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Preference by the Nile Rat (Arvicanthis niloticus) For Five Cereal Grains and Two Oil Additives

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A Cooperative Program

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Government of Chad/Ministry of Agriculture,
U.S. Agency for International Development,
and
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By J. Juan Spillett, Djibo Koulangar, and Joe E. Brooks

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PREFERENCE BY THE NILE RAT (*ARVICANTHIS NILOTICUS*) FOR FIVE CEREAL GRAINS AND TWO OIL ADDITIVES

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Abstract: Preference by captive Nile rats (*Arvicanthis niloticus*) for five medium-coarse ground cereal grains was determined by presenting two food choices simultaneously to between three and seven individually caged rats for periods of three or four days. The resulting order of preference was: (1) millet, (2) rice, (3) wheat, (4) sorghum, and (5) maize. Using the same procedures, millet with 5% peanut oil was preferred to millet with 5% cotton seed oil. There was no significant difference between millet with 5% peanut oil and millet with 2% peanut oil. These results suggest that medium-coarse ground millet, with 2% peanut oil as a toxicant binder, should be used as a rodenticide bait for the control of pest populations of Nile rats. Broken or ground rice, with peanut oil, is recommended as an alternate bait to millet. Both materials should prove useful in reducing Nile rat damage to vegetables and cereal crops in wadi situations.

INTRODUCTION:

Periodic rodent population irruptions, such as those of 1962-64, 1975-77, and 1986-87, probably have occurred in the Sahel region of northern Africa for centuries. Although Sahelian rodent outbreaks often have been widespread and have severely reduced food production, these phenomena have been poorly documented and little studied (Fiedler 1987). Even the major rodent pest species involved in crop depredations often have not been identified, let alone their population dynamics nor effective methods of control determined.

Monitoring of rodent populations in the N'Gouri area of Chad at approximately monthly intervals demonstrated that the Nile rat (*Arvicanthis niloticus*) is the major rodent pest of "wadi" agriculture. "Wadi" agriculture is the labor-intensive cultivation and irrigation of crops such as okra, manioc, onions, tomatoes, peppers, corn, sorghum, and millet, in scattered and usually small (< 10 ha) oases in the Sahelian region of Chad. Of 410 rodents captured on wadis during 20 trapping periods between October 1989 and October 1991, 308 (75%) were *A. niloticus*, 44 (11%) were *Gerbillus andersoni*, 38 (9%) were *Tatera robusta*, and 20 (5%) were unidentified or other rodent species.

Limited toxicological trials with closed/open burrows in the field and with caged rats suggested that 1% zinc phosphide baits should effectively control Nile rats (Savarie 1990). However, results were inconclusive and should be verified. For rodenticides to be effective in field situations, they need to be presented in palatable bait materials because bait acceptance by rodents is a common problem in control programs. Food preference behavior in wild rodents is very complex (Bullard and Shumake 1977). Rodents often display individual tastes and preferences (Fitzwater and Prakash 1966). The determination of which baits will effectively deliver rodenticides to target species of pest rodents is, therefore, an important aspect of rodent population control.

Cereal grains and seeds are preferred foods for most rodents and represent typical baits for delivering toxicants to rodents (Suliman, Shumake, and Jackson 1984). The four most common cereal grains in Chad, namely millet, sorghum, maize, and rice, were used for food preference trials with Nile rats. Wheat also was tested in the food preference trials since it apparently is commonly used as a rodent bait in Chad. Edible oils commonly are used as a binder or to improve adherence of toxicants to cereal grain baits. The two most common food or cooking oils in Chad, cotton seed oil and peanut oil, also were included in the food preference trials.

The primary objective of this study was to determine which of the readily available cereal grains and edible oils in Chad, when used as bait, would most effectively deliver rodenticides to pest populations of Nile rats.

MATERIALS AND METHODS:

Adult Nile rats were captured in an orchard/hedgerow complex on a Government of Chad, Ministry of Agriculture (MOA) horticultural farm near the village of Walia, across the Chari River and south of N'Djamena. Rats were sexed, weighed, and individually caged in 15 x 15 x 30-cm wire cages in the office/laboratory complex of the MOA/Chad Rodent Control Research Project in N'Djamena. A minimum acclimation period of two weeks was provided for the rats prior to initiating food preference trials.

Samples of millet, sorghum, maize, and rice were purchased in the N'Djamena market. Wheat was not available in the market, but was obtained from the Chad MOA's Gassi Seed Production Farm south of N'Djamena. Brooks and Bowerman (1973) reported that particle size may be more important than the actual choice of material as bait, particularly with hard, dense seeds. Therefore, the test cereal grains were ground into uniform medium-coarse meals at a local mill.

Food cups, made from milk tins, measuring 6 cm both in diameter and height, were used to present individual cereal grains or grains with oil additives, two food choices at a time, to test animals. Food cups were wired to the bottoms of the cages for stability. Papers were placed beneath the elevated cages to catch spilled foods. For each trial, two food cups were presented in side-by-side positions at the front of each cage. The position of the test food grains offered was altered during the trials to eliminate position bias, because rodents sometimes prefer to feed on one side of the cage, away from the light, air currents and such (Brooks 1991). Preference trials for different combinations of two of the five cereal grains (a total of 10 combinations) were run for three or four 24-hour periods, and then later replicated for all the grain combinations except those including wheat.

Rats were individually weighed to the nearest 0.1 gm and test foods to the nearest 0.01 gm on an Ohaus GT2100 balance at the beginning and end of each paired foods trial. Twenty-five grams of each test food was placed in a respective food cup at the beginning of each trial, and additional test foods were added in 10-gm increments to the respective food cups whenever needed. Free-choice water was available at all times. At the end of each trial, food consumption for each food was determined by weighing both the food remaining

in the food cups and that spilled onto the paper beneath the cages. These were added together and subtracted from the total amount of the respective food presented during the trial.

Data were analyzed as a series of 2X2 contingency tables. Pearson's Chi-Square statistic was not justified due to the small samples sizes for some of the tests, so Fisher's Exact test was used. Significance at the 5 and 10% probability levels were examined.

RESULTS:

The amounts consumed of each of the five cereal grains presented two at a time to three to seven individually caged adult Nile rats during initial three- to four-day trial periods are presented in Table 1. Rats preferred millet over corn, sorghum, rice , and wheat. In 43 individual trials in which millet was presented alongside the other four cereal grains, millet was preferred 37 times (Table 2). In 14 trials where millet and sorghum were simultaneously offered, millet was preferred 10 times (71%). In 14 trials between millet and rice, millet was selected 12 times (86%). In 9 trials against maize and 6 against wheat, millet always was preferred. Analysis of these results using Fisher's Exact Test showed that the preference for millet was significant at the 10% level over the 4 other grains (Table 4). The difference between millet and sorghum was not significant at the 5% level, however.

The order of preference after millet was rice (chosen 21 out of 38 offerings), wheat (picked 9 times out of 24 trials), sorghum (selected 13 out of 39 trials), and maize was least preferred (picked 8 out of 32 times). This order of preference doesn't reflect the fact that maize and sorghum are about equal in preference, however, with one being selected against the other on alternate trials. The preference for rice was significant at the 10% level over maize and wheat; there was no significant preference between rice and sorghum (Table 4). The percent total consumption for each of the five cereal grains presented two at a time to the caged Nile rats is presented in Figure 1.

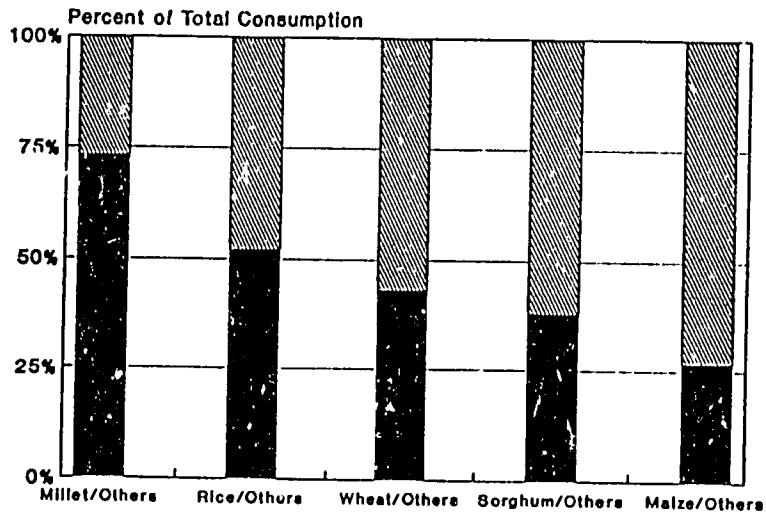

Fig. 1. Percent consumption of total diet of several cereal grains offered two at a time to caged Nile rats.

Table 1. Consumption of cereal grains when offered in pairs to Nile rats, *Arvicanthis niloticus*, and number of times each food chosen.

No. of Rats	No. of Days	Grains Presented	Amount of grains Consumed, gm	Mean amount eaten/rat/day	No. rats Preferred
7	3	Millet	99.4	4.7	7
		Rice	39.3	1.9	0
7	3	Millet	132.5	6.3	5
		Rice	62.7	3.0	2
6	4	Millet	167.8	7.0	6
		Wheat	60.7	2.5	0
7	3	Millet	164.6	7.8	4
		Sorghum	61.6	2.9	3
7	4	Millet	188.6	6.7	6
		Sorghum	89.5	3.2	1
3	4	Millet	84.5	7.0	3
		Maize	0.1	0.0	0
6	4	Millet	167.1	7.0	6
		Maize	52.0	2.2	0
6	3	Rice	93.0	5.2	5
		Wheat	48.9	2.7	1
3	3	Rice	70.9	7.9	3
		Sorghum	4.0	0.4	0
7	4	Rice	98.3	3.5	4
		Sorghum	105.6	3.8	3
3	4	Rice	49.3	4.1	3
		Maize	25.8	2.2	0
5	3	Rice	96.5	6.4	4
		Maize	47.3	3.2	1
6	4	Wheat	102.7	4.3	4
		Maize	78.4	3.3	2
6	4	Wheat	107.6	4.5	4
		Sorghum	81.3	3.4	2
6	4	Sorghum	98.3	4.1	3
		Maize	100.8	4.2	3
3	3	Sorghum	22.6	2.5	1
		Maize	24.8	2.8	2

Two to 5% concentrations of edible oils commonly are used to bind or improve adherence of rodenticides to grain baits. The two most common food or cooking oils in Chad are cotton seed oil and peanut oil. Replicate trials with six individually caged adult Nile rats were conducted for three or four days to compare consumption or determine their preference for either 5% peanut oil or 5% cotton seed oil with ground millet (Table 3).

More millet with 5% peanut oil was consumed than millet with 5% cotton seed oil in 11 of the 12 individual trials. Results were similar on the basis of the percentages of each food consumed by the rats are compared. Of 219.9 gm of total food consumed by 6 rats during initial 4-day preference trials, 70% was millet/peanut oil and 30% was millet/cotton seed oil. On the replicate

Table 2. Number of times an offered food was chosen over its alternate food on paired choice food preference trials.

No. Times chosen/ times offered	Millet	Rice	Wheat	Maize	Sorghum	Times Chosen
Millet	---	12/14	6/6	9/9	10/14	37/43
Rice	2/14	---	5/6	7/8	7/10	21/38
Wheat	0/6	1/6	---	4/6	4/6	9/24
Maize	0/9	1/8	2/6	---	5/9	8/32
Sorghum	4/14	3/10	2/6	4/9	---	13/39

Table 3. Preferences of Nile rats, *Arvicanthis niloticus*, when given a paired choice between millet with peanut and cotton seed oils added at several concentrations.

No. of Rats	No. of Days	Foods Presented	Amount of foods Consumed, gm	No. of rats Preferred
6	4	Millet + 5% peanut oil (PNO)	154.8	6
		Millet + 5% cotton seed oil (CSO)	65.1	0
6	3	Millet + 5% peanut oil (PNO)	124.8	5
		Millet + 5% cotton seed oil (CSO)	48.7	1
6	4	Millet + 5% peanut oil (PNO)	118.8	4
		Millet + 2% peanut oil (PNO)	92.9	2
6	4	Millet + 5% peanut oil (PNO)	136.7	4
		Millet + 2% peanut oil (PNO)	98.1	2

trial of 6 rats for 3 days, 72% of the total food consumed was millet/peanut oil and 28% was millet/cotton seed oil. The preference for peanut oil over cotton seed oil was significant at the 5% probability level (Table 4).

Replicate trials were conducted with 6 individually caged adult Nile rats where medium-coarse ground millet with 2% peanut oil was compared with millet with 5% peanut oil for trial periods of 3 or 4 days (Table 3). In 8 of the 12 trials, millet with 5% peanut oil was preferred over the 2% oil concentration but the findings were not significant at either the 5% or 10% probability levels (Table 4).

Table 4. Significance of differences in preference of several grains and oils by *Arvicanthis*. (Data from 2X2 contingency tables, number of rats choosing each grain or oil on the several tests)

Grains Tested	Fisher's p	Significant 5%	10%
Millet/Rice	0.000423	*	*
Millet/Sorghum	0.057		*
Millet/Maize	0.000041	*	*
Millet/Wheat	0.00216	*	*
Rice/Sorghum	0.179		
Rice/Maize	0.0101	*	*
Rice/Wheat	0.0801		*
Sorghum/Maize	1.000		
Sorghum/Wheat	0.567		
Maize/Wheat	0.567		
Millet with:			
5% PNO/5% CSO	0.000107	*	*
5% PNO/2% PNO	0.220		

DISCUSSION AND RECOMMENDATIONS:

The order of preference for the five cereal grains presented two at a time to individually caged Nile rats was well defined. Millet was highly preferred, followed by rice and then wheat. Maize and sorghum were about equal in preference.

El-Deeb et al. (1985a) reported that the order of preference of *A. niloticus* "under field conditions" was: (1) crushed wheat, (2) broken maize, and (3) sorghum, which is the same order of preference determined here. However, he didn't look at millet or rice. Sultana (1981) in Bangladesh reported that the lesser bandicoot rat (*Bandicota bengalensis*) preferred rice to wheat, and Spillett (1968) found the same for the lesser bandicoot rat in Calcutta, India. However, Suliman (1980) and Suliman et al. (1984) reported that *A. niloticus* preferred sorghum to wheat. They also claimed the Nile rat preferred whole sorghum "to cracked and ground sorghum", and that the addition of peanut oil and/or sugar "enhanced" the consumption of sorghum baits. Bullard and Shumake (1977) similarly reported "that intensifying the flavor cues associated with a familiar or preferred food" enhanced bait acceptance by ricefield rats (*Rattus rattus mindanensis*). Whether or not these differences may be attributed to differences in grain texture (whole vs. ground) should be determined.

El-Deeb et al. (1985b) reported "under field conditions" Nile rats preferred "crushed maize bait without cotton seed oil".... and, that bait "attractiveness decreased by increasing the concentration of cotton seed oil from 1% to 5%" in crushed maize. Our results differed from those of El-Deeb

et al. (1985b) as Nile rats preferred peanut oil to cotton seed oil, and a 5% peanut oil concentration over the 2% peanut oil concentration.

RECOMMENDATIONS: Based upon our studies, it is recommended that medium-coarse ground millet, with 2% peanut oil as a toxicant binder, be used as a bait to deliver rodenticides to pest populations of Nile rats. Broken or medium-coarse ground rice is recommended as an alternate bait material, with the addition of peanut oil as a binder. These bait materials, with the peanut oil additive, should be useful in reducing Nile rat damage to vegetable and cereal gain crops in irrigated wadi agriculture where the Nile rats live. Since they have permanent habitat in the thorny hedgerows that surround the irrigated fields, the appropriate situations to place baits would be along their pathways or near their burrow openings in the hedgerows. The millet or rice medium-coarse meals should mix easily with either zinc phosphide or with anticoagulant concentrates and provide a bait with good keeping qualities for field use.

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