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INFILTRATION OF INSECTICIDES USING KEROSENE, DIESEL FUEL, WATER, AND POLYMER INTO WOOD

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Abstract Current solvents used for the application of insecticides include: kerosene, diesel fuel, and aliphatic and naphthenic hydrocarbon-based molecules. These solvents are toxic and, due to their flash points, create fire hazards. The insecticides are environmental and public health risks. This study specifically addresses carriers that demonstrate low health risk and toxicity, with an emphasis on the study of the physical properties: surface tension, absorption volume and infiltration volume into dry wood. A comparison was performed on the physical properties of the products: Politrox (Polymer), kerosene, diesel fuel, and water, when applied to dry wood (*Pinus sp.* and *Qualea sp.*). The comparison resulted in efficient infiltration and absorption when the tested solvents were applied to dry wood.
Key Words Solvents, carrier, wood, insecticides, termite

INTRODUCTION

The function of the solvents is to lead the molecules of active principles to the points to be treated. Emulsions in water are, usually used in soil treatment, however, for wood treatment, water does not always guarantee an appropriate and sufficient level of penetration for an effective treatment. Besides that water causes dimensional movements into the wood, problems as surface fissures, displacements and warping in plywood and etc may occur. Therefore, to address elements of wood, generally, we use organic solvents. Among these kerosene is certainly the most used. The main disadvantage of kerosene in household and service is its strong smell, it remains in the environment for weeks or even months until all the solvent evaporates from treated elements. A good solvent for household treatments should ensure a good penetration into the wood, it's not supposed to have a strong smell, it may have low toxicity and evaporates quickly. (Milano, 1996).

Currently available is a vehicle for application of insecticides with lower toxicity as those cited above. It was verified in this study the Polymer, this product offers technological innovation with respect to toxicity, flammability, and also offers occupational and patrimonial safety. Also, a study of physical properties such as: surface tension, volume absorption and infiltration into dry wood, for later comparison with the physical properties of water and petrochemical solvents also used for the same purpose.

"The external chemical treatment of wood is almost always superficial due to the impermeability of this material". Therefore, structures that immunized suffer cuts, punctures should receive additional treatment (Fontes and Araújo, 1999).

In this case the solvent or vehicle used to carry molecules of active into wood, must be the most efficient way to reach out to the chambers where is the pest. It must also provide a good spread in the wood, should not react or interact with the insecticide. Also it should be homogeneous and mainly providing security.

Technological advances and environmental compliance mean that companies and NGOs linked to the sector of Urban Pest Control have a need to improve its services using less aggressive products, adapting to and seeking for products and efficient systems in the preservation of the environment such as the environmental management and implementation of ISO.

To clarify about the vehicles or solvents used in pest control, addressed mainly the need to use solvents that minimizes environmental aggression and offers safety to the professionals applicators of these products, thus providing safety to customers of such services. For this study is also needed to know a little about the organisms that trigger deterioration of wood specifically the dry wood termites. Also, requires knowledge of woods and procedures needed to control pests and the types of existing treatments.

MATERIALS AND METHODS

Materials to verify the absorption of polymer, water, kerosene and diesel fuel in dry woods *Qualea* sp. and *Pinus* sp.: two species of dry-wood: *Pinus* sp. and *Qualea* sp.; reactor; petrochemical solvents, kerosene and diesel fuel; Polymer; water; thermocouple; semi-analytical balance; chronometer. Specimens dimensions: 3.5 cm (diameter) and 4.5 cm (height) format with turning a screwdriver to fit in the reactor of 0.5 cm (width) and 1.5 cm (depth). For each sample of solvent introduced into the reactor, immersed the two samples in duplicate for 50 minutes. Every 2, 3 minutes the samples were placed in the reactor in a diagonal position to drain the excess solvent that may stay on the surface by 1 minute. After weighing each sample in the semi-analytical balance, the samples returned to the starting position and were immersed again, the procedure was repeated until the weight became constant.

Materials to check the infiltration of Polymer, Water, Kerosene and Diesel fuel in histological tissue in dry woods *Qualea* sp. and *Pinus* sp.: Pressure pan; microtome (Zess brand, model GmBh 69190 Walldorf, type HM325 - Germany); microscopic cell slides; micropipette (0.1 – 10 µl); two types of dye: oil based dye (blue) and water based dye (turquoise); caliper; glycerin; petrochemical solvents: kerosene and diesel fuel; Polymer, water, semi-analytical balance; beaker. The histological technique constitutes the preparation of tissue for microscopic examination. This preparation comprises subjecting a selected tissue or part of a series of processes such as fixation, dehydration, clearing, impregnation, cutting and coloring. This technique is applied by pathologists in body tissues, and other applications. (Michalany, 1980).

RESULTS AND DISCUSSION

Absorption of Solvents in Wood

First there was variation of the average volume in mL absorbed by the specimens in the four types of vehicles (solvents) to insecticides, polymer, kerosene, diesel fuel and water. The results are shown in Tables 1 and 2. We used two specimens in each test, it was used the average value of the volumes absorbed by the wood between the two specimens of the same type of wood immersed in four kinds of vehicles (solvents). Table 1 shows average volumes absorbed in the specimens of *Pinus* sp. Table 2 shows average volumes absorbed in the specimens of *Qualea* sp.

Table 1. Absorption of vehicles for household insecticides on *Pinus* sp.

Time (min)	Water (ml) 23°C	Kerosene (ml) 27°C	Polymer (ml) 23°C	Diesel fuel (ml) 24°C
2,3	3,125	20,890	22,486	20,029
5,0	3,965	20,933	22,606	20,053
7,3	4,625	20,958	22,666	20,077
10,0	5,230	20,990	22,702	20,083
12,3	5,700	21,032	22,732	20,088
15,0	6,225	21,051	22,757	20,106
17,3	6,620	21,076	22,912	20,106
20,0	7,090	21,113	22,917	20,130
22,3	7,565	21,126	22,937	20,130
25,0	8,035	21,150	22,948	20,142
27,3	8,455	21,163	22,968	20,154
30,0	8,815	21,200	22,968	20,160
32,3	9,175	21,219	23,053	20,172
35,0	9,535	21,237	23,053	20,201
37,3	9,910	21,275	23,103	20,201
40,0	10,130	21,293	23,103	20,207
42,3	10,345	21,325	23,188	20,225
45,0	10,590	21,350	23,188	20,225
47,3	10,790	21,350	23,244	20,231
50,0	11,055	21,380	23,244	20,237

Table 2. Absorption of vehicles for household insecticides in *Qualea* sp.

Time (min)	Water (ml) 23°C	Kerosene (ml) 27°C	Polymer (ml) 23°C	Diesel fuel (ml) 24°C
2,3	0,775	1,051	1,129	0,911
5,0	0,960	1,325	1,309	1,059
7,3	1,155	1,486	1,450	1,172
10,0	1,250	1,604	1,530	1,260
12,3	1,330	1,710	1,621	1,314
15,0	1,395	1,797	1,716	1,379
17,3	1,475	1,859	1,776	1,456
20,0	1,540	1,946	1,832	1,509
22,3	1,615	2,021	1,917	1,556
25,0	1,675	2,065	1,987	1,609
27,3	1,710	2,133	2,017	1,651
30,0	1,760	2,183	2,067	1,686
32,3	1,770	2,233	2,118	1,728
35,0	1,825	2,243	2,153	1,745
37,3	1,880	2,319	2,193	1,781
40,0	1,890	2,382	2,248	1,8l7
42,3	1,935	2,425	2,278	1,828
45,0	1,990	2,456	2,308	1,887
47,3	2,015	2,494	2,323	1,911
50,0	2,035	2,532	2,368	1,940

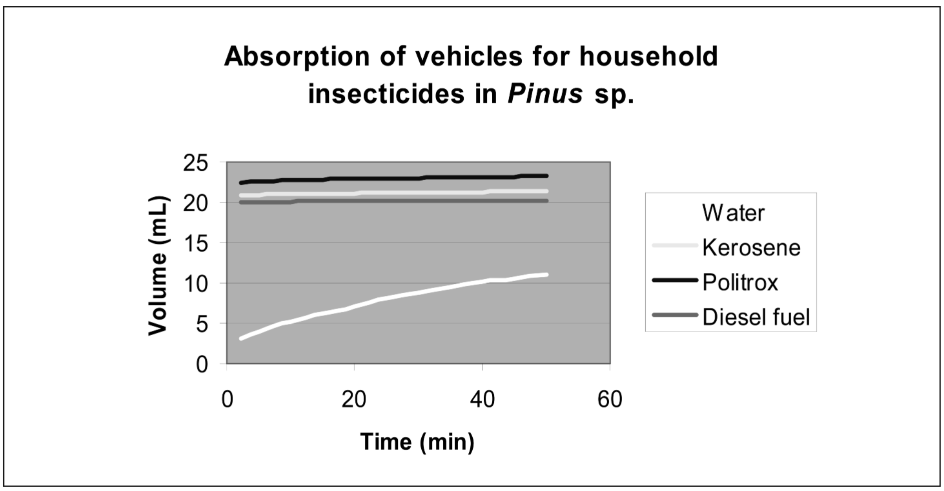

Figure 1. Graphic representation of the absorption of the vehicles for household insecticides on *Pinus* sp.

Figure 1 shows that for *Pinus* sp. vehicles for absorption of household insecticides is immediate, since in the first immersion there is a stability in relation to Polymer which showed better results in absorption followed by kerosene, diesel fuel and water respectively. It can be observed that the water needed more time to be absorbed by the wood, or during the 50 minutes of immersion only 50% of water if other solvents was absorbed thus presents itself well below the solvent kerosene and diesel fuel in the chart.

All solvents over the minutes of immersion reached some stability where the measures of varying volumes were less and less absorbed. It is also observed that this type of wood water tends to be absorbed very slowly while the absorption for the other solvents of higher volume was immediate in the first immersion. Verifying the Table 1 can be noticed a difference of up to 12 ml in volume absorbed by the wood between polymer and water. Water is absorbed slowly because of the affinity for this type of wood (pine), and also due to the high surface tension of water (72,13 dyn /cm).

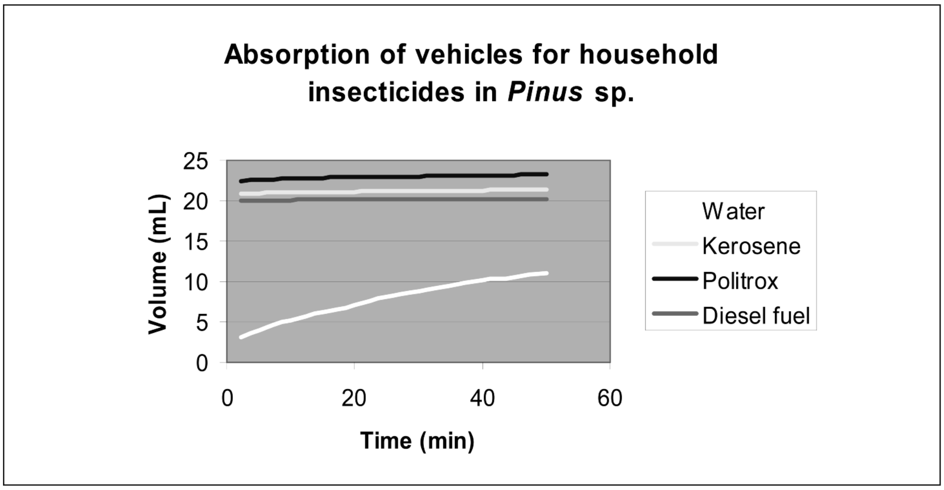

Figure 2. Representative graph of the absorption of the vehicles for household insecticides in *Qualea* sp.

Figure 2 demonstrates that in the first immersion 2,3 minutes, the Polymer was the most absorbed solvent by the Qualea, followed respectively by kerosene, diesel fuel and water. It was observed that after a while the solvents were practically the same. The table 2 demonstrates that the volume of absorption of the four solvents is about 1,90 to 2,50 mL. It was also observed in relation to the other solvents that in this wooden type the solvent that less demonstrated to be able of absorption was of the Oil Diesel, related to others solvent. The water took more time again to be absorbed, but with the variation of the time it passes the curve of the Diesel fuel.

A comment to be made comparing the two types of wooden is that the Pinus sp. being, “soft wood” absorbs more volume of the solvents than the *Qualea* sp. (hard wood). The *Pinus* wood absorbed above 20 ml of the polymer, kerosene and diesel fuel, only water was absorbed below 20 ml. Then in the Qualea wood the absorption of the solvents was not even 3 ml.

Surface Tension of the Polymer, Method of Weight Drop

As a result of the drop weight method for polymer the calculated surface tension was γ=24.49dyn/ cm24ºC. In literature, the surface tension of water 24ºCisγ=72.13dyn/ cm (Lange, 1967). The calculated values show that the product under study, having a lower surface tension, effectively has a greater absorption in the means under study.

Table 3. Values of surface tension obtained experimentally for polymer and the theoretical value of surface tension of water, kerosene and diesel fuel.

Vehicle	Surface tension (ºC)	Temperture
Water	Theoretical value ± 72,13	24
Polymer	Experimentally value 24,49	24
Kerosene	Theoretical value ± 23,00	20
Diesel fuel	Theoretical value ± 27,00	20

The values reported in Table 3 indicate that surface tension of the product polymer is below the surface tension of water near the surface tension of kerosene and diesel fuel. Water really does not provide good transportation to household insecticides when applied to wood. Results achieved from the proceeded accomplished to verify the infiltration of the solvents in the histology of the wooden tissue.

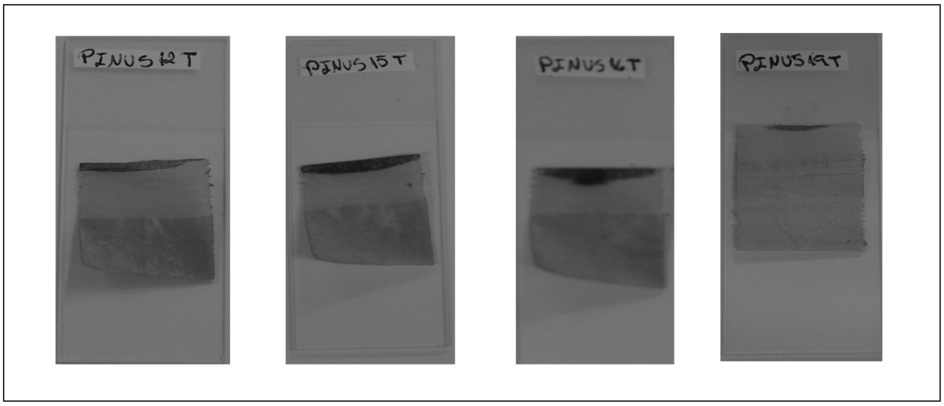

Figure 3. The *Pinus* sp. tissues in transversal cuts of 60 µm, applied samples against the direction of the tissue fibers; polymer, kerosene, diesel, and water.

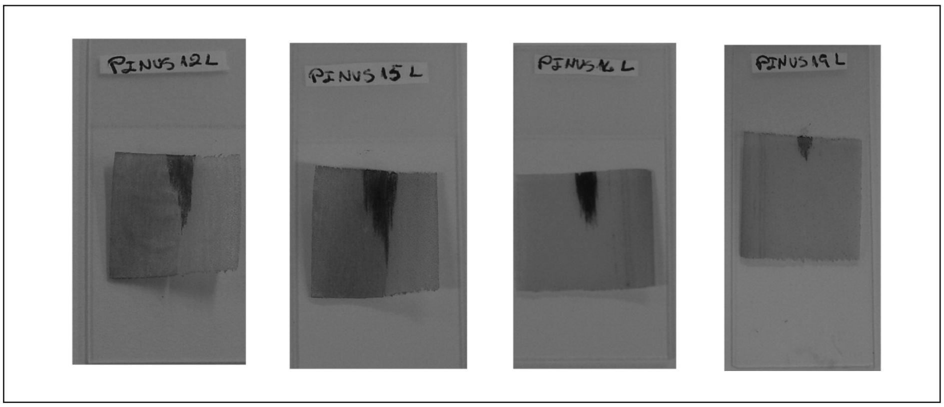

Figure 4. *Pinus* sp. tissue in longitudinal cut of 60 µm (micrometers), applied samples in the direction of the tissue fibers; polymer, kerosene, diesel, and water.

Applying the solvents against the direction of the fibers the spreading is wider than the infiltration, as such in the Pinus tissue. Also verifies that kerosene, Polymer and Diesel fuel spread with more efficiency than water. In the Pinus tissue the spreading efficiency is identical to Kerosene, Polymer and Diesel fuel. The water comes in last place.

CONCLUSIONS

From the results obtained, it can be argued that the Polymer showed good results for absorption in these woods. It can be proved by the result of surface tension values, that the Polymer has lower surface tension than water.

Regarding to the absorption of the solvents in *Qualea* sp., it can be concluded that viscosity is also a relevant factor in this study, because since diesel fuel is more viscous if compared to other solvents, this result provided verification of the fact that the flow of the Angiosperms fluids is more complex because their greater hardness and porosity compared the Gymnosperms.

For the specific purpose to determine quantitatively the volume of absorption of the product polymer into the wood in relation to water and solvents, petrochemicals, it is clear that in *Pinus* sp., considered a soft wood, the absorption of solvent flows easily. Regarding the product polymner , the good absorption observed is probably due to the fact that the observed surface tension is very close to of the surface tension of petrochemical solvents, while in *Qualea* sp., considered a hard wood, the absorption of solvent flows with more difficulties but even so the product polymer showed good performance compared to other solvents.

Regarding the goal of determining quantitatively infiltration of the product into the wood comparing to water and petrochemical solvents, one can see that this is a test which requires more preparation and study of properties of the wood used. One can see a wide variation in results obtained from the tissues of *Qualea* sp., as this wood has proved difficult to handle in the histological sections, because its fibers are irregular and very porous. To work with the histological tissue *Pinus* sp. is easier since as it can be easily seen to be a soft wood and having less porosity of the fibers. This fact showed similar results to the absorption, where the product Polymer also provided good performance.

There is a need for creating and developing further research regarding to the properties of woods since further tests should be made and research on other types of woods often used in construction and economic relevance. Similarly, research with petrochemical solvents for quantitative and qualitative comparisons. It is also important for future studies to take into account of the temperature factor, because depending on weather conditions the use of petrochemical solvents in laboratory environment (air conditioned) and field should be also considered. Still, the viscosity, the porosity of the fiber types of chains of cellulose, the structure of the solvents and the constant dielectric are items of relevance for future studies.

This work is in line with environmentally friendly solutions for pest control industry. The intention is to contribute to scientific understanding and importance of the use of solvents and products that increasingly and clearly obvious environmental aggression today, not only in the business of pest control as in different areas and economic sectors in the modern world.

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