

## Efficiency of Eco<sub>2</sub>-fume gas against some dry and semi-dry date fruit insect pests in different stores

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### Abstract

The present study aimed to investigate the efficiency of ECO<sub>2</sub>-fume gas (98% CO<sub>2</sub>+2% Ph<sub>3</sub> w/w) against mature and immature stages of some insect pests infesting dry and semi-dry date fruits in different stores at three storage locations: namely 1-container made from steel in Tamr El-Waha factory at Bader city, Cairo governorate...2-Air conditioned store 17°C at El-Kharga oasis, New Valley governorate...3-Jute bags at Shouna under plastic sheet at Aswan governorate. The results indicated clearly that when ECO<sub>2</sub>-fume gas fumigation was used the date fruits stores at the rate of 50 g/m<sup>3</sup> for three days exposure period gave 100% mortality of all stages of *Ephesia cautella*, *Ephesia calidella* and *Oryzaephilus surinamensis*. The obtained data showed that the highest concentration of ECO<sub>2</sub>-fume during the fumigation period was in a steel container followed by air-conditioned store then at Shouna. Also no changes in the color of date fruit after fumigation when using of recommended dose of the gas which helps to export the date fruit abroad.

**Keywords:** Eco<sub>2</sub>-fume, fumigation, date fruit insect, *Ephesia cautella*, *Oryzaephilus surinamensis*

### Introduction

The date crops of El-Kharga oasis suffer annually to very considerable extent from the ravages of the larvae of an *Ephesia sp. larvae* feeding in the interior of the date fruits, reducing the value of Fruits (Gough, 1917), Ali, et al. 2003) they stated that semi-dry dates were the most injurious by *E. calidella*, *E. cautella* and *O. surinamensis* through storage. Also, Ali, et al. (2001) mentioned that date fruits pests caused 20-73.3% loss of date fruits annually, consequently shortage in the productivity. Metwally, et al. (2007) reported that approximately 50% of stored date fruits were lost after elapsing of 6-7 month of the storage.

Among stored products insect pest, the almond moth, cadra (*Ephesia*) *cautella* (walker) is one of the infestations that begin in date palm plantations and continue in stores and can go through infested dates and can go through multiple generations (Howard et al., 2001).

Besides the date palm fruits, dried fig, raisin rice and maize ,product grain cereals , cocoa, chocolate spices , nuts , dried fruits ,processed foods and peanut are reported as hosts of almond moth (Singh and Moore, 1985: Shakkosseini and Kamal, 1989: Hodges and Farell ,2004 and Rees, 2007). Larvae cause considerable damage by feeding or by contaminating stored food with dead bodies and their own products, e.g. excretes, webbing, silk and feces; Abdel Salam and El-Saeedy (1982) found that both of *E. calidella* and *E. cautella* as pests of date fruits. The larvae of these two species attack fruits either in pre-harvest or in store house in Baharia date fruits. They added that *E-cautella* has two generations per year under the store house conditions. Mohamed and Sayed (2012) studied the efficacy of ECO<sub>2</sub>-fume fumigant gas (20% Ph<sub>3</sub>+98% CO<sub>2</sub> w/w) at five concentrations

(300,400,500 and 700 ppm) against immature stages of *E. cautella* (Hubm) (Eggs, larvae and pupae) at 28 ±1°C and 60+5% RH at El-kharga oasis, New valley Governorate. The results indicated that hatchability of eggs and mortality of larvae and pupae clearly influenced by gas concentrations. The same results were found in percent of reduction, results also indicated clearly that, infestation in tamer El-Wady increased in date fruits without capsul by this pest.

ECO<sub>2</sub>-fume fumigant gas is non-flammable mixture of phosphine and carbon dioxide that enables highly effective fumigation in a wide variety of sealed storage applications. It is dispensed externally to stores or structures using simple techniques which avoid the applicator's exposure and enhance worker's safety

The present work studies the effect of ECO<sub>2</sub>-fume gas of the recommended dose (50g/ m<sup>3</sup>) against all stages of the *Ephesia sp.* and *O-surinamensis* in different stores, semidry and dry date fruits.

### Materials and Methods

#### Materials:

ECO<sub>2</sub>-fume gas cylinders (Fumigant gas produced by CYTEC, Canada), 241 Tons of date fruits, protective clothes, silo check (Ph<sub>3</sub> detector), sealing materials, weight digital scale and plastic sheets (14x20m.)

#### Methods:

After sealing the place of fumigation well, put ECO<sub>2</sub>-fume gas cylinder on the platform balance and record its weight. Open the cylinder valve. Determine the weight of the cylinder and close the valve when we reach the required dose (50g/ m<sup>3</sup>). Disconnect the

cylinder after closing inlet of the Piping. At the end of the fumigation period the commodities are aerated.

#### Insects:

Samples of date fruits (5 sample /site) contain eggs, larvae or pupae of *E. cautelle* and *E. calidella* inside the date but in case of *Oryzaephilus surinamensis* the date contain adults, larvae and pupa sometimes these samples contain one or more insects in the samples.

#### Bioassay procedure:

Random samples before and after fumigation by  $ECO_2$ -FUME gas were taken from three locations (factory of Semi dry date fruits and Shounas of dry dates), and samples from El-Kharga Oasis and translate into the insect laboratory of central administration agricultural research stations and agricultural experiments at El-Kharga Oasis to determine and calculate the larvae and pupae inside the infested date (100 dates/sample) but the eggs samples were kept in the laboratory at  $28 \pm 1$  °C and  $60 \pm 5\%$  R.H. for 45 days of treatment to inspect the number of adults emerged from the sample treated and untreated samples.

#### Fumigation procedure:

$ECO_2$ -fume provided in steal cylinders of various weight and applied in the store airtight through piping nuzzle after the sealing is completed. For calculating the required dose, the store's volume was measured.

#### Measuring of $ECO_2$ -fume concentration:

$ECO_2$ -FUME gas concentration was determined by silo check detector inside the fumigated chambers (store or under plastic sheet) during the whole exposure period (3 days). Through ten m polyethylene tubes (diameter 5mm.) which were inserted at the middle of store levels inside the date boxes, (Plastic boxes (50x30x30cm each) or high and bottom levels under plastic sheet in the jute bags of dry date storage. These tubes were connected to the gas detector.

#### Mortality assessment:

As we have mentioned above Random samples before and after application that were taken each one of them weighted about 1 kg.

100 date fruits from each sample in case of larvae and pupae for *Ephastia* sp. and alive *surinamensis* or dead inside the date fruits and calculated the infestation in each sample. Some from the sample, were put under daily observation for 45 days after treatment to record the emerged adults and calculate reduction in progeny according to the following equation:

$$\% \text{ Reduction} = (AC-AT) / AC \times 100$$

AC: No. of adults emerged in control

AT: No. of adults emerged in treatments

#### Results and Discussion

**First application:**  $ECO_2$ -fume gas on date fruits stored in "Governorate's dates factory" El-Kharga oasis. This data tabulated in table (1).

**Table 1.** Effect of  $ECO_2$ -fume at  $50g/m^3$  on some insect stages in sample of (1kg) from governorate locations of date fruits factory El-Kharga Oasis through 3 days' exposure

Insect Species	Stages	Before fumigation (Infestation %)		After fumigation (Infestation %)			
		Alive	Dead	2 days		45 days	
				Alive	Dead	Alive	dead
<i>Ephestia</i>	Adults	10±2.16	0.0	0.0	8±1.41	0.0	0.0
<i>Cautella</i>	Larvae	5±0.28	0.0	0.0	7±0.28	0.0	0.0
	Pupae	3±2.16	0.0	0.0	5±0.28	0.0	0.0
<i>Ephestia</i>	Adults	6±1.63	0.0	0.0	8±2.16	0.0	0.0
<i>Calidella</i>	Larvae	2±1.63	0.0	0.0	4±0.28	0.0	0.0
	Pupae	3±2.16	0.0	0.0	4±3.55	0.0	0.0
<i>O. surinamensiss</i>	Adults	5±1.41	0.0	0.0	6±0.28	0.0	0.0
	Larvae	0.0	0.0	0.0	0.0	0.0	0.0
	Pupae	0.0	0.0	0.0	0.0	0.0	0.0

± SE. Standard Error

During testing this sample before fumigation by  $ECO_2$ -fume gas were found 10, 5 and 3 adults, larvae and pupae of *Ephestia Cautella* respectively. In the case of *Ephestia Calidella* found 6, 2 and 3 adult larvae and pupae respectively the same found five adults of *o.surinamensiss*. However, complete mortality of all stages of insects in the sample were found after the application of fumigation.

#### Second Application:

**Applying of  $ECO_2$ -FUME gas at  $50g/m^3$  in the storage of central Agricultural Society New valley, El-Kharga oasis:** when we took the random samples from the date fruits storage in the store before and after treatment (1Kg) we found in this sample 15, 10 and 6 adults, larvae and pupae of *Ephestia Cautella* respectively but in case of *Ephestia Calidella* was found 5, 6 and 2 adults, larvae and pupae respectively. This is tabulated in table (2)

**Table 2.** Effect of ECO<sub>2</sub>-FUME gas at the concentration of 50g/m<sup>3</sup> on stages of insects in the random sample from the store of date fruits storage in plastic boxes.at central agricultural society factory, El-Kharga oasis.

Insect Species	Stages	Before fumigation (Infestation %)		After Fumigation (Infestation %)			
		Alive	Dead	2 days		45 days	
				Alive	Dead	Alive	dead
<i>Ephestia</i>	Adults	15±1.41	0.0	0.0	20±1.63	0.0	0.0
<i>Cautella</i>	Larvae	10±2.44	0.0	0.0	15±6.48	0.0	0.0
	Pupae	6±1.63	0.0	0.0	3±0.28	0.0	0.0
<i>Ephestia</i>	Adults	5±0.28	0.0	0.0	10±4.32	0.0	0.0
<i>Calidella</i>	Larvae	6±1.41	0.0	0.0	8±1.41	0.0	0.0
	Pupae	2±2.16	0.0	0.0	4±0.28	0.0	0.0

± SE. Standard Error

After fumigation by ECO<sub>2</sub>-FUME gas at 50g/m<sup>3</sup> found all insects stages in the random sample was 100% mortality after 2 and 45 days from treatment.

**Third Application** by ECO<sub>2</sub>-FUME fumigant of Methyl bromide alternative in storage of regional agricultural research station of the new valley date

fruits at 50g/m<sup>3</sup> concentration random samples from the date fruits stored in plastic boxes (5 samples) before and after fumigation (1kg) were found in this sample 20 adults, 12 larvae and 6 pupae of *Ephestia cautella* the same sample found 4 larvae and 2 pupae of *Ephestia calidella* are given in table (3)

**Table 3.** Effect of ECO<sub>2</sub>-FUME gas at 50g/m<sup>3</sup> on the insects infested the date fruits storage in plastic boxes.

Insect Species	Stages	Before fumigation (Infestation %)		After Fumigation (Infestation %)			
		Alive	Dead	2 days		45 days	
				Alive	Dead	Alive	dead
<i>Ephestia</i>	Adults	20±6.37	0.0	0.0	23±2.16	0.0	0.0
<i>Cautella</i>	Larvae	12±3.55	0.0	0.0	10±3.55	0.0	0.0
	Pupae	6±2.16	0.0	0.0	8±2.16	0.0	0.0
<i>Ephestia</i>	Adults	5±1.41	0.0	0.0	3±0.28	0.0	0.0
<i>Calidella</i>	Larvae	4±1.29	0.0	0.0	6±0.28	0.0	0.0
	Pupae	2±1.63	0.0	0.0	4±2.16	0.0	0.0

± SE. Standard Error

After fumigation the sample determined, there were found 23 adults 10 larvae and 8 pupae dead of *E. cautella*, Respectively and 3 adults, 6 larvae and 4 pupae dead of *E. calidella*, Respectively:

**Fourth Application:** Applying of ECO<sub>2</sub>-FUME gas in recommended dose in the storage of El-Barry dates factory, El-Kharga oasis.

In the samples before fumigation there were found 10 adults ,5 larvae and 8 pupae alive of *E.cautella* and

found 1 adults and 2 larvae of *E.calidella* alive and 10 adults of *oryzaephilus surinamensiss* as shown in table (4).

After fumigation with Eco<sub>2</sub>-fume of date fruits in the store of El-Barry factory are found complete mortality of all insects in the samples in case of 2 days and 45 days from treatment.

**Table 4.** Effect of ECO<sub>2</sub>-FUME gas against the insects found in these samples at 50g/m<sup>3</sup> in storage of date fruits storage in El-Kharga oasis.

Insect Species	Stages	Before fumigation (Infestation %)		After Fumigation (Infestation %)			
		Alive	Dead	2 days		45 days	
				Alive	Dead	Alive	dead
<i>E.Cautella</i>	Adults	10±5.71	0.0	0.0	8±0.28	0.0	0.0
	Larvae	5±0.28	0.0	0.0	3±1.29	0.0	0.0
	Pupae	8±1.63	0.0	0.0	4±1.63	0.0	0.0
<i>E.Calidella</i>	Adult	1±0.28	0.0	0.0	6±1.41	0.0	0.0
	Larvae	2±0.28	0.0	0.0	4±1.41	0.0	0.0
	Pupae	0.0	0.0	0.0	2±0.28	0.0	0.0
<i>o.surinamensiss</i>	Adults	10±3.74	0.0	0.0	12±1.63	0.0	0.0
	Larvae	0.0	0.0	0.0	0	0.0	0.0
	Pupae	0.0	0.0	0.0	0	0.0	0.0

± SE. Standard Error

**Table 5.** Concentration of Eco<sub>2</sub>-fume gas in (ppm) during the fumigation period (50gm/ m<sup>3</sup>) on semi dry dates.

Location	Concentration 50g/m <sup>3</sup>	Concentration				Average
		Initial time	1 <sup>ST</sup> DAY	2 <sup>ND</sup> DAY	3 <sup>RD</sup> DAY	
Factory of Governorate (1)		1100	434 (60.6)	398 (63.8)	160 (76.1)	533 (50.2)
Central of agricultural society factory (2)		1650	694 (57.9)	648 (60.7)	280 (83.0)	818 (50.4)
Regional of agricultural research station of new valley (3)		1142	390 (48.3)	261 (60.4)	157 (77.5)	4875 (48.6)
El-Barry factory (4)		1995	762 (61.8)	540 (72.9)	223 (88.9)	880 (55.9)

Number between brackets represents % reduction.

Data in table (5) revealed that all gas concentrations decreased gradually through the exposure period. While they were 1100,1650,1142 and 1995 ppm at the initial time, they decreased with about (48.3-61.1%), (60.4-72.9%) and (76.1-88.9%) through the three successive days of exposure, respectively.

#### 2<sup>nd</sup> location Bader -city:

**Application of ECO<sub>2</sub>-FUME gas at storages of semi-dry dates in El-Waha factory in steal container:** - the container contains 15 tons of date fruits in plastic boxes (50x50x30cm) fumigated by ECO<sub>2</sub>-FUME at (50gm/ m<sup>3</sup>) in El-waha dates factory.

When the random samples (5) from the container of date fruits determined before and after treatment with ECO<sub>2</sub>-FUME in the stored product laboratory there were found, 13,10 and 9 Adults, larvae and pupae of *E-cautella* respectively. But *E-calidella* were found 8,5 and 4 Adults, larvae and pupae, Respectively. all stages were alive before fumigation data tabulated in table (6). After the fumigation period of the tested sample 100% mortality after 2 days from aeration and f<sub>1</sub>-progeny after 45 days from fumigation period of the tested sample 100% mortality of all insect's stages.

**Table 6.** Effect of ECO<sub>2</sub>-FUME on the mortalities of all stages in the samples before and after treatment from semidry date fruits at El-Waha factory for dates Badr city cairo Governorate.

Insect Species	Stages	Before fumigation (Infestation %)		After Fumigation (Infestation %)			
		Alive	Dead	2 days		45 days	
				Alive	Dead	Alive	dead
<i>E.Cautella</i>	Adults	13±1.41	0.0	0.0	10±3.25	0.0	0.0
	Larvae	10±3.55	0.0	0.0	15±3.55	0.0	0.0
	Pupae	9±2.16	0.0	0.0	7±1.63	0.0	0.0
	Eggs	0.0	0.0	0.0	0.0	0.0	0.0
<i>E.Calidella</i>	Adults	8±1.63	0.0	0.0	6±1.41	0.0	0.0
	Larvae	5±0.28	0.0	0.0	10±2.49	0.0	0.0
	Pupae	4±2.16	0.0	0.0	4±0.28	0.0	0.0
	Eggs	0.0	0.0	0.0	0.0	0.0	0.0

± SE. Standard Error

**Table 7.** Concentration of ECO<sub>2</sub>-FUME at steal container of date fruits at 3 days' exposure in El-Waha factory, Bader city:

Location	Concentration ppm	Initial time	1 <sup>st</sup> day	2 <sup>nd</sup> day	3 <sup>rd</sup> day	Average
Steal container El-Waha factory	50gm/m <sup>3</sup>	1935	1680 (13.18)	774 (60.0)	738 (61.86)	1281.75 (33.80)

Number between brackets represents % reduction.

Concentration inside the container through the exposure time was found to be 1935, 1680,774 and 738 ppm in initial time, 1<sup>st</sup> day, 2<sup>nd</sup> day and 3<sup>rd</sup> day, respectively. The Average concentration of ECO<sub>2</sub>-fume after 3 days was 1281.75 ppm. This number is considered to be highly concentrated at the end of the exposure's time, depending on the good sealing of the

container which is an appropriate location for fumigation of ECO<sub>2</sub>-fume gas.

#### 3<sup>rd</sup> location "Aswan governorate"

Dry date: Mature fruits of this group contain low moisture percentage (15-20%) and high percentage of sugar (65-70%) in which sucrose represents a significant part. They can be for a very long time under normal ambient temperature. The process of

fumigation dry dates using ECO<sub>2</sub>-FUME Drying dates by spreading in open Sunny area from 20-30 days, storing the dried dates in jute bags, stack jute bags in piles, cover the piles with plastic sheet (thickness 200 microns) injecting ECO<sub>2</sub>-FUME at 50gm/m<sup>3</sup> and uncover the plastic sheet in the third day of fumigation.

**First Application:** Application of ECO<sub>2</sub>-fume gas at 50gm/m<sup>3</sup> under plastic sheet at Abo-ElRish Shouna

“Aswan governorate” after collecting random samples from the pile of dates fruits storage in shouna before fumigation. In 1kg sample were found some stages, of *E.cautella* and *E.calidella* are tabulated in table (8). After fumigation period is completed, mortality was found for all stages of *E.cautella* and *E.calidella* and the same results after 45 days occupation.

**Table 8.** Effect of ECO<sub>2</sub>-fume at 50gm/m<sup>3</sup> on all stages of insects in the random sample from dates at Abo-ElRish shouna.

Insect Species	Stages	Before fumigation (Infestation %)		After Fumigation (Infestation %)			
		Alive	Dead	2 days		45 days	
				Alive	Dead	Alive	dead
<i>E.Cautella</i>	Adults	2±0.28	0.0	0.0	5±0.28	0.0	0.0
	Larvae	13±2.44	0.0	0.0	15±3.11	0.0	0.0
	Pupae	3±0.28	0.0	0.0	5±1.42	0.0	0.0
	Eggs	0.0	0.0	0.0	0.0	0.0	0.0
<i>E.Calidella</i>	Adults	1±1.42	0.0	0.0	4±1.63	0.0	0.0
	Larvae	4±1.16	0.0	0.0	5±1.42	0.0	0.0
	Pupae	1±1.42	0.0	0.0	3±1.63	0.0	0.0
	Eggs	0.0	0.0	0.0	0.0	0.0	0.0

± SE. Standard Error

**Table 9.** Concentration of ECO<sub>2</sub>-fume gas (ppm) under plastic sheet during the fumigation period (3 days) at Abo-ElRish Shouna.

Location	Dose	Initial time	1 <sup>st</sup> day	2 <sup>nd</sup> day	3 <sup>rd</sup> day	Average
Abo -ElRish	50gm/m <sup>3</sup>	1064	722 (32.1)	425 (60.1)	346 (67.5)	639.3 (39.9)

-Numbers between brackets represent% reduction.

-Monitoring gas concentration under sheet was found 1064 ppm at the initial time and decreased to 346 ppm at the third day. The average through the three days was 639.3 ppm.

**-Second Application** of ECO<sub>2</sub>-fume gas at 50gm/m<sup>3</sup> under plastic sheet at EL-Gaaphra shouna, Daraw center, Aswan Governorate. In the random samples from the date fruits storage in jute bags before

fumigation was found 20 larvae ,6 pupae and 2 adults of *E.cautella* but *E.calidella* found 8 larvae and 2 pupae only. These data are tabulated in table (10).

After treatment by using recommended dose of ECO<sub>2</sub>-FUME gas all insect's stages were found complete mortality in the random samples after 2 and 45 days from the treatment.

**Table 10.** Effect of ECO<sub>2</sub>-FUME gas at (50g/m<sup>3</sup>) against some date insects in Gaaphra shouna under plastic sheet.

Insects Species	Stages	Before fumigation Infestation rate%		After Fumigation Infestation rate%			
		Alive	Dead	2 days		45 days	
				Alive	Dead	Alive	dead
<i>E.Cautella</i>	Adults	2±2.38	0.0	0.0	5±0.28	0.0	0.0
	Larvae	20±3.55	0.0	0.0	12±2.16	0.0	0.0
	Pupae	6±2.16	0.0	0.0	6±4.32	0.0	0.0
	Eggs	0.0	0.0	0.0	0.0	0.0	0.0
<i>E.Calidella</i>	Adults	0.0	0.0	0.0	2±0.28	0.0	0.0
	Larvae	8±4.32	0.0	0.0	6±2.94	0.0	0.0
	Pupae	2±1.37	0.0	0.0	4±4.24	0.0	0.0
	Eggs	0.0	0.0	0.0	0.0	0.0	0.0

± SE. Standard Error

**Table 11.** Concentration of ECO<sub>2</sub>-fume gas (ppm) under plastic sheet during the fumigation period (3 days) in El-Gaaphra Shouna, Daraw center, Aswan Governorate.

Location	Dose	Initial time	1 <sup>st</sup> day	2 <sup>nd</sup> day	3 <sup>rd</sup> day	Average
El-Gaaphra Shouna (2)	50gm/m <sup>3</sup>	1305	683 (47.7)	383 (70.7)	363 (72.1)	683.5 (47.6)

-Numbers between brackets represent% reduction.

-Measuring the concentration of ECO<sub>2</sub>-FUME gas by silo check under plastic sheet, it was found 1305 ppm at initial time and decreased to 683,383 and 363 ppm at the third day. However, its average was 683.5 ppm.

**-Third Application:** - Application of ECO<sub>2</sub>-fume gas in dates stores in jute bags under plastic sheet at El-Redesia, Edfu, Aswan Governorate. Samples from the

dates stored in El-Redesia shouna are tested in the laboratory stored products insects. These data are tabulated in table (12) after and before the treatment that found adults, larvae and pupae of *E.cautella*, *E.calidella* and adults of *Oryzaephilus surinamensis*.

**Table 12.** Effect of ECO<sub>2</sub>-FUME gas at (50g/m<sup>3</sup>) on insects in sample (1 kg) from date fruits at El-Redesia, Shouna (1) Edfu Aswan governorate.

Insect Species	Stages	Before fumigation (Infestation %)		After Fumigation (Infestation %)			
		Alive	Dead	2 days		45 days	
				Alive	Dead	Alive	dead
<i>E.Cautella</i>	Adults	2±0.28	0.0	0.0	4±1.41	0.0	0.0
	Larvae	10±4.32	0.0	0.0	12±0.28	0.0	0.0
	Pupae	5±1.41	0.0	0.0	3±0.28	0.0	0.0
	Eggs	0.0	0.0	0.0	0.0	0.0	0.0
<i>E.Calidella</i>	Adults	3±0.28	0.0	0.0	2±2.16	0.0	0.0
	Larvae	4±1.63	0.0	0.0	6±0.28	0.0	0.0
	Pupae	2±0.28	0.0	0.0	1±1.41	0.0	0.0
	Eggs	0.0	0.0	0.0	0.0	0.0	0.0
<i>O.surinamensis</i>	Adults	4±1.41	0.0	0.0	6±0.28	0.0	0.0
	Larvae	0.0	0.0	0.0	0.0	0.0	0.0
	Pupae	0.0	0.0	0.0	0.0	0.0	0.0
	Eggs	0.0	0.0	0.0	0.0	0.0	0.0

± SE. Standard Error

During testing this sample before fumigation by ECO<sub>2</sub>-fume gas there were found 2,10 and 5 Adults, larvae and pupae of *E.cautella*, respectively and thus 3, 4 and 2 Adults, larvae and pupae of *E.calidella* but

*O.surinamensis* only found 4 Adults alive After fumigation period complete mortality was found for all stages of this insects at the concentration of 50g/m<sup>3</sup> after 3 days exposure.

**Table 13.** Concentration of ECO<sub>2</sub>-fume gas (ppm) under plastic sheet at 3-day exposure for date storage in jute bags at El-Redesia shouna, Edpho center, Aswan Governorate.

Location	Concentration ppm	Initial time	1 <sup>ST</sup> DAY	2 <sup>ND</sup> DAY	3 <sup>RD</sup> DAY	Average
Sheet (1) El-redesia	50gm/m <sup>3</sup>	1829	638 (62.7)	410 (77.6)	244 (86.7)	780.3 (57.3)

-Numbers between brackets represent% reduction.

Average concentration of ECO<sub>2</sub>-FUME gas through 3 days' exposure are 780.3 ppm and 1829,638,410 and 244 ppm in initial, 1<sup>ST</sup> DAY, 2<sup>ND</sup> DAY and 3<sup>rd</sup> DAY, respectively.

**-Forth Application:** - Application of ECO<sub>2</sub>-FUME gas the alternative of methyl bromide in date storage in jute bags under plastic sheet at El-Redesia bahary Edfu center Aswan Governorate.

Sample are tested before fumigation treatment with ECO<sub>2</sub>-FUME gas (1kg) are found to be 3 species insects *Ephestia cautella*, *Ephestia calidella* and *oryzaephilus surinamensis* alive some stages and presented in table (14).

**Table 14.** Effect of ECO<sub>2</sub>-FUME gas at (50g/m<sup>3</sup>) against some stages of insects date fruits under plastic sheet at El-Redesia shouna (2) Edfu,Aswan Governorate.

Insects Species	Stages	Before fumigation (Infestation %)		After Fumigation (Infestation %)			
		Alive	Dead	2 days		45 days	
				Alive	Dead	Alive	dead
<i>E.Cautella</i>	Adults	1±1.41	0.0	0.0	0.0	0.0	0.0
	Larvae	8±2.82	0.0	0.0	10±4.32	0.0	0.0
	Pupae	4±1.41	0.0	0.0	2±1.63	0.0	0.0
	Eggs	0.0	0.0	0.0	0.0	0.0	0.0
<i>E.Calidella</i>	Adults	0.0	0.0	0.0	2±0.28	0.0	0.0
	Larvae	8±1.41	0.0	0.0	6±0.28	0.0	0.0
	Pupae	4±0.28	0.0	0.0	3±0.28	0.0	0.0
	Eggs	0.0	0.0	0.0	0.0	0.0	0.0
<i>O.surinamensiss</i>	Adults	12±1.63	0.0	0.0	7±2.16	0.0	0.0
	Larvae	0.0	0.0	0.0	0.0	0.0	0.0
	Pupae	0.0	0.0	0.0	0.0	0.0	0.0
	Eggs	0.0	0.0	0.0	0.0	0.0	0.0

± SE. Standard Error

After fumigation with ECO<sub>2</sub>-FUME gas 3 days exposure the results indicated complete mortalities were achieved for the adults and immature stages in

the random sample after treatment 2 days of the treatment and 45 days from the treatment.

-In this Shouna average concentration during the whole exposure period was to be 685.8 ppm.

**Table 15.** Concentration of ECO<sub>2</sub>-FUME gas (ppm) under sheet date fruits storage in jute bags at El-Redesia Shouna Bahary, Edpho center, Aswan Governorate

Location	Concentration ppm	Initial time	1 <sup>ST</sup> DAY	2 <sup>ND</sup> DAY	3 <sup>RD</sup> DAY	Average
El-Redesia Edfu shouna (2)	50gm/m <sup>3</sup>	1573	542 (65.5)	386 (75.5)	242 (78.3)	685.8 (54.8)

-Numbers between brackets represent% reduction.

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## فعالية غاز إيكوفيوم ضد بعض الآفات الحشرية لثمار البلح الجاف والنصف جاف تحت ظروف تخزين مختلفة

رفعت عبد الشافي محمد ، احمد امين سيد احمد

"معهد بحوث وقاية النباتات -مركز البحوث الزراعية -الدقى -جيزة -مصر"

الهدف من اجراء هذه الدراسة تقييم تأثير غاز ايكوفيوم (2%فوسفين+98% غاز ثانى اكسيد الكربون وزن/ وزن ) على الاطوار الكاملة والغير كاملة لبعض الآفات الحشرية لثمار البلح الجاف / والنصف جاف تحت ظروف تخزين مختلفة بثلاث محافظات.

حيث تم اجراء عملية التبخير فى ثلاث اماكن وهى :

1. حاوية من الصلب فى مصنع تمور الواحة بمدينة بدر بمحافظة القاهرة .
  2. مخزن مبرد على درجة حرارة 17م° بمدينة الخارجة بمحافظة الوادى الجديد.
  3. التبخير فى الشونة اسفل مشمع التبخير بمحافظة اسوان .
- وقد اظهرت النتائج انه عند استخدام الغاز بجرعة مقدارها 50 جم/م<sup>3</sup> فراغ لمدة ثلاث ايام ادى الى موت جميع الاطوار الكاملة والغير كاملة لفراشة دودة البلح العامرى وفراشة دودة بلح الواحات وكذلك خنفساء السورينام فى البلح الجاف والنصف جاف .
- كما لوحظ ان اعلى نسبة تركيز للغاز خلال فترة التبخير كانت بالحاوية المصنوعة من الصلب يليها المخزن المبرد ثم الشونة على التوالى .
- وايضا" لم يلاحظ حدوث تغيير فى لون ثمار البلح نتيجة عملية التبخير بالجرعة المستخدمة مما لا يؤثر على المظهر العام للثمار .