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Species Composition, Abundance and Bait Preference of Fruit Flies in Domestic and Wild Habitats in Ahmadu Bello University Main-Campus and Environs, Zaria – Nigeria

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ABSTRACT

The control of fruit flies is largely done with baited traps, but finding what substances they are most attracted to can improve the effectiveness of these baits. In this study, six fruits and two household substances including, banana, orange, watermelon, pineapple, cocktail, locally made pap and decayed bread were used as bait traps. These were placed in two ecologically distinct habitats - domestic and wild, to determine the species composition, abundance and bait preference of fruit flies. The domestic habitat had a total of 805 flies, including *Drosophila melanogaster* 753, *Zaprionus tuberculatus* 30 and *Drosophila buzatti* 22. In the wild, a total of 1492 flies were trapped of which 813 were *Drosophila melanogaster*, *Zaprionous tuberculatus* 491, *Zaprionous indianus* 113 and *Drosophila ananasea* 75. Orange baits proved most effective in trapping flies possibly due to the chemical compounds discharged by the peel known as limonene in both domestic and wild habitats.

Keywords: Species composition, fruit flies, abundance, bait-preference, habitat

INTRODUCTION

Fruit flies belong to the family *Drosophilidae* and are most frequently often called vinegar, wine or pomace flies (Beers, Van Steenwyk, Shearer, Coates & Grant, 2011). Their main distinguishing character is to stay on fruits, which are ripped or rotten, and many species of *Drosophila* are agricultural pests, especially the Mediterranean fruit flies. They oviposit and capable of colonizing fruits that are still in the process of ripening, causing massive agricultural damage (Senior, Wright, Missenden & DeFaveri, 2016). The most prominent species is *Drosophila melanogaster*, which appears to have originated from sub-Saharan Africa

(Abdulazeez, Ndams, Shehu & Auta, 2019). Fruits producing communities in Africa have experienced many losses due to fruit flies infestation, and this occupies a large proportion of profitable fruit fly pests in African cities, whose average was estimated at about 20-30% on mango and citrus (Basoalta, Hilton, & Knight, 2003). Fruit flies nutrition has been given much attention in studies because of the ease in which the fly diet can be manipulated in the laboratory, especially when considering environmental factors that affect stress-induced acquired and innate traits (Rion & Kawecki, 2007; Vijendravarma & Kawecki, 2013). In the wild, *Drosophila* larvae develop in ephemeral habitats such as rotting

vegetative matter, resulting in rapid changes to food quantity and quality. Nutritional stress can include starvation due to food deprivation and malnourishment due to nutrient imbalance or depletion. Nutritional scarcity is further exacerbated by competition as greater larval density depletes scant resources. Moreover, other species share habitats with *Drosophila*, resulting in interspecies competition that further contributes to nutritional stress (Vijendravarma & Kawecki, 2013).

There are various different baits that have proved effective on attracting fruit flies, including apple cider vinegar, and fermenting baits (Burrack 2015). *Drosophila* larval populations selected on nutrient-poor food exhibit various behavioral and physiological changes (Vijendravarma & Kawecki, 2013). Apart from genetic factors, diet and food intake are critical determinants of fly longevity (Monteiro, 2019). However, adult life for a fruit fly is much more challenging out in nature, where it in order to survive, it needs to compete for resources and overcome environmental stressors and other threats, resulting in a significantly shorter life span (Beers, Van Steenwyk, Shearer, Coates, & Grant, 2010). Additionally, fruit flies, like most all animals, are attracted to sugar, as it is the basic nutritive source of energy (Witjaksono, Linda, & Suputa, 2018). The damage caused by fruit flies includes small surface blemishes, destruction of the edible flesh, and spoilage from decay (Singh, Singh, Anwar, & Solomon, 2011). The key to stopping and controlling fly populations is early detection, and the most effective and least harmful way of getting rid of fruit flies is to lure and trap them in either commercial or home-made traps.

This study was aimed to evaluate and assess the species composition, diversity, abundance

and bait preference of fruit flies in the study area. Identification of flies requires knowledge of the appropriate individual for excellent bait preparation. Developing simple and economic fly rearing media, baits and traps is of paramount importance to the maintenance of bulk population of flies for several studies. Therefore, the research will provide insights regarding species composition and baits preference of fruits flies. Given the fragile and dynamic nature of species abundance and community dynamics, understanding the dynamics of temporal changes in habitats can provide insights into the biology and ecology of organisms.

MATERIALS AND METHODS

Study area

The study was carried out in Ahmadu Bello University (ABU), main-campus and environs, Zaria. The experimental field was of two ecologically distinct locations on Latitude 11°7.4' 05"N to 11°8'43.81188"N and Longitude 7°8'11.094"E to 7°54'7.7864"E with an altitude of 686 m above sea level (Figure 1). The climate of the area has been categorized into: the warm rainy (October to early April), the cool dry season and the hot dry (mid-April to early October) seasons (FAO, 1971). The mean annual rainfall is 1050 mm based on annual rainfall record of forty-three years 1969 – 2012 (NIMET, 2012). The general vegetation of the area is classified under the Northern Guinea Savannah vegetation characterized by woodland consisting of different layers rather less distinct than those of the forest (Barbour, Oguntuyibo, Onyemeluke & Nwagfor, 1999). The temperature was between 21°C and 22°C while humidity ranges between 72% and 77% as at the point of sample collection.

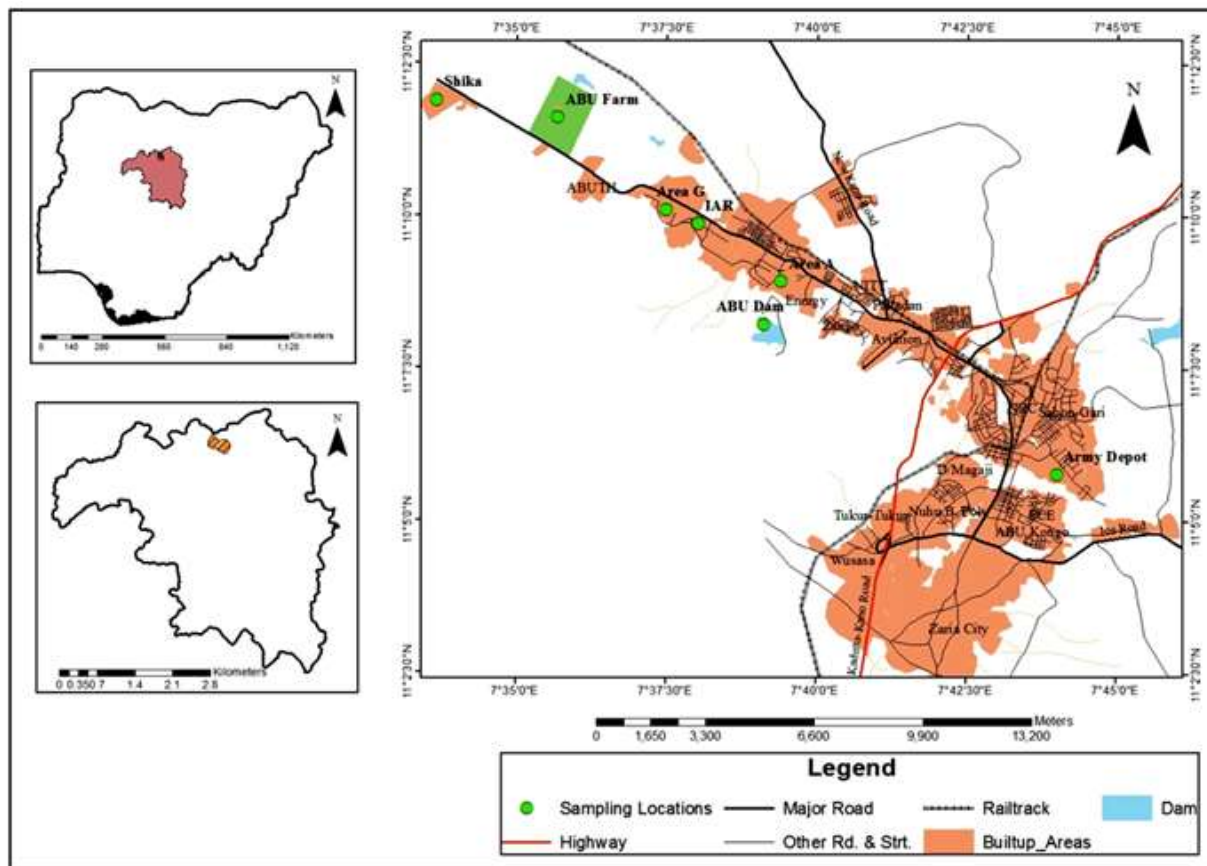


Figure 1: Sampling locations in A. B. U. and environs, Zaria
Source: Satellite images of Zaria

Source of Fruit Flies

Bait traps were placed in six different locations in ABU main-campus and environs, which include three (3) domestic and three (3) wild habitats. The domestic habitats include Hanwa - 11°8'43.81188"N 7°40'12.86378"E, Area BZ - 11°7.4' 05"N 7°4'56"E, and Zango - 11°34'11.5437"N 7°54'7.7864"E. Wild habitats include Botanical garden Forest-like - 11°8'432.59472"N 7°39'16.05932"E, Botanical garden Woodland - 11°8'44.5506"N 7°39'15.82164"E and ABU Dam - 11°8'11.094"N 7°8'11.094"E.

Preparation of Bait Trap

The fruits - banana, watermelon, orange, pineapple and tomatoes were purchased from Samaru market, peeled, chopped to pieces and placed inside vials. Little amount of yeast was

added to the fruits which helped in their decaying and finally covered for 24 hours. For the cocktail preparation, the aforementioned fruits were chopped, mixed altogether in a rubber with additional yeast and allowed to decay for 24 hours. The pap was prepared by soaking millet, grinded into paste, sieved and allowed to settle. Some quantity of the paste were collected and stirred after which boiled water was added to it. It was then left for 24 hours for decaying. For the fungus, it was gotten from spoiled bread and put into different vials.

Counting of Flies

After the collection of fruit flies from different baits, they were taken to *Drosophila* and Neurogenetics laboratory, Department of Zoology, ABU, Zaria, and smogged using an iced cube. A small paint brush was used to

remove single flies from the vial and then put into a Petri-dish and counted the total number.

Identification of Fruit Flies

The flies were identified using their morphological features in *Drosophila* and Neurogenetics laboratory, Department of Zoology, ABU, Zaria and the keys of Bächli *et al.* (2004) to species level. The species were then deposited in the aforementioned laboratory.

Data Analyses

Descriptive statistics was used to analyse the differences of bait preferences and abundance of fly species while Shannon-Weiner diversity Index and Simpson coefficient were used to analyse species diversity and dominance.

RESULTS

The results of species composition of fruit flies and abundance based on bait preference is shown on table 1, while tables 2 and 3 show

flies species composition, diversity and abundance based on bait preference in domestic and wild habitats respectively. Table 1 showed the diverse species of fruit flies with *D. melanogaster* having the highest abundance of 68.18 across all baits while *D. buzatti* had the lowest abundance of 0.96. The orange bait caught the highest number of flies across all species. Similarly, Table 2 showed that *D. melanogaster* had the highest abundance of 753 flies while both *D. ananasae* and *Z. indianus* were not recorded across all the baits in the domestic habitats. Meanwhile, pineapple bait attracted the highest number of flies in the domestic habitats with 288 flies. However, in table 3, *D. buzatti* was completely absent in all the baits while *D. melanogaster* dominated with a total of 813 flies across all the baits in the wild habitats. The orange bait caught the highest number of flies – 512 while the fungus bait attracted no flies here (wild), like in table 2 (domestic), as well.

Table 1: Species composition and abundance of flies species based on bait preference in ABU main-campus and environs, Zaria, Nigeria

Baits	Species					Total
	<i>D. ananasae</i>	<i>D. buzatti</i>	<i>D. melanogaster</i>	<i>Z. indianus</i>	<i>Z. tuberculatus</i>	
Pineapple	0.52	0.26	17.50	0.00	2.66	20.94
Cocktail	0.00	0.70	16.28	0.00	1.39	18.37
Banana	0.44	0.00	9.23	0.00	1.65	11.32
Orange	0.96	0.00	14.80	0.00	14.37	30.13
Tomatoes	0.22	0.00	5.49	0.00	0.87	6.57
Fungus	0.00	0.00	0.00	0.00	0.00	0.00
Watermelon	0.91	0.00	4.44	0.00	1.70	7.05
Pap	0.22	0.00	0.44	4.92	0.04	5.62
Total	3.27	0.96	68.18	4.92	22.68	100

Table 2: Species composition and abundance of flies species based on bait preference in domestic habitat of ABU main-campus and environs, Zaria, Nigeria

Species	Baits								Total
	Pineapple	Cocktail	Banana	Orange	Tomatoes	Fungus	Watermelon	Pap	
<i>D. ananasae</i>	0	0	0	0	0	0	0	0	0
<i>D. buzatti</i>	6	16	0	0	0	0	0	0	22
<i>D. melanogaster</i>	272	188	135	80	38	0	35	5	753
<i>Z. indianus</i>	0	0	0	0	0	0	0	0	0
<i>Z. tuberculatus</i>	10	0	0	20	0	0	0	0	30
Total	288	204	135	100	38	0	35	5	805
Dominance_D	0.8936	0.8554	1	0.68	1	0	1	1	
Simpson_1-D	0.1064	0.1446	0	0.32	0	0	0	0	
Shannon_H	0.2513	0.2749	0	0.5004	0	0	0	0	
Evenness_e^H/S	0.4286	0.6582	1	0.8247	1	0	1	1	

Table 3: Species composition and abundance of flies species based on bait preference in wild habitat of ABU main-campus and environs, Zaria, Nigeria

Wild	Pineapple	Cocktail	Banana	Orange	Tomatoes	Fungus	Watermelon	Pap	Total
<i>D.ananasae</i>	12	0	10	22	5	0	21	5	75
<i>D.buzatti</i>	0	0	0	0	0	0	0	0	0
<i>D.melanogaster</i>	130	186	77	260	88	0	67	5	813
<i>Z.indianus</i>	0	0	0	0	0	0	0	113	113
<i>Z.tuberculatus</i>	51	32	38	310	20	0	39	1	491
Total	193	218	125	592	113	0	127	124	1492
Dominance_D	0.527	0.750	0.478	0.469	0.640	0	0.400	0.834	
Simpson_1-D	0.473	0.251	0.522	0.532	0.360	0	0.600	0.166	
Shannon_H	0.791	0.417	0.863	0.823	0.639	0	0.998	0.383	
Evenness_e^H/S	0.735	0.759	0.790	0.759	0.632	0	0.904	0.367	

DISCUSSION

The species composition and abundance from the results showed that *D. melanogaster* is a generalist, as it has its ecological niches broaden in both domestic and wild habitats. This revealed that *D. melanogaster* was most attracted and survived better to all the baits than other species. However, the Orange bait was most preferred, probably because of the chemical compound discharged by orange peel known as limonene. It could also have been

attracted because orange peels serves as a better substrate for egg laying of the flies which as well, aid their reproduction. This result is in congruent with the findings of Parkovic-lucic and Kekic (2014) where *D. melanogaster* was observed to be dominant species in domestic habitats with about 96% of all flies studied, and gave same reason of bait preference.

Similarly, two species of *Z. tuberculatus* and *Z. indianus* were recorded in this study. This

was not surprising because they are widespread Afrotropical species often transported by man in different regions such as Cyprus and India. It is reasonable to buttress that they are native species in Nigeria and not introduced. Also, the distribution of *D. buzatti* and *D. ananasae* within the study area has further confirmed their ecological niches. Although, *Z. tuberculatus* was found in both domestic and wild habitats, *Z. indianus* and *D. buzatti* were only found in the wild habitat while *D. ananasae* was only found in the domestic habitat. This could probably be the effect of land use pattern which can determine the species composition of fruit flies in different habitats. Also, some abiotic factors like temperature and humidity might have favoured *Z. tuberculatus* and *D. ananasae* to be found in both habitat types which might have affected *Z. indianus* and *D. buzatti* to only be found in the wild habitat. Rosalie, Bassirou, Amadou, Yousouf and Bernard (2020) recorded that temperature and humidity play a role in fruit fly species composition, when the temperature drops (below 30°) in increasing humidity (greater than 70%), wild habitat species of fruit flies flourishes. Meanwhile, according to Raghuvanshi, Satpathy and Mishra (2012), temperature play a specific role in regulating the behavior of the fruit fly adults, which indicates positive correlation of prevailing temperature with the number of ovipositing females, thereby, the influence of relative humidity and rainfall harmed female abundance. Additionally, the host range, presence of suitable host plants in the habitat might have influenced *Z. tuberculatus* and *D. ananasae* in the wild habitat, as noted by Witjaksono *et al.* (2018) while it is possibly a disadvantage to *D. ananasae* which was only present in the domestic habitat.

The different species of fruit flies found in the habitat can also be influenced by the preference of each species for a particular habitat. The availability of hosts such as fruit baits has further determined the ecological

niches of the species composition based on preference to the baits. Such bait preferences have influenced the individual abundance of each species that makes up the species composition in both domestic and wild habitats as earlier reported by Witjaksono *et al.* (2018) and Supratiwi, Apriyadi, Asriani (2020). The abundance of individuals in both habitats was not evenly distributed across all species, indicating the dominance of certain species such as *D. melanogaster* and *Z. tuberculatus*. This could be the reason why the species richness of fruit flies in domestic and wild habitats is not significantly different while their abundance is very different. Furthermore, the studies of Shamshir and Wee (2019) and Senior *et al.* (2016) suggested that male fruit flies often forage for sugary substances from floral nectar, overripe fruit sap, or on decaying organic matter and are attracted to plants that provide a source of food and shelter produced by infestations of homopteran insects. The female fruit fly also needs protein for fecundity (Biasazin, Chernet, Herrera, Bengtsson, Karlsson, Lemmen & Dekker, 2018).

Generally, the effect of differences in hosts in the habitat is important in determining the number of fruit fly species present. The numbers of fruit fly species collected in the wild were higher than in the domestic because vegetation diversity in the wild varies more as pointed out by Witjaksono *et al.* (2018). A natural habitat such as the wild is capable of creating more conducive environmental conditions for fruit flies, especially non-dominant species. This habitat has higher plant diversity than that of the domestic habitat. Thus, competition between community structure and fruit fly species is relatively low. Meyer, Delatte, Mwatawala & Quilici (2015) viewed that at least one abiotic factor (altitude) and two biotic ones (host availability, interspecific competition) are the primary screening factors for species dominance. Monteiro (2019) similarly reported that the existence of certain cultivated

plants results in the potential for the development of certain species of fruit flies that have close associations with those plants in their habitats.

CONCLUSION

In conclusion, the species composition of fruit flies showed in their diversity between domestic and wild habitats, as well as the abundance which differs significantly but not in species richness. The wild habitats attracted more flies across all the baits, making it the most preferred than the domestic habitat. In addition, it revealed that orange baits proved most effective in trapping fruit flies as they clearly showed more preference to it than other baits. Further research could look into the attractiveness of each of the active chemicals the fruit flies are attracted to, and also find out the concentrations and mixtures that are most attractive to make bait for the flies.

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