Pakistan J. Agric. Res. Vol. 28 No 3, 2015

EVALUATION OF DIFFERENT FOOD GRAINS AS BAITS FOR MANAGEMENT OF *HYSTRIX INDICA*

Amjad Pervez*, Syed Muzaffar Ahmed*, Akhlaq Ahmad**
and Qazi Mehmood Ali**

ABSTRACT:- Indian crested porcupine, *Hystrix indica* is widely distributed and serious rodent pest of orchards, field crops and vegetables in Pakistan. Laboratory studies were conducted to determine highly effective cereal used as bait base for its management. Six locally available food grains viz., wheat, rice, maize, black gram, sorghum and millet were offered in whole/crack form. Under no choice and choice tests, rice was the most preferred food, followed by wheat, maize and others. The present study suggested that rice in whole or cracked form alone or in combination with wheat can be applied as very palatable (32% and 27%, respectively) and cost effective grain as bait base for effective management of Indian porcupine, *Hystrix indica*, being an economically important rodent pest of agriculture, forestry and irrigation network in Pakistan.

Key Words: Indian Crested Porcupine; Hystrix indica; Food Grains; Baits; Pakistan.

INTRODUCTION

Indian crested porcupine (*Hystrix indica*, Kerr) is the largest rodent and its distribution range extends throughout South East and Central Asia and parts of the Middle East, including India, Pakistan, Nepal, Bhutan, Bangladesh, Sri Lanka, Israel, Yemen, Turkey and Saudi Arabia (Roberts, 1997). It is mainly herbivorous and causes serious damage to forest plantation (Greaves and Khan, 1978), fruit trees (Mian et al., 2007) and agricultural crops (Khan et al., 2000; Pervez et al., 2009). Porcupine damages 38.1% to 90% young plants of *Pinus* sp. (Sheiker, 1998; Hussain, 2004), 42% of *Robinia pseudoacacia* (Khan et al., 2000) and 30-70% damage to Gladiolus and Dutch iris plantation, cultivated for commercial purpose (Khan and Mian, 2008). Amongst crops, maize, potato and groundnut are more susceptible to porcupine damage (Brooks et al., 1988; Hafeez et al., 2011). Success of afforestation programme and food security demands that such losses be prevented through effective management of porcupine population.

Rodenticide baiting is the main stay of all present day practical porcupine control programmes. Physical control practices e.g. trapping, snaring, dog hunting, electric fencing and active policing etc. are not effective, while biological control efforts are still not available leaving the only alternative of using chemicals for its management (Hadler and

* *Vertebrate Pest Control Institute (VPCI), Southernzone Agricultural Research Centre, Pakistan Agricultural Research Council, Karachi University Campus, Karachi, Pakistan.*
** *Food Quality and Safety Research Institute (FQSRI), Southernzone Agricultural Research Centre, Pakistan Agricultural Research Council, Karachi University Campus, Karachi.*
Corresponding author: dramjadvpci57@gmail.com

Buckle, 1992; Khan and Mian, 2008; Pervez et al., 2009). The application of acute rodenticides is effective for quick knock down of pest population but they have little selectivity and poor efficacy (Prakash and Mathur, 1992) as almost all rodent species exhibit strong shyness against such chemicals (Mushtaq, 2015). In contrary, the use of antico-agulant rodenticide requires high operational cost (Khan and Mian, 2008). Fumigation of porcupine burrows is only feasible in loamy soils where retention of lethal quantity of gases in burrows is possible.

The success of rodenticide control largely depends upon a better acceptance of bait by the target species than the food available in the area, so that lethal amount of rodenticide is passively consumed as the bait has to compete with foods available in the wild (Petrusewicz, 1967). Economics of rodenticidal bait also demands that bait material and the rodenticide should be cheap and readily available in local market. Different workers have tried various bait options for the control of porcupine without knowing proper dose. Mian et al. (2007) evaluated seven cereals (groundnut, barley, wheat, rice, sorghum, maize and black grains) under field conditions of the Central Punjab. Likewise, Mushtaq et al. (2009) tested seven grain baits against *H. indica* under field conditions of the forest ecosystem of the northern Pakistan. In another study, Mushtaq et al. (2010) evaluated various fresh baits like guava, potato, sweet potato and carrot in different combinations as best poison carrier for effective management of porcupine, however, due to shorter shelf life of bait the technique could not be rated as cost effective. The published literature does not report any work on relative preference of locally available cereals against *H.* indica under captivity. Present study is, therefore designed, with main objective of laboratory based investigations to determine dose/animal and relative preference of various cereal grains to select highly effective and cheaper bait against Indian crested porcupine, *Hystrix indica*.

MATERIALS AND METHOD

Collection and Maintenance of Animals

Indian porcupines, *Hystrix indica* were live trapped through professional animal catchers from Thatta district (24°, 45'N, 67° 55'E) lower Sindh, Pakistan during September-December, 2010 and safely transported to the laboratory in Karachi, Pakistan, where these were sexed and individually caged for three weeks to acclimatize them before undertaking feeding tests. The animals were fed on standard laboratory diet containing wheat, rice, maize and millet, and fish meal prior to and between tests. Animals were provided clean water ad libitum, housed in especially designed mesh enclosures each measuring 9m x 5m x 3.6m.

Experiments were conducted in different sets i.e., no choice, paired choice and multiple choice tests. Under no choice tests, six locally available food grains (wheat, rice, maize, black gram, sorghum and millet) were offered in their whole form. Under paired choice, two of these food grains were offered in separate containers in different

combinations, while in multiple choice test all grains were offered together placed in separate containers. For each trial, 10 animals (5 male, 5 female) were kept singly and test continued for 05 days with rest period of 03 days between different tests to nullify carry over effect (Johnston et al., 2005).

Under each test, 1kg of grain bait was offered daily in especially designed containers to avoid spillage. The left over bait was collected every 24 h, weighed using precision balance with minimum count of 0.1 g and the weight of diet consumed was calculated. The positions of feeding containers were changed daily to avoid place preference trend.

Statistical Analysis

Food consumption data of different food grains was subjected to one way analysis of variance (ANOVA) and means of different bait consumed were compared by LSD at 5% significance level. Mean daily consumption value among different food grain intake was compared by STATISTIX-10 programme. Percent preference value among different food grain in choice tests were calculated by following formula:

$$\% \text{ Acceptance} = \frac{\text{Consumption of food grain offered}}{\text{Total food grain placed}}$$

RESULTS AND DISCUSSION

No Choice Test

The data on relative consumption of six different food grains, offered separately to porcupine showed that whole rice was the most favorably consumed food item (520.00 $\pm$ 22.86 g day^{-1} animal^{-1}) followed by wheat (447.75 $\pm$ 12.53 g day^{-1} animal^{-1}), maize (326.67 $\pm$ 8.49 g day^{-1} animal^{-1}) and black gram (313.33 $\pm$ 25.92 g day^{-1} animal^{-1}) (Table 1). Among the offered cereals, millet was the least consumed cereal (262.50 $\pm$ 16.64 g day^{-1} animal^{-1}). The ANOVA test revealed significant difference among the offered cereals ($P<0.05$). The consumption of rice and wheat cereal was significantly higher than other

Table 1. Different cereals consumed during different days by Indian porcupine in no choice test

(g day^{-1} animal^{-1})

Cereal	No. of enclosure				Overall mean
	I	II	III	IV	
Rice	584.0	480.0	496.1	520.0	520.00±22.86[a]
Wheat	464.0	446.0	413.3	468.1	447.75±12.53[b]
Maize	320.0	350.0	310.0	326.6	326.67±08.49[c]
Black gram	350.0	240.0	350.0	313.3	313.33±25.92[c]
Sorghum	280.0	275.0	250.0	264.0	267.25±06.65[d]
Millet	290.0	215.0	265.0	280.0	262.50±16.64[d]

Means followed by same letter do not differ significantly at 5% probability level.

tested food grains as judged by LSD values.

Paired Choice Test

Under paired choice test, in rice with other grains combination offered as whole (Table 2) significant difference was recorded in consumption between rice vs sorghum combination [P<0.05] as indicated by LSD value. Non-significant difference in grain intake (P>0.05) was revealed in comparison of rice vs wheat and rice vs maize. Wheat consumption was significantly higher than sorghum and maize (P<0.05). Millet consump-

Table 2. Different cereals consumed during different days by Indian porcupine in no choice test in paired choice test

(g day^{-1} animal^{-1})

Cereal combinations	No. of enclosure				Overall mean	Preference (%)
	I	II	III	IV		
Rice vs	167.3	180.4	176.4	185.6	177.43 ± 3.86^{ab}	58
Wheat	192.2	105.3	100.0	175.4	127.48 ± 17.20^{c}	42
Rice vs	235.4	240.2	312.4	324.5	278.13 ± 23.43^{a}	59
Maize	210.5	198.2	183.4	167.5	189.90 ± 9.30^{a}	41
Rice vs	125.3	110.4	100.3	125.4	115.35 ± 6.13^{ab}	49
Black gram	135.4	80.31	35.4	120.5	117.90 ± 13.10^{a}	51
Rice vs	316.4	286.5	245.3	286.7	283.73 ± 14	69
Sorghum	123.4	145.6	128.2	110.4	126.90 ± 7.28^{cd}	31
Rice vs	246.4	325.6	286.4	345.6	301.00 ± 21.96	63
Millet	178.4	168.6	156.7	178.4	170.53 ± 5.16^{ab}	37
Wheat vs	258.2	335.3	352.6	345.6	322.85 ± 21.84^{a}	76
Sorghum	120.2	089.5	092.4	101.8	100.8 ± 6.93^{d}	24
Wheat vs	187.4	175.6	183.4	196.5	185.73 ± 7.23^{b}	59
Maize	145.0	125.2	110.0	123.4	125.76 ± 6.13^{cd}	41
Wheat vs	110.4	090.3	105.6	160.4	116.68 ± 15.20^{a}	51
Black gram	108.3	088.6	104.7	159.7	115.32 ± 4.35^{a}	49
Millet vs	177.6	125.4	165.3	80.2	137.13 ± 22.0^{e}	47
Black gram	184.8	180.3	125.4	135.2	156.43 ± 15.24^{bc}	53
Millet vs	185.4	216.8	245.6	230.8	219.65 ± 12.85^{b}	63
Sorghum	110.2	136.4	124.6	136.4	126.90 ± 6.23^{cd}	37

Means followed by same letter do not differ significantly at 5% probability level by LSD test.

tion was significantly higher (P<0.05) than black gram and sorghum.

The preference of rice was almost double than those of black gram and millet (rice 69% sorghum 31% : rice 63%, millet 37%). Likewise wheat was preferred in prominently higher quantities with sorghum and maize (wheat 76%, sorghum 24%, wheat 59%, maize 41%).

Multiple Choice Test

Under multiple choice tests, all six offered cereals were tested by providing simultaneously to animals in separate containers. The grain baits were presented in two textures i.e., whole and cracked form (Table 3). The preference of rice bait recorded the highest in both whole and cracked form of grains (32% and 27%, respectively) followed by wheat (25% and 25%, respectively). Sorghum was the least preferred grain (3%) as well as in cracked form 6%.

Both in no-choice and choice tests, rice was the most preferred food item, which was consumed in significantly higher quantities than wheat, black gram, maize, sorghum and millet. The preference for rice could be due to its smell and taste (Mushtaq et al., 2010). Rice preference to Indian porcupine to rice may be acclimatization of the captured stock of porcupine as being trapped from rice growing area of lower Sindh, Pakistan (Pervez, 2007). Wheat was

Table 3. Different cereals consumed during different days by Indian porcupine in multiple choice test

(g day^{-1} animal^{-1})

Cereal	No. of enclosure				Overall mean	Preference (%)
	I	II	III	IV		
Whole						
Rice	154.2	159.7	150.8	160.2	156.84 ± 2.61^{a}	30
Wheat	140.3	132.5	138.2	129.2	135.74 ± 2.94^{b}	25
Maize	088.7	094.9	090.9	099.7	094.50 ± 2.77^{c}	18
Black gram	076.4	078.6	078.6	082.2	080.13 ± 1.96^{d}	15
Millet	040.9	029.4	032.9	032.9	035.34 ± 2.84^{e}	07
Sorghum	011.7	028.9	018.5	018.5	020.15 ± 4.16^{f}	03
Cracked						
Rice	140.3	132.5	138.0	129.2	187.30 ± 3.54^{b}	27
Wheat	161.4	165.6	172.3	169.1	167.75 ± 2.70^{b}	25
Maize	088.7	094.8	090.9	099.6	125.16 ± 3.00^{c}	18
Black gram	116.8	128.4	120.1	107.2	118.34 ± 5.05^{c}	17
Millet	048.7	043.8	039.6	052.8	046.36 ± 3.31^{d}	07
Sorghum	042.36	51.67	38.23	48.05	045.32 ± 3.44^{d}	06

Means followed by same letter do not differ significantly at 5% probability level by LSD test.

recorded the second most abundantly consumed food grain. The preference of porcupine for wheat has also been reported by others in field studies. Mian et al. (2007) conducted food preference trials against Indian porcupine in the Central Punjab, Pakistan where wheat is a dominant crop. However, field preference for ground-nut was recorded in the non-ground nut growing area of Abbotabad-Balakot, KPK province where maize is the major cultivated crop (Mushtaq et al., 2009). However, the preference for groundnut has been reported by Mian et al. (2007) in a multiple choice test conducted in groundnut growing areas of Central Punjab.

Most of the field rodents are very selective in choosing their foods, when different natural foods are available (Prakash, 1969; Jackson, 1965). According to Moulton (1967) the ability to detect, analyze and exploit odour is highest among mammals. Since bait has to compete with natural food available, rats and mice may react to the smell of bait (Volfova and Stejskol, 2003). The volatile components of unprocessed rice act as attractant and hence a higher bait acceptance by field rats (Bullard and Holguin, 1977).

The rejection of any offered bait for rodent control is a complicated phenomenon, as it may be due to bait base shyness, poison shyness or additives (Prakash and Mathur, 1988). Bait represents foods to the rodents and different species have different preferences (Adamczewska et al., 1979). Little documented information is available on bait preference of Indian porcupine in captivity, however, studies conducted on rodents (murids) show variation in bait preference, mainly based on texture of grains (Weerakoom and Banks, 2011) calorigenic value (Mathur et al., 1992) availability of food (Donlan and Howald, 2003) and behaviour of the species concerned (Barnett, 1956).

The food items were consumed in significantly higher quantities when presented in cracked form than in whole form. There is an agreement to field study of Mushtaq et al. (2009) conducted for evaluation of different grain bait bases in Abbotabad-Balakot track, KPK Pakistan. The present findings suggest increased consumption of bait material in cracked form certainly has practical value in porcupine control, as it can carry a larger quantity for the rodenticides. Field studies using rice bait or rice-wheat combination is suggested to test the efficacy of bait against Indian porcupine in different agro-climatic zones of Pakistan. Furthermore, the preference for rice or rice-wheat combination has importance due to low price compared to maize, millet and black gram slashing burden on small farm holders, which constitute more than 90% farmers community in Pakistan.

It is thus suggested that rice grain in whole or in crack form applied in single or in combination with wheat are highly palatable and cost effective and may be used as bait for pest based management of Indian porcupine, especially in the Southern Sindh. However, further field/laboratory trials are required under different habitats before the results of present study are adopted for management of this species.

ACKNOWLEDGEMENTS

The financial support of ALP/-

PARC to conduct the study is highly appreciated.

LITERATURE CITED

Adamczewska, A.K., G. Bujalska and R. Macki-Rogal. 1979. The dynamics of a rodent community in agro-cenosis. Bull. Acad. Pol. Sci. Sec. Sci. Biol. 27: 723-728.

Barnett, S.A. 1956. Behaviour components in the feeding of wild and laboratory rats. Behaviour, 9: 24-43.

Brooks, J.E., E. Ahmed and I. Hussain. 1988. Damage by vertebrate pest to groundnut in Pakistan. In: Crabs A.C. and Marsh R.E. (eds.) Proc. 13th Vert. Pest Conf. University of California. Davis, USA. p. 129-133.

Bullard, R. and G. Holguin. 1977. Volatile components of unprocessed rice. J. Wild Mangt. 4: 290-297.

Donlan, C.J. and G.R. Howald. 2003. Evaluating alternative rodenticides for Island conservation: Roof rat eradication from the San Jorge Island. Mexico. Bio Censer, 114(29-34).

Greaves, J.H. and A.A. Khan. 1978. The status and control of porcupine genus *Hystrix* as forest pests. Common. For. Rev. 57: 25-31.

Hadler, M.R. and A.R. Buckle. 1992. Forty five years of anticoagulant rodenticidies pest, present and future trends. In: Borrecco, J.E. and Marsh, R.E. (eds.). Proc. 15th Vert. Pest Conf. New Post Beach California, USA. March 3-5. p. 149-155.

Hafeez, S., S.S. Khan, M. Ashfaq and Z.H. Khan. 2011. Food habits of the Indian crested porcupine *Hystrix indica* in Faisalabad, Pakistan. Pakistan J. Agric. Sci. 48: 205-210.

Hussain, I. 2004. Investigations on Indian crested porcupine, *Hystrix indica*, damage to forest flora and development of prevention practices in Tarbela-Mangla watershed area, Annual Progress Report IPEP, NARC, Islamabad. 12 p.

Jackson, W.B. 1965. Feeding pattern in domestic rodents. Pest Control, 33: 12-15.

Johnston, J.J., D.L. Nolte, B.A. Kimbal, K.R. Perry and J.C. Hurley. 2005. Increasing acceptance and efficacy of zinc phosphide rodenticide baits via modification of the carbohydrate profile. Crop Protect. 24: 381-385.

Khan, A.A., S. Ahmed, I. Hussain and S. Munir. 2000. Deterioration impact of Indian crested porcupine, *Hystrix indica* on forestry and agriculture system in Pakistan. Int. Biodet. Biodeg. 45: 143-149.

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

Khan, A.A., A. Mian and R. Hussain. 2007. Investigation on the use of poison baits and fumigants against Indian crested porcupine (*Hystrix indica*). Pakistan J. Sci. Ind. Res. 49: 418-422.

Mathur, R.P., A.P. Jain, N. Kashyap and F. Parveen. 1992. Studies on bait preference and acceptance of flocomafen on infesting poultry farms and godowns. In: Borrecco J.E. and Marsh, R.E. (eds.). Proc. 15th Vert. Pest Conf., New Post Beach California, USA. March 3-5. p. 178-181.

Mian, A., A.A. Khan and R. Hussain. 2007. Biology and management of porcupine, *Hystrix indica* in Central Punjab, Pakistan. Final progress report (2003-2007), ALP project, Dept. of Zoology, PMAS. University of Arid Agriculture, Rawalpindi. 129p.

Moulton, D.G. 1967. Olfaction in mammals. Ann. Zoologist, 7: 421-429.

Mushtaq, M. 2015. Effectiveness of grain based bait as carrier of Strychnine Alkaloid for the control of Indian crested porcupine, *Hystrix indica*. Sarhad J. Agric. 31(1): 10-15.

Mushtaq, M., A. Mian, I. Hussain, S. Munir, I. Ahmed and A.A. Khan. 2009. Field evaluation of different grain bait bases against Indian crested porcupine, *Hystrix indica.* Pakistan J. Zool. 41(1): 7-15.

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

Pervez, A. 2007. Developmental biology, feeding pattern and management strategy against Indian crested porcupine (*Hystrix indica*) in Sindh and Balochistan provinces. Final Technical Report, VPCI/SARC/PARC. 125 p.

Pervez, A., S.M. Ahmed, S.B. Lathiya and E. Khadija. 2009. Food habit of Indian crested porcupine (*Hystrix indica*) in Sindh, Pakistan. Pakistan J. Zool. 41: 319-322.

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

Prakash, I. 1969. Eco-toxicology of Indian desert gerbil, *Meriones hurrianae* Jerdon, food preference in the field during monsoon. J. Bombay Nat. Hist. Soc. 65: 581-589.

Prakash, I. and R.P. Mathur. 1988. Rodent problem in Asia. In: Prakash I. (ed.) Rodent Pest Management CRC. Press Boca Raton Florida USA. p. 67-84.

Prakash, I.R.P. and R.P. Mathur. 1992. Acute rodenticides in rodent. In: Prakash, I. and Ghosh, P.K. (eds). Indian Agriculture Vol.I. Scientific Publishers, Jodhpur, India. p. 497-515.

Roberts, T.J. 1997. The mammals of Pakistan (revised edn). Oxford University Press, Karachi, Pakistan. 525p.

Sheikar, C. 1998. Porcupine damage to agro-forestry system in Himachal Pradesh, Rodent Newl. 22: 12-13.

Volfova, R. and V. Stejskol. 2003. Responses of house mice (*Mus musculus*) to different stations, the role of size, shape, material and odour. Advances in Stored Product Prot. UK. p. 22-26.

Weerakoom, M.K. and P. Banks. 2011. Not just a matter of taste, palatability of bait marker is influenced by the need to reach for alternative food. Wildlife Res. 38: 596-602.

(*Continued on next page..*)

AUTHORSHIP AND CONTRIBUTION DECLARATION

S. No	Author Name	Contribution to the paper
1.	Dr. Amjad Pervez	Conceived the idea, Supervised the research, write up
2.	Syed Muzaffar Ahmed	Conducted research, Technical input at every step
3.	Dr. Akhlaq Ahmad	Conductive research, Write up of paper
4.	Qazi Mehmood Ali	Data entry in SPSS and analysis

(Received June 2015 and Accepted August 2015)