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Jigger Flea (*Tunga penetrans*) Infestations and Use of Soil-Cow Dung-Ash Mixture as a Flea Control Method in Eastern Uganda

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***Abstract*—**Despite several interventions, jigger flea infestations continue to be reported in the Busoga sub-region in Eastern Uganda. The purpose of this study was to identify factors that expose the indigenous people to jigger flea infestations and evaluate the effectiveness of any indigenous materials used in flea control by the affected communities. Flea compositions in residences were described, factors associated with flea infestation and indigenous materials used in flea control were evaluated. Field surveys were conducted in the affected communities after obtaining preliminary information on jigger infestation from the offices of the District Health Inspectors to identify the affected villages and households. Informed consent was then sought from the local authorities and household heads to conduct the study. Focus group discussions were conducted with key district informants, namely, the District Health Inspectors, District Entomologists and representatives from the District Health Office. A GPS coordinate was taken at central point at every household enrolled. Fleas were trapped inside residences using *Kilonzo traps.* A *Kilonzo Trap* comprised a shallow pan, about three centimetres deep, filled to the brim with water. The edges of the pan were smeared with Vaseline to prevent fleas from crawling out. Traps were placed in the evening and checked every morning the following day. The trapped fleas were collected in labelled vials filled with 70% aqueous ethanol and taken to the laboratory for identification. Socio-economic and environmental data were collected. The results indicate that the commonest flea trapped in the residences was the cat flea (*Ctenocephalides felis*) (50%), followed by Jigger flea (*Tunga penetrans*) (46%) and rat flea (*Xenopsylla Cheopis*) (4%), respectively. The average size of residences was seven squire metres with a mean of six occupants. The residences were generally untidy; with loose dusty floors and the brick walls were not plastered. The majority of the jigger affected households were headed by peasants (86.7%) and artisans (13.3%). The household heads mainly stopped at primary school level (80%) and few at secondary school level (20%). The jigger affected households were mainly headed by peasants of low socioeconomic status. The affected community members use soil-cow dung-ash mixture to smear floors of residences as the only measure to control fleas. This method was found to be ineffective in controlling the insects. The study recommends that home improvement campaigns be continued in the affected communities to improve sanitation and hygiene in residences as one of the interventions to combat flea infestations. Other cheap, available and effective means should be identified to curb jigger flea infestations.

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I. Introduction

JIGGER FLEA (*Tunga penetrans*) infestations in the Busoga sub-region in Eastern Uganda have become endemic [1], [2]. An estimated 2.4 million people are reported to have been affected or at risk of jigger infestation with 20 deaths in the sub-region in the year 2010/11 [3], [4]. Flea bites cause allergic reactions in some hosts such as pets. Penetration of female jigger fleas into the skin causes pain and wounds that may lead to entry of other pathogens such as *Clostridium tetani*, the bacterium that causes tetanus [5].

Demographic factors associated with low socio-economic conditions of local communities perpetuate flea endemicity [6]. Therefore, an understanding of the factors associated with flea infestations provides a means to target their management and control, since local biological communities usually have a relationship with the environment and demographic factors [7]. However, exposure of people to jigger infestations is as a result of combination of several factors that include poverty, low level of education, poor sanitary and hygiene conditions, traditional myths, presence of alternative animal reservoirs and suitable environment [4].

Fortunately, local materials have traditionally been used for repelling and killing insects. Varying techniques such as burning plant material for its smoke, plant extracts, oils, tars, and mud have been described [8]-[10]. However, the indigenous techniques used in the control of insects need to be scientifically validated. Furthermore, the government of the Republic of Uganda through the Ministry of Health put in place a number of interventions to control jigger infections in the affected districts [3] but the infestations have persisted. Hence, there was need for an in-depth understanding of the factors that perpetuate flea infestations in Busoga sub-region so that appropriate mitigation measures can be recommended.

II. Materials and Methods

The study was conducted in two districts of Busoga region in Eastern Uganda that have been reported to have jigger flea infestations. It employed both qualitative and quantitative methods.

Households that were reported to have jigger infestations were purposively traced for possible inclusion in the study. After obtaining records of jigger infestation from the Districts Health Inspectors of each district to identify the affected

villages and households, informed consent was then sought from the local authorities and the household heads to conduct the study. Only households that consented and confirmed to have current jigger infestations were evaluated.

A. Study Design

The study involved focus group discussions with key district informants, namely: District Heath Inspectors, District Entomologists and District Health Officers of each district to identify affected households and obtain other data on flea infestation in the districts including myths and control measures implemented. Household surveys were conducted to identify factors associated with flea infestation. Fleas were trapped in the residences of the jigger infested persons.

B. Collection of Fleas from Residences

At each homestead identified for flea collection, a GPS coordinate was taken at a central point for reference. Fleas were trapped inside residences of flea infested persons by using *Kilonzo traps*. A *Kilonzo trap* comprised a shallow pan about three centimetres deep filled to the brim with water. The edges of the pans were smeared with Vaseline to prevent fleas from crawling out. A flashlight was suspended over the trap to attract the fleas.

The traps were placed in evening after sunset and checked each morning. Trapped fleas were collected with fine brushes and placed in labelled vials filled with 70% aqueous ethanol for preservation. Information for each flea specimen collected included: location, date of collection, place of collection, latitude and longitude coordinates.

C. Collection of Socio-Economic and Environmental Data

Socio-economic and environmental data were collected for every household selected. The household heads were requested to provide information on household characteristics that included: level of education of household head, occupation and number of occupants for the selected residences.

The sizes of the residences selected for flea trapping were measured and the number of huts/ houses within a homestead counted. The roof, floor and wall material for each residence and the types of foods stored were noted.

Sanitary conditions of the homesteads were described in terms of functional toilets, disposal of domestic refuse and cleanness at the homestead. Pets and livestock kept and their resting quarter over night and crops grown around homestead were also described. The households were requested to name any local materials they used in flea control and describe the mode of application.

D. Data Analyses

Flea prevalence and socio-economic data of households were entered in SPSS Version 20. Regression analysis was then done to assess the effect of socio-economic and physical characteristics of households on the number of fleas trapped in the residences at 95% confidence interval. The variables affecting flea occurrence were ranked and further used for multiple correlations.

III. Results

A. Characteristics of Jigger Flea Infested Households

A total of 53 households that had cases of persons infested with jigger fleas at the time of the study were evaluated in Jinja and Iganga Districts in Busoga Sub-Region in Eastern Uganda. The majority of the household heads were peasants (86.7%) who are mainly engaged in subsistence farming, followed by artisans (13.3%) involved in the construction of houses. The highest formal education of the household heads was primary school (80%) and secondary school level (20%), while none had reached tertiary school level.

The homesteads were generally untidy. The residences had a mean area of 7 m^2 and an average of six occupants. The floors of the residences were either loose dust (78.8%), soil-cow dung-ash smear (9.6%), cement plaster (7.7%), mud smear (1.9%), or plastic carpet cover (1.9%). The brick wall surfaces of the residential houses were either not plastered (62.7%), or comprised mud smear (23.5%), soil-cow dung ash smear (9.8%) and cement plaster (3.9%).

B. Composition of Flea Species Trapped in Residences

A sum of 132 fleas were trapped belonging to three species: Cat flea (*Ctenocephalides felis),* 50%, Jigger fleas (*Tunga Penetrans*) 46% and rat fleas (*Xenopsylla cheopis*) 5.4% (Fig. 1).

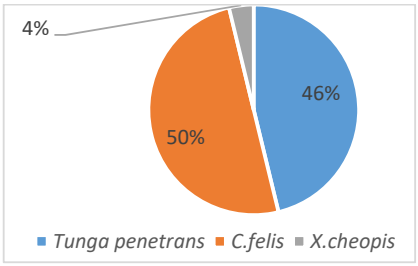

Fig. 1 Relative abundance of flea species trapped in residences

C. Effect of Household Characteristics on Flea Infestation

Level of education and occupation of household head, tidiness of homestead, number of residences within a homestead, sizes of residences, floor and wall surface type, roof material type, number of occupants, food storage, toilet conditions and resting quarter of livestock had a combined significant effect on the number of fleas trapped in the residences ($F=3.464$, $p=0.006$, $R^2=0.654$).

Occupation of household head, tidiness in residences, floor and wall surface types each individually had a significant correlation with the number of jigger fleas trapped in the residences (at 95% confidence level); whereas, level of education, number of houses within household, size of houses, roof type, number of occupants, food storage, toilet conditions and resting quarter for livestock were not individually significant in influencing the number on *T. penetrans* trapped.

There was no significant difference ($p>0.005$) in the number of fleas trapped in different floor types (Table II) and wall surface types (Table III).

TABLE I
REGRESSION ANALYSIS OF FACTORS THAT INFLUENCE *T. PENETRANS* ABUNDANCE IN RESIDENCES

Factors	B	Beta	t	p
(Constant)	1.58		0.15	0.88
Level of Education	-0.98	-0.10	-0.65	0.52
Occupation	3.86	0.42	3.06	0.01
Homestead conditions	3.44	0.34	2.47	0.02
Number of houses	-0.10	-0.06	-0.36	0.72
Size of house (m^2)	-0.02	-0.05	-0.33	0.74
Floor type	4.33	0.67	4.51	0.00
Wall surface type	-2.69	-0.50	-3.06	0.01
Roof type	-3.69	-0.13	-0.89	0.38
Number of occupants	-0.27	-0.18	-1.07	0.30
Food storage	0.52	0.10	0.63	0.53
Toilet conditions	0.79	0.12	0.79	0.44
Resting quarter for Livestock	-0.67	-0.20	-1.45	0.16

Dependent Variable: Number of Jigger flea (*Tunga penetrans*) trapped; Unstandardized (B) and Standardized (Beta) coefficients.

TABLE II
COMPARISON OF THE NUMBER OF FLEAS TRAPPED IN RESIDENCES OF VARIOUS FLOOR TYPES

Floor type	Min	Max	Mean±SE	SD	F	p
Cow dung smear (n=5)	0	1	0.40±0.25	0.55		
Loose dust (n=41)	0	22	2.59±0.77	5.00		
Mud smear (n=1)	0	0	0.00± -	-	0.719	0.583
Carpet cover (n=1)	0	0	0.00± -	-		
Cement plaster (n=4)	0	23	6.00±5.67	11.34		

TABLE III
COMPARISON OF THE NUMBER OF FLEAS TRAPPED IN RESIDENCES OF VARIOUS WALL SURFACE TYPES

Wall surface type	Min	Max	Mean±SE	SD	F	p
Cow dung smear (n=5)	0	1	0.40±0.25	0.548		
Unplastered brick (n=32)	0	23	3.78±1.14	6.459	1.45	0.24
Mud smear (n=12)	0	5	0.67±0.47	1.614		
Cement plaster (n=2)	0	1	0.50±0.50	0.707		

There was no significant difference ($p>0.005$) in the number of fleas trapped in different wall surface types (Table III).

IV. DISCUSSION

Jigger flea infested households in Eastern Uganda occur in communities with low socioeconomic status. The homes are characterized by household heads who are mainly peasants engaged in subsistence farming. They grow crops and rear some domestic animals such as birds, goats, cattle and pigs.

Low household incomes, as a result of low level of education and peasantry, hinder the provision of good health care services and housing conditions. Although the majority of residences of jigger infested households had brick walls and iron roofs, they were of poor condition; mainly unfinished structures; with unplastered wall surfaces; loose dusty floors or smeared with a mixture of soil-cow dung and ash.

This area has large scale sugar-cane estates [11] where some members of the community either work for companies or engage in sugar cane growing which they sell to the companies. Some members lease out land to individuals for purpose of sugar cane growing. During dialogues in Busedde Sub-county in Jinja district, it was reported that an acre of land is hired out at Ugandan shillings 1,300,000 to out-growers for five years on renewable basis (1 USD: 3650 UGSH). With such low lease value of land, a family is deprived of an alternative source of income or growing of food crops for a better quality of life [12], [13]. An earlier study showed that children living in the sugar cane growing area were malnourished and the majority of families were food insecure [14].

The jagged wall surfaces and crevices provide hiding places for adult fleas, while the loose dusty floors provide nutrients and environments conducive for growth and development of flea larvae.

Additionally, the cow dung used in the smears is nutritious to flea larvae, though it needs to be scientifically evaluated if the component of ash in the mixture could dehydrate the flea larvae. Some communities traditionally use ash as means of insect pest control [15]. However, overall there was no significant influence of soil-cow dung-ash mixture on flea infestation in this study.

Poor hygiene and sanitation compounds the problem of flea infestation [16] as the residences were typically untidy. The floors were not routinely swept. Floors of residences were seen littered with rugs, cloths and bedding. Negligence of good sanitation and hygiene practices provides environments conducive for fleas to flourish.

V. CONCLUSIONS

There was high flea abundance in residences in jigger infested households. The underlying factors influencing the persistence of jigger infestations points to low socio-economic status of the households. The use of soil-cow dung-ash mixture as a means of flea control is ineffective. Scientifically validated appropriate flea control and management practices need to be identified and recommended to the affected communities. There is a need to improve household incomes and housing to prevent jigger infestation.

VI. RECOMMENDATIONS

Improving housing conditions in the Busoga sub-region is necessary to control jigger flea infestations in the communities. This calls for an integrated approach since jigger infestation is not only a health problem but socio-economic as well. Viable options to improve household incomes need to be identified so as to improve on housing conditions. Community sensitization should be continued to eliminate fleas from residences.

Cow dung should be discouraged for smearing floors of residences, since cow dung is known to be nutritious to flea larvae.

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