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Phytotoxitic activity of *Apeiba tibourbou* Aubl. and *Curatella americana* L. aqueousextracts on seed germination of *Lactuca sativa* L.

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ABSTRACT – (Phytotoxitic activity of *Apeiba tibourbou* Aubl. and *Curatella americana* L. aqueousextracts on seed germination of *Lactuca sativa* L.). Allelochemicals have been used as an alternative to pesticides and inhibit the action of pathogens or stimulating the growth of other plants. This study aimed to analyze the phytotoxic potential of the species *Apeiba tibourbou* Aubl. (Malvaceae) pau-de-jangada and *Curatella americana* L. (Dilleniaceae) lixeira on the germination of *Lactuca* sativa L. seeds (Asteraceae). Aqueous extracts of *A. tibourbou* and *C. americana* leaves at different concentrations were applied on L. sativa seeds for seven days. The species studied have the potential to control the germination of lettuce seeds treated with lixeira and pau-de-jangada extracts, especially in terms of germination speed index and average germination time. The extracts of both species have phytotoxic potential for controlling germination.
Keywords: allelopathy, bioinputs, native species

RESUMO – (Atividade fitotóxica dos extratos aquosos de *Apeiba tibourbou* Aubl. e *Curatella americana* L. na germinação de sementes de *Lactuca sativa* L.). Aleloquímicos têm sido utilizados como alternativa aos agrotóxicos e inibem a ação de patógenos ou estimulam o crescimento de outras plantas. Este estudo teve como objetivo analisar o potencial fitotóxico da espécie *Apeiba tibourbou* Aubl. (Malvaceae) pau-de-jangada e *Curatella americana* L. (Dilleniaceae) lixeira na germinação de sementes de *Lactuca sativa* L. (Asteraceae). Extratos aquosos de folhas de *A. tibourbou* e *C. americana* em diferentes concentrações foram aplicados em sementes de *L. sativa* durante sete dias. As espécies estudadas apresentam potencial para controlar a germinação de sementes de alface tratadas com extrato de lixeira e pau-de-jangada, principalmente no índice de velocidade de germinação e tempo médio de germinação. Os extratos de ambas as espécies apresentam potencial fitotóxico para o controle da germinação.
Palavras-chave: alelopatia, bioinsumos, espécies nativas

Introduction

Although Brazil is a country of continental dimensions and classified as a megadiverse, research characterizing the allelochemical effects of its flora has received scant attention and still needs to be expanded (*Sousa et al.* 2022). Furthermore, the use of pesticides has been widespread in alarming proportions in the country, calling for the need to alternatives to replace these products (Lima *et al*. 2019).

The secondary metabolism of plants can confer an evolutionary advantage against pathogens or predators as they can be used as an alternative to pesticides such as herbicides, insecticides and nematicides (Waller 1989). Resistance or tolerance to secondary metabolites that function as allelochemicals present some level of specificity, as some species are more sensitive than others (Ferreira & Aquila 2000). Chemical compounds as aqueous substances released into the soil or gaseous substances volatilized in the air into the environment can affect the production directly or undirectedly on effects of one plant, (Kong et al. 2019, Rice 1984). In this scenario, the use of plants with allelopathic effects can represents an alternative to synthetic herbicides.

This study aimed to analyze the allelopathic potential of the species A. *tibourbou* Aubl. (Malvaceae) and *C. americana* L. (Dilleniaceae) on the germination of *Lactuca sativa* L. seeds (Asteraceae).

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Material and Methods

Apeiba tibourbou Aubl., popularly known as pau-de-jangada or pente-de-macaco, is a species of the family Malvaceae native to Brazil, it has a wide distribution, occurring in the North, Northeast, Midwest and Southeast regions of the country. Its wood is light and of low natural durability, but it is used to make rafts, small vessels, cellulosic pulp, and can also be used in the manufacture of ropes. For permanent preservation, it can be used in the reforestation of degraded areas due to its rapid growth (Ferreira *et al*. 2010, Colli-Silva 2022).

The species *Curatella americana* L., known as lixeira or cajueiro-bravo-do-campo, is a species of Dilleniaceae native to Brazil. It occurs in the North, Northeast, Midwest and Southeast regions of the country. Its wood can be used in inner construction structures, carpentry, joinery, and lathe services. Its leaves are impregnated with silica and have a hard, rough surface, often used to sand wood (Muniz 2022).

Young and fully expanded leaves of *A. tibourbou* and *C. americana* were randomly collected in the surroundings of the Tropical Plants Laboratory (LPT) in the Arboretum of the Universidade Federal de Alagoas – UFAL (9°33'11.9" S 35°46'10.3" W), A. C. Simões Campus, Maceió, Alagoas State.

After removal, the leaves were crushed in a blender without previous phytosanitary treatment. Then, 100 g of leaf and 400 mL of distilled water were used to prepare the aqueous extracts in both species until a homogeneous mixture was formed. The mixture was further filtered on a plastic sieve and the resulting extract was again filtered on a semi-permeable surface (cloth filter), to produce a more refined extract.

Five treatments were applied according to the following concentrations of aqueous extracts: 100% extract; 75% extract + 25% distilled water; 50% extract + 50% distilled water; 25% extract + 75% distilled water; and 0% extract + 100% distilled water (control). For each treatment, 25 mL was prepared following the dilutions described in Table 1.

Table 1. Dilutions of extracts in each treatment.

Concentration	Extract
0% (Control)	0 mL
25%	6.25 mL
50%	12.5 mL
75%	18.75 mL
100%	25 mL

The establishment of the experiment and analyses of the two species were made separately. Fifty seeds of *L. sativa* (lettuce) were used in each repetition, totaling 1000 seeds and five concentrations (0%, 25%, 50%, 75%, and 100%) of *A. tibourbou* and *C. americana* extracts, with four repetitions per concentration. Lettuce seeds were chosen in this work for their sensitivity to the environment and rapid growth which make it a model species in studies of allelopathic effects (Ferreira & Aquila 2000).

Fifty seeds were distributed on each of two germination paper discs in Petri dishes (10 cm) and 5 mL of the extracts of each concentration were dripped, wetting all the paper and all the seeds. All Petri dishes were identified with their respective treatment numbers, repetition and concentration and then taken to the germination chamber at an average temperature of 25 ºC for seven days.

Seeds with signs of initial germination were counted on a daily basis. Radicle protrusion was taken as the criterion for germination. After counting, the Petri dishes were returned to the germination chamber and placed in the same original position.

The parameters used in this study were: germination percentage (GP), indicating the percentage of germinated seeds; mean germination time (MGT), representing the number of days before the start of germination; and germination speed index (GSI), indicating the number of germinated seeds per day.

The mean daily number of seeds germinated was compared using the Tukey test (Tukey 1953) with a significance level of 5%.

The germination experiment was carried out for 15 days in 2016. One day for the establishment of the experiment, seven days for the germination monitoring and seven days for the data analysis.

Results

Apeiba tibourbou Aubl. (pau-de-jangada)

The germination percentage (GP) of lettuce seeds was significantly equal at all concentrations of the extract of pau-de-jangada used in the experiment. As for mean germination time (MGT), the shortest times were obtained with concentrations of 0% (control) and 25%, and the longest with a concentration of 100%. This indicates that the start of seed germination is delayed as the concentration of the aqueous extract increases. The germination speed index (GSI) was higher at the concentrations of 25 and 50% of the extract.

It was also observed, thus, that the extract of pau-de-jangada at higher concentrations exerts inhibitory activity on the germination of lettuce seeds (table 2).

Table 2. Mean values for germination percentage (GP), mean germination time (MGT) and germination speed index (GSI) of Lactuca sativa L. seeds subjected to different leaf extracts of *Apeiba tibourbou* Aubl.

Treatments	GP (%)	MGT (day)	GSI (seeds/day)
0 (control)	100.00 a	1.54 b	37.15 a
25%	99.00 a	1.65 b	33.81 ab
50%	99.00 a	1.81 ab	31.31 ab
75%	97.50 a	1.86 ab	28.79 b
100%	98,50 a	2,02 a	25.99 b

Means followed by the same letter are not significantly different at a significance level of 5% according to the Tukey test: a and b: statistical differences.

Curatella americana L. (lixeira)

The germination percentage (GP) of lettuce seeds treated with the lixeira extract was significantly equal at all concentrations, similar to the results obtained with the extract of pau-de-jangada. The mean germination time (MGT) was significantly lower when using the lowest concentrations of the extract (0 and 25%). The germination time of the seeds treated with 100% extract was significantly longer than that of the other treatments, which indicates that the inhibitory influence of the extract on the seeds increases with the concentration.

As for the germination speed index (GSI), seeds treated with the concentrations of 50, 75 and 100% took longer to germinate compared to those treated with lower concentrations (table 3). The data indicate that aqueous extract of lixeira exerts phytotoxic activity on lettuce seeds as the concentration increases.

Table 3. Mean values for germination percentage (GP), mean germination time (MGT) and germination speed index (GSI) of *Lactuca sativa* L. seeds subjected to different leaf extracts of *Curatella americana* L.

Treatments	GP (%)	MGT (day)	GSI (seeds/day)
0 (control)	94.5 a	1.69 c	31.29 a
25%	97.5 a	2.22 c	25.12 c
50%	96.5 a	3.32 b	15.87 c
75%	95.0 a	3.80 a	13.27 c
100%	93.5 a	4.16 a	11.92 v

Means followed by the same letter are not significantly different at a significance level of 5% according to the Tukey test: a and b: statistical differences.

Discussion

The chemical components of species *Luehea divaricate* Mart., *Melochia corchorifolia* L., *Pavonia multiflora* A.St.-Hil. and *Waltheria viscosissima* A.St.-Hil. (Malvaceae), have been studied (Lopes *et al*. 2014, Dhanu et al. 2020, Nawaz *et al*. 2020, Garcia-Manieri et al. 2022, Souza et al. 2022), revealing results similar to ours, which *A. tibourbou* presented inhibitory action. The allelopathic potential of these species can be a possible indicator of the secondary metabolites, being a trait of their botanical family.

Alexandre-Moreira et al. (1999) in a study on the allelopathic capacity of *Curatella americana* L. leaf extract in dichloromethane and its phytochemical characterization concluded that this species has chemical compounds that cause an inhibitory allelopathic effect. Our results with this species reaffirm its inhibitory allelopathic effect, however, aqueous extracts are easier to produce, indicating a more affordable way of obtaining a natural compound.

It is noteworthy that the Brazilian flora has several individuals which produce metabolites with allelopathic activity, including the two species studied here, *A. tibourbou* and *C. Americana*. This indicates the importance of carrying out studies on allelopathy and the chemical characterization of Brazilian plants.

Conclusions

This study results showed the allelopathic inhibitory action of *A. tibourbou* (pau-de-jangada) and *C. americana* (lixeira) extracts at the highest concentrations on the germination of *Lactuca sativa* L. (lettuce) seeds. The allelopathic inhibitory effect on seed germination of *C. Americana* extract was more efficient than that of *A. tibourbou* extract.

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Conflicts of Interest

The authors declare no conflicts of interest.

Authors Contribution

Ana Cecília Marques de Carvalho Santos: Data curation; formal analysis; methodology; writing-reviewing and editing; writing - original draft.

Leomar da Silva de Lima: Conceptualization; investigation; methodology; visualization; writing-reviewing and editing; writing - original draft.
Graziela Cury: Validation; writing- reviewing and editing.
Flávia de Barros Prado Moura: Conceptualization; project administration.

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