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EFFECTS OF NEEM PLANT (*AZADIRACHTA INDICA* JUSS, MELIACEAE) PRODUCTS ON MAIZE GRAIN CONSUMPTION BY THREE COMMON RODENT PESTS IN KENYA

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Abstract. We investigated the effect of neem plant (*Azadirachta indica*) products on maize grain consumption and body weights of *Lemniscomys striatus, Mastomys natalensis* and *Arvicanthis niloticus* live trapped in a Kenyan sub-humid grassland. The rodents were fed on oven dried crushed maize grains (mean wt=0.04 ± 0.003 g each, n=300) either plain, adulterated with neem derivative or with powder from leaf or fruit. Consumption over a five-day period and body weights (pre- and post-treatment) were recorded. Leaf derivative lowered consumption by 50.3%, 51% and 59.8% and the powder by 13.4%, 12.4% and 25.1%, respectively, by *L. striatus, M. natalensis* and *A. niloticus*. Neem fruit derivative and powder, respectively, depressed consumption for *L. striatus* (54.4% and 22.6%), *M. natalensis* (49.3% and 25.1%) and *A. niloticus* (60.4% and 27.7%). Post treatment body weights for all species were reduced by 9.3% (leaf) and 12.6%(fruit derivative) with a respective mortality rate of 7% and 20%. Our study showed that neem products significantly ($p<0.001$) lowered maize grain consumption in the three pests with the derivative being more effective than the powder ($p<0.05$). In the provision of effective repellent properties, formulation was more important than plant parts alone. *Azadirachta* products, due to their repellent effects, have potential in dry maize seed protection and may form a useful component in the development of an integrated pest management (IPM) strategy for rodents in Africa.

Key words: Neem, repellent, pests, *Mastomys, Lemniscomys, Arvicanthis*.

INTRODUCTION

One of the most serious problems facing developing countries is food security. In Africa, cereals are important staple foods. Although much is produced, large portions are lost through pest destruction or contamination at planting, growth, pre harvest, and storage. Rodents are known to attack crops at each of these stages. Some common rodent pests in sub-Saharan Africa include *Mastomys natalensis* (Smith, 1834) (a multimammate rat), *Arvicanthis niloticus* Desmarest, 1822 (the common grass rat) and *Lemniscomys striatus* L. (1758) (the striped grass mouse) (FIEDLER, 1994). In Kenya, these species cause major losses of field and stored grains (MARTIN *et al.*, 1989) but may also harbour deadly zoonotic diseases. Conventional control has involved trapping, digging, flooding burrows and, very often, the use of chemical poisons. Although rodenticide use can be expensive (anticoagulants) or hazardous (acute poisons), they form an integral part of successful rodent pest management, and in some areas, the only practical method available (FIEDLER, 1994). This study assessed the repellant effects of *Azadirachta indica* (neem plant) derivatives on three sub-Saharan African rodents. The aim was to provide baseline information in the development of additional or alternative approaches to mitigating grain losses to rodents at planting and storage. Neem plant is widely available in Africa and easy to grow. It has known insecticidal properties (DUNKEL *et al.*, 1995) and limited evidence suggests that it may be useful as a repellent for birds (MASON & MATTHEW, 1996). In Kenya, it is widely used in the management of insect pests, and traditionally in the management of various protozoan, bacterial and fungal diseases. Neem tree products have been used for centuries in India for crop protection especially against storage pests (WATT, 1972). To our knowledge, evidence of its application for control of vertebrate pests in Africa is not documented and our study explores this approach.

MATERIAL AND METHODS

The study was carried out at Kenyatta University, 25 km north-east of Nairobi, Kenya (1°14′ S, 36° 48′ E). Rodents were collected from grasslands within the campus as described by OGUGE (1995). Captured animals were dusted (2-3 g) in insecticide powder (pyrethrin, 0.2%; piperony butoxide, 1.0%; inert ingredients, 98.8% w/w) identified, sexed, reproductive condition noted and weighed before being housed individually in metal cages (30 x 24 x 18 cm). Each animal was provided with commercial mouse pellets and water *ad libitum.*

Neem plant formulations

Fresh ripe fruits and mature green leaves of *Azadirachta* were obtained from Kanamai at the Kenya coast (3° 55′ S, 39° 47′ E). These were dried on air under shade to a constant weight (six weeks). The different plant parts were milled separately to a fine powder using an electric grinder and the powder packed in polythene bags. Storage was at room temperature (25° C) for 24-96 h, in a dark well-ventilated room, before extraction. Extraction was in methanol using the Soxhlet method (see FABRY *et al.*, 1977). To coat maize with neem preparations, crushed, oven-dried grains (108° C, 24 h)were soaked (100 g/50 ml neem extracts) either in derivative or powder for 24 h and then dried in an oven at 32° C for 12 h.

Feeding experiment

Rodents were first provided with plain, oven-dried (108° C, 24 h) maize (mean wt=0.04±0.003 g each, n=300) and water *ad lib.* Daily uptakes were recorded for five consecutive days. Untreated grains were replaced with derivative-treated ones, then powder-coated and finally plain grains, each treatment regime running for five days. Three rodent species were included in the tests: *M. natalensis*, *L. striatus* and *A. niloticus*. To assess for possible effects of extraction solvent on feeding, five *Tatera robusta* (Cretschmar, 1830) individuals were simultaneously and similarly fed on grains soaked in methanol overnight and oven dried as above. Daily consumption was recorded for 20 days. In this design, each individual acted as its own control at pre- and post-treatment periods. Thus, any changes in adulterated-feed uptake could be directly assessed against a background of untreated ones.

Statistical analysis

Split-plot, split-split and one-way ANOVA were used to test treatment effects, variations between animal species and effects of different plant parts and formulations (powder & derivative) on feed uptake. Significantly different means were separated using Tukey-HSD tests. Regression analysis was used to assess for any relationship between feed uptake and time post treatment.

RESULTS

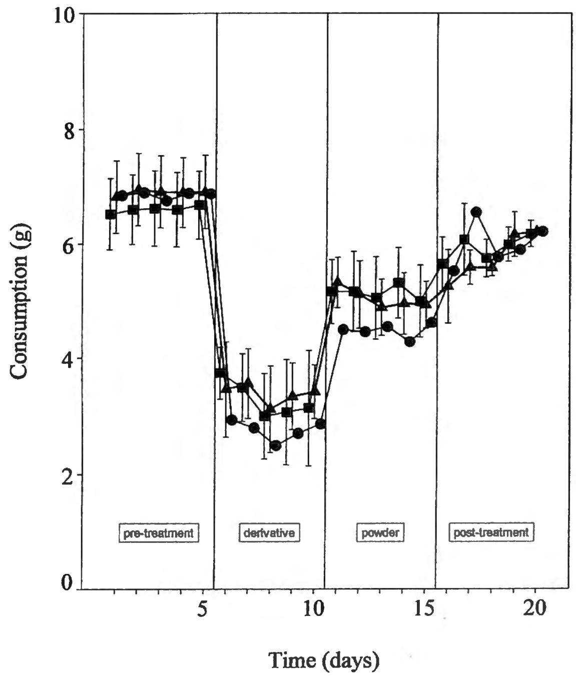

Fig. 1. – Mean (±SEM) consumption of crushed dry maize seeds by *Mastomys natalensis* (▲, n=5), *Lemniscomys striatus* (■, n=8), and *Arvicanthis niloticus* (●, n=2) over a 20-day period. The grains were either untreated (pre- and post-treatments) or adulterated with *Azadirachta indica* (neem plant) leaf products (derivative and powder). There was a highly significant ($p<0.001$) treatment effect. Powder-coated grains were more acceptable to the rodents than derivative-treated ones yet consumed in significantly lower quantity ($p<0.05$) than untreated maize seeds (post treatment) suggesting a repellent effect.

Following grain treatment with neem products, consumption by the three rodent species was significantly ($p<0.001$) reduced by an average of 52.3% (Figs 1-2). Leaf derivative reduced consumption in *A.niloticus* from a mean of 6.86 ± 0.05 g to 2.76 ± 0.15 g, a reduction of 59.8% (Fig. 1). *M.natalensis* consumption decreased from 6.9 ± 0.04 g to 3.38±0.15 g (51%) and in *L.striatus,* from 6.6±0.03 g to 3.29±0.28 g (50.3%). Consumption of grain, coated in leaf powder was also significantly ($p<0.05$) lower than the post treatment ones. These were by 25.1, 13.4 and 12.4%, respectively, for *A.niloticus, L.striatus* and *M.natalensis*. Similarly, maize adulterated with neem fruit products was consumed less by 60.4% (7.38±0.09 to 2.93±0.42 g) in *A.niloticus,* 54.4% (6.73±0.03 to 3.08±0.63 g) in *L.striatus* and in *M.natalensis* by 49.3% (6.62±0.05 to 3.35±0.46 g). Fruit powder also showed repellent effects as post treatment consumption of untreated grains increased by 27.7, 22.6 and 25.1%, respectively, for the three species. Variation in feeding by *T.robusta* throughout the 20 days was negligible (range=10.05±0.07 to 10.13±0.1 g).

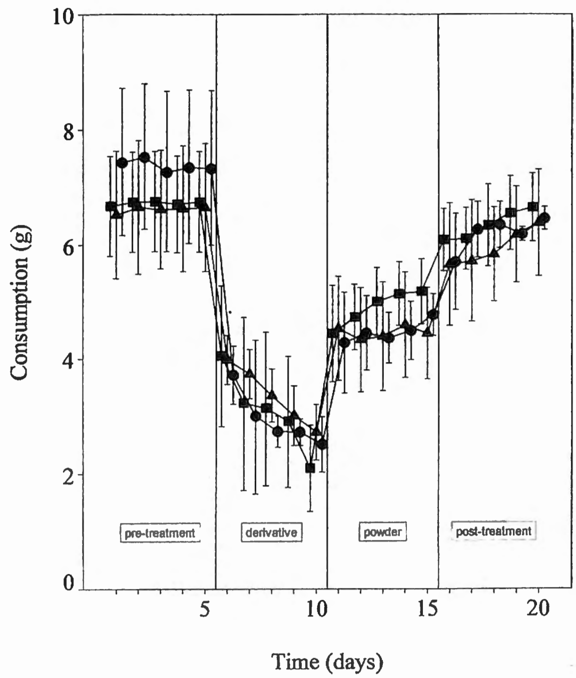

Fig. 2. – Mean (±SEM) consumption of crushed dry maize grains by *Mastomys natalensis* (▲, n=5), *Lemniscomys striatus* (■, n=11), and *Arvicanthis niloticus* (●, n=4) over a 20-day period. The grains were either untreated (pre- and post-treatments) or adulterated with *Azadirachta indica*'s (neem plant) fruit products (derivative and powder). Consumption was significantly ($p<0.001$) lowered by application of neem derivatives. As in leaf treatment, powder-coated grains were more acceptable to the rodents than derivative-treated ones yet consumed in significantly ($p<0.05$) lower quantity than unadulterated maize (post treatment) suggesting a repellent effect.

For the two plant parts, effects of derivatives were similar ($p>0.05$) but the effect of powder was different ($p=0.02$). Daily grain consumption following fruit derivative treatment reduced significantly ($R^2=0.77$, $p<0.001$, $n=15$) for all the species for the five-day period (Fig. 2). Although higher consumption was recorded during the subsequent powder treatments, post treatment consumption showed further increases with time always (Figs 1-2). Loss in body weight was observed in all individuals of the three species after the twenty-day period. The respective percentage weight loss for *M. natalensis, A. niloticus* and *L. striatus* following neem leaf treatment was 8.9, 9.7 and 9.3. Loss following fruit treatment was higher, *i.e.* 11.9, 11.2 and 14.6 respectively for *M. natalensis, A. niloticus* and *L. striatus*. A mortality rate of seven and 20% was recorded following leaf and fruit products treatments, respectively. The control animals registered a gradual increase in body weight and no mortality was recorded.

DISCUSSION

Our study has shown that *Azadirachta indica* products significantly ($p<0.001$) lower maize grain uptake by *Mastomys natalensis, Lemniscomys striatus* and *Arvicanthis niloticus* in a no choice experiment. *Azadirachta* contains the chemical azadirachtin (ASCHER, 1981), a product with unpleasant taste and smell. The concentrations of azadirachtin in crude extracts of neem trees in Kenya have been estimated at 1.5 and 7.2 mg/g for leaves and fruits, respectively (unpublished data, ICIPE, Nairobi). Although azadirachtin is the most important compound in seed kernels, others that provide less or synergistic effects are meliantriol, salannin, diacetylnimbin, nimbin, limonoids, vepaol, isovepaol and quercentin (SCHUMUTTARER & ZEBITZ, 1983). Neem plant concoctions may be consumed in fair quantities without apparent hazardous consequences (ARNASON *et al.*, 1989). Its seed kernel cake has been successfully used as protein-supplements for livestock (ANANDAN *et al.*, 1996; NAGALAKSHMI *et al.*, 1996; VERMA *et al.*, 1996). Thus, reduced uptake of neem-treated grains by the rodents here may have been due to a repellent rather than toxic effects. Similar findings have been shown (MASON & MATTHEW, 1996) in birds who avoid feed or water adulterated with neem preparations. In our study, consumption significantly decreased ($R^2=0.77$, $p<0.001$, $n=15$) over a five-day period in all individuals following neem fruit derivative treatment. In the few animals that died, consumption had reduced up to less than 0.5 g per day. The fact that surviving individuals increased their consumption post treatment (Figs 1-2) gives further credence to the suggested repellent effects.

Consumption in *A.niloticus* was affected most, being lowered by up to 60% compared with 54% in *L.striatus* or 50% in *M.natalensis*. These differences were highly significant ($p<0.001$). All individuals under treatment exhibited weight loss after 20 days. This may be attributed to lower quantity of grain eaten during that period. Since the individuals who died consumed very little, they may have starved. We found that the source of a neem product (the plant part from which it is extracted) was not as critical as the mode of preparation. For instance, fruit and leaf derivatives had similar depressing levels on consumption, while fruit powder was more effective ($p=0.02$) than leaf one. However, grain consumption was significantly ($p<0.05$) lower following derivative than powder coating. Therefore, in incorporating neem products in an integrated pest management programme, the method of product preparation would be critical. Our study has shown that reducing maize grain consumption by *M.natalensis, L.striatus* and *A.niloticus* using *Azadirachta* concoctions is possible. Critical questions may arise in the use of this approach on grains used for human consumption. However, a recent study (Dunkel *et al.*, 1995) has shown that stored beans (*Phaseolus vulgaris* L.) protected by ethanol extracted neem seed products were acceptable for consumption eight weeks after application. Acceptability of similarly protected maize grains is a possibility that needs exploring. Successful protection of mung beans and its crop, the chickpea (Tiyagi & Alam, 1995) and of pigeon peas (Akhter & Mahmood, 1996) by oil seed cakes of the neem against plant parasitic nematodes and soil-inhibiting fungi have been established. Use of this plant's products as repellents to rodents and other pests on seeds at planting may offer the seeds further protection and enhance germination (Tiyagi & Alam, 1995). These preliminary findings from our study have shown strong repellent properties of neem plant products towards dry maize seed consumption by three species of sub-Saharan field rodents. We conclude that neem, used as a repellent, can provide an economical, biologically safe and socially acceptable approach that should be developed for integrated pest management for rodents in Africa.

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