CHEMICAL COMPOSITION OF CARAWAY (*Carum carvi* L.) ESSENTIAL OIL AND PHYTOTOXICITY ON RADISH

KEMIJSKI SASTAV ETERIČNOG ULJA KIMA (*Carum carvi* L.) I NJEGOVO FITOTOKSIČNO DJELOVANJE NA ROTKVICU

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ABSTRACT

Caraway essential oil (*Carum carvi* L.) exhibits significant herbicidal potential against weed seedlings and crops. This study evaluated the phytotoxic effects of fractions of caraway oil, main compounds: carvone, and d-limonene in different proportions, on the germination and seedling growth of radish (*Raphanus sativus* L.). The findings revealed that both carvone and d-limonene demonstrated inhibitory effects on all the tested seedlings, but depending on the proportion of carvone in the fraction – the higher the stronger herbicidal effect toward radish.

Keywords: botanical herbicide, carvone, d-limonene.

INTRODUCTION

Weeds are the main factor limiting agricultural productivity and can cause yield losses of up to 45%. Therefore, weed management is the most crucial crop protection technique. Sadly, the increasing resistance of weeds to synthetic herbicides has necessitated exploring alternative, eco-friendly weed management strategies. As a result of this, the use of plant derived chemicals e.g. EOs as potential synthetic replacements is more and more important. The aim of this experiment was to evaluate the phytotoxicity of oil-in-water (o/w) emulsions containing different proportions of carvone and limonene of natural origin in relation to seedlings of model crop - radish (*Raphanus sativus*).

MATERIALS AND METHODS

Caraway essential oil (EO) was subjected to fractionation of the oil and analysis of its composition. Fraction A: limonene (94%) and carvone (5%); Fraction B: limonene (84%) and carvone (15%); Fraction C: limonene (80%) and carvone (18%); Fraction D: limonene (74%) and carvone (25%); Fraction E: limonene (53%) and carvone (46%); Fraction F: limonene (3%) and carvone (96%); Fraction G: limonene (0.1%) and carvone (99%). The oil in water (o/w) nanoemulsions included various fractions (A-G) derived from the essential oil of caraway (*Carum carvi* L.). Concentrations of I- 0.1%, II- 0.05% and III - 0.001% were selected for each fraction. The control treatment was composed of water only. A Petri dish (11 cm diameter) experiment was carried out in glass dishes, with three repetitions. Two sterile filter paper rings were placed in each petri dish and soaked with 5 mL of an appropriate o/w solution of EO (Fraction A-G). Thirty seedlings (pre-germinated) of the tested species were placed on two layers of sterile filter paper in each dish. The seedlings were allowed to grow for seven days in the dark at room temperature (±25 °C). The seedlings were counted, and the lengths (cm) of their roots and shoots were measured.

RESULTS AND DISCUSSIONS

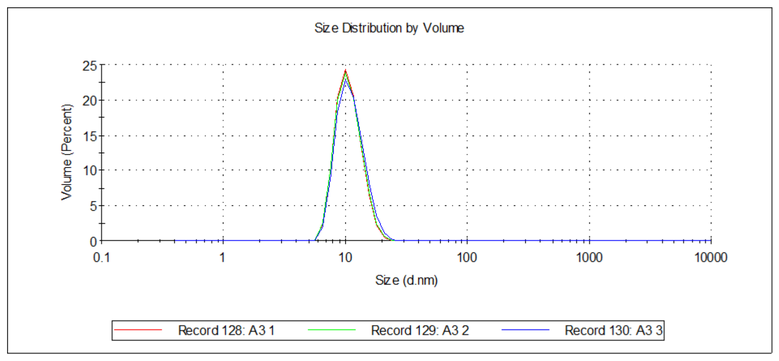


Figure 1: Droplet sizes of the nanoemulsion A3.

The average droplet size was used to determine the rheological properties of the obtained preparations.

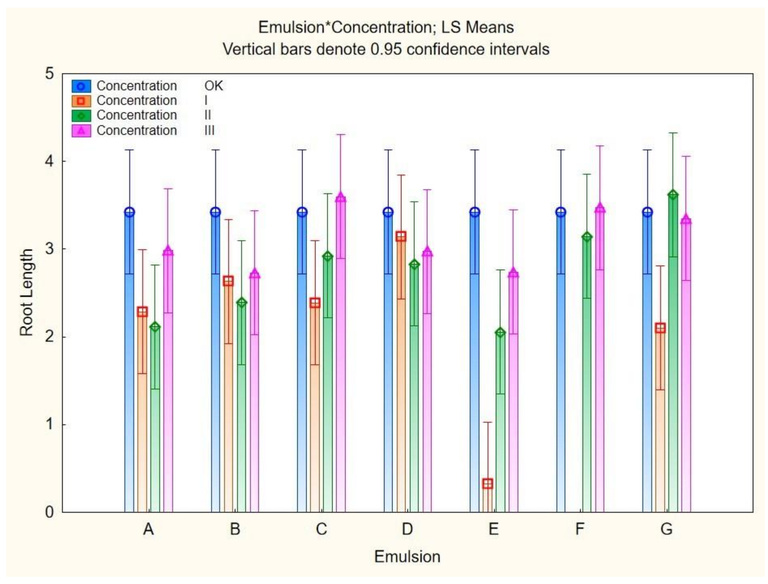


Figure 3: The response of Radish roots to different concentration of caraway oil (mean value ± standard error). 0K – control (water only), Concentration I – 0.1%, Concentration II – 0.05%, Concentration III - 0.001%.

The Radish roots were all affected by the presence of Limonene and Carvone. Fraction E had the most effect on the seedlings for all the concentrations.

CONCLUSIONS

Under laboratory conditions and at the concentrations tested, limonene significantly inhibited the germination and growth of radish seedlings. At higher concentrations in nano emulsions, seedling death was observed. These findings highlight the potential selective properties of d-limonene, warranting further investigation.

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Figure 2: Seedlings after seven days growth in the dark at room temperature (±25 °C), treatment F. The growth of seedlings was highly affected by the carvone. The seedlings did not survive prolonged exposure to the highest concentration of the compound.

The phytotoxic effect of emulsions depended on both the concentration and the rate of carvone to limonene. The strongest inhibition of roots and shoots of radish were posed by the emulsions where carvone was a dominating compound and in the highest concentration (I – 0.1%).

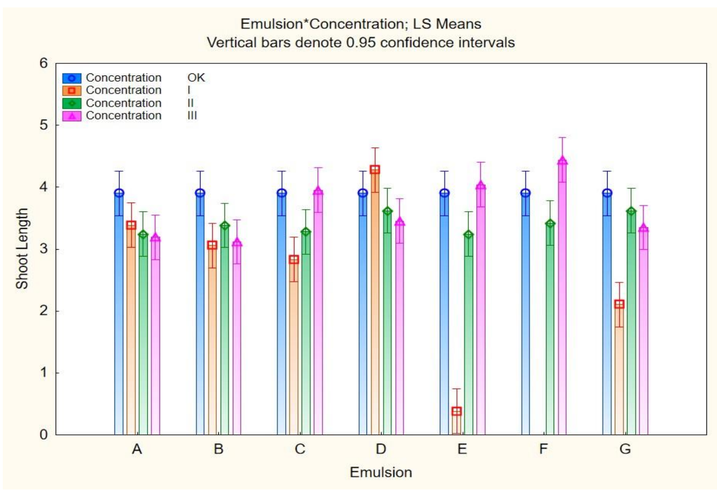


Figure 4: The response of Radish shoots to different concentration of caraway oil (mean value ± standard error). 0K – control (water only), Concentration I – 0.1%, Concentration II – 0.05%, Concentration III - 0.001%.

The radish shoots were inhibited by the presence of limonene as seen in Fraction (A-C). On the contrary, the effect of carvone was weaker, as seedlings had significant growth especially at the lowest concentration. Fraction E had somewhat equal percentage of Limonene and Carvone and the effect can be seen on seedlings exposed to the highest concentrations.

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