Research Article

Effectiveness of Grain Based Bait as Carrier of Strychnine Alkaloid for the Control of Indian Crested Porcupine, *Hystrix indica*

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Abstract | Field trials were conducted in Abbottabad - Balakot tract of the northern Pakistan for testing the effectiveness of groundnut – maize grain bait in delivering the lethal amount of strychnine alkaloid in controlling the Indian crested porcupine, *Hystrix indica*, during 2006-07. Indian crested porcupine is a severe forest and agricultural pest throughout southern Asia and the Middle East, including Pakistan. The results suggested that in case of pre-baiting trial, a 25% reduction in burrow activity was achieved in case of groundnut – maize (1:1) grain bait loaded with 2% strychnine alkaloid and supplemented with 5% saccharin and a 10% reduction could be achieved without saccharin supplementation. In case of without pre-baiting trial, a 10% reduction in burrow activity was recorded in case of saccharin supplemented groundnut – maize grain bait impregnated with strychnine alkaloid; while no reduction was recorded in case of no saccharin supplementation. The results of the study suggested that strychnine alkaloid is not an effective rodenticide for the control of Indian crested porcupine at least with the present bait and conditions. Further trials with low concentrations of strychnine alkaloid and decreasing the poison-baiting duration are suggested.

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Introduction

Indian crested porcupine, *Hystrix indica,* is a medium sized mammal (weighing 11-18 Kg), lives in extensive burrow systems, which are scattered in the denning habitat and are occupied by one or more family groups. This porcupine species has been little studied because of the shy nature, nocturnal habits and tendency to live in remote and inaccessible habitats (Gurung and Singh, 1996). It is widely distributed in different parts of Pakistan and its distribution range extends throughout southeast and the central Asia and parts of the Middle East, including countries, like, Nepal, Bhutan, India, Sri Lanka, Bangladesh, Israel, Saudi Arabia and Yemen (Roberts, 1997). Indian porcupine is a serious pest of agricultural crops and forest plantations in Pakistan and many other countries of the world. This species inflicts 38.1 - 90% damage to young plants of *Pinus* spp. (Sheikher, 1998; Khan et al., 2000), 42% to *Robinia pseudoacacia* (Khan et al., 2000) and 30% to the seedlings of *Azadirachta indica* (Idris and Rana, 2001). Groundnut, maize and potato are the crops most severely affected by porcupine (Khan et al., 2000).

Porcupine population needs to be kept under control for the success of agriculture sector and afforestation campaigns. The use of chemicals /rodenticides is the most successful strategy for porcupine control, because physical control practices are generally ineffective. The populations of natural predators, i.e., leopard (*Panthera pardus*), hyaena (*Hyaena hyaena*) and wolf (*Canis lupus*), has dropped to a very low levels in the current study area (Sheikh and Molur, 2005), but it is

not known whether these predators when present can significantly reduce porcupine numbers. The use of anticoagulants for porcupine control gives better results than acute rodenticides, but involves longer baiting period and higher operational cost (Khan and Mian, 2008; Mushtaq et al., 2012), while burrow fumigation (aluminium phosphide) is feasible only in the loamy soils (Mushtaq et al., 2008). The acute rodenticides can produce a quick knockdown of the rodent pest population (Khan et al., 1992; Prakash and Mathur, 1992), yet are not more effective due to strong aversion of most of the rodent species to such chemicals (Sterner, 1994; Mushtaq et al., 2010, 2013a). Therefore, a pre-baiting of 2-3 days is suggested for acclimatizing the pest species for consuming the lethal dose of the bait on the first day of the poison-baiting (Prakash, 1988).

Groundnut – maize, which has been reported as the most palatable bait against Indian crested porcupine (Mushtaq et al., 2009) needs to be tested for delivering the lethal quantities of rodenticides. Strychnine alkaloid ($C_{21}H_{22}O_2N_2$), found in the seeds of *Strychnos nuxvomica* is economical, easily available and highly toxic against a wide variety of vertebrate pests, has not been properly tested for its effectiveness against porcupine, by utilizing some bait base. Nawaz and Ahmed (1974) suggested that strychnine baiting was ineffective against the Indian crested porcupine but did not mention the dose applied and the bait used, while Anthony et al. (1986) used a heavy dose of strychnine alkaloid (5.79%) for controlling north American porcupines (*Erethizon dorsatum*) in USA and concluded that it was ineffective toxicant for porcupines.

Current study was designed to test the effectiveness of groundnut – maize for facilitating the intake of lethal quantities of strychnine alkaloid by porcupine, by applying a continuous as well as by practicing the pre-baiting for three nights. A sweetener (saccharin) was also tested for its bait consumption enhancement properties, which has been reported as the most effective bait additive against Indian crested porcupine (Mushtaq et al., 2013b).

Materials and Methods

Study Area

Present study was conducted between July 2006 and January 2007 under the field conditions of Abbottabad- Balakot (34° NL, 73° E), Pakistan, located at 1400 – 1700 m above sea level. Wild herbs and grasses were abundantly available in the area. Scattered patches of potato and maize crops, where porcupine damage was observed by the author and reported by the local farmers, were found in the area during the current study duration.

Selection of Porcupine Burrows

Active porcupine burrows were located with the help of the local staff of the Forest Department, Khyber Pakhtoonkhwa and the local farmers and hunters, and their active status was further confirmed by observing the footprints in the three consecutive mornings on the tracking patches laid in front of the burrow openings the previous evenings.

Table 1: *Different bait formulations used in different sets of bait consumption against Indian crested porcupine, Hystrix indica.*

Bait type	Bait formulations (by weight: w/w)
Basic bait (BB)	Groundnut + maize (50 : 50)
Poison bait (PB)	Groundnut + maize + strychnine alkaloid (49 : 49 : 2) i.e. 2% active ingredient
Saccharin supplemented basic bait (SSBB)	Groundnut + maize + saccharin (47.5 : 47.5 : 5)
Saccharin supplemented poison bait (SSPB)	Groundnut + maize + saccharin + strychnine alkaloid (46.5 : 46.5 : 5 : 2) i.e. 2% active ingredient

Bait Preparation

Bait was prepared (w/w) by mixing cracked groundnut and maize grains, saccharin (Saccharine soluble - Choheung Chemical Ind. Co. Ltd., Seoul, Korea) and strychnine alkaloid (100%), available in local market in the crude form, in the ratios as given in Table 1. The saccharine product was the same material as used in Mushtaq et al. (2013a), while the strychnine is assumed to be of the purity stated, although analytical testing to verify the purity of these materials was not conducted. For bait preparation, a measured quantity of rodenticide was dissolved in distilled water (for saccharin supplemented baits, measured quantity of saccharin was also added), which was then mixed with the cracked groundnut – maize grains 1:1 mixture and packed in the plastic bags for field use.

Experimental Procedure

For each experimental set (with pre-baiting and without pre-baiting), 80 active porcupine burrows were

randomly divided into four groups (20 burrows for each bait formulation; i.e. basic bait, poison bait, saccharin supplemented basic bait and saccharin supplemented poison bait) as given in Table 1. A weighed quantity (1 kg, using Pesola spring balance, with a minimum count of 1 g) of the bait material was offered in earthen bowls, placed deep at the opening of the burrow, late in the evening, when the human and/or livestock activity subsided in the area. The burrow baiting has proved more effective and safer than the surface baiting against field rodents (Khan et al., 1998). Each burrow was checked in the next morning and the unconsumed and/or spillage bait materials were weighed, and the difference between the two weights was considered as consumption by the night. The bowls were replenished with fresh bait materials and placed at the burrow the next evening, and the process continued for six consecutive nights.

The consumption of strychnine alkaloid impregnated bait was tested under two experimental sets. For the first experimental set, three nights of pre-baiting (rodenticide was not used in the bait) was followed by three nights of poison baiting, while for the second experimental set, a continuous baiting campaign was practiced for six consecutive nights. Under each set, the respective bait formulation was offered at 20 randomly selected burrows, under no-choice test pattern.

Burrow activity was judged by spotting the porcupine foot prints on freshly sprayed tracking patches (1 x 1 m) at the burrow openings. Burrow activity was monitored, daily, starting from first poison baiting day till three days of the last poison baiting and used to calculate the reduction in porcupine burrow activity.

Statistical Analysis

Student's 't' test was applied for comparison of different treatments, using 5% significance level (Steel and Torrie, 1980), while the pre - poison-baiting ratio was calculated by dividing average per night bait consumption during pre-baiting by average per night bait consumption during poison-baiting.

Results and Discussion

The results of the experiments conducted to test the consumption of groundnut – maize grain (1:1) bait, with or without 5% saccharin and loaded with 2% strychnine alkaloid, offered to Indian crested porcupine during different test nights suggested that there was a gradual increase in average bait consumption in all the plain bait consumption tests. In the first experimental set (pre-baiting test, Table 2), a regular increase in bait consumption was recorded for both the control groups (basic bait and saccharin supplemented basic bait) during treatment nights (4 – 6) by 1.54 – 1.81 times, respectively, as compared with the average bait consumption during the first three nights. The consumption of the rodenticide baits (with and without saccharin), however, decreased by 0.29 - 0.37 times the average of three pre-baiting nights. A non-significant difference in the average bait consumption was recorded on the first poison baiting night and the last pre-baiting night, in case of the saccharin supplemented bait ($t_{(38)} = 0.77, P < 0.05$), while the average bait consumption on the first poison baiting night was significantly lower ($t_{(38)} = 1.75, P > 0.05$) than the average consumption on the last pre-baiting night, in case of without saccharin supplementation bait. The average consumption of poison bait (three nights) with 5% saccharin was significantly higher ($t_{(116)} = 0.84, P < 0.05$) than the poison bait without saccharin, indicating that saccharin has worked as additive. A 25% reduction in burrow activity was achieved by using saccharin supplemented poison bait, while 10% reduction could be recorded by bait without saccharin. There was, however, no reduction in burrow activity in both the control groups, where bait offered did not contained rodenticide.

In the 2nd experimental set, i.e. without pre-baiting campaign (Table 3), average consumption of bait materials, loaded with 2% strychnine alkaloid remained very low, as compared to the control groups. In case of poison baiting, maximum consumption was recorded on the 2nd baiting night, followed by a decline till the last night, where a continuous increase in bait consumption was recorded on two control groups (without strychnine alkaloid). Burrow activity was reduced by 10% only in the saccharin supplemented poison baiting group, while no reduction was recorded in the poison group without saccharin supplementation.

The use of rodenticides for the controlling pest rodents may lead to the development of rodenticide resistance, which is common in many parts of the world (Singleton et al., 2004). Yet, due to limited effectiveness and/or unavailability of the alternative methods, use of rodenticide is the only effective strategy for controlling porcupine population and minimizing the losses caused by this species (Khan and Mian, 2008).

Table 2: *Consumption (g, mean ± SE) of groundnut – maize (1:1) grain compared to bait mixed with strychnine alkaloid (2%) by Indian crested porcupine, by practicing the pre-baiting, under the field conditions of Abbottabad – Balakot area, Pakistan.*

Bait type	Baiting nights								Poison / pre bait consumption ratio	Reduction in burrow activity (%)
	Pre-baiting *			Mean ± SE	Poison baiting			Mean ± SE		
	1	2	3		4	5	6			
BB	28.9 ± 15.54	45.6 ± 15.45	68.5 ± 25.67	47.7 ± 14.56	78.6 ± 20.55	65.7 ± 14.66	75.7 ± 25.33	73.33 ± 8.45	1.54	0
PB	13.7 ± 5.54	39.8 ± 12.63	72.2 ± 15.29	41.9 ± 7.31	33.7 ± 15.60	2.2 ± 1.11	0.0 ± 0.00	12.0 ± 5.58	0.29	10
SSBB	32.6 ± 9.36	49.4 ± 12.11	80.1 ± 13.64	53.88 ± 7.87	87.5 ± 19.16	95.2 ± 19.40	110.6 ± 20.29	97.8 ± 11.53	1.81	0
SSPB	38.2 ± 14.10	49.6 ± 16.27	78.9 ± 16.40	55.6 ± 9.57	59.5 ± 19.38	2.2 ± 1.33	0.2 ± 0.25	20.7 ± 7.30	0.37	25

*BB = Basic bait, PB = Poison bait, SSBB = Saccharin supplemented basic bait, SSPB = Saccharin supplemented poison bait * Without strychnine alkaloid*

Table 3: *Consumption (g, mean ± SE) of groundnut – maize (1:1) grain compared to bait mixed with strychnine alkaloid (2%) by Indian crested porcupine under, in a continuous baiting campaign under the field conditions of Abbottabad – Balakot area, Pakistan*

Bait type	Baiting nights							Reduction in burrow activity (%)
	1	2	3	4	5	6	Mean ± SE	
BB	29.4 ± 16.08	40.6 ± 12.65	62.4 ± 20.07	70.6 ± 21.50	75.7 ± 13.66	79.7 ± 21.31	59.73 ±7 .55	0
PB	10.7 ± 7.54	15.8 ± 10.63	12.2 ± 5.29	9.7 ± 5.60	7.2 ± 1.12	5.5 ± 5.5	10.18 ± 2.48	0
SSBB	52.6 ± 19.06	57.4 ± 22.11	70.1 ± 23.64	81.5 ± 18.6	85.4 ± 12.40	107.6 ± 24.3	75.76 ± 9.52	0
SSPB	13.2 ± 7.10	19.6 ± 10.27	8.9 ± 6.4	9.5 ± 4.38	5.5 ± 2.33	5.2 ± 2.25	10.31 ± 7.21	10

BB = Basic bait, PB = Poison bait, SSBB = Saccharin supplemented basic bait, SSPB = Saccharin supplemented poison bait

The present results on the effectiveness of groundnut – maize grain bait for delivering the lethal quantities of strychnine alkaloid against Indian crested porcupine suggested that there was a persistent trend of decline in bait consumption with the increase in the duration of bait exposure. There was a negligible amount of bait consumption on the second night of poison baiting and no consumption was recorded on the third night in case of the pre-baiting trial, while a nominal rodenticide bait consumption was recorded in case of the continuous baiting test. This is characteristic of the acute rodenticides (Prakash, 1988; Idris and Prakash, 1992), because rodents associate the symptoms of illness with the bait material ingested. porcupine during This may suggest that a single night of the poison baiting may be sufficient for strychnine alkaloid, at least with the present bait and under present baiting conditions. Extending the strychnine alkaloid baiting beyond the first night is not a useful exercise, costing labor and material without increasing the intake of the bait. Reduction in the consumption of the bait may be because of the development of bait shyness after consumption of a sub-lethal dose of the rodenticides (Prakash, 1988), or because of the death of the individuals inhabiting the burrows subjected to poison baiting caused by consuming lethal dose of rodenticide.

In both the experiments, strychnine alkaloid bait with 5% saccharin was consumed in higher quantities than the bait without saccharin. Saccharin has worked as additive and has facilitated the consumption of higher quantities of the poison bait which resulted in a higher reduction in burrow activity. This was expected, yet, required direct testing with the specific rodenticide. With the present results, it can be suggested that 5% saccharin can result in 10-20% higher mortality of porcupines; hence it can be exploited in porcupine control programmes. Present results support the previous studies, declaring strychnine alkaloid ineffective for controlling porcupines (Indian crested porcupine in Pakistan; Nawaz and Ahmed, 1974; North American porcupine (*Erethizon dorsatum*) in North America; Anthony et al., 1986). Current bait (groundnut – maize), impregnated with saccharin could not properly deliver the required amount of strychnine alkaloid at 2% concentration for killing the Indian crested porcupine population in the Abbottabad-Balakot tract of Pakistan.

Conclusions and Recommendations

On the basis of the results and discussion, it is suggested that the strychnine alkaloid is not effective rodenticide, at least with the present bait and conditions; yet being a very useful rodenticide, it may be tested at certain lower concentrations and by decreasing the duration of pre-baiting practice.

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