SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 6 | Issue: 11 | November 2021 - Peer Reviewed Journal

CHARACTERIZATION OF BACKYARD SOIL APPLIED WITH VARYING LEVELS OF WOOD VINEGAR

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ABSTRACT

Backyard soil collected from the vicinity of the Graduate School, Eastern Samar State University was subjected to analysis and modification using different ratios at 1:5, 1:10, 1:20 and 1:30 of coconut shell wood vinegar to water ratio as soil conditioner. The soil samples were tested qualitatively for its color, texture, and soil structure and soil consistency, quantitative determinations were also conducted to the samples in terms of their electrical conductivity, pH and salinity. Results found out that soil samples subjected to coconut shell wood vinegar has a Dark gray brown to Very dark gray color according to the Munsell color chart, the soul, its texture was determined to be clay loam, a granular soil structure and a friable soil consistency, regardless of the ratio of coconut shell wood vinegar applied. Chemical analysis of the soil revealed a lower pH range of 4.213 (1:5 ratio) to 5.140 (1:30) than the untreated soil at 6.347. In terms of its electrical conductivity, soil samples have a very slight increase in soil EC which is 16.577 µS/cm (1:5) - 16.689 µS/cm (1:30) than the untreated soil component at 16.269 µS/cm. Salinity conversions also revealed a very small change in pH from 10.3 for the negative control to 10.5 – 10.6 salinity range. Overall, the chemical results on pH and soil EC are within the acceptable range, while salinity is higher than the acceptable range. Finally, statistical analysis revealed no significant difference to all the chemical parameters on 1:5, 1:10, 1:20 and 1:30 ratio application to the untreated or negative control soil group, indicating that higher concentrations of coconut shell wood vinegar might give feasible results.

KEYWORDS: ***wood vinegar, soil analysis, soil characterization, soil conditioner, wood vinegar ratio***

BACKGROUND OF THE STUDY

As commonly known, chemical fertilizers which are usually utilized in the agricultural industry can cause the soil being sprayed to be too acidic and leads to another problem in the environment; water pollution.

Wood vinegar is the substance produced through the condensation of smoke emitted during the pyrolysis of wood and its residues from processing. It is an essential substance that promotes healthy method for propagating plants, and also, it can be used as fertilizer or soil conditioner. Several researches have already evidenced the great impact of using wood vinegar for elevating the nutrient level of soil.

According to Payamara, J. (2011), the major component of wood vinegar products are acetic acid, methanol, propanoic acid, phenolic and carbonyl compounds. The wood vinegar improves soil quantity eliminates pests, accelerating plant growth, plant growth regulator or growth inhabiting. The bio–test of wood vinegar inhibit the growth of *Xanthomonas comprestris pv*. The wood vinegar was applied on maize with spraying on leaf compare with spraying on soils every 6 days after planting. The acidity range 1.95 to 2.14 the major component in wood vinegar was observed to be acetic acid.

According to Thailand's Department of Agriculture (2010), wood vinegar can improvement of soil quality, eliminates of plant and soil pests, controls plant growth, is able to accelerate the development of roots, stems, tubers, leaves, flowers, and fruits, and, increases amounts of fruit produced in orchards.

According to Brunette, R. (2010), wood vinegar is produced when smoke from charcoal production is cooled by outside air while passing through a chimney or flue pipe. The cooling effect causes condensation of pyroligneous liquor, particularly when the temperature of smoke produced by carbonization ranges between 80 and 180ºC/176 and 356ºF (Nikhom, 2010). This temperature is reached at the carbonization stage of exothermic

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decomposition (see previous article about charcoal production) and is indicated by the production of yellowish, acrid smoke.

Moreover, Tancho, A. (n.d.) reported that wood vinegar can be applied to the soil surface to help increase the population of beneficial microbes and to promote plant root growth. Additionally, the product can help boost crop defenses against disease. A strong solution of wood vinegar with a 1:30 ratio application to the garden soil surface at a rate of 6 liters of solution per 1m² will enrich the soil prior to planting crops. Also, it can be used to control soil-based plant pathogens with an even stronger rate of 1:5 to 1:10 ratio.

The study anchors on determining the characteristics of backyard soil when subjected to different levels of wood vinegar. Moreover, utilizing the many uses of wood vinegar in the agricultural sector, to further prove the best exploit of wood vinegar in backyard soil to further determine if the application of wood vinegar for agriculture is reasonable.

METHODOLOGY

Research Design

This experimentally designed research used both qualitative, semi-quantitative and quantitative analyses focused on extracting wood vinegar from coconut shell and wood and further determined its physical and chemical effects to backyard soil in terms of six (6) parameters which are important in determining healthy soil.

Instrument and Data Gathering procedure

Dry distillation of coconut wood and shell was done using procedures from Phywe (2017). The dry distillation (as seen on Figure 1) was assembled by the researchers for a faster rate of extracting wood vinegar. Experimental procedures were done under laboratory conditions, all in triplication to minimize errors. Extra care was also utilized in this experiment for explosive and toxic fumes are emitted during distillation.

Figure 1. Kiln for Extracting Wood Vinegar

Wood Vinegar Ratio

The wood vinegar produced from the dry distillation of coconut wood was diluted in the manner of ratio:

Table 1. Wood Vinegar to Water Ratio

Ratio	Amount of WV	Amount of H_2O	Total volume
1:5	10 mL	50 mL	60 mL
1:10	10 mL	100 mL	110 mL
1:20	10 mL	200 mL	210 mL
1:30	10 mL	300 mL	310 mL

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The following ratio were adopted following the suggestions made by Tancho, A. (n.d.) wherein a strong solution of wood vinegar with a 1:30 ratio application to the garden soil surface at a rate of 6 liters of solution per $1m^2$ will enrich the soil prior to planting crops. Also, it can be used to control soil-based plant pathogens with an even stronger rate of 1:5 to 1:10 ratio.

PHYSICAL AND CHEMICAL CHARACTERIZATION

Color

Soil color was determined utilizing the Munsell Notation, the water state and the physical state. To determine the color, the following procedure will be done:

1. Place a dry sample in the palm of your hand
2. With your light source behind you (light shining over your shoulder), choose a page from the Munsell color book that is close to the color of your sample.
3. Holding the color page over the sample, move the page around to view your sample through the holes in the page.
4. Find the closest match.
5. When you have found a close match, determine if your sample may be redder or yellower than the color chip you have chosen; if you think it may be, go one page to the front of the book (for red) or to the back of the book (for yellow) and look at the chip with the same value and chroma. Is this a better match?

Texture

To determine the texture of the soil, the analysis was done using the Flow diagram for teaching texture by feel analysis. Journal of Agronomic Education. 8:54-55 modified from S.J. Thien. 1979. Also, Texture class was determined fairly well in the field by feeling the sand particles and estimating silt and clay content by flexibility and stickiness.

Soil Structure

Soil structure is the shape that the soil takes based on its physical and chemical properties. Each individual unit of soil structure is called a ped. Take a sample of undisturbed soil in your hand (either from the pit or from the shovel or auger). Look closely at the soil in your hand and examine its structure. Possible choices of soil structure are: granular, blocky, prismatic, columnar, platy, massive and single grained.

Soil consistence

Take a ped from the top soil horizon. If the soil is very dry, moisten the face of the profile using a water bottle with a squirt top and then remove a ped to determine consistence. (Repeat this procedure for each horizon in your profile.) Holding it between your thumb and forefinger, gently squeeze the ped until it pops or falls apart. Record one of the following categories of soil consistence on the data sheet. Soil consistence will be recorded either as loose, friable, firm and extremely firm.

Soil Preparation for Chemical Analysis

Soil samples was collected and treated in its natural, raw state, any foreign materials like plastics and non-biodegradable constituents will be separated by pulling it out of the soil sample. A total of 300 grams of raw soil will be utilized. The prepared soil samples will then be added with 3 liters of distilled deionized water; roughly agitated and separated into three parts. Each part will be utilized for determining pH, electrical conductivity and salinity.

pH

Soil samples will be subjected to pH determination by submerging a pH electrode to the prepared soil samples. The pH reading will be recorded and this will be done in triplication.

Electrical conductivity

Soil samples will be subjected to electrical conductivity testing by submerging an electrical conductance device electrode into a potted soil sample. The electrical conductance test will be repeated three times.

Salinity

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Soil electrical conductivity was converted to determine the salinity number of the soil samples.

Statistical Analysis of Data

T-test for correlated samples and 1-way Analysis of Variance (ANOVA) was used to determine the significant differences in soil ratio characteristics of the soil sample using IBM SPSS version 28.

Results and Discussion

The following data were gathered after before administration of wood vinegar ratios and 30 days after its exposure to the different levels under natural conditions. The following results were obtained after 10 days of laboratory analysis:

CHARACTERISTICS OF THE SOIL SAMPLES ADDED WITH VARYING LEVELS OF WOOD VINEGAR

Color

Color testing was done using the Munsell Color Name Diagram and the Munsell Soil Color Chart which is a combination of both qualitative and quantitative examination of soil color. The results of the color testing are tabulated below:

Table 1. Color Testing Result

WV/ H_2O Ratio	Trials	Before administration		After Administration	
		Numerical Value	Qualitative Value	Numerical Value	Qualitative Value
1:5	T_1	3/2	Dark brown	3/1	Very dark gray
	T_2	4/1	Dark gray brown	3/1	Very dark gray
	T_3	4/1	Dark gray brown	3/1	Very dark gray
	Common Observation	**4/1**	**Dark gray brown**	**3/1**	**Very dark gray**
1:10	T_1	3/2	Dark brown	3/1	Very dark gray
	T_2	4/1	Dark gray brown	3/2	Dark brown
	T_3	4/1	Dark gray brown	3/1	Very dark gray
	Common Observation	4/1	Dark gray brown	3/1	Very dark gray
1:20	T_1	3/2	Dark brown	3/2	Dark brown
	T_2	4/1	Dark gray brown	3/1	Very dark gray
	T_3	4/1	Dark gray brown	3/1	Very dark gray
	Common Observation	**4/1**	**Dark gray brown**	**3/1**	**Very dark gray**
1:30	T_1	3/2	Dark brown	3/1	Very dark gray
	T_2	4/1	Dark gray brown	3/1	Very dark gray
	T_3	4/1	Dark gray brown	3/1	Very dark gray
	Common Observation	4/1	Dark gray brown	3/1	Very dark gray

Based on the table above, it was observed that prior the administration of the wood vinegar solution, the backyard soil has a color date of 4/1 which is translated as dark brown gray. But after consecutive addition of wood vinegar solution, it was observed to be 3/1 or has a very dark gray color. This result is uniform on all levels of wood vinegar indicating that regardless of ratio, wood vinegar affects the color of the soil in which it is administered.

Texture

It can be observed from the experiment that the wood vinegar regardless of its ratio has little to no effect to the texture of the soil samples after 30 days of administration. This is indicated by the texture of the soil before any administration which is “clay loam” and after administration which is still clay loam in texture.

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Soil Structure

It was observed from that the wood vinegar regardless of its ratio has no effect to the soil structure of the soil samples after 30 days of administration. This is indicated by the soil structure of the sample before any administration which is "granular" and after administration which is still granular in structure. This result is in support to the texture of the soil as most clay loam soils are granular in texture.

Soil consistency

It was also observed from that the wood vinegar regardless of its ratio has no effect to the soil consistency after 30 days of administration. This is indicated by the soil structure of the sample before any administration which is "friable" and after administration which is still friable in consistency. This result further supports the result in the texture and soil structure analysis data as clay loam soils are granular in nature and usually, most granular loam soils are friable or easily breakable.

CHEMICAL CHARACTERISTICS OF THE SOIL ADDED WITH VARYING LEVELS OF WOOD VINEGAR

Soil pH

Table 5. pH test results

Ratio	Before Administration			Average	30 days After Administration			Average
	T_1	T_2	T_3		T_1	T_2	T_3	
1:5	6.24	6.22	6.23	**6.23**	4.22	4.24	4.18	**4.213**
1:10	6.24	6.22	6.23	**6.23**	4.37	4.36	4.34	**4.357**
1:20	6.24	6.22	6.23	**6.23**	4.83	4.85	4.87	**4.850**
1:30	6.24	6.22	6.23	**6.23**	5.11	5.14	5.17	**5.140**
Negative Control	6.24	6.22	6.23	**6.23**	6.32	6.37	6.35	**6.347**

Wood vinegar is acidic with a pH of around 2.5 – 3.0 and contains a multitude of organic compounds: the major components aside from water include acetic acid and methanol. According to the Queensland Government (n.d.), most soils have pH values between 3.5 and 10. In higher rainfall areas the natural pH of soils typically ranges from 5 to 7, while in drier areas the range is 6.5 to 9. The result from the table above indicates that the soil pHs of the wood vinegar as well as in the untreated group are acidic and is within the accepted range of pH for most soils.

Soil Electrical Conductivity

Table 6. Electrical conductivity results

Ratio	Before Administration (mS/cm)			Average	30 days After Administration (mS/cm)			Average
	T_1	T_2	T_3		T_1	T_2	T_3	
1:5	16.266	16.267	16.267	**16.267**	16.577	16.575	16.579	**16.577**
1:10	16.266	16.267	16.267	**16.267**	16.810	16.812	16.812	**16.811**
1:20	16.266	16.267	16.267	**16.267**	16.590	16.590	16.591	**16.590**
1:30	16.266	16.267	16.267	**16.267**	16.689	16.690	16.689	**16.689**
Negative Control	16.266	162.67	16.267	**16.267**	16.268	16.269	16.271	**16.269**

Soil electrical conductivity is a measure of the amount of salts in soil and it can be used as an excellent indicator of nutrient availability and loss, soil texture, and available water capacity.

In terms of soil electrical conductivity, the optimal EC levels in the soil therefore range from 11.0-57.0 milliSiemens per centimeter (mS/cm) (Fourie, M., n.d.). In relation to Fourie's statement above, it can be observed that the electrical conductivity of the soil samples added with the different ratios of wood vinegar is within the acceptable limit for soil electrical conductivity.

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Soil Salinity

Table 7. Soil salinity test results

Ratio	Before Administration (ppt)			Average	30 days After Administration (ppt)			Average
	T_1	T_2	T_3		T_1	T_2	T_3	
1:5	10.3	10.3	10.3	**10.3**	10.5	10.5	10.5	**10.5**
1:10	10.3	10.3	10.3	**10.3**	10.6	10.6	10.6	**10.6**
1:20	10.3	10.3	10.3	**10.3**	10.5	10.5	10.5	**10.5**
1:30	10.3	10.3	10.3	**10.3**	10.6	10.6	10.6	**10.6**
Negative Control	10.3	10.3	10.3	**10.3**	10.3	10.3	10.3	**10.3**

>H_2O density at 1.0056 – 1.0059 g/cm^3: Temp.=21.6 - 25ºC; specific gravity at 1.0078 – 1.0081

In terms of soil salinity, a perfect soil should be moderately saline with a range of 200 to 400 mS/m or a range of 4.5 to 9 saline. The result above show that the salinity of soil samples before and after administration as well as the untreated is above the acceptable range of salinity of 10.3 to 10.6. This indicates that the salinity of the soil is within the range of medium saline at 9 – 18.

STATISTICAL ANALYSIS OF DATA

Under statistical analysis of data retrieve above, it can be gleaned upon the assumption categorized by Aerd Statistics (2018) and EZ SPSS Tutorials (2021) that:

a. If the p-value is MORE THAN .05, then there is not a statistically significant difference between the two independent groups in identified columns; and,
b. If the p-value is LESS THAN .05, then there is a statistically significant difference between the two independent groups identified in columns.

pH, soil electrical conductivity and salinity statistical analysis using IBM SPSS version 28 results are found in the following tables:

Table 8. pH ANOVA results

		Sum of Squares	df	Mean Square	F	Sig.
Soil pH @ 1:5 ratio	Between Groups	.002	2	.001	.	.
	Within Groups	.000	0	.		
	Total	.002	2			
Soil pH @ 1:10 ratio	Between Groups	.000	2	.000	.	.
	Within Groups	.000	0	.		
	Total	.000	2			
Soil pH @ 1:20 ratio	Between Groups	.001	2	.000	.	.
	Within Groups	.000	0	.		
	Total	.001	2			
Soil pH @ 1:30 ratio	Between Groups	.002	2	.001	.	.
	Within Groups	.000	0	.		
	Total	.002	2			
Soil pH @ untreated	Between Groups	.001	2	.001	.	.
	Within Groups	.000	0	.		
	Total	.001	2			

From the table above, ANOVA test in the pH testing revealed no significant difference between individual ratios administered into the soil sample and the negative control. As postulated, the F and T values are not computed due to 0 results in the sum of squares. It was further found out based on

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ANOVA above that the difference was insignificant in all treatments over the control plots (Aerd Statistics, 2018; EZ SPSS Tutorials, 2021).

Table 9. ANOVA Soil Electrical Conductivity Results

		Sum of Squares	df	Mean Square	F	Sig.
Electrical Conductivity of 1:5 ratio	Between Groups	.000	1	.000	.000	1.000
	Within Groups	.000	1	.000		
	Total	.000	2			
Electrical Conductivity of 1:10 ratio	Between Groups	.000	1	.000	.	.
	Within Groups	.000	1	.000		
	Total	.000	2			
Electrical Conductivity of 1:20 ratio	Between Groups	.000	1	.000	.333	.667
	Within Groups	.000	1	.000		
	Total	.000	2			
Electrical Conductivity of 1:30 ratio	Between Groups	.000	1	.000	.333	.667
	Within Groups	.000	1	.000		
	Total	.000	2			
Electrical Conductivity of untreated	Between Groups	.000	1	.000	1.333	.454
	Within Groups	.000	1	.000		
	Total	.000	2			

It can be found from the table above that there is a significant difference in terms of soil electrical conductivity between the 1:5, 1:10, 1:20 and 1:30 ratios against the 'before administration' soil sample, but in contrast, there is no significant difference between the soil electrical conductivity between the untreated or negative control and the 'before administration' plots. This result is evidence by the fact that 1.333 is greater than the significance value of 0.454. For this kind of data, it is postulated that if the p-value is MORE THAN .05, then there is not a statistically significant difference between the two independent groups in identified columns (Aerd Statistics, 2018; EZ SPSS Tutorials, 2021).

Table10. Salinity Warnings on SPSS results

There are fewer than two groups for dependent variable Salinity of 1:5 ratio. No statistics are computed.
There are fewer than two groups for dependent variable Salinity of 1:10 ratio. No statistics are computed.
There are fewer than two groups for dependent variable Salinity of 1:20 ratio. No statistics are computed.
There are fewer than two groups for dependent variable Salinity of 1:30 ratio. No statistics are computed.

Now since the data has fewer groups, the researchers run MVA or Missing Value Analysis to determine where the data sets are missing, the results are shown in the table below:

Table 11. Univariate Statistics for Salinity

	N	Mean	Std. Deviation	Missing Count	Missing Percent	No. of Extremes[a,b] Low	No. of Extremes[a,b] High
Salinity1.10	3	10.600	.0000	3	50.0	.	.
Salinity1.20	3	10.500	.0000	3	50.0	.	.
Salinity1.30	3	10.600	.0000	3	50.0	.	.
Salinity.NC	3	10.300	.0000	3	50.0	.	.
Salinity.before	3			3	50.0		

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).
b. . indicates that the inter-quartile range (IQR) is zero.

As seen from the table above, since the number of extremes in both high and low is zero (0) this indicates that in all the wood vinegar ratios together with the negative control and 'before administration', it indicate no difference between them since univariate statistics show 50.0% missing values and a similar standard deviation between samples which is 0 (Aerd Statistics, 2018; EZ SPSS Tutorials, 2021). It means that

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all individual samples from different groups have the same salinity result thus there is no variability in that salinity of soil samples, regardless of its origin.

This result indicates that there are no significant differences between individual ratios versus the negative control and the 'before administration and that, after 30 days of administering wood vinegars, in terms of salinity, the soil samples are of the same salinity before and after administration of wood vinegar.

CONCLUSIONS

1. The characteristics of the soil samples added with varying levels of wood vinegar in terms color is Dark gray brown to Very dark gray color; has a clay loam texture; granular soil structure and a friable soil consistence.
2. The pH range is at 4.213 (1:5 ratio) to 5.140 (1:30). The electrical conductivity range of the soil samples is from 16.577 µS/cm (1:5) - 16.689 µS/cm (1:30). Salinity conversions revealed a very small change in pH from 10.3 for the negative control to 10.5 – 10.6 salinity range in the administered soil samples.
3. It was statistically revealed that there are no significant differences to all the chemical parameters on 1:5, 1:10, 1:20 and 1:30 ratio application to the untreated or negative control soil group.

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