Specifically the study sought to answer the following questions.

1. In which set up will the lakatan banana will prolong its shelf life.
   - Set up A – lakatan banana with peel color # 3 with light green and with light yellow based on the 7-degree standard color chart for banana only.
   - Set up B– lakatan banana with peel color # 3 with light green and with light yellow with based on the 7-degree standard color chart for banana with discarded desiccant silica gel.
2. Is there a significant difference in the lakatan banana (*Musa acuminata*) in 2 set-ups after 7 days in terms of the following :

A. pulp to peel ratio
B. Peel color
C. Total soluble solid (sugar content)

Hypothesis

H_o :

1. The shelf life rate of Lakatan banana (*Musa acuminata*) will not vary in the two different set ups.
2. The pulp to peel ratio, peel color and total soluble solid (sugar content) of lakatan banana (*Musa acuminata*) will not vary in the two different set ups after 7 days.

H_1 :

1. The shelf life rate of lakatan banana (*Musa acuminata*) will vary in the two different set-ups.
2. The pulp to peel ratio, peel color and total soluble solids (sugar content) of lakatan banana (*Musa acuminata*) will vary in the two different set ups after 7 days.

Objectives of the study

1. Determine the potential of discarded desiccant silica gel as agent in prolonging the shelf life of lakatan banana (*Musa acuminata*).
2. Determine the significant difference between the different set-ups in terms of their : pulp to peel ratio, peel color and total soluble solids of the lakatan banana (*Musa acuminata*) after 7 days.
3. Identify which set-ups will prolong the shelf life of lakatan banana (*Musa acuminata*) within 7 days of treatment.

Significance of the study

This investigatory project will be beneficial to the following :

- **Vendors**

The result of this study is beneficial to our vendors of banana , because the result of this study will give them an idea on to what agent can be use in prolonging the shelf life of banana.

- **Future Researchers**

This study would also benefit future researchers who would study the same or related topic. This could serve as a guide or reference for them, especially for those who would like to study long-term agent in which could help to preserve or prolong shelf life of fruits and vegetables using different agent.

Scope and Delimitations

The main purpose of this study was to test the effectiveness of discarded desiccant silica gel in prolonging the shelf life of lakatan banana (*Musa acuminata*). The study focuses mainly on the silica gel. Discarded desiccant Silica gel packed was collected and asked by the researcher together with the adviser to those pupils and teachers who bought shoes. Six paper bags with same sizes were bought from Bazaar.

The investigation utilized lakatan bananas with peel color # 3 with light green and with light yellow based on 7-degree standard color chart for banana, similar sizes with the same number of lakatan per set-up. The application of treatment , extraction of banana extract and qualitative analysis were done in the Science laboratory of Talon-Talon Central School SPED Center, Talon-Talon , Zamboanga City , Philippines. The quantitative analysis of banana extract was done at the Department of Science and Technology IX (DOST IX), Zamboanga City , Philippines.

The researchers made use of the IBM statistics for social science (SPSS) version 2.0 to analyzed the collected data. The study used the paired T-test to determine the statistical significant difference between the set-ups.

II. METHODOLOGY

The study, particularly the application of treatment and extraction of banana extract was conducted in the Gifted and talented music room of Talon-Talon Central School SPED Center, Talon-Talon , Zamboanga City, Philippines. The test for total soluble solid was conducted in the Department of Science IX (DOST IX) , Zamboanga City, Philippines. Complete Randomized Design (CRD) with sub-sampling was used in the study with two (2) set up replicated three (3) times. Three (3) fingers of bananas were used as sub-samples. The materials that the researchers used in conducting the experiment were : surgical gloves , lakatan bananas , 15 packs of discarded desiccant silica gel , weighing scale , 6 paper bags, small plastic containers distilled water , tissue ,laboratory masks , laboratory gown and laboratory hair net, blender , measuring cup and husi cloth.

Lakatan banana with peel color # 3 with light green and with light yellow based on the 7-degree standard color chart for banana (*Musa acuminata*) were collected from a single bunch bought from market in this city. Lakatan banana was chosen as the specimen because it is available all year round and has a hardly peeling. A total of 18 fingers of bananas with similar sizes were used in the entire duration of the study. 6 paper bags of uniformed sizes were used as containers for the different set up with each paper bag containing 3 fingers of bananas.

A total of 2 set ups , were replicated 3 times and were randomly laid out using CRD with sub-sampling. Each finger of banana fruit was randomly assigned to the different set up using controlled lottery method. This is to ensure that bananas will be randomly distributed to the set-up. In set-up A 3 fingers of Lakatan banana with peel color # 3 with light green and with light yellow based on the 7-degree standard color chart for banana with similar sizes were placed in the paper bag labelled as R1 , R2 and R3. then the paper bags were covered with paper clips with same sizes and number. Following the conventional way. In set-up B 3 fingers of Lakatan banana with peel color # 3 with light green and with light yellow based

on the 7-degree standard color chart for banana with similar sizes were placed in the paper bag. Afterwards 10 grams (10 packs) of silica gel were placed inside the paper bags labelled as R1 , R2 and R3. then the paper bags were covered with paper clips with same sizes and number. All the set-ups were replicated 3 times and covered for 7 days.

Each banana from the different set ups were peeled off. The pulp and peel were weighed separately using weighing scale. The recorded weight of the pulp was divided by the recorded weight of the peel to determine its pulp to peel ratio. The 7-degree Standard Color Chart for banana (SH Pratt and Co. Ltd.) was used as the reference for color measurements , where 1 = full green, 2= green with a trace of yellow, 3= more green than yellow, 4 more yellow than green, 5 = yellow with a trace of green, 6 = all yellow , 7 = all yellow with brown speckles. The banana was considered unripe at stages , and ripe at stages 5-7. *(Fig. 9 in appendix shows the SH Pratt and Co. Standard Color Chart for Banana).* The banana pulp of each set up was pureed with water using a blender. The pureed was poured in a clean husi clot and was squeezed to separate the pulp and the extract. The extract was poured in a small plastic containers and were brought to the DOST to measure its total soluble solid content as $Brix^0$ using a hand-held refractometer.

After gathering the data needed, the different set ups were disposed following the proper waste disposal procedure. All biodegradables wastes were disposed in one trash bag, non-biodegradable wastes were disposed in separate trash bag and the recyclable wastes were placed in separate trash bag also.

Statistical Analysis

For each set up, one sample for each replicate was randomly selected and the average values were analyzed. Experimental data were analyzed using Paired T-Test for Peel color , Pulp to peel ratio and Total Soluble Solids was employed to determine the statistical significant difference between the 2 set ups. The level of significant was at .05. The analysis was performed using the IBM SPSS statistics version 2.0

III. RESULTS AND DISCUSSION

A. PULP TO PEEL RATIO

Table 1 : Changes in the physiological loss in terms pulp to peel ratio in the banana fruits after 7 days.

Replicate	Weight of Pulp (grams)	Weight of Peel (grams)	Ratio
Set up A			
R1	35 grams	25 grams	1.4
R2	45 grams	25 grams	1.8
R3	35 grams	20 grams	1.75
Average			1.65
Set up B			
R1	35 grams	20 grams	1.75
R2	35 grams	20 grams	1.75
R3	30 grams	25 grams	1.2
Average			1.57

The table 1 shows the changes in the pulp to peel ratio of the banana fruits under different set ups. The weight of individual lakatan banana in the experiment on the day of observation and the ratio of pulp and weight on the day of observation was calculated on the weight of pulp then divide the weight of peel. The data shows that the bananas under set up A without ethylene absorbent total average ratio of 1.65 compared to set up treated with 10 grams silica gel total average of 1.57 respectively. The banana stored with ethylene absorbents particularly with silica gel documented lower weight ratio compared to banana stored without ethylene absorbents and marketability of these fruits were almost lost after 7 days in storage.

Table 2: Quantitative analysis of Pulp to peel ratio using Paired T-Test.

	Paired Differences					**t**	**df**	**Sig.(2-tailed)**
	Mean	**Std. Deviation**	**Std. Error Mean**	**95 % Confidence Interval of the Difference**				
				Lower	**Upper**			
Set A ratio & Set up B ratio	**13.33333**	**5.16398**	**2.10819**	**7.91407**	**18.75260**	**6.325**	**5**	**.001**

As determined by Paired t-Test in table 2, it shows that there is statistically significant difference between the two set ups in terms of their pulp to peel ratio (*P*=.001).

Tarpe A.R. and Jain R.K , were able to conclude that as the ripening of banana precede, the pulp to ratio increases. As the banana ripens the weight of the peel decreases while the weight of the pulp increases. This change in ratio could be due to the osmotic transfer of moisture from the peel to the pulp as the sugar content of the pulp increased. Thus , the increased in ratio is coefficient to the ripening of banana. In the study of P.A Borkar et al.,2008 entitled ***"Effect of ethylene absorbent and different packaging materials on storage life of banana"***, the results was the banana treated with ethylene absorbent were found significantly superior over the rest of the treatment in maintaining low pulp to peel ratio. Because the production of ethylene and sugar is slow , which make the weight of the peel and pulp decreased. The shelf life of banana was extended to 15 days.

The result implies that lakatan banana (*Musa acuminata*) treated with 10 grams discarded desiccant silica gel decreases the weight of the pulp and peel due to the silica gel absorb the ethylene as the banana ripen.

B. PEEL COLOR

Table 3 :Changes in the physiological loss in terms of peel color of the banana fruits after 7 days.

Replicate	Peel Color Before the treatment	Peel Color After the treatment
Set up A		
R1	3	7
R2	3	7
R3	3	6
Set up B		
R1	3	6
R2	3	6
R3	3	5

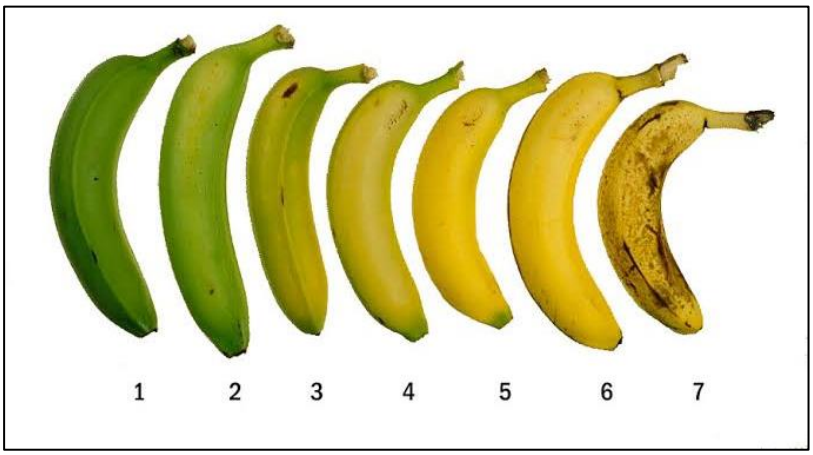

Figure 1: SH Pratt and Co. standard color chart for banana.

Table 3 shows the changes of the peel color of the banana fruits under different set ups. Peel color # 3 light green with light yellow were used in the study (*Fig.1 shows SH Pratt and Co. standard color chart for banana*). The bananas in set up A without ethylene absorbents shows most evident changes in color documented and recorded with spoilage compared to the bananas treated with 10 grams only shows little evident which means the color are still good no recorded with spoilage.

Table 4 : Quantitative analysis of Peel color using Paired T-Test.

	Paired Differences					t	df	Sig.(2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95 % Confidence Interval of the Difference				
				Lower	Upper			
Before and After Peel color	**-3.16667**	**.75277**	**.30732**	**-3.95665**	**-2.37668**	**-10.304**	**5**	**.000**

The result of Paired T-test in table 4 , shows that there is significant difference between the two set ups in terms of their peel color (*P*=.000).

There are several studies revealed that peel color is an important indicator of the stage of maturity (Mendoza and Aguilera ,2004 ; Soltani et.al 2010 ; Soltani et al., 2011). According to Barry (2009) that the change in peel color cause by the breaking down of molecules by the enzyme as the banana ripens, so the green pigment of the chlorophyll is destroyed and replaced by yellow or red pigments.

In the study of P. Kumari et al., 2008 entitled , ***" Effect of ethylene absorbent (KMnO4) with different carrier materials for shelf life of banana CV. Nendran,"***, the finding was the banana treated with ethylene absorbent KMnO4, Talc (Magnesium silicate hydroxide , $Mg_3Si_4O_{10}$) the skin color or peel color appearance of the banana was good. The peel color of the banana shows a little changes compared to those banana without ethylene absorbent.

The result implies that ethylene absorbent like silica gel have the potential in preserving or prolonging the peel color of the banana up to 7 days of storing.

C. TOTAL SOLUBLE SOLIDS (SUGAR CONTENT)

Table 5 : The total soluble solid content of the bananas after 7 days.

Replicate	Set up A Without ethylene absorbent	Set up B With ethylene absorbent (10 gams silica gel)
1	15.7%	17.4%
2	14.8%	17.5%
3	14.5%	17.2%
Ave.	**15 %**	**17.37 %**

Table 5 shows the total soluble solids of the banana fruits under different set ups. The data shows that the bananas under set up with ethylene absorbent has the highest average of total soluble solids which is 17.37% respectively, compared to the set up without ethylene absorbent with 15%.

Table 6 :Quantitative analysis of Total Soluble Solids using Paired T-Test.

	Paired Differences							
	Mean	**Std. Deviation**	**Std. Error Mean**	**95 % Confidence Interval of the Difference**		**t**	**df**	**Sig.(2-tailed)**
				Lower	**Upper**			
Setup-Total soluble solids	**-12.68333**	**1.28284**	**.52372**	**-14.02959**	**-11.33708**	**-24.218**	**5**	**.000**

It was determined by Paired T-TEST in table 6 , that there is significant difference between the two set ups in terms of total soluble solids (sugar content) (*P*=.000).

Total soluble solid content is another quality indicator or parameter used to determine the ripening of banana (Tarpe A.R and Jain R.K). The study conducted by M. Soltani et. Al , entitled ***"Prediction of Banana Quality During Ripening Stage using Capacittance Sensing System"*** and the study of Liew , C.Y and Lau entitled , ***" Determinantion of quality parameters in Cavendish banana during ripening by NIR spectroscopy "*** proves that test for total soluble solids content of banana is a quality parameter to be used in determining the its ripeness. As the banana ripen the sugar content increases. The present of ethylene absorbent agent shows that the production of sugar was controlled or the flavor and sweetness was preserved. In the study of R. Kumari et al.,2017, entitled ***"Effect of Packaging with Ethylene Absorbents on Quality of Banana Fruits Cv. Martaman "*** ,the results revealed that there was constant increased in Total soluble solids with the treated banana compared to the untreated banana resulting in less increase.

The result implies that bananas in set up A with ethylene absorbent, the total soluble solids recorded with 17.37 % , the production of sugar was increasing but with the help of ethylene absorbent it preserve and control which make the banana firm and preserve its flavor and sweetness. The bananas in set up A without ethylene absorbents the total soluble solids is 15 % ,the production of sugar rapidly increased which makes the banana very soft, overripe and results to decay.

IV. CONCLUSIONS

The results obtained from present study revealed that removal of ethylene with an absorbent is beneficial for prolonging the shelf life of lakatan banana. Hence, it could be concluded that the results further prove that the discarded desiccant silica gel can be used as agent in prolonging the shelf life of lakatan banana (*Musa acuminata*). Silica gel has the potential to maintain the peel color, weight loss in terms of pulp to peel ratio, decay incidences, total soluble solids content , sugar content of lakatan banana. This also indicates that discarded desiccant silica gel can replace the use of hazardous and expensive chemical methods in prolonging and preserving the shelf life of fruits especially the banana.

RECOMMENDATIONS

For further study regarding the use of discarded desiccant silica gel as agent in prolonging the shelf life of lakatan banana (*Musa acuminata*), the following recommendations are to be considered;

1.Other fruits such as the bitter gourd , strawberry and other species of banana can be used as a specimen aside from lakatan.
2. Additional amount of silica gel can be used to test the effectiveness in prolonging the shelf life of lakatan banana (*Musa acuminata*).
3. Parameters such as firmness and moisture can also be used in determining the shelf life of banana.

ACKNOWLEDGEMENT

The conduct of this study will not be possible without the help and effort of the important people whom the researcher will forever be grateful of. To researcher Family, especially to the parents who undyingly supported the researcher in his entire research both emotionally and financially.

And above all, to our Almighty God for the knowledge, strength, unfailing love and endurance to pursue this study.

REFERENCES

[1] S. Jayarajan , R.R Sharma,"Impact of Ethylene absorbents on Fruits Firmness and Quality of Nectarine (Prunus ersica var. nectarina) Fruits during storage at super market conditions",*Madrige Journal of Food Technology,* **Vol.3,Issue.2**,pp.149-152, **2018**.
[2] D. Bhatatacharjee., R.S Dhua, "Influence of Ethylene absorbents on Shelf life of Bitter gourd (Momordica charantia L.) Fruits during storage".*International Journal of Current Microbiology and Appied Sciences,* **Vol.6,Issue 5**,pp.1553-1563,**2017**.
[3] P. Ponce. G.LR Carbonari G.L.R, A. Lugao.*" Active Packaging Using Ethylene Absorber To Extend Shelf-Life"*,International Nuclear Atlantic Conference,**2009**.
[4] E. Mikal,"Effect of Ethylene on Quality of Fresh Fruits and Vegetables",*Science Direct,***Vol.15,issue.3**,pp.279-292,**1999**.
[5] P.A Borkar, S.D Jadhao, S.L Borkar, R.P Murumkar"Effect of Ethylene Absorbent and Different Packaging Materials in Storage Life of Banana",*Asian Journal of Bio Science,***Vol.3,Issue.2**,pp.233-236,**2008**.
[6] S.A Zomo ,S.M Ismail, M. Shah Jahan, K. Kabir, M.H Kabir,"Chemical Properties and Shelf life of Banana (Musa sapientum L.) as Influenced by Different Postharvest Treatments",*A Scientific Journal of Krishi Foundation,*Vol.12.Issue.2.pp.6-17,**2014.**
[7] G.L Digma, "Effect of Different Desiccants on Preserving the Germination Capacity of Yard Long Bean (Vigna Unguiculata Sesquipedalis) after storage".*International Journal of Novel Research in Life Sciences,***Vol.3,Issue.6**,pp.66-71,**2016.**
[8] S. Amarakoon, S. Navaratne,"Evaluation of the effectiveness of silica gel Desiccant in Improving the keeping quality of rice crackers",*International Journal of Science and Research (IJSR),***Vol.6,Issue.1**,**2017.**
[9] A.R Tarpe, R.K Jain,"Study of advanced maturity stages of banana", *International Journal of Advanced Engineering Research and Studies,***Vol.1,Issue.3**,**2012.**
[10] N. Suseno, E. Savitri ,L. Sapei, K. Padmawijaya,"Improving shelf-life of Cavendish Banana Uisng Chitosan Edible Coating",*Procedia Chemistry,***Vol.9**,pp.113-120,**2014.**
[11] P. Kumar, K.V Singh K.V ,S. Kumari, V.M Prasad, N. Jain,"Effect of Ethylene Absorbent ($KMnO_4$) with Different carrier Materials for Shelf Life of Banana CV. Nendran*",International Journal of Chemical Studies*,**Vol.5,Issue.5**,pp.2243-2245,**2017.**
[12] E.B Esguerra, D.B Mendoza DB , E.B Pantastico,"Regulation of fruit ripening. Use of Perlite $KMnO_4$ insert as an ethylene absorbent",*Food and Agriculture Organization of the United Nations*,**Vol.107,Issue.1**,pp.23-31,**2013.**
[13] K.J Scott,"Effect of the temperature on the storage life of banana held in Polyethylene bags with ethylene absorbent",*Food and Agriculture Organization of the United Nations,***Vol.51,**pp.23-26,**2012.**

