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# Safe guarding Date Palm from *Oryzaephilus surinamensis* Infestation through Oil Palm Inflorescence Ash and Hermetic Storage Technique Treatments and the Combination of both Treatments

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**Abstract**
Possible control of *Oryzaephilus surinamensis* infestation on date palm (*Phoenix dactylifera*) using oil palm inflorescence ash and hermetic storage technique combined with Oil Palm Inflorescence Ash (OPIA) treatment were conducted in the Entomology Laboratory, Department of Zoology, University of Ibadan, Oyo state, Nigeria. Relative efficacy of oil palm inflorescence ash at 0.625 g /25 g and 1.25 g /25 g and 3 bags layer hermetic storage technique combined with oil palm inflorescence ash 0.625 g/25 g and 1.25g/25 g were tested on pristine and simulated date. The experiments were laid out in a completely randomized design and each treatment replicated four times for 5 and 10 weeks exposure periods. Result showed that oil palm inflorescence ash recorded adult mortality of (10.00±0.00) and (9.00±0.41) at 1.25 g, while (8.00±1.68) and (7.00±0.71) were recorded at 0.625 g after five weeks of exposure on both pristine and simulated date respectively. At 1.25 g concentration, reductions in larval and adult emergence were recorded. Combination of 3 bags layer hermetic storage technique with oil palm inflorescence ash treatment was highly effective with higher adult mortality, lower larval and adult emergence. Combined treatment of oil palm inflorescence ash and hermetic storage technique was found to have significant difference when compared to only oil palm inflorescence ash treatment at $p<0.05$, ANOVA. It is evident from this study that it may be necessary to combine hermetic storage technique with oil palm inflorescence ash to achieve a more effective control on dried date palm against *O. surinamensis* infestation during storage for a storage period of ten weeks.

**Key words:** Hermetic, Storage technique, *Oryzaephilus surinamensis*, Mortality, Efficacy, Date palm.

## Introduction

Larvae and adults of Oryzaephilus *surinamensis* (L.), the "Saw-toothed grain beetle" is a Coleoptera that destroys stored products. Hence, *O. surinamensis can* damage a mass of grain significantly when population density is high, thereby leading to the wide use of insecticides in ware-houses (1). Its' host ranges from cereals, cereal-based products, copra, spices, nuts as well as dried fruit, and the host part often affected are the fruits, pods, seeds and grains. However the host life stage often affected is post-harvest (Bioearfrinet 2011).

Date palm (*Phoenix dactylifera*) has long been one of the most important fruit crops in the arid regions of the Arabian, Peninsula, North Africa, and the Middle East (2). It was later introduced to new production areas in Australia, India/ Pakistan, Mexico, Southern Africa, South America, and the United States during the past three centuries (2) and marketed around the world. The date fruit contains 70% carbohydrates (mostly sugars), thus making it one of the most nourishing natural foods available to man, with its water content between 15 to 30% depending on the variety and maturity stage of the fruit. The flesh of dates contains about 60 to 65% sugar, 2.5% fiber, 2% protein and less than 2% each of fat, minerals, and pectin substances (3). Date fruit, can be eaten fresh, dried, or in various processed forms such as in cereal, pudding, bread, pressed cakes, cookies, candy bars and ice cream (4).

Dates are often stored by farmers in locally available materials ranging from baskets made of palm leaflet, goatskins, and oil drums to old kerosene tins for protection against pest (5). While, in store dates are often damage by insect pest such as *O. surinamensis* (Linnaeus) (6). Several

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instances of oil palm inflorescence ash usage in protecting agricultural produce during storage from insect infestation have been reported in Nigeria and other parts of the tropics (7; 8; 9), but the applications of ash to date palm in storage have not been assessed. Hermetic storage technique (triple bags treatment) which leads to depletion of oxygen and accumulation of carbon dioxide inside storage container (10), resulting in elimination of insect pests have also been employed in protecting date fruit (11).

It has thus become necessary to search for an option that can produce satisfactory result in a way that such an option is not only acceptable to the farmers, but also feasible from a socio-economic point of view. This paper thus investigates the efficacy of oil palm inflorescence ash and hermetic storage technique combined with oil palm inflorescence ash treatment for possible control of *O. surinamensis* infestation on date palm during storage.

## Materials and Methods

### *Source of Insect Pest, Date Palm Fruit and Processing*

*Oryzaephilus surinamensis* was collected from previously infested dates fruits purchased from Sabo market located at latitude 7º24'N, longitude 3º53'E in Ibadan. They were cultured in a 500 ml specimen bottle covered with muslin cloth and fastened with rubber band for a period of 5 months at room temperature (23.0 ±3.0 $^{o}$C and 68.0 ± 5.0% temperature and relative humidity respectively) in the Entomology Research Laboratory, Department of Zoology, University of Ibadan. Subsequently, *O. surinamensis* used in the research work was collected from this raised stock culture. The date palm (*Phoenix dactylifera*) was purchased from Sabo market, Mokola, Ibadan, Oyo state. The dates were sterilized in a Gallencamp hot box oven at 60 $^{o}$C for 3 hours in case of any pre-infestation on the fruits and bored to mimic pre-infestation for simulated dates; which will enable the insect pest to infest since they were secondary pest. The experiment was laid out in a completely randomized design, and replicated four times.

### *Ash Preparation from Oil Palm (Elaeis guineensis Jacq.) Inflorescence*

Male inflorescence of oil palm (*E. guineensis* Jacq.) collected from oil palm plantation of Mayflower College Ikenne, Ogun state was used. The inflorescence was dried and burnt to ash. The ash form of the inflorescence was gotten by burning the inflorescence indirectly in aluminium pot on fire wood source and subsequently used for treatments of the prepared dates.

### Application of Inflorescence Ash on Date Fruits

Twenty-five grams of date fruits in 48 places were divided into two groups—pristine and simulated, were weighed and transferred into 200 ml specimen bottles. Thereafter, treatments at concentration levels of 0.625 g and 1.25 g inflorescence ash were weighed separately and ash was mixed with 25 g of pristine and simulated dates respectively. Mixtures of the dates and inflorescence ash were shaken thoroughly to ensure adequate mixing. Thereafter, 10 adults laboratory reared *O. surinamensis* were introduced into the inflorescence ash treated pristine and simulated dates already placed in the individual 200 ml specimen bottles. Vaseline was also applied around the inner top surface of the bottle to prevent the pests from crawling out. Muslin cloth was used to cover the bottle and fastened tightly with rubber band to allow for proper aeration, to prevent contamination of the set up and escape of the pest therein. The control was set up separately without ash treatments. These set up was replicated 4 times and stored away in screened cages (60×30×30) cm free from rodents and other insects for a period of 5 and 10 weeks in the Entomology Research Laboratory, Department of Zoology, University of Ibadan. After the period of infestation, emergence (larval and adult) and adult mortality rate of *O. surinamensis* were determined on the date fruits.

**Application of Hermetic Storage Technique Combined with Inflorescence Ash Treatment on** *O. surinamensis*

*O. surinamensis* infestations on date palm were controlled using hermetic storage technique combined with inflorescence ash treatment. 32 transparent polythene bags (11×6.5) cm in dimension and 0.056 mm thick, capable of holding 25 g of dates were prepared using an impulse sealing machine to achieve hermetic/airtight condition. Triple bag treatment (5 × 6; 5.5× 10; 11 × 6.5 tucked in each other) in dimensions were used for hermetic control (11). After filling the polythene bags with 25 g of sterilized dates, 0.625 g and 1.25 g oil palm (*E. guineensis*) inflorescence ash were weighed separately and admixed with the 25 g of pristine and simulated dates respectively. Mixtures of the dates and inflorescence ash were agitated thoroughly to ensure adequate mixing. Thereafter, 10 adults laboratory reared *O. surinamensis* were introduced into the pristine and simulated dates already placed in the individual prepared bags. Thereafter, the polythene bags were firmly sealed up with very minimal air present. The set up was stored in a well screened cages (60×30×30) cm free from rodents and insects for a period of 5 and 10 weeks. Each bag treatment was opened after $5^{th}$ and $10^{th}$ weeks to check level of infestation of *O. surinamensis*.

**Results**

***Insecticidal Effect of Oil palm Inflorescence Ash (OPIA) on Mortality and Emergence of O. surinamensis on Pristine and Simulated Date Palm***

The result of infestation of stored date palm (pristine and simulated) by *Oryzaephilus surinamensis* for 5 and 10 weeks of exposure using OPIA is shown in Table 1. The result revealed that OPIA treatment recorded a significant mortality on pristine date compared with the control ($p< 0.05$), while 1.25 g OPIA was found to record the highest mortality of 10.00±0.00 on pristine date (SNK). Subsequently, larval and adult emergence was not recorded on the pristine date since zero mean values were recorded. On simulated date, larval emergence was not significantly different in the set up using SNK. However, OPIA 1.25 g recorded zero adult emergence, with recorded significant ($p>0.05$) mortality mean value of 10.00±0.00 (Table 1).

***Efficacy of Combination effect of Hermetic Storage Technique and Oil palm Inflorescence Ash treatment on stored date palm fruit***

Hermetic control combined with oil palm inflorescence ash treatment (HC+OPIA) on stored date palm (pristine and simulated) recorded a significant difference on mortality ($p< 0.05$) for both concentrations at the two exposure periods when compared with the controls, (Table 2). Subsequently, larval and adult emergence were not recorded on the pristine date since the out come was zero mean. HC+OPIA treatment on simulated date did not record any significant difference on *O. surinamensis* larval emergence when compared with the control ($p< 0.05$) (Table 3).

**Table 1: Effect of Oil Palm Inflorescence Ash at 0.625 g and 1.25 g Concentrations on Adult Mortality, Larval and Adult Emergence of *O. surinamensis* on 25 g stored Date Palm Fruit**

| Treatment Concentrations (g) | Exposure Period (Weeks) | *O. surinamensis* Infestation on Pristine Date | | | *O. surinamensis* Infestation on Simulated Date | | |
|---|---|---|---|---|---|---|---|
| | | Emergence | | Adult Mortality (Mean ±S.E)* | Emergence | | Adult Mortality (Mean ±S.E)* |
| | | Larvae (Mean ±S.E)* | Adult (Mean ±S.E)* | | Larvae (Mean ±S.E)* | Adult (Mean ±S.E)* | |
| **OPIA 0.625** | | 0.00±0.00 | 0.00±0.00 | 8.00±1.68$^{b}$ | 5.75±3.09$^{a}$ | 1.75±1.18$^{a}$ | 7.00±0.71$^{bc}$ |
| **OPIA 1.25** | **5** | 0.00±0.00 | 0.00±0.00 | 10.00±0.00$^{b}$ | 2.25±1.44$^{a}$ | 0.00±0.00$^{a}$ | 9.00±0.41$^{c}$ |
| **CONTROL** | | 0.00±0.00 | 0.00±0.00 | 3.00±1.08$^{a}$ | 4.25±2.66$^{a}$ | 3.75±1.49$^{a}$ | 1.75±0.25$^{a}$ |
| **OPIA 0.625** | | 0.00±0.00 | 0.00±0.00 | 9.50 ±0.50$^{b}$ | 7.00±2.80$^{a}$ | 38.50±4.94$^{bc}$ | 8.25±1.18$^{c}$ |
| **OPIA 1.25** | **10** | 0.00±0.00 | 0.00±0.00 | 9.50±0.50$^{b}$ | 4.75±1.89$^{a}$ | 22.00±10.96$^{ab}$ | 9.50±0.50$^{c}$ |
| **CONTROL** | | 0.00±0.00 | 0.00±0.00 | 7.00 ±1.08$^{b}$ | 6.25±0.63$^{a}$ | 51.50±11.44$^{c}$ | 5.25±0.25$^{b}$ |

OPIA: Oil palm Inflorescence Ash
* Mean in a column followed by the same letters are not significantly different at p> 0.05 using Student – Newman.
Values are means of 4 replicated.

***Comparison between Efficacy in Oil Palm Inflorescence Ash Treatment (OPIA) versus HC+OPIA at 5 and 10 weeks period of exposure on stored Date Palm Fruit***

Comparing OPIA with HC+OPIA treatment did not elicit any significant treatment, dependence difference between OPIA 0.625 g versus HC+OPIA 0.625 g at the two exposure periods on mortality (pristine date), larval and adult emergence (simulated date). Consequently, larval and adult emergence were not determined due to the zero observations recorded on pristine date (Table 3). On the contrary, comparison between OPIA 1.25 g versus HC+OPIA 1.25 g for the two exposure periods could not produce significant difference on *O. surinamensis* mortality rate in pristine date, as well as in OPIA 1.25 g versus HC+OPIA 1.25 g on simulated after 10 weeks of infestation (Table 4). Furthermore, OPIA 1.25 g versus HC+OPIA 1.25 g after 5 weeks of infestation recorded a significant difference on mortality, followed by a no significant difference in larval emergence; while adult emergence was not determined (Table 4).

**Discussion**

*Oryzaephilus surinamensis* is ubiquitous with a worldwide geographical distributions, and it is a pest of date palm which require adequate control measure to reduce its pest status. The poor financial status of farmers and low income of traders that cultivate and trade in this crop militate the use of chemical insecticide usage, thereby enhancing the pest status of *O. surinamensis*, therefore an effective and cheap control method is thus required. The Hermetic Control (HC) combined with Oil Palm Inflorescence Ash (OPIA) versus OPIA only revealed this method as possible control measure with promising results. The mechanism of action of hermetic storage was based on low level of oxygen and high level of carbon dioxide due to metabolic activities of the pest; which in turn imposes high metabolic stress with increase mortality. However, there is a dearth of information on the mode of action of oil palm inflorescence ash; but it was stated that pesticidal properties may be linked to the 4% or more potassium content present in the ash as reported by (9), or high caustic soda (Sodium hydroxide) in the ash reported by (8).

From this study, a significant mortality was recorded on both pristine and simulated date using OPIA treatment. Increased concentration of the ash increases mortality rate of the pest. So also, with increase in exposure period the insecticidal potential of the ash might have reduced and so have less impact on the insect. Therefore, OPIA 1.25 g at 5 weeks exposure period was found to be more effective on both pristine and simulated date; by recording high mortality on pristine and simulated date, lowest larval emergence and zero adult emergence on simulated date. Consequently, zero emergence was recorded at both concentrations for larval and adult emergence on pristine date for all treatment, this may be attributed to the nature of *O. surinamensis* which is a secondary pest that does not infest wholesome grains or dates.

Furthermore, HC combined with OPIA treatment at both concentrations and exposure periods had relatively different effect on mortality of *O. surinamensis* on both date palm status compared with the controls. Consequently, zero emergence was recorded at both concentrations for larval and adult emergence on pristine date, this may be associated to the nature of *O. surinamensis* which is a secondary pest that does not infest wholesome grains or dates.

**Table 2: Effect of Hermetic Control combined with Oil Palm Inflorescence Ash at 0.625 g and 1.25 g Concentrations on Adult Mortality, Larval and Adult Emergence of *O. surinamensis* on 25 g stored Date Palm Fruit**

| Treatment Concentrations (g) | Exposure Period (Weeks) | *O. surinamensis* Infestation on Pristine Date | | | *O. surinamensis* Infestation on Simulated Date | | |
|---|---|---|---|---|---|---|---|
| | | Emergence | | Adult Mortality (Mean ±S.E)* | Emergence | | Adult Mortality (Mean ±S.E)* |
| | | Larval (Mean ±S.E)* | Adult (Mean ±S.E)* | | Larval (Mean ±S.E)* | Adult (Mean ±S.E)* | |
| **HC+OPIA 0.625** | | 0.00±0.00 | 0.00±0.00 | 9.75±0.25$^{c}$ | 4.75±3.82$^{a}$ | 0.00±0.00$^{a}$ | 10.00±0.00$^{c}$ |
| **HC+OPIA 1.25** | **5** | 0.00±0.00 | 0.00±0.00 | 10.00±0.00$^{c}$ | 1.00±1.00$^{a}$ | 0.00±0.00$^{a}$ | 10.00±0.00$^{c}$ |
| **CONTROL** | | 0.00±0.00 | 0.00±0.00 | 3.00±1.08$^{a}$ | 4.25±2.66$^{a}$ | 3.75±1.49$^{a}$ | 1.75±0.25$^{a}$ |
| **HC+OPIA 0.625** | | 0.00±0.00 | 0.00±0.00 | 10.00±0.00$^{c}$ | 1.50±0.65$^{a}$ | 6.25±1.38$^{a}$ | 8.50±0.87$^{c}$ |
| **HC+OPIA 1.25** | **10** | 0.00±0.00 | 0.00±0.00 | 10.00±0.00$^{c}$ | 0.00±0.00$^{a}$ | 4.75±2.43$^{a}$ | 9.50±0.29$^{c}$ |
| **CONTROL** | | 0.00±0.00 | 0.00±0.00 | 7.00 ±1.08$^{b}$ | 6.25±0.63$^{a}$ | 51.50±11.44$^{b}$ | 5.25±0.25$^{b}$ |
| **F-VALUE** | | - | - | 20.31* | 1.56 | 16.99* | 69.65* |

HC+OPIA: Hermetic control combined with Oil palm Inflorescence Ash
* Mean in a column followed by the same letters are not significantly different at p> 0.05 using Student – Newman.
Values are means of 4 replicated.

**Table 3: Effect of 0.625 g OPIA and HC+OPIA on Adult Mortality, Larval Emergence and Adult Emergence in *O. surinamensis* on stored Date Palm Fruit**

| Treatment | Exposure period (weeks) | Date palm Status | Adult mortality | Emergence | |
|---|---|---|---|---|---|
| | | | | Larval | Adult |
| | | | t- value | t- value | t- value |
| **OPIA Vs HC+OPIA** | **5** | **Pristine** | 1.03NS | ND | ND |
| **OPIA Vs HC+OPIA** | **10** | | 1.00NS | ND | ND |
| **OPIA Vs HC+OPIA** | **5** | **Simulated** | 4.24NS | 0.20NS | 1.48NS |
| **OPIA Vs HC+OPIA** | **10** | | 0.17NS | 1.91NS | 6.29NS |

OPIA- Oil palm Inflorescence Ash
HC+OPIA- Hermetic control combined with Oil palm Inflorescence Ash
ND- Not Determined (this is because zero values were recorded)
NS- Not Significant using t-test.

**Table 4: Effect of OPIA 1.25 g and HC+OPIA 1.25 g on Adult Mortality, Larval Emergence and Adult Emergence in *O. surinamensis* on stored Date Palm Fruit**

| Treatment | Exposure period (weeks) | Date palm Status | Adult mortality | Emergence | |
|---|---|---|---|---|---|
| | | | | Larval | Adult |
| | | | t- value | t- value | t- value |
| **OPIA Vs HC+OPIA** | **5** | **Pristine** | NS | ND | ND |
| **OPIA Vs HC+OPIA** | **10** | | 1.00NS | ND | ND |
| **OPIA Vs HC+OPIA** | **5** | **Simulated** | 2.45* | 0.71NS | ND |
| **OPIA Vs HC+OPIA** | **10** | | 0.00NS | 2.52* | 1.54NS |

OPIA- Oil palm Inflorescence Ash
HC+OPIA- Hermetic control combined with Oil palm Inflorescence Ash
*Indicates significant difference at $p < 0.05$ (t-test)
ND- Not Determined
NS- Not Significant

These treatments applied above for different date fruits reaffirm the performance of *O. surinamensis* as secondary pest, since *O. surinamensis* could not infest the date (11). However, the pest were able to infest the simulated date fruit due to the mechanically bore hole on them, which automatically changed the crop state which could be taken as been previously infested. The application of the hermetic control shortens the infestation period of *O. surinamensis.* Pest mortality may be due to lack of Oxygen ($O_2$) and increase in Carbon dioxide ($CO_2$) as a result of metabolic activities of the pest in the set up (12; 13; 14).

Hermetic control technique for storage products is not only user friendly but highly economical. It protects dried date palm from *O. surinamensis* infestation which in turn protects the crop quality for high marketability and availability as food and raw materials for factories and all users. Therefore, it may be necessary to combine hermetic storage technique with oil palm inflorescence ash to achieve an effective protection on dried date palm from infestation by *O. surinamensis* infestation during storage.

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