Research, Society and Development, v. 11, n. 12, e444111233352, 2022
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v11i12.33352

Allelopathic activity of *Matayba Guianensis* Aubl. on *Lactuca sativa* L. and *Cenchrus echinatus* L.

Atividade Alelopática de *Matayba Guianensis* Aubl. sobre *Lactuca sativa* L. e *Cenchrus echinatus* L.

Actividad alelopática de *Matayba Guianensis* Aubl. sobre *Lactuca sativa* L. y *Cenchrus echinatus* L.

Received: 07/25/2022 | Reviewed: 08/16/2022 | Accept: 09/12/2022 | Published: 09/20/2022

Marcio Pereira do Nascimento
ORCID: https://orcid.org/0000-0001-5838-4818
Universidade Regional do Cariri, Brazil
E-mail: marcio.nascimento@urca.br
Isabella Hevily Silva Torquato
ORCID: https://orcid.org/0000-0001-6476-2045
Universidade Regional do Cariri, Brazil
E-mail: isabella.torquato@urca.br
Natália Cavalcante da Costa
ORCID: https://orcid.org/0000-0002-9255-3184
Universidade Regional do Cariri, Brazil
E-mail: nathalliacc@hotmail.com
Natália Barbosa Campos
ORCID: https://orcid.org/0000-0003-1805-6216
Universidade Regional do Cariri, Brazil
E-mail: campos.b.natalia@gmail.com
Marcos Aurélio Figueiredo dos Santos
ORCID: https://orcid.org/0000-0002-3409-5242
Universidade Regional do Cariri, Brazil
E-mail: marcos.figueiredo@urca.br
Maria Arlene Pessoa da Silva
ORCID: https://orcid.org/0000-0001-8148-5350
Universidade Regional do Cariri, Brazil
E-mail: arlene.pessoa@urca.br

Abstract
Allelopathy is the beneficial or harmful effect that a plant can have on another, which can occur directly or indirectly, being a phenomenon still little known in relation to native species. So with this work the objective was to verify the cytotoxic activity of the aqueous extracts and by infusion of the leaves of *Matayba guianensis* Aubl. on the germination and development of seedlings of *Lactuca sativa* L., (lettuce) and *Cenchrus echinatus* L., (burr), in addition to identifying the classes of secondary compounds present in these extracts. The treatments consisted of aqueous extract and extract by infusion at 25, 50, 75 and 100% of concentration and a control group (0%) consisting of distilled water. The bioassays were arranged in a completely randomized design, where each treatment consisted of five replications containing 20 seeds each. The osmotic potential and pH of the extracts were recorded at different concentrations. The experiments were carried out in a BOD germination chamber at 25ºC and a photoperiod of 12 hours for five days for burr seeds and seven days for lettuce seeds. The percentage of germination, the germination speed index (GSI), the length of the stalk and radicle and the occurrence of necrosis of the seedlings radicles were evaluated. Data were submitted to analysis of variance using the ASSISTAT 7.7 beta program. The prospection of chemical constituents was done through the staining technique. The aqueous extract of *M. guianensis* promoted inhibition of germination, in the germination speed index of lettuce seeds, positively affected the growth of the stem, inhibited the growth of the radicles and promoted necrosis in these when submitted to the aqueous extract at 75% of concentration. The extract by infusion did not cause any effect on seed germination, root length or necrosis, however it promoted inhibitory effects on GSI; and positive effects in relation to the growth of stems of lettuce seedlings. The aqueous extract of *M. guianensis* inhibited germination, GSI, stem and rootlet growth of the bur. The extract by infusion, on the other hand, did not promote significant effect on germination, GSI, growth of stems and radicles of the referred species. As for phytochemical prospection, the aqueous extract of *M. guianensis* leaves showed phlobaben tannins; flavones, flavonols and xanthones; chalcones, aurones and flavononols. While the infusion extract showed phenols; flavones, flavonols and xanthones; chalcones and aurones; flavononols; leucoanthocyatidines; catechins and flavonones. It is likely that the allelopathic action observed is due to the compounds identified in these extracts, requiring more effective studies to isolate them in order to verify their isolated action with a view to future use as a bioherbicide.

Keywords: Allelopathy; Phytochemistry; Allelochemicals; Bioherbicide.

Resumo

Alelopatia é o efeito benéfico ou danoso que uma planta pode exercer sobre outra, podendo ocorrer de forma direta ou indireta, sendo um fenômeno ainda pouco conhecido em relação as espécies nativas. Assim com este trabalho o objetivo foi verificar a atividade citotóxicas dos extratos aquoso e por infusão das folhas de *Matayba guianensis* Aubl. sobre a germinação e desenvolvimento das plântulas de *Lactuca sativa* L., (alface) e *Cenchrus echinatus* L., (carrapicho), além de identificar as classes dos compostos secundários presentes nos referidos extratos. Os tratamentos constaram do extrato aquoso e do extrato por infusão a 25, 50, 75 e 100% de concentração e um grupo controle (0%) constando de água destilada. Os bioensaios foram dispostos em delineamento experimental inteiramente casualizado, onde cada tratamento constou de cinco repetições contendo 20 sementes cada. Foram registrados o potencial osmótico e o pH dos extratos nas diversas concentrações. Os experimentos foram conduzidos em câmara de germinação do tipo BOD a 25ºC e fotoperíodo de 12 horas por cinco dias para as sementes de carrapicho e sete dias para as de alface. Foram avaliados, a porcentagem de germinação, o índice de velocidade de germinação (IVG), o comprimento do caulículo e da radícula e a ocorrência de necrose das radículas das plântulas. Os dados foram submetidos à análise de variância utilizando o programa ASSISTAT 7.7 beta. A prospecção dos constituintes químicos foi feita através da técnica de coloração. O extrato aquoso de *M. guianensis* promoveu inibição na germinação, no Índice de Velocidade de Germinação das sementes de alface, afetou de forma positiva o crescimento do caulículo, inibiu o crescimento das radículas e promoveu necrose nas nestas quando submetidas ao extrato aquoso a 75% de concentração. Já o extrato por infusão, não provocou nenhum efeito sobre a germinação das sementes, comprimento das radículas ou necroses, entretanto promoveu efeitos inibitórios no IVG; e efeitos positivos em relação ao crescimento dos caulículos das plântulas de alface. O extrato aquoso de *M. guianensis*, inibiu a germinação, o IVG, o crescimento do caulículo e da radícula do carrapicho. Já o extrato por infusão, não promoveu efeito significativo sobre a germinação, IVG, crescimento dos caulículos e das radículas da referida espécie. Quanto a prospecção fitoquímica, o extrato aquoso das folhas de *M. guianensis* apresentou taninos flobabênicos; flavonas, flavonóis e xantonas; chalconas, auronas e flavononóis. Enquanto o extrato por infusão apresentou fenóis; flavonas, flavonóis e xantonas; chalconas e auronas; flavononóis; leucoantociatidinas; catequinas e flavononas. É provavel que a ação alelopatica observada se deva aos compostos identificados nos referidos extratos, sendo necessários estudos mais efetivos para isolamento destes a fim de se verificar a ação isolada dos mesmos com vistas a uma futura utilização como bioherbicida.

Palavras-chave: Alelopatia; Fitoquímica; Aleloquímicos; Bioherbicida.

Resumen

La alelopatía es el efecto benéfico o dañino que una planta puede tener sobre otra, el cual puede ocurrir de manera directa o indirecta, siendo un fenómeno aún poco conocido en relación a las especies nativas. Por lo que con este trabajo el objetivo fue verificar la actividad citotóxica de los extractos acuosos y por infusión de las hojas de *Matayba guianensis* Aubl. sobre la germinación y desarrollo de plántulas de *Lactuca sativa* L., (lechuga) y *Cenchrus echinatus* L., (rebaba), además de identificar las clases de compuestos secundarios presentes en estos extractos. Los tratamientos consistieron en extracto acuoso y extracto por infusión al 25, 50, 75 y 100% de concentración y un grupo control (0%) compuesto por agua destilada. Los bioensayos se dispusieron en un diseño completamente al azar, donde cada tratamiento constó de cinco repeticiones conteniendo 20 semillas cada una. El potencial osmótico y el pH de los extractos se registraron a diferentes concentraciones. Los experimentos se realizaron en una cámara de germinación DBO a 25ºC y un fotoperíodo de 12 horas durante cinco días para semillas de erizo y siete días para semillas de lechuga. Se evaluó el porcentaje de germinación, el índice de velocidad de germinación (IVG), la longitud del tallo y de la radícula y la ocurrencia de necrosis de las radículas de las plántulas. Los datos fueron sometidos a análisis de varianza utilizando el programa ASSISTAT 7.7 beta. La prospección de constituyentes químicos se realizó mediante la técnica de tinción. El extracto acuoso de *M. guianensis* promovió la inhibición de la germinación, en el índice de velocidad de germinación de las semillas de lechuga, afectó positivamente el crecimiento del tallo, inhibió el crecimiento de las radículas y promovió la necrosis en estas al ser sometido al extracto acuoso al 75% de concentración. El extracto por infusión no provocó ningún efecto sobre la germinación de semillas, longitud de raíces o necrosis, sin embargo promovió efectos inhibitorios sobre IVG; y efectos positivos en relación al crecimiento de tallos de plántulas de lechuga. El extracto acuoso de *M. guianensis* inhibió la germinación, el IVG, el crecimiento de tallos y raicillas de la fresa. El extracto por infusión, en cambio, no promovió efecto significativo sobre la germinación, IVG, crecimiento de tallos y radículas de las referidas especies. En cuanto a la prospección fitoquímica, el extracto acuoso de hojas de *M. guianensis* mostró taninos de phlobaben; flavonas, flavonoles y xantonas; chalconas, auronas y flavononoles. Es probable que la acción alelopática observada se deba a los compuestos identificados en estos extractos, requiriendo estudios más efectivos de aislamiento de estos para verificar su acción aislada de cara a un futuro uso como bioherbicida.

Palabras clave: Alelopatía; Fitoquímica; Aleloquímicos; Bioherbicida.

1. Introduction

The harmful or beneficial effect exerted directly or indirectly by one plant on another, is defined as allelopathy, and occurs through chemical compounds, the allelochemicals, produced by the secondary metabolism of plants and released into the environment (Rice, 1992).

Secondary compounds with allelopathic properties can be present in practically all parts of the plant, and their distribution is not uniform, with records of their occurrence in leaves, roots, fruits, bark and seeds of several species (Alves & Santos, 2002). The concentration of these compounds varies according to intrinsic characteristics of the plant, such as the species and its age (Rizvi & Rizvi, 1992).

Such substances, eventually released into the environment by leaching, decomposition of plant tissues or volatilization, can be absorbed by other plants, affecting their growth and/or differentiation pattern (Ferreira, 2004). Despite such effects, researches focused on the allelopathic action of native species are still scarce, making it necessary to intensify them.

In Chapada do Araripe, the cerrado is partially protected in the area of the Araripe National Forest - FLONA, thus being the only preserved area of cerrado existing in the state of Ceará, being considered by the Ministry of the Environment as of priority importance for conservation considering the lack of scientific research (MMA, 1999). This area was characterized in terms of its floristic composition, life forms, dispersion syndromes and phenological patterns of the phanerogamic flora, but studies on the ecophysiology of its species, especially with regard to their allelopathic action, are still scarce. In this context, species such as *Matayba guianensis* Aubl. of ecological interest since it is used for the reforestation of degraded areas (Oliveira, et al., 2003) and an important source of allelochemicals are neglected regarding the knowledge of their allelopathic potential.

The study of the allelopathic activity of plant species is a practice that mainly aims at the isolation of a substance that may act as a bioherbicide, enabling the selection of plants to control weeds and contributing to the reduction of agricultural production costs and the impact caused by the excessive use of pesticides (Tokura & Nóbrega, 2006).

Considering the aspects mentioned above, the objective was to analyze the allelopathic potential of aqueous extracts and by infusion of *M. guianensis* leaves on seeds of *Lactuca sativa* L. and *Cenchrus echinatus* L., as well as to verify the chemical composition of these extracts, in an attempt to to obtain subsidies for the development of a natural herbicide that can be used to help establish an ecologically correct agriculture.

2. Methodology

The research was carried out at the Laboratory of Applied Botany of the Department of Biological Sciences of the Regional University of Cariri - URCA. The collection of Matayba guianensis was carried out on the Cajueiro trail, in the municipality of Crato - CE, on the Crato - Exu road.

Flowering branches were collected for botanical identification and leaves for the production of extracts. Species identification was performed by comparison with previously identified material, the sample being incorporated into the collection of the Herbário Caririense Dárdano de Andrade-Lima - HCDAL with registration number 12.429.

2.1 Extract by infusion

The extract by infusion of *M. guianensis* leaves (100%) was produced from 30 g of fresh leaves immersed in a beaker containing one liter of boiling distilled water. (Iganci et al., 2006). The becker was sealed for approximately 1:00 hours to

avoid the release of vapors and the volatilization of allelopathic substances. After cooling, concentrated infusion extract (100%) was diluted in distilled water at 75%, 50% and 25% concentration.

The bioassay consisted of 4 treatments (infusion extract at different concentrations) of five replications with 20 seeds of the receptor species (lettuce and burr) each, totaling 100 seeds per treatment and a control group consisting only of distilled water (0%), being conducted in clean, dry and sterilized Petri dishes with two sheets of filter paper moistened with 3 ml of extract at different concentrations as substrate. The parameters analyzed were: mean seed germination, germination speed index (GSI), mean root and stem lengths and occurrence of necrotic rootlets.

The germination speed index (GSI) was evaluated every 24h for a period of five days for burr seeds and seven days for lettuce seeds. Its determination was made through the sum of the ratio between the number of seeds germinated on day i (ni) and the number of days (i), according to the formula proposed by Fernandes, Miranda & Sanqueta, (2007).

$$GSI = (\Sigma\ ni/\ i)$$

Where:
ni - Number of seeds germinated on day i.
i - Number of days.

2.2 Aqueous Extract

For the preparation of 100% Aqueous Extract (AE), 200 g of fresh leaves of *M. guianensis* were used, crushed in an industrial blender with 1000 ml of distilled water for 5 minutes. After grinding, the extract was strained into a funnel lined with sterile hospital gauze to separate larger particles and centrifuged at 3.000 rpm for 10 minutes. Then 100% AE was diluted in distilled water at concentrations of 25, 50 and 75%.

2.3 Physicochemical variables (pH and Osmolarity)

The aqueous extracts of *M. guianensis* were individually evaluated for pH using a pH meter (Tecnal). The pH adjustment was performed with HCL (acid) and NaOH (base) to values between 6 and 8, in order to avoid the interference of this variable in the allelopathic tests.

Osmolarity was evaluated using a PZL 1000 osmometer, where the values obtained in mOsm/kg were converted to osmotic pressure (MPa) through the equation proposed by Larcher (2004):

$$\pi = -W \times 0.00832 \times tabs$$

Where:
π = Osmotic pressure in MPa;
W = Osmotic potential in Osm/Kg;
Tabs = Absolute temperature in degrees Kelvin.

2.4 Chemical compounds

The infusion and aqueous extracts of *M. guianensis* leaves were lyophilized to perform the phytochemical analysis. The prospection tests were carried out according to the methodology proposed by Matos (2009), which is based on the change in color and formation of precipitate caused by the addition of specific reagents.

For the phenols and tannins test, 3 drops of FeCl3 alcoholic solution were used. For anthocyanidins, anthocyanidins and flavonoids, the samples were acidified with HCl and alkalized with NaOH, observing a change in the color of the solution. For the alkaloids, 5% acetic acid was added followed by alkalization with 10% NH4OH (ammonium hydroxide), after evaporation of the solvent, drops of 1% HCl were added and after homogenization, a drop of the hydrochloric solution was applied on a slide together with 1 drop of Draggendorff reagent, then the two solutions were mixed. For all tests, wait until the end of the effervescence (indicating the end of the reaction) and observe the color change.

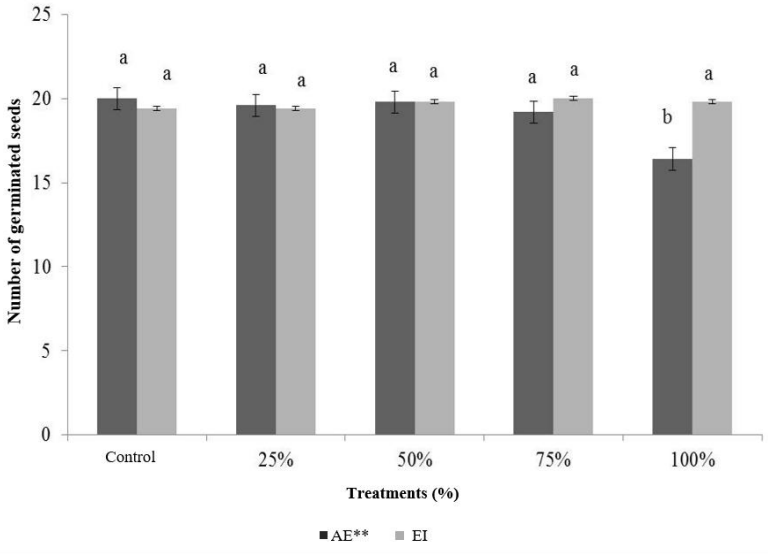
2.5 Statistical Analysis

For statistical analysis, the data were submitted to analysis of variance, ANOVA. Means were compared by Tukey's test at 5% probability. All analyzes were performed using the statistical program ASSISTANT 7.7 beta.

3. Results and Discussion

There was no allelopathic action on the germination of lettuce seeds subjected to infusion (EI) and aqueous extracts (AE) at different concentrations, except for the 100% aqueous extract, which inhibited the germination of said seeds (Fig.1). Grisi et al. (2011) studying the allelopathic potential of the aqueous extract of the fruits of *Sapindus saponaria* (Sapindaceae) on diaspore germination and seedling morphology of *Lactuca sativa* (lettuce), *Allium cepa* (onion), *Echinochloa crus-galli* (barnyard grass) and *Ipomoea grandifolia* (viola string), observed that compounds from the fruit extract of *S. saponaria* showed an inhibition in the germination process of these species.

Figure 1. Number of germinated seeds of *Lactuca sativa* L. subjected to diferente EA and EI concentrations of *Matayba guianensis*.

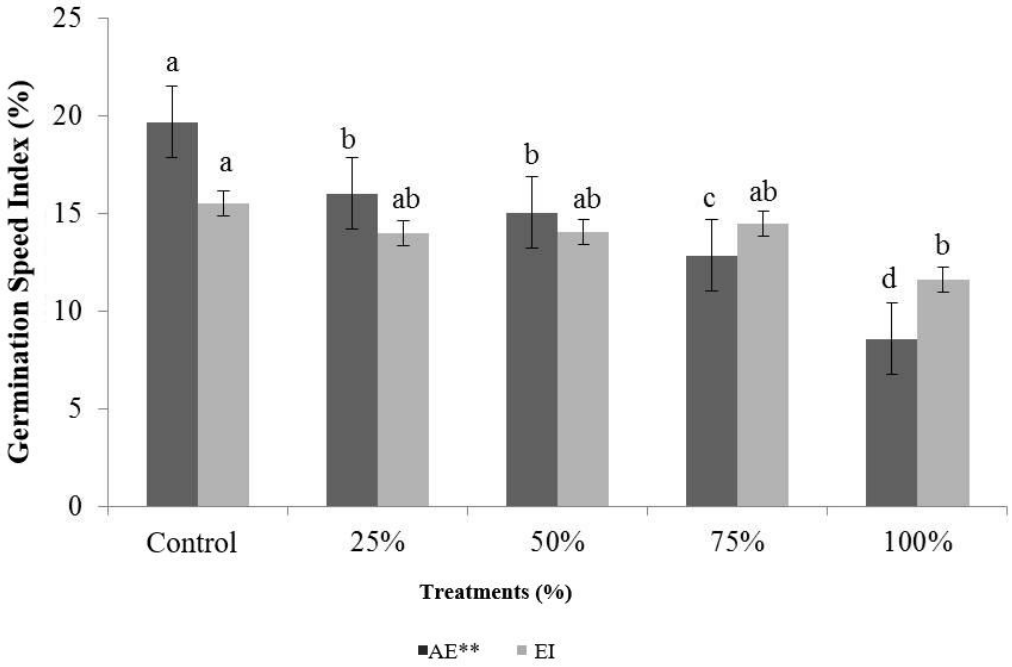


(**) significance at 1% probability level ($p < 0.01$), (*) significance at 5% probability level ($\leq p < 5$), (ns) non-significance ($p \geq 0.05$). Equal letters do not differ statistically by Tukey's test at 5% probability. Source: Authors. (2022)

Both extracts promoted a reduction in the germination speed index (GSI) of lettuce seeds, from the lowest concentration (25%) when compared to the control (Fig. 2). As mentioned by Ferreira and Áquila (2000), often the allelopathic effect is not only on germinability, but also on germination speed or other characteristics of the process, which shows the influence of the allelochemical on seed metabolism. Pereira et al. (2014) using extract of mature leaves of *Serjania lethalis*

(Sapindaceae) on the germination and growth of *Panicum maximum* observed that it promoted a decrease in the average speed and in the germination synchrony.

Figure 2. Germination speed index (GSI) of *Lactuca sativa* L. subjected to different concentrations of AE and EI of *Matayba guianensis*.

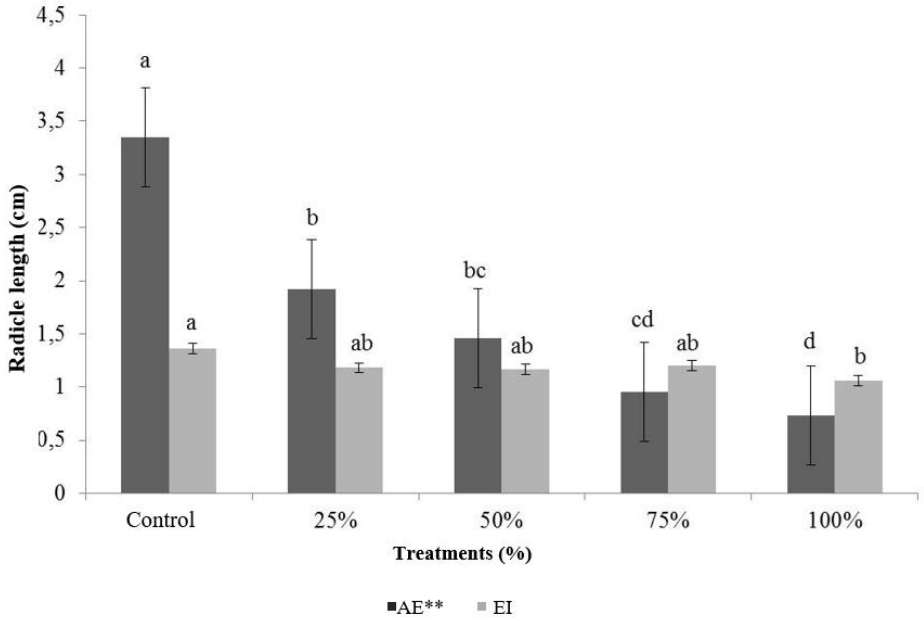


(**) significance at 1% probability level ($p < 0.01$), (*) significance at 5% probability level ($\leq p < 5$), (ns) non-significance ($p \geq 0.05$). Equal letters do not differ statistically by Tukey's test at 5% probability. Source: Authors. (2022)

Seeds with GSI altered by contact with some allelochemical take longer to germinate, as they present difficulty in elongating the root system (Hoffmann et al., 2007). Changes in the germination pattern caused by allelochemicals may be the result of effects on membrane permeability, ácido desoxirribonucleico - ADN transcription and translation, functioning of secondary messengers, respiration with the sequestration of oxygen by phenols and enzyme formation (Ferreira & Aquila, 2000).

The development of lettuce seedlings' rootlets was not altered by the infusion extract (EI). The aqueous extract (AE) at different concentrations inhibited the development of that structure significantly when compared to the control group (Fig. 3). According to Ferreira and Áquila (2000), the rootlets are the structures most affected by allelochemicals, probably because they are in direct contact with them.

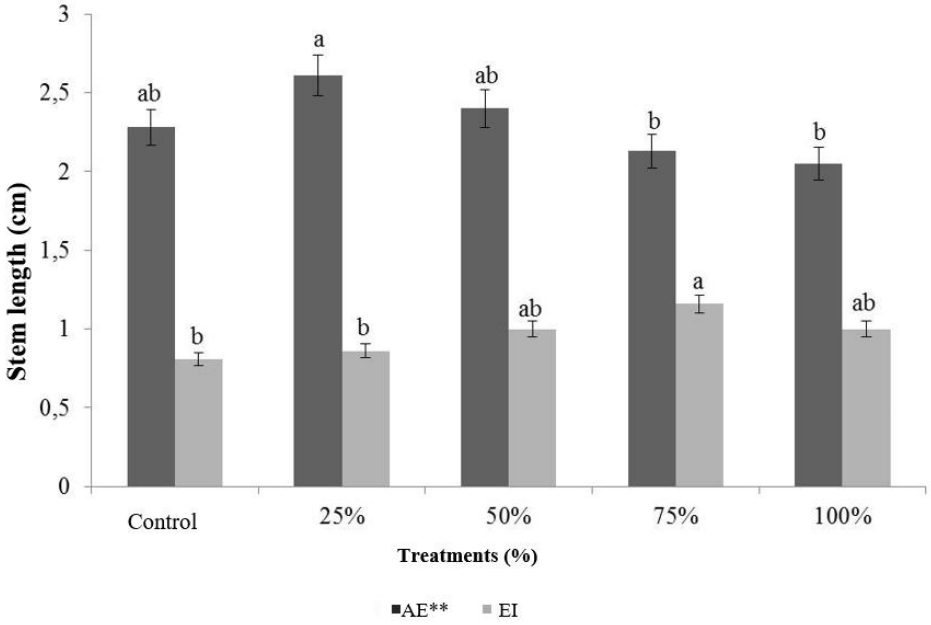
Figure 3. Length of the radicle of *Lactuca sativa* L. subjected to different concentrations of AE and EI of *Matayba guianensis*.



(**) significance at 1% probability level ($p < 0.01$), (*) significance at 5% probability level ($\leq p < 5$), (ns) non-significance ($p \geq 0.05$). Equal letters do not differ statistically by Tukey's test at 5% probability. Source: Authors. (2022)

Regarding the stem length of lettuce seedlings, it was observed that the extract by infusion (EI) of *M. guianensis* caused an increase in concentrations of 50% and 75% (Fig. 4). And the aqueous extract (AE) also promoted an increase in that structure, at concentrations of 25% and 50%, and inhibition at concentrations of 75% and 100%.

Figure 4. Stem length of *Lactuca sativa* L. subjected to different concentrations of AE and EI of *Matayba guianensis*.



(**) significance at 1% probability level ($p < 0.01$), (*) significance at 5% probability level ($\leq p < 5$), (ns) non-significance ($p \geq 0.05$). Equal letters do not differ statistically by Tukey's test at 5% probability. Source: Authors. (2022)

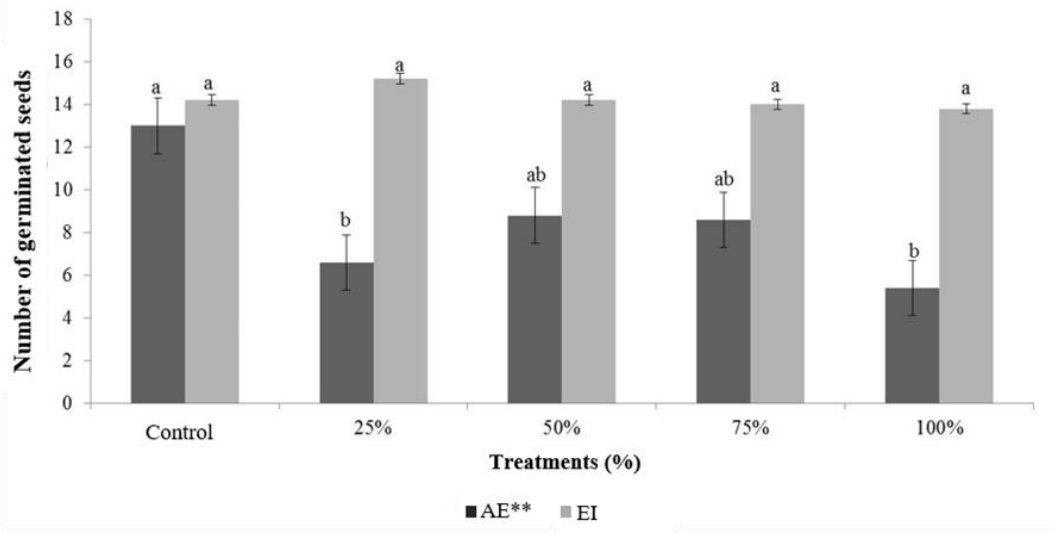
Sometimes, the allelopathic action does not only imply a reduction, it may also result in a stimulus on the growth and development of the recipient plant (Bitencourt, et al., 2007).

The aqueous extract (AE) of *M. guianensis* caused more pronounced necrosis in the radicle in the seedlings submitted to a concentration of 75%, while the infusion extract (EI) did not cause such an effect at any of the concentrations tested. Some allelochemicals can affect seedling growth in addition to inducing the appearance of abnormal seedlings, for example, the occurrence of necrotic parts (Ferreira & Áquila, 2000).

Grisi et al. (2011) when studying the allelopathic effect of the fruit of *S. saponaria* (Sapindaceae) on the germination and morphology of lettuce, found that the root was the organ that showed greater sensitivity to allelopathic agents, with necrosis being the most common symptom.

Burr seed germination was inhibited in the presence of aqueous extract (AE) of *M. guianensis* leaves at 25% and 100% concentration when compared to control. The extract by infusion (EI) did not promote any significant effect (Fig. 5).

Figure 5. Number of germinated seeds of *Cenchrus echinatus* L. subjected to different concentrations of AE and EI of *Matayba guianensis*.

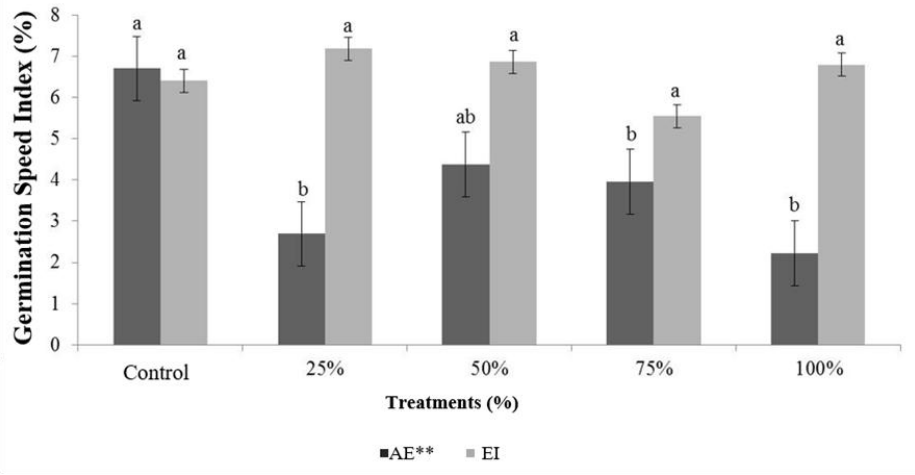


(**) significance at 1% probability level ($p < 0.01$), (*) significance at 5% probability level ($\leq p < 5$), (ns) non-significance ($p \geq 0.05$). Equal letters do not differ statistically by Tukey's test at 5% probability. Source: Authors. (2022)

Grisi et al. (2012) state that some representatives of the Sapindaceae family, such as *S. saponaria*, have phytotoxic effects, altering the germination process and causing morphological changes in weeds and vegetables.

In this research, the aqueous extract promoted a delay in relation to the germination speed index (GSI). While the GSI of burr seeds submitted to extract by infusion (EI) of *M. guianensis* did not change (Fig. 6). Petersen et al. (2001), assert that allelochemical substances, when they are in low concentrations, can delay germination and, when they are in high concentrations, they can penetrate the seeds, making them unviable.

Figure 6. Germination speed index (GSI) of *Cenchrus echinatus* submitted to different concentrations of AE and EI of *Matayba guianensis.*

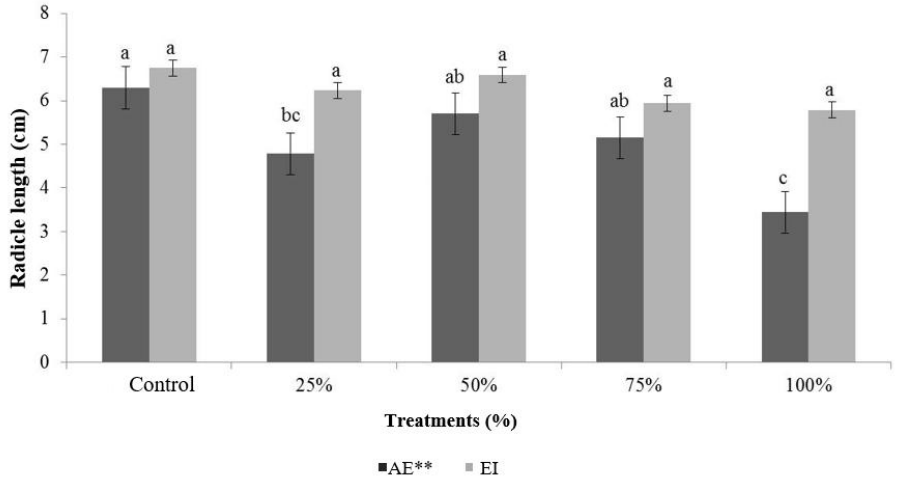


(**) significance at 1% probability level ($p < 0.01$), (*) significance at 5% probability level ($\leq p < 5$), (ns) non-significance ($p \geq 0.05$). Equal letters do not differ statistically by Tukey's test at 5% probability. Source: Authors. (2022)

There was inhibition of GSI of burr seeds at all concentrations tested. It is known that changes in germination speed can have ecological consequences, as seeds that germinate more slowly can give rise to seedlings with reduced size (Jefferson & Pennachio, 2003) and with a lower possibility of developing into an adult individual.

Regarding the development of the radicles, the aqueous extract (AE) of *M. guianensis*, at 25% and 100% of concentration promoted inhibition of that structure, whereas the extract by infusion (EI) did not cause any significant effect (Fig 7).

Figure 7. Root length of *Cenchrus echinatus* subjected to different concentrations of AE and EI of *Matayba guianensis*.

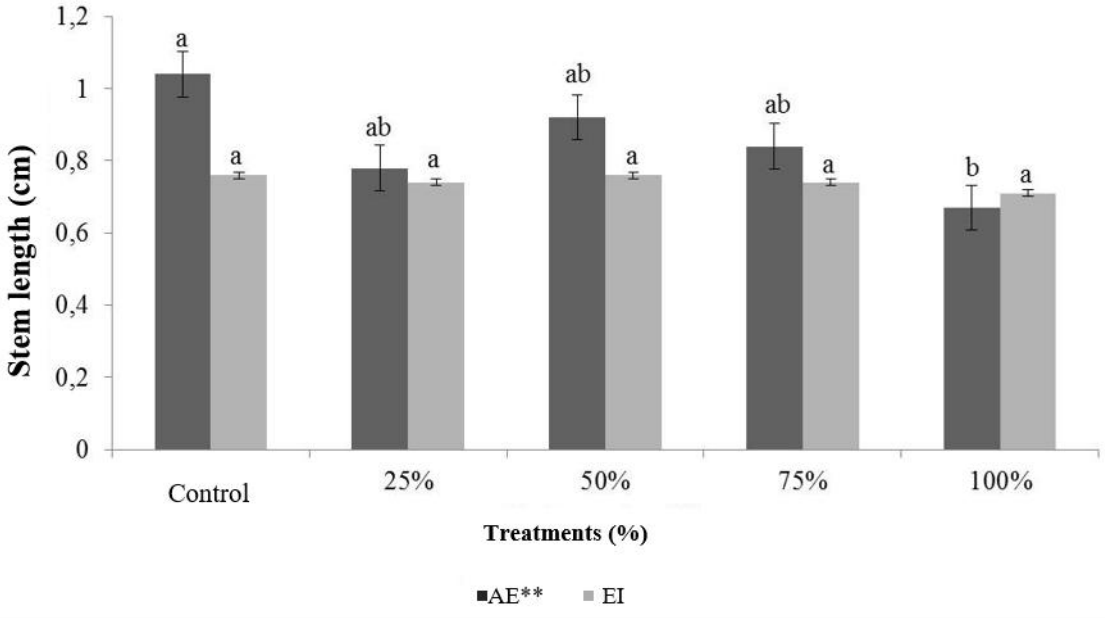


(**) significance at 1% probability level ($p < 0.01$), (*) significance at 5% probability level ($\leq p < 5$), (ns) non-significance ($p \geq 0.05$). Equal letters do not differ statistically by Tukey's test at 5% probability. Source: Authors. (2022)

According to Hoffmann et al. (2007), the root system of plants is the most sensitive to the action caused by allelochemicals, since, for its normal development, cell divisions cannot be inhibited.

The 100% concentration, the aqueous extract (AE) of *M. guianensis*, promoted a significant inhibition in the length of the stems of *C. echinatus* seeds, while the extract by infusion (EI) did not cause significant changes in any of the concentrations tested (Fig. 8). The aqueous extract (AE) of *M. guianensis* did not cause necrosis in the burr radicles.

Figure 8. Stem length of *Cenchrus echinatus* L. subjected to different concentrations of AE and EI of *Matayba guianensis* Aubl.



(**) significance at 1% probability level ($p < 0.01$), (*) significance at 5% probability level ($\leq p < 5$), (ns) non-significance ($p \geq 0.05$). Equal letters do not differ statistically by Tukey's test at 5% probability. Source: Authors. (2022)

It can be considered that changes in seedling growth and germination parameters may be due to the presence of saponins, a class of compounds of secondary metabolism characteristic of the Sapindaceae family (Murgu & Rodrigues-Filho, 2006).

The root of *C. echinatus* seedlings was the organ most affected by the applied extract, with size reduction and necrosis being the most common symptoms. These effects are similar to the damage caused by natural detergents, such as saponins (Soares & Vieira, 2000).

The values obtained for pH and osmotic potential of the aqueous extracts of *M. guianensis* are within the recommended range, thus ruling out the possibility of interference of pH and osmotic potential in the results. The pH values of aqueous extracts by infusion and aqueous extracts of *M. guianensis* for concentrations of 25, 50, 75 and 100% are described in Table 1.

Table 1: pH values of aqueous extracts and infusion *Matayba guianensis* Aubl.

Concentrations (%)	Extract by Infusion		Aqueous Extract	
	Initial pH	Adjusted pH	Initial pH	Adjusted pH
25%	4.7	6.8	4.8	6.3
50%	4.2	6.5	4.9	6.4
75%	5.1	6.5	4.9	6.1
100%	5.1	6.3	4.9	6.3

Source: Authors. (2022)

The values of osmotic potentials presented in Table 2 are in accordance with acceptable standards for germination and seedling development in studies covering allelopathic potentialities, which should not exceed -0.2 Mpa as stated by Gatti, et al., (2004).

The evaluation of pH and osmotic potential in any allelopathy research is essential, as extreme values of both can act on the seeds and/or seedlings and mask the alleged allelopathic effect observed (Carmo, et al., 2007). The extracts may contain solutes such as sugars, amino acids and organic acids, which can mask the allelopathic effect of the extracts, because they interfere with pH and are osmotically active. A high osmotic potential can intervene in seed germination and delay their germination speed (Ferreira & Aquila, 2000).

Table 2 Osmotic potential values of infusion and aqueous extracts *Matayba guianensis* Aubl.

Concentrations (%)	Osmolarity (MPa)	
	Extract by Infusion	Aqueous Extract
25%	-0.029	-0.027
50%	-0.022	-0.068
75%	-0.018	-0.102
100%	-0.006	-0.129

Source: Authors. (2022)

Qualitative phytochemical prospection of the extract by infusion of *M. guianensis* leaves revealed the presence of phenols, flavones, flavonols, xanthones, chalcones, aurones, flavononols, leucoanthocyanidins, catechins and flavonones. For

the aqueous extract, the following were detected: phlobaben tannins, flavones, flavonols, xanthones; chalcones, aurones and flavononols. All compounds with proven allelopathic activity by Gusman, et al. (2011); Borella et al. (2009); Borella & Pastorini (2009); Pelegrini et al. (2008); Lee, et al. (2002); Rodrigues & Lopes (2001).

4. Conclusion

The aqueous extract of *M. guianensis* at different concentrations showed greater allelopathic effects than the infusion extract.

The aqueous extract of *M. guianensis* leaves promoted inhibition of germination, GSI, radicle length of *L. sativa*; and stimulated stem growth; having also caused necrosis of the radicles. While the extract by infusion did not interfere in the germination of lettuce seeds, in the development of the radicles or in the occurrence of necrosis; having promoted inhibitory effects on GSI and positive effect on stem length.

The aqueous extract of *M. guianensis*, promoted inhibitory effects on germination, GSI, radicle and stem length of *C. echinatus*. While the infusion extract did not promote any significant effect on germination, IVG, root and stem length or necrosis in the seeds or seedlings of the recipient species.

The phytochemical determination of the aqueous extract of *M. guianensis* leaves indicated the presence of phlobaben tannins; flavones, flavonols, xanthones, chalcones, aurones and flavononols. The extract by infusion had the presence of phenols; flavones, flavonols, xanthones, chalcones, aurones, flavononols, leucoanthocyanidins, catechins and flavonones. It can be inferred that the allelopathic action observed may be due to the joint or isolated action of such compounds, making it necessary to isolate them in order to determine in future research those with bioherbicidal potential.

Acknowledgments

The Project Financier (FINEP) and the Ceará Foundation for Support to Scientific Development (FUNCAP), for granting the research grant and for the support grant granted within the Productivity and Research, Stimulus to Interiorization and Technological Innovation (BPI).

References

Alves S. M., & Santos L. S. 2002. Natureza Química dos Agentes Alelopáticos. In: Souza Filho, A. P. S., & Alves, S. M. (Editores). *Alelopatia:* princípios básicos e aspectos gerais. Belém, PA: Embrapa Amazônia Oriental, p. 25-47.

Bitencourt, H. R., Santos, L. S., & Souza-Filho, A. P. S. 2007. Atividade alelopática de chalcona sintética, de seus precursores e de cetonas e aldeídos relacionados. *Planta Daninha*. 25(4), 747-753.

Borella, J., & Pastorini, L. H. 2009. Influência alelopática de *Phytolacca dioica* L. na germinação e crescimento inicial de tomate e picão-preto. *Biotemas*. 22(3), 67-75.

Borella, J., Wandscheer, A. C. D., Bonatti, L. C., & Pastorini, L. H. 2009. Efeito alelopático de extratos aquosos de *Persea americana* Mill. Sobre *Lactuca sativa* L. *Revista Brasileira de Biociências*. 7(3), 260-265.

Carmo, F. M. S., Borges, E. E. L., & Takaki, M. 2007. Alelopatia de extratos aquosos de canela-sassafrás (*Ocotea odorifera* (Vell.) Rohwer). *Acta Botanica Brasilica*. 21(3), 697-705.

Fernandes, L. A. V., Miranda, D. L. C., & Sanquetta, C. R. 2007. Potencial alelopático de *Merostachys multiramea* Hackel. sobre a germinação de *Araucaria angustifolia* (Bert.) Kuntze. *Revista Acadêmica*, 5(2), 139-146.

Ferreira, A. G., & Aquila, M. E. A. 2000. Alelopatia: uma area emergente da ecofisiologia. *Revista Brasileira de Fisiologia Vegetal***,** Ed. Especial. Londrina, v. 12.

Ferreira, A. G. 2004. Interferência, competição e alelopatia. In: Ferreira A.G.; Borghetti F. (Editores). *Germinação***:** do básico ao aplicado. Artmed. Porto Alegre. 251-262.

Gatti, A. B., Perez, S. C. J. G. A., & Lima, M. I. S. 2004. Atividade alelopática de extratos aquosos de *Aristolochia esperanzae* O. Kuntze na germinação e no crescimento de *Lactuca sativa* L. e *Raphanus sativus* L. *Acta Botanica Brasilica*. 18(3), 459-472.

Grisi, P. U., Gualtieri, S. C. J., Ranal, M. A., & Santana, D. G. 2011. Efeito alelopático do fruto de *Sapindus saponaria* na germinação e na morfologia de plântulas daninhas e de hortaliças. *Planta Daninha*. 29(2), 311-322.

Grisi, P. U., Ranal, M. A, Gualtieri, S. C. J., & Santana, D. 2012. Allelopathic potential of *Sapindus saponaria* L. Leaves in the control of weeds. *Acta Scientiarum Agronomy*. 34(1), 1-9.

Gusman, G. S., Yamagushi, M. Q., & Vestena, S. 2011. Potencial alelopático de extratos aquosos de *Bidens pilosa* L., *Cyperus rotundus* L. e *Euphorbia heterophylla* L. *Iheringia*, Sér. Bot. 66(1), 87 – 98.

Hoffmann, C. E. F., Neves, L. A. S., Bastos, C. F., & Wallau, G. L. 2007. Atividade alelopática de *Nerium oleander* L. e *Dieffen bachiapicta S*chott em sementes de *Lactuca Sativa* L. e *Bidens pilosa* L. *Revista de Ciências Agroveterinárias*. 6(1), 11-21.

Iganci, J. R. V., Bobrowski, V. L., Heiden, G., Stein, V. C., & Rocha, B. H. G. 2006. Efeito do extrato aquoso de diferentes espécies de boldo sobre a germinação e índice mitótico de Allium *cepa* L. *Arquivos do Instituto Biológico*. 73(1), 79-82.

Jefferson, L.V., & Pennachio, M. 2003. Allelopathic effects of foliage extracts from four Chenopodiaceae species on seed germination. *Journal of Arid Environments*. 55(2), 275-285.

Larcher, W. *Ecofisiologia vegetal.* 2004. São Carlos: Editora Rima Artes e Textos, 531p.

Lee, H. Y., Kim, H. S., & Park, Y. S. 2002. Hovenodulinol, an active compound extracted from Hovenia dulcis Thunb., a process for preparing the same, and an alcohol decomposing agent or an agent for allevating lingering intoxication containing the same. Korean patent WO/2002/024678;

Matos, F. J. A. 2009. *Introdução à fitoquímica experimental*. (3ª ed.): Edições UFC, 150p.

MMA, Ministério do Meio Ambiente. 1999. *Ações prioritárias para a conservação da biodiversidade do Cerrado e Pantanal*. Brasília, MMA/FUNATURA/Conservation International / Fund. Biodiversitas /UnB.

Murgu, M., & Rodrigues-Filho, E. 2006. Dereplication of glycosides from *Sapindus saponaria* usingliquid chromatography massspectrometry. *Journal of the Brazilian Chemical Society*. 17(7), 1281-1290.

Oliveira, T. V. S., Ranal, M. A., & Santana, D. G. 2003. Emergência de plântulas de *Matayba guianensis* Aubl (Sapindaceae) ocorrentes no município de Araquari – MG. *Informativo Abrates*. 13(3), p. 337.

Pelegrini, D. D., Tsuzuki, J. K., Amado, C. A. B., Cortez, D. A. G., & Ferreira, I. C. P. 2008. Biological activity and isolated compounds in *Sapindus saponaria* L. and other plants of the genus *Sapindus*. *Latin American Journal of Pharmacy*. 27(6), 922-927.

Pereira, V. C., Grisi, P. U., Dodonov, P., Anese, S., Toffano, L., & Gualtieri, S. C. J. 2014. Atividade fitotóxica de *Serjania lethalis* sobre a germinação e crescimento de *Panicum maximum. Biotemas*. 27(1), 29-35.

Petersen, J., Belz, R., Walker, F., & Hurle, K**.** 2001. Weed suppression by release of isothiocyanates from turnip-rape mulch. *Agronomy Journal*. 93, 37-43.

Rice, E.L. 1992. Allelopathy effects on nitrogen cycling. In: Rizvi, S. J. H., Rizvi, H. (Editores). *Allelopathy***:** Basic and applied aspects. London: Chapman & Hall, p.31-58.

Rizvi, S. J. H., & Rizvi, V. 1992. *Allelopathy*: basic and applied aspects. London: Chapman e Hall, p.443-472.

Rodrigues, F. C. M. P., & Lopes, B. M. 2001. Potencial Alelopático de *Mimosa caesalpinaefolia* Benth sobre sementes de *Tabebuia alba* (Cham.) Sandw. Rio de Janeiro. *Floresta e Ambiente*. 8(1), 130-136.

Soares, G. L. G., & Vieira, T. R. 2000. Inibição da germinação e do crescimento radicular de alface (cv. "Grand Rapids") por extratos aquosos de cinco espécies de Gleicheniaceae. Floresta e Ambiente. 7(1), 180-197.

Tokura, L. K., & Nóbrega, L. H. 2006. Alelopatia de cultivos de cobertura vegetal sobre plantas infestantes. *Acta Scientiarum Agronomy*. 28(3), 379-384.