Pakistan J. Zool., vol. 55(3), pp 1417-1422, 2023 DOI: https://dx.doi.org/10.17582/journal.pjz/20220117080109

Efficacy of Some Additives for Enhancing Bait Consumption Against Indian Crested Porcupine (*Hystrix indica* Kerr) in Mianwali District, Punjab, Pakistan

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Article Information
Received 17 January 2022
Revised 20 February 2022
Accepted 15 March 2022
Available online 02 June 2022 (early access)
Published 19 April 2023

Authors' Contribution
MM conceived the idea and supervised the study. MK, SK and IA conducted the field experiments. MM, MSN and MK wrote the article. ARK and TM proof read and analysed the data.

Key words
Food additives, Bait consumption, Groundnut-maize supplemented diet, Indian crested, Porcupine, Monosodium glutamate

ABSTRACT

The aim of this research study was to evaluate the effect of four different additives on the bait consumption by Indian crested porcupine under the field conditions of district Minawali, Punjab, Pakistan, where groundnut is grown as a major cash crop during the kharif season. Four additives (monosodium glutamate, sugar, milk powder and whole egg) at two different concentrations (2.5 and 5% each) were tested for their relative consumption. Groundnut and maize (1:1 ratio) were used as basic bait; for control group, additives were not included in the basic bait. Each experiment was performed under a single choice test pattern. Whole egg at a concentration of 5%, enhanced the intake of the bait significantly over the basic / plain bait, while a non-significant difference of consumption was recorded in case of 2.5% egg supplemented bait over the control bait. While none of the other additive could enhance the consumption of the bait material at both the concentrations. Milk powder added bait was the less preferred bait combination, followed by sugar and monosodium glutamate added baits. Results of the present study suggested that groundnut–maize (1:1 ratio) supplemented with 5% egg components (albumen and yolk) was the most preferred bait combination; and it is suggested that this combination may be further tested with different rodenticides (acute and anticoagulants) for controlling Indian crested porcupine populations in agro-forestry ecosystems.

INTRODUCTION

Indian crested porcupine (*Hystrix indica* Kerr) is a large rodent species, inhabiting in different habitats, i.e., forests, grasslands, temperate scrublands, sandy deserts and steppe mountains (Gurung and Singh, 1996). It is widely distributed in different habitats of Pakistan (Roberts, 1997; Khan *et al*., 2000). Being a herbivore species, the porcupine causes severe losses to the orchards and/ or fruit trees (Mian *et al*., 1988), agriculture (Khan *et al*., 2000) and to the forest plantations (Khan *et al*., 2014; Talukdar *et al*., 2019). Indian porcupine causes economic losses to young plants of *Pinus roxburghii* and *Robinia pseudoacacia* (Khan *et al*., 2000), seedlings of *Azadirachta indica*, *Eucalyptus* spp. (Idris and Rana, 2001) coconut plantations (Chakravarthy and Girish, 2002), maize, potato and groundnut (Khan *et al*., 2000, 2021; Hafeez *et al*., 2014). In addition, the species also inflicts severe damage to the orchards and green belts due to its digging and clipping behavior (Khan *et al*., 2016).

As regards the control measures for this vertebrate pest species, use of chemical is considered as the most effective method of all control campaigns (Khan *et al*., 2011, 2016). Other controlling strategies, i.e., the natural/ biological control, using of snares, dog hunting, etc. are mostly not effective in reducing the population of the porcupine. As regards the success of a chemical control method, it depends upon the consumption of a lethal dose, which depends upon the better acceptance of the toxic bait material as compared with the food items/materials, which are available in the natural habitats of the wild animals (Petrusewicz, 1967). Mostly, the limited bait

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0030-9923/2023/0003-1417 $ 9.00/0

consumption is a serious issue in many control campaigns against pest rodent species, worldwide. So comparatively more preferred food baits are needed to attract rodent species in the area (Berry and Alleva, 2010). A bait may become more palatable by adding certain food additives in the plain bait in an optimum concentration, so that the target species consumes a lethal dose of the rodenticide. A number of studies have shown the enhancement of the bait consumption by adding a variety of additives for different small rodent species, such as *Rattus norvegicus*, *Rattus rattus*, *Mus musculus* and *Bandicota bengalensis* (Shafi *et al*., 1992, 1993; Yamaguchi, 1995; Shumake *et al*., 1997; Pervez *et al*., 2000, 2003; Johnston *et al*., 2005; Pervez, 2007; Singla and Kanwar, 2014); yet limited studies are available for enhancing bait consumption in Indian porcupine (Mushtaq *et al*., 2013). Present study was designed to test the efficacy of four different food additives by incorporating in groundnut maize based bait against the Indian crested population in the groundnut/wheat cropping area of Mianwali, Punjab. Pakistan.

MATERIALS AND METHODS

Study area

The present research study was conducted between April and December 2021 in a groundnut cropland area of Chak 14 ML (32º 14' 0" N 71º 26' 50"E), district Mianwali, Punjab, Pakistan; where wheat, groundnut and chickpea are the major crops grown during the kharif season. During the field experiments, groundnut was the dominant crop of the area. In addition, maize and some vegetable crops were also available at some scattered locations. Wild herbaceous plants and grasses were also available on limited scale. In addition to the small rodents (rats/ mice) species in the area, Indian porcupine is considered as a serious pest of the groundnut crop of the area, especially at the maturity stage.

Preparation of the bait material

Four different types of bait additives (monosodium glutamate- Fufeng, China; sugar from Moiz Foods Crystalline White Sugar, Pakistan; milk powder Millac from Millac Foods, Pakistan and whole egg prepared in fresh from poultry eggs which were purchased from the local market) were used to investigate their potentials in enhancing the bait consumption by the Indian crested porcupine. Each bait additive was tested at 2.5 and 5% concentrations by using the groundnut (*Arachis hypogia*) and maize (*Zea mays*) as the base at equal ratios and in their cracked forms. Groundnut and maize have been previously identified as the most consumed bait combination for the Indian crested porcupine by Mushtaq *et al*. (2009, 2013). A weighed quantity (w/w) of 250 g (for 2.5% concentration) and 500 g (for 5% concentration) of each additive was thoroughly mixed with the basic bait (groundnut and maize 1:1) to prepare 1000 g bait, respectively. Monosodium glutamate, milk powder and sugar were dissolved in distilled water before mixing with the basic bait, while the egg components were directly mixed with the bait by removing the egg shell. The basic bait (groundnut, maize in 1:1 ratio) without any additive was, simultaneously, tested for its consumption to measure the intake of control/ reference bait material.

Experimentation procedure

A detailed visit was performed in the study area to search the burrows of Indian crested porcupine. Activity status of each burrow was determined by the presence of fresh footprints, quills and/or fresh fecal pellets etc. and it was confirmed by recording the footprints/ fecal pellets etc. for three consecutive mornings on the dirt tracking patches made from the loose soil, laid at the opening of all the burrows in the previous nights.

For recording the bait consumption by the porcupine, three experimental sets were conducted; viz. a, 2.5% and b. 5% additive concentrations and c. without any additive, i.e., control group. Each experimental set was conducted in 15 randomly selected porcupine burrows: 5 burrows for each test bait i.e., 2.5%, 5% and control. Each additive was tested at a time and each test remained continue for 7 days. At the end of each test/ experiment, almost two-week interval was allowed to nullify the effect of the previous possible acclimatization of the porcupines of the area on the bait materials etc., following Johnston *et al*. (2005). For recording the bait consumption by the porcupine, in each burrow, 1000 gm (using balance with a minimum count of 1 g) of bait material was offered in locally-made earthen bowls (diameter = 15 cm, depth = 10 cm). The bait material was placed deep in the burrow openings, late in the evening and the bait consumption was recorded early in the following/ next morning. The left-over bait material and spillage etc. (if any) was collected and weighed, and the daily consumption measured; each pot was replenished/ filled with the fresh bait material, on daily basis, for seven days.

Data analysis

Analysis of variance (ANOVA) was used to compare the bait consumption data and least significant difference (LSD) was used to work out the difference between different additives and their concentrations; a 5% significance level was used. Simple linear regression was used to evaluate the relationship between consumption of bait material and the nights of exposure of the bait materials (Steel and

Torrie, 1980).

RESULTS

Results on the groundnut maize based bait, applied with four different additives (2.5% and 5% concentrations; Table I), by Indian crested porcupine under the field conditions of Mianwali, Punjab, Pakistan, suggested that groundnut maize bait with 5% whole egg was consumed in significantly higher ($P < 0.05$) than the control (without any additive) and all other baits combinations offered. As regards the average consumption of different additives supplemented baits, 5% egg added bait was recorded as the most preferred bait combination (552.62 ± 31.34 g/ night), followed by the 5% milk powder added bait (312.60 ± 22.84g/night), plain/ control bait (without additive; 300.31 ± 41.07 g/night). All other bait combinations were consumed under 300 g/night; the least consumed bait additive was the monosodium glutamate (2.5% concentration: 184.14 ± 15.43 g/night; 5% concentration: 211.80 ± 19.37 g/night). Analysis of variance ANOVA revealed that there was significant difference in the consumption between different additives, i.e., sugar, milk powder, whole egg and monosodium glutamate (F= 10.73, P= 8.32E-07) and between different concentrations (2.5%, 5% and Control) used in the current trials. LSD was applied as post ANOVA and it reflected that 5% egg bait was consumed in significantly higher amounts than all other baits. Similarly, monosodium glutamate was consumed in significantly lower than the control bait at both the concentrations, i.e., 2.5 and 5%, while all other baits combinations were non-significantly different to each other including the plain / control bait.

Linear regression analysis (Fig. 1) suggested a positive regression between the bait consumption and the test nights for all the four additives at 2.5% concentration, yet it was highest in case of sugar ($R^2 = 0.64$; y = 57.4x + 44.6), followed by the monosodium glutamate ($R^2 = 0.24$; y = 10.9x + 140.2), egg ($R^2 = 0.08$; y = 7.36x + 264.2), and the least positive regression was recorded in case of milk powder ($R^2 = 0.08$; y = 7.4x + 264.3). Similarly, in case of 5% additives concentrations (Fig. 2), there was a positive regression between bait consumption and test nights in case of the egg ($R^2 = 0.85$; y = 66.7x + 285.7), sugar ($R^2 = 0.20$; y = 23.4x + 164.1) and monosodium glutamate ($R^2 = 0.04$; y = 7.7x + 181.1), while there was a negative regression in case of the milk powder ($R^2 = 0.2$; y = 12x + 360.7). As regards the consumption of the control / plain bait (Fig. 3), there was a positive regression ($R^2 = 0.4$; y = 34.5x + 162.0) and increasing trend was recorded in the bait consumption with the in the test night.

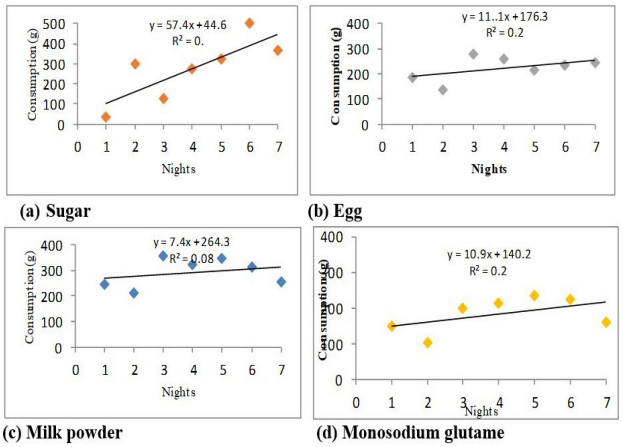

Fig. 1. Daily consumption (grams) of groundnut maize based bait added with 2.5% concentration of four different additives in Mianwali, Punjab, Pakistan.

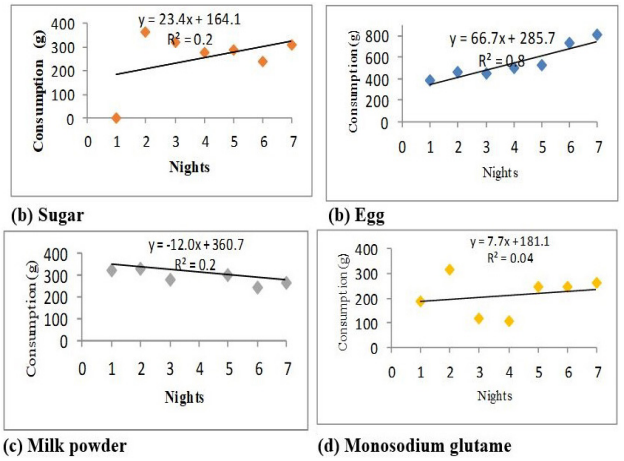

Fig. 2. Daily consumption (grams) of groundnut maize based bait added with 5% concentration of four different additives in Mianwali, Punjab, Pakistan.

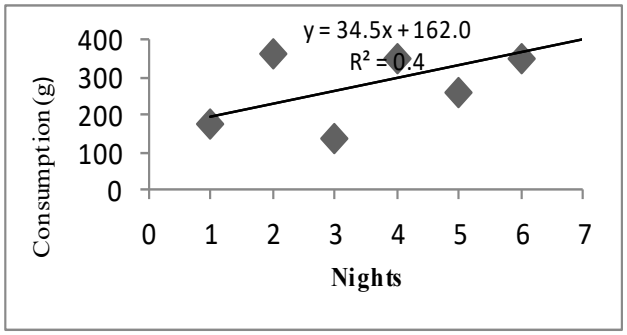

Fig. 3. Daily consumption (grams) of groundnut maize based bait added with any additive (Control bait) in Mianwali, Punjab, Pakistan.

Table I. Comparison (Mean ± SE) of consumption of additives supplemented groundnut maize bait by the Indian crested porcupine (*Hystrix indica*) in district Mianwali, Punjab Pakistan.

Additive		Mean±SEM
Sugar		
5%		257.74±34.87
2.5%		257.54±47.84
Egg		
2.5%		293.71±28.30
5%		552.62±31.34
Milk powder		
2.5%		220.94±23.40
5%		312.60±23.84
Monosodium glutamate (MG)		
5%		211.80±19.37
2.5%		184.14±15.43
Control	0	300.31±41.05
ANOVA		
	df	**P values**
Between additives	3	0.000
Between concentrations	2	0.000
Interaction	6	0.000
LSD		
		P values
Sugar 2.5% vs 5%		0.997 ^{NS}
Egg 2.5% vs 5%		**0.000****
Milk powder 2.5% vs 5%		**0.036***
MG 2.5% vs 5%		0.482 ^{NS}
Sugar 2.5% vs Control		0.469 ^{NS}
Sugar 5% vs Control		0.471 ^{NS}
Egg 2.5% vs Control		0.891 ^{NS}
Egg 5% vs Control		**0.000****
Milk powder 2.5% vs Control		0.069 ^{NS}
Milk powder 5% vs Control		0.777 ^{NS}
MG 2.5% vs Control		**0.004****
MG 5% vs Control		**0.026***
Sugar 2.5% vs Egg 2.5%		0.413 ^{NS}
Sugar 2.5% vs Milk powder 2.5%		0.407 ^{NS}
Sugar 2.5% vs MG 2.5%		0.098 ^{NS}
Sugar 5% vs Egg 5%		**0.000****
Sugar 5% vs Milk powder 5%		0.169 ^{NS}
Sugar 5% vs MG 5%		0.249 ^{NS}
Egg 2.5% vs Milk powder 2.5%		0.101 ^{NS}
Egg 5% vs Milk powder 5%		**0.000****
Milk powder 2.5% vs MG 2.5%		0.405 ^{NS}

*P < 0.05; ** P < 0.01; NS, Non-significant P > 0.05

DISCUSSION

The results of the experiments on the bait consumption tests for comparing different additives, incorporated in the groundnut maize based bait against *Hystrix indica* in district Mianwali, Punjab, Pakistan, reflected that the bait supplemented with the whole egg (5% concentration) resulted in a significant increase in bait over the other additives and/ or the plain bait. Yet, by using the whole egg at 2.5% concentration, a non-significant difference in the bait consumption was recorded; although an increasing trend of the bait acceptance remained in practice, during the whole experiment. A number of previous studies have reported the preference of egg yolk and egg shell powder as bait additive against many species of rats and mice in different parts of the world (Shafi *et al*., 1992; Pervez *et al*., 2000; Abbas, 2003; Pervez, 2007; Singla and Kanwar, 2014); yet Mushtaq *et al*. (2013) reported that egg yolk added bait was less consumed as compared to the plain, tested under the watershed area of northern Pakistan, where maize was the dominant crop during the field trials.

Sugar, milk powder and monosodium glutamate could not enhance the bait intake in the current trials. Monosodium glutamate has remained the least consumed bait combination and acted as a repellent, rather than additive (its consumption was significantly lower than the plain bait at both the concentrations, i.e., 2.5 and 5%). Previous studies documented the preference of salt by the North American porcupine (Bloom *et al*., 1973), the house mouse (Rao and Prakash, 1980), while, Anthony *et al*. (1986) reported that salt is not an effective bait enhancing agent for the management of porcupine (*E. dorsatum*) in the pine forest habitats of California (USA). Parshad and Natt (2007) reported that monosodium glutamate increased that bait consumption in laboratory rats under lower concentrations. Mushtaq *et al*. (2013) also concluded that sodium chloride added bait acted as a repellent against Indian crested porcupine in northern Pakistan. Indian porcupine is reported to meet the sodium requirements from the its food items (Gurung and Singh, 1996). Our hypothesis that monosodium glutamate may be useful in bait preparation for the final bait formulation, which ultimately may be helpful in rodenticide bait for management campaigns of the porcupines, has been rejected and it is concluded from the results of the present study that salts are not useful in the preparation of bait material for controlling porcupines. A variety of sweetening components have been reported as bait enhancing agents for different species of vertebrate pests in improvement of bait consumption (Rao and Prakash, 1980; Yamaguchi, 1995; Shumake *et al*., 1997; Johnston *et al*., 2005; Mushtaq *et al*., 2013). Khan *et al*. (2006) and Khan and Mian (2008) reported the usefulness of molasses a concentration of 5% in cracked maize and broken rice; while Mushtaq *et al*. (2013) concluded that

saccharin at 5% concentration is the most preferred bait additive by the *Hystrix indica* population in Tarbela watershed area of northern Pakistan. Saccharin, as bait additive, has also been reported against the rice-field rats (*Rattus rattus*; Shumake *et al*., 1997) and in general rodent baits for their management practices (Hsuan *et al*., 1978). It's hard to justify the non-significant difference in sugar added bait consumption over the other additives and plain bait in the area. The porcupine population of the area, may be adapted to the groundnut and other natural and wild plantations of the area in the current study; studies on the food preferences of Indian porcupine in different agro-forestry ecosystems of the country support this assumption (Inayatullah, 2006; Hafeez *et al*., 2014; Khan *et al*., 2022).

Porcupine population surviving under the conditions of the current study area may have acclimatized to the groundnut crop, which is the major crop of the area and porcupine is considered as the number one pest of the groundnut crop of the area. So groundnut maize bait with 5% whole egg could a useful bait combination and may be tested by incorporating different rodenticides for controlling porcupine populations in different ago-forestry ecosystems of the country.

ACKNOWLEDGEMENTS

We are thankful to the Vertebrate Pest Control Laboratory, NARC, Islamabad for providing maize for the field experiments. We, also acknowledge the support of the local community during the field surveys for burrows and data collection.

Statement of conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Abbas, S.M., 2003. *Field evaluation of cereal grain bait materials against the lesser bandicoot rat* (Bandicota bengalensis) *in wheat crop*. M.Sc. thesis, Dept. Zool. Univ. Arid Agric., Rawalpindi, Pakistan. pp. 54.

Anthony, R.M., Evans, J., and Lindsey, G.D., 1986. *Strychnine-salt blocks for controlling porcupines in pine forests: Efficacy and hazards*. Proc. 12th Vertebr. Pest Conf. Univ. Calif., Davis., pp. 191–5.

Berry, A., and Alleva, E., 2010. Preference for novel food in a familiar verses unfamiliar context: A pilot study on C57BL/6J mice. *Rend. Lincei. Sci. Fis. Nat*., **21:** 233–237. https://doi.org/10.1007/s12210-010-0081-5

Bloom, J.C., Rogers, J.G., and Maller, O., 1973. Taste responses of the North American porcupine (*Erethizon dorsatum*). *Physiol. Behav.*, **11:** 95–98. https://doi.org/10.1016/0031-9384(73)90128-5

Chakravarthy, A.K., and Girish, A.C., 2002. Porcupine (*Hystrix indica* Kerr) damage to three coconut varieties in coastal Karnataka. *Rod. Newsl.*, **26:** 2.

Gurung, K., and Singh, R., 1996. *Field guide to the mammals of the Indian subcontinent*. Academic Press, San Diego.

Hafeez, S., Khan, A.A., Gul, S., Nawaz, M.F., and Malik, A.A., 2014. Determining the food habits of the Indian crested porcupine (*Hystrix indica*) in Thal desert lands of Punjab, Pakistan. *FUUAST J. Biol.,* **42:** 253-259.

Hsuan, Y.K., Hague, C.W., and Ku, T.Y., 1978. Preliminary tests on the use of saccharin liquid baits in the control of rice grain storehouse rodents. *Pl. Prot. Bull.,* **20:** 171–174.

Idris, M., and Rana, B.D., 2001. Some observations on infestations of porcupine, *Hystrix indica* Kerr, in the forest nursery of arid region. *Rod. Newsl.,* **25:** 5.

Inayatullah, M., 2006. *To study the dietary habits of local porcupine* (Hystrix indica). Doctoral dissertation, M. Phil. thesis, Quaid-i-Azam University, Islamabad, Pakistan., pp. 57.

Johnston, J.J., Nolte, D.L., Kimball, B.A., Perry, K.R., and Hurley, J.C., 2005. Increasing acceptance and efficacy of zinc phosphide rodenticide baits via modification of the carbohydrate profile. *J. Crop. Prot.,* **24:** 381–385. https://doi.org/10.1016/j.cropro.2004.09.006

Khan A.A., Mushtaq, M., and Ghumman, A.M., 2016. Digging and clipping behavior of Indian crested porcupine, *Hystrix indica* Kerr 1792 in a green belt of Islamabad, Pakistan. *Pakistan J. Zool.,* **48**: 817-820.

Khan, A., Mushtaq, M., Nadeem, M.S., Kayani, A.R. and Ahmed A., 2016. Testing aluminum phosphide in Indian crested porcupine burrows as a pest management technique in Bannu, Pakistan. *Asian J. Agric. Biol.,* **4**: 85-90.

Khan, A.A., Ahmad, S., Hussain, I., and Munir, S., 2000. Deterioration impact of Indian crested porcupine, *Hystrix indica*, on forestry and agricultural systems in Pakistan. *Int. Biodeterior. Biodegrad.,* **45:** 143–149. https://doi.org/10.1016/S0964-8305(00)00046-9

Khan, A.A., and Mian, A., 2008. Field evaluation of coumatetralyl bait against Indian crested porcupine, Hystrix indica Kerr. *Pakistan J. Zool.,* **40:** 63–64.

Khan, M.B., Irshad, N., Ahmed, B., Khan, M.R.,

Minhas, R.A., Ali, U., Mahmood, M., Muhammad, A., Sheikh, A.A. and Ashraf, N., 2021. Food habits of Indian crested porcupine (*Hystrix indica*) (Kerr 1792) in district Bagh, Azad Jammu and Kashmir. *Braz. J. Biol.*, **82**: 2022. https://doi.org/10.1590/1519-6984.243063

Khan. A.A., Mian, A., and Hussain, R., 2006. Investigations on the use of poison baits and fumigants against Indian crested porcupine (*Hystrix indica*). *Pak. J. Scient. Indust. Res.,* **49:** 418–422.

Khan. A.A., Mian, A., and Hussain, R., 2011. A delivery system for carbon monoxide fumigation of Indian crested porcupine, *Hystrix indica*, den using two-ingredient cartridge. *Pakistan J. Zool*., **43**: 727-732.

Khan. A.A., Mian, A., and Hussain, R., 2014. Deterioration impact of Indian crested porcupine, *Hystrix indica*, on irrigated forest plantations in Punjab, Pakistan. *Pakistan J. Zool*., **46**: 1691-1696.

Mian, A., Ali, M., Ali, R., and Touseef, S.B., 1988. Distribution of some mammalian pests of orchards in Balochistan. *Pakistan J. agric. Res.,* **9:** 125–130.

Mushtaq, M., Hussain, I., Mian, A., Munir, S., Ahmed, A., and Khan, A.A., 2013. Field evaluation of some bait additives against Indian crested porcupine (*Hystrix indica*) (Rodentia: Hystricidae). *Integr. Zool*., **8**: 285-292. https://doi.org/10.1111/1749-4877.12014

Mushtaq, M., Mian, A., Hussain, I., Munir, S., Ahmed, I., and Khan, A. A., 2009. Field evaluation of different grain bait bases against Indian crested porcupine, *Hystrix indica*. *Pakistan J. Zool.*, **41**: 7–15.

Mushtaq, M., Mian, A., Hussain, I., Munir, S., and Khan, A.A., 2010. Evaluation of fresh food baits for the management of Indian crested porcupine, *Hystrix indica* Kerr (Rodentia: Hystricidae). *Pakistan J. Zool.,* **42:** 507-513.

Parshad, R.K. and Natt, J.K., 2007. Effects of monosodium glutamate on food acceptance and toxicity of selenium in rats. *Indian J. exp. Biol*., **45**: 802-806.

Pervez, A., 2006. *Developmental biology, feeding patterns and management strategy against Indian crested porcupine* (Hystrix indica) *in Sindh and Balochistan provinces*. 3rd Annual Progress Rep. (2005-2006). ALP Project, VPCI/SARC/PARC, Karachi, pp. 56.

Pervez, A., 2007. Laboratory evaluation of some additive poison baits for controlling commensal and field rodents. *Pakistan J. Zool.,* **39**: 35–41.

Pervez, A., Ahmad, S.M., and Rizvi, S.W.A., 2003. Evaluation of some additives to improve poison bait acceptance in the lesser Bandicoot rat, *Bandicota bengalensis*. *Pakistan J. Zool.,* **35**: 109–113.

Pervez, A., Rizvi, S.W.A., and Ahmad, S.M., 2000. Laboratory evaluation of some additives as enhancers for bait acceptance in short-tailed mole rat, *Nesokia indica*. *Pakistan J. Zool.,* **32**: 351–354.

Petrusewicz, K., 1967. *The estimation of animal number based on the analysis of population structure.* Warsana.

Rao, A.M.K., and Prakash, I., 1980. Evaluation of bait bases for the control of the house mouse, *Mus musculus bacterianus* Blyth. *Bull. Grain Technol.,* **18**: 111–118.

Roberts, T.J., 1997. *The mammals of Pakistan*. Oxford University Press, Karachi, Pakistan, pp. 525.

Shafi, M., Pervez, M.A., and Ahmad, S., 1993. Some approaches to enhance poison bait acceptance in the lesser bandicoot rat, *Bandicota bengalensis*. *Trop. Sci.,* **33**: 350–358.

Shafi, M.M., Ahmad, S., Pervez, A., and Ahmed, S.M., 1992. Taste enhancers improve poison bait acceptance in field rodents damaging wheat crop. *Int. J. Pest Manag.*, **38:** 214-217. https://doi.org/10.1080/09670879209371687

Shumake, S.A., Gaddis, S.E., and Crane, K.A., 1997. Liquid baits for rodent control: A comparison of wild Norway versus wild rice field rat response to glucose plus saccharin solutions. *Crop. Prot.,* **16**: 35–39. https://doi.org/10.1016/S0261-2194(96)00053-1

Singla, N., and Kanwar, D., 2014. Poultry egg components as cereal bait additives for enhancing rodenticide based control success and trap index of house rat, *Rattus rattus*. *Asian Pac. J. trop. Biomed.,* **4:** S341-S347. https://doi.org/10.12980/APJTB.4.2014C1260

Steel, R.G.D., and Torrie, I.H., 1980. *Principles and procedures of statistics.* McGraw Hill, New York, USA.

Talukdar, N.R., Choudhury, P., and Singh, B., 2019. Current records of porcupine in northeast India: Distribution, habitat preference and conservation. *Trop. Ecol.*, **60:** 41-51. https://doi.org/10.1007/s42965-019-00005-4

Yamaguchi, K., 1995. The taste sensitivity preference for five basic tasting substances in DS strain mice. *J. Home Econ.* Japan, **46:** 1037-1045.