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FEEDING PREFERENCES OF SUBTERRANEAN TERMITES, *Psammotermes hypostoma* (DESNEUX) (BLATTODEA: RHINOTERMITIDAE) FOR IMPROVING TRAPPING SYSTEM IN EGYPT UNDER FIELD CONDITIONS

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The feeding preferences of the subterranean termites depend on the cellulose contents of the subjected material. Therefore, the effectiveness of a trap is measured through the rate of bait consumption by termite individuals. Accordingly, the present study aimed to evaluate the feeding preferences of subterranean termites toward nine types of dry plant materials. The experimental area was selected as it is highly infected. The results obtained showed that the sugarcane pit (*Saccharum officinarum*), in the first year, and berseem hay (*Trifolium alexandrinum* L.), in the second year, were the most preferred hays among all evaluated hays as they recorded the highest food consumption rate during two successive years, 2018 and 2019, respectively. We can conclude that using either sugarcane pit or berseem hay can provide excellent content for termite traps for further employment to control this pest.

Keywords: Subterranean termites; feeding preferences; dry plant materials; hays; straws.

1. INTRODUCTION

Termites, white ants, are exopterygot insects that belong to the order Isoptera. They are classified according to their food preferences into three categories: one-piece termites, which feed on and inhibit wood, arboreal termites, and subterranean termites [1,2]. All groups cause significant wastage, however, subterranean termites are considered the most dangerous species [3,4]. Subterranean termites include soil feeders, litter feeders, and wood feeders [1,5,6]. They live in the soil in communities and feed on cellulose [7]. In Egypt, eight species were identified to exist, four of which belong to the genus *Psammotermes*. They are abundant in arid and semi-arid Upper Egypt [8,9]. Termites play a key role in the ecosystem as decomposers due to their unique ability to digest cellulose [10,11], however, they are considered pests when they cause damage and destroy the timber of any plant materials. Field studies for subterranean termites typically use a cellulosic bait placed on the ground [12,13,14]. Bait effectiveness depends on the rate at which it is consumed by the termite workers and distributed to the brood and queen [12,15]. Food consumption is dependent on nutritional demands of the colony, however, the consumption of any substances is frequently controlled by the termite feeding preferences [16,14].

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Feeding preferences are determined partially by the presence of feeding stimulants and deterrents [16,12]. Therefore, the current study was conducted to study the feeding preferences of the subterranean termites towards some dry plants wastes in order to employ them latterly in termite traps. Nine types of dry plant wastes were analyzed and evaluated for the termites' feeding preferences in order to improve termite's trap.

2. MATERIALS AND METHODS

2.1 Chemical analysis of Dry Hays

The chemical composition of nine dry plant parts were analyzed. The tested hays were alfalfa hay (*Medicago sativa* L.), sugarcane pit (*Saccharum officinarum*), wheat straw (*Triticum aestivum* L.), broad bean hay (*Vicia faba* L.), berseem hey (*Trifolium alexandrinum* L.), rice straw (*Oryza staiva* L.), corn stalks (*Zea mays* L.), corn cobs, and rice husks. The tested hays were supplied from Animal Production Research Institute, Agricultural Research Center, Dokki, Giza, Egypt. Dry matter was determined by drying the samples at 105ºC overnight and ash by igniting the samples in a muffle furnace at 525ºC for 8 h. Nitrogen concentration was measured by the Kjeldahl method [17]. Crude protein was calculated as N X 6.25. Crude fiber (CF) and ether extract (EE) were determined by the methods of AOAC [17].

2.2 Tested Area

In order to study the termites' feeding preferences, 55 infected positions were selected in the tested area, at Al Maslamiya village, Zagazig Center, Sharkia Governorate, Egypt, and the field experimentation was carried out through two successive years, 2018 and 2019. The traps were distributed randomly in the infested area to detect and determine the infestation level in the selected area a month before experiment carried out. After that, for each hay type, three traps were previously prepared at Termite Research Unit, Plant Protection Research Institute, Dokki, Giza, were used. Before usage, the traps were dried in an electric oven at 105° C for 24 hours, then, weighed (gm) for each trap type and monthly sent to the experimental area in the field. The traps were then placed in a circular organization at the center of the termite colony (Fig. 1). El-Sebay traps was used as the control trap, which consists of corrugated card-board wrapped in a roll shape, 7-10 cm in diameter and 12 cm in length, covered with polyethylene sack except 1-2 cm at the end position fixed with rubber band.

2.3 Field Work

After monitoring the existence of the subterranean termites, *Psammotermes hypostoma* (Desn.), using El-Sebay traps (control trap) [4,18,19] (Fig. 2), the traps were weighed and supplied with different types of straw. Each trap was marked and buried at 15 cm depth in soil. Traps were replaced monthly by new ones throughout 2018 and 2019. The trap width was 30 cm, and the length was one meter. The traps were then placed in half and filling them with dirt and placing a plastic bag at the end of the trap to be examined after a month. The traps were latterly removed, and the remining materials were weighed. The same steps were repeated for two successive years within six months each year. The collected traps were transferred to the laboratory to estimate the seasonal activity of termites. The collected traps were dried at 105° C for 24 hours and re-weighed to calculate the rate of food consumption according to the following equation:

$$FC = TWB - TWA \quad \text{[Eq. 1]}$$

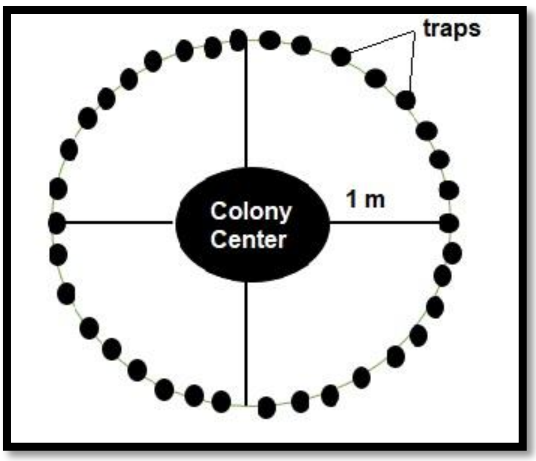

Fig. 1. Experiment design

Fig. 2. The traps used for evaluating the food consumption

Where, FC is the food consumption of the trap (gm), TWB is the trap weight before (gm), and TWA is the trap weight after (gm). Three replicates were used for each type of hay.

2.4 Statistical Analysis

Simple correlation “r” and estimated values corresponding to attraction and rate of food consumption (gm) during two successive seasons, 2018 and 2019, were analyzed using ANOVA test ($P<0.05$) using SPSS 17.0 release 17.0.0 software (Statistical Package for Social Sciences, USA).

3. RESULTS AND DISCUSSION

3.1 Chemical Composition of Tested Hays

Data presented in Table (1) showed the chemical composition of nine types of plant dry matters. The tested hays were alfalfa hay, sugarcane pit, wheat straw, broad bean hay, berseem hey, rice straw, corn stalks, corn cobs, and rice husks. Results revealed considerable variation in the constituents among all examined hays. Results showed that the dry matter constituents represented about 90-92% of all tested hays. In addition, the highest cellulose content was obtained in sugarcane pit (51%), followed by berseem hay (48.6%), broad bean hay (41.9%), and corn stalks (40.9%). The lowest cellulose constituents were 21.3% in corn cobs. The crude proteins ranged from 3% in rice husks to 15.5% in alfalfa hay.

Furthermore, the crude fiber concentration was ranged from 25% in alfalfa hay to 46% in sugarcane pit. The highest lignin concentration was observed in sugarcane pit (19%), and the lowest lignin content was 3.7% in corn stalks. The highest neutral detergent and acid detergent fibers were determined in sugarcane pit, while the lowest neutral detergent and acid detergent fibers was obtained in alfalfa hay.

3.2 Food Consumption Rate

The rate of food consumption by the subterranean termites through 2018 and 2019 was listed in Table (2) and (3). Results showed that the highest rate of food consumption by the insect was observed through February, March, and April (Spring season) and through September, October, and November (Autumn season) compared to the rest months. This can be due to the appropriate climatic conditions for the activity of the insect [20,21]. Moreover, results revealed that the highest food consumption percentage was observed when the sugarcane pit (95.18%) was used in the first year. However, in the second year the food consumption rate showed its highest value when berseem hay traps were used (29.11). This might be due to its high contents of lignin and the cellulose. It is well documented that the subterranean termites prefer wide range of feeding preferences toward synthetic and natural substances [12,22]. In addition, the rate of food consumption was high through September, October, November, and December in the second year. Results revealed a correlation of 98.1% between the type of hay offered and the rate of food consumption in the first year, however, the correlation was decreased to 67.1% in the second year.

The food consumption increased by the termites as they offered food baits contained simple carbohydrates [22, Wallace & Judd, 2010). As a procedure to increase food consumption, phagostimulants such as urea, amino acids, and simple carbohydrates are added (Castillo et al., 2013); [12, 22].

Table 1. The proximate analysis of different hays used in the study

Feedstuffs	%DM*	C.P.*	%E.E.*	Fibers					Ash
				%C*	%L*	NDF*	ADF*	C.F.*	
Alfalfa hay	90.0	15.5	2.0	23.0	10.0	45.0	32.0	25.0	8.0
Sugarcane pit	92.0	1.5	0.5	51.0	19.0	86.0	60.0	46.0	4.0
Wheat straw	90.0	3.2	1.5	38.2	9.0	80.0	55.0	42.1	8.0
Broad bean hay	90.0	5.5	1.0	41.9	4.85	-	56.0	40.0	12.0
Berseem hay	90.0	6.0	0.8	48.6	4.3	8.0		39.0	-
Rice straw	90.0	4.0	1.0	23.6	5.0	71.0	55.0	40.0	16.0
Corn stalks	90.0	6.0	0.5	40.9	3.7	6.4		37.0	10.0
Corn cobs	90.0	4.0	1.0	21.3	9.4	57.0	33.0	29.2	6.1
Rice husks	92.0	3.0	7.0	39.1	11	75.0	66.0	39.4	18.9

** DM: Dry matter, C.P.: Crude Protein, E.E.: Ether extract, C: Cellulose, L: Lignin, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, C.F.: Crude fiber*

Table 2. The rate of food consumption on different hay types through 2018

Food type	% Food consumption in a month												Mean ± S.D.
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Alfalfa hay	89.46	98.29	95.91	98.67	92.94	89.82	89.98	88.87	89.66	78.89	95.66	94.45	$91.88\pm4.10^{**}$
Sugarcane pit	96.66	89.89	97.99	96.45	97.48	95.56	98.55	97.44	94.39	96.95	89.88	90.88	$95.18\pm2.61^{**}$
Wheat straw	79.37	73.86	76.76	78.66	76.42	69.55	72.88	77.33	79.75	79.33	73.88	80.22	76.50 ± 2.65^{ns}
Broad bean hay	71.35	74.54	77.71	77.64	79.73	76	82.81	79.81	75.19	77.95	80.5	80.71	77.83 ± 2.42^{ns}
Berseem hay	80.61	77.19	78.63	88.56	89.42	77.01	77.16	79.88	80.55	75.81	77.88	80.99	$80.31\pm3.10^{*}$
Rice straw	73.77	87.67	81.55	82.55	88.56	87.32	86.67	85.63	83.67	88.56	82.44	78.54	$83.91\pm3.49^{*}$
Corn stalks	76.39	76.53	75.67	74.49	87.69	77.17	72.97	75.54	73.97	74.88	76.22	74.97	76.37 ± 2.05^{ns}
Corn cobs	88.94	84.55	87.47	89.75	85.73	83.85	81.55	86.55	83.23	80.65	80.44	81.63	$84.53\pm2.63^{*}$
Rice husks	65.88	62.75	61.65	64.74	65.99	61.87	62.72	59.64	64.72	65.11	62.81	63.88	63.48 ± 1.57^{ns}
Control	86.75	80.03	71.54	78.19	80.60	75.91	77.15	79.55	77.87	79.51	74.45	78.44	78.33 ± 2.48
F-value	9.269												
***P*-value**	0.00												
r	0.981												
r^2	0.782												

*ns: not significant, * significant, ** high significant at P<0.05.*

Table 3. Rate of food consumption through the subterranean termite's active time through 2019

Food type	% Food consumption in a month												Mean ± S.D.
	1	2	3	4	5	6	7	8	9	10	11	12	
Alfalfa hay	0	1.2	11.2	20.7	19.2	26.9	32.1	26.18	35.8	38.7	39.5	43.6	14.61±4.22
Sugarcane pit	0	.5	5.3	8.8	10.3	18.4	18.6	19.8	32.7	37.9	41.2	45.8	22.32±6.44
Wheat straw	4.7	5.9	18.3	30.8	42.7	48.9	55.7	45.8	60.88	67.7	69.7	49.5	20.43±5.89
Broad bean hay	5.5	6.5	28.8	37.8	48.4	53.9	65.3	52.5	53.4	59.2	62.5	55.4	3.69±1.07
Berseem hay	10.2	14.8	45.8	53.88	60.7	68.5	65.77	68.7	72.4	80.2	58.5	72.8	29.11±8.40
Rice straw	12.4	9.3	26.5	35.3	42.7	48.9	53.71	85.7	77.3	69.7	80.2	56.77	25.71±7.42
Corn stalks	11.22	11.5	35.58	57.88	62.8	55.4	76.7	66.87	90.8	98.3	84.76	85.16	16.00±4.62
Control	86.75	80.03	71.54	78.19	80.60	75.91	77.15	79.55	77.87	79.51	74.45	78.44	78.33±2.48
F-value	10.269												
***P*-value**	0.00												
r	0.671												
r^2	0.450												

4. CONCLUSION

From obtained results, we can conclude that using dry sugarcane pit or alfalfa hay can be consider as excellent termite traps contents as they can attract termite individual effectively as they contain high cellulose and lignin contents. This may be an achievement to the termites' baits in order to use them latterly in termites' management programs.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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