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Cite as: AIP Conference Proceedings **2454**, 080002 (2022); https://doi.org/10.1063/5.0078268
Published Online: 09 June 2022

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Malaysian Wood Vinegar as Potential Vegetative Booster

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Abstract. The increment of awareness on food safety and environmental pollution caused by synthetic vegetative chemical agents leads the consumers and farmers to look for a safer and natural product as an alternative. Currently, the farmer in Malaysia mainly depends on the vegetative chemical agents imported from overseas. Therefore, the potential of the local vegetative agent is keen to be revealed. Wood vinegar is recognised as a safe natural vegetative agent with various effect. In this research, the booster effect of wood vinegar on the growth of *Brassica rapa* was investigated. Wood vinegar was obtained from Forest Bio Energy Sdn. Bhd. at Jeli District, Kelantan. The crude wood vinegar was aged for six months, and the clear wood vinegar above the tar layer was collected. The basic properties of wood vinegar, including pH, acidity, total polyphenol content, heavy metal content and bacteria count were analysed. Wood vinegar solution with five different dilution concentration (1:100, 1:250, 1:500, 1:750 and 1:1000) and one blank (distilled water as control) was prepared. The wood vinegar solutions were sprayed on the *Brassica rapa* with interval seven days for three weeks, begin from the day after transplanting (DATP). Soil pH, leaf area index, number of leaf, length of stem, fresh weight and length of root were examined. The physical properties analysis indicated that the wood vinegar is rich in acetic acid and total polyphenol content with low heavy metal content. The vitality result indicated that wood vinegar solution able to improve the growth of *Brassica rapa*. However, the high concentration of wood vinegar showed an adverse effect. The wood vinegar solution with 1:750 dilution exhibited the best performance in the promoting growth of *brassica rapa* in leaf area, leaf number, fresh weight and length of root and 1:1000 dilution for promoting the growth of stem.

International Conference on Bioengineering and Technology (IConBET2021)
AIP Conf. Proc. 2454, 080002-1–080002-5; https://doi.org/10.1063/5.0078268
Published by AIP Publishing. 978-0-7354-4193-4/$30.00

INTRODUCTION

Food security and safety is the crucial concerns nowadays. In the 21st century, people become more concerned with their health. The good food criteria are not only providing good nutrition but also it is also a safe food [1]. The safety concern due to the synthetic chemical residuals found in vegetation has alarmed the farming industries shift to a healthier practice in farming. Simultaneously, the agro-based industries still need to ensure the food supply is sufficient for the demands. The global food demand is increasing annually due to the growth of the population. Hence, to increase food supply, a safe boosting agent in vegetative crops is highly needed.

Wood vinegar is a pyroligneous liquid condensed from the released smoke during the carbonization of woody biomass [2]. It has been widely used in many countries including China, Japan and, America and some European countries, in their agricultural sector for various functions, including pesticide, fruit enhancer, soil conditioner and others. The wood vinegar market is growing and expecting to hit 2.09 Billion USD in 2025 [3]. The efficacy of wood vinegar in promoting food crops highly depends on the quality of the wood vinegar. Different wood species and process parameter significantly influence the quality of wood vinegar.

Generally, various bioactive compounds were found in wood vinegar and the research studies on wood vinegar in agriculture were widely reported. The high content of polyphenol compounds and organic acids in wood vinegar are essentially in biocide and stimulating the growth of plants, depending on the concentration [2]. The wood vinegar derived from Chinese Fir wheat seed germination and root growth [4]. Zhang et al. [5] proposed the co-application of biochar and wood vinegar derived from furniture wood waste resulting in blueberry fruit yield and fruit quality improvement. Mungkunkamchao et al [6] found that wood vinegar derived from eucalyptus improved the fruit number, weight and total soluble solutes of tomatoes.

The potential of wood vinegar in Malaysia still underexplored. Regardless of conventional farming or organic farming, the agricultural sector in Malaysia mainly depends on the imported pesticide or fertilizing agent. These imported vegetative chemical agents are expensive and it will increase the burden of local farmers and consumer. The research on local wood vinegar in Malaysia is limited. Local wood vinegar could be a cheaper alternative to the imported vegetative chemical agents. This paper aims to provide scientific data of efficacy of local wood vinegar to promote the vitality of vegetative and reveal the potential of local wood vinegar as vegetative booster in agricultural sector particularly food crops industries.

MATERIALS AND METHODS

Wood Vinegar

Wood vinegar was provided by a local manufacturer (Forest Bio Energy Sdn. Bhd.) located in Jeli, Kelantan. The wood vinegar samples were yielded from the kiln during the carbonization process for tropical wood sawdust briquette. The condensed crude wood vinegar was stored in IBC tank for 6 months to allow precipitation of tar. After six months, the clear wood vinegar above the tar layer were collected for further research.

Characterization of Wood Vinegar

Several basic properties of wood vinegar were inspected. The pH analysis of wood vinegar was done according to The Association of Official Analytical Chemists method AOAC 981.12. The acidity of wood vinegar was analyzed according to AOAC 935.57. Total polyphenol content was measured according to AOAC SMPR 2105.009. Heavy metal compounds analysis including arsenic, cadmium, lead, antimony, tin, and mercury was conducted according to AOAC 968.08. Bacteria count of wood vinegar was done according to AOAC 990.12.

Effect of Wood Vinegar in Vegetative Growth

Five different wood vinegar: distilled water dilution (1:1000, 1:750, 1:500, 1:250 and 1:100) (v/v) were prepared. Distilled water was introduced as the negative control in the experiment. The experiment was conducted at 10 replications for each treatment. In this study, *Brassica rapa* is also known as choy sum was selected as the food crop because it is an important crop in Malaysia with a short harvest period. The seeds of *Brassica rapa* were placed in a seedling tray for germination. After the emergence, the healthy and uniform seedling transplanted into separate nursery

polybag randomly. Black soil without any further treatment or fertilizer addition was used as the soil medium. The *Brassica* rapa specimens were watering twice a day.

The leaf area, leaf number, height of stem and soil pH of each specimen were measured seven days interval for three weeks, begin from the day after transplanting (DATP). In addition, fresh weight and length of root were measured on harvest day. Each specimen in the polybag was foliar sprayed with wood vinegar dilution on the plant until the plant is wet, each time after the measurement.

Statistical Analysis

The data of vegetative growth with replication were presented in Mean (Standard deviation). The comparison of mean among the treatment were conducted using ANOVA with TUKEY post-hoc test at alpha level 0.05.

RESULTS AND DISCUSSION

Basic Properties of Wood Vinegar

The local wood vinegar specimen is appeared in dark brown and with a strong smoky odour. The pH of the local wood vinegar specimen was marked at 2.4. Similar pH was reported by Luo et al [7] and Fang et al [8], the pH of wood vinegar produced from poplar tree was marked at 2.2 and the wood vinegar produced from forest residue and pine was marked at the range of 2.2-2.4. The acidity of wood vinegar was found at 8.4%, slightly lower than the *Cinnamomum parthenoxylon* wood vinegar reported by Adfa et al [9] at the record of 9.59%. The total polyphenol content found in the wood vinegar was 27.38 mg GAE/ml. The detected heavy metal including arsenic, cadmium, lead, antimony, tin and mercury, was less than 0.1 mg/L in wood vinegar. No bacteria strain was detected on the agar plate.

Effects of Wood Vinegar in Vegetative Growth

Area and Number of Leaf

TABLE 1. Area and Number of *Brassica rapa* leaf treated with various dilution ratio of local wood vinegar

Treatment	Leaf area (cm^2)				Leaf number			
	DATP	Week 1	Week 2	Week 3	DATP	Week 1	Week 2	Week 3
Control	1.37	45.90	78.20	112.68	4.0	4.5	5.3	5.6
	(0.17)a	(7.37)a	(5.49)a	(8.14)a	(0.0)a	(1.3)a	(2.1)a	(1.1)a
1:1000	1.44	50.75	76.84	121.50	4.0	5.5	6.0	6.2
	(0.15)b	(3.13)b	(2.80)a	(6.33)b	(0.0)a	(0.8)b	(0.9)b	(1.5)b
1:750	1.26	66.56	115.26	151.98	4.0	6.3	7.3	7.5
	(0.18)c	(3.74)c	(7.54)b	(2.60)c	(0.0)a	(0.8)c	(1.5)c	(1.3)c
1:500	1.28	59.16	97.24	145.56	4.0	5.7	5.2	5.6
	(0.26)c	(5.25)d	(5.26)c	(5.99)d	(0.0)a	(0.6)b	(1.2)a	(1.8)a
1:250	1.36	58.91	87.72	119.90	4.2	5.2	5.8	5.3
	(0.11)a	(4.14)d	(7.95)d	(4.07)b	(0.4)a	(0.8)d	(2.1)b	(1.5)a
1:100	1.32	55.08	82.28	122.99	4.0	5.3	4.5	4.0
	(0.18)a	(5.66)e	(6.27)e	(6.44)b	(0.0)a	(0.9)d	(1.3)d	(0.8)d

The data is expressed in mean (standard deviation). The different letter within the same column and row are statistically significant at α=0.05

Leaf is the essential edible part of *Brassica rapa*. As shown in Table 1, wood vinegar succeeded in promoting the growth of leaf in both area and number of leaves. This could be due to local wood vinegar has improved the nutrient uptake ability of *Brassica rapa*. Besides of promoting the leaf area and leaf number, *brassica rapa* sprayed with wood vinegar is more resistant to the pest through the observation. However, the promotion effect on increasing leaf area has gradually decreased with an increase wood vinegar concentration higher than 1:750 dilution ratio in this study. Similar trend found in the growth of number of leaf. The number of leaf was in the hit to 7.5 in mean at the treatment

of 1:750 and gradually reduced to 4 in mean at 1:100 dilution ratio at week 3. The adverse effect of wood vinegar treatment at high concentration could be due to the lower pH and higher phenolic compounds reported by Luo et al. [7].

Height of Stem

Table 2 showed the height of *Brassica rapa* stem treated with wood vinegar at different dilution ratio. Similar to the growth of leaf, wood vinegar treatment was proved in improving the growth of stem. All the stem of *Brasicca rapa* that treated with wood vinegar were taller than the control samples in mean. The increment of the length of stem is an essential primary growth of the plant. The stem is important as the medium to transfer water from root to leaf and to store the nutrient. As an edible plant, the length of stem has importance economically. The treatment of wood vinegar at 1:1000 dilution exhibited the most potent boosting effect on the stem growth. At week 3, The length of stem length reached 13.59cm in mean at 1:1000 dilution ratio treatment and significantly longer than the stem treated at other dilution ratios. However, the growth of stem shows a decrement when the concentration of wood vinegar become higher. The decrement of boosting effect could be attributed to the phenolic compound in wood vinegar. On one hand, the phenolic compounds in wood vinegar are important against bacteria and other pathogen growth, but on the other hand, they can reduce the plant growth rate by disturbing the auxin transport and enzymatic performance [10].

TABLE 2. Height of *Brassica rapa* stem treated with various dilution ratio of local wood vinegar

Treatment	Height of stem (cm)			
	DATP	Week 1	Week 2	Week 3
Control	2.03 (0.11)a	4.88 (0.59)a	6.94 (0.94)a	10.75 (0.72)a
1:1000	2.32 (0.44)b	5.83 (0.41)b	8.28 (1.42)b	13.59 (1.18)b
1:750	1.90 (0.25)c	5.42 (0.40)c	7.88 (1.55)c	12.50 (0.79)c
1:500	1.85 (0.21)c	5.55 (0.48)c	7.79 (0.55)c	11.59 (1.54)d
1:250	2.00 (0.49)a	5.00 (0.53)d	7.82 (0.33)c	11.67 (1.00)d
1:100	2.05 (0.17)a	4.94 (0.60)ad	7.09 (0.21)d	11.38 (1.21)e

The data is expressed in mean (standard deviation). The different letter within the same column and row are statistically significant at α=0.05

Final Fresh Weight and Length of Root

As shown in Table 3, the promotion effect from the wood vinegar on the fresh weight and length of root is promising. The development of root is highly related to the soil condition. Although the wood vinegar was applied on the plant using the foliar spray, yet the soil was still received the wood vinegar dripped from the plant and the spray. The pH of soil did not change tremendously with the foliar spray method. The pH of soils was maintained in the range of 5.8-6.0. The effect on soil pH could be more apparent if the wood vinegar is applying by other methods such as soil drench method.

TABLE 3. Final fresh weight and length of root *Brassica rapa* treated with various dilution ratio of local wood vinegar

Treatment	Final fresh weight (g)	Length of root (cm)
Control	66.83 (11.91)a	7.95 (2.71)a
1:1000	93.83 (9.80)b	10.86 (2.48)b
1:750	98.81 (12.16)b	11.63 (3.89)b
1:500	85.33 (7.68)c	9.33 (0.58)c
1:250	78.47 (13.57)d	8.13 (2.06)a
1:100	74.58 (11.66)d	7.75 (1.55)a

The data is expressed in mean (standard deviation). The different letter within the same column and row are statistically significant at α=0.05

Statistically, treatment at 1:1000 and 1:750 dilution ratio has no significant difference in their performance in promoting final fresh weight and length of root of *Brassica rapa*. Numerically, the dilution ratio of 1:750 exhibited the greatest effect in promoting both fresh weight and length of root. Length of root is important to indicate the water and nutrient uptake ability of the plant. The longer root can provide better surface area of root for water and nutrient uptake of the plant and directly influence the plant growth rate [11]. This could be the reason the final fresh weight has shown similar trend of length of root.

CONCLUSIONS

In conclusion, the local wood vinegar used in this study has exhibited a promising boosting effect in promoting *Brassica rapa.* The basic properties of local wood vinegar indicated that wood vinegar is safe and shares similar properties with the wood vinegar reported in other studies. Overall, the local wood vinegar treatment has successfully improved the vitality of *Brassica rapa*, including the growth of leaf, stem, fresh weight and root. The wood vinegar treatment at dilution of 1:750 significantly improved the area of the leaf, number of the leaf, final fresh weight and length of the root of *Brassica rapa,* while the growth of stem at of wood vinegar dilution of 1:1000. However, the overdose of wood vinegar will bring an adverse effect. High phenolic compounds will slow down the growth of *brassica rapa*.

ACKNOWLEDGEMENT

Author is thankful to Forest Bio Energy Sdn Bhd and Institute of Food Security and Sustainable Agriculture (IFSSA) Universiti Malaysia Kelantan for the facilities and materials to support this research.

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