

Effectiveness of Corncob Liquid Smoke on Storageability of Tomatoes and Mango

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Abstract: Corncob waste is expected as a source of biomass to be converted through pyrolysis into liquid smoke, charcoal, and tar. The study aimed to determine the effectiveness of corncob liquid smoke on the storageability of tomatoes and mango. The liquid smoke treatments, which consisted of 0, 1, 2, 3, and 4% were arranged in a randomized block design with four replications. Data analysis using ANOVA and Duncan's Multiple Difference Test. The study was conducted in two sets of experiments in parallel, on tomatoes and mangoes. The experimental results showed that pyrolysis for every 1,000 g of corncob waste produced 279.2, 396 and 5.86 g of liquid smoke, charcoal and tar, respectively. Then the redistillation results for every 1,000 mL of crude liquid smoke produce 850 mL of food grade liquid smoke. The liquid smoke treatment gave better storageability than no treatment for tomatoes and mango. The storageability was measured by holding weight loss, increase in total dissolved solids, intensity of pathological damage, and fruit appearance within 12 days of storage. In general, as a result of the treatment the increase in liquid smoke concentration from 1 to 4% was followed by an increase in the storageability of tomatoes and mango.

Keywords: Corncob, Liquid Smoke, Mango, Storageability, Tomatoes

1. Introduction

Post-harvest losses are one of the problems of food security and food deficits in many countries. The proportion of fruit and vegetable loss reaches up to 50%, so reducing fruit and vegetable loss and waste is a major issue to provide sustainable food for the world's population in the future. The main causes of post-harvest losses of fruit and vegetables occur during harvest, post-harvest handling and storage, processing, distribution and consumption stages. Therefore, proper handling of harvest, packaging, transportation, and storage are very important efforts to minimize the amount of post-harvest loss [1].

Tropical fruits have relatively high postharvest losses and are easily damaged due to their inherent biological properties. On the other hand, these fruits have high productivity, for example tomatoes, papaya, avocado, banana and mango are

2.95, 17.05, 8.1, 8.12 and 9.03 tons/ha, respectively. Fruits will have a high economic and environmental contribution if they are produced in large quantities and managed properly at postharvest. In addition, efforts to increase fruit production will prevent the degradation of natural resources, overcome the challenges of climate change, increase fresh exports to international markets, also trigger the emergence and development of the fruit processing industry [2].

The corncob waste only causes serious problems for the environment, especially as the result of burning the waste will cause pollution and harm the environment. Whereas the material and energy contained in the solid organic waste can be utilized through a process to convert it into other forms of economic value. Gorontalo province has a total corn production of 501,685 tons per year. In line with that, the potential for corn cobs waste can reach 172,913 tons per year [3].

The yield of liquid smoke from corn cobs was 31.65% 2, had a phenol content of 1.38% and acetic acid of 1.3% [4].

Corncob liquid smoke was used for preserving agricultural products and smoking fish because it contained acids that could give aroma and decrease pH for durability of storage of these commodities. In addition, there were phenolic compounds that had oxidative and antibacterial effects which were very effective for fish preservation so that they could be stored for four days [5].

Corncob liquid smoke, which was rediluted and purified using activated charcoal, turned out to be after GC-MS analysis containing 15 compounds with different retention times, areas and percentages. Important compositions including acetic acid, phenol and carbonyl are 75.16, 0.23, and 0.19%, respectively. The organoleptic characteristics of the purified liquid smoke had an odor on a scale of 3.0 (less smell) and a color of 1.8 scale (clear yellow) [6].

This study aimed to determine the effectiveness of corncob waste liquid smoke on the storageability of tomatoes and mango.

2. Materials and Methods

2.1. Materials

The materials used in this experiment were tomatoes cultivar Serpo purchased from farmers in Tamansari District, Tasikmalaya City; and mango cultivar Gincu purchased from farmers in Majalengka. Other materials were corncobs waste taken from Cikurubuk Market, Tasikmalaya City as an feedstock for liquid smoke. The tools used in this research include: a pyrolysis and distillation set, an electric balance, an oven, a hand refractometer, a pnenometer, and other supporting laboratory equipment.

2.2. Experimental Methods

In this experiment there were five treatments of corncob liquid smoke concentration, namely: 0, 1, 2, 3, and 4% with four replications, arranged in a completely randomized design. Observational data were processed by analysis of variance (ANOVA) and continued with Duncan's multiple difference test [7].

The cleaned corn cobs were chopped into 2 cm x 2 cm sizes for easy loading into the kiln. After that, the chopped cobs were dried in the sun for 48 hours and the moisture content was measured.

Proses The pyrolysis process continues until the temperature reaches 400°C, so that coarse liquid smoke, charcoal, and tar are obtained [8]. Crude liquid smoke was distilled at a temperature of 150 C, then filtered with zeolite grains. The distillation process was repeated again and filtered with activated charcoal to produce grade 1 liquid smoke for food products.

Assessment of the quality of liquid smoke based on the specifications of the Japanese Standard Parameters tested include: color, pH, odor, content of phenolic compounds, and acid content [9].

Before being given treatment, tomatoes and mangoes were first measured their initial weight and TDS. The liquid smoke treatment was carried out by soaking the 10 tested fruits for 8

minutes according to each treatment with the liquid smoke concentration. After being treated, all fruits were incubated at room temperature and observed at 0, 3, 6, 9, and 12 days after incubation (DAI).

2.3. Data Collection

2.3.1. Fruits Weig-Loss

Weight loss was recorded in percentage on a fresh weight basis (w/w) assessed in every ecotype using three replicates of 10 fruit per tray [10]. The percentage of fruit weight loss was calculated from the initial fruit number minus the fruit weight after 12 days of storage, then compared to the initial fruit weight.

2.3.2. Total Dissolved Solids

Measurement of total dissolved solids (TDS) according to SNI 01-3546-2004 using a digital hand refractometer (PAL-1 Atago Co., Ltd., Tokyo, Japan). This tool needs to be calibrated first using aquadest [11].

2.3.3. Intensity of Pathogenical Damages

The intensity of pathogenical damage is the percentage of the ratio between the number of plants affected to the total number of plants in one observation plot [12].

2.3.4. Fruits Appreance

Fruit appearance is the percentage of the number of fruits that are visually assessed by texture and color, which are still fit for consumption compared to the total number of fruits in each observation plot [13].

3. Results and Discussion

3.1. Product of Pyrolysis Process

As shown in Table 2. from 1,000 feedstocks of corncob was produced liquid smoke, charcoal. and tar produced of 279.2, 396, and 5,86 g, respectively. One liter of crude liquid smoke was continued for two redistillation processes. The result of the reditillation was food grade (grade 1) liquid smoke with a quantity of 850 ml. Then the grade 1 liquid smoke was tested as a preservative for tomato and mango fruits in storage.

Table 1. Pyrolysis yield of 1.000 g corncob waste.

Component of pyrolysis products (g)	Batch					Average (g)
	1	2	3	4	5	
Liquids smoke	260	280	290	280	286	279.2
Charcoal	434	400	410	380	360	396
Tar	50	60	60	70	53	58.6

The results of liquid smoke from corncobs were slightly lower than previous studies that, the pyrolysis results of 1,000 g of teak wood shavings produced charcoal, liquid smoke, and tar of 222 g, 487.67 mL, and 41.76 g, respectively [8]. This difference was caused by the type of biomass and higher water content. The water content contained in agricultural waste is free water, so it is easily evaporated when pyrolyzed [14].

The yield quantity of the liquid smoke depends on the type

of raw material and the temperature of the pyrolysis process. The highest yield from the pyrolysis process of tabah bamboo produced at a temperature of 400°C was 46.11%. While at 300°C was 44.38% and the lowest was obtained at 200°C was 38.92% [15]. The previous study on the pyrolysis process of nyamplung shell obtained liquid smoke yields between 19.8 to

48.8%. The highest yield was obtained at a temperature of 500°C for 7 hours was 48.8% and the lowest was obtained at a temperature of 200°C for 5 hours. There is a tendency that, the higher the temperature and the longer pyrolysis time, the higher the liquid smoke produced [16].

3.2. Effectiveness of Liquid Smoke

Table 2. The effect of liquid smoke on percentage (%) storageability of tomatoes and mango fruits in 12 days after incubation.

Concentration of Liquid smoke (%)	Weight loss		TDS		Damage intensity		Appearance	
	Tomatoes	Mango	Tomatoes	Mango	Tomatoes	Mango	Tomatoes	Mango
0	6.99 ^c	20.64 ^b	3.60 ^c	15.53 ^b	15.0 ^b	68.75 ^b	50.62 ^a	68.00 ^a
1	5.18 ^b	18.23 ^a	3.45 ^{bc}	15.43 ^{ab}	7.5 ^{ab}	48.75 ^{ab}	59.37 ^{ab}	69.50 ^a
2	4.83 ^b	17.41 ^a	2.90 ^{ab}	14.70 ^{ab}	5.0 ^{ab}	46.25 ^a	76.25 ^b	71.00 ^{ab}
3	4.78 ^b	17.21 ^a	3.55 ^{bc}	13.73 ^a	10.0 ^{ab}	40.00 ^a	54.37 ^a	74.00 ^b
4	4.41 ^a	18.08 ^a	3.01 ^{abc}	13.15 ^a	2.5 ^a	45.00 ^a	65.62 ^{ab}	74.00 ^b

Note: numbers followed by the same letter in each column, showed no significant difference according to Duncan's Multiple Range Test at the 5% level.

In general, all treatments of corncob liquid smoke on tomato and mango fruit storage provided a protective effect against: fruit weight loss, TDS increase, damage by pathogens, and decreased appearance. There is a tendency that, the higher the concentration of liquid smoke, the more protection against storageability of the both fruit species.

Fruit weight loss occurred in tomatoes and mangoes, although tomatoes were lower. In the two fruit species, the highest of weight loss occurred in the control, and it was different for all treatments of liquid smoke concentration. Starting from the 1% liquid smoke treatment, it had a suppressive effect on the weight loss.

The increase in total dissolved solids (TDS) in mangoes was higher than in tomatoes. In tomatoes, 1% concentration of liquid smoke was effective in suppressing the increase in TDS. But in mangoes, liquid smoke treatment began to show its effectiveness from a concentration of 3%.

In the control, the intensity of pathogenic damage in mango was higher than that in tomato, which were 68.75 and 15%, respectively. This variable is influenced by genetic factors in contrary to each pathogen. In the presence of 4% liquid smoke treatment, it turned out that the mango fruit was able to reduce the intensity of the damage to 45%; and in tomatoes to 2.5%.

After 12 days of storage in the control treatment, the appearance of tomatoes and mangoes had values of 50.62 and 68.00%, respectively. While the appearance of the fruit in the best liquid smoke treatment, tomatoes and mangoes each had a value of 76.25% (2% liquid smoke) and 74% (3%). The appearance assessment was seen visually on the color, texture, and freshness of the fruit.

Weight loss occurs during storage depending on the type of fruit or vegetable. However, the rate of water loss depends on the species and is closely related to its physiological characteristics, as well as the expected storage duration under the conditions used [17]. The loss of fruit weight in storage occurs due to physiological processes of fruit cells, namely the process of respiration and transpiration. The phenomenon of weight loss, decrease in water content, increase in TDS, and decrease in appearance (shape and color) of fruit as a result of

the physiological process of fruit enzymatically during storage [18]. Physiological loss in weight (PLW) decreased significantly after 3 to 6 days at room temperature during storage, but the decrease was more pronounced at 6 days storage time. PLW fruit that exceeds the limit causes the fruit to shrink, which ultimately results in a loss of freshness, appearance and quality of the fruit [19]. Storage time affects the quality of mango fruit, which includes: an increase in TDS, and a decrease in fruit weight and hardness. At 14 days storage has the highest TDS value and weight loss. While the value of fruit hardness decreased the longer it was stored [20].

The application of liquid smoke affected the storageability of Macau bananas, which lasted 7 to 12 days compared to the control which only lasted for three days. The higher the concentration of liquid smoke given, the slower the fruit ripening process. The slow ripening process has the effect of decreasing the biochemical processes that occur in the fruit so that it affects the reducing sugar levels and vitamin C levels [21].

Several factors that caused a decrease in the quality of mangoes in storage included: sticking sap resulting in sapburn injury, anthracnose fungal (*Colletotrichum gloeosporioides*), and fruit base rot pathogen (*Botryodiplodia theobromae*). These three factors can be reduced by treating a mixture of 1% detergent solution, 0.5% Ca(OH)₂, and fungicide [22]. The most common and aggressive soft rot bacteria is the *Pectobacterium carotovorum* strain. Certain species of *Pseudomonas*, *Xanthomonas* and *Bacillus* can also cause a soft rot of tomatoes. The mode of action, symptoms and control for these pathogens are nearly identical to those for *Pectobacterium*.

The pathogenic fungus of opaque rot, *Geotrichum candidum* forms lesions on the fruit resembling a thick gelatinous mass. The second common fungal pathogen is *Rhizopus stolonifer* whose growth is very aggressive [23]. Palm oil shell liquid smoke was proven to strongly suppress the diameter of the rot pathogen mycelium (*Phytophthora palmivora*) lesions of cocoa pods. Phenolic compounds and acetic acid contained in liquid smoke function as antimicrobial and bacteriostatic [24].

4. Conclusion

Pyrolysis of 1,000 g of corncob waste produced liquid smoke, charcoal, and tar were 279.2, 396, and 5.86 g, respectively; and redistillation of 1,000 mL of the crude liquid smoke produced was 850 mL of food grade liquid smoke.

Liquid smoke treatments gave better storageability than no treatment (control) for both tomatoes and mango. In tomatoes, the weight loss of the treated fruit compared to the control was 4.41 and 6.99%; the increase in TDS of treated fruit compared to the control was 2.9 and 3.6%; disease intensity of treated tomatoes compared to control was 2, 5 and 15%; the appearance of the treated fruit compared to the control was 76.25 and 50.62%;

Whereas in mangoes, the weight loss of the treated fruit compared to the control was 17.21 and 20.64%; the increase in TDS of treated fruit compared to the control was 13.15 and 15.53 %; fruit disease intensity treated compared to control was 40 and 68.75%; the appearance of the treated fruit compared to the control was 68 and 74%.

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