Proceedings of the International Conference on Industrial Engineering and Operations Management
Toronto, Canada, October 23-25, 2019

Combination of Corncob, Cornhusk, and Kirinyuh (*Eupatorium odoratum L.*) Leaf Extract as Materials of Anti-Termite Paper

Sigit Trimayanto, Prestylia Ikke Kurnia Mayasari, Faraqanita Dwi Novianti, and Dian Novita
Departement of Chemistry
State University of Surabaya
Surabaya, Indonesia
sigittrimayanto@mhs.unesa.ac.id, presty.ikke.23@gmail.com, faraqanita21@gmail.com, diannovita@unesa.ac.id

Abstract

One of the plants that is considered to have the potential to be developed as anti-vaporous material on paper is the Kirinyuh plant, because it is contain sesquiterpene. The main material used is corncob and cornhusks, both are mixed with a ratio of 3: 1 and cooked using a 800 ml NaOH solution of 800 ml for 60 minutes. The results of the dishes were washed using clean running water and added Kirinyuh leaf extract with variations in extract concentrations of 0%, 2%, 4% and 8% respectively. Paper pulp printed in accordance with A4 paper size and dried under the sun. This test is carried out to determine the best concentration to kill termites. The number of test animals for each treatment was 5 animals. In the preliminary test for Kirinyuh leaf extract the concentrations were 0%, 2%, 4% and 8% (m/v). The testing process is carried out for 48 hours. Based on the results obtained, it was found that kirinyuh leaf extract had activity against termite mortality. Data shows that paper with the addition of extract with 8% concentration has the best activity against termite mortality with a percentage reaching 100% in two days.

Keywords
Paper, termite, extract, and kirinyuh leaves.

1. Introduction

Until now the paper industry still has problems related to termites. Cellulose which is the main raw material for paper is very vulnerable to being eaten by termites. If this problem is not resolved, it will certainly cause losses to the paper company. One of the plants that is considered to have the potential to be developed as anti-vaporous material on paper is the Kirinyuh plant (*Eupatorium odoratum*). Plants *E. Odoratum* originating from South America in Indonesia grows well at an altitude of 200 - 1800 masl. In infertile soils it often grows very much (Graige, and Ahmed, 1988). This plant is a shrub that grows upright and has many branches. The height of the plant *E. odoratum* 2-6 m. The stem diameter of *E. odoratum* is about 2 cm (Heyne, 1987). Single leaves, face to face, ovoid, jagged edges, pointed edges and base, smooth furry surfaces pinnate, light green with a length of 4-5 cm and a width of 1-1.5 cm, and short stem. Compound flower, grows on the tip of the stem, bells shaped petals and needle shaped flower crowns. Small fruits, furry blackish brown with needle-shaped seeds, small and black (Department of Health, 2006).

In a previous study Harto (1998) stated that the content of sesquiterpenes in neem leaves was effective against the mortality rate of termites. The leaves of E. odoratum have a content similar to quiterpenes which are expected to control the mortality rate in termites. From its potential as an insecticide, it can be used as a controlling environment for termites (Coptotermes sp.). According to Hadi, et al (2000), that in Eupatorium odoratum leaf extract there were 66% monoterpene and 28% sesquiterpene compounds. In addition, it also contains 11-17% α-pinene, 12.5-24.8% cymene, and 10.6% thymyl acetate.

As explained by Harbone (1987) in Hadi (2008: 14), phenol, triterpenoid, alkaloid and steroid compounds found in plants are active ingredients as pest control. These compounds cause biological activities such as toxic inhibiting food, antiparasites, and pesticides. During this time, Kirinyuh plants (Eupatorium odoratum L.) which are wild plants and easily found around us, have not been used optimally as biological control material because they are considered as plants bullies that are hard to eradicate. Though these plants contain compounds that can be used as vegetable pesticides for pest control. Some reports say that the leaves of Kirinuh extract can be used to control several types of pests such as cocoa fruit pests (*Helopeltis spp.*) (Fitriana, 2012), termites Coptotermes sp. (Hadi, 2008), cockroaches (*Periplaneta americana*) (Udebuani, 2015), and snails (*Achatina fulica*) (Diana, 2009).

Corn cobs have enormous potential to be used as a variety of products that benefit human life, one of which is pulp raw material for paper making (Supranto, 2014). Corn cobs contain high cellulose fiber, so they can be used as raw material for making art paper. Corn cobs contain lignocellulose which consists of lignin, cellulose and hemicellulose. According to Irawadi (1990), agricultural waste (including corn cobs), contains cellulose (40-60%), hemicellulose (20-30%) and lignin (15-30%). Septiningrum (2011), the results of chemical analysis of corn cobs contain hemicellulose 30.91%; alpha cellulose 26.81%; lignin 15.52%; carbon 39.80%; nitrogen 2.12%; and water content 8.38%.

Corn husk is the outermost skin that covers the grains of corn. This corn husk is also a modified leaf sheet that wraps corn cobs. Morphologically, the skin or corn husk has a rough surface and is light green to dark green. The average amount of corn husk in one cob is 12-15 sheets (Gustina, 2015). Fagbemigun (2014), the chemical composition of corn skin includes 15% lignin; 5.09% ash; 4.57% alcohol-cyclohexane; and 44.08% cellulose. According the reasearch from Ningsih (2012), the pulp making process can use non-wood raw materials, one of which is corn husk agricultural waste. Therefore, in this study combining the three ingredients, namely corncob, cornhusk, and kirinyuh leaf extract as raw material for making anti-wing paper.

2. Materials and Methods Used

2.1 Tools and materials

The equipment used in this paper is erlenmeyer, oven, rotary evaporator, measuring cup, beaker, knife, selep machine, electric stove, mortar, sieve, and pestle. The materials used in this paper are soil termites (*C. curvignathus*), corn husk, corn cobs with a ratio (3: 1), Tween 80, and kirinyuh (*Eupatorium odoratum*) leaf extract. The following is a picture of the Kirinuh plant that will be used in this experiment.

Figure 1. Kirinyuh (*Eupatorium odoratum*) plant.

2.2 Making crude extract of Kirinyuh leaves (*Eupatorium odoratum*)

First, the leaves are cleaned of dirt and separated from the stem. After that, the dried leaves dry in the oven at 65^{o}C until the water content reaches less than 10%. The dried leaves are crushed with a blender up to 100 mesh in size. The 100 mesh fine powder of leaves of Kirinuh was macerated with ethyl acetate and left for 3-4 days at room temperature. The ethyl acetate extract from the leaves of Kirinyuh was evaporated using a vacuum evaporator at 65^{o}C, so that the concentrated extract was obtained.

2.3 Paper making

Corncob and cornhusks are washed and cut into 5 mm sizes. Then, both are dried using an oven at a temperature of 100^{o}C. After drying, both are mixed with a ratio of 3: 1 and cooked using a 800 ml NaOH solution of 800 ml for 60 minutes. The results of the dishes were washed using clean running water and added Kirinyuh leaf extract with variations in extract concentrations of 0%, 2%, 4% and 8% respectively. Each ingredient of PVAc 7.5 g is added as the adhesive, so that paper pulp is produced. Paper pulp printed in accordance with A4 paper size and dried under the sun. From this process A4 paper is produced.

2.4 Termite Mortality Test Caused by Paper

Paper from each treatment is placed in a hollow jar filled with 100 g of soil as a test medium. Five termites were placed into the test medium for 72 hours. After that, observations were made to determine the number of termites that died from the treatment.

3. Results and Discussion

3.1 Making crude extract of Kirinyuh leaves (*Eupatorium odoratum*)

Kirinyuh leaves (Eupatorium odoratum) obtained from the area around Trenggalek Regency. These leaves are green. The leaves are separated from the stem and cleaned from dirt using water. The clean leaves are dried air so that the secondary metabolites are not damaged due to exposure to direct sunlight (Harborne, 1987). To eliminate the water content, the air dried leaves are heated at 60^{o}C until the time is constant. Then the leaves are crushed to powder.

Leaf leaf with a temperature of 60^{o}C aims to reduce the water content in the leaves. This is done in order to facilitate the process of destruction of leaves. In addition to reducing the water content, heating at this temperature also has another purpose, namely to maintain the active ingredient (phytochemical) in the leaf. According to Harbone (1987) most phytochemical substances will be damaged if heated to more than 75^{o}C. In this experiment a temperature lower than 75^{o}C was chosen, because it anticipated increasing temperatures to the maximum extent.

Kirinyuh powder was macerated by adding organic solvent ethyl acetate for 24 hours at room temperature (Harborne, 1987). Extraction is the process of soaking samples with organic solvents used at room temperature. The results of maceration are accommodated in erlenmeyer. Maserate is evaporated so that a thick extract is obtained (when the left leaf extract is diluted with water, it is necessary to add Tween 80 so that the extract can dissolve in water).

In this maceration process, ethyl acetate was chosen as a solvent because this compound is a semipolar solvent. This is adjusted to the nature of the sesquiterpene compound, which is semipolar. Semipolar compounds tend to be more soluble in semi-polar solvents such as ethyl acetate (Satoloma, et. al., 2015). The choice of solvent is very important in the extraction process, this is related to the type of compound you want to obtain. Polar compounds, will be easily extracted with polar solvents, whereas non-polar compounds will be easily extracted with non-polar solvents as well, known as likes disolve likes (Wulan, 2008).

Dilution of dried leaves extract with water, Tween 80 needs to be added so that the extract can dissolve in water. Tween 80 is an organic compound that functions as a substance. Organic compounds that have low polarity are difficult to dissolve with water because they have a large surface tension. Addition of Tween 80 to a mixture of organic compounds (which have low polarity) and water can reduce the surface tension of the two substances, so that they will be homogeneous faster.

The concentrated extract that was obtained was diluted with concentrations of 2%, 4% and 8% (v / v). To obtain the three variants of the concentration, 0.5 mL, 1 mL were taken, and 2 mL of the concentrated extract were dissolved in a 25 mL volumetric flask to the boundary mark. The aqueous extract solution obtained was stored in three bottles and labeled. At this stage the solution with the expected concentration is obtained. For concentrations of 2%, 4%, and 8%, each solution is concentrated green according to figure 2.

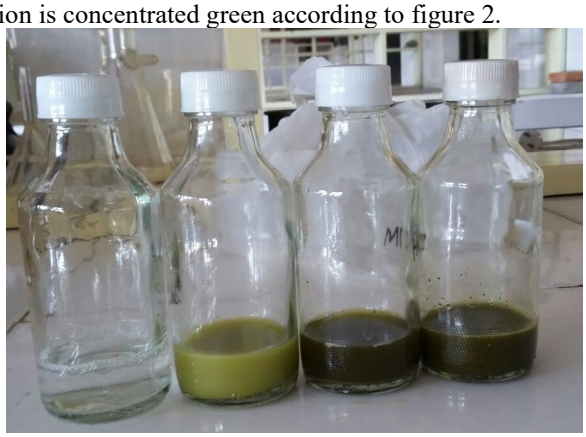

Figure 2. Kirinyuh leaf extract solution with a concentration of 0%, 2%, 4%, and 8%.

In the solution produced, the higher the concentration, the more the color becomes darker (thicker).

3.2 Paper Making

The process of making paper begins with washing, cutting, and drying the skin and corn cobs. Next, the skin and corn cobs are mixed with a ratio of 3: 1 (total mass of 100 grams) and done cooking. Cooking is done using a 5 m NaOH solution of 800 mL. Cooking is done on heater until it boils for 60 minutes. After that, it is washed using clean running water. The pulp milling (blender) with the addition of kirinyuh leaf extract with various extract concentrations was 0%, 2%, 4%, and 8% and PVAc 7.5g glue respectively. Then the pulp is printed and drained of paper under the sun.

Various treatments in papermaking certainly have various purposes. Washing the material serves to clean the dirt that sticks to the skin and corn cobs and simplifies the cooking process. Drying material functions so that the water content in the skin and corn cobs gets lower. The addition of 5% NaOH solution aims to eliminate lignin compounds in the material. This process is often referred to as the delignification process. The delignification reaction that occurs is in accordance with the equation as follows:

The lignin compound must be removed because the substance is an impurity in the paper making process. The heating process is carried out in order to speed up the delignification reaction. Because the heating process will increase the kinetic energy of the compound in the system which causes collisions to occur more frequently, so the reaction will take place faster. Kirinyuh leaf extract is added as an active ingredient that has the potential as an anti-termite ingredient. There are four paper variants at this stage, namely paper without extracts (as a control) and three other paper extracts with concentrations of 2%, 4%, and 8%.

The addition of PVAc (Polyvinylacetate) glue serves as an adhesive for cellulose fibers in the pulp. Then the resulting mixture is carried out printing and drying paper under the sun. Drying paper under the sun aims to remove the moisture content on the paper produced.

After drying, paper is obtained as shown in Figure 3.

(a) (b) (c) (d)

Figure 3. (a) paper with 0% extract solution, (b) paper with 2% extract solution, (c) paper with 4% extract solution, (d) paper with 8% extract solution.

The difference in the composition of kirinyuh leaf extract also causes differences in physical results on paper. Based on the results obtained, the paper with the composition of 0% extract is the brightest color, while the paper with the extract composition of 8% is the darkest color. The greater the concentration of kirinyuh leaf extract causes the color of the paper to become darker.

3.3 Termite Mortality Test Caused by Paper

This test is carried out to determine the best concentration to kill termites. determined by three levels of treatment concentration of the extract to be tested plus one control treatment, so that the total number of treatments was four with one repeated. The number of test animals for each treatment was 5 animals. In the preliminary test for Kirinyuh leaf extract the concentrations were 0%, 2%, 4% and 8% (b / v). The testing process is carried out for 48 hours. The following are termite mortality data obtained from the tests that have been carried out.

Table 1. Data of termite mortality.

Treatment	Concentration (%)	Mortality Number	Percentage of Mortality (%)
1	0	0	0
2	2	2	40

3	4	3	60
4	8	5	100

Based on the results obtained, it was found that kirinyuh leaf extract had activity against termite mortality. Data shows that paper with the addition of extract with 8% concentration has the best activity against termite mortality with a percentage reaching 100%. Kirinyuh leaves have poisonous activity against termites caused by the content of several active compounds such as sesquiterpene.

4. Conclusions and Recommendations

To obtain anti-wiping active ingredients, it can be obtained from the extraction of dried leaves using ethyl acetate solvents. Dilution of extracts with water can be done with the addition of Tween 80. Making anti-slip paper can be done by processing corn husks and corn cobs with a ratio (3: 1) and the addition of the active ingredient of leaves kirinyuh extract. Paper with the addition of extract with a concentration of 8% has the best activity against termite mortality with a percentage reaching 100% in 2 days.

Acknowledgements

The greatest thanks, praise and adoration belong to the God who kept me going, His uncountable love, blessings, kindness and grace throughout our study. We very grateful, earnestly acknowledge and appreciate the contributions of Dian Novita, S.T., M.Pd. for their knowledge, constructive analysis and comments have helped me develop generally as a student, to an extent that this project became a success. Their remarks shall forever be at the front of my thoughts.

References

Departement of Health. *Eupatorium odoratum,* Available: fpt.ui.edu/bebas/v12/artikel/ttg_tanaman_obat/depkes/buku1-120.pdf, April 21, 2018.

Diana, E., *Pengaruh Pemberian Ekstrak Daun Kirinyuh (Chromolaena odorata) Terhadap Mortalitas Bekicot (Achatina fulica),* Thesis*,* University of Syiah Kuala, Banda Aceh, 2009.

Fagbemigun, T. K., Pulp and Paper-Making Potential of Cornhusk, *Lagos-Nigeria International Journal of Agri Science* vol. 4, no. 4, pp. 209-213, 2014.

Ningsih, E. R., *Uji Kinerja Digester pada Proses Pulping Kulit Jagung dengan Variabel Suhu dan Waktu Pemasakan,* Universitas Diponegoro Press, Semarang, 2012.

Graige, M. and Ahmed, S., *Handbook of Plant With Pest Control Properties,* John Willey & Sons, Singapore, 1988.

Hadi, M., J.W. Hidayat, and K. Baskoro, Uji Potensi Ekstrak Daun Eupatorium odoratum sebagai Bahan Insektisida Alternatif: Toksisitas dan Efek Anti makan Terhadap Larva Heliothis armigera Hubner, *Jurnal Sains dan Matematika Fakultas MIPA Undip,* 2000.

Hadi, M., Pembuatan Kertas Anti Rayap Ramah Lingkungan dengan Memanfaatkan Ekstrak Daun Kirinyuh (*Eupatorium odoratum*), *Jurnal Bioma,* vol. 6, no. 2, pp. 12-18, 2008.

Harto, S., *Toksisitas Ekstrak Akar dan Daun Paitan (Tithonia diversivolia Gray) dan Pengaruhnya terhadap Mortalitas serta Aktivitas Makan Anti Rayap Tanah (Coptotermos sp.) di Laboratorium,* Thesis, University of Diponegoro, Semarang, 1998.

Heyne, K., *Tumbuhan Berguna Indonesia, Jilid III,* Badan Litbang Kehutanan, Jakarta, 1987.

Irawadi, T. T., *Selulase, PAU – Bioteknologi,* Institut Pertanian Bogor, Bogor, 1990.

Satoloma, C. C., Runtuwenea, M. R. J., and Abidjulua, J., Isolasi Senyawa Flavonoid pada Biji Pinang Yaki (*Areca vestiaria Giseke*)". *Jurnal MIPA Unsrat* vol. 4, no. 1, pp. 40-45, 2015.

Septiningrum, K, and Apriana, C., Produksi Xilanase dari Tongkol Jagung dengan Sistem Bioproses menggunakan Bacillus circulans untuk Pra-Pemutihan Pulp Production of Xylanase from Corncob by Bioprocess System Using Bacillus circulans for Pre-Bleaching Pulp. *Balai Besar Pulp dan Kertas, Kementerian Perindustrian Indonesia,* vol. 5, no. 1, 87-97, 2011.

Supranto, D., Pengaruh Simultan Parameter Suhu dan Konsentrasi Larutan NaOH Terhadap Kuantitas dan Kualitas Hasil Cellulose Powder pada Proses Delignifikasi Tongkol Jagung. *Jurnal Sains dan Teknologi Lingkungan* vol. 6, no. 2, pp. 86, 2014.

Tappi, Tensile properties of paper and paperboard (using constant rate of elongation apparatus) (Revision of T 494 om-01). Available: http://www.tappi.org/content/SARG/T494.pdf, April 20, 2018.

Gustina, T., Pemanfaatan Kulit Jagung sebagai Bahan Baku Alternatif Pembuatan Pulp, Thesis, Polytechnic of Sriwijaya, Palembang, 2015.

Udebuani, A. C., Studies on The Insecticidal Properties of Chromolaena odorata Against Adult Stage of Periplaneta americana. *Journal Entomology and Zoology Studies,* vol. 3, no. 1, pp. 318-321, 2015.

Wulan R. D. R. Aktivitas insektisida ekstrak daun *Tephrosia vogelii* Hook. f. (Leguminosae) terhadap larva *Crocidolomia pavonana* (F.) (Lepidoptera: Pyralidae), Thesis, Bogor Agricultural University, Bogor, 2008.

Biography / Biographies

Sigit Trimayanto is an Undergraduate at State University of Surabaya in Indonesia majoring in Chemistry. He is one of the educators in tutoring institutions and education consultants in Indonesian Education Laboratory. He conducted his reasearch project under the supervision of Dian Novita, S.T., M.Pd. at State University of Surabaya, East Java. He is the chairman of this research program. He once won various awards, one of which was third place in the Chemical Engineering Paper Competition 2019 held at Riau University, Indonesia. He is also one of the researchers who has published various scientific works in various national and international journals and proceedings.

Prestylia Ikke Kurnia Mayasari is an Undergraduate at State University of Surabaya in Indonesia majoring in Chemistry. He conducted his reasearch project under the supervision of Dian Novita, S.T., M.Pd at State University of Surabaya, East Java.

Faraqanita Dwi Novianti is an Undergraduate at State University of Surabaya in Indonesia majoring in Chemistry. He conducted his reasearch project under the supervision of Dian Novita, S.T., M.Pd at State University of Surabaya, East Java.

Dian Novita is a lecturer of Physical Chemistry and secretary of Chemistry Major at State University of Surabaya. Ms. Dian holds a Bachelor of Science degree in Chemistry from Institut Technology of Sepuluh Nopember, and a Master of Education degree in Science Education from State University of Surabaya. His research interests include science materials, paper materials, and education chemistry.