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Comparison of Torula Yeast and Three Locally Made Food – Based Attractants in Trapping *Bactrocera dorsalis* (Diptera: Tephritidae)

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ABSTRACT

High cost of commercial attractants is a major limiting factor to fruit fly control by small-scale farmers in Nigeria. Field trials were conducted in Ibadan, Oyo state at two locations (Jericho and Eniosa) to compare the trapping of *B. dorsalis* in commercial food attractants (Torula yeast) and locally made food-based attractants on bush mango. The locally made food attractants included orange juice, pineapple juice and hydrolyzed brewery waste. Methyl eugenol a para-pheromone was used as a standard check while water served as control. The food attractants were baited with cypermethrin and applied at 40ml/trap/week. Data on trapped *B. dorsalis* were recorded at weekly intervals and subjected to Analysis of Variance (ANOVA) at 0.05 level of probability. Results showed that *B. dorsalis* were trapped by the various attractants on bush mango at both locations. Pineapple and orange juices were more effective than Torula yeast in trapping *B. dorsalis* at both locations. Pineapple juice (10.5-13.9), orange juice (10.5 -11.2) and Torula yeast(7.4-10.3) significantly trapped higher number of flies than hydrolyzed brewery waste(2.8-3.1)at both locations. All the food-based attractants trapped both sexes of flies with higher number of females. Methyl eugenol significantly trapped higher number of male flies than all the attractants. Pineapple juice was the most effective in trapping *B. dorsalis* among the food attractants evaluated. Pineapple and orange juices showed better potential than Torula yeast in trapping *B. dorsalis* suggesting that they can be incorporated in *B. dorsalis* management program under organic standards in orchards.

Keywords: local attractants, oriental fruit fly, food baits, bush mango, commercial lure

Introduction

Oriental fruit fly, *Bactrocera dorsalis*, (Hendel) [Diptera: Tephritidae] is an invasive fruit fly species in the Tephritidae family introduced into African in 2003 (Lux *et al.*, 2003; Drew *et al*., 2005). The species was first detected in Kenya and has spread to more than 30 African countries since its arrival in Africa (Lux *et al*., 2003; Goergen *et al*., 2011). In West and Central Africa, *B. dorsalis* is highly polyphagous, attacking several cultivated and wild fruits of about 46 species from 23 families with guava, mango and citrus being the preferred hosts while *Terminalia catappa* (Tropical almond), *Irvingia gabonensis* (African bush mango) and *Vitellaria paradoxa* (Sheanut) are main wild hosts with high infestation incidence (Goergen *et al.*, 2011.). *B. dorsalis* was formally considered a new species and was identified as *Bactrocera invadens* (Drew *et al.*, 2005). Recently the *B. invadens* was synchronized as the same species with *B. dorsalis* (Schutze *et al.*, 2015. The infestation rates by *B. dorsalis* varied among different countries, fruits and seasons ranging from 5-

70% (Lux *et al.*, 2003). The infestation rates on mango has been reported to be very high ranging from 30- 80% depending on the mango variety and the season (Ekesi *et al.*, 2006; Rwomushana 2008; Vayssie `res *et al.*, 2009)

Management of fruit flies targeting female population by application mixture of protein baits with killing agents to trap and kill flies is a common practice ((Roessler, 1989; Mangan and Thomas, 2014).

Many commercial fermented food substrates and protein hydrolysates are generally used for monitoring and management of many fruit fly species in the Tephiritidae family (Epsky *et al.*, 2014). The food lures comprises of vital mineral elements like sugar, yeast , by-products from brewery plants , hydrolyzed protein and amino acids required by the female fruit flies for reproductive activities such as egg development and sexual growth(Placido-Silva *et al.*, 2005). The formulation of these food baits can be in combination of with insecticides or in single forms (Heath *et al.*, 1997). Torula yeast, Biolure, Ceratrap and Buminal are some of the commercial protein based lures that are usually formulated in combination of insecticidal agents like ' GF-120'. They are commercially available for monitoring many fruit flies species through attract and kill method by trapping system with the use of MCPhail traps (Epsky *et al*, 2014; Navarro-Llopis and Vacas, 2014). The major constraints with the use of these commercial food lures is that they are non-specific with the target fly species, thus they capture many beneficial insects like bees, wasps and biological control insects when they are used in large control programs (Miranda *et al.*, 2001; Enkerlin *et al.*, 2015,). A more specific lures like ammonia and putrescine with trimethylamine that trap low amount of non-target organisms were later identified by researchers and they are commercially sold as BioLure or 3C Biolure (Mazor, 2009, Epsky *et al*, 2014). However, these commercial food lures are very expensive and are not always available hence; it hinders their usages by small-scale farmers from many developing countries. The cost of importation in addition to shipment problems constitute additional hindrances in their use by fruit farmers in the country. Hence, farmers from many developing countries have adopted the used of local products like fruit juices, vinegar, brewery waste, syrups and disposable plastic bottles(traps) as an alternatives in managing many fruit flies species in their fruit orchards (Figueroa, 2005). Thus, this study compared the efficacies of three locally made fruit juices and Torula yeast a commercial food bait in trapping *B. dorsalis* on Bush mango plantation.

Materials and Methods

Field studies were conducted at two locations in Ibadan southwest Nigeria during the fruiting season of bush mango in 2018. Ibadan is located within latitude 7^{o} and 9^{o} N longitude 3^{o} and 58^{o}E of greenwich meridian (GMT) with annual rainfall of about 1300 mm to 1500 mm and average relative humidity of about 80 to 85 % (FRIN, 2014

The two selected study sites are Forestry Research Institute of Nigeria (FRIN) Jericho , Ibadan and Eniosa in Akinyele local government area, Ibadan. The brewery waste was collected early in the morning from Nigerian brewery Alakia, Ibadan Oyo state, Nigeria when fresh. Twenty kilogram of fresh brewery waste was poured inside an aluminum pot and placed inside another pot containing water. The setup was placed on a gas cooker and boil at 100 ^{o} C for 15 hours consecutively. It was observed for color

change, when the color changes from light brown to deep brown the heating was stop, it was allow to cool for 2 hours and later served with the aid of muslin cloth to collect hydrolyzed protein from brewery waste as described by Ugwu *et al* (2018a). Fully ripped fresh pineapple and orange fruits were purchased from fruit sellers in the local market and one kilogram of each fruit was used to prepare the juice solution. The preparation was done by peeling 1kg of each of the fruit and blending it into a smooth slurry paste using an electric kitchen blender. The juices were extracted separately with 1 litre of water for each and sieved with muslin cloths to obtain a homogenous solution as described by Ugwu *et al.,* (2018b). The prepared samples were refrigerated until when used. Torula yeast is a commercial food based attractants and was sourced from International center for insect Physiology and ecology ,(ICIPE) Kenya). Modified Lynfield trap (MLT) was used in setting the traps. The modified Lynfield trap used was made from a recycled transparent 500-ml cylindrical plastic bottle (Eva Water, Nigeria) with two equidistant holes created opposite each other in the uppermost part, a lid and a small metal string which was used as a hanger for one of the attractant following the standard design of Lyfield trap as describe by (Copeland, 2012).

Methyl eugenol a commercial hydrolyzed protein for trapping *B. dorsalis* was used as a standard check while water served as control.

Cypermethrin (2 ml) was added to each prepared food –based attractant to knock down the trapped flies. Three trees were selected from each location at a distance of 15m from each other to obtain three independent replicates per site. Setting of traps commenced at the onset of fruit ripening and six traps were hung per tree at both locations. Forty milliliters (40ml) of each prepared food baits was dispensed with the aid of 10 ml injection syringe, carefully dropped on 0.5 gm of absorbent cotton wool, and placed at the bottom of the trap while twenty milliliters of Methyl eugenol were used following the same procedure. All the prepared fruit juice were vigorously shaken before dispensing. The traps were suspended with 20g weight of stones at the bottom before placing the attractants. Each lure was replicated three times per location in a Complete Randomized Block Design (CRBD). The treatments were the lures (Torula yeast, Pineapple juice, orange juice, brewery waste, methyl eugenol) while vegetations between each tree stand served as blocking effect between each selected tree per site. The baited traps were hung on the bush mango tree with a string at 10- 15 meter above ground level within the plant canopy.

Data were collected on the number of fruit flies trapped per trap every week at both sites for 9 weeks consecutively. The trapped flies were taken to the laboratory for identification, counting, and sexing. Data collected were transformed using square root transformation (X + 0.5), then subjected to ANOVA and significant mean separated at 5% level by Turkey's Honestly Significant Difference using ASSISTAT 7.7en 2016 version

Results

Density of *B. dorsalis* trapped on Bush mango at FRIN site

Analysis of variance for the trapped flies at FRIN site after nine weeks showed significant differences among the treatments (Table 1).

The results revealed that all the food baits evaluated trapped *B. dorsalis* on bush mango at varied proportion in this study site. (Table

2). Methyl eugenol significantly ($p<0.05$) recorded highest population of *B. dorsalis* from first week to the 9 th week with mean density of 41. 54 flies after 9 weeks. The efficacy of the two locally made juice baits (orange and pineapple) were higher than the commercial bait Torula yeast in trapping *B. dorsalis*. Orange and pineapple baits trapped mean number of 10.51 and 10. 53 of *B. dorsalis* respectively after 9 weeks of study. However, there were no significant difference on the number of flies trapped by orange juice, pineapple juice and Torula yeast. Torula yeast significantly ($p<0.05$) trapped higher number of *B. dorsalis* than brewery waste. Control did not trap any *B. dorsalis* flies . The population the flies fluctuated within the weeks of the study, Higher number of flies were trapped in week one followed by week 8 while the least number of flies was recorded on the second week.

Table 1. ANOVA Table for the trapped flies after nine weeks at FRIN site

V.S.	D.F.	S.S.	S.A.	F
-				
Blocks	2	111.43570	55.71785	1.2485 ns
Treatments	5	3310.81738	662.16348	14.8370 **
Error	10	446.29057	44.62906	
Total	17	3868.54365		

Table 2 . Weekly mean density of *B. dorsalis* trapped on bush mango at FRIN site

	Weeks									
Treatments	1	2	3	4	**5**	**6**	**7**	**8**	**9**	**MNTF**
Torula yeast	2.23b	0.00b	1.24a	0.33b	1.11b	0.00b	0.00b	2.50b	0.00b	7.41b
Pineapple juice	0.00b	0.00b	2.30ab	1.67b	1.15b	1.87b	0.00b	1.33b	2.21a	10,53b
Orange juice	1.58b	0.00b	1.68ab	0.33b	2.61b	0.00b	1.11b	2.62b	0.58b	10,51b
Brewery waste	1.56b	0.00b	0.00b	0.67b	0.00b	0.58b	0.00c	0.00c	0.00b	2.81c
Methyl Eugenol	8.30a	1.92a	4.29a	4.11a	6.21a	5.18a	2.85a	5.89a	2.79a	41.54a
Control	0.00b	0.00b	0.00b	0.00b	0..00b	0.00b	0.00b	0.00b	0.00b	0c

Mean values with the same letter within the column are not significantly different ($p<0.05$).MNTF= Mean number of trapped flies after 9 weeks.

Density of trapped *B. dorsalis* flies on bush mango at Eniosa site

Analysis of variance for the trapped flies at Eniosa site after nine weeks also showed significant differences among the treatments (Table 3). The results of the weekly density of the flies trapped at Eniosa site followed a similar pattern with what was observed at FRIN site. All the attractants trapped *B. dorsalis* at diverse proportion (Table 4.) Methyl eugenol also significantly ($p<0.05$) trapped higher population of *B. dorsalis* at this site from first week to the last week of the study. Pineapple juice trapped higher number of flies than other food baits, followed by orange juice and Torula yeast while brewery waste was the least in trapping *B. dosalis* flies among the food bait tested. There were no significant differences ($p>0.05$) on the number of files trapped by pineapple juice, orange juice and Torula yeast. However, the number flies trapped by the three food baits (orange, pineapple and Torula yeast) were significantly higher than that of brewery waste while no flies was trapped on the control experiment. Higher number of flies were trapped at the 5th week of the study in this location.

Table 3. ANOVA Table for the trapped flies after nine weeks at Eniosa site

V.S.	D.F.	S.S.	S.A.	F
Blocks	2	34.87003	17.43502	1.1495 ns
Treatments	5	3453.72498	690.74500	45.5406 **
Error	10	151.67663	15.16766	
Total	17	3640.27165		

Table4 . Weekly mean density of *B. dorsalis* trapped on bush mango at Eniosa site

	Weeks									
Treatments	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**MNTF**
Torula yeast	0.00b	1.74b	0.57bc	0.00c	1.51b	2.77b	0.82b	2.88ab	0.00c	10.29b
Pineapple juice	1.62b	0.00b	1.73bc	1.80b	2.91ab	1.48bc	2.03b	1.33c	1.00b	13.9b
Orange juice	0.00b	0,81b	2.23b	0.91bc	2.04b	0.82bc	1.92b	2.44b	0.00c	11.17b
Brewery waste	0.00b	1.00b	0.00c	0.00c	0.67b	0.00c	0.75b	0.00d	0.67b	3.09c
Methyl Eugenol	5.32a	6.56a	4.57a	4.06a	5.22a	6.13a	5.03a	3.75a	1.87a	42.51a
Control	0..00b	0.00b	0.00c	0.00c	0..00b	0.00c	0.00b	0.00d	0.00c	0c

Mean values with the same letter within the column are not significantly different (p<<0.05). MNTF= Mean number of trapped flies after 9 weeks

Percentage male and female *B. dorsalis* trapped at both locations

All the food baits trapped both male and female adult *B.dorsalis* at the two study sites for two year (Fig 1). Methyl eugenol trapped only adult male fruit flies and the number of trapped male is significantly higher that other attractants for the two years of study

Pineapple juice trapped higher number of female than other food attractants at FRIN location while Torula yeast trapped higher females at Eniosa. All the food baits significantly ($p<0.05$) higher number of females than males at both location. There were no significant differences ($p>0.05$) between the number of males and females trapped by the different food attractants. Control trapped no *B. dorsalis* flies

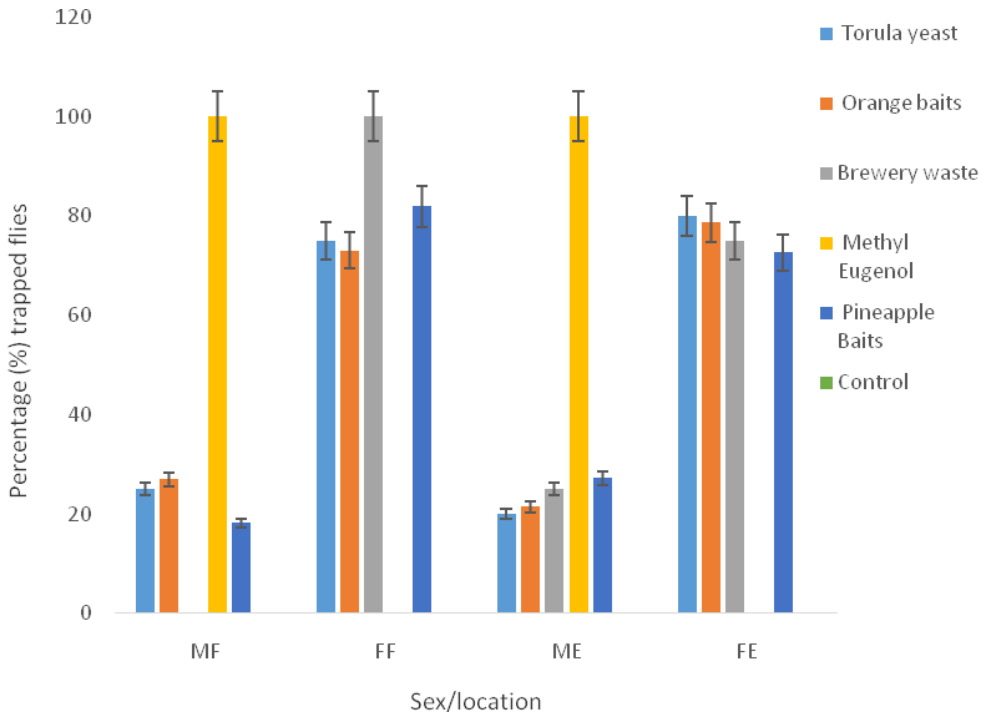

Fig 1. The Percentage density of female and male *B. dorsalis* trapped at both locations

(MF= Male at FRIN location, FF= Female at FRIN location , ME= Male at Eniosa, FE = Female at Eniosa)

Discussion

Adult fruit flies, especially females, must feed on protein food compounds during the post-emergence period to reach sexual maturation (Heath *et al.*, 1994). The results of this study demonstrate that all the food attractants tested attracted both sexes of *B. dorsalis* at varied rates with the different food attractants assessed. Pineapple and orange juice outperformed the Torula yeast and brewery waste in trapping *B. dorsalis*. These results corroborate earlier findings by Ugwu *et al*., (2018a) who reported that orange and pineapple juice has potential in trapping *B. dorsalis* on bush mango. Similarly, Azevedo *et al*. (2012), have earlier confirmed the potential of fruit juices for fruit fly monitoring. However, according to Mendonça *et al*. (2003), fruit juices are difficult to clean off because they leave residues on the traps. Torula yeast trapped higher flies than hydrolyzed protein from brewery waste. This study supports the results obtained by Scoz *et al.* (2006) in Brazil who reported that higher numbers of adults of *A. fraterculus* were caught with traps baited with Torula™ yeast than with the hydrolyzed protein BioAnastrepha in a peach orchard. Similarly, Ekesi *et al.* (2014) reported that Mazoferm and Torula yeast outperformed other commercial food attractants in attracting *B. dorsalis*. Moreno and Mangan (1995) compared the attraction of *Anastrepha ludens* (Loew) to Mazoferm E802, Torula yeast, and three other commercial food baits and reported that all the baits were significantly more attractive than water or Nulure. Protein sources in the food baits and commercial lures has been used to trap *B. cucurbitae* and *B. dorsalis* (Alyokhin *et al.,* 2000; Cornelius *et al.,* 2000 Satpathy and Samarjith, 2002; Fabre *et al.,* 2003). Correspondingly, Rajitha and Viraktamath (2005) also reported attraction of female fruit flies to protein food baits in guava and mango orchards. Recent study by Ugwu *et al.* (2018b) reported attraction of *B. dorsalis* to fruit juices, Torula yeast and brewery waste on guava, however, brewery waste was more effective than Torula yeast and pineapple juice in that study. In this study, the population of *B. dorsalis* fluctuated with time at both sites. This results support findings by Montes *et al*., (2011) who reported that fruit fly population fluctuates due to a succession of primary or alternative hosts, environmental complexity, and abiotic factor

Conclusion

Bactrocera dorsalis were trapped on bush mango at both locations by all the food-based attractants tested. Pineapple and orange juices were more potent in trapping *B. dorsalis* than Torula yeast. Food based attractants tested trapped higher number of female flies than male. The study has further confirmed the potential of locally made food based as attractants in trapping *B. dorsalis*. Hence, small and medium scale farmers could adopt their use in fruit fly management in orchards while further studies are necessary on increase dosage and baiting frequency to ascertain their effectiveness in mass trapping.

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