FUNGICIDAL EFFECT OF *Equisetum hyemale* EXTRACT OBTAINED THROUGH SOLID-LIQUID EXTRACTION

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ABSTRACT

Concern about preserving the environment and human health is growing in the agro-industrial sector. Therefore, the search for alternatives that are beneficial to these aspects has received significant attention. In this project, the objective was set to produce an extract of organic components that would be beneficial to the environment, human health and effective in plant nutrition. The plant *Equisetum hyemale* (Horsetail) was selected due to the presence of Silicon in its composition, which has fungicidal properties. The study aimed to evaluate Horsetail extract in the fight against the fungus *Exserohilum turcicum*, known as leaf spot, which can negatively affect agricultural production. The extract production process involved steps such as harvesting, pre-drying, grinding, solid-liquid extraction and filtering. To test its effectiveness, the fungus was inoculated in contact with the extract in petri dishes containing a specific culture medium. The results showed that extracts with alkaline pH were more effective than those with acidic pH, as evidenced by IVCM and PIC calculations.

Keywords: *Equisetum hyemale*, *Exserohilum turcicum*, Extraction, Silicon, Solid-Liquid.

1 INTRODUCTION

In Brazil, competition with weeds causes major losses in soybean production, affecting up to 30% of crops and generating losses of around 9 billion reais. Plantations also face threats from pathogens, which require the use of agrochemicals, harming the environment and human health[2,4].

The evolution of agrochemicals is essential to meet food demand without compromising the environment and public health. Medicinal plants can be alternatives to conventional fungicides, with lower costs and environmental impact. *Equisetum hyemale* (Horsetail) shows potential as an agricultural fungicide due to the Silicon in its composition, helping with the immune response of plants. This study evaluates the effect of horsetail extracts on the phytopathogen *Exserohilum turcicum*, highlighting its potential in the immunological defense of plants [1,3,5,6].

2 MATERIAL & METHODS

The first stage of the project was carried out with the production of 4 extracts to define the amount of organic matter to be used as a percentage factor of silicon in the medium. In this context, the production of all proposed extracts followed the flowchart shown in figure 1.

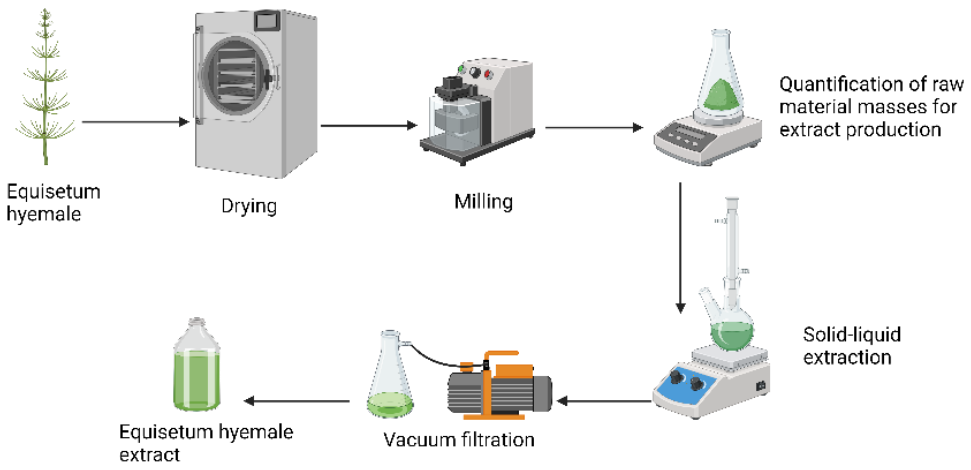

Figure 1 *Equisetum hyemale* extract production flowchart

The extraction experiments were conducted using ethyl alcohol (C2H5OH) and water (H2O) as solvents, with the aid of the PCC (Central Compound Planning) statistical method, which can provide us with the best formulation variations for the extracts, totaling 17 variations. Due to PCC, there was a variation between the solvents, transferring them from the liquid phase to the surface of the solid, allowing ethyl alcohol to penetrate the solid matrix by molecular diffusion. As the amount of solids in mackerel was lower than that of ethyl alcohol and water, dilution of the solutes occurred. Subsequently, the solution containing the solute returned to the surface of the solid and was transferred to the liquid medium by convection, resulting in the horsetail extract.

After producing the extracts, they were subjected to the vacuum filtration process, where it was possible to separate the solid part from the liquid part. Therefore, analyzes of PIC (Mycelial Growth Inhibition), IVCM (Mycelial Growth Speed Index), pH and silicon were carried out to prove the effectiveness of the horsetail extract.

3 RESULTS & DISCUSSION

The Silicon analysis results in figure 2 shows that horsetail extracts absorbed Silicon, which can strengthen the immune resistance of plants. Four extracts were produced with different mackerel masses (1 g, 5 g, 10 g and 20 g) using 100% ethyl alcohol at 50°C for 15 minutes of stirring. The extracts, named A (1 g), B (5 g), C (10 g) and D (20 g), showed that increasing the mackerel mass during extraction increases the silicon concentration in the final extract. The value of 1 g of horsetail for 100 mL of solvent was kept fixed to avoid mass overload.

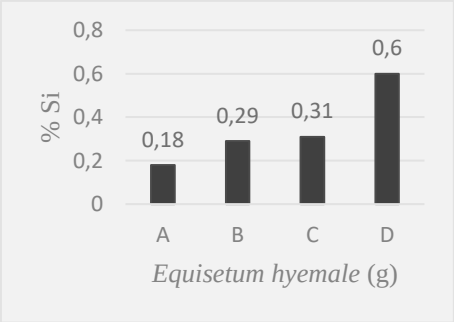

Figure 2 Grafic silicon percentage analysis chart in horsetail extract

The pH of the medium significantly influences the mycelial growth of the fungus, with acidic media (pH between 4 and 7) favoring its growth, while basic media have antifungal effects. With table 1, we noticed that the Mycelial Growth Speed Index (MCVI) was significantly reduced by the extracts, especially by extracts 6, 9, 16 and 17 compared to their controls which obtained values of 2.23 for extract 6, 1.9 for extract 9 and 1.3 for extracts 16 and 17. The growth of the fungus Exserohilum turcicum was affected by the temperature and humidity of the environment, this is due to the carrying out of IVCM tests on different days, explaining the three controls distinct. Among all extracts, in percentage, sample 9 had the greatest reduction compared to its control. Extract 9 also showed the best result in the percentage of mycelial growth inhibition (PIC), inhibiting 44.74% of growth in the first two days, but its effectiveness decreased over time.

Table 1 Variables proposed by the PCC and IVCM results

Sample	Temperature (°C)	Time (min)	% Solvent	IVCM
1	25	15	30	1,6829
2	25	15	90	1,7875
3	25	75	30	1,9267
4	25	75	90	1,9946
5	50	15	30	1,9294
6	50	15	90	1,988
7	50	75	30	1,8138
8	50	75	90	1,88
9	20,6	45	60	1,5217
10	54,4	45	60	1,90042
11	37,5	4,40	60	1,4772
12	37,5	85,59	60	1,70486
13	37,5	45	19,4	1,4729
14	37,5	45	100	1,81167
15	37,5	45	60	1,2454
16	37,5	45	60	1,27
17	37,5	45	60	1,1971

The data was also subjected to desirability analysis, which indicates what would be the best conditions for producing the extract to better reduce IVCM. Figure 3 shows us the desirability analysis, which indicated that the best extract would be following the conditions of 37.5 °C temperature, 45 minutes of agitation and 60% solvent, this being ethyl alcohol and 40% water. The calculated desirability value was 0.936 or 93.6%, where the ideal is 1. This indicates that the predicted values tend to have high reproduction reliability.

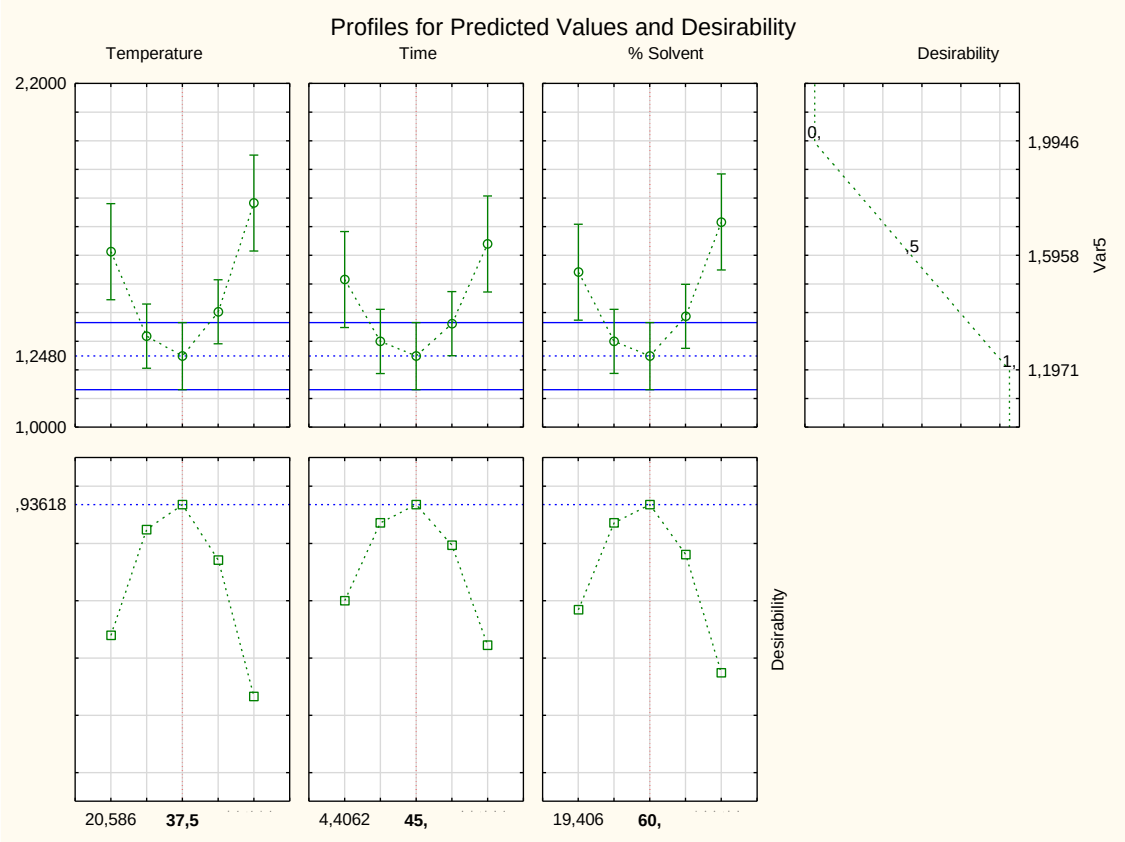

Figure 3 Desirability graph

4 CONCLUSION

Equisetum hyemale extract, based on IVCM and PIC, shows potential as a substitute for agrochemicals, acting as a resistance inducer in plants. Future research should focus on variations in concentration of extracts in contact with *Exserohilum turcicum*.

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