Influence of Acetylene on Ripening Process of Avocado Pear and Orange Fruits

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***Abstract*—Postharvest handling on ripening process of avocado and orange fruits was conducted in this study. Ripening systems which include application of acetylene gas generated from overripe banana (T_1), storage in airtight drum (T_2) and use of smoke (T_3) were adopted while fresh samples without any treatment were used as control (C) measure. The results obtained revealed a general trend indicating that both treated climacteric fruits begun to ripen on the third day with scoring values of 3.33±0.33 and 2.67±0.33 for avocado and orange fruits respectively except for control which showed ripening symptom on day five with scoring values of 3.33±0.33 and 3.00±0.00 for the fruits respectively. T_1 and C maintain fully ripen state on the fruits as other systems begun to rotten samples on the 8th day of storage duration. Sensory evaluations for both samples under acetylene treatment were very good and pleasantly good throughout the period of observation in term of texture, appearance and flavour as compared to other treatments except that the flavour were fairly bad and fairly good at the initial stage and on day 2 respectively. Acetylene treatment on both sample has demonstrated high tendency to sustain textural feel on fruits under this postharvest handling process without any noticeable deteriorative changes and can be recommended for application in food processing industries.**

***Index Terms*—Avocado Pears; Orange Fruits; Postharvest Handling Process; Sensory Evaluation.**

I. Introduction

Right from time immemorial, it has been established that climacteric fruits could attain their ripen stage while on parental tree but avocado pear is one of the agricultural fruits which cannot ripen while on tree unless harvested and allow for some days. However, consumers are concern with the challenge of hard inedible characteristics of such fruit which cannot be harvested and consumed immediately [1]. Avocados pear and orange fruits have climacteric characteristic with the ability to continue respiring even after harvest which could commenced its ripening process almost immediately after harvest due to their high respiration rates [2].

Avocado pears (*Persea americana* M.) is considered as highly perishable food produce which its quality at final destination is a major threat during exportation [3]. However, advancement in postharvest technological handling system could aid in improving the quality and consequently extend the shelf stability of avocados and many other fruits both locally and during export to distant markets [2].

Orange juice is one of the major source of carotenoids as revealed by researchers. The endocarp is rich in soluble sugar and contains significant amounts of vitamin C, pectin, fibres, different acids and potassium salt which give the fruits its characteristic "citrus flavour" [4]. Consumption of this vitamin has been correlated with a reduction in the incidence of certain cancers [5].

Avocado and orange are generally cholesterol free agricultural produce, low in fat and high in variety of dietary needs. These peculiar feature has promoted them as a substitute for animal based foods [2]. It is also indisputable that these natural fresh foods are superior to processed foods because they contain little or no chemical additives. This has resulted in additional pressure been maintained on postharvest technology to retain their fresh natural image by reducing the use of synthetic chemicals during production and postharvest handling [2].

The respiration of avocados consists of three climacteric stages namely; pre-climacteric (minimum of least respiration stage), climacteric (maximum of highest respiration stage) and a post-climacteric stage (degeneration in respiration stage). It is during the pre-climacteric and climacteric stages where much of the changes associated with ripening occur [6]. The shelf life of fresh commodities is inversely related to respiration and ethylene rates as stated by [6]. An excessive increase in the respiration rate accelerates senescence contributing to poor fruit quality [7]. Therefore, to improve postharvest handling of avocados and orange fruits once harvested modified atmosphere packaging (MAP) system is an important technique necessary to be employed to ensured qualitative end products at consumers table.

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II. Materials and Method

A. Materials

Materials used for the study was procured from a market in Jos, Plateau State, Nigeria which include freshly harvested avocado pear, orange, airtight drum, and perforated clay pot, reseal able plastic bags, plastic tray, knife, hand gloves, distilled water among others. Acetylene gas (C_2H_4) was obtained from over ripped banana used as ripening enhancer while other materials are weighing balance, masking tape, plastic bottle (brown) and thermometer.

B. Experimental Design and Layout

The experiment was assay and fitted into a split – plot experimental design of 3(treatments) × 2(fruit samples) × 4(observation days) for the study. Each sample of avocado and orange were conditioned in four different storage containers and labelled accordingly. Ordinary samples without enhancing their ripeness using induced method were regarded as control (C). Other treatments employed to enhance ripening process of avocado pears and orange fruits include; acetylene gas (overripe banana) (T_1), airtight container (T_2), and smoke (T_3) (Table I). The days taken for the fruits observation under various mentioned treatment are initial day regarded as 0, followed by2^{nd}, 3^{rd}, 5^{th} and 8^{th} days (Table I). To determine for ripeness potassium permanganate ($KMnO_4$), potassium iodine (KI), and iodine (I) was used to evaluate for starch and sugar content. The presence of starch indicated that ripening has not taken place, while the presence of sugar is indicative of ripeness. Five members of panellist were trained for rating the fruits on each days under observation based on ripeness and organoleptic response. The rating was carried out and guided on scoring scale as follows (not ripe – 1, slightly ripe – 2, just ripe –3, fully ripe–4, and rotten –5) and (1 – bad, 2 – fairly bad, 3 – fairly good, 4 – good, and 5 – very good) for ripeness and sensory evaluation respectively. Both generated data were statistically analysed using IBM SPSS statistical tool version 20 and mean values were separated by Duncan multiple range test (DMRT).

C. Ripening Procedure for Avocado and Orange Fruits

Both avocado pears and orange fruits were initially tested with iodine stain solution to ascertain the unripe fruits at the initial stage. After this was done, the samples were conditioned to three different treatments as follow:

D. Control

Some quantities of both avocado pear and orange fruits were kept in polyethylene sack at room temperature between 20 ^oC – 25^oC. It was tested for ripeness and organoleptic test at2^{nd}, 3^{rd}, 5^{th} and 8^{th} days while findings were recorded and presented in Table I and Fig. 1 – 8 respectively.

E. Treatment (T_1)

Some quantities of avocado pears and orange fruits were separately wrapped in a reseal able bag together with overripe banana (acetylene gas) at room temperature between 20 ^oC – 25^oC. It was tested for ripeness and organoleptic test at 2^{nd}, 3^{rd}, 5^{th} and 8^{th} days and the findings were recorded and presented in Table I and Fig. 1 – 8 respectively.

F. Treatment (T_2)

Avocado pears and orange fruits were kept in an airtight dark container under ambient temperature. Samples were tested for ripeness and organoleptic test at 2^{nd}, 3^{rd}, 5^{th} and 8^{th} days and the result recorded and presented in a Table I and Fig. 1 – 8 respectively.

G. Treatment (T_3)

Samples were placed in clay pot with straw inserted to enable smoke penetration into the chamber to induced ripening process. Samples were tested for ripeness and organoleptic test responses were recorded accordingly.

III. Experimental Analysis

After all the above experimental procedures were completed, the data generated were subjected to statistical analysis to ascertain the effects of the treatments level of significance and tables were used to interpret the data generated (Table I)

IV. Results And Discussion

A. Presentation of Results

Table I shows the summarised mean values of the results obtained using the responses of five trained panelist with respect to various treatments employed in the study. The result obtained for avocado under control revealed that in the first day, the avocado was tested for ripeness by dipping it in iodine solution which showed that it was not ripe at subjective value of 1 (not ripe) (Table I). The value of the ripeness perception increased to 2 (slightly ripe) at day 2 and progressed in the value to 3 (ripe) and 4 (fully ripe) in day 3 and day 5 respectively however on day 8, the sample begun rotting. Similar trends were observed for the avocadoes treatment with acetylene gas except that slightly after the fifth day of storage, the sample begun to deteriorate in nature as the storage duration approached day 8 with scoring value of 4.67±0.33 which panelist termed as rotten (Table I). This is an indication that the acetylene gas used to accelerate the ripening process of avocado enable the fruits attain its ripening peak earlier as compared to the response obtained under the treatment T_2 and T_3. Similar pattern was followed for other levels of avocado treatments up to the day 8 ripening observation.

The result of this study also revealed that avocado treatment under airtight drum (T_2) and smoke (T_3) all having 4.00±0.00 and 5.00±0.00 respectively indicating that the avocado fruits are fully ripped all at day 5 and suddenly became rotten at day 8 under each storage system respectively (Table I). This was in agreement with previous findings of [8] which states that avocado fruits will complete its ripening process between 5 to 7 days under storage temperature of 25^oC. Observed data under this two conditions implies that little heat application on avocado fruits could influence the ripening process while excessive can enable the fruit becomes bad without prolong shelf life of the sample depending on the packaging system used along postharvest handling chain.

TABLE I: RIPENING RESPONSES OF AVOCADO AND ORANGE FRUITS WITH RESPECT TO DIFFERENT TREATMENTS

Treatments on sample	Days under observation	Avocado fruit response	Orange fruits response
C (Control)	0	1.00±0.00[a]	1.00±0.00[a]
	2	2.33±0.33[b]	1.33±0.33[b]
	3	3.00±0.00[c]	2.00±0.00[b]
	5	3.33±0.33[c]	3.00±0.00[c]
	8	4.00±0.00[d]	3.67±0.33[e]
T_1(Acetylene gas)	0	1.00±0.00[a]	1.00±0.00[a]
	2	2.67±0.33[b]	2.00±0.00[b]
	3	3.33±0.33[c]	2.67±0.33[c]
	5	4.00±0.00[d]	4.00±0.00[d]
	8	4.67±0.33[e]	4.33±0.33[e]
T_2(Airtight drum)	0	1.00±0.00[a]	1.00±0.00[a]
	2	2.33±0.33[b]	2.00±0.00[b]
	3	3.33±0.33[c]	2.67±0.33[c]
	5	4.00±0.00[d]	3.33±0.33[d]
	8	5.00±0.00[e]	4.00±0.00[d]
T_3 (Smoke)	0	1.00±0.00[a]	1.00±0.00[a]
	2	2.67±0.33[b]	2.00±0.00[b]
	3	3.33±0.33[c]	2.67±0.33[c]
	5	4.00±0.00[d]	4.00±0.00[d]
	8	5.00±0.00[e]	4.33±0.33[e]

Triplicate values are mean ± SEM while values on the same column with the same superscript/treatment are not significantly, while values with different superscripts /treatment are significantly different as determined by DMRT ($P < 0.05$)

The general behaviour of the ripening process in the case of orange fruits significantly differs as experienced in the avocado fruits. Orange samples under control showed that fruit slightly begun it's ripening process on day 2 and continued it ripening trend until day 5 and 8 when the sample was observed to be almost ripped as shown in Table I. This is an indication that orange storage shelf stability is steady under the control depending on the packaging material. Contrary to orange fruits under control, results of the study showed that samples treated with acetylene gas, airtight drum and smoke system are all fully ripen on days 5 and 8 without any trace of deterioration on the sample irrespective of the treatment employed (Table I).

The observed result in orange ripening trend is an indication that moderate release of gas and heat requirement would help to enhance the ripening process of orange fruit without adverse effect on the sample depending on the storage duration.

B. Sensory Evaluation on Avocado Pear

Texture is a significant indicator of fruits quality and of great concern to the consumer [9]. Members of trained panelists were guided to grade avocado pears and orange fruits under storage durations with respect to different treatments as follow; 1 – bad, 2 – fairly bad, 3 – fairly good, 4 – good, and 5–very good as indicated in Fig. 1 to 8. Results of the study as revealed by panelist indicates statistical significant difference in the textural feel of avocado pears where texture decrease in its original fresh impression obtained at inception after samples were allowed for storage under control measure for 8 days' duration. Panelist indicated that sample was very good on the initial stage, and was observed to be of good texture on the second day of storage.

The sample begin to denature while becoming shrink in third and fifth days of storage and were termed as fairly good and finally became fairly bad on day 8 of the experiment (Fig. 1).

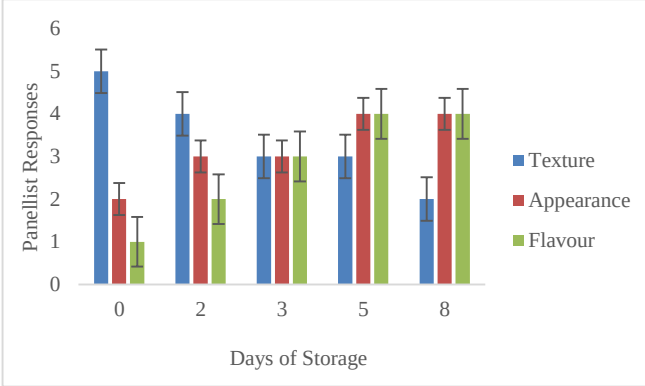

Fig. 1. Organoleptic test on avocadoes under control

Results also showed that there were significant statistical differences in the appearance of avocado fruit with respect to postharvest handling durations. It was observed that avocado pear was looking fairly bad at the initial stage while sample shows no significant difference in its appearance between the second and third days of storage, they were fairly good looking and on day 5 and 8, samples were good looking in appearance as perceived by the panelists which also shows no significant difference in their appearance in the days respectively (Fig. 1).

Study showed that the sample were not palatable in term of flavour at the initial stage, but as the storage days progressively increased between second and third days of duration, sample had flavour reports of being fairly bad and fairly good respectively. Increase in storage durations between day 5 and day 8 normalized the flavour making samples having good flavour as the mouth feels (Fig. 1).

The results of this study also revealed that avocado fruits under observation had very good texture at the initial stage while the sample maintain its good textural feel on the second and third days under observation, on the fifth day of storage in airtight drum, the pears was observed to be fairly good and on the eight day of the storage, the sample was said to be fairly bad which is an indication that the sample begun to deteriorate in nature in term of textural feel by the panelist. Consequently, the physical appearance of the sample in question was observed to be fairly bad both on the

initial day and on the second day of observation, but as the day progresses, the sample was observed to be fairly good on days 3 and 5. Sample under observation in the airtight drum was finally observed to be very good in term of physical appearance on the eight day of storage observation (Fig. 2). The taste of avocado fruits stored in airtight drum were so bad in terms of flavour at initial day of the study which became fairly bad but were tolerated on the second and third day of observation and as the day progresses, sample became somewhat good in the flavour as prescribed by the panelists.

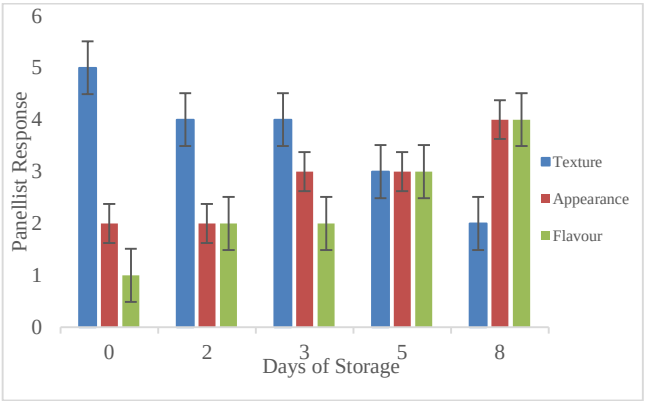

Fig. 2. Organoleptic test on avocado pears in airtight drum

It was observed that avocado fruit under acetylene storage system was so good without any statistical significant difference in the samples from the initial stage up to the day 5 of the treatment. This is an indication that acetylene gas has help to sustain the textural feel of samples under this postharvest handling process without any noticeable changes in the texture while samples only showed fairly good appearance in the texture as scored by the panelist on the last day under this treatment observation. Appearance and flavour under this treatment followed similar trend. Samples were observed to be fairly bad up to day 2 and so good between day 5 and day 8 (Fig. 3). This implies that acetylene gas under this study has proven pleasant on the samples and could be employed in the postharvest technology without fair of sample deterioration during storage for 8 days.

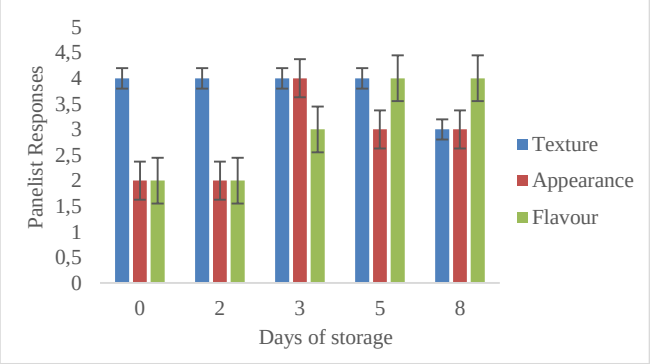

Fig. 3. Organoleptic test on avocado pears in airtight drum

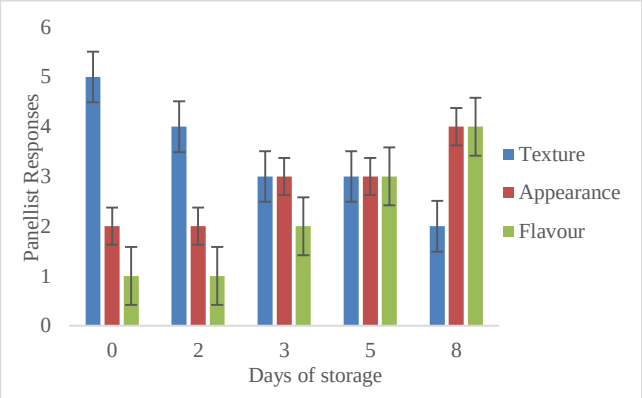

Fig. 4. Organoleptic test on avocado treatment with smoke

Sensory evaluation of samples treated with smoke in this study showed that the sample texture appeared to be very good looking, good and maintain fairly good texture at the initial stages, second day, between third and fifth day respectively. However, samples only showed fairly bad texture on the eight days of sample handling process. Subsequently, the appearance of sample was fairly bad as the flavour was also bad up to day two of the observation, this gradually improved and maintain fairly bad on day 5 and finally became very good on the eight day of samples treatment with smoke as indicated in Fig. 4. This also indicated that both appearance and flavour of avocado pears are in agreements with postharvest treatment with acetylene and smoke system of ripening process as sample appeal to panelist in term of acceptability.

C. Sensory Evaluation on Orange Fruits

Texture is a significant indicator of fruits quality and of concern to the consumer [9]. The result of sensory observation of orange fruit treated with different ripening process in this study indicated that oranges under acetylene treatment were very good and pleasantly good throughout the period of observation in term of texture, appearance and flavour, except that the flavour were fairly bad and fairly good at the initial stage and on day 2 respectively (Fig. 5). This is an indication that acetylene gas is naturally good ripening enhancer as the observation were of similar experience when applied to avocado fruits. This could be a very good natural gas necessary for further postharvest handling system in the food processing industries in term of food safety, food flavouring and rapid boosting of food ripening process.

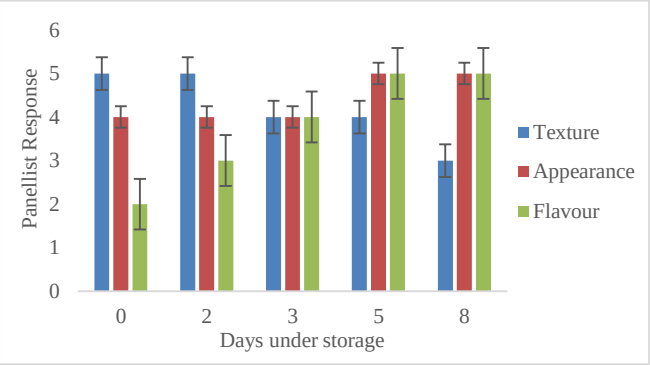

Fig. 5. Organoleptic test on orange treatment with acetylene gas

The results of the observation on orange fruits placed under airtight treatment showed similar trend with obtained values of samples treatment with acetylene gas except that in this case, sample were somewhat bad in term of flavour at the initial stage (Fig. 6). This experience could be realistic due to the fact that unripe freshly harvested oranges are expected to taste pleasantly sweet as compared to the similar sample placed under watch for about three to four days after harvesting.

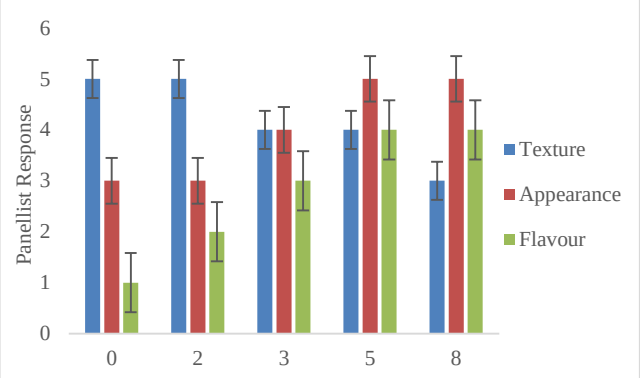

Fig. 6. Organoleptic values on orange treatment with airtight drum

Study revealed that sample under control gave very good and good textural feel at the initial stage up to day 3 of the storage observation and maintain its fairly good texture throughout the period of storage (Fig. 7). Appearance was also fairly bad without significant difference in the trend up to day two which maintain its fairly good appearance up to day 5 and progressively increased to a very good appearance on the last day of observation having similar response as the flavour (Fig. 7).

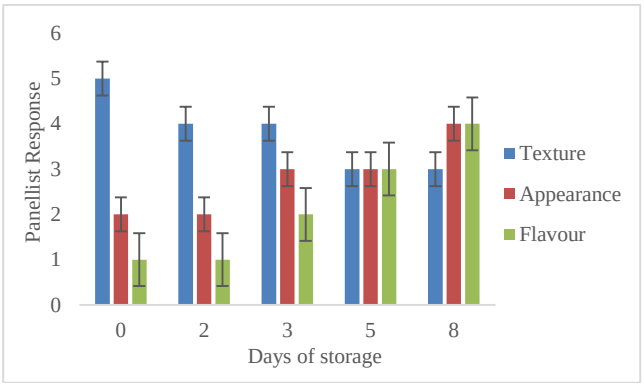

Fig. 7. Organoleptic test on orange under control

Between the initial and the second day of orange inspection under smoke ripening process, samples were observed to be of very good texture and pleasantly good appearance with fairly good flavour which maintain fairly bad flavour throughout the study duration as the days progress. However, texture and appearance were observed to maintain good quality until the last day which the flavour decline fairly bad in terms of appearance (Fig. 8).

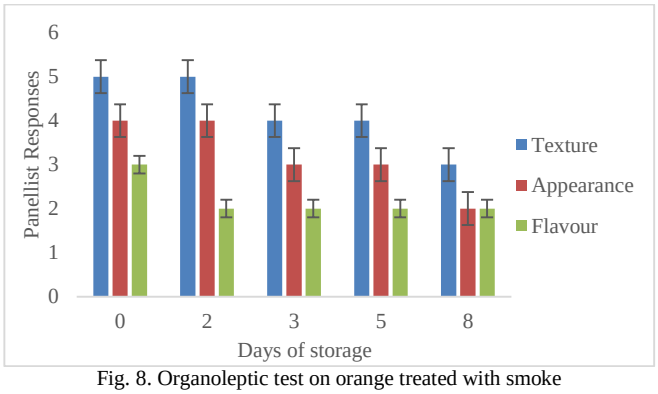

Fig. 8. Organoleptic test on orange treated with smoke

V. Conclusion

The results of physical and sensory evaluation on ripening process of avocado and orange fruits obtained in this study revealed that acetylene gas is a natural fruit ripening enhancer which rather improves on sample flavour and has no adverse effect on the textural feels and physical appearance of samples under treatment observation. The more the quantity of acetylene gas released in a system, the faster the fruits ripening process which has influence on the storage duration as well. Air tight drum also as a postharvest ripening techniques employed in this study promote uniform ripening process and better sensory response than the smoke system of fruits handling.

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