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EVALUATION OF THE TOXIC EFFECT OF SPONTANEOUS PLANTS FROM THE ALGERIAN SAHARA AGAINST THE VINEGAR FLY

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Introduction

The use of chemical insecticides has had serious consequences for both the environment and human health, including intoxication of people and animals, contamination of water, air, and soil, residues on food, high environmental persistence, and negative impacts on beneficial insects. Resistance to chemical insecticides has been reported in all major pest species; nevertheless, these products are still widely used in many developing countries, particularly in agriculture and pest management programs (e.g., against mosquitoes, cockroaches, and locusts).

The exploration of bioactive medicinal plants as part of vector management programs represents an environmentally friendly alternative, as these natural compounds are easily biodegradable. By their very nature, plants are rich reservoirs of bioactive molecules, which have received growing attention from the scientific community in recent years. As in the rest of the Maghreb, Algeria is one of the Mediterranean countries with a long tradition of using spontaneous plants. The Algerian Sahara is characterized by exceptional floristic biodiversity, with more than 500 species, including 162 endemic species recorded in the northern Sahara alone, along with a long-standing tradition of ethnopharmacology. Spontaneous plants from the Mediterranean region are considered valuable phytogenetic resources, offering agronomic, economic, ecological, and strategic potential. In this context, the present study investigates the insecticidal effects of spontaneous and medicinal plants from Algeria *Citrullus colocynthis (Cucurbitaceae), Cleome arabica (Capparaceae), Peganum harmala (Zygophyllaceae), and Solanum nigrum (Solanaceae)*. The work focuses on both the direct effects of ethanolic plant extracts (mortality) and the indirect effects on vital behaviors of *Drosophila melanogaster*, including sexual behavior, fecundity, fertility, and oviposition.

Materials and methods

Toxicity and mortality assay*:* The toxicological evaluation was conducted on second-instar larvae of *D. melanogaster.* Larvae were exposed to plant extracts through ingestion, and mortality was monitored daily over a period of 15 days.

Lethal concentrations (LC_{50} and LC_{90}) were calculated using probit analysis in order to determine the doses required to cause 50% and 90% mortality, respectively.

***Sexual behavior test**:* Sexual behavior assays were performed using sexually naïve males and females. Individual pairs were introduced into dry glass tubes, and their courtship and mating behaviors were observed continuously for 30 minutes. The behavioral sequences were recorded and analyzed, with particular attention to the frequency and duration of key courtship elements and successful copulation.

Oviposition preference test: Oviposition assays were carried out to assess the effect of plant extracts on egg-laying behavior. Adult females were offered a dual-choice substrate consisting of treated versus untreated media. The number of eggs deposited in each medium was recorded after the exposure period, and oviposition preference was calculated as an indicator of attraction or deterrence.

Results and conclusion:

The evaluation of the insecticidal activity of ethanolic extracts from four spontaneous plants of the Algerian Sahara reveals significant differences in efficacy. *Peganum harmala* stands out with a particularly high mortality rate, reaching 98% even at low concentrations (0.25 g/l), indicating strong toxic potential. The ethanolic extract of *Solanum nigrum* also shows marked effectiveness, with a mortality rate of 75% at relatively low doses (1 µg/ml). In comparison, *Cleome arabica* and *Citrullus colocynthis* display more moderate mortalities, 50% and 45% respectively, requiring higher concentrations to induce a significant effect. The analysis of lethal concentrations (LC) corroborates these observations. The LC50 values for *P. harmala* (0.12 g/l) and *S. nigrum* (0.83 µg/ml) confirm their strong insecticidal efficacy, since only small amounts are required to kill 50% of the individuals. Conversely, *C. arabica* and *C. colocynthis* exhibit much higher LC50 values (1.48 g/l and 1.005 g/l), reflecting weaker toxicity. These results highlight a clear hierarchy among the tested plant species, with *P. harmala* and *S. nigrum* emerging as the most effective. Beyond direct mortality, the plant extracts also affect the reproductive behavior of *D. melanogaster*. In *C. colocynthis*, the main effect occurs at the mating level, with a reduction in female reproductive success (60%). *C. arabica* exerts a stronger inhibition, reducing female reproductive success to 75%. *P. harmala* severely impairs mating attempts, limiting success to 20% in treated females, while *S. nigrum* produces the most drastic effects, with reproductive success reduced to only 5% in both males and females. These findings suggest a strong impact of the extracts on the behavioral dynamics of populations. The study of behavioral responses related to attraction and repellence also reveals distinct profiles. Extracts from *C. colocynthis* and *P. harmala* appear to attract untreated larvae, whereas *C. arabica* and *S. nigrum* induce a repellent effect. In adults, most extracts exhibit repellent activity, confirming a potential antifeedant effect and habitat disturbance. These properties are particularly relevant for biological control, as they not only reduce survival and reproduction but also limit attraction to infested substrates. Finally, the analysis of oviposition confirms the extracts' impact on fecundity. *P. harmala* and *S. nigrum* cause the strongest inhibitions, drastically reducing egg numbers (down to 12 and 35 eggs under treated conditions, respectively). *C. arabica* and *C. colocynthis* also show significant reductions, though less pronounced. These results demonstrate that the effects of plant extracts extend beyond lethal action to essential biological functions of insects, particularly reproduction. Thus, the studied Saharan plants appear to be promising candidates for the development of ecological alternatives in the biological control of pest insects.