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Insecticidal activity of *Solanum sodomaeum* (Solanaceae) extracts on *Schistocerca gregaria* (Forskål) larvae

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Abstract

The effects of four extracts of *Solanum sodomaeum* fruit peel (*Solanaceae)* were observed in the laboratory on *Schistocera gregaria* fifth instar larvae. Larvae fed with lettuce soaked in various extracts showed a decrease in their food consumption, due probably to a repulsive and antifeedant effect of this plant. Both survival and development were affected: prolongation of the fifth instar and the appearance of malformations at the imaginal molt.

Key words

Solanum sodomaeum, insecticidal activity, *Schistocera gregaria*

Introduction

The locust *Schistocerca gregaria* (Forskål) is extremely harmful to plants in Morocco and in many parts of the African continent. Chemical insecticidal products are dangerous for the environment and can lead to the appearance of resistance in these insects. So there is a necessity to search for new, efficient methods, such as the use of specific molecules (Girardie *et al.* 1998) or substances extracted from plants (Spencer 1988, Bernays 1992). The present work reports the effect of some extracts of *Solanum sodomaeum* (Solanaceae)fruit on locust larvae.

This plant is used in traditional medicine as a pain killer against migraine headaches and gastric discomfort; it is used to treat dermatological diseases (Perrot 1930) and skin cancer (Cham et *al.* 1987), but excessive administration is highly toxic (Bellakhdar 1978).

Materials and Methods

Animal material.—Locust larvae used in our study came from a colony of *S. gregaria* bred in the Laboratory of Zoology and General Biology of the Science Faculty of Rabat. These insects originated from eggs taken from an area of gregarious-phase swarming in the south of Morocco, during the last invasions of the locust. Locusts, in gregarious phase, were raised in screened cages illuminated by lamps of 40 W; the temperature of the room varied between 28°C at night and 32°C by day. The photoperiod was 12:12; the relative humidity was maintained at about 60 %. Food consisted of lettuce leaves and bran.

Plant material.—*S. sodomaeum* grows wild in Morocco. We find it in glades and sandy pastures (Charnot 1945, Jahandiez and Marie 1934). The berries of this plant were harvested in June, in the Maamora forest near Rabat Morocco. The fruit skins were dried at room temperature for 7 d.

Plant determination was carried out by A. Ouyahya of the National Herbarium of the Scientific Institute of Rabat, where a sample is registered under the coding 64241.

E*xtracts preparation.*—One hundred g of dried fruit skin were ground and treated with a system of extraction (soxhlet) by four solvents of increasing polarity: hexane, dichloromethane, ethyl acetate and methanol. The yield for each fraction was successively 0.15%, 0.14%, 0.085% and 0.20%. After evaporation, the residues were diluted in ethanol (5%) to 1000 ppm and preserved for subsequent testing.

Studied activity.—Larvae used in our tests were selected 48 h after the fourth molt. Five groups (1 to 5) each contained eight fifth-instar larvae. These larvae were starved for 24 h. Then they were fed over 3 d according to the following protocols: each day, the experimental groups (2 to 5) received 20 g of lettuce, sprinkled with 10 ml of a test solution; the control group received 20 g of lettuce sprinkled with 5% ethanol. Treated lettuce leaves were dried in the open air before presentation to the insects.

The control group with the ethanol completed their development to imaginal stage without any disruption. This result allowed us to eliminate possible effects of the ethanol.

Our observations concerned: 1) food intake assessed by weight (grams of lettuce consumed by larvae during 24 h as determined by weighing the offered lettuce before and after feeding), and 2) cumulative mortality rate from the first day of the test until the emergence of the imago. We also noted the effect of these tests on the insects' behavior from the larval period to the imaginal molt.

Statististical analysis.—Significance of the food intake results were compared by t-test using the statistical software.

Results

Effects on food intake.—We noted a repellent effect of the extracts: larvae aggregated at the top of the cage just after introduction of the treated lettuce in the cage below. We also noted immediate hyperexcitability, followed by a period of declining activity 15 to 30 min after they had begun to eat.

A reduction in food consumption was observed in larvae whose-food was treated with extracts of methanol, dichloromethane and ethyl acetate (Fig. 1). The three extracts evoked a significant decline in food intake during treatment (Table 2) compared to the untreated controls; this was not so for larvae fed lettuce treated with hexane

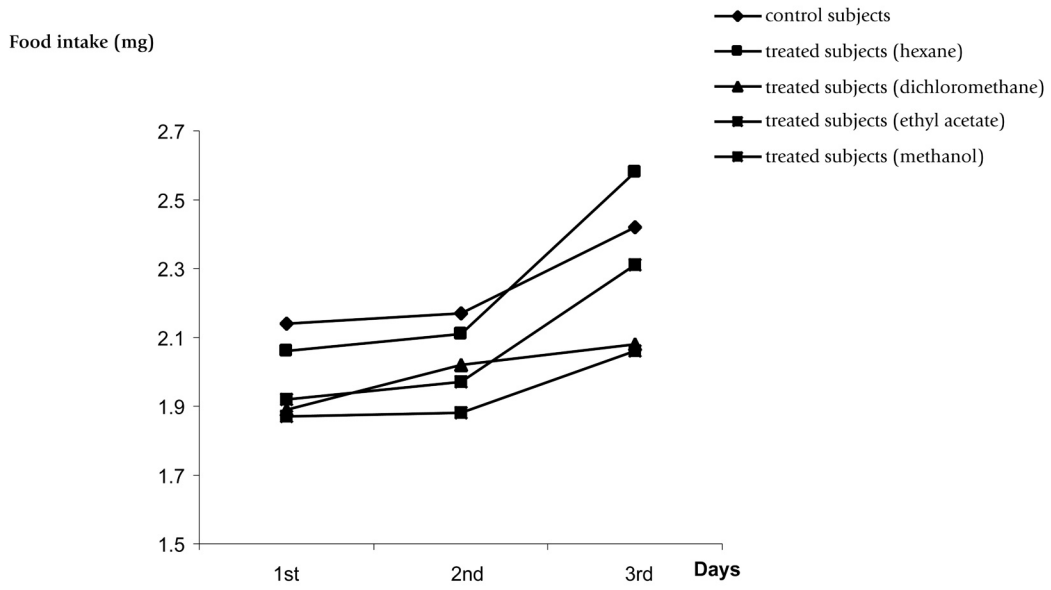

Fig. 1. Effects of extracts of *S. sodomaeum* berry skins on the food intake of fifth instar *S. gregaria* larvae.

extract of *S. sodomaeum* (p = 0.939). This feeding reduction may be due to the presence of saponins, alkaloids and probably other secondary metabolites unidentified by these techniques. The hexane extract did not have any effect.

Effect on mortality.—The methanol and ethyl acetate extracts led to a 50 % death rate on the fifth day from the begining of the test, whereas the death rate was only 37.5% for the dichloromethane extract. The hexane extract was without any effect (Fig. 2).

Other effects.—We also observed in some cases an excitability of larvae, possibly due to a neurotoxic effect of this plant. We observed a lengthening of time spent in the fifth instar and important morphological distortions arising during the imaginal molt. Among these latter were unsuccessful spreading of the wings, a distortion of legs and antennae and an inability of the insects to cast off their exuvia: in this latter case they died after 3 to 5 d.

We noted the presence of a liquid feces produced by treated larvae: this is probably owing to an effect of these extracts on hydromineral metabolism.

Table 1. Phytochemistry screening of the *S. sodomaeun* berry skins.

	Hexane	Dichloro methane	Ethyl Acetate	Methanol	Testing methods
Saponins	-	-	-	+	Vaniline sulfur (Wagner *et al.* 1984)
Alkaloids	-	+	±	±	Mayer (Wagner *et al.* 1984)
Flavonoids	-	-	±	±	Reaction of Schinod (Wagner *et al.* 1984)

+ : Positive reaction
- : Negative reaction
± : Doubtful reaction

Phytochemistry screening.—Table 1 shows that the berry skins of *S. sodomaeum* contain saponins and alkaloids, whereas the presence of flavonoids is uncertain. These results are in agreement with those obtained by Charnot (1945), and recently re alkaloids by El Sayed *et al.* (1998).

Table 2. Results of t test.

Extracts	*t*	df	*p*	Significance
Control *vs* hexane	0.087	2	0.939	NS
Control *vs* dichloro methane	4.495	2	0.046	S
Control *vs* methanol	5.222	2	0.035	S
Control *vs* ethyl acetate	11.240	2	0.008	S

Discussion and conclusion

This is the first instance of testing the insecticidal activity of *S. sodomaeum* berry skins against *S. gregaria* larvae. Extracts derived from this plant part provoked, among other effects, a reduction of food intake, a significant mortality rate, as well as important morphological disturbances that affected the mobility of the insects. These different perturbations, probably reflect a neurotoxic and antifeeding effect of the secondary substances (alkaloids and saponins) extracted from *S. sodomaeum*. The neurotoxic activity of alkaloids is already known from a number of toxic plants (Breneton 1996); similar results are obtained with indolic alkaloids extracted from leaves and seeds of *Peganum harmala* (Abbassi *et al.* 2002-2003; 2003b) and the alkaloids occurring in leaves of *Calotropis procera* (Abbassi *et al.* 2003a). Toxic effects of saponins have also been observed in other species (Bellakhdar 1978). *S. sodomaeum* possesses both a molluscicidal activity (Bekkouche *et al.* 2000) and a larvicidal activity (Markouk *et al.* 2000).

Our results are similar to those obtained with extracts of the

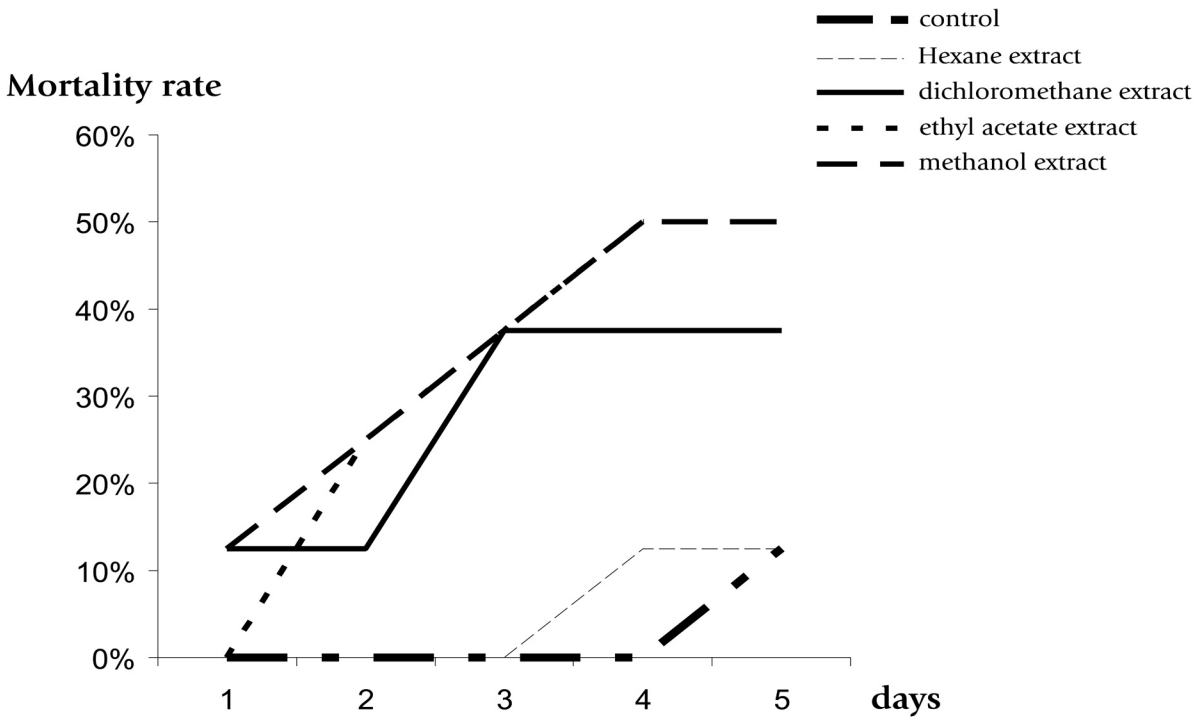

Fig. 2. Effects of *S. sodomaeum* berry-skin extracts on the mortality rate of fifth instar *S. gregaria* larvae.

fruit of *Melia azadirachta indica* (Wilps *et al*. 1992) and also of *Melia volkensii* (Nasseh *et al.* 1993) on *S. gregaria*. The same is true for the effects of the fruit of *Melia azedarach* on *Lymantria dispar* (Atay-Kadiri *et al*. 2002).

These encouraging results have motivated us to search for the fractions responsible for this insecticidal effect and to determine their impact on reproduction and other functions of locusts.

Acknowledgements

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References

Abbassi K., Mergaoui L., Atay Kadiri Z., Stamboli A., Ghaout S. 2002-2003. Effets des extraits de *Peganum harmala (Zygophyllaceae)* sur le criquet pèlerin *(Schistocerca gregaria Forskal,* 1775). Zoologica Baetica 13/14: 203-217.

Abbassi K., Atay-Kadiri Z., Ghaout S. 2003a. Biological effects of alkaloids extracted from three plants of Moroccan arid areas on the desert locust. Physiological Entomology 28: 232-236.

Abbassi K., Mergaoui L., Atay-Kadiri Z., Stambouli A., Ghaout S. 2003b. Activité biologique de l'extrait de graines de *Peganum harmala* sur le criquet pèlerin (*Schistocerca gregaria* Forskäl 1775). Journal of Orthoptera Research 12: 71-78.

Atay-Kadiri Z., Semlali A., Benhsain N., Villemant C. 2002. Action de l'extrait de *Melia azedarach* (*Meliaceae*) sur le développement et la reproduction de *Lymantria dispar* (L.) (*Lepidoptera, Lymantriidae*). Integrated protection in Oak forest. IOBC Bull. 25: 139-146.

Bekkouche K., Markouk M., Larhsini M., Jana M., Lazrek HB. 2000. Molluscicidal properties of glycoalkaloid extracts from Moroccan *solanum* species. Phytotherapy Research 14: 366-367.

Bellakhdar J. 1978. Médecine traditionnelle et toxicologie - Ouest Saharienne. Contribution à l' étude de la pharmacopée Marocaine. Techniques Nord-africaine, Rabat, Morocco.

Bernays E.A. 1992. Insect Plant Interactions. Vol. 4, CRC Press, Boca Raton, Florida.

Breneton J. 1996. Plantes Toxiques. Végétaux Dangereux pour l'Homme et les Animaux . Edition Lavoisier, Paris.

Charnot A. 1945. La toxicologie au Maroc. Memoire de la Societé des Sciences Naturelle du Maroc XLVII.

Cham B. E., Gilliver M., Wilson L. 1987. Antitumour effects of glycoalkaloids isolated from *Solanum sodomaeum*. Planta Medica 53: 34-36.

El Sayed K. A., Hamanr M.T., Abd El-Rahman H. A., Zaghloul A. M. 1998. New pyrrole alkaloides from *Solanum sodomaeum*. Journal of Natural Products. 61: 848-850.

Girardie J., Huet J. C., Atay-Kadiri Z., Et-Taouil S., Delbecque J. P., Fournier B., Pernollet J. C., Girardie A. 1998. Isolation, sequence determination, physical and physiological characterization of the neuroparsins and ovary maturing parsins of *Schistocerca gregaria*. Insect Biochemistry and Molecular Biology 28: 641-650.

Jahandiez E., Marie R. 1934. Catalogue des Plantes du Maroc., 3: 662p.

Markouk M., Bekkouche K., Larhsini M., Bousaid M., Lazrek HB., Jana M. 2000. Evaluation of some Moroccan medicinal plant extracts for larvicidal activity. Journal of Ethnopharmacology 73: 293-7.

Nasseh O., Wilps H., Rembold H., Krall S. 1993. Biologically active compounds in *Melia volkensii*: larval growth inhibitor and phase modulator against the desert locust *Schistocerca gregaris* (Forskal) (Orthoptera, Cyrtacanthacrinae) Journal of Appliced Entomology 116: 1-11.

Spencer K.C. 1988. Chemical Mediation of Coevolution. Academic Press. San Diego, California.

Wagner H., Bladt S., Zgainski E.M. 1984. Plant Drug Analysis: a Thin Layer Chromatography Atlas. Springer-Verlag, Berlin.

Wilps H., Nasseh O., Krall S., Kabo O. 1992. Lutte contre les *Schistocerca gregaria* adultes au moyen de nouvelles préparations et méthodes. Sahel. PV Info. 7: 44.