

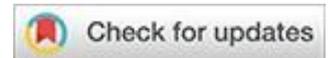
Evaluation of fermented lures for monitoring Tephritid flies in mangoes cultivation (*Manguifera indica*) Chongón-Province of Guayas.

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ABSTRACT

The research was conducted in an open field at the *Villaforest* farm, Chongón parish, Guayas Province. The genus *Anastrepha* spp. is one of the pests considered quarantine for other countries worldwide and is the most prevalent in South America. This research aimed to find an effective low-cost lure that helps reduce fruit fly populations. The experimental design used was a randomized complete block (RCBD), and means comparisons were made with the non-parametric Friedman test. The treatments were evaluated from the blossom to fruiting stages of mangoes. The control (T5) hydrolyzed protein obtained the highest captures with 524 specimens, (T3) Torula with 261 specimens, and (T1) Em-yeast-molasses-Ammonium Sulfate with 239 specimens. The most prevalent genera and species were *Anastrepha fraterculus*, *Anastrepha obliqua*, and *Anastrepha serpentina*. The most economical cost between the treatments was (T1) Em-yeast-molasses-Ammonium Sulfate. In the mean comparisons during the first and second month of the trial, (T3) Torula and (T5) hydrolyzed protein showed no significant differences in terms of FTD (fly/trap/day), and in the third month during the mango fruiting period, (T5) hydrolyzed protein achieved the best results followed by (T1) Em-yeast-molasses-Ammonium Sulfate, and then (T3) Torula.

Keywords: Lures, *Anastrepha* spp., fruit flies, mangoes, FTD

INTRODUCTION

The following research was conducted because many fruit producers do not have an alternative or tool to determine the presence of fruit flies in their crops at a low cost. In Ecuador, to determine the phytosanitary status of fruit crops, it's first necessary to use Mcphail traps or homemade traps with food lures; this one is expensive and not too easy to buy due to being an imported product. Regarding the investigation of Fazal

Maula et al.(2022),¹ The use of traps with food baits and other techniques, such as traps with stickers, there are some ways to reduce fruit fly populations without eliminating beneficial insects and being more environmentally friendly.

In other countries such as Mexico, Argentina, and Brazil, fermented foods (hydrolyzed proteins) have already been developed using products from their regions with good results. In the research of Jang and Light, cited by Cornelius(2000)², the female Tephritid fruit flies are attracted to the odors of proteins and host fruit. Olfactory attractants can be effectively used to develop nontoxic attractants to detect, monitor, and control fruit fly pests.

The main idea of the research was to test different fermented food lures made from local products such as guava, molasses, baker's yeast, and pineapple and determine which has the greatest attraction for fruit flies in mangoes cultivation compared to the commercial product that has been used for years; it calls hydrolyzed protein based on corn ferments and imported. In the research by Tibebe Dejene Biasazin et al.(2019)³, brewer's yeast, a product of the beer brewing process that is usually discarded, was used as an alternative protein source for the control of Tephritid fruit flies. Additionally, baker's yeast (*Saccharomyces cerevisiae*) activated with sugar, a standard diet for adult Tephritid flies, and torula yeast (*Candida utilis*), which is a species of yeast often grown on wood sugars left over after paper production and is an attractive bait for tephritidos.

Therefore, three treatments were fermented for 30 days before being installed in the trial. Once the treatments were fermented, the McPhail traps with different types of food lures were installed at the *Villaforest* farm in the mangoes crop. Specifically, the trial was installed in the Tommy Atkins mangoes variety, with five traps per hectare in five hectares, giving 25 experimental units. The use of alternative food proteins to control the population of fruits was described in search of S. Ekesi et al. (2018)⁴ in which the treatment with wasted brewery beer (WBB) got better results than the NuLure, commercial lure used to control the plague in Kenya. (WBB) had 112.1 flies/trap/day in Kenya, and 109.8 FTD in Uganda was superior to NuLure's 56.8 FTD. The results will help fruit producers (mangoes, dragon fruit, plum, goldenberry, and grapes.) to have a tool to make their fermented food lure, which will serve for the timely detection of the fruit fly pest at low cost and with local products.

According to the research by Aluja M. et al. (2019)⁵ using McPhail traps with lures such as IscaMosca (5%), Isca Samaritá Traditional (5%), torula yeast, Bio Anastrepha (5%), Ceratrap, and guava juice (50%) with three weeks inspection, the treatment with Ceratrap had the best results, followed by Torula, IscaMosca, and Bio Anastrepha. Isca Samaritá and guava juice presented the lowest results.

The research by Shafiq et al. (2012)⁶ claims that fruit flies know their associations with bacteria well, and many species exhibit morphological adaptations due to resident bacteria in the digestive tract. Alternatively, the gut microbiota may provide the metabolic capacity to generate the missing nitrogen component from the diet. As demonstrated in other insect-bacteria associations, amino acids can be secreted by the bacteria and assimilated by fruit flies.

MATERIAL AND METHODS

The study was led experimentally in the field for 25 years since he planted his variety, Tommy Atkins, collecting data on fruit fly captures using different types of food lures, and the attractiveness was evaluated. The experiment lasts from August 1, 2023, until December 15, 2023, in an open field at the *Villaforest* farm, Chongón parish, Guayas Province.

Variables

The independent variable was the different types of fermented food lures in McPhail traps for monitoring and capturing fruit flies. The dependent variables were:

- a) **Number of adult flies per treatment:** At 7, 14, and 21 days for each treatment, the individuals were collected using entomological forceps to pick up the insects, a sieve, and a container. The traps were rebaited with food lures every 21 days for 3 months.
- b) **Identification of flies by genus and species per treatment:** For macroscopic identification, a magnifying glass, entomological forceps, 70% alcohol, and a field guide for the recognition of fruit flies of the genus *Anastrepha* from Senasica-Sagarpa were used. Additionally, the app Picture Insect was used to corroborate the genus and species of captured specimens macroscopically. The identification was done to determine the genus of *Anastrepha spp.* get the highest population in the investigation. In the essay of Bermudez M. et al. (2020)⁷, who evaluated a kind of fermented lure and used alcohol to get the adults of fruit flies, later identified the genus and determined the fruit flies with a high population, in that case, were *Anastrepha fraterculus* and *Anastrepha obliqua*.
- c) **Number of fruit flies, females and males per treatment:** The specimens were collected and separated by sex.
- d) **Population dynamics of the pest:** The formula flies per trap per day (FTP) was used to monitor fruit flies; Agrocalidad and USDA-APHIS use this formula. This formula determined the prevalence of the plague in an area, according to the exposure of the lures and Mcphail traps.

Formula:

$$\text{FTP} = \frac{\text{Flies}}{\text{Traps} \times \text{Days}} \quad (1)$$

Flies: Total Number of fruit flies captured

Traps: Total Number of traps checked

Days: Total Number of exposition days

If the FTP is high to 0,14 or equal in a determined area of mangoes of exportation, the area can't be cut or harvested because the area is infested for fruit flies, the range permissible is too high, and the area is under quarantine for 28 days, according to Salas D. et al. (2018)⁸.

Population and Data Technique

The population for the study consisted of 25 experimental units; the sample in the field was 25 mango plants of the Tommy Atkins variety. The technique applied was direct observation of the captures in the field, using Mcphail traps, which allowed for determining the attractiveness of the fermented food lures. In the investigation of Yeralf J. et al. (2021),⁹ used 12 experimental units for each farm to determine the attraction of his food baits and lures.

The complete randomized block design (CRBD), non-parametric Friedman test, and Poisson Binomial Distribution were applied. These tests were used because the data collected from the captures did not have a normal distribution. Each experimental unit was placed in a mango tree; 50 mts between them separated all the units. Infostat statistical software was used to compare the mean results of the treatments. The means of each treatment were taken for comparison analysis.

Treatments

The treatments used in the study were three food lures fermented based on yeast molasses and a conventional control lure (hydrolyzed protein) based on corn fermentation, also called Torula, with five repetitions each, totaling 25 experimental units. Molasses and pineapple were chosen as sugar sources for the treatments due

to their attraction to fruit flies, and guava was used as the primary host for the fruit fly.

Lures	Components	Doses per Trap
T1	Effective Microorganism (EM)+yeast+molasses+Ammonium Sulfate	125cc + 125cc water
T2	Guava fermented (<i>Psidium guajava</i> L.) +(EM)+yeast+molasses	125cc + 125cc water
T3	Torula	2 pellets
T4	Pineapple fermented (<i>Ananas comosus</i>) +(EM)+yeast+molasses	125cc + 125cc water
T5	(Control) Hydrolyzed protein	12,5cc + 238cc water

Table 1. Treatments with the components and doses per trap.

Field Conditions

The 25 experimental units were installed across 5 hectares, five Mcphail traps per hectare were placed, and captures of adult fruit flies were recorded every 7, 14, and 21 days, after which the treatments were rebait.

Fermentation of the Treatments

Only three treatments were fermented for 30 days, namely T1(Effective Microorganism (EM)+yeast+molasses+Ammonium Sulfate), T2(Guava ferment (*Psidium guajava* L.) +EM+yeast+molasses), and T4(Pineapple (*Ananas comosus*) +EM+yeast+molasses).

For fermenting the treatments described above, a 50 L plastic tank was used for T1. As a base for fermentation, 250 g of yeast, 5 L of molasses, 2 L of Effective microorganisms, and 45 L of water were used, and 3 lb of Ammonium Sulfate.

For the treatment T2, the same ingredients as above were used, with 1lb of chopped guava added without ammonium sulfate. For treatment T4, the base ingredients were used with the addition of 1 lb of chopped pineapple. These treatments were fermented for 30 days.

Once fermentation was completed, the trial was set up. The doses for each fermented treatment were 125 cc per trap, with the remaining 125 cc filled with water. All the fermented treatments and the control were applied with 5 g of borax per trap to help delay the decomposition of collected insects and facilitate their identification.

Materials Used

Vegetal: Mangoes tress of Tommy Atkins variety.

Ferments: Guava, Pineapple, molasses.

Chemical: Borax salt, Ammonium Sulfate

Physical: GPS, fermentation tanks, lever and hook, basin, strainer and sieve, plastic jars, Mcphail traps, wire for hanging traps, pencil, notebook, tweezers, 70% alcohol, magnifying glass.

Software: Google Earth for trap location, Infostat, and Sigmaplot (statistics and graphics).

RESULTS

Total Number of Adult Flies per Treatment

Regarding the treatment with the highest number of detections of adult fruit flies and the highest prevalence of the pest, the treatment with hydrolyzed protein (T5) captured the most with 524 specimens, followed by treatment with Torula(T3) with 261 specimens. The treatment with EM+yeast+molasses+Ammonium Sulfate(T1) ranked third with 239 captures. The low prevalence was of pineapple fermented treatment(T4) with 77 specimens and guava fermented treatment(T2) with 14 specimens. In total, 1.115 fruit flies were captured throughout the trial.

According to the Friedman test, highly significant differences were established between the evaluated treatments. The comparison identified two groups, with the hydrolyzed protein treatment (T5) having the highest number of captures, followed by Torula(T3). The other group was led by the EM-yeast-molasses-Ammonium Sulfate treatment(T1), followed by the guava ferment treatment (T2) and the pineapple ferment treatment (T4). Although the hydrolyzed protein(T5) is superior in quantitative values, statistically, it is equivalent to the Torula treatment(T3).

A similar behavior was also observed with the EM-yeast-molasses-Ammonium Sulfate (T1) and Torula(T3). The hydrolyzed protein (T5) had the highest captures during the fruiting period of the mango and Torula (T3) during flowering and the beginning of fruit growing. The captures of the EM-yeast-molasses-Ammonium Sulfate treatment (T1) increased during fruiting, most likely because fruit flies are attracted to fermented odors and sugars. The treatment Torula(T3) decay it captures every 2 weeks, was the only lure that needed to replace the bait; it's analogous to Torula yeast pellets are not recommended for fruit fly trapping in mango farms, and the conclusions of the results by Elsje Joubert et al.(2015)¹⁰ due to the relative low trap catch numbers and high non-target catches, these were the results the investigation in South Africa in according to the two-pest target *Ceratitis capitata* and *Bactrocera dorsalis*.

Treatments	Means ¹ - Deviation Standard
(T1) EM+yeast+molasses+Ammonium Sulfate	5,31 ± 14,45 abc
(T2) Guava fermented+EM+yeast+molasses	0,31 ± 1,14 a
(T3) Torula	5,80 ± 9,95 d
(T4) Pineapple fermented+EM+yeast+molasses	1,71 ± 6,22 ab
(T5) (Control) Hydrolyzed protein	11,64 ± 26,47 d
Significance of Friedman Test-Highly significant differences (p<0,01)	**

Table 2. Total Number of Adult Fruit flies per Treatment-¹Means with the same letter does not differ significantly according to Friedman Test. A single asterisk (*) indicates a significant difference (p < 0.05), and a double asterisk () indicates a highly significant difference (p < 0.01).**

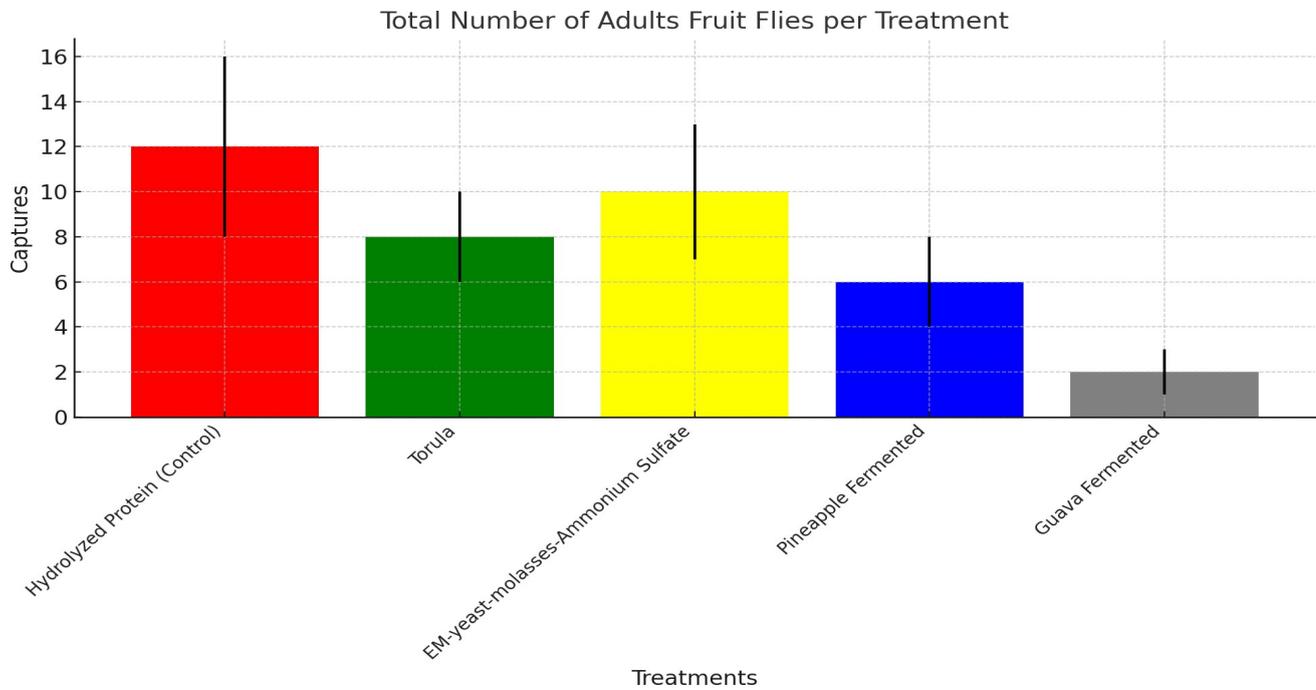


Figure 1. Total Number of Adult Fruit flies per treatment.

Identification of Flies by genus and species per treatment

In terms of macroscopic identification of the specimens, the genus with the highest number of detections was *Anastrepha fraterculus* (822), followed by *Anastrepha obliqua* (256), and the last *Anastrepha serpentina* with (31) captures.

Treatments	<i>Anastrepha fraterculus</i>	<i>Anastrepha obliqua</i>	<i>Anastrepha macrura</i>	<i>Anastrepha chichlayae</i>	<i>Ceratitis capitata</i>	<i>Anastrepha serpentina</i>	Total
(T1)M+yeast+molasses+Ammonium Sulfate	155	70	0	0	3	11	239
(T2) Guava-fermented+EM+yeast+molasses	14	0	0	0	0	0	14
(T3) Torula	208	52	0	1	0	0	261
(T4) Pineapple-fermented+EM+yeast+molasses	53	17	0	0	0	7	77
(T5) (Control) Hydrolyzed protein	392	117	1	0	1	13	524
Total	822	256	1	1	4	31	1115

Table 3.- Identification of flies by genus and species per treatment.

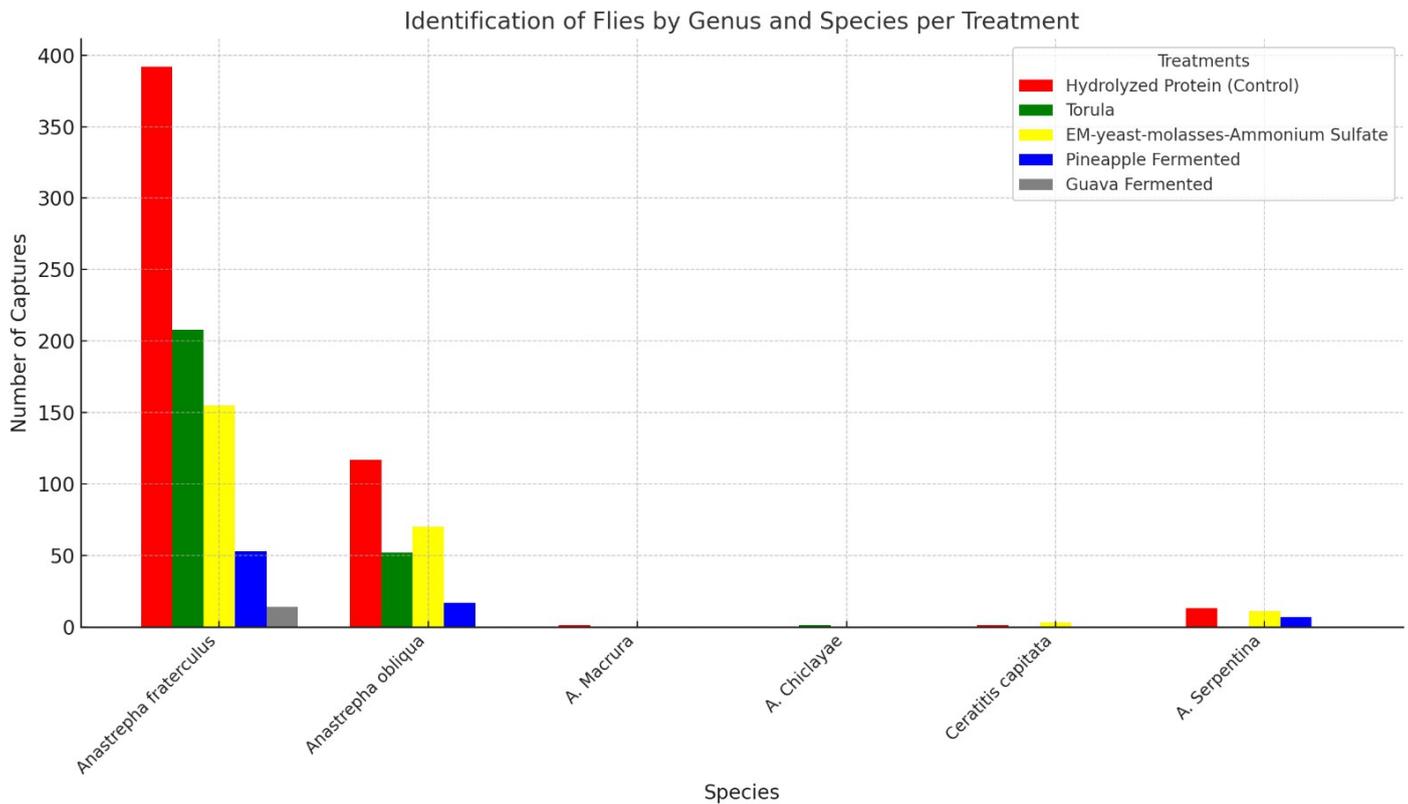


Figure 2. Identification of flies by genus and species per treatment.

Number of fruit flies, females and males, by treatment

Regarding the number of males and females detected by each treatment, the control, the hydrolyzed protein(T5), resulted in 149 males and 375 females. This was followed by treatment (T3) with 133 males and 148 females. Treatment (T1) was in third place, with 55 males and 184 females. The other treatments, (T4) and (T2), had the lowest capture values. The percentage of females captured was 68.70%, and the rate of males was 31.30% of the total captures in the entire trial. In total, there were 766 females and 349 males.

According to the Friedman test, no statistical differences exist between the hydrolyzed protein treatment (T5) and the Torula treatment(T3). The (T1) EM+yeast+molasses+Ammonium Sulfate treatment captured slightly more females than the Torula (T3). Possibly, adult female fruit flies are attracted to food lures and fermented smells during the fruit and ripening season.

Treatments	Means ¹ – Deviation Standard
(T1) EM+yeast+molasses+Ammonium Sulfate	4,09 ± 11,45 ab
(T2) Guava fermented+EM+yeast+molasses	0,24 ± 0,96 a
(T3) Torula	3,29 ± 5,68 b
(T4) Pineapple fermented+EM+yeast+molasses	1,07 ± 3,96 a
(T5) (Control) Hydrolyzed protein	8,33 ± 19,93 b
Significance of Friedman Test-Highly significant differences	**
p<0,01)	

Table 4. According to the Friedman Test, the total number of female fruit flies per Treatment-¹Means with the same letter does not differ significantly. A single asterisk (*) indicates a significant difference (p < 0.05), and a double asterisk (**) indicates a highly significant difference (p < 0.01).

Treatments	Means ¹ – Deviation Standard
(T1) EM+yeast+molasses+Ammonium Sulfate	1,22 ± 3,06 ab
(T2) Guava fermented+EM+yeast+molasses	0,07 ± 0,25 a
(T3) Torula	2,51 ± 4,70 b
(T4) Pineapple fermented+EM+yeast+molasses	0,64 ± 2,30 a
(T5) (Control) Hydrolyzed protein	3,31 ± 7,36 b
Significance of Friedman Test-Highly significant differences (p<0,01)	**

Table 5. According to the Friedman Test, the total number of male fruit flies per Treatment-¹Means with the same letter do not differ significantly. A single asterisk (*) indicates a significant difference (p < 0.05), and a double asterisk (**) indicates a highly significant difference (p < 0.01).

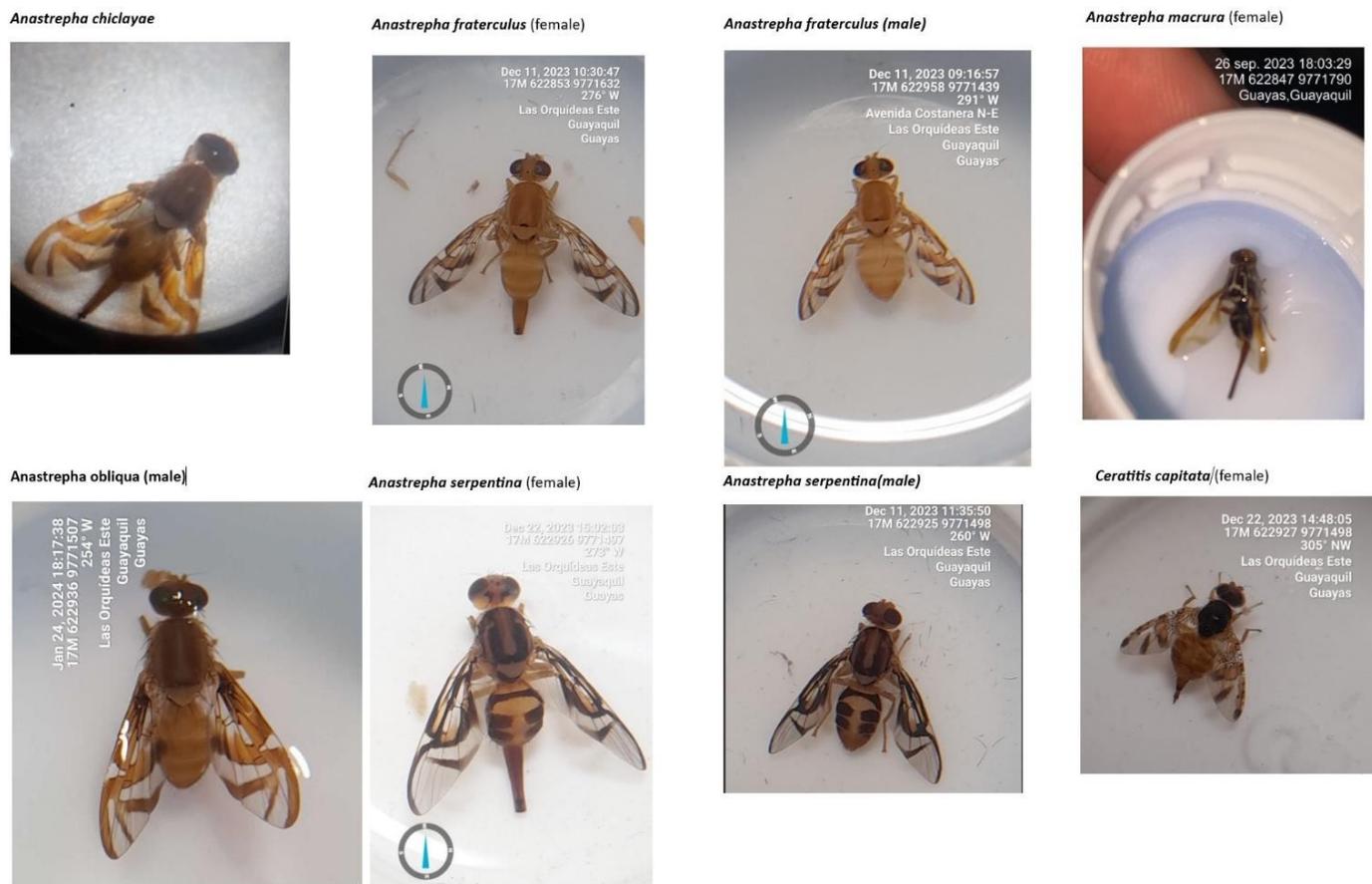


Figure 3.- Identification of fruit fly species captured in the research.

FTD Prevalences by month and each treatment

The prevalence of FTD (Flies per Trap per Day) by month and each Torula(T3) treatment showed high prevalences during the blossoming and growing fruit in the first and second months. However, during the mango fruiting period in the 3rd month of the trial, the hydrolyzed protein treatment(T5) detected the highest captures, followed by the treatment (T1) EM+yeast+molasses. This is likely due to the influence of climatic conditions (high temperatures and the beginning of precipitations) in December. Additionally, the presence of mango fruits contributed to the increase in the captures of adult fruit flies for the treatment (T5) and treatment (T1).

Treatments	First month	Second month	Third month
(T1) EM+yeast+molasses+Ammonium Sulfate	0,06 abc	0,06 abc	2,16 abc
(T2) Guava fermented+EM+yeast+molasses	0,02 ab	0,02 a	0,10 a
(T3) Torula	0,41 d	0,71 d	1,36 abc
(T4) Pineapple fermented+EM+yeast+molasses	0,01 a	0,02 ab	0,71 ab
(T5) (Control) Hydrolyzed protein	0,33 d	0,73 d	3,92 c
Significance of Friedman Test-Highly significant differences (p<0,01)	**	**	
Significance of Friedman Test-Significant differences (p<0,05)			*

Table 6. FTD (Flies Trap per day) prevalences by month and each Treatment-¹Means with the same letter do not differ significantly according to the Friedman Test. A single asterisk (*) indicates a significant difference ($p < 0.05$), and a double asterisk () indicates a highly significant difference ($p < 0.01$).**

DISCUSSION

The hydrolyzed protein treatment was the lure with the highest number of adult fruit fly captures (T5). Similarly, results found in the investigation by Meza J. (2022)¹¹ the hydrolyzed protein treatment had the most captures in a trial conducted in Los Ríos, the investigation conducted in the Vinces sector, the treatment with the highest captures was hydrolyzed protein with 3749 flies. In another study by T. Grout et al.(2021)¹², the results coincide about lures and attraction; the treatment with hydrolyzed protein attracted significantly more flies than any other treatment, and in all research, the females were significantly more attracted to the baits than males. The same results were obtained in the survey by Delgado et al.(2022)¹³ hydrolyzed protein was more effective in capturing young *Anastrepha fraterculus* and *Ceratitis capitata* females. In their trial, they used Mcphail traps under a mass trapping system.

It is worth mentioning that the treatment with Torula yeast(T3) also achieved good capture results over 2 months. Additionally, according to the analysis by Vásquez et al.(2022)¹⁴ in Homestead, Florida, the Torula yeast and borax treatment got the best results. The same results were found in the exploration of Hanna et al.(2020)¹⁵ his study found that the Torula yeast had more captures of fruit flies than the other variables like Biolure, NuLure, in that case, *Ceratitis cosyra*, and *Bactrocera dorsalis*, all the research was conducted in mangoes fields in Kenya, Africa. The results attached to the exploration of Shelly et al.(2024)¹⁶ in which the treatment with Torula yeast captured females of fruit flies (*Bactrocera dorsalis*) better than the others treatments, 2 or 3 components with food cones (2 components Ammonium Acetato+Putrescina and 3 components Ammonium Acetato+Putrescina+Trimetilamina), the captures were a significant amount numbers of females. The Data indicated in the results of the investigation by Torres Q. et al.(2021)¹⁷ the torula yeast was attractive 85,2 % and 80,2% more males and females of Caribbean fruit flies compared to torula yeast+benzalkonium chloride; the last one is a quaternary compound that was used to evaluate the effect the addition of this particularly element with nitrogenous.

However, it should also be highlighted that the mangoes crop's phenology influences the fruit fly's behavior. The prevalence or not prevalence of the fruit flies depends on the season of fluctuations in accordance to Nanga S. et al.(2022)¹⁸ it means that with the appears the fruit in the mangoes tree and also the rainy season, the peak of capture is highest in the results in this examination.

The EM-yeast-molasse-ammonium sulfate(T1) showed good detection results in the third month of exposure

during the fruiting period that findings agreed with the survey of Benitez L. et al.(2023)¹⁹ the attraction of the fruit flies is related with ripening of the fruit it was the conclusion in the searching of the results suggest that the olfactory preference of *A. obliqua* for attractive host is based on the presence or absence of compounds associated with fruit mature. The combination of the different lures increases the captures of fruit flies like in the research of Muhammad Hasnain et al.(2023)²⁰ according to the investigators, the combination of a source of nitrogenous, in this case Ammonium Acetato+Putrescina and food lure jaggery (Guava pulp), both sexes were attracted of fruit flies (*Bactrocera zonata*). The same tendency was evident in the findings of J.A. Ugwu et al.(2018)²¹ in the field of mangoes using different kinds of lures and food baits, showing that the treatment with food baits (Brewery Waste) trapped both male and female fruit flies and the populations was the highest at the peak of mangoes ripening.

Also, in the study of Piñero et al.(2020)²², the attraction of Tephritid fruit flies to specific food sources can be enhanced by the presence of ammonia derivatives, compounds that are perceived as volatile signals from protein-rich food sources. In that research, their findings strengthen the understanding of the olfactory behavior of female fruit flies in response to food-based materials and the extent to which ammonium acetate modulates the response of females to protein-rich and protein-deficient materials. The results also concur with the review of Muhammad Dildar et al.(2020)²³ the addition of ammonium increases the captures of fruit flies; in his investigation, the treatment with juice grape plus ammonium acetate improved the attraction of females of fruit flies. The finding suggests that adding ammonium acetate could enhance grape juice performance in the field. Varikou et al. (2021)²⁴ in his results show that the mix of source nitrogenous like ammonium salts with beta-cyfluthrin increases the mean number of captured flies at least 3 to fold (depending on the salt) higher compared to the respective protein-containing mixture baits instead of the organophosphate phosmet. Ammonium salts can successfully replace proteins in bait sprays.

Related to the *Torula* yeast treatment (T3) were almost similar values; this finding is consistent with the research by Kendra et al.(2021)²⁵, which noted that fruit odors were more effective lures for female flies than hydrolyzed proteins.

The most prevalent genera and species were *Anastrepha fraterculus*, *Anastrepha obliqua*, and *Anastrepha serpentina*. Regarding the diversity of fruit flies at the genus and species levels, the specimen with the highest presence throughout the trial was *Anastrepha fraterculus*, followed by *Anastrepha obliqua*. Similarly, (mentioned in their research by Bortoli et al.(2023)²⁶ in Brazil that the species and genus with the highest number of captures per trap was *Anastrepha fraterculus*, in their study using different lures. The genus *Anastrepha spp.* has the largest population of fruit flies in Central and South America, as referred to by Enkerlin et al.(2021)²⁷. Following the captures of females and males, the results obtained show 68,70 % females and 31,30% males; the percentage was high for fruit fly females. The same results agreed with the research by Lasa R. et al.(2022)²⁸ the number of female fruit flies captured was higher than the males in the investigation mentioned that all the treatments, food baits, and lures had a higher number of females than males, and that is a patron reported for food baits following the genus *Anastrepha spp.* According to the examination of Santos J.P. et al.(2022)²⁹, the genus and species most prevalent in South America is the *Anastrepha fraterculus*; in his research, using a food bait with traps, they captured 657 males and 1.064 females of *Anastrepha fraterculus*. It also found that the treatment with fewer captures was the grape juice, and the most effective and higher attraction was the food lure with animal and vegetal elements. The search of Abinaya S. et al.(2020)³⁰ determined that the captures of females were higher than males in all the lures tested.

In addition, we can use another alternative, lures or baits, to reduce the populations of fruit flies on mangoes farms, such as wasted brewer's yeast. This kind of lure was used in the investigation in Africa by Ekesi S. et al.(2016)³¹ the wasted brewer's yeast was used in Kenya, captured 112.1 flies/trap/day, and in Uganda 109.8 FTD, this kind of lure was used in Ecuador because there a lot of companies of beer that could offer wasted

brewer's yeast.

In China, bait from orange juice to control fruit flies to examination by Leyuan Liu et al.(2024)³² found a compound called D-Limonene in the orange juice that attracts fruit flies when they are sexually mature; that kind of bait could be used to control the population of fruit flies. The orange is a local product that could be used as an alternative bait in our country.

Regarding the exploration of Gwang Hyun Roh et al.(2021)³³, another alternative to get an effective bait is the guava; the juice of guava could be a great bait to attract fruit flies; in other research, the juice of guava increases the attractions of fruit flies for his odor, inclusive better than yeast.

In the Andean countries, there is an ancient beverage called "chicha," usually used for the celebrations of Andean people; in Bolivia, the chicha was used as an alternative use to attract fruit flies to protect their peach crops in the review of Figueroa Ilich et at.(2018)³⁴ the results show that the chicha and baker's yeast were more effective (average FTD 10.31 and 9.49) than the commercial baits hydrolyzed protein (4.71) or Torula yeast (6.82).

The current problem of food baits like Torula is that the longevity or attractiveness power is only two weeks. In our investigation, treatment was changed every two weeks, and the other therapies and food lures were altered until the twenty-one days. In the case of the hydrolyzed protein, his attractiveness is around fourteen days. In the investigation by EnkerlinW. et al.(2025)³⁵ have tried synthetic food lures with a significant range of longevity of around ten weeks.

In every research by EnkerlinW. et al.(2025)³⁵ about food baits like Torula versus Vial lures in all the countries México, Argentina, and Colombia the investigations were 8 to 10 weeks; that research is similar to our investigation, the time duration was so long, around 12 weeks I mean 3 months, there is to think that the cycle of life of the fruits flies is around 28 days. So, our investigation tried to be present in the cycles of the fruit flies and also to get information about the behavior and attraction of different baits from the blooming until the ripening of mangoes to understand the plague better.

The study carried out by Suarez L. et al.(2023)³⁶ get results a little bit similar to our findings in the investigation; they used different baits foods from the extraction of orange, apple, peach, and grapes, versus Torula and found that orange juice could be more effective to capture Medflies in Autumn, but not in Summer. Our research found that the treatment of Em-molasses-Ammonium Sulfate got more captures, not at the beginning of the blooming of mangoes, but the captures were better at the ripening.

COST ANALYSIS

Regarding the economic analysis of the different attractants, treatment (T1) EM+yeast+molasses+Ammonium Sulfate was cheaper than the others, with 239 specimens captured (21.43% attraction). Treatment (T3) Torula was the most expensive attractant, with 261 specimens captured (23.41% attraction). Treatment (T5)

Hydrolyzed protein resulted in 524 specimens captured, with a 47% attraction rate. The other treatments had low attraction rates, such as (T2) Guava fermented with 14 specimens (1.26% attraction) and (T4) Pineapple fermented with 77 specimens (6.90% attraction).

Materials	(T1)	(T2)	(T3)	(T4)	(T5)
Ammonium Sulfate	25	0	0	0	0
Tank	6	6	0	6	0
Hose	1	1	0	1	0
Handle	1	1	0	1	0
Neplo	3	3	0	3	0
Yeast	3	3	0	3	0
Molasses	3	3	0	3	0
Fruit	0	1,5	0	1,5	0
EM	6	6	0	6	0
Torula	0	0	30	0	0
Hydrolyzed Protein	0	0	0	0	3,06
Traps	50	50	50	50	50
Labor cost	100	100	100	100	100
Borax	0,02	0,02	0	0,02	0,02
Water	5	5	5	5	5
Other Expenses	50	100	100	100	100
*Total	253,02	279,52	285	279,52	258,08

(T1) EM+yeast+molasses+Ammonium Sulfate Captures: 239 esp¹

(T2) Guava fermented+EM+yeast+molasses Captures: 14 esp¹

(T3) Torula Captures: 261 esp¹

(T4) Pineapple fermented Captures: 77 esp¹

(T5) Hydrolyzed Protein Captures: 524 esp¹

Table 7. Cost Table and Economic Analysis of Fermented Attractants

Prepared by: Bravo, 2023

*Costs expressed in US dollars.

¹ Specimens.

CONCLUSIONS

Based on the results obtained in the experimental trial, it can be concluded that the hydrolyzed protein lure was the most effective, achieving the highest captures of adult fruit flies throughout the trial. However, the Torula lure demonstrated effectiveness during the blossom and fruit growth stages. Among the fermented food lures, the EM+yeast+molasses+Ammonium Sulfate treatment was the only one to show a high prevalence of captures during the fruiting stage. In contrast, the guava and pineapple-fermented treatments exhibited the lowest levels of effectiveness.

In terms of the diversity of genus and species observed throughout the trial across all treatments, *Anastrepha fraterculus* and *Anastrepha obliqua* were identified as the predominant species. These results underscore the significant role of these species in the pest population dynamics in the trial area.

The EM+yeast+molasses+Ammonium Sulfate treatment (T1) proved a viable food lure for monitoring and ethological control. The data revealed its effectiveness in attracting species such as *Anastrepha fraterculus*, *Anastrepha obliqua*, *Ceratitis capitata*, and *Anastrepha serpentina*, particularly during the fruiting period of mangoes. Additionally, this treatment showed superior female capture rates during the ripening stage compared to the Torula lure.

Finally, the EM+yeast+molasses+Ammonium Sulfate treatment (T1) was also identified as the most cost-effective option among all the treatments tested. This makes it a promising alternative for small-scale producers seeking affordable and efficient solutions for fruit fly management.

Supplementary Materials: Not applicable.

Patents: The treatment EM+yeast+molasses+ammonium sulfate was patented in Guayaquil, Ecuador, with a commercial called "Biofly" in SENADI- National Service of Intellectual Rights.

Fundings: This research has not received external funding.

International Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Acknowledgments: The author FB is pleased for the support to the MSc research thesis, which is part of this sheet, by the Master of Science in Plant Protection (specialization in agriculture) program at Ecuadorian Agrarian University.

Conflicts of Interest: Autor declares no conflict of interest. The funders had no role in the study's design in the collection, analysis, or interpretation of data, the writing of the manuscript, or the decision to publish the results.

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Received: November 16, 2024 / **Accepted:** January 28, 2025, / **Published:** March 15, 2025

Citation: Bravo Díaz L, de la Torre E M, Varas Carvajal I, Alvarado Barzallo A, Valdez D. Evaluation of fermented lures for the monitoring of Tephritid flies in mangoes cultivation (*Manguiфера indica*) Chongón-Province of Guayas, Ecuador. *Bionatura journal*. 2025; 2(1):10. doi: 10.70099/BJ/2025.02.01.10

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Peer review information. Bionatura thanks anonymous reviewer(s) for their contribution to the peer review of this work using <https://reviewerlocator.webofscience.com/>

ISSN.3020-7886

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