

USE OF INDIGENOUS PLANT EXTRACTS TO MANAGE ALMOND MOTH, *EPHESTIA CAUTELLA* IN STORED DATES

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Abstract – *Ephestia cautella* is a serious pest of dates both in the field as well as in storage with an average infestation rate of 16.8%. However, the fruit losses may reach to 100% if appropriate control measures are not applied. Plant extracts are the most biodegradable, less toxic to mammals and environment friendly and one of the best alternatives to chemicals to manage stored commodities. In this study, the suitability of indigenous plant extracts of olive leaves, bhang leaves, neem leaves, rhizomes of turmeric and seeds of ajwain were tested against *E. cautella*. The study parameters included number of egg per grain, number of holes per grain, percentage reduction of F1 adults emerged, percent inhibition rate, percent weight loss of grains and adult mortality. All the tested plant extracts were effective against *E. cautella* as compared to the control. The lowest number of 0.43 eggs was observed in dates treated with plant extract of *Azadirachta indica* compared with the control with 3.77 eggs. All plant extracts significantly reduced number of holes made by *E. cautella* as compared to the control, which provided the maximum 1.90 holes. The minimum number of F1 adults (3.07) of *E. cautella* was recorded in dates treated with plant extract of *A. indica*. The minimum weight loss of 4.51% was recorded in *A. indica* treated dates, which was statistically different from all other plant extracts. The maximum adult mortality 6.1, 8.53 and 10.0 after 24, 48 and 72 hours, respectively, was observed in the treated dates with extract of *A. indica*. The results of this study will lead to development of effective formulations of indigenous plant extracts as bio-pesticides against pests of stored dates to avoid nutritional, qualitative and quantitative losses.

Keywords – *Ephestia Cautella*, Stored Dates, Plant Extracts, Management, Qualitative And Quantitative Losses.

I. INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is the most primitive grown tree. Saudi Arabia is the leading country in dates production throughout the world where more than 400 different cultivars of the date palm are grown with production of 700,000 tons annually [1] and dates yield reached 986,000 tons in 2008. The production of dates of Saudi Arabia was ranked second in 2011 [2]. The date palm tree is the highest yielding crop on per hectare basis [3]. Date palm growers mostly prefer to take improvement in export and marketing. Dates contains carbohydrates (44-88%), (fats 0.2-0.5%), (proteins 2.3-5.6%), (pectin 0.5-3.9%), (dietary fiber 6.4-11.5%), about 15 salts, 15 minerals and 6 vitamins. Date seeds have Al, Cd, Cl,

Pb, S and oleic acid with different amount [4]. Five countries Egypt, Islamic republic of Iran, Islamic republic of Saudi Arabia, Pakistan and Iraq were ranked at top in dates production in the year 2001.

Ephestia cautella damages dried plant products and have been found in different products and cereals, dry fruits, pulses, cacao, oilseeds, nuts and including stored dates [5]. Due to its great significance and wide cultivation areas of conventional dates, pre-harvesting and storage damages are high. Due to such problems, high date production countries like North Africa and Central and West Asia are focusing the research on dates. *E. cautella* causes substantial damage to dates in storage with an average infestation rate of 16.8% and its four to five generations have been recorded in a year [6].

Plant-derived material is mostly eco-friendly, low lethal for mammals, highly selective in action and delay the growth of resistance. Hence, search for the alternative method of almond moth control utilizing some non-toxic, environment friendly and human health hazard free methods are being pursued now-a-days. Various medicinal plant species were used for controlling pests [7] [8]. A great number of farmers and experts mostly claim the successful pests control by using plant material, including ashes in stored grains [9], vegetable oils [10] [11], plant-derived materials [8] and botanicals in powder form [12] [13] [14]. It was claimed that many plant extracts were most successful used method for management of pests rather than chemical control [15] [16] [17]. Therefore, plant materials should be explored to protect stored products including dates to be used against pest infestation. Essential oils extracted from black cumin, neem, ajwain, staranise and saunf has proved greater inhibition oviposition in *Bruchus chinensis* [18].

The objective of the research was to determine the effectiveness of different formulations of indigenous plant extracts against *Ephestia cautella*.

II. MATERIALS AND METHODS

1. Collection and Rearing of *Ephestia cautella*

Ephestia cautella were collected from ware houses and storages of dates and brought to “Stored Product Entomology Laboratory” for rearing of *E. cautella* under laboratory conditions (25°C and 65 ± 5% RH). Plastic containers (77 mm diameter, 146 mm deep) were used for rearing of moths and cotton swabs soaked with 10% sugar solution was used as diet for adult. Newly emerged adults of *E. cautella* were collected and 50 male, female pairs was transferred to plastic containers (77 mm diameter, 146 mm deep, one container per pair) containing cotton swabs soaked with 10% sugar solution. The mouth of the container was wrapped with a plastic mesh (Bell and Bowley, 1980) using a rubber band and inverted on a loosely affixed lid. Eggs laid were collected daily from the lid and individually transferred to rearing cups (65 mm diameter, 32 mm deep) using a No.0 brush. Each cup was provided with 20 mg of artificial diet (each kilogram of diet contained 350g broiler diet, 350g layer diet, and 250g wheat flour) in 150 ml glycerin and kept at temperature 25°C and 65 ± 5% relative humidity, furthermore, a photoperiod of 15:9 h (L:D) in a incubator until bring hatching.

2. Collection of Test Plant Materials

Plant Extracts:

The leaves of plants including olive, bhang, neem, rhizomes of turmeric and ajwain were collected from different localities of Pothwar region of Punjab, Pakistan.

3. Preparation of Plant Extracts.

Leaves of the collected above mentioned plants were washed in running water and dried in the shade until those become crispy dry. The dried leaves were made in powder form. 100 g of each powder was put in 1.5 L flask separately and 130 ml ethanol was added in each flask. These flasks were kept for 72 hours with interim of shaking. After 72 hours the solution of every flask was filtered by filter paper (diameter 40). The solvent was dissipated by utilizing flimsy film rotating evaporator under decreased weight. The obtained rough extract was put away in the refrigerator at 0°C for insect bioassay.

4. Bioassays for plant extracts

In each jar, 100 g of dates were treated with different application rate of plant extracts. Each extract has three replications along with the control. Five pairs of newly emerged adults of *E. cautella*

were released in each jar. The jars were covered with muslin cloth tightened with rubber band and then placed in the incubator at 25 °C.

The effectiveness of extracts was studied by the parameters like number of eggs, number of F₁ adults emerged, weight loss of dates and percent adult mortality.

Number of eggs

To determine the effect of plant materials on the oviposition/fecundity, average number of eggs laid by *E. cautella* per date was calculated. Ten dates were randomly selected from each jar and number of eggs laid was counted to work out the average.

Number of F₁ adults emerged

Number of F₁ (fresh emerged) adults in each jar was counted to determine inhibition of *E. cautella* emergence.

Percentage inhibition rate

Percentage reduction in emergence of F₁ adults or inhibition rate was calculated by using the following formula:

$$\%IR = \{(C_n - T_n) / C_n\} \times 100$$

Where

C_n = number of newly emerged adults in untreated jar (control)

T_n = Number of newly emerged adults in treated jar

Weight loss (%) of dates

The percent weight loss was calculated at the end of experiment by using the formula

$$\text{Weight loss (\%)} = \frac{(\text{Initial weight} - \text{Final weight})}{\text{Initial weight}} \times 100$$

Adult Mortality

Mortality of *E. cautella* was counted in treated and untreated 10g of stored dates. Petri plates in 7cm diameter (38.5 cm²) were used containing filter paper (Whatman No. 1) to determine the effect of treatments on the life span of its adults after 24, 48, and 72 hours. Each treatment had three replications. Ten moths of *E. cautella* were released. Petri plates were covered with muslin cloth tightened and then placed in incubator at 30°C.

Statistical analysis

Data collected was analyzed statistically by using SPSS 21.0 and MS Excel for graphs.

III. RESULTS

APTNESS OF PLANT EXTRACTS AGAINST *E. CAUTELLA* IN STORED DATES

1. Number of Eggs

The lowest number of 0.43 eggs per date was observed in dates treated with plant extract of *Azadirachta indica* which was non-significantly different from plant extracts of *Cucurma longa* and *Trachyspermum ammi* showed in Table 1. Among the treated dates, the maximum 1.95 eggs per dates were found in dates treated with extract of *Trachyspermum ammi* that was significantly similar to that of *Cucurma longa*. All the plant extracts significantly reduced number of eggs when compared with the control, which provided the maximum 3.77 eggs per dates. The plant extract *Trachyspermum ammi* was statistically different from plant extracts of *Azadirachta indica*, *Cannabis sativa*, *Olea europaea*, and *Cucurma longa* and provided the best control.

Table 1. Numbers of Eggs per Date laid by *E. Cautella* in Stored Dates, Treated with Different Plant Extracts

| S. No. | Plant Extracts | Mean Number of Eggs \pm S.E |
|--------|---------------------------|-------------------------------|
| 1 | <i>Cucurma longa</i> | 1.66 \pm .031 c |
| 2 | <i>Azadirachta indica</i> | .43 \pm .041 a |
| 3 | <i>Trachyspermum ammi</i> | 1.95 \pm .023 d |
| 4 | <i>Cannabis sativa</i> | 1.21 \pm .034 b |
| 5 | <i>Olea europaea</i> | .51 \pm .024 a |
| 6 | Control | 3.77 \pm .12 e |

Means followed by the same letters within columns and rows are significantly similar ($P \leq 0.05$); DMRT, Duncan, 1951.

2. Number of F₁ Adults Emerged

The highest number of F₁ adults (62.23) of *E. cautella* was observed in the untreated dates (Table 2). The minimum number of F₁ adults (3.07) of *E. cautella* was recorded in dates treated with plant extract of *Azadirachta indica*. However among the treated dates, the maximum number of F₁ adults (33.55) was observed in dates treated with extract of *Trachyspermum ammi*. *Cucurma longa* was observed significantly similar to extracts of *Trachyspermum ammi*. The extract *Olea europaea* was statistically different from that of *Azadirachta indica* and provided the best result in reducing number of F₁ adults.

Table 2. Number of F₁ Adults Emerged by *E. cautella* in Stored Dates Treated with Different Plant Extracts

| S. No. | Plant Extracts | Mean F ₁ Adults Emerged ± S.E |
|--------|---------------------------|--|
| 1 | <i>Cucurma longa</i> | 31.667±.32d |
| 2 | <i>Azadirachta indica</i> | 3.07±.120 a |
| 3 | <i>Trachyspermum ammi</i> | 33.55±.427 d |
| 4 | <i>Cannabis sativa</i> | 13.73±.260 c |
| 5 | <i>Olea europaea</i> | 5.60±.173 b |
| 6 | Control | 62.23±1.46 e |

Means followed by the same letters within columns and rows are significantly similar ($P \leq 0.05$); DMRT, Duncan, 1951.

3. Percent inhibition rate

Figure 1 showed the percent reduction/inhibition in emergence of F₁ adults of *E. cautella* due to application of different plant extracts. The results showed that the maximum inhibition (57.30%) was seen in *Azadirachta indica* treated dates. The minimum inhibition (8.28%) of F₁ adults was calculated in dates treated with plant extract of *Trachyspermum ammi*. It could be seen from the figure that *Azadirachta indica* was the best extract that caused the highest inhibition.

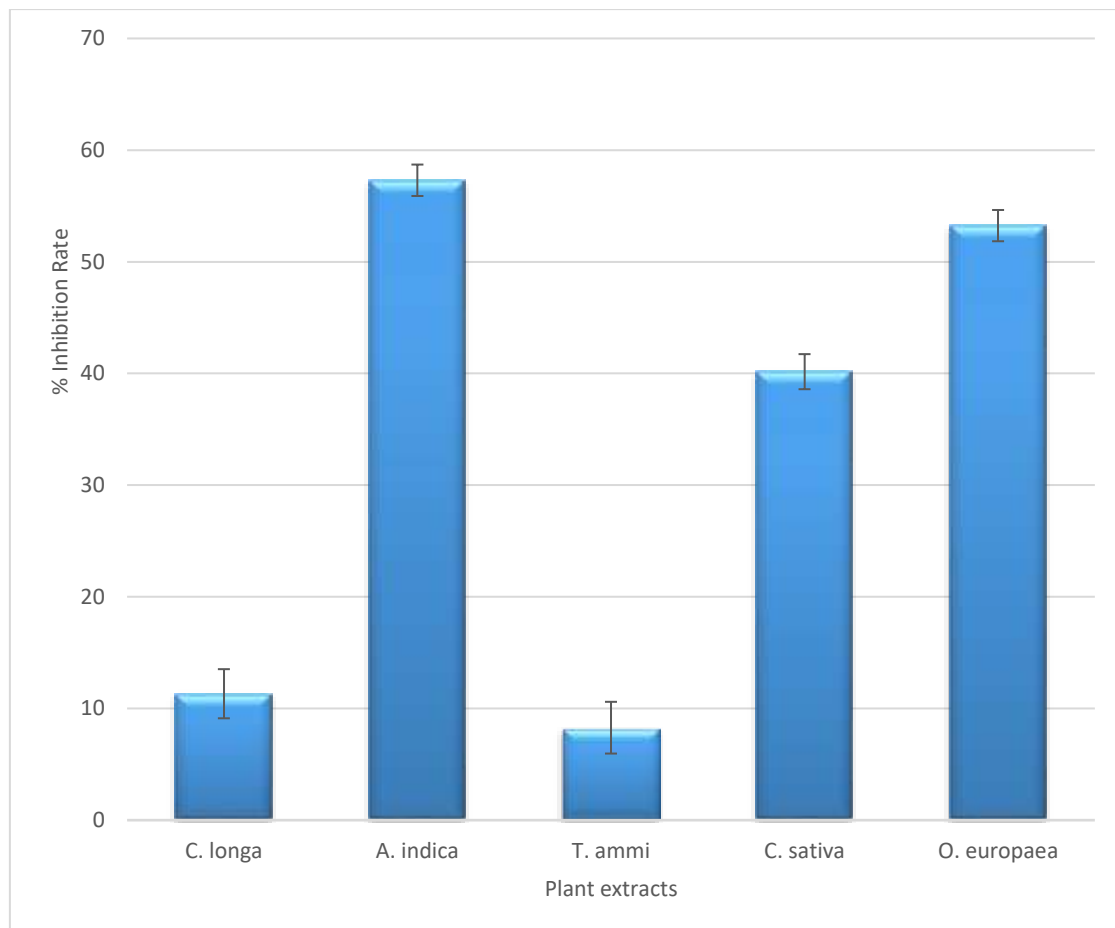


Figure 1. Aptness of different plant extracts on percent F₁ adult inhibition rate of *E. cautella* attacking the stored dates

4. Percent weight loss of dates

The effect of plant extracts on dates' weight loss by *E. cautella* showed that all the plant extracts significantly reduced weight loss of dates as compared to the control, which provided the maximum weight loss of 25.60% stored dates (Figure 2). The minimum weight loss of 4.51% was recorded in *Azadirachta indica* treated dates, which was statistically different from all other plant extracts. Among the treated dates, *Trachyspermum ammi* and *Cucurma longa* provided the maximum weight loss of 25.60% and 24.35%, respectively.

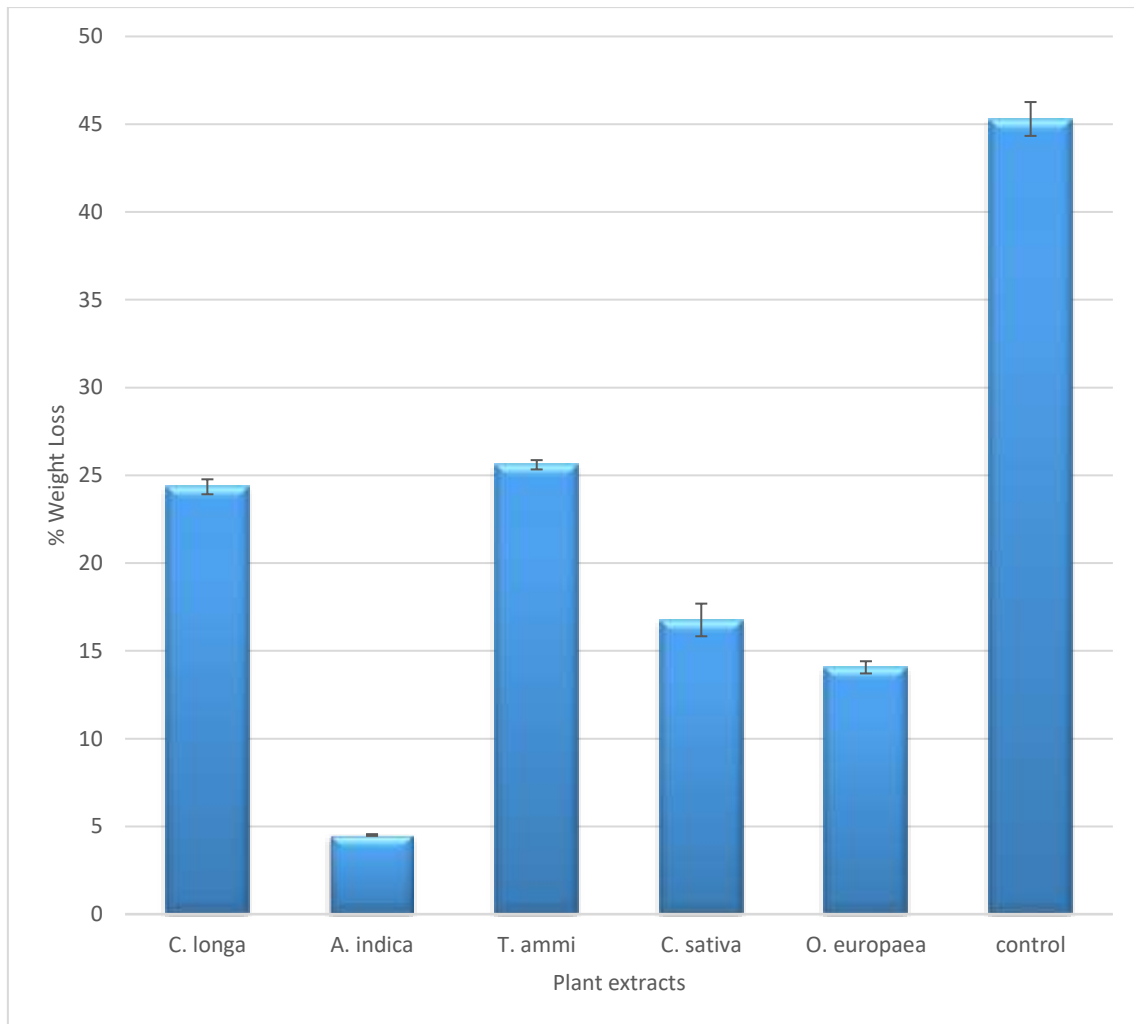


Figure 2 Aptness of different plant extracts on percent weight loss of stored dates due to damage by *E. cautella*

5. Adult mortality

The highest adult mortality (6.1) was observed in dates treated with extract of *Azadirachta indica* after 24 hours. At 48 hours interval the maximum number of dead adults 8.53 were found in dates treated with *Olea europaea* extract. After 72 hours of application, *Olea europaea* and *Azadirachta indica* extracts were the best. Table 3 showed that all plant extracts were significantly different from the control, which provided the minimum adult mortality of 3.30, 5.26 and 8.13 after 24, 48 and 72 hours, respectively. However the maximum adult mortality 6.1, 8.53 and 10.0 after 24, 48 and 72 hours, respectively, was observed in the treated dates with extract of *Azadirachta indica*. After 24, 48 and 72 hours, the effect of plant extract *Azadirachta indica* on adult mortality of *E. cautella* was non-significantly different from plant extracts of *Cucurma longa* and *Cannabis sativa*. After 48 and 72 hours, the effect of *Azadirachta indica* extract was statistically not different from plant extract of *Olea europaea*. The plant extract of *Cucurma longa* showed the least adult mortality of 3.30, 5.33 and 8.13 after 24, 48 and 72 hours, respectively. *Azadirachta indica* plant extract provided the best result in controlling adult population of *E. cautella* in stored dates. It could be seen that *Azadirachta indica* extract was the best in reducing weight loss of stored dates.

Table 3. Adult Mortality *E. cautella* in Stored Dates Treated with Different Plant Extract

| No. | Plant Extracts | Mean Mortality \pm S.E after | | |
|-----|---------------------------|--------------------------------|---------------------|--------------------|
| | | 24 hours | 48 hours | 72 hours |
| 1 | <i>Cucurma longa</i> | 3.30 \pm 0.231 ab | 5.33 \pm 0.317 b | 8.13 \pm 0.203 b |
| 2 | <i>Azadirachta indica</i> | 6.1 \pm 0.153 c | 8.53 \pm 0.185 d | 10.0 \pm 0.233 d |
| 3 | <i>Trachyspermum ammi</i> | 3.56 \pm 0.203 ab | 6.06 \pm 0.233 b | 8.3 \pm 0.231 b |
| 4 | <i>Cannabis sativa</i> | 3.97 \pm 0.375 b | 5.26 \pm 0.376 c | 9.2 \pm 0.346 c |
| 5 | <i>Olea europaea</i> | 5.53 \pm 0.203 c | 8.23 \pm 0.2027 d | 10.0 \pm 0.176 d |
| 6 | Control | 3.06 \pm 0.088 d | 4.133 \pm 0.203 a | 6.03 \pm 0.203 a |

Means followed by the same letters within columns and rows are significantly similar ($P \leq 0.05$); DMRT, Duncan, 1951.

IV. DISCUSSION

The use of plant extracts to manage insect pests of stored products is one of the best alternatives to traditionally used chemicals and fumigants. Botanical extracts inhibit adult emergence of storage insect pests and that the active ingredient present in these extracts suppress the embryonic development of eggs. The result of this study are in conformity with [19] who used plant oils of *Capsicum frutescens*, *Anacardium occidentale*, *Monodora tenuifolia*, *Xylopiya aethiopica*, and *Ricinus communis* to manage *Ephestia cautella* in the laboratory at ambient temperature of 28 ± 2 °C and relative humidity of $78 \pm 5\%$. Results showed that oil of *A. occidentale* was more effective than other extracts as it effects up to 76.65 and 90.00% adult mortality of the moth at 0.5 and 1.0 ml, respectively. Researchers [8] conducted experiments to evaluate the efficiency of leaf powders of *Tridax procumbens*, *Withania somnifera*, *Pongamia pinnata* and *Gliricidia maculata* against pulse beetle. Dried leaf powders of *T. procumbens* and *W. somnifera* (5 mg/g seed) was found to be more effective, causing 100% mortality, than leaf powders of *P. pinnata* and *G. maculata* (20 mg/g seed), that showed 73.1 and 69.2% mortality, respectively. However, all plant leaf powders showed 100% ovicidal activity. In a study executed by Aldawood *et al.*, (2003) who tested the effect of covering dates bunches on *Ephestia cautella* infestation during date fruit development season in the field. Results indicated that dates fruit bunches provided with covers showed less *E. cautella* infestation as compared to uncovered dates fruit bunches. Studies on *E. cautella* population dynamics revealed that this insect starts building up in the month of September and reach to its peak during November and then starts declining and remains low in the subsequent months. Our results showed that plant extracts reduce hatchability of eggs laid by moths and inhibit emergence of F1 adults and confirming results revealed by [20] in which *M. tenuifolia* was used to reduce egg hatching.

V. CONCLUSION

In this study, the use of ethanol extracts of different indigenous plants extracts of olive leaves, bhlang leaves, neem leaves, rhizomes of turmeric and seeds of ajwain were tested against *E. cautella*. The study parameters included number of egg per grain, number of holes per grain, percentage reduction of F1

adults emerged, percent inhibition rate, percent weight loss of grains and adult mortality. All the tested plant extracts were effective against *E. cautella* as compared to the control. The lowest number of 0.43 eggs was observed in dates treated with plant extract of *Azadirachta indica* compared with the control with 3.77 eggs. All plant extracts significantly reduced number of holes made by *E. cautella* as compared to the control, which provided the maximum 1.90 holes. The minimum number of F1 adults (3.07) of *E. cautella* was recorded in dates treated with plant extract of *A. indica*. The minimum weight loss of 4.51% was recorded in *A. indica* treated dates, which was statistically different from all other plant extracts. The maximum adult mortality 6.1, 8.53 and 10.0 after 24, 48 and 72 hours, respectively, was observed in the treated dates with extract of *A. indica*. The results of this study will lead to development of effective formulations of indigenous plant extracts as bio-pesticides against pests of stored dates to avoid nutritional, qualitative and quantitative losses. This will also be made part of an effective IPM strategy to manage this key pest in different stored commodities particularly dates.

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