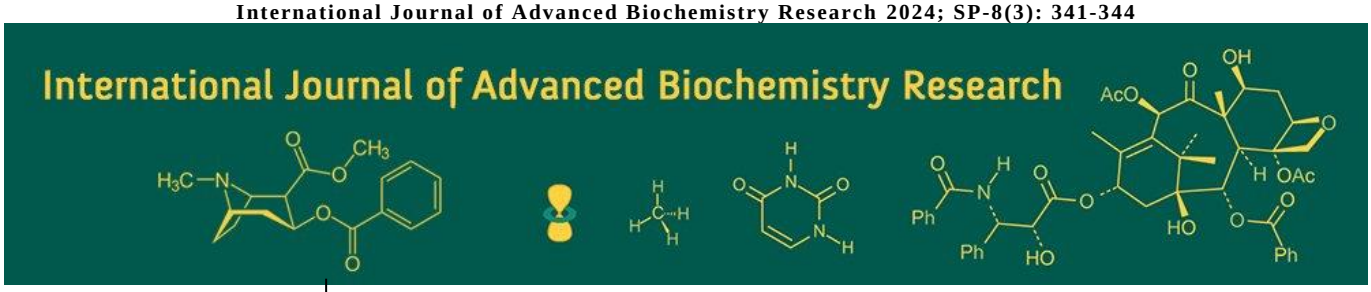

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(3): 341-344
www.biochemjournal.com
Received: 01-12-2023
Accepted: 06-01-2024

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Inhibitory effect of spice extracts on seed germination of *Parthenium hysterophorus* L.

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DOI: https://doi.org/10.33545/26174693.2024.v8.i3Se.762

Abstract
Laboratory based experiments were conducted to evaluate inhibitory effect of different spice extracts (2, 5, 10, 20% concentration) on seed germination of *Parthenium hysterophorus* L. Among the five spice extracts *Syzigium aromaticum* was found to be most effective in inhibiting the germination of parthenium seed, it caused 100% inhibition even in 2% concentration. *Piper nigrum* and *Cinnamomum tamala* completely restricted the germination of parthenium seed in 10 and 20% concentration. Inhibitory effect of 10 and 20% concentration of *Allium sativum* and *Zingiber officinalis* was more than that of 2 and 5%. Thus with increasing the concentration of spice extract inhibition in germination was also increased. Effectiveness of different spice extract on inhibition of seed germination of parthenium are as *Syzigium aromaticum* > *Piper nigrum* > *Cinnamomum tamala* > *Zingiber officinalis* > *Allium sativum.*

Keywords: Parthenium, spice extracts, inhibition, germination

Introduction
Parthenium hysterophorus L, is an obnoxious weed, indigenous to North and Central America, Mexico and West Indies. In India it was first reported from Pune. It has now spread throughout most of the Indian Subcontinent (Aneja *et al*. 1991) [5] and considered to be principal terrestrial weed in India (Dhawan *et el.* 1993) [10]. It has spread to more than 40 Countries (Bajwa *et al*. 2018) [7]. The successful establishment of parthenium weed in fields is supported by several factors, such as its numerous seed production, genetic diversity, tolerance to stresses, and its allelopathic potential (Bajwa *et al* 2016) [6]. It is an aggressive coloniser of grassland, open woodland, road sides, vacant land and disturbed ground, and possessing allelopathic properties, parthenium effectively displaces native flora and forms dense monospecific stands (Qureshi *et al*. 2018; Adkins *et al*. 2019) [22, 1]. Parthenium is considered highly allergenic and causes dermatitis, eczema, hay fever, asthma, allergic rhinitis (Evans, 1997) [13]. Harmful effects of Parthenium in agriculture, horticulture, and silviculture is well documented (Agarwal and Anand, 1992, Agrawal and Kohli, 1994) [3, 2].
There are several methods available for controlling Parthenium weed such as Physical, Chemical, Biological, Competitive replacement, Utilization and integrated approach etc. In the recent years, creating competition between native and alien species has gain momentum. Numerous plants are reported to possess allelopathic potential and effort has been made to use them in weed control. Natural products release from allelopathic plants may help to reduce the use of synthetic herbicides for weed management as they are free from problems associated with present herbicides. Allelopathy as a component of biological control and allelochemicals as biological herbicides have been a challenge to current synthetic chemical approaches (El-Rokiek *et al* 2006) [11]. Numerous allelochemicals are involved in the allelopathic activities of the allelopathic plants; such as phenolics, terpenoids, alkaloids, coumarins, tannins, flavonoids, steroids and quinines (Xuan *et al*. 2005) [26]. Various plants are proposed to have allelopathic prospective and struggles are being made to practice them in weed control. Planting plants such as *Cassia sericea*, *C. tora*, and *C. auriculata* can help to replace parthenium in a competitive manner (Javaid and Anjam, 2006; Wahab, 2005) [14, 25], *Amaranthus spinosus*, *Tephrosia purpurea*, *Croton bonplandianum*, *Sida spinosa*, and *Mirabilis jalapa*, *Hyptis suaveolens* (Knox *et al*. 2010) [19] which are able in suppressing Parthenium effectively in natural habitats (Wahab 2005) [25].

According to one study, *Cassia sericea* diminishes parthenium accumulation by 70% and parthenium population by 52.5 percent (Javaid *et al* 2005) [15].

The deleterious effect of eucalyptus oils extracted from *Eucalyptus glohulus* and *Eucalptus citriodora* on *P. hysterophorus* was reported by (Dhakad *et al* 2018) [9]. Shafique, *et al*. 2005 [23] assessed the herbicidal activity of aqueous extracts (2, 4, 6, 8, and 10%) of dry leaves of *Ficus bengalensis*, *Azadirachta indica*, *Melia azadarach*, *Mangifera indica* and *Syzygium cumini* against parthenium seeds germination in lab bioassays. The 8% and 10% extracts of these tree species significantly suppressed the germination of parthenium seeds.

Allelopathy is a natural and an environment-friendly technique which may prove to be a unique tool for weed control, increase crop yields, decrease our reliance on both synthetic pesticides and improve the ecological environment. The objective the present study was to assess the potential of spice extract of five plant species viz., *Allium sativum*, *Cinnamum tamala*, *Piper nigrum*, *Syzygium aromaticum* and *Zingiber officinalis* to control the germination of *Parthenium hysterophorus* seed.

Materials and Methods

Spices which were used in extraction were dipped in 0.2% Sodium hypochloride solution for one minute and washed with sterilized distilled water. After air drying, macerated with the aid of grinder and blender and extraction was done with the process evolved by Ahmad and Prasad (1995) [4]. Powder of spices were mixed with distilled water (1:5 w/v). These mixtures were placed in Soxhlet bottle of extraction apparatus for the extraction purpose. Temperature was adjusted for 60-75 degrees Celsius. Extracts were collected in a bottle, desired concentration (2, 5, 10, 20%) were prepared and autoclaved at 15 psi for about 15 minutes. Spices which were used are as follows- *Piper nigrum*, *Allium sativum*, *Cinnamomum tamala*, *Syzygium aromaticum, and Zingiber officinalis.*

Seed Germination Bioassay

Seeds of *Parthenium hysterophorous* were collected, air dried and stored in sterilized bottles. Healthy seeds were dipped in 0.2% Sodium Hypochloride solution for 1 minute and washed with sterilized and distilled water. Seeds were soaked in 10 ml of each spice extracts of different concentration (2, 5, 10, 20%) for 24 hrs. 20 seeds of each were arranged equidistantly in sterilized petridishes containing sterilized moist sand and incubated at 25 $\pm$ 2 degrees Celsius. Three replicates of each set were used. After 15 days germinated normal seedlings were counted and % germination inhibition was calculated by the following formula.

$$\% \text{ inhibition} = \frac{\% \text{ of germination in control} - \% \text{ of germination treated}}{\% \text{ of germination in control}} \text{ X } 100$$

Result

In the present study effect of different concentration (2%, 5%, 10% and 20%) of spices extracts on seed germination of *Parthenium hysterophorus* was evaluated and observation was recorded after 15 days. Effect of spice extracts on seed of *Parthenium hysterophorus* is presented in table (1 Fig. 1). From the table (1, Fig.1), it is evident that all the 5 test spices significantly affected the germination of parthenium seed. Effect of extract concentration was also significant. Extract of *Syzigium aromaticum* proved to be the most effective where 2% 5%, 10% and 20% extract completely affected the germination of parthenium and caused 100% inhibition in germination. In case of *Piper nigrum* and *Cinnamomum tamala* also 10% and 20% concentration completely check the germination of *Parthenium hysterophorus* seed and cause 100% inhibition of seed germination.

Minimum 42.85% inhibition was recorded in 2% concentration of *Allium sativum* while the rest of the concentration 5%, 10% and 20% caused 51.67%, 71-43% and 83.14% inhibition of seed germination respectively. 2% and 5% concentration of *Cinnamomum tamala* and *Piper nigrum* were also effective in inhibiting the seed germination, while former caused 82.14% and 85.75% inhibition of seed germination and later caused 80.63% and 92.86% inhibition of seed germination respectively.

10 and 20% concentration of *Zingiber officinalis* were also effective and caused 82.92% and 92.86% inhibition of seed germination respectively. In case of 2% and 5% concentration of *Z. officinalis* 58.93% and 69.64% Inhibition of germination was recorded.

From the table it is also clear that with the increase in the concentration of spice extract inhibition percentage of seed germination of parthenium is also increased.

Effectiveness of different spice extract on inhibition of seed germination of parthenium are as follows: *Syzigium aromaticum* > *Piper nigrum* > *Cinnamomum tamala* > *Zingiber officinalis* > *Allium sativum.*

Table 1: Inhibitory effect of spices extracts on seed germination of *Parthenium hysterophorus*

Effect on seed germination									
S. No	**Spice extracts**	**2%**		**5%**		**10%**		**20%**	
		% germination	**% inhibition**	**% germination**	**% inhibition**	**% germination**	**% inhibition**	**% germination**	**% inhibition**
1.	*Allium sativum*	53.33	45.10	45.10	51.67	26.66	71.43	16.66	82.14
2.	*Cinnamomum tamala*	16.66	82.14	13.33	85.75	0	100	0	100
3.	*Piper nigrum*	18.33	80.36	6.66	92.86	0	100	0	100
4.	*Syzigium aromaticum*	0	100	0	100	0	100	0	100
5.	*Zingiber officinalis*	38.33	58.93	28.33	69.64	15	82.92	6.66	92.68

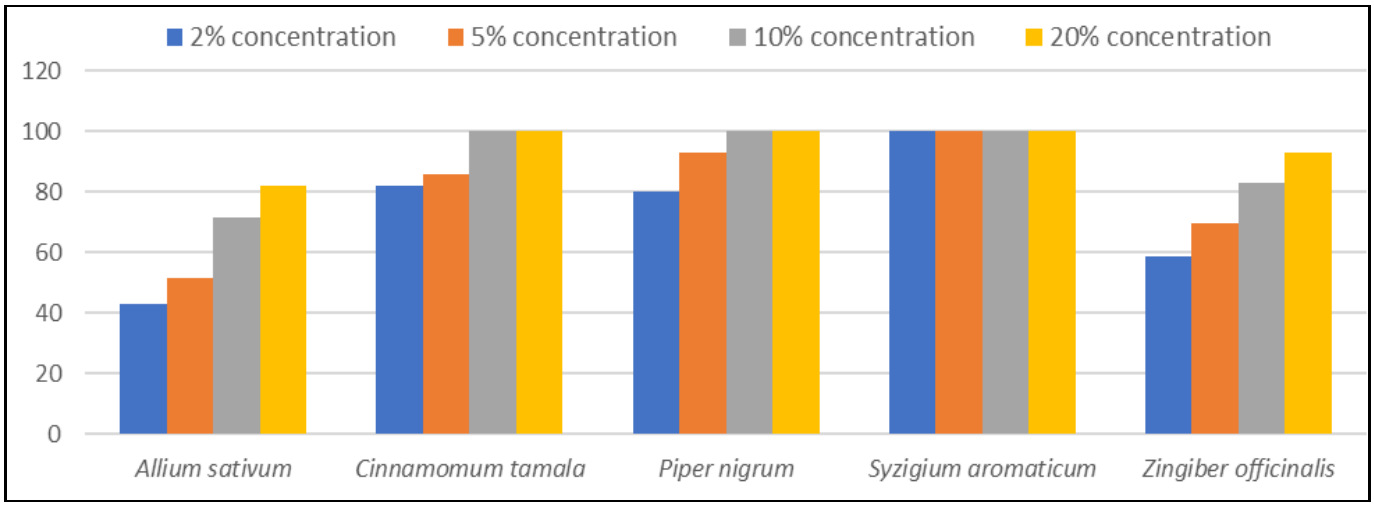

Fig 1: Inhibitory effect of spices extracts on seed germination of *Parthenium hysterophorus*

Discussion and Conclusion

Among the extracts of all the spices, 2, 5, 10, and 20% concentration of *Syzygium aromaticum* caused 100% inhibition of seed germination. This might be due to the presence of highly potential allelochemicals.

10 and 20% concentration of *Piper nigrum* and *Cinnamomum tamala* completely restricted the germination of parthenium seed. 2% 5% concentration will also effective inhibiting the seed but less in comparison to 10% and 20%. 10 and 20% concentration of *Allium sativum* and *Zingiber officinalis* were more inhibitory as compared to 2% on 5%. More inhibition at higher concentration maybe due to the presence of higher amount of Allelochemicals. The effect of allelochemicals was concentration dependent (Lehman *et al*., 1994; Karthiyayini *et al*., 2003) [20, 16].

Inhibition of germination was directly dependent on concentration of extracts (Evanari, 1949; Kato- Noguchi, 2003) [12, 17]. At higher concentration of extract/leachate, the seed germination was adversely affected due to the imbalance in metabolism and metabolic pathways regulated by various hydrolysing enzymes (Kaul and Bedi, 1995; Dhawan, 1997; Tiwari *et al*., 1998; Oudhia and Tripathi, 2000; Batish *et al*., 2002) [18, 10, 24, 21, 8].

The present study, thus concludes that all the concentrations of extract of *Piper nigrum*, *Allium sativum*, *Cinnamomum tamala*, *Syzygium aromaticum*, *and Zingiber officinalis* can be used as a green herbicides. Further studies are required to isolate and identify their herbicidal constituents, especially from these spices. These natural compounds may be used for the synthesis of natural product-based herbicides for the control of one of the world's worst hazardous weed *Parthenium hysterophorus*.

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