Biochemical properties of black tea (*Camellia sinensis*) and its activities in controlling weeds

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Abstract:

Allelopathy is a physiological process that plants excrete several types of substances which have allelopathic effects on seed germination and seedling growth of other plants. This experiment was conducted to examine allelopathic effects of black tea residue (*Camellia sinensis*) aqueous leaf extract on seed germination and seedling growth of rapeseed (*Brassica napus*), wheat (*Triticum aestivum*), mung bean (*Vigna radiata*) and corn (*Zea mays*). The study was performed in sanitized petri dishes for seven days at 22C^0. The experimental design was arranged for completely randomized design (CRD). In terms of concentrations, (0%, 2.5%, 5%, 7.5% and 10%) were chosen for this experiment. The results showed that big concentrations (7.5% and 10%) aqueous leaf extracts of black tea had significant inhibitory effect on seed germination while the least concentration (%2.5) caused the lowest significant influence in seed germination. Other study parameters such as shoot length, root length, shoot dry weight, and root dry weight were significantly affected at concentrations (7.5 and 10%). The results illustrated that *B. napus* turned out to be the most sensitive studied plant to the application of black tea residue aqueous shoot extracts. The findings of this experiment suggest that black tea after cooking can still be recommended to use as a bioherbicide henceforward.

Key words: Allelopathy, allelochemicals, bioherbicide, aqueous extract, black tea.

1. Introduction

Allelopathy is defined as any direct influence or a non-direct harmful or advantageous beneficial of a plant or a microorganism on physiological activities of other organisms by allelochemical production and the release to the environment [1-3]. This phenomenon of plants which have influence on other plants by releasing chemicals was first addressed by Theophrastus in 370 BC [4]. The term of Allelopathy was first mentioned by Molisch [5] in 1937. Based on the previous records that are related to the production of allelochemicals, there are numerous of secondary plant metabolite which are meant to have allelopathic activities. For instance, some of the allelopathic plant products, such as, phenolics and alkaloids play crucial role in the activities of plants, for example, seed germination activity and the growth [2, 6-8].

Plants, that have ability to produce phytochemical compounds, should be able to produce chemical compounds which are named allelochemicals, that has be delivered into the surroundings which must be capable of reaching its chemicals for the process of transportation in order to make an influence to another plant[3, 7]. Various methods are found for delivering allelopathic active compounds to the environment, for example, leaching, leaf volatile, root exudation as well as the decomposition of plants [3, 9]. According to the current scientific studies, using chemical herbicides causes a range of risks to neighbouring that have negative influence on human health and disqualifies water, and it brings complications to soil microorganisms [10]. Further to the previous complications, about 470 weed species are resistant to synthetic herbicides which are no longer effective. Therefore , to avoid such an expected problem, plants that have bio-active compounds can be used as an alternative herbicide for reducing weed appearance, to such an extent which allelopathy might be considered to be a possible tool to minimize existence of weeds and improve crop yield [11,12, 14].

Tea is a drinkable beverage exceptionally well-known drink worldwide after water [13, 15]. *Camellia sinensis* is known as tea plant that makes up the most popular variety of tea, cultivated at least in 30 countries. Tea production is produced best in tropical and subtropical region and is cultivated and appropriately consumed in many Asian countries for thousands of years [15]. The original location of green Tea is returned to China which is classified into two types: Camellia sinensis and Camellia *sinensis Asemia* [16, 17]. The aim of this study was to investigate bioherbicidal effects of black tea residue aqueous extract on seed germination and growth parameters plants and weeds.

2. Materials and Methods

2.1 Collecting Samples

Black tea samples brand do ghazal were purchased in a local supermarket in Erbil-Kurdistan Region of Iraq in March - 2022. The tea samples were cooked normally. After cooking, the samples then filtered to obtain the residue. The residue samples then left for the air-dried purposes for two weeks.

2.2 Preparation of Aqueous extract

Aqueous extracts of the dried residue of black tea were prepared through the mix of 10 grams with 100 ml of distilled water. The samples then put into a shaker machine for the better mixing and then the extract was left shaking overnight. Centrifugate (1000 rpm) was utilized for the extracts for 10 min after filtration by using filter paper. The supernatant was then filtered by utilizing a micropore filter (0.45 µm). Finally, the resultant extracts were obtained and then stored at temperature 4°C until use for the germination test.

2.3 Experiment of seed germination

Seeds of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*) were utilized for this experiment. They were obtained from College of Agricultural Engineering Sciences/ Salahaddin University in Erbil. To avoid facing contamination, the seeds were sterilized with sodium hypochlorite (10%) and then washed and rinsed 3 times in deionized water. This process was performed to escape from contamination with pathogens during bioassay.

2.4 Bioassay

For this experiment, 10 seeds of the studied plants were put in petri dishes with 9 cm diameter separately and Whatman No.1 filter paper was placed under the seeds. Black tea residue extracts were applied to the petri dishes as 5 ml of different of concentrations (2.5%, 5.0%, 7.5%, and 10%) were utilized and added to the seed samples which they were the petri dish treatments. For the control petri dish treatments, they received 5 ml deionized water only. The experiment was composed of three replications of each seed species which include control and test treatments. During bioassay, petri dishes were placed in a growth chamber incubation at 22°C. After 7 days, seed germination percentage, shoot and root length, shoot and root dry weight of the seedlings were measured.

2.5 Statistical Analysis

The findings of this experiment were analyzed by using ANOVA general linear model (Minitab software, version 17). Completely randomized design (CRD) was chosen with three replications. Tukey's test (P ≤ 0.05) was used to calculate the significant differences between means.

3. Results

3.1 Effect of black tea residue aqueous extract on seed germination

Figure 1 illustrates the influence of concentrations of black tea residue aqueous extracts on germination of rapeseed (*Brassica napus*), wheat (*Triticum aestivum*), mung bean (*Vigna radiata*) and corn (*Zea mays*). Results indicate that the tea aqueous extracts recorded significant inhibition on seed germination of all the studied plants at concentrations (7.5% and 10%). The highest effect was in *B. napus* which was significantly inhibited by all the concentrations.

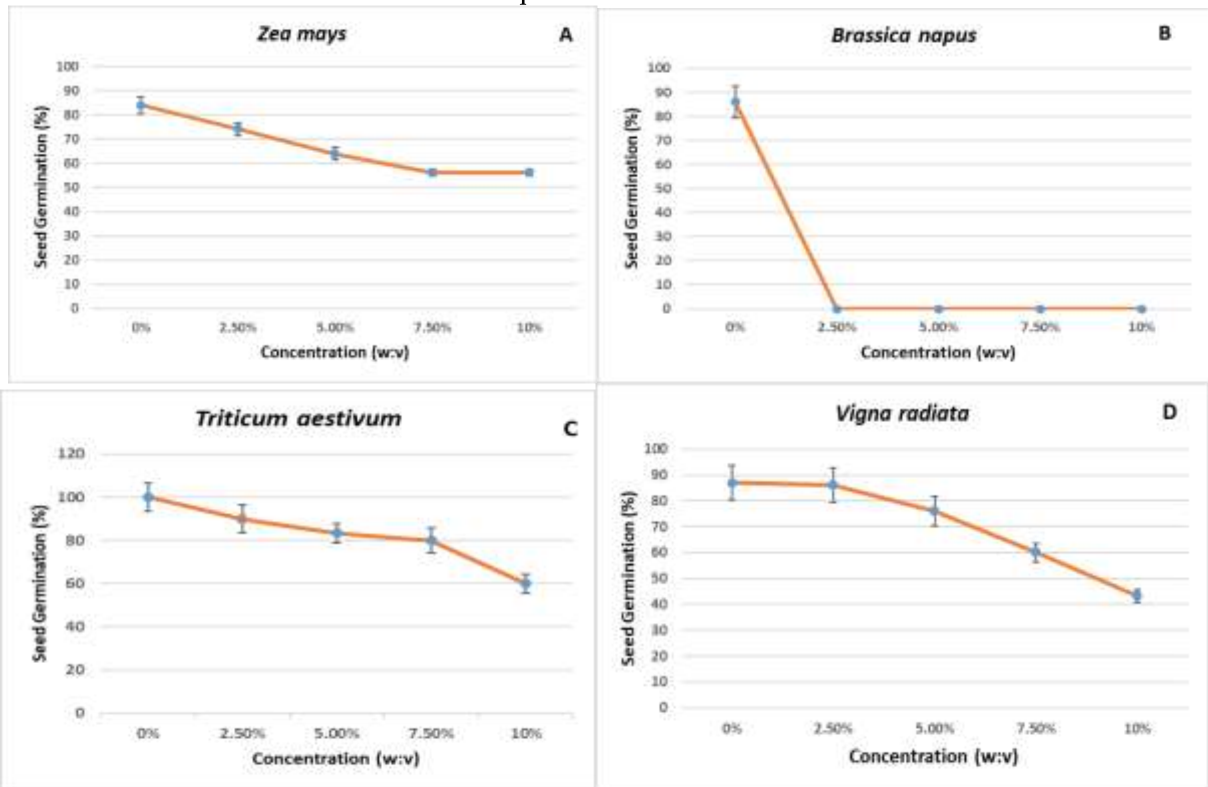

Figure 1 Effect of black tea residue extracts on seed germination of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*). The results refer to the means of three replications. Standard Error was representing error bars. Tukey's test (P ≤ 0.05) was used to calculate the significant differences between means.

3.2 Effect of black tea residue aqueous extract on shoot length

The results of this study (Figure 2) indicate that black tea residue extracts at 5%, 7.5% and 10% concentrations significantly inhibited shoot length of all the examined species. Shoot length of *B. napus* turned out to be more sensitive and significantly influenced by the evaluation of all the concentrations of black tea residue aqueous extracts (Figure 6).

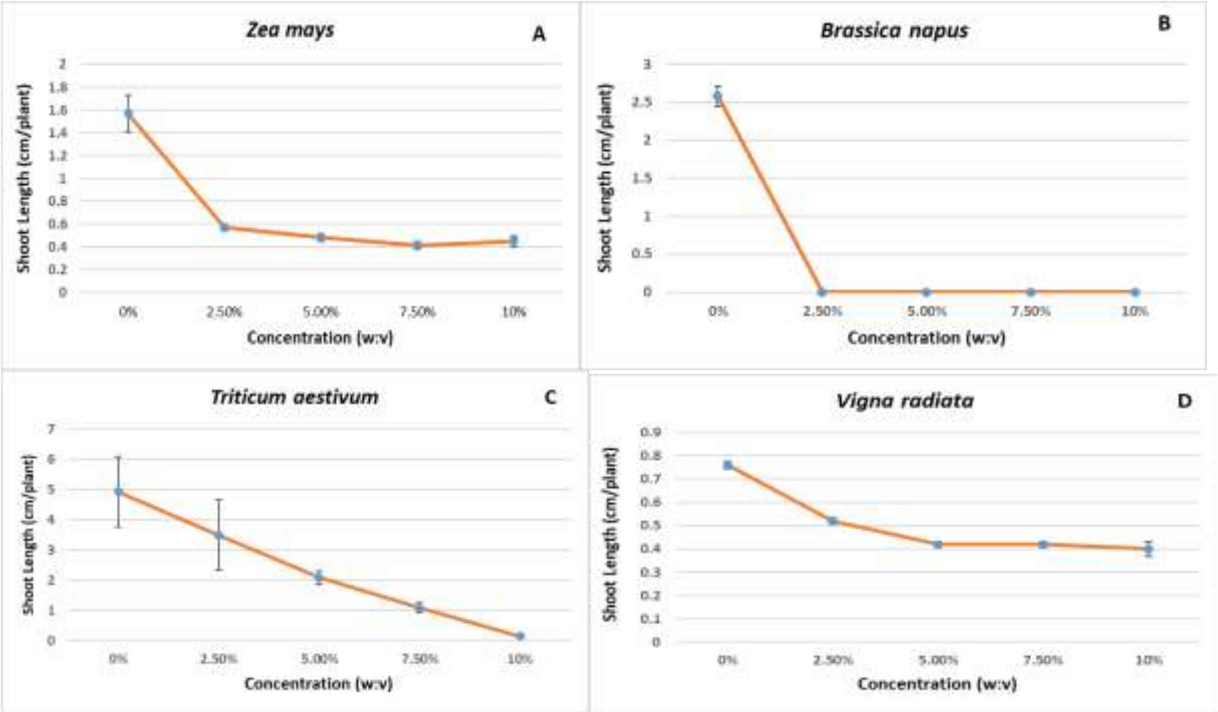

Figure 2 Effect of black tea residue extracts on shoot length of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*). The results refer to the means of three replications. Standard Error was representing error bars. Tukey's test ($P \leq 0.05$) was used to calculate the significant differences between means.

3.3 Effect of black tea residue aqueous extract on root length

The findings from Figure 3 show that root length of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*) were significantly inhibited using black tea residue shoot aqueous extracts at the highest concentration (10%). Additionally, most significant reduction was recorded by the application of black tea residue aqueous extracts on root length of *B. napus* (Figure 6).

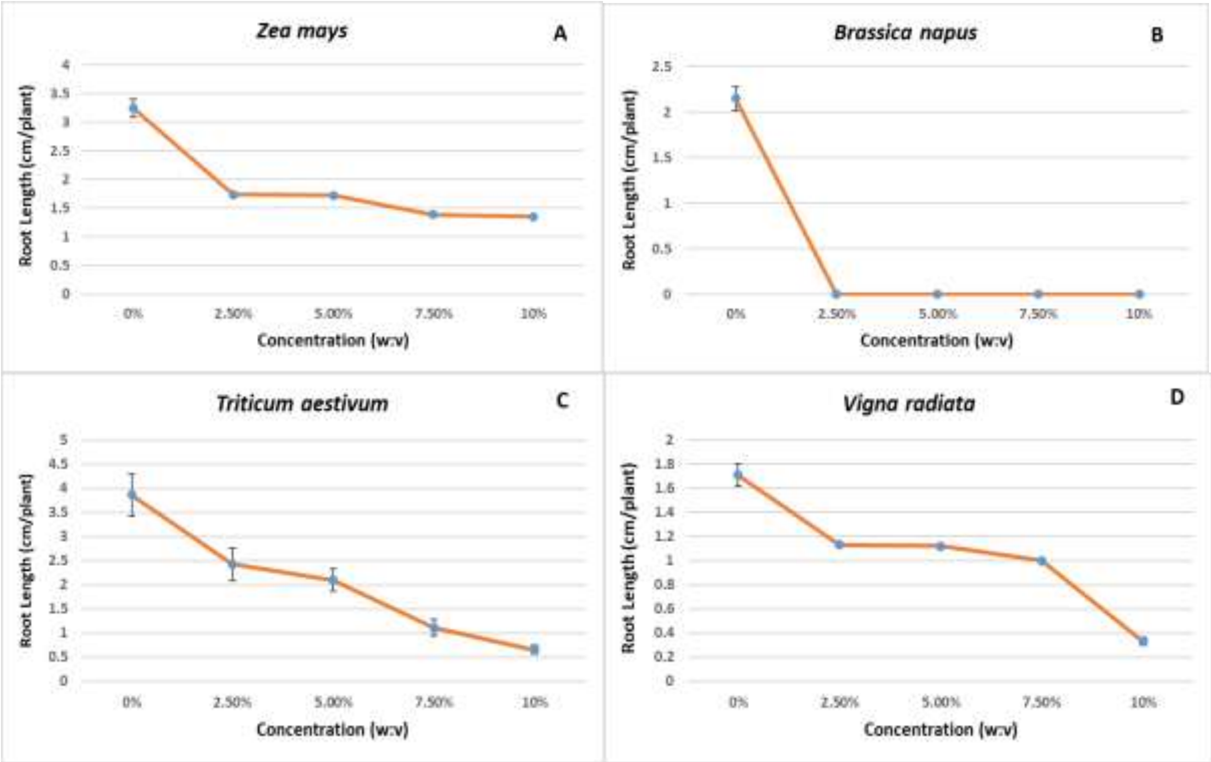

Figure 3 Effect of black tea residue extracts on root length of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*). The results refer to the means of three replications. Standard Error was representing error bars. Tukey's test ($P \leq 0.05$) was used to calculate the significant differences between means.

3.4 Effect of black tea residue aqueous extract on shoot dry weight

Figure 4 indicates the influence of black tea residue aqueous extract at different concentrations on the dry weight of shoots of *B. napus*, *T. aestivum*, *V. radiata* and *Z. mays*. The results of this investigation show that shoot dry weight of all the studied species were highlighted to have significant reduction in shoot dry weight by the application of higher concentrations (7.5% and 10%). Among the studied species, *B. napus* was totally affected using aqueous extract ($P < 0.001$) of black tea residue at all concentrations in comparison to other plant species as they were less significantly inhibited.

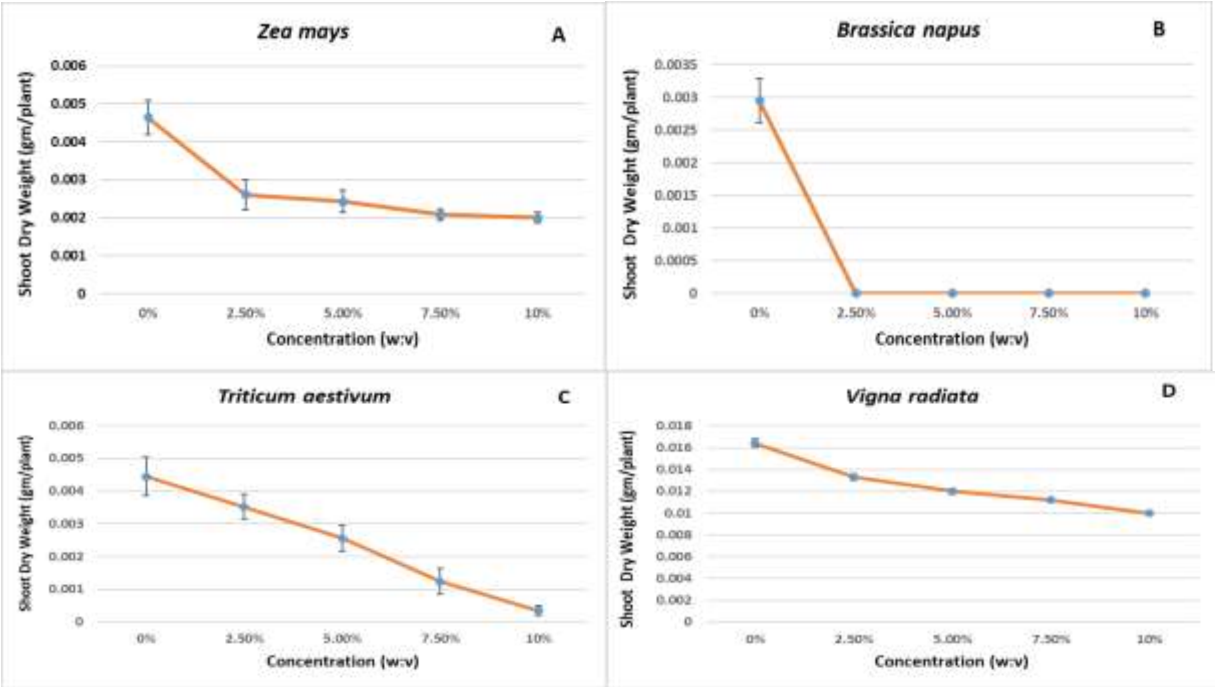

Figure 4 Effect of black tea residue extracts on shoot dry weight of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*). The results refer to the means of three replications. Standard Error was representing error bars. Tukey's test ($P \leq 0.05$) was used to calculate the significant differences between means.

3.5 Effect of black tea residue aqueous extract on root dry weight

Figure 5 illustrates that root oven dry weight of *B. napus*, *T. aestivum*, *V. radiata* and *Z. mays* were significantly ($P < 0.001$) inhibited by the concentrations 5% 7.5% and 10 % of shoot aqueous extracts black tea residue aqueous extracts. Additionally, the results of this study indicate that root dry weight of *B. napus* had more significant reduction when compared to other evaluated species.

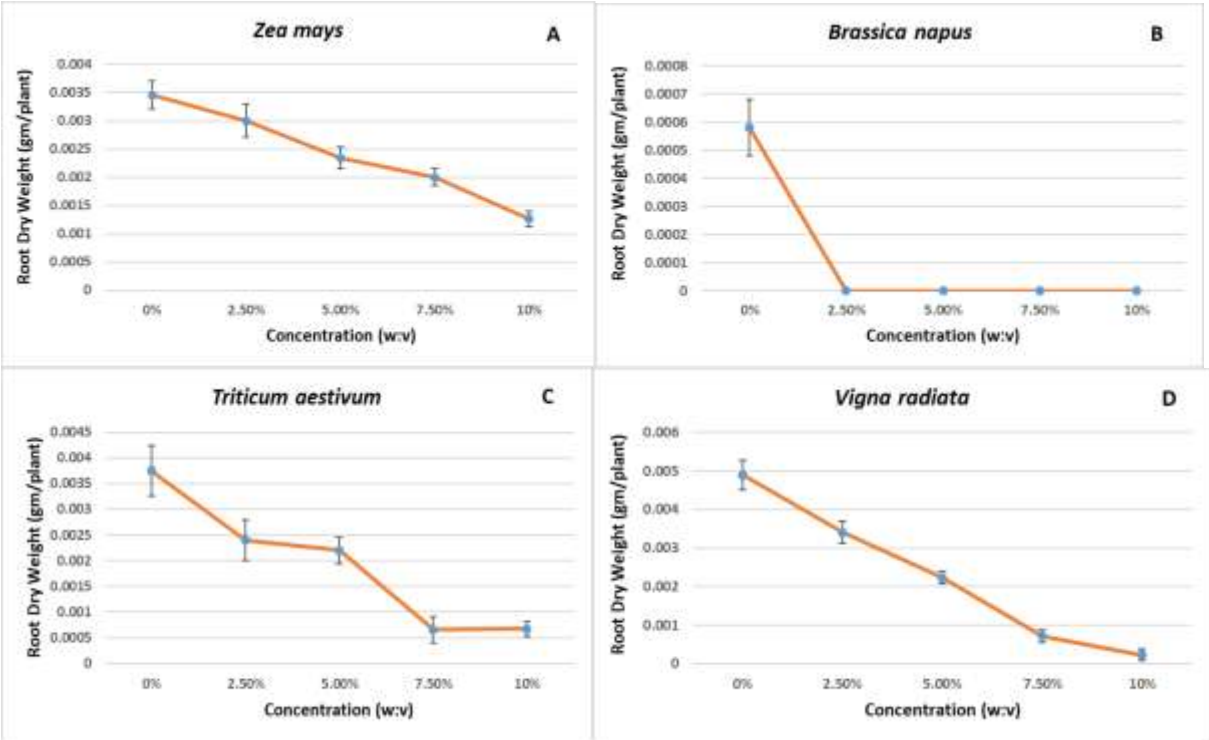

Figure 5 Effect of black tea residue extracts on root dry weight of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V. radiata*) and corn (*Z. mays*). The results refer to the means of three replications. Standard Error was representing error bars. Tukey's test (P ≤ 0.05) was used to calculate the significant differences between means.

%0 %2.5 %5 %7.5 %10
%0 %2.5 %5 %7.5 %10

Figure 6 Effect of black tea residue aqueous extracts (%2.5, %5, %7.5, %10) on growth parameters of *Z. mays, V.* %0 %2.5 %5 %7.5 %10 %0 %2.5 %5 %7.5 %10 *radiata, T. aestivum* and *B. napus.*

4. Discussion

The biochemical activities of black tea residue (*Camellia sinesis*) aqueous extracts at different concentrations (0%, %2.5, %5, %7.5, and %10) on germination and seedling growth of rapeseed (*Brassica napus*), wheat (*Triticum aestivum*), mung bean (*Vigna radiata*) and corn (*Zea mays*) were evaluated. The seed germination reduction, shoot length and root length, shoot oven dry weight and root oven dry weight of the examined species can be as a result of the influence of allelopathic compounds, for example, phenolic acids that appear in black tea dried leaves extract [18]. Previous investigations were found to mention the effect of phenolic compounds on seed germination and seedling growth of plants that have a contribution with growth and its hormonal activities [19]. The findings are in accordance with Rezaaenodehi *et al* (2006) who indicated that extracts of tea (leaf, flower and fruit) at different concentrations significantly reduced on germination and growth of garden cress (*Lepidium sativum* L.), lettuce (*Lactuca sativa* L.), redroot pigweed (*Amaranthus retroflexus* L.) and golden foxtail (*Setaria glauca* (L.) P.Beauv.) and the results in [18].

The results regarding the allelopathic properties of the concentrations (0%, %2.5, %5, %7.5, and %10) of black tea residue shoot extracts on seed germination and seedling growth of rapeseed (*B. napus*), wheat (*T. aestivum*), mung bean (*V.*) and corn (*Z.*) illustrated that the negative influence can be increased by increasing of concentration of the black tea residue shoot aqueous extract[19] . The higher concentrations (7.5% and 10%) extracts showed the most allelopathic effects on seed germination and growth parameters of the studied species[20, 21]. These findings are in accordance with the results recorded by Sharma and Satsangi [22], who mentioned that that bigger concentrations such as (50-100%) of *Helianthus annuus* shoot aqueous extracts gave more negative reduction than the lower application of the concentrations on seed germination and growth of *Amaranthus viridis* and *Parthenium hysterophorus*. In addition, these results are similar with the results of Waris *et al* (2016) who illustrated that black tea methanolic extract significantly inhibited seed germination and growth of wheat and maize [23].

Seed germination and growth reduction of *B. napus*, *T. aestivum*, *V. radiata* and *Z. mays* may be due to the appearance of allelopathic compounds in black tea residue shoot extracts as this interprets that they may give negative influences on plant growth through affecting cell division and the physiological activities that are related to growth and development of plants. In addition, during the seed germination activities, cell membrane permeability of the studied plant and weeds could be suffered due to the production of allelochemicals in black tea residue extracts [24]. Phytochemical compounds may alter respiration process and could reduce RNA and ATP concentration or *forestry*. 2008: Springer.

they might disturb the functions of secondary messengers that are crucial for seed germination and growth development [25].

The findings of this experiment showed that black tea leaf residue aqueous extracts have allelopathic effects on seed germination, shoot length, root length, shoot oven dry weight and root dry weight [26, 27]. Furthermore, our results are in agreement with Turk and Tawaha [28], who indicated leaf aqueous extracts of black mustard produces the greater allelochemical compounds and could have greater allelopathic effects [29]. In addition, this could be due to the reason that allelochemicals which are water soluble have great inhibitory influences from shoot aqueous extracts [30, 31, 32]. In conclusion, black tea residue aqueous extracts have allelopathic influences on seed germination and seedling growth of both monocot and dicot studied species which these findings could lead to be alternative to using of synthetic herbicides and it can be a production of bioherbicides for eliminating weeds henceforth.

5. Acknowledgment

We are thankful to both Tishk International University-Erbil and Salahaddin University-Erbil for providing support and facilities during the lab work.

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