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The Effect of Nepeta Cataria on Polyvinyl Alcohol as Blatella Germanica Cockroaches Repellent

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Abstract: Polyvinyl alcohol films are an environmentally friendly polymer that is widely used in packaging factoring. Nepeta Cataria essential oil consists of two isomers that are known as German cockroach repellent. This research is carried out with the objective to investigate the effect of Nepeta Cataria on polyvinyl alcohol as German cockroaches' repellent. In this study, the essential oil is combined with polyvinyl alcohol with different concentrations from 0%, 20%, 25%, 30%, and 40% in the tensile test, FTIR test, and density test to evaluate the mechanical and physical properties of polyvinyl alcohol with essential oil. The result shows that the best repellency of German cockroaches is a 40% which is 2ml concentration of essential oil. The tensile test shows the increased concentration of essential oil the elongation at break point increases but young modulus and tensile strength decrease.

Keywords: Polyvinyl Alcohol, Catnip Essential Oil, German Cockroach

1. Introduction

Cockroaches are social creatures who prefer to dwell in groups. They are most active at night they eat a wide range of foods, including everything consumed by humans. They favors items that are starchy and sweet. They consume cheese, meats, pastry, grain items, sugar, and sweet chocolate while sipping milk. They also eat cardboard, book bindings, starch-containing ceiling boards, the tiny inside lining of shoe soles, their own cast-off skins, dead and crippled insects, fresh and dried blood, faeces, sputum, and the fingernails and toenails of babies and sick people. PVA films are widely employed as environmentally friendly polymers and have greatly aided the expansion of the sustainable packaging sector. The main driver for the market is anticipated to be growing government initiatives to boost green packaging. Polarizer film is produced and packaged using polyvinyl alcohol (PVA) film. Detergents, water treatment chemicals, agrochemicals, and dyes can all be packaged in small water-soluble doses using polyvinyl alcohol films, which are biodegradable and water-soluble.

Essential oils have been reported to have antimicrobial, antiviral, nematicidal, antifungal, insecticidal, and antioxidant properties in the nutritional, pharmaceutical, and agricultural. When the assembled properties are combined, they result in a wide range of applications: Essential oils have been proposed as antioxidants and preservatives in food.

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2. Materials and Methods

The method of this analysis is using casting method where PVA is dissolving in 100ml of water and heated in microwave, then the solution poured in the petri dish. After that, the drying method is for the solution to dry in the room temperature to get solid sample.

2.1 Materials

Polyvinyl alcohol is used in powder. Then, catnip essential oil that extracted by using steam distilled. Polyethylene glycol 3000 is used as a plasticizer.

2.3 Preparation of PVA/EO

The sample is prepared by using the ratio of EO. The concentration start with 0%, 20%, 25%, 30%, 40% which is 0ml, 1ml, 1.25ml, 1.5ml and 2ml of PVA and catnip essential oil. The PVA is weight and dissolved in the 100ml of water and then heated in microwave in 30 seconds. 5g of PEG is added with PVA after being weight and dissolving together with 100ml of water. After that, the solution poured in the petri dish to keep drying. For the drying process the solution in the petri dish is drying in the room temperature for 5 days.

3. Results and Discussion

3.1 Density

Density test is performed to find the different of each sample with different concentration of essential oil and it relationship with density. Each sample is cut about 1 cm and weight it on the plate at the air and recorded. Then the sample is weighted on the plate in the water and recorded. The density of sample will automatically print. The density test machine that uses is from METTLER TOLEDO.

The density of the sample is decrease with the increase concentration of essential oil. The figure shows that without essential oil have the highest density that is 1.1605 g/cm^3. Then the density start lower as the essential oil is added. As we can see the that 1.25ml and 1.50ml have a very minimal different this is due to the different amounts of the essential oil between the two sample is also small. We can conclude that the more the concentration of essential oil, the less the density of sample.

3.2 Mechanical Properties of PVA/EO

The tensile test is use in this research because to find the elongation at break point and the tensile strength for each sample that have different concentration of essential oil. First the sample is being cut according to ISO 527-2. Then the sample is place at the tensile machine following the gauge length that being plot. Tensile machine that use is universal testing machine that is from SHIMADZU. The load that been set is 5kN and the speed rate 10min/mm.

Figure 1 shows that the tensile strength decrease when the concentration of EO is increase. The highest of tensile strength is 40.1167 MPa there is no essential oil is added and it cause of the bond between the hydrogen and monomer group hydroxy bond was commonly stabilized in PVA sample. Then, when 1 ml of essential oil is added the tensile strength is fell to 36.78MPa, it shows that development of inter-molecular (hydrogen) interaction between the function of PVA and EO component group. Then, tensile strength fall to 20.3667, 12.0083 and 8.35MPa as the concentration is

added with 1.25,1.5 and 2 ml of EO. As a result, new hydrogen bonds between PVA and EO could replace the original hydrogen bonds between PVA chains that maintained the sample matrix, leading to a loss in tensile strength. Figure 2 shows the elongation is increase with the concentration of EO. Elongation at break is an indication of flexibility and extensibility of film prior to breakage. The highest value of elongation is at the 2ml concentration of EO. This is because the addition of EO to polymer matrix can caused the diameter pores and porosity is increase. Then, as the concentration of EO is decrease to 1.5ml, the elongation is also decrease to 400.2185mm. This shows that increase the concentration of EO make the elongation of break point is also increase. The development of new hydrogen bonds between EO and PVA matrix, which increased the segmental mobility of PVA chain and increased the sliding effect of PVA chains against one another, may be the source of the films' increased flexibility with the addition of EO.

Figure 3 shows a measure of a film's stiffness (hardness) is its elastic modulus. In the figure show that the highest value of young modulus is at no concentration of EO that is 0.1508. The figure shows that when the concentration of EO is increase the young modulus of is decrease. According to experimental findings by Bonilla et al., the elastic modulus of the films was dramatically reduced by the addition of EO, making the film structure significantly less flexible.

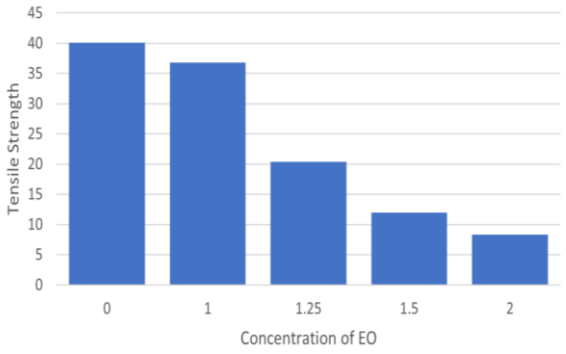

Figure 1: Tensile Strength

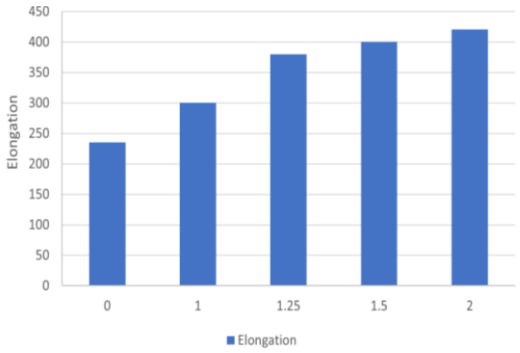

Figure 2: Elongation at break point

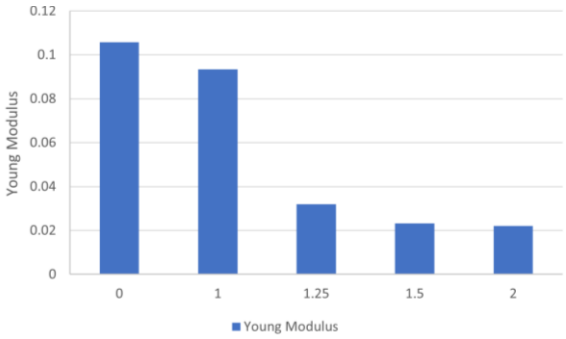

Figure 3: Young Modulus

3.3 Fourier Series Transformation of PVA/EO

FTIR spectra displayed a fairly wide range between 3600 and 3200 cm1. Without EO, the composite's FTIR spectrum had a relatively wide band at 3252 cm1, whereas when EO concentration raised, the absorption peaks shifted to the left and were respectively, 3252, 3253 and 3275 cm1. PVA

chains' numerous hydroxyl groups made it simple to create both intramolecular and intermolecular hydrogen bonds. Strong absorption was generated by the hydroxyl interaction of PVA and PEG. There were also peaks in the 3000–2800 cm–1 range caused by the saturated CH stretching vibration of C–CH 3, which could be found at 2942, 2918, 2946, 2945, and 2945 cm–1 from Figure 4.3, respectively. The C=O stretching vibration of the carbonyl and carboxylic groups present was attributed to the absorption peaks at 1645, 1649, 1639, 1640, and 1641 cm1. With an increase in EO concentration, the peaks from 1500 to 1000 cm1 were widened, mostly because of the unsaturated aromatic rings and the C-C stretching inside the rings. PVA, PEG, and EO interaction was primarily responsible for the partial displacement of the characteristic absorption band.

3.4 PVA/EO Repellence to German Cockroaches

The sample with 2.0 ml of oil content has the highest percentage of insect repellency, with a value of 85.7 percent, according to the graph as shown in Figure 4. When compared to 1.5 ml and 2.0 ml oil concentration with a value of 57.14 percent to 85.7 percent, the repellency percentage gap between 1.25 ml and 1.5 ml is not too wide. This is because the sample with the greater oil concentration composition transmits the catnip oil's characteristics more effectively. This result is confirm by the other result in other essential oil against with Aedes aegypti ,Anopheles dirus and Culex quinquefasciatus. This is stated in the journal by Siriporn Phasomkusolsil (2011), the percentage repellency increased when the concentration of essential oils increased.

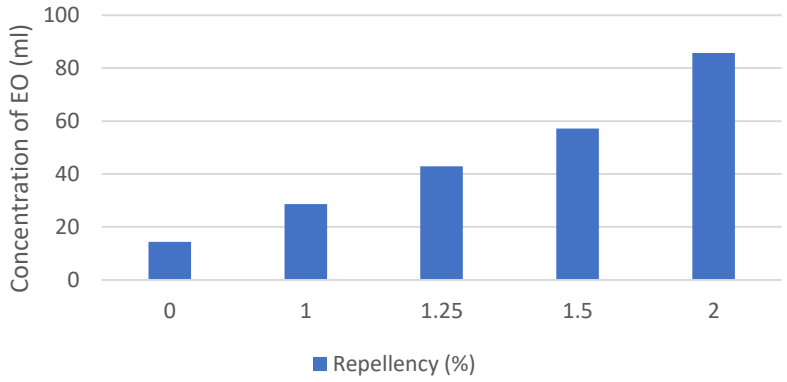

Figure 4: PVA/EO Repellence to German Cockroaches

4. Conclusion

Based on the objective, the Nepeta Cataria on polyvinyl alcohol is approved as a repellent of the German cockroach. This have approved by the percent that the repellency of each sample that have different concentration of essential oil. The more the concentration of essential oil is added the more the odor that can lasting and the more effective of the repellency towards German cockroach. Then for the tensile test, we can say that this essential have reduce the strength of tensile and increase the elongation at break point of the sample by see the graph that been plotted in chapter 4 that is because of the essential oil that make. For the FTIR test the compound in the FTIR analysis showed that EO had molecular interaction between PVA and PEG, which led to the change of the structure of the sample

The recommendation for this research are the essential oil is better extract by your own to prevent other element added in the oil. Then, the drying process is better put in a chamber for the same temperature to prevent the change of temperature that can affect the sample. Then, the amount of PEG must be reduce to make the molecules bonding between PVA and EO will be more clearly seen.

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