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Effects of pyroligneous acid of eggplant under different storage conditions

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ABSTRACT

This study was determined the effects of pyroligneous acid on the quality and shelf life of eggplant and to characterize the effectiveness of the different storage condition the ambient condition and evaporative storage conditions of eggplant fruits. The results revealed that the most effective storage conditions to prolong the shelf life of eggplant fruits. In addition, the results revealed that 10% concentration of wood vinegar under cold storage were found significantly different than the ambient, evaporative cooler storage conditions. And based on the result, among the storage conditions it was the ambient storage conditions was the least effective among all the storage conditions.

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INTRODUCTION

The Morena F1 eggplant (*Solanum melongena* var. *Morena*) is the new benchmark in the long list of eggplant varieties. It is a vigorous hybrid which produces fruits of the highest quality. It yields class A fruits that are long, smooth and a deep glossy purple color. Because of its excellent fruit quality, this is highly preferred by traders and consumers and commands premium price.

This innovative hybrid has also a long shelf life and strong disease tolerance. Eggplant is very perishable vegetable with a short shelf life and high susceptibility to fungal diseases.

Postharvest diseases affect a wide variety of crops particularly in developing country which lack sophisticated postharvest storage facilities. And because of time and resource constraints, small scale farmers desire pest control methods that do not require additional labor and material inputs. Labor intensive control methods such as manual removal of infested shoots, tapping of insects and application of netting are usually ineffective. In addition, intensive pesticide use often leads to environmental and health issues, ultimately increase the total production costs.

Wood Vinegar offers as an emerging technology to prolong eggplants shelf life where in farmers may benefit from high yields of good quality fruits. They may also save in production and labor costs as well as less pesticide to control the pre and postharvest diseases. Wood vinegar serves as an organic disease and pest control. It's a by-product from charcoal production. It is a liquid generated from the gas and combustion of fresh wood burning in airless condition. When the gas is cooled, it condenses into liquid. The main effect of the wood vinegar is the suffocation of small pests. Some known importance of wood vinegar on plant pest and diseases is its excellent effects on mite control, prevention of plant from fungal, bacterial and virus – like disease infection (Oramahi and Yoshimura, 2013).

The scale of application of wood vinegar has no limitation, like hormones, it will be absorbed into twigs, trunks, leaves or fruits. Plants will be stronger, and leaves will be greener and resistant to pest and diseases. The technology offers an alternative agricultural product that is environmentally safe, locally available, and seemingly easy to follow technology. This addresses the present and emerging problems that are affecting the farming industry. These are compounded by issues related to the production of safe and cheap food, environmental pollution from the use of chemicals, and from decomposing animal and farm waste. Wood vinegar is safe to human beings, animals, plants, and the environment. Low cost of production attributes to savings from cost of chemicals. Effects of wood vinegar mixture varies depending on plant species, growth stage and cultivation system. But high concentration or over use may damage on crop.

A major constraint in eggplant production and marketing is the high perishability of the fruits. The fruits have relative humidity; shelf is much shorter at tropical ambient conditions (25-32°C). The first has high moisture content, a large surface area to volume ratio, and a relatively thin cuticle, which makes it very susceptible to moisture loss and physical injury. Undesirable changes including loss of violet color or browning, shriveling, and rotting will occur after harvest. Improper handling, packaging, storage and transportation could result in huge losses of the fruit (Mohammed *et al.*, 2010).

Once harvested, vegetable and fruit are subject to the active process of senescence. Numerous biochemical processes continuously change the original composition of the crop until it becomes unmarketable. The period during which consumption is considered acceptable is defined as the time of "postharvest shelf life". Postharvest shelf life is typically determined by objective methods that determine the overall appearance, taste, flavor, and texture of the commodity. These methods usually include a combination of sensorial, biochemical, mechanical, and colorimetric (optical) measurements. Postharvest physiology is the scientific study of the physiology of living plant tissues after they have denied further nutrition by picking.

It has direct applications to postharvest handling in establishing the storage and transport conditions that best prolong shelf life. An example of the importance of the field to post-harvest handling is the discovery that ripening of fruit can be delayed, and thus their storage prolonged, by preventing fruit tissue respiration. This insight allowed scientists to bring to bear their knowledge of the fundamental principles and mechanisms of respiration, leading to post-harvest storage techniques such as cold storage, gaseous storage, and waxy skin coatings. Another well-known example is the finding that ripening may be brought on by treatment with ethylene. Temperature is the single most important tool for maintaining postharvest quality. For products that are not field-cured or exceptionally durable, the removal of field heat as rapidly as possible is highly desirable.

Harvesting cuts a vegetable off from its source of water, but it is still alive and will lose water, and therefore turgor, through respiration. Field heat can accelerate the rate of respiration and with it the rate of quality loss. Proper cooling protects quality and extends both the sensory (taste) and nutritional shelf life of produce. The capacity to cool and store produce gives the grower greater market flexibility. Growers have a tendency to underestimate the refrigeration capacity needed for peak cooling demand. It is often critical that fresh produce rapidly reach the optimal pulp temperature for short-term storage or shipping if it is to maintain its highest visual quality, flavor, texture, and nutritional content. The five most common cooling methods are: 1. Room cooling is an insulated room or mobile container equipped with refrigeration units. It is slower than other methods. Depending on the commodity, packing unit, and stacking arrangement, the product may cool too slowly to prevent water loss, premature ripening, or decay. 2. Forced-air cooling-fans used in conjunction with a cooling room to pull cool air through packages of pro-duce. Although the cooling rate depends on the air temperature and the rate of airflow, this method is usually 75 to 90% faster than simple room cooling. Design considerations for a variety of small- and large-scale units are available in Commercial Cooling of Fruit, Vegetables, and Flowers (ANR Publication 21567). Hydro cooling– showering produce with chilled water to remove heat, and possibly to clean produce at the same time. The use of a disinfectant in the water is essential, and some of the currently permitted products are discussed later in this publication. 3. Hydro-cooling is not appropriate for all produce. Waterproof containers or water-resistant waxed-corrugated cartons are required. Currently waxed corrugated cartons have limited recycling or secondary use outlets, and reusable, collapsible plastic containers are gaining popularity. A list of vegetables that are suitable for hydro cooling is available in Postharvest Technology of Horticultural Crops (ANR Publication 3311) as well as in Commercial Cooling of Fruit, Vegetables, and Flowers. 4. Top or liquid icing- an effective method to cool tolerant commodities, and equally adaptable to small- or large-scale operations. Ice-tolerant vegetables are listed in Postharvest Technology of Horticultural Crops and in Commercial Cooling of Fruit, Vegetables, and Flowers. It is essential that you ensure that the ice is free of chemical, physical, and biological hazards. 5. Vacuum cooling- uses a vacuum chamber to cause the water within the plant to evaporate, removing heat from the tissues. This system works well for leafy crops that have a high surface-to-volume ratio, such as lettuce, spinach, and celery. The operator may spray water onto the produce before placing it into the vacuum chamber. As with hydro cooling, proper water disinfection is essential (see Sanitation and Water Disinfection). The high cost of the vacuum chamber system restricts its use to larger operations. In eggplant, the cap or calyx is more sensitive and turns black before the fruit itself is affected. The effects of chilling injury are cumulative in some crops. Chilling injury may not be apparent until produce is removed from low-temperature storage. Depending on the duration and severity of chilling, chilling symptoms become evident in the following ways several hours or a few days after the produce is returned to warmer temperatures:

Prolonging the postharvest life of vegetable commodities is one of the primary concerns of farmers and traders, the success of which depends much on the storage environment (Pantastico, 1975). In the countryside, the objective in storage is not to actually keep the produce for a long time but to lessen the perishability so that the usefulness of the product is maximized and a larger profit can be derived if the crops are to be marketed (Bautista, 1982). Postharvest handling is the stage of crop production immediately following harvest, including cooling, cleaning, sorting and packing. The instant a crop is removed from the ground, or separated from its parent plant, it begins to deteriorate. Postharvest treatment largely determines final quality, whether a crop is sold for fresh consumption, or used as an ingredient in a processed food product. The most important goals of post-harvest handling are keeping the product cool, to avoid moisture loss and slow down undesirable chemical changes, and avoiding physical damage such as bruising, to delay spoilage. Sanitation is also an important factor, to reduce the possibility of pathogens that could be carried by fresh produce, for example, as residue from contaminated washing water.

After the field, post-harvest processing is usually continued in a packing house. This can be a simple shed, providing shade and running water, or a large-scale, sophisticated, mechanized facility, with conveyor belts, automated sorting and packing stations, walk-in coolers and the like. In mechanized harvesting, processing may also begin as part of the actual harvest process, with initial cleaning and sorting performed by the harvesting machinery. Initial post-harvest storage conditions are critical to maintaining quality. Each crop has an optimum range for storage temperature and humidity. Also, certain crops cannot be effectively stored together, as unwanted chemical interactions can result. Various methods of high-speed cooling, and sophisticated refrigerated and atmosphere-controlled environments, are employed to prolong freshness, particularly in large-scale operations.

Several techniques are available to minimize the perishability problem of eggplant especially to control pests.

The wood vinegar (Pyroligneous acid) has many beneficial effects and one of them is suffocation of small pests. It has also excellent effects on mite control, repel pests and prevent plant from fungal, bacterial and virus- like disease infection. Like hormones, wood vinegar will be absorbed into twigs, trunks or leaves. Plants will be stronger, and leaves will be greener and resistant to pests and diseases. Wood vinegar is safe to human beings, animals, plants, and environment. In terms of economic issue, the low cost of production can be attributed to savings from cost of chemicals. Effects of wood vinegar mixture is various depending on plant species, growth stage and cultivation system. In addition, crop produce is high and safe. On the other hand, high concentration or overuse may damage to crop.

Wood Vinegar is a natural extract from woods. It is used in agriculture and animal fodders. It is a good choice for organic farming. The natural contents make it an attractive alternative to chemical pesticides and fertilizers. Furthermore, it is non-toxic and biodegradable. Benefits on crops: Stimulates vegetable growth, strengthens roots and leaves, enriches soil fertility, reduce odor, works as flavor enhancer for agricultural end products, inhibits virus and soil disease, when mixed in high concentration, increases the quantity of useful microbes, repels insects on plants, prevents diseases caused by bacteria, improves fruit quality and increases sugar content in fruit, nourishes seeds for germination and facilitates composting. The advantages of using wood vinegar are to increase crop resistance to adverse condition, repel pests, prevent plant infection from fungal, bacterial and virus-like disease, improve flavor, color, firmness and preservation of fruit, strengthen the photosynthesis; increase the content of chlorophyll of the plants, improve absorption through the roots.

Temperature management also plays a key role in limiting water loss in storage and transit. As the primary means of lowering respiration rates of fruits and vegetables, temperature has an important relationship to relative humidity and thus directly affects the product rate of water loss.

The relative humidity of the ambient air conditions in relation to the relative humidity of the crop (essentially 100%) directly influences the rate of water loss from produce at any point in the marketing chain. Water loss may result in wilting, shriveling, softening, browning, stem separation or other defects. Transport to and display at roadside stands or farmers markets often result in extended periods of exposure of sensitive produce to direct sun, warm (or even high) temperatures, and low relative humidity. Rapid water loss under these conditions can result in limp, flaccid greens and a loss of appealing natural sheen or gloss in fruits and vegetables. By providing postharvest cooling before and during transport and a shading structure during display, you can minimize rapid water loss at these market outlets. Approved fruit and vegetable waxes are effective tools for reducing water loss and enhancing produce appearance. The uniform application and coverage for waxes or oils using proper packing line brushes or rolling sponges is important. Plastic wraps or other food-grade polymer films retard water loss. Adequate oxygen exchange is necessary to prevent fermentative respiration and the development of ethanol and off- odors or flavors. Wraps or bags must have small perforations or slits to prevent these conditions, especially when temperature management is not available. The exposure of bagged or tightly wrapped produce to direct sunlight will cause the products internal temperature to rise rapidly. Water loss will result and, as cool storage must show no detectable residue prior to the start of organic packaging (e.g., fresh-cut salads). Controlled or modified atmosphere storage or shipping offer little benefit to eggplant quality maintenance. Low O_2 levels (3-5%) delay deterioration and the onset of decay by a few days. Eggplant tolerates up to 10% CO_2 but storage life is not extended beyond the benefit of reduced levels of O_2. The temperature, relative humidity, carbon dioxide and oxygen concentrations are the alterable components of the storage environment (Ryall, 1979).

Among the storage methods, refrigerated storage of fruits or cold storage is considered as the most effective method for long term storage of fruits and vegetables. It was observed that produce stored at lower temperature and higher relative humidity are generally required to reduce the rate of deteriorative process such as respiration and transpiration and to improve shelf life of the produce (Bautista, 1990). Rapid cooling, primarily to reduce water loss, soon after harvest is essential for optimal postharvest keeping quality. The precooling endpoint is typically 10°C (50°F). Forced-air cooling is the most effective practice. Room cooling after washing or hydro-cooling is the most common practice. Moistened paper or waxed cartons are often used to reduce water loss. Japanese eggplants lose water 3 times more rapidly than American-type eggplants. Visible signs of water loss are reduction of surface sheen, skin wrinkling, spongy flesh, and browning of the calyx. Chilling injury and water loss can be reduced by storing of eggplant in polyethylene bags or polymeric film overwraps. Increased decay from Botrytis is a potential risk of this practice. Diseases are an important source of postharvest loss, particularly in combination with chilling stress. Common fungal pathogens are *Alternaria* (Black Mold Rot), *Botrytis* (Gray Mold Rot), *Rhizopus* (Hairy Rot), and *Phomopsis* Rot.

Evaporative cooling is a storage method in which it uses the evaporation of the liquid water to vapor that brings about the cooling effect. It was revealed that it is important to maintain in storage a lower level of temperature and a higher RH to prevent excessive deteriorative changes on the commodity which may be physical, physiological or biochemical in nature (Andales and Lozada, 1980). Evaporative cooling storage has been found to effectively prolong the postharvest life of sweet pepper (Mante, 1992; Cabudlan, 1993), cucumber (Granada, 1987), and pechay (Reyes, 1990).

Ambient air cooling is the use of naturally cool air surrounding a building to reduce heat inside the facility. The use of ambient air and/or nearby water sources to maintain appropriate ambient temperatures is sometimes referred to as free cooling because they take advantage of naturally occurring phenomena rather than more heavily technological solutions. One of the first things to consider for ambient air cooling is location. The prevailing air at many latitudes and elevations can be considerably cooler during certain seasons and times of day than the air that is warmed by data center equipment. There are two types of ambient air cooling: In air-side free cooling, outside air is brought in directly through filters or indirectly through heat exchangers. In adiabatic free cooling, the air is brought into some sort of chamber and used along with water evaporation to cool the air.

The study aims to prolong the shelf life of eggplant using pyroligneous acid under different storage conditions.

MATERIALS AND METHODS

Preparation of vegetables samples

Eggplant fruits were harvested from a local farm located at Barangay Butigan, Baybay City, Leyte. The fruit samples were brought to the Postharvest Technology Laboratory (PTL), Department of Horticulture VSU, Visca, Baybay, Leyte. The fruit samples were sorted and only fruits with uniform size and free from damage were utilized in the experiment.

Experimental design and lay-out

A 2×3 factorial experiment was laid out in Completely Randomized Design (CRD) with 6 treatments, each consisting of 5 fruits samples replicated 3 times.

Factor A - Wood vinegar treatment
W_1- control (No wood vinegar application)
W_2- wood vinegar 10% concentration
Factor B- Storage conditions
S_1- Ambient room
S_2- Refrigerated
S_3- Evaporative cooler

Wood vinegar/Pyroligneous acid dips treatments

Wood vinegar were applied as 10% solution dipped for 2 minutes, prepared by adding 300 ml Pyroligneous acid into 2700 ml distilled water (Rivera *et al.*, 2013, in press). Distilled water served as control representing farmers practice.

Post-treatment conditions

Ambient storage was done by keeping the fruits under ordinary room conditions at 25°C.

Evaporative storage was setup using a box-type evaporative cooler at 17-18°C while refrigerated storage was done using a chiller with temperature maintained at 7-10°C.

A pan of water was provided in the chiller to maintain high RH. Temperature and RH at ambient, evaporative and in the chiller was monitored daily using dry and wet bulb thermometers and physichrometric chart.

Data gathered

Weight loss (g) and shriveling

The initial weight of the fruits and the weight at each sampling period were taken. Weight loss was expressed as percentage of the initial weight. Fruit shriveling was determined using the following shriveling index (SI).

SI	Description
1	No shriveling
2	Slight shriveling (1- 25% fruit surface affected)
3	Moderate shriveling (26- 50% fruit surface affected)
4	Severe shriveling (more than 50% fruit surface affected)

Ripening changes

Peel color development: Changes in fruit surface color associated with ripening were determined at each observation period using the color index (CI) below. This was commenced before storage using representative samples of the whole and continue after every 2 days using replicate samples/treatments until termination.

CI	Color description
1	violet
2	Breaker, up to 25% brown
3	25-50% brown
4	50-75% brown
5	More than 75% brown
6	Full brown

Fruit softening: Fruit softening was measured by finger-feel method using a scale of 1-4 where:

1 – Firm or hard

2 – Slight, first perceptible softening

3 – Moderately soft

4 – Ripe-soft

Pulp Firmness: Fruit hardness test which determines pulp firmness was conducted using a penetrometer where reading was taken at the stalk end, middle and blossom end of the sample. Pulp firmness was measured in kilogram/force (kg/F) and all experiments will be carried out in triplicates.

Total soluble solids (TSS), titratable acidity (TA) and pH: TSS, TA and pH was determined before storage using 3 replicate fruits (initial) and at fruit softening stage 3 (moderately soft) using one fruit per replicate. The whole fruit was sliced into small pieces and blended with distilled water (1:1 ratio) using a blender. The homogenate was filtered through a filter paper or several layers of cheese cloth and the filtrate was subjected to analysis. TSS was measured using a hand-held refractometer. TA was measured by the titrimetric method using standardized 0.1N sodium hydroxide (NaOH) solution and 0.1% phenolphthalein as indicator. Titratable acidity was calculated using the formula:

% TA of Predominant acid = $\{(V \times N \times M)/ W\} \times 100$

Where:

V- Volume of NaOH added, ml

N- Concentration of NaOH, normality (N)

M- Milliequivalent weight of predominant acid, g/meq.

W- Weight equivalent of aliquot, g

% TA of Predominant acid = {(Weight of sample, g)/ (Wt. of sample, g X vol. of water added, ml pH)}× vol. of aliquot

Incidence of postharvest disorders

Disease development: Disease development such as anthracnose was noted by taking the number of diseased fruits. Severity of its infection was assessed using a scale of 1-4 where:

1-disease-free

2-slight, disease symptoms affecting less than 10% of fruit surface

3-moderate, 10-25% of fruit surface affected

4-severe, more than 25% of fruit surface affected.

Visual quality

The physical appearance of eggplant was evaluated using the following visual quality rating (VQR):

VQR	Description
9	Excellent, field fresh or no defect
7	Good, defects minor
5	Fair, defects moderate, limit of marketability
3	Poor, defects serious, limit of edibility
1	Non-edible under usual condition

Shelf life

The defects responsible for visual quality loss were noted. The number of days to VQR 5 was taken as a measure of the potential shelf life of eggplant under ambient, evaporative, and refrigerated storage conditions.

Data analysis

Analysis of variance (ANOVA) and treatment mean comparison by the Least Significant Difference (LSD) was performed using the STAR program of the International Rice Research Institute.

RESULTS AND DISCUSSION

Percent weight loss

Eggplant fruits treated by control stored under ambient, refrigerated and evaporative condition lost faster than those treated by 10% wood vinegar concentration under ambient, refrigerated and evaporative condition (Fig. 1). On the 4th day of storage and thereafter eggplant fruits treated by 10% wood vinegar concentration almost maintain its initial weight from the start of storage under ambient, refrigerated and evaporative condition. Generally, on the 10th day of storage the results revealed that eggplant fruits under refrigerated condition treated by 10% wood vinegar concentration had highly effective in preventing rapid weight loss which prolongs the shelf life of eggplant fruits.

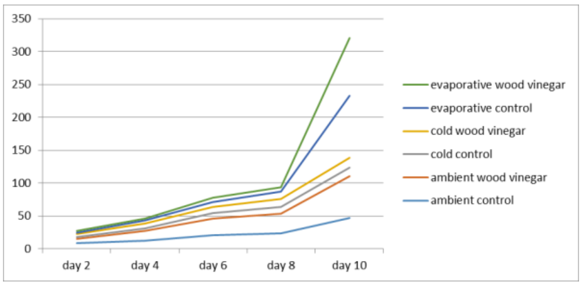

Fig. 1. Percent weight loss of eggplant fruits treated by control and 10% wood vinegar concentration under ambient, refrigerated and evaporative storage conditions

The rapid weight loss of eggplant fruits at ambient condition possibly caused by increasing vapour pressure between the tissue and the air surrounding which will leads enhancement of transpiration. In addition high temperature increased the rates of respiration and other metabolic processes that caused depletion of substrates like sugars and proteins resulting into further weight loss (Buescher, 1979). The higher weight loss was observed at higher temperature which can be attributed to air movement thus increased water vapour deficit. As water evaporates the tissue, turgor pressure decreases and the cells begin to shrink and collapse thus leading to loss of freshness and increase in shrivelling. VPD is the difference between the amounts of moisture in the air can hold when it is saturated. It is the driving force of the water loss. Low RH and high temperature consequently increased VPD. As a result weight loss correspondingly increased.

Visual quality rating

The eggplant fruits appeared fresh and free from defects on the first day of storage, but thereafter, the visual quality decreased except for the eggplant fruits treated by 10% wood vinegar concentration stored under refrigerated condition. Loss of visual quality was relatively less rapid in eggplant fruits treated by control than treated by wood vinegar (Table 1).

Table 1. Visual quality rating of eggplant fruits treated by control and 10% wood vinegar concentration under ambient, refrigerated and evaporative storage conditions

Wood	Ambient	Refrigerated	Evaporative
Control	7.47b	6.40a	4.27
Wood vinegar	6.7b	6.40a	4.67

Means with the same letters are not significantly difference.

The number of days for each eggplant fruits to reach VQR 3 was taken as an approximate measure of its shelf life. Table 1 shows that eggplant fruits treated with wood vinegar at refrigerated conditions had the longest shelf life while those treated by control under ambient and evaporative condition had the shortest shelf life.

The effect of wood vinegar in prolonging shelf life was clearly revealed, the 10% wood vinegar concentration was clearly beneficial in reducing loss of saleable weight or number of eggplant fruits. The great advantage of applying wood vinegar in different parameters was clearly revealed especially for the eggplant fruits under refrigerated condition.

Shrivelling index

All the eggplant fruits treated by 10% wood vinegar concentration prevented the rapid shrivelling of its freshness as a result of the marked reduction of fast weight loss. On the other hand, eggplant fruits treated by control shrivelled rapidly. The results revealed that eggplant fruits treated by control under ambient condition directly shows shrivelling on the first day of storage this was due to high temperature at ambient condition which results to rapid transpiration of freshly harvested eggplant fruits (Table 2). The rest of the treatments a showed a perceptible symptoms of shrivelling of 2 days of storage except for wood vinegar under refrigerated condition which was the first perception of symptoms occurred after 4 days of storage.

Table 2. Shrivelling index of eggplant fruits treated by control and 10% wood vinegar concentration under ambient, refrigerated and evaporative storage conditions

Wood	Ambient	Refrigerated	Evaporative
Control	7.73b	6.67a	4.67a
Wood vinegar	5.87b	6.80a	4.80a

Means with the same letters are not significantly difference.

Generally the results revealed that eggplant fruits treated by wood vinegar under refrigerated was found out significantly different in terms of shrivelling index from eggplant fruits stored under ambient and evaporative storage condition.

Peel color development

Ripening changes determined using color index (1-6). The color of CI was based on the percentage of total surface areas affected by color changes. The results revealed in Table 3 that eggplant fruits treated by control under ambient and evaporative storage conditions were found out not significantly different in delaying color changes with that of eggplant fruits treated by 10% wood vinegar concentration under refrigerated condition.

Table 3. Peel color development of eggplant fruits treated by control and 10% wood vinegar concentration under ambient, refrigerated and evaporative storage conditions

Wood	Ambient	Refrigerated	Evaporative
Control	7.40b	5.27a	3.67b
Wood vinegar	6.13b	5.73a	4.20b

Fruit softening

The results revealed there is an increase in fruit softness in eggplant fruits stored under ambient and evaporative storage condition than that treated by 10% wood vinegar concentration stored under refrigerated condition. Results revealed that the rate of softening was significantly affected by the application of wood vinegar under refrigerated condition.

Table 4. Fruits softening of eggplant fruits treated by control and 10% wood vinegar concentration under ambient, refrigerated and evaporative storage conditions

Wood	Ambient	Refrigerated	Evaporative
Control	6.80a	7.33b	5.00a
Wood vinegar	6.13a	6.87b	5.33a

Means with the same letters are not significantly difference.

Fruit softening during ripening is frequently attributed to the extensive breakdown of cell wall which is associated with an increase in activities of hydrolytic enzymes. During ripening, solubilisation of cell wall polysaccharide complex occur involving enzymatic cleavage of critical bonds including depolymerisation of the polygalacturonide chains (Hasegawa *et al.*, 1969).

Pectin methyl esterase (PME) prepares the cell wall for hydrolysis by polygalacturonase .PME removes the methyl groups of ploygalacturonic, plymers and polygalacturonase activity splits the glucosidic bonds of the intensified polygalcturoide chain and reduces its molecular weight (Lineweaver and Jansenc, 1951).

Disease development

During the conduct of this study, I keenly observed if there was a disease developed after it was sorted and applied by control and 10% wood vinegar concentration and was stored under ambient, refrigerated and evaporative storage condition. Then, the results revealed that eggplant fruits by control under ambient and evaporative condition that there was a disease developed on the eggplant fruits than that eggplant fruits treated by 10% wood vinegar concentration under refrigerated condition (Table 5). Disease development also reflected the type of cultivation system of the crop grown, like this eggplant fruits I'd used in the experiment it was from an open cultivation system of planting and in an open cultivation system there were lots of environmental factors that could affect or inhibit the fruits to be affected with diseases, it may not appear on its physical appearance of the fruits but on the internal part of the fruits it was already affected.

On the other hand those diseases or pests that would attacked or infected to the fruits was prevented by using this wood vinegar, since wood vinegar minimizes the perishability problem of eggplant especially problem especially to control pests, prevent plant from fungal, bacterial and virus like disease infection. In general, wood vinegar is resistant to pest and disease.

Table 5. Disease development of eggplant fruits treated by control and 10% wood vinegar under ambient, refrigerated and evaporative storage conditions

Wood	Ambient	Refrigerated	Evaporative
Control	7.53b	6.93a	4.87b
Wood vinegar	6.73b	6.53a	5.13b

Means with the same letters are not significantly difference.

Average soluble solids, TA and PH

The results revealed that the final TSS and TA increase, resulting to PH to increase. Ambient condition cooler by control had the highest TSS content followed by refrigerated by control and ambient with wood vinegar (Fig. 2-4).

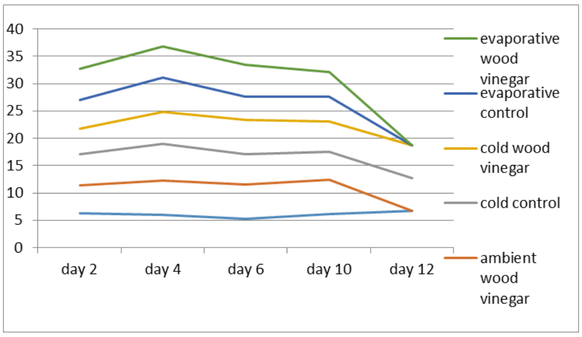

Fig. 2. Average soluble solids of eggplant fruits treated by control and 10% wood vinegar concentration under ambient, refrigerated and evaporative storage conditions

On the other hand, TA those eggplant fruits stored under refrigerated was significantly higher to those eggplant fruits at ambient condition. This result suggested that refrigerated storage condition in conjunction with 10% wood vinegar concentration can maintain the TSS and TA content of eggplant fruits.

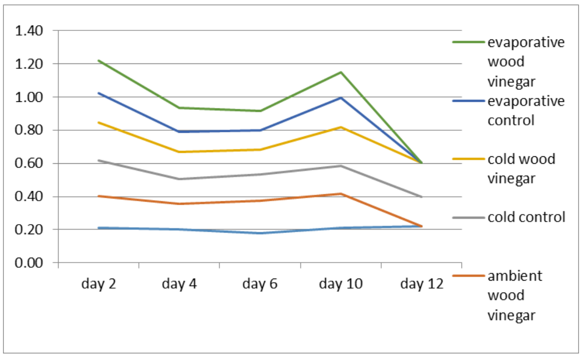

Fig. 3. Titratable acidity of eggplant fruits treated by control and 10% wood vinegar concentration under ambient, refrigerated and evaporative storage conditions

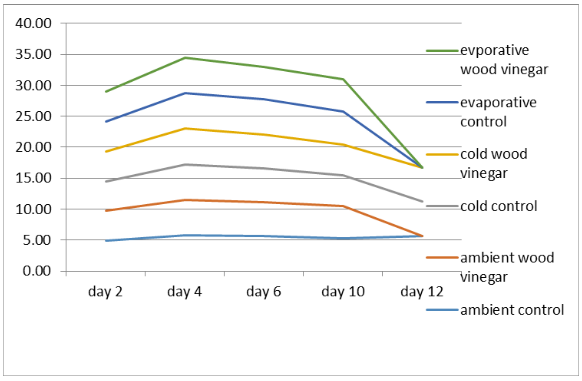

Fig. 4. pH of eggplant fruits treated by control and 10% wood vinegar concentration under ambient, refrigerated and evaporative storage conditions

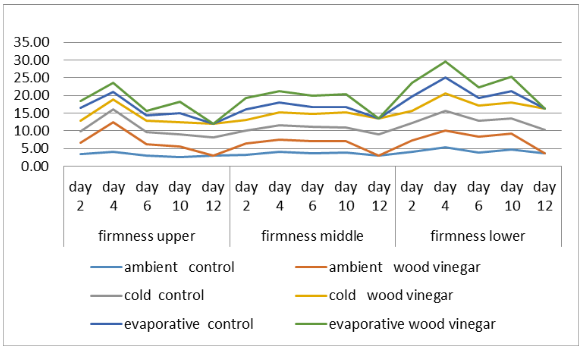

Fig. 5. Firmness (upper, middle and lower) parts of eggplant fruits treated by control and 10% wood vinegar concentration under ambient, refrigerated and evaporative storage conditions

Firmness

The results revealed that firmness in the upper part of the eggplant fruits treated by 10% wood vinegar concentration under refrigerated condition is significantly different from other storage conditions especially to those treated by control (Fig. 5). On the other hand, on the middle part and lower parts of the eggplant fruits at 12 days storage treated by control and 10% wood vinegar are significantly different. Firmness is one of the consumers preference in choosing the fruits or vegetables for their own consumption since quality and quantity of a fruits and vegetables vary from its physical characteristics.

CONCLUSION

This study was conducted to determine the effects of pyroligneous acid on the quality and shelf life of eggplant under different storage conditions.

A 2×3 factorial experiment was laid out in completely randomized design with 6 treatments, each consisted of five fruits samples replicated three times. Factor A for wood vinegar treatment W1 represented as control (no wood vinegar application) and W2 represented the application of 10% wood vinegar concentration. Factor B represented the storage conditions S1 for ambient room condition, S2 for cold storage and S3 for evaporative cooler.

The results revealed that 10 % solution of wood vinegar in eggplant fruits stored under ambient, and evaporative cooler were found not significantly different ($p>0.05$) that of the eggplant fruits stored under at cold storage condition. And was revealed that the most effective storage condition applied 10% wood vinegar concentration to prolong the shelf life of eggplant fruits was at cold storage condition.

RECOMMENDATION

1. Pre-harvest factors should be evaluated first since it may affect the postharvest quality of eggplant fruits.

2. Further studies are needed with increase in percent concentration of wood vinegar stored at different storage condition have significant effect on the postharvest shelf life of eggplant fruits.

3. Eggplant fruits under protected cultivation system should be employed to determine the best treated with wood vinegar.

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