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Research Article

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Colored-Sticky Paper Trapability of Periurban Population of Sand Flies (Diptera: Psychodidae)

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Abstract

Background

Sand flies are the natural vectors of humans leishmaniasis a neglected disease, yet universally endemic in 98 countries with 350 million people at risk. Though significant advancements have been made in developing therapeutics attack on the vectors is anticipated to be a promising approach for controlling the vectors and the disease. Hence the current study was carried out to provide accurate data required for execution of successful control of local sand flies population.

Mehtods

The randomized Latin square technique was used to determine the aparnt effeicency and performance of colored sticky paper traps in order to establish an effective sampling and controling system.

Results

The white, yellow and green colored sticky paper traps were found to be significantly more attractive and effective than red and blue colored ones to the local sand flies population.

Conclusion

The trap color was the source of captured variation observed. White and yellow sampling system was suggested for clarifying sand fly population under quantitative studies to generate information necessary for carrying out successful control as they captured the efficient leishmaniasis vectors P. papatasi and P. orientalis though prevalent in low densities.

Keywords: Sand Fly, P. Papatasi and P. Orientalis, Trapability, Colored-Sticky Paper Traps, Randmized Latin Squire

1. Background

Leishmaniasis remains on the top emergent infectious diseases with predictable increasing number of cases due to exposure to infected vectors consequent to the human encroachment into animal reservoirs neighborhood [1]. The disease considered to be neglected and it has a universal disperstion in the tropical and sub-tropical regions of Africa, Asia, Mediterranean and Southern Europe, more frequent in rural areas with 350 million people at risk with a burden of about 12 million people suffering infection and two million new cases are estimated to occur annually [2-5].

The Sudan has been sorted as one of the six countries globally with highest leishmaniasis infection and prevalence, nevertheless leishmaniasis are one of the most abandoned diseases in the country consequently information about the disease burden and distribution is erroneous [6]. Both visceral (VL) and cutaneous leishmaniasis (CL) forms are endemic with sporadically discrete foci spread over a belt running west from the eastern Sudanese-Ethiopian border to the White Nile River then to north up to Khartoum State and distant foci are reported far west in the Nuba Mountains and North Darfur State [7,8]. Leishmaniasis is a dynamic disease concerning demographic and environmental factors that affect the reservoirand the vector occurrence; the diseases form distribution is co-related with the distribution of their specific vector species [9].

Since leishmaniasis is vectored by certain species of sand fly

attack on such vectors based on sound ecological information is a promising approaches for control both the vectors and the disease [10,11]. Key data required for estimating risk of disease transmission and successful control implementation in a given vicinity are vectors presence, diversity, density, population structure, habitat type of occurrence and distribution limit hence sampling system with high potency is central for address the issue[12].

The diversity and spatial distribution maps of the sand flies in the Sudan were generated by and fragmental efforts for renewing and authenticating were carried out [13-25]. Most Phlebotomus species inhabited semiarid and savanna belts however, P. orientalis has been encountered in a semi-desert area in preference to open woodland forest of Acacia seyal/Balanites aegyptiaca trees growing on crack dark black cotton soil conversely, P. papatasi is mainly found in human dwelling habitations [26-28]. Few studies were attempted to address the sand flies seasonality and ecology or to link inter-annual fluctuations in the incidence of leishmaniasis to climate cycles or the ecological factors controlling the spatial-temporal distribution of the sand fly vectors [29,30]. The obviously ecological changes have altered the classical sand flies distribution limits, hence renewing the insight existence, magnitude and nature of distribution of the sand flies in the Sudan is prerequisite.

Studies have revealed that only Phlebotomus orientalis and P. papatasi are the competent vectors of VL and CL leishmaniasis, respectively, out of the ten species reported in the Sudan including P. rodhaini, P. pedifer, P. longipes P. alexandri, P. saevus, P. bergeroti, P. duboscqi, and P. martini Since leishmaniasis are vectored by certain species attack on such vectors based on sound ecological information is a promising approaches for control both the vectors and the disease. Key data required for successful control implementation in given vicinity are vectors occurrence, diversity, density, population structure, habitat type of incidence and distribution limit consequently sampling system with high potency is central for address the issue [31-35].

The concern regarding environment pollution and prohibitive financial burden reverse the trend of area-wide chemical control in leishmaniasis endemic areas and lead to propose the integrated management. The battle should be handled via integration systems, consists alongside case-detection and treatment, vector control involving community and systematic monitoring. Traps have been recommended for both monitoring and controlling sand fly-vector population [35]. Fly group from same vicinity collected with different traps usually show different value as the capture by a trap is end point of a series of behavioral responses by the fly and trap visual appearance, ornamentation and potency [36]. High performance trap capable to trap the target vectors, delimit the distribution limit and predict areas of transmission risk and clarify habitat type of occurrence is central for successful control implementation. The criteria requested for trap recommended for monitoring and controlling sand fly-vector population are cheap to construct, operate and maintain, operate in different ecological conditions, sampling and cover relatively broad vicinity, provide sequential yields and environmental-friendly, out of the all known traps the sticky trap stand out.

The present study was conducted to assess trapability and performance efficiency of sticky traps formed of different colored papers in order to establish trapping system capable to provide accurate data, in term of compositions, size and structure of sand flies population under quantitative studies, and potentially attractive to the target vectors to avert infection subsequently control leishmaniasis.

In general traps are recommended for both monitoring and controlling sand fly-vector population out of which sticky paper traps stand out [35]. Fly group from same vicinity collected with different sampling methods usually show different value. Capture by a trap is end point of a series of behavioral responses by the fly and trap visual appearance, ornamentation and potency [36]. The present study was conducted to assess trapability and performance efficiency of sticky paper traps formed of different colored papers in order to establish sampling system capable to provide accurate data, in term of compositions, size and structure of sand flies population under quantitative studies for execution successful control.

2. Materials and Methods

2.1 Efficiency of Different Colored Sticky Paper Traps

Trials were conducted to compare the relative efficiency of the white standard sticky paper traps against blue and red and further against yellow and green colored traps to enhance the efficiency of the traps for attractant and sampling sand flies.

Randomized 3X3 Latin square design incorporating the effects of day, site and treatment were used; the experiment was replicated thrice [37]. Traps were placed in various habitat types deemed to harbor sand flies at 200m apart for three consecutive days; and alternated between sites daily in each replicate of three days; catches were collected every 24 hours.

Numerical data (n) were transformed to log10 (n + 1) prior to comparisons by analysis of variance (ANOVA). Catch indices for each trap were calculated as back-transformed mean catch for the test trap divided by the back-transformed mean catch of the standard trap. Back-transformed means were presented, significant differences between trap catches were detected by the multible range test and between treatment means by the shortest significant range (SSR= Q√MS residual/n; P = 0.05).

3. Results

3.1 Traps Efficiency

In an initial test the performance of the white, red and blue traps for trapping the sand flies was tested. Regardless of vicinity type the red and blue traps caught up to 0.33 and 0.24 times significant ($P \leq 0.05$) less sand flies than the white trap, respectively, (Tables 1 and 2). Multiple range test was carried out and the SSR critical values at 5% level was calculated (0.187 and 0.148). The differences between the highest and the lowest values of the three means were

highest than the corresponding SSR critical values. The results illustrated that the mean catch of the white trap was significantly highest than those of the blue and red traps; thus the color was considered the source of variations in the obtained data.

Source of variation	Df	SS	MS	F-ratio
Replicates	02	0.18199	0.0909	
Site w'in reps.	06	0.6781	0.33905	
Treatment	02	1.2146	0.6073	4.001 ns
Days	02	0.1668	0.0834	0.549 ns
Residual	14	2.125	0.1518	
Total	26			
ns $P \leq 0.05$				

Table 1: ANOVA Table of Pooled Sand Flies in Surugiya Village Using White Standard and Modified Red and Blue Sticky Paper Traps

Trap type	Total	Mean	G. Mean	Index	SSR
Blue sticky paper traps	4.2	0.467	1.93	0.24	0.489 s
Red sticky paper traps	5.03	0.559	2.62	0.33	0.397 s
White sticky paper traps	8.6	0.956	8.03	1.0	
$P \leq 0.05$; critical values 0.187 and 0.148					

Table 2: Back-Transformed Mean Catches and Catch Indices of Pooled sand Flies in Surugiya Village Using White Standard and Modified Red and Blue Sticky Paper Traps

Table 3 and 4 show that the yellow and green colored traps, caught 0.95 and 0.68 times less flies than the original sticky paper traps, respectively, yet the later was not statistically significantly ($P > 0.5$) better than them. Moreover the differences between the highest and the lowest values of the three means were less than the corresponding SSR critical values. Therefore the traps were likely equally attractive for the sand flies local population and their colors were not the significant source of the observed capture variations.

Source of variation	Df	SS	MS	F-ratio
Replicates	02	0.3133	0.15665	
Site within reps.	06	0.7544	0.1257	
Treatment	02	0.1164	0.0582	0.467 ns
Days	02	0.1123	0.0562	0.451 ns
Residual	14	1.741	0.1247	
Total	26			
ns $P > 0.05$				

Table 3: ANOVA Table of Pooled Sand Flies in Surugiya Village Using White Standard and Modified Yellow and Green Sticky Paper Traps

Trap type	Total	Mean	G. Mean	Index	SSR
Green sticky					
paper traps	7.27	0.808	5.42	0.68	0.148 ns
Yellow sticky					
paper traps	8.43	0.937	7.64	0.95	0.019 ns
White sticky					
paper traps	8.60	0.956	8.03	1.00	
ns $P > 0.05$; critical values 0.187 and 0.148					

Table 4: Back-Transformed Mean Catches and Catch Indices of Pooled Sand Flies in Surugiya Village Using White Standard and Modified Yellow and Green Sticky Paper Traps

4. Trap Capture Structure

During the course of the study period sand flies encountered regardless of trap form were Phlebotomus papatasi and P. orientalis and those of Sergentomyia were S. antennata, S. clydei, S. squamipleuris and S. africana; these species were all captured with the white sticky paper traps. The yellow trap missed S. africana, the red one failed to attract P. orientalis while the green trap failed to spot both species so the Blue trap did beside S. squamipleuris (Table 5).

Fly species	White	Yellow	Red	Green	Blue
P. papatasi	0.92	0.67	0.17	0.08	0.25
P. orientalis	0.17	0.08	0.00	0.00	0.00
S. antennata	2.17	4.42	1.33	2.67	1.42
S. clydei	1.50	1.08	0.75	1.17	0.83
S. squamipleuris	2.25	1.67	0.08	0.42	0.00
S. africana	0.42	0.00	0.17	0.00	0.00

Table 5: Diversities of Sand Flies Species Captured with Different Colored Sticky Paper Traps in Surugiya County, Khartoum State, Sudan

5. Discussion

The sample constituent of fly-vector population attracted by a particular catching method is a function of trap performance, density and activity of the vector being sampled, time of day, sites, locations and weather [36-40]. Sampling methods existed for host-seeking female population of sand flies are light and sticky paper traps [35]. In this study, trials were conducted to compare the relative efficiency of the white standard sticky paper traps against yellow, green, red and blue, the purpose was to assess which one of these colors is significantly attractive to sand flies. Hence randomized Latin square design where trap-rows set 200m apart was applied to avoid effects of day, site and intervention between treatments [37].

Sand flies are found associated with contaminated soils of animal shelters, rodent burrows and termite mounds, also in the earthen floors of human habitations [28]. Broadly, Sand flies inhabit Sudan were commonly prefer to the forest, animal shed and bar land in-village, however, principle vector of VL Phlebotomus orientalis inhabit semi-arid and savanna areas in preference to forest areas [26,27].

An autogenous sand fly females are weak fliers require vertebrate blood for eggs maturation, disperse usually for 100m or less from their larval habitats seeking hosts, consequently biting is often much localized [41,42]. The activity of sand flies is mainly crepuscular thus sticky paper traps were anticipated passively capture those flies seeking host or suitable resting sites and trap-color has nothing to play. Yet in the view of the facts that the majority of females of most species are mainly exophagic feed on human when encroach into their habitat at dusk, during late evening or early morning, while others attack in daytime and insects are known to perceive light at different wave length or spectrum between 300 – 650nm, thus the colors of the traps might determine the capture construction and variation.

Regardless of vicinity the red and blue sticky paper traps caught significant ($P \leq 0.05$) less sand flies than the white standard trap. Thus color might be the source of variations in obtained data, because the differences between the highest and the lowest values of the three means were highest than the corresponding SSR critical values. Thus the results illustrated that the mean catch and potency of the white standard trap was significantly ($P \leq 0.05$) greatest than those of the blue and red traps [37,40]. Contrarily, in another study using light-emitting diode (LED) Colors influence the capturing of sand fly found blue have a more capture significant than white and red light, although white light showed high significant than red [23].

Since these results confirmed the confidence that the white trap was significantly more attractive and effective against the species of the sand [32,35]. Yellow and green colored traps were tested to enhance the trap performance. However, the white sticky paper traps was not significantly ($P > 0.5$) better than the yellow and green colored traps yet they caught 0.95 and 0.68 fold times less than the white trap, respectively. The highest and the lowest values of the three means were less than the corresponding SSR critical values [37]. Therefore tested colors were as attractive as each other in capture configuration and the electromagnetic radiations with wave length of light that is between 495 - 590nm of the green-yellow is preferred by the sand flies [43-45].

The white and yellow sampling system captured both the efficient leishmaniasis vectors P. papatasi and P. orientalis though they prevalent in very low densities meaning both traps are highly effective and sensitive. Hence the both sampling system capable for clarifying sand fly-vectors population under quantitative studies and generate data required for execution successful control [46].

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