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Potential of Modified Food - Based Lures in Trapping Oriental Fruit Fly on *Vitellaria paradoxa* (C.F.Gaertn) at Opara Forest Reserve in Oyo State, Nigeria

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ABSTRACT

Oriental fruit fly (*Bactrocera dorsalis* Hendel) is a polyphagous insect pests of several vegetable crops and fruit trees including *V. paradoxa* that causes significant economic damage across the globe. A study was conducted at Opara forest reserve in Oyo state, Nigeria to assess the potency of modified food-based attractants in trapping *B. dorsalis* on shea nut tree (*Vitelleria paradoxa)* during the 2022 fruiting season. The treatments include; modified mango juice, modified pineapple juice, modified orange juice, methyl eugenol (standard check) and water (control).The populations of adult *B. dorsalis* trapped on each trap were documented weekly for ten successive weeks. The obtained data were analyzed using analysis of variance (ANOVA). The results revealed that modified fruit juices and methyl eugenol trapped adult *B.dorsalis on V. paradoxa* at varied rates during the study periods. Higher population of *B. dorsalis* were significantly ($P<0.05$) trapped by Methyl eugenol compared to other attractants. The overall percentage trapped *B. dorsalis* after 10 weeks were 91.81%(methyl eugenol),3.19% (mango juice), 3.08%(orange juice),1.97%(pineapple juice) and 0%(control).There were no significant differences ($P>0.05$) on the population of trapped oriental fruit fly among the fruit juices. The food based lures evaluated have shown some potential as attractants for trapping *B. dorsalis* on *V. paradoxa* in forest ecosystem. Hence, they could be used for monitoring *B. dorsalis* on *V. paradoxa* however, there is need for further modifications and dosage increase to enhance their efficacy.

Keywords: Attractants, Oriental fruit fly, Shea nut fruits, Food based lures, Forests

Introduction

Non-timber forest products (NTFPs) contributes significant roles in alleviating poverty among rural populace through provision of food as well as reduction of malnutrition(Aleza *et al.*, 2018). Many tree crops today are edible and they provide nutritional and economic needs of several small holder farmers (Tena, 2019). The shea tree (*Vitellaria paradoxa* C.F.Gaertn.) is a native fruit tree in the family Sapotaceae, classified as crucial African orphan crops with strong potential to improve the livelihoods of many rural farmers (Mabhaudhi *et al.,* 2019). Shea trees are established in the belt of Sudan vegetation that extends to south of the Sahel vegetation within the western, central, and eastern regions of sub-Saharan Africa (SSA) (

Aremu *et al.*, 2019). Shea tree is accredited as a species that contributes to the socio-economic development and economic growth in sub Saharan Africa (SSA) countries (Moore, 2008) and is among the most essential fruit tree species utilized in agroforestry parkland across SSA(Bondé et al., 2020). It is a multipurpose tree, producing nutritious fruit pulp, kernels and several other derived products with edible and medicinal applications (Choungo-Nguekeng *et al.*, 2021) Many parts of SSA are currently suffering from unseen hunger, food insecurity and malnutrition(FAO;IFAD; UNICEFWFP; WHO, 2020). About 25% of harvested shea fruits are consumed locally as source of food while remaining 75% are sold in the local markets to generate income (Pouliot, 2012; Tom-Dery *et al*., 2018). Biotic factors constitutes one of the major reasons for the present decline in shea tree production (Salle *et al.*, 1991). Shea tree is attacked by several insect species in some west African countries such as Burkina Faso, Ghana, Mali, Nigeria and Togo (Salle´ *et al.*, 1991; Odebiyi *et al.*, 2004).. Several fruit fly species in the family Tephitidae have been trapped on shea tree in Burkina faso (Zida *et al.,* 2020). Fruit flies in the family of Tephritidae (Tephritid) are the most important insect pests of fruits and vegetable causing significant economic losses to farmers globally (Badii *et al*., 2015). The oriental fruit fly (*Bactrocera dorsalis* Hendel)is one of the most important fruit fly species currently devastating fruit productions in sub-Saharan Africa region(Ekesi *et al.,* 2011). Among the seven tephritid fruit fliy species trapped on shea tree in Burkinafaso, *B. dorsalis* was among the dominant species (Zida *et al.*, 2020).*B. dorsalis* causes losses to fruits through direct damage by laying eggs on mature fruits which leads to fruits drops before maturity and export limitations due to quarantine policy.Diverse control procedures for fruit fly species attacking crops has been developed in different parts of the world (Dias *et al.,* 2018). Monitoring of fruit fly population using traps and attractants is a significant management procedure that confirm population status and determine the presence of quarantine species in the region (Santos, 2009). The baiting approach has reduced the use of pesticide in fruit fly management and has been successfully incorporated into Integrated pest management(IPM) strategies for many fruit fly species including *B. dorsalis* and *B. cucurbitae* (Vargas *et al.,* 2010). Development of the effective locally produced attractants might offer substitutes for fruit fly management and enhance crop protection for the small scale fruit and vegetable farmers and consequently mitigate the problems of cost and availability of commercial lures (Epsky *et al.,* 2014). Hence, the study evaluated the potential of three modified fruit juice attractantsin trapping *B. dorsalis* on shea nut trees at Opara forest reserve during the fruiting season between May and July 2022.

Materials and Methods

Study site

The study was conducted at Opara Forest Reserve located in Atisbo, Saki West and Iwajowa Local government of Oyo state

Nigeria. It covers 248,640 hectare of land and is the largest among all the forest reserves in Oyo state accounting for about 73% of total forest reserve (Alo, 2017). it is situated at 237meters above sea level within latitudes 8°4 '.60"N and longitude 2°49 '60" E Greenwich meridian time (GMT) The average annual rainfall is 1252.5 mm, and the average daily temperature ranges between 23.2°C and 31.9 °C, nearly throughout the year. (NBS,2012).

Preparation of Modified food based lures

The modified food based lures were prepared from pineapple, orange and mango fruits. The fruit juices were prepared by peeling 1kg of each ripe fruit and blending them separately with one liter of water into a smooth slurry paste using an electric blender (Binatone blender BLG.450). The homogenous solution was extracted from each blended fruits using muslin cloth as described by (Ugwu *et al.,*2018). The extracted juices were modified by adding 10g each of yeast and sugar to 500ml of each extracted juice. The substance was vigorously shaken for 10 minutes for proper mixing and then kept in refrigerator until when used.

Experimental procedure

Modified Lynfield traps were improvise using 400ml cylindrical transparent plastic bottles with a lid, two equidistant holes were created opposite each other in the uppermost part of the bottles and small plastic string (1m) was attached to each lid which was used to hang the traps. The treatments were modified orange juice, modified pineapple juice, modified mango juice, methyl eugenol (standard check) and water (control). The forest reserve was divided in to three parts to obtain 3 independent study locations. Three shear trees were chosen from each location and the tree within each location was separated by 20m to obtain three independent replications within each location. Five hundred (500mL) of each prepared modified juice was baited with 2 ml of cypermethrin to knock down the trapped flies and the mixed solution was then used to set the traps. Fifty milliliters (50mL) of each baited modified fruit juice was dispensed with aid of syringe and carefully dropped on 0.5 gm of cotton wool and placed at bottom of the traps while Methyl eugenol was dispensed at the rate of 20 ml per trap following the same procedure and while ordinary water served as control. The traps were later hung within the tree canopy at about 2.0m - 3.0m above ground level (Figure 1). Five traps containing different treatments were randomly hung on each selected tree at the three study locations . The experiment was set up in a randomized block design (RBD) in three replicates per study location during the on-set of fruiting to ripening stage of shea fruits (May – July) when the environmental temperature varied within 27-30°C for 10 weeks. The blocking factors were vegetation and other trees between the selected trees on which traps were set.

Data collection and statistical analysis

Data on the population of *B. dorsalis* caught on each trap was collected at weekly interval for 10 weeks consecutively. Data collected were transformed using square root transformation, thenanalyzed using analysis

of variance (ANOVA) and significant means was separated using Tukey's Honestly Significant Difference (HSD) using ASSISTAT 7.7en 2016 version.

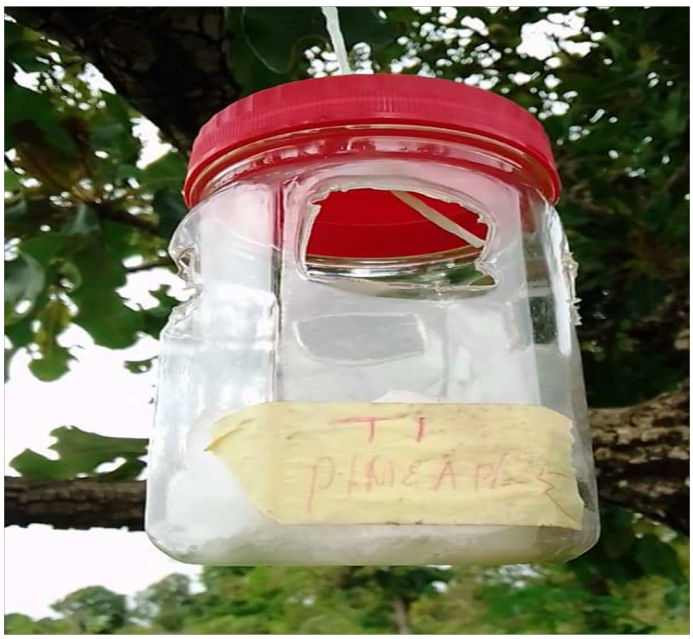

Figure 1. Modified Lynfield trap with attractant hung on *Vitellaria paradoxa* at the study site

Results and Discussion

The density of trapped *B. dorsalis* on Shea tree at the study site

The results showed that modified fruit juices evaluated had potential as attractants *for B. dorsalis.* All modified fruit juices and methyl eugenol trapped adult *B.dorslis on V. paradoxa* trees at varied rates as time progressed during the study periods (Figure 2). The density of trapped *B. dorsalis* increased on Methyl eugenol attractants as the period of the experiment progressed with the peak at 4^{th} – 6^{th} week with mean square root transformed values of 8.42, 8.70, and 8.35 and then declined from week 7 to the end of the study. Modified mango lures attracted the highest density of *B. dorsalis* at first and second week with mean transformed values of 0.6 and 0.46 respectively. Modified orange and Pineapple lures trapped higher population of adult flies at 1^{st} and 7^{th} week with mean transformed values of.0.74 and 6.78 respectively. Control experiment did not trap any *B. dorsalis* all through the study.

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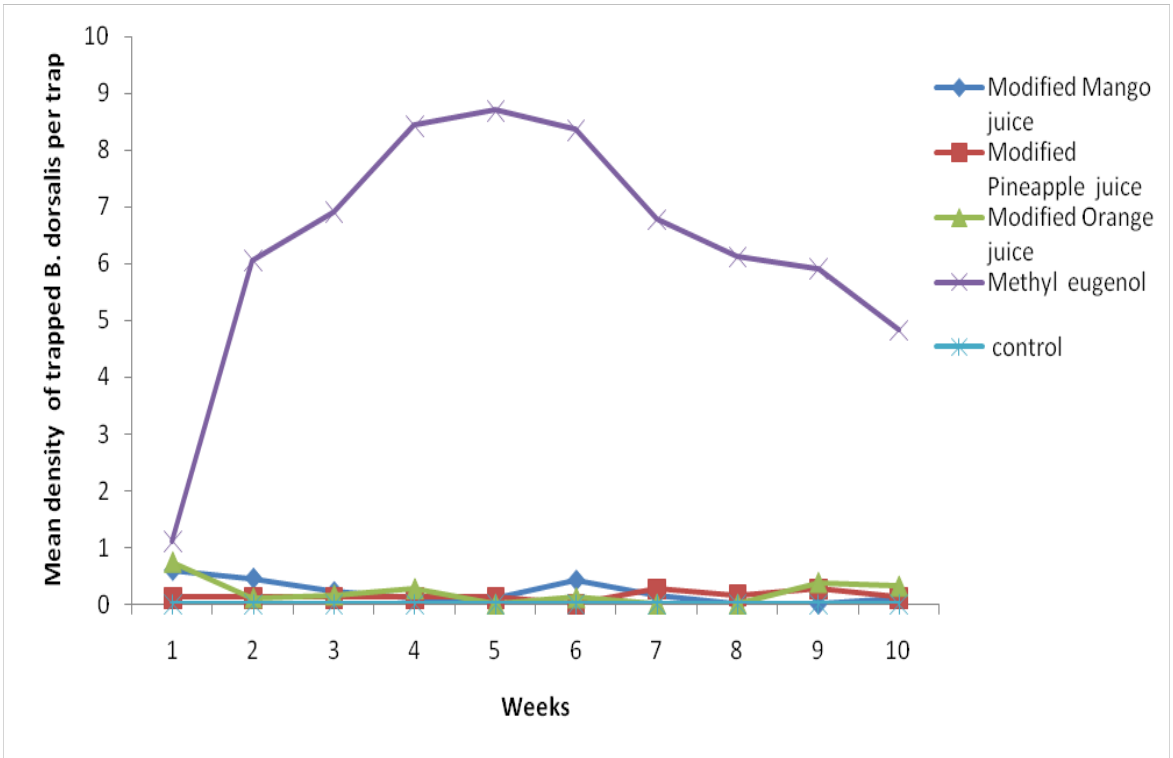

Figure 2.The weekly trapped *B.dorsalis* at the study site

ANOVA for the trapped adult *B. dorsalis* on *V. paradoxa* at Opara forest after ten weeks showed significant differences (P<0.01) among the treatments. However, there was no significant differences (P>0.05) on the density of flies trapped on the different blocks. Similarly, the interaction between treatments and the different block showed no significant difference (Table 1).

Table 1. ANOVA table for the trapped *B. dorsalis* after ten weeks at the study site

V.S	D.F	S.S	S.A.	F
Treatments	4	2976.08057	744.02014	210.7028 **
Blocks	2	4.27205	2.13603	0.6049 ns
Treat x Bloc	8	31.64577	3.95572	1.1202 ns
Error	135	476.70331	3.53114	
Total	149	3488.70171		

*V.S. = Variation source D.F. = Degree of freedom, S.S. = Sum of Square, S.A. = Square average, F = Statistics of the test, ** ***Significant at a level of 1% of probability (p<.01),***

about 92% of the total trapped flies during the study (Fig.2) .

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The percentage population of *B. dorsalis*trapped by different treatments at the study sites after ten weeks

Methyl eugenol significantly (P<0.05) trapped the higher population of adult *B. dorsalis* during the study with about 92% of the total trapped flies (Figure 3) .

The modified mango juicetrappedrelatively higher population of *B. dorsalis*(3.19%) than modified orange (3.03%) and pineapplejuices (1.97), however, there were no significant differences (P>0.05) among them. No adult *B. dorsalis* was trapped on control traps throughout the study period.

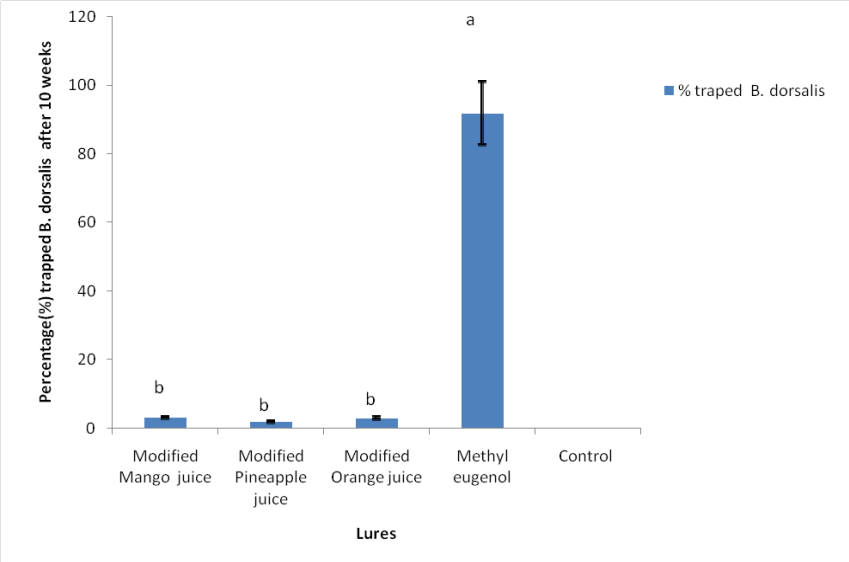

Figure 3. Mean percentage population of *B.dorsalis* trapped at the study site after ten weeks.

Discussion

The results of this study has further confirmed the potential of food –based lures for trapping *B. dorsalis*. All the modified fruit juices evaluated trapped *B. dorsalis* on *V. paradoxa* during the study. These results corroborates the reports from various researchers that fruit juices have potential for monitoring and trapping different fruit fly species (Azevedo *et al*., 2012; Ugwu *et al*., 2018). Methyl eugenol considerably caught high population of *B. dorsalis* on *V. paradoxa* at the study site implying that *V. paradoxa* is a major wide host of *B. dorsalis* .The results of this study is consistence with the study by Zida *et al.* (2020) who reported that seven species of fruit fly were observed on *V.paradoxa* fruits in Burkinafaso with *Ceratitis silvestrii* and *B. dorsalis* being the most important species among them. Modified mango juice showed better prospect than modified pineapple and orange juices in

attracting *B. dorsalis* on *V. paradoxa*. The attractiveness of modified mango juice to *B. dorsalis* could be attributed to its appealing flavor which has been reported that mango is one of the major preferred host of *B. dorsalis* (Goergen *et al.,* 2011).Similarly, Utomi (2006) reported that mango is the most important and favorite host of *B. dorsalis*. According to Adebayo and Akinbola (2014) highest number of *B. dorsalis* catches was recorded on mango plant compared to other host plants in Akure and its environs in Nigeria. Similarly, Ugwu *et al.* (2018) reported that *B. dorsalis* were trapped in high densities on mango homestead trees in Ibadan, Nigeria using methyl eugenol. The population of *B. dorslis* trapped by methyl eugenol fluctuated all through the duration of the study and higher density of *B. dorsalis* were trapped at the 5^{th} – 7^{th} week (Figure 2.) of the study which synchronized with the maturity to the ripening of *V. paradoxa* fruits in the month of June. This results corroborate the studies by Abu-Ragheef and Alfayyadh (2019) who reported that increase in population density of mediterian fruit fly synchronized with the maturity of peach and citrus in Baghdad. Similarly, Montes *et al.* (2011) also reported that Fruit fly population fluctuates due to a series of primary or alternative hosts, ecological intricacy, and abiotic factors.

Conclusion

B. dorsalis were trapped on *Vitellaria paradoxa* at Opara forest reserve by all the food attractants evaluated. Methyl eugenol trapped higher population of *B. dorsalis* all through the study period while modified mango juice relatively trapped more flies than modified pineapple and orange juice. The study has further confirmed the potential of locally made food -based lures in trapping *B. dorsalis* and also that *V. paradoxa* is one of the major wild host of *B. dorsalis.* Hence, small and medium scale farmers could adopt the use of modified fruit juices for *B. dorsalis* management in orchards. However, further studies are required in the modification of the food based lures, increase dosage and baiting frequency to ascertain their efficacy in mass trapping process.

References

Abu-Ragheef, A.H., and Alfayyadh, M.J. (2019). Population density of mediterranean fruit fly Ceratitis capitata using sexual and food attractants in the city of Baghdad.*International Journal of Agriculture and Statistical Science.* 15,(2), 687-691.

Adebayo, R. A. and Akinbola, S. T. (2014). Distribution pattern and host preference of African invader fly, *Bactrocera invadens* (Drew, Tsuruta and White) (Diptera: Tephritidae) in Akure and its environs. *Molecular Entomology*, l5 (7), 1-6

Aleza, K., Villamor, G.B., Nyarko, B.K., Wala, K., Akpagana, K. (2018). Shea (Vitellaria paradoxa Gaertn C. F.) Fruit Yield Assessment and Management by Farm Households in the Atacora District of Benin. *PLoS ONE* 13, e0190234.

Alo, A.A. (2017). Spatial Distribution of Forest Reserves and Sawmills in Oyo State, Nigeria *Forests and Forest Products Journal* 10,60-72

Aremu, M.O., Andrew, C., Salau, R.B., Atolaiye, B.O., Yebpella, G.G., Enemali, M.O.(2019). Comparative Studies on the Lipid Profile of Shea (*Vitellaria paradoxa* C.F. Gaertn.) Fruit Kernel and Pulp. *Journal of Applied Science* . 19, 480–486.

Azevedo, F.R, Gurgel, L.S, Santos, M,L.L., Silva, F.B, Moura, M.A.R., Nere. D.R.. (2012). Eficácia de armadilhas e atrativos alimentares alternativos na captura de moscas-das-frutas em pomar de goiaba. *Arquivos do Instituto Biológico* 79, 343–352.

Badii, K. B., Billah, M. K., Afreh-Nuamah, K., Obeng-Ofori, D., and Nyarko, G. (2015). Review of the pest status, economic impact and management of fruitinfesting flies (Diptera: Tephritidae) in Africa. *African Journal of Agricultural Research,* 10(12), 1488 -1498.

Bondé, L., Camara Assis, J., Benavides-Gordillo, S., Canales-Gomez, E., Fajardo, J., Marrón-Becerra, A., Noguera-Urbano, E.A.,Weidlich, A.E.W., Ament, J.M.(2020). Scenario-Modelling for the Sustainable Management of Non-Timber Forest Products in Tropical Ecosystems Scenario-Modelling for the Sustainable Management of Non-Timber Forest Products in Tropical Ecosystems. *Biota Neotropical*. 20. https://doi.org/10.1590/1676- 0611-BN- 2019-0898

Choungo-Nguekeng, P.B., Hendre, P., Tchoundjeu, Z., Kalousová, M., Tchanou Tchapda, A.V.,Kyereh, D., Masters, E. and Lojka, B.(2021). The Current State of Knowledge of Shea Butter Tree (*Vitellaria paradoxa* C.F.Gaertner.) for Nutritional Value and Tree ImprovementinWestandCentral Africa. *Forests,* 12, 1740. https://doi.org/10.3390/f12121740.

Dias, N.P., Zotti, M.J., Montoya, P. Carvalho, I.V. and Nava, D.E. (2018). Fruit fly management research: A systematic review of monitoring and control tactics in the world,Crop Protection, 112: 187-200 ,https://doi.org/10.1016/j.cropro.2018.05.019

Ekesi, S., Maniania, N. K. and Mohamed, S. A. (2011). Efficacy of soilapplication of *Metarhizium anisopliae* and the use of GF-120 spinosadbait spray for suppression of *Bactrocera invadens* (Diptera: Tephritidae)in mango orchards. *Biocontrol Science and Technology, 2*1, 3, 299 —316, doi: 10.1080/09583157.2010.545871

Epsky, N.D., Kendra, P.E. and Schnell E.Q (2014). History and development of food-based attractants. In T.Shellyetal.(eds.),Tra pping and the Detection, Control and Regulation of Tephritid Fruit Flies. Springer, Dordrecht, The Netherlands. Pp643

FAO; IFAD; UNICEF; WFP; WHO.(2020). The State of Food Security and Nutrition in the World 2020; FAO, IFAD, UNICEF, WFP and WHO: Rome, Italy.

Goergen, G, Vayssie`res, J.F., Gnanvossou, D.and Tindo, M. (2011). *Bactrocera invadens* (Diptera: Tephritidae), a new invasive fruit fly pest for theAfrotropical region: Host plant range and distribution in west and centralAfrica. *Entomological Society of America*, 40(4),844–854.

Mabhaudhi, T., Chimonyo, V.G.P., Hlahla, S., Massawe, F., Mayes, S., Nhamo, L., Modi, A.T.(2019). Prospects of Orphan Crops in Climate Change. *Planta* , 250, 695–708.

Montes, S.M.N.M., Raga, A., Boliani, A.C.and Santos, P.C. (2011) Dinâmica populacional e incidência de moscas-dasfrutas e parasitoides em cultivares de pessegueiros (*Prunus persica* L. Batsch) no município de Presidente Prudente – SP. *Revista Brasileira de Fruticultura*,*Jaboticabal*,33(2),402-411

Moore, S.(2008). The Role of *Vitellaria paradoxa* in Poverty Reduction and Food Security in the Upper East Region of Ghana. *Earth Environment* 3, 209–245.

National Bureau of Statistics (NBS), (2012): Annual Abstract of Statistics of theFederal Republic of Nigeria. Pp.619.

Odebiyi J. A., Bada S. O., Omoloye A. A., Awodoyin R. O. and Oni P. I. (2004) .Vertebrate and insect pests and hemi-parasitic plants of Parkia biglobosa and Vitellaria paradoxa in Nigeria. *Agroforestry Systems* 60,51–59.

Pouliot, M.(2012).Contribution of "Women's Gold" to West African Livelihoods: The Case of Shea (Vitellaria paradoxa) in Burkina Faso. *Economic Botany.* 66, 237–248

Salle´, G., Boussim, J., Raynal-Roques, A. and Brunck, F. (1991). Le karite´, une richesse potentielle: perspectives de recherche pour ame´ liorer sa production. *Bois et Fore^ts des Tropiques* 228, 11–23

Santos, O.O. (2009). Effects of food attractions on fruit flies (Diptera: Tephritidae) and evaluation of botanical species in *Anastrepha spp*. Masters dissertation. State University of Santa Cruz..pp 59.

Tena,G.(2019).Sequencing Forgotten Crops.*Natural. Plants* 5 :5. https://doi.org/10.1038/s41477-018-0354-z

Tom-Dery, D., Eller, F., Reisdorff, C., Jensen, K.(2018). Shea (Vitellaria paradoxa C.F. Gaertn.) at the Crossroads: Current Knowledge and Research Gaps. *Agroforestry Systems.* 92, 1353–1371.

Ugwu J.A., Omoloye A.A. and Ogunfumilayo A.O. (2018). Evaluation of traps and attractants for mass trapping of Africaninvader fly, *Bactrocera invadens* on mango in South West Nigeria. *Agro-Science*, 17 (3), 40-45.

Utomi, C.I.(2006). The Distribution, Host Range and Natural Enemies of the new Invasive Fruit Fly Species, *Bactrocera invadens* (Diptera, Tephritidae) in Southeastern Ghana. M.Phil Thesis. pp50.

Vargas, R.I., Piñero, J.C ., Mau, R.F.L., Jang, E.B., Klungness, L.M., McInnis, D.O., Harris E.B., McQuate, G.T., Bautista, R.C. and Wong, L. (2010). Area-wide suppression of Mediterranean fruit fly, Ceratitiscapitata, and oriental fruit fly, *Bactrocera dorsalis*, in Kamuela, Hawaii. *Journal of Insect Science* 10, 1–17.

Zida, I., Nacro, S., Dabiré, R. Ouédraogo S.N and Irénée Somda, I. (2020). Shea fruit-infesting fruit flies (Diptera: Tephritidae) and evaluationof infestation level according to the ethno-varieties in WesternBurkina Faso. I*nternational Journal of Tropical Insect Science,* 40,493–501.