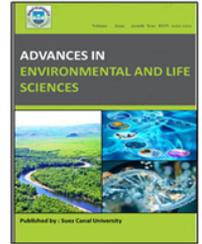


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Allelopathic Effect of Some Wild Species on Germination and Growth of *Bidens pilosa*

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Abstract

The present study was conducted to determine the allelopathic effect of the aqueous extracts of *Cynanchum acutum*, *Anagallis arvensis*, *Chenopodium murale*, *Malva parviflora*, *Sonchus oleraceus* and *Portulaca oleracea* on the germination and growth of *Bidens pilosa* plant. Also, the presence of total phenols, flavonoids, saponins, tannins and alkaloids, were screened in the studied plants. The results indicated that the aqueous extract of *C. acutum*, *A. arvensis*, *C. murale*, *M. parviflora*, *S. oleraceus* and *P. oleracea* showed a remarkable allelopathic effect on germination and growth of *B. pilosa*. The effectiveness of the extract was much higher on *C. acutum*, as it is the most effective in reducing the shoot and root growth of *B. pilosa* followed by *S. oleraceus*, *M. parviflora*, *P. oleracea*, *C. murale* and *A. arvensis*. The allelochemicals such as total phenols, flavonoids, saponins, tannins and alkaloids present in *C. acutum*, *A. arvensis*, *C. murale*, *M. parviflora*, *S. oleraceus* and *P. oleracea*. From the present study, it is concluded that the aqueous extract of the tested plants can be used as natural source in controlling *B. pilosa*.

Keywords: Allochemicals, Allelopathy, Herbicides, Weeds

1. Introduction

In recent years, weed biology and its importance to management has been considered very much [1]. Weeds of arable lands represent a biologically important component of their environments. These weeds did not exist before agriculture but grew beside the cultivated crops [2]. These weeds are characterized by their rapid and aggressive growth, they share the habitats, moisture, nutrients and soil of the plants in their space or disturbing the habitats that they invade.

Portulaca oleracea L., that is known commonly as purslane is belongs to family Portulacaceae. It is a succulent, herbaceous, annual and warm-climate plant with a cosmopolitan distribution. It is used as a potherb and is used in salad sand soups

in tropical Asian and Mediterranean nations. Many countries have utilized it as folk medicine [3]. *Cynanchum acutum* L. (Swallowwort) of the Asclepiadaceae family is a perennial invasive plant with significant therapeutic potential [4]. *Anagallis arvensis* (family: Primulaceae) is a winter annual herb that grows all over the world. It is used medicinally for many purposes [5]. *Chenopodium murale* L. is an essential annual herbaceous weed that belongs to family Chenopodiaceae. It is commonly known as nettle leaf goosefoot [6]. *Malva parviflora* (family: Malvaceae) leaf and root bark are eaten as vegetables in Ethiopia. It is also used to treat carbuncles, furuncles, wound infections, and other similar conditions [7]. *Sonchus oleraceus* (Asteraceae family) is an annual herbaceous plant endemic to West Asia, North Africa and Europe. It has expanded to South and North America, Australia's south, India, and China [8].

Most common problems that face the agricultural production is the weeds interference with

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crop growth and production. These weeds produce chemical compounds called allelochemicals. Allelopathy refers to the biochemical reactions that take place between two or even more plants and it occurs as a result of the existence of natural chemical compounds (allelo-chemicals) emitted by a species that is antagonistic to the physiological processes of plants or neighboring organisms [9, 10].

The allelopathic phenomena has been known for over 2000 years. It occurs as a result of the existence of natural chemical compounds (allelochemicals) emitted by a species that is antagonistic to the physiological processes of plants or neighboring organisms [11]. The International Allelopathy Society defined allelopathy in 1996 as "any process connected to the generation of secondary metabolites by plants that influences the development and growth of biological and agricultural systems, including both negative and positive influences" [12]. Allelochemicals enter the environment by a variety of mechanisms, including root exudation, leaching from aboveground sections, volatilization, and/or degradation of plant components [11].

Allelopathic interactions between plants were identified in both natural and controlled settings. In cultivated environments, allelopathy can contribute to weed-crop interactions as well as crop-crop interactions. This can cause an effect in the economic outcome of plant production [13]. Recently, several researchers have recommended that allelopathy embraces great predictions for finding alternative strategies for weed management [14]. Weed control mediated by allelopathy either through the release of allelochemicals from plant or as natural herbicides appears to be advantageous for the environment compared to traditional herbicides. Some authors recommend that the allelopathic compounds may be a biodegradable and less polluting than traditional herbicides [15]. Allelochemicals such as alkaloids, phenolic derivatives, coumarins, flavonoids, terpenoids, ethylene, and other secondary metabolites can either impede or accelerate plant and microbe growth and development [16, 17].

Golzardi *et al.* [18] investigated the allelopathic

effect of two *Cynanchum acutum* L. populations' leaf, stalk, and root on the germination percentage, radicle, and shoot length of corn (*Zea mays* L.). Researchers Faridmarandi *et al.* [1] investigated the allelopathic effect of *Cynanchum acutum* L. aqueous extract on the germination of wheat (*Triticum aestivum* L.). At higher concentrations of *Cynanchum acutum*, wheat and maize germination percentages, root and shoot length, and seedling weight all suffered. According to research by Batish *et al.* [19], the phenolic allelochemicals released by *Chenopodium murale* have a detrimental effect on the development, nodulation, and macromolecule content of chickpeas and peas. According to Gomaa *et al.* [20], *Sonchus oleraceus* dry shoot aqueous extracts have an allelopathic impact on the *Trifolium alexandrinum*, three additional weed species (*Melilotus indicus*, *Brassica nigra*, and *Chenopodium murale*), as well as *S. oleraceus* itself.

The present study was conducted to determine the allelopathic effect of the aqueous extracts of *C. acutum*, *A. arvensis*, *M. parviflora*, *C. murale*, *P. oleracea*, and *S. oleraceus* on the germination and seedling growth of *B. pilosa*.

2. Materials and methods:

2.1. Plant material:

The shoot system of *Cynanchum acutum*, *Anagallis arvensis*, *Chenopodium murale*, *Malva parviflora*, *Sonchus oleraceus* and *Portulaca oleracea* were collected from the fields randomly distributed in newly reclaimed lands in Ismailia Governorate. The plants shoot system were air-dried at room temperature and then ground into uniform powder [21].

2.2. Preparation of Aqueous Extracts:

According to Jafari *et al.* [22], the air-dried plants were grinding to fine powder using mortar and pestle. One hundred grams of plant powder were soaked in one liter of distilled water for 24 hours. The solution was filtered through Whatman No.2 filter paper. Four concentrations were prepared (25, 50, 75 and 100%) from the plants shoot system extract and stored separately in a sprayer. Distilled water was considered as control (0 %).

2.3. Collection and sterilization of tested seeds:

The seeds of *Bidens pilosa* (family: Asteraceae) were collected from the weed communities associated with crops grown in Ismailia governorate.

Seeds were sterilized with 1% sodium hypochloride, and then rinsed with sterilized distilled water for several times to remove excess of chemicals.

2.4. Seed germination bioassay:

The experiment covered a period of ten days to allow seed germination. The germination test was carried out in sterile Petri-dishes (12 cm. in diameter) using Whatman No.2 filter papers. The aqueous extract of different concentration (control, 25, 50, 75 and 100%) was added every 2 days to each corresponding Petri-dishes [23].

Twenty seeds of *Bidens pilosa* were randomly placed in the Petri-dishes. Three replicates were done. Daily germination percentages were recorded, and seeds were deemed germinated when the radicle appeared. Therefore, inhibition and germination percentages were calculated using formulas described by Sundra and Pote [24]:

Germination percentage = (Number of germinated seeds / Total number of sown seeds) x 100

Inhibition percentage = 100 – (E2 x 100/E1)

E1 = Response of control seed.

E2 = Response of treated seed.

2.5. Seedling Growth Test:

The experiment covered a period of thirty days to measure the shoot and root length. The seeds were sown at equal depths in the pots 14 cm. in diameter filled with sandy soil. The pots were kept at room temperature (32°C) and the plants in the pots were irrigated with leaf aqueous extracts of the tested concentrations when needed. Meanwhile, the plants in the control pot were irrigated with distilled water. Only ten seeds were kept in each pot in order to avoid intraspecific competition among the plants for limited supply of nutrients. Shoot length were measured at thirty days from sowing, in order to assess the effect of various aqueous extracts of different concentrations on the growth of the plants grown in the pots [25].

2.6. Preliminarily phytochemical screening:

The collected shoot systems of the selected invasive weed species from the studied sites, (*Portulaca oleracea*, *Cynanchum acutum*, *Sonchus oleraceus*, *Malva parviflora*, *Anagallis arvensis* and *Chenopodium murale*) previously prepared were used to explore some bioactive secondary constituents. Five grams of air-dried plant powder were refluxed for 6 hours in 250 ml of distilled water before being filtered. After that, the residue was rinsed multiple times with hot 95% alcohol. The mixed filtrates were concentrated using a rotary evaporator at decreased pressure. The temperature does not exceed 50°C, and then used in tests for alkaloids, saponins, phenols, tannins and flavonoids.

2.6.1. Alkaloids Detection:

The method of Woo *et al* [26] was followed to test for the presence of alkaloids using Mayer's reagent [27].

2.6.2. Saponins Detection:

Foam test was carried out according to the method of Kokate *et al.* [28].

2.6.3. Phenols Detection:

Ferric chloride test was used to test for the present of phenols [29].

2.6.4. Tannins Detection:

Tannins were detected in the plant extracts by using lead acetate test [30].

2.6.5. Flavonoids Detection:

Schinoda's test was carried out to test for the presence of flavonoids according to Geissmann [31].

3. Results

3.1. Effect of aqueous extracts of *Portulaca oleracea*, *Cynanchum acutum*, *Sonchus oleraceus*, *Malva parviflora*, *Anagallis arvensis* and *Chenopodium murale* on seed germination of *Bidens pilosa*

The allelopathic potential of the studied invasive weeds aqueous extract on the germination of *B. pilosa* is shown in Table (1). The results showed that

the aqueous extract of the tested plants reduced the germination of *B. pilosa*. The magnitude of germination reduction is more pronounced in the high concentrations of the tested plants than the lower concentrations.

At the concentration 100%, the aqueous extract of all the tested plants totally inhibited the germination of *B. pilosa* (100%). On the other hand, at the concentration 75%, the extracts of *C. acutum*, *S. oleraceus*, *M. parviflora* and *C. murale* showed the highest inhibition percentage (100%), while the extract of *A. arvensis* showed the lowest inhibition percentage (13.33%).

At the concentration 50%, the extracts of *M. parviflora* showed the highest inhibition percentage (100%), while the extract of *A. arvensis* showed the lowest inhibition percentage (6.67%). On the other hand, *C. murale*, *S. oleraceus*, *C. acutum* and *P. oleracea* showed the value of 93.33%, 66.67%, 60% and 20% respectively.

C. murale and *M. parviflora* showed the highest inhibition percentage (33.33% for each) at the concentration 25%, but *A. arvensis* and *P. oleracea* showed the lowest inhibition percentage (6.67% for each). On other hand, *C. acutum* and *S. oleraceus* showed the value of 26.67% and 13.33% respectively.

3.2. Effect of the aqueous extract of the selected weeds on the shoot length of *Bidens pilosa*

The length and the inhibition percentage of the shoot of *B. pilosa* are shown in Figure (1). At the concentration 100%, the aqueous extracts of *P. oleracea*, *C. acutum*, *S. oleraceus* and *M. parviflora* showed a complete inhibition percentage of shoot growth (100% each), while the extract of *C. murale* and *A. arvensis* showed the lowest value (75.53% and 78.16% respectively).

At the concentration 75%, the extracts of *C. acutum*, *S. oleraceus* and *M. parviflora* showed the highest shoot growth inhibition percentage (100% each), while the extract of *A. arvensis* showed the lowest value (55.10%). On the other hand, *C. murale* and *P. oleracea* showed the values of 67.23%.

At the concentration 50%, the extract of *C. murale* showed the highest shoot growth inhibition percentage (73.30%), while *P. oleracea* showed the

lowest value (34.95%). The other plant species attained the values of 62.38% (*C. acutum*), 57.52% (*A. arvensis*), 55.58% (*M. parviflora*) and 53.88% (*S. oleraceus*).

At the concentration 25%, the extract of *S. oleraceus* showed the highest shoot growth inhibition percentage (47.82%), while *M. parviflora* showed the lowest value (4.37%). On the other hand, *C. murale*, *A. arvensis*, *C. acutum* and *P. oleracea* attained the values of 46.60%, 25.97%, 19.40% and 13.35% respectively.

It is obvious that *C. acutum* is the most effective plant extract inhibit the shoot growth of *B. pilosa* followed by *S. oleraceus*, *M. parviflora*, *P. oleracea*, *C. murale* and *A. arvensis*.

3.3. Effect of the aqueous extract of the selected weeds on the root length of *B. pilosa*

The length and the inhibition percentage of the root of *B. pilosa* are shown in Figure (2). At the concentration 100%, the aqueous extracts of *P. oleracea*, *C. acutum*, *S. oleraceus* and *M. parviflora* showed the highest root growth inhibition percentage (100%). On the other hand, *A. arvensis* and *C. murale* showed the values of 48.94% and 40.43% respectively.

At the concentration 75%, the extracts of *C. acutum*, *S. oleraceus* and *M. parviflora* showed the highest inhibition percentage (100%), while the extract of *P. oleracea* showed the lowest inhibition percentage (17.02%). *C. murale* and *A. arvensis* showed the values of 25.53% and 34.04% respectively.

At the concentration 50%, the extract of *M. parviflora* showed the highest root growth inhibition percentage (48.94%), while *C. acutum* showed the lowest inhibition percentage (17.02%). The other weed species attained the values of 43.40% (*P. oleracea*), 42.55% (*C. murale*), 39.15% (*A. arvensis*) and 36.17% (*S. oleraceus*).

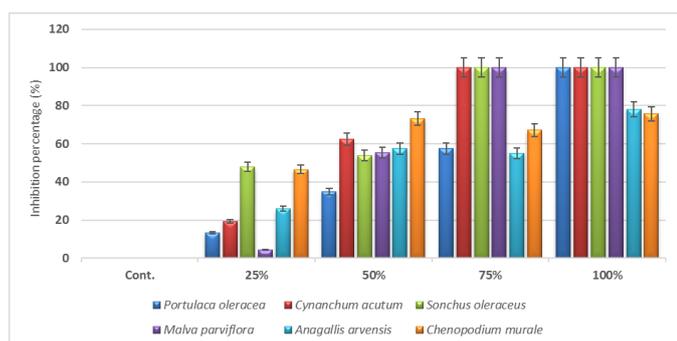
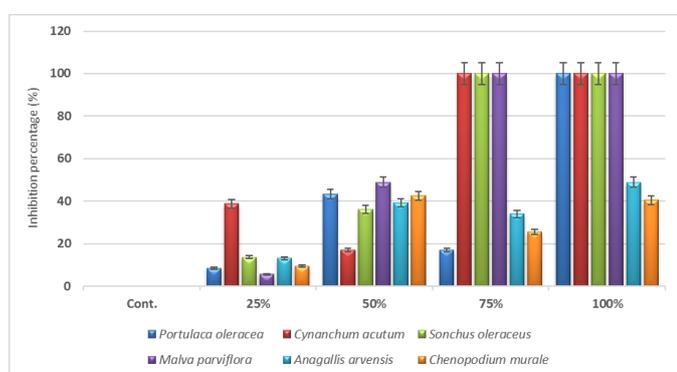
At the concentration 25%, the extract of *C. acutum* showed the highest root growth inhibition percentage (38.72%), while *M. parviflora* showed the lowest inhibition percentage (5.53%). On the other hand, *S. oleraceus*, *A. arvensis*, *C. murale* and *P. oleracea* showed an inhibition 13.62%, 13.19%, 9.36% and 8.51% respectively.

Table 1: Germination (G%) and inhibition (I%) percentages of *Bidens pilosa* treated with aqueous extracts of the selected invasive weeds, (high values are in bold)

Concentrations	Cont.		25%		50%		75%		100%		P-value
	(0%)		% G	% I	% G	% I	% G	% I	% G	% I	
<i>Portulaca oleracea</i>	75	0	80	6.67	60	20	5	93.33	0	100	0.021*
<i>Cynanchum acutum</i>	75	0	55	26.67	30	60	0	100	0	100	0.005*
<i>Sonchus oleraceus</i>	75	0	65	13.33	25	66.67	0	100	0	100	0.010*
<i>Malva parviflora</i>	75	0	50	33.33	0	100	0	100	0	100	0.041*
<i>Anagallis arvensis</i>	75	0	80	6.67	80	6.67	65	13.33	0	100	0.121
<i>Chenopodium murale</i>	75	0	50	33.33	5	93.33	0	100	0	100	0.029*

* Values are significant at $p < 0.05$

It is obvious that *C. acutum* is the most effective plant extract inhibit the root growth of *B. pilosa* followed by *S. oleraceus*, *M. parviflora*, *P. oleracea*, *C. murale* and *A. arvensis*.

Figure 1: Shoot inhibition percentage (%) of *Bidens pilosa* treated with aqueous extract of the selected invasive weedsFigure 2: Root inhibition percentage (%) of *Bidens pilosa* treated with aqueous extract of the selected invasive weeds

3.4. Preliminarily phytochemical screening

The results of preliminarily phytochemical screening for active constituents of the selected weeds are presented in Table (2). The ethanolic extract of *P. oleracea*, *C. acutum*, *S. oleraceus*, *M. parviflora* and *C. murale* revealed the presence of flavonoids, tannins, alkaloids, saponins and phenols. On the other hand, the extract of *Anagallis arvensis* exhibited presence of all the previous secondary metabolites and the absence of saponins.

4. Discussion

Allelopathy is referred to the harmful or beneficial effects of one plant on another plant, by releasing some allelochemicals by several ways as volatilization leaching, root exudation, and residue decomposition. Allelochemicals are secondary metabolites that are not necessary for metabolism (development and growth) [32].

Many types of allelochemicals are present in plants. Phenolic compounds contain aromatic phenols, some flavonoids, tannins, cinnamic acid derivatives, quinones, and hydroxyl and substituted benzoic acids. Many researchers reported that alkaloids are also recognized for their allelopathic effect. Terpenoids have been used medicinally since ancient times, but they also include a number of allelochemicals. 1,8-cineole and camphor are volatile monoterpenes that hinder plant development [33].

Table 2: Preliminarily phytochemical screening of theselected invasive weed species

Phyto-chemicals	<i>Portulaca oleracea</i>	<i>Cynanchum acutum</i>	<i>Sonchus oleraceus</i>	<i>Malva parviflora</i>	<i>Anagallis arvensis</i>	<i>Chenopodium murale</i>
Flavonoids	++	++	++	++	++	++
Tannins	++	++	++	++	++	++
Alkaloids	++	++	++	++	++	++
Saponins	++	+	++	++	-	++
Phenols	++	+	++	++	+	++

(++: highly present, +: moderately present, -: absent)

The results in the present study of the allelopathic potential of *P. oleracea*, *C. acutum*, *S. oleraceus*, *M. parviflora*, *A. arvensis* and *C. murale* aqueous extract on the germination of *B. pilosa* showed that the aqueous extract of the tested plants reduced the germination and seedling growth of *B. pilosa* at different concentrations.

The aqueous shoot extract of *C. acutum* decrease the seed germination of *B. pilosa*. It showed 26.67% inhibition at concentration 25%, 60% inhibition at concentration 50% and 100% inhibition at the two concentrations 75% and 100%. Also, the shoot and the root growth of *B. pilosa* is affected, it showed 19.4% inhibition of shoot growth at concentration 25%, 62.38% inhibition at concentration 50% and 100% inhibition at the two concentrations 75% and 100%. While, it showed 38.72% inhibition percentage of root growth at the concentration 25%, 17.02% inhibition at the concentration 50% and 100% inhibition at the two concentrations 75% and 100%. These findings are consistent with those of Golzardi *et al.* [18], who discovered that raising the concentration rate of *C. acutum* reduced the germination percentage, radicle, and shoot length of *Zea mays* crop. The aquatic extract of *C. acutum* showed different allelopathic effects on germination and seedling growth of wheat [1]. Golzardi *et al.* [34] showed that the water extract of *C. acutum* had allelopathic effects on germination trait and crops development; as by increasing the concentration rate of the extract of the plant, the germination percentage, radicle and shoot length of Barley crop decreased. The allelopathic potential of *C. acutum* may be attributed to the presence of allelochemicals (tannins, alkaloids, flavonoids, phe-

nolic acids and saponins), which are described in *C. acutum* by Abu Ziada *et al.*, Shivamanjunatha *et al.*, and Youssef *et al.* [35–37] and confirmed in the present study in table (2).

S. oleraceus aqueous shoot extract reduced the seed germination of *B. pilosa*. It showed 13.33%, 66.67% and 100% inhibition at concentrations 25%, 50%, 75% and 100% respectively. Also, the shoot and the root growth of *B. pilosa* is affected, it showed 47.82% inhibition of shoot growth at concentration 25%, 53.88% inhibition at concentration 50% and 100% inhibition at the two concentrations 75% and 100%. While, it showed 13.62% inhibition percentage of root growth at the concentration 25%, 36.17% inhibition at the concentration 50% and 100% inhibition at the two concentrations 75% and 100%. These results are in line with that of Gomaa *et al.* [20] which revealed that the aqueous extract of *S. oleraceus* had inhibitory effects on the germination and seedling growth of *Trifolium alexandrinum*, *Brassica nigra*, *Chenopodium murale*, *Melilotus indicus* and *Sonchus oleraceus* itself. Hassan *et al.* [38] confirmed that *S. oleraceus* inhibited germination and growth of *Brassica nigra* and *Melilotus indicus*. The results of Hassan [39] suggest that *S. oleraceus* could affect the productivity of wheat and cause weed suppression due to its allelopathic potential. The aqueous extract of *S. oleraceus* (8%) can be used for controlling red rice weed [40]. The allelopathic potential of *S. oleraceus* may be due to the presence of allelochemicals (tannins, alkaloids, flavonoids, phenolic acids and saponins). These results were confirmed by Shehata and Galal, Shadid *et al.*, and Mohasib *et al.* [41–43] in *S. oleraceus*.

The aqueous extract of *M. parviflora* reduced the seed germination of *B. pilosa*. It showed 33.33% inhibition at concentration 25% and 100% inhibition at the three concentrations 50%, 75% and 100%. Also, the shoot and the root growth of *B. pilosa* is affected, it showed 4.37% inhibition of shoot growth at concentration 25%, 55.58% inhibition at concentration 50% and 100% inhibition at the two concentrations 75% and 100%. While, it showed 5.53% inhibition percentage of root growth at the concentration 25%, 48.94% inhibition at the concentration 50% and 100% inhibition at the two concentrations 75% and 100%. Al-Johani *et al* [44] revealed that *M. parviflora* affected the growth of Barley at the concentrations 25%, 50%, 75% and 100%. The allelopathic potential of *M. parviflora* is related to the presence of allelochemicals (tannins, alkaloids, flavonoids, phenolic acids and saponins). These findings are confirmed by Zahedi and Ansari [41, 45] as they reported the inhibitory role of allelochemicals in *Malva sp.* extract.

Portulaca oleracea reduced the seed germination of *Bidens pilosa*. It showed 6.67% inhibition at concentration 25%, 20% at concentration 50%, 93.33% at concentration 75% and 100% inhibition at concentration 100%. Also, the shoot and the root growth of *Bidens pilosa* is affected, it showed 13.35% inhibition of shoot growth at concentration 25%, 34.95% inhibition at concentration 50%, 57.52% inhibition at concentration 75% and 100% inhibition at concentration 100%. While, it showed 8.51% inhibition percentage of root growth at the concentration 25%, 43.40% inhibition at the concentration 50%, 17.02% inhibition at concentration 75% and 100% inhibition at concentration 100%. These findings are consistent with Rashidi *et al.* [46], who found that the inhibitory chemicals emitted by *P. oleracea* may impact the competitive ability of surrounding plants or crop species throughout the development stage. Furthermore, *P. oleracea* aqueous extracts can be produced as bio-herbicides for weed control, and some crop species with allelopathic potential can be employed to suppress weeds, reducing the need for synthetic herbicides in conventional weed management. In the present study, the phytochemical analysis of *P. oleracea* indicated

that it is rich in tannins, alkaloids, flavonoids, phenolic acids and saponins. These allelochemicals also were described in *P. oleracea* by Youssef and Mokhtar, El Gindy, Almashad *et al.* and El-Desouky [47–50].

The aqueous shoot extract of *Chenopodium murale* reduced the seed germination of *Bidens pilosa*. It showed 33.33% inhibition at concentration 25%, 93.33% at concentration 50% and 100% at the two concentrations 75% and 100%. Also, the shoot and the root growth of *Bidens pilosa* is affected, it showed 46.60% inhibition of shoot growth at concentration 25%, 73.30% inhibition at concentration 50%, 67.23% inhibition at concentration 75% and 78.16% inhibition at concentration 100%. While, it showed 9.36% inhibition percentage of root growth at the concentration 25%, 42.55% inhibition at the concentration 50%, 25.53% inhibition at concentration 75% and 40.43% inhibition at concentration 100%. El-Khatib, *et al.* and Shafique, *et al.* [51, 52] reported that the aqueous extract of *C. murale* suppressed total root length, shoot biomass, shoot length, root biomass and number of roots of some plants. Daizy *et al.* [53] reported that the extract of *C. murale* has an effect on chickpea and pea plants. Al-Johani *et al.* [44] showed that the aqueous extract of *C. murale* effects the growth of barley plants. Majeed *et al.* [54] reported a reduction in photosynthesis of wheat (*T. aestivum*) by the action of different concentrations of *Chenopodium sp.* extracts. Islam *et al.* [55] suggests that *C. murale* has allelopathic potential due to its inhibitory effects on some tested plants. The phytochemical analysis of *C. murale* proved that the plant is rich in tannins, alkaloids, flavonoids, phenolic acids and saponins. These allelochemicals in *C. murale* were also in line with Zhou and Yu and Batish *et al.* [56, 57].

In *Anagallis arvensis*, the shoot extract reduced the seed germination of *Bidens pilosa*. It showed 6.67% inhibition at the two concentration 25% and 50%, 13.33% at concentration 75% and 100% at concentration 100%. Also, the shoot and the root growth of *Bidens pilosa* is affected, it showed 25.97% inhibition of shoot growth at concentration 25%, 57.52% inhibition at concentration 50%, 55.10% inhibition at concentration 75% and 78.16% inhibition at concentration 100%. While,

it showed 13.19% inhibition percentage of root growth at the concentration 25%, 39.15% inhibition at the concentration 50%, 34.04% inhibition at concentration 75% and 48.94% inhibition at concentration 100%. Rebaz *et al.* [58] reported that the aqueous extract of *A. arvensis* inhibited germination, root and shoot growth of *Triticum aestivum*, *Zea mays*, *Daucus carota*, *Brassica campestris*, *Brassica napobrassica*, *Schumann iplearl* and *Pennisetum americanm*. Salam *et al.* [59] showed that *A. arvensis* reduced the radical growth of mung bean. In the present study, the phytochemical analysis of *A. arvensis* indicated that it is rich in tannins, alkaloids, flavonoids, phenolic acids and saponins. These allelochemicals in *A. arvensis* were also in agreement with Al-Snafi and Edrah *et al.* [60, 61].

5. Conclusion

In conclusion, the aqueous extracts of *Portulaca oleracea*, *Cynanchum acutum*, *Sonchus oleraceus*, *Malva parviflora* and *Chenopodium murale* showed a potent allelopathic effect on the growth and germination of *Bidens pilosa*. The results of the present study revealed that the inhibitory effect of *Portulaca oleracea*, *Cynanchum acutum*, *Sonchus oleraceus*, *Malva parviflora* and *Chenopodium murale* aqueous extracts may be due to the presence of bioactive secondary compounds (allelochemicals).

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