Journal of Nutritional Science and Healthy Diet
Volume 1 | Issue 1

Research Article Open Access

Study the effect of postharvest heat treatment on infestation rate of fruit date palm (Phoenix dactylifera L.) cultivars grown in Algeria

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Citation: Marouf Aribi Mohamed, Khali Mustapha *(2020) Study the effect of postharvest heat treatment on infestation rate of fruit date palm (Phoenix dactylifera L.) cultivars grown in Algeria. J Nut Sci Heal Diet 1(1): 37- 40*
https://doi.org/10.47890/JNSHD/2020/MAMohamed/10243804

Received Date: June 21; 2020; **Accepted Date:** July 6; 2020; **Published Date:** July 10; 2020

Abstract

Effect of heat treatment (55°C/20 min) on infestation rate was investigated in Algerian dates (Deglet Nour variety) at Tamar (fully ripe) stage and in dates stored for 5 months at ambient temperature and in cold storage (10°C). Results obtained showed a variable percentage of rate infestation. These rate decreased weakly as the fruit advanced in storage at ambient temperature, whereas, they are less high in heat treated and cold stored dates. Heat treatment did show a significant effect on infestation variation. Deglet Nour dates showed that there was a decrease in rate infestation during storage for either heat treated dates samples. Whereas, rate infestation was weaker in chilled dates comparatively to those stored at ambient temperature. Rate infestation showed a similar trend where a decrease was observed in all samples during storage, particularly in heat treated dates. In all cases, heat treatment seems to benefit reducing rate infestation, whereas a relative stability in rate infestation was noted.

Key word: Postharvest; Heat treatment; Infestation; Date palm; Phoenix dactylifera L.

Introduction

Deglet Nour is the commercial variety that occupies most of the international trade in dates [1-4]. For Algeria, it represents 60% of the dates produced, i.e. 40% of the total revenue from agricultural exports [5]. Dates are rich in carbohydrates, comprising 70-80% in the form of glucose and fructose. Date fruit also contains vitamins, fiber, minerals and polyphenols, a class of bioactive compounds, especially phenolic acids [6]. Date fruit has special religious importance for Muslims people all over the world as it mentioned in many places in the Quran. There is a tradition to eat date fruit to break the fast during Ramadan fasting [7].Contamination of fresh fruits and vegetables with pathogens or spoilage agents can occur during production, harvesting, packaging, processing, distribution or marketing [8]. Among the most commonly encountered pests are the Esctomyelois ceratoniae Zaller, Ectomyelois decolor Zaller, Ephestia calidella, which is a lepidoptera and Oryzaephilus surinamensis L. (Coleoptera) as well as Olygonychus afrasiaticus which is a spider [9]. The observations of Ben-Lalli carried out in the palm groves of Sud in the region of Biskra (South-East of Algeria), show that more than 30% of organic dates of the Deglet Nour variety are infested with pests especially lepidoptera [9]. Soft and semi-soft dates were more infested than dry dates [10,11]. Chemical treatment of dates is very effective to eliminate pests, but it affects the quality of the premium date, and poses a danger to the health of the consumer [12]. Heat treatment is a good alternative and a technological solution compatible with an organic label. Refrigeration significantly reduces insect infestation. Storage at 5°C or below is effective for the conservation of this type of date, and prevents the development of all kinds of insects [3]. According to Kader and Hussein, for a long storage period, temperatures below the freezing temperature of up to -15.7°C can be used to store dates at the Tamar stage [13]. Dates with a water content of 20% or less can be stored at -18°C for more than a year. With a water content

<20%, these dates can be stored at 0°C for one year, or 4°C for 8 months, and 20°C for only one month (with an RH which must be maintained between 65 and 75% in all cases). One of the main causes of quality and quantity post-harvest losses is the infestation of dates with insects and the resulting damage [13]. Heat treatments can be used to combat yeasts and spoilage mold [14,15]. This physical treatment was also effective in controlling postharvest insects and pests [16,17]. This traditional physical process of decontamination is still in use today, because it is efficient, healthy and inexpensive compared to other technologies such as chemical processes and irradiation (Gamma ray) [18]. Heat can be applied to fruits and vegetables in several ways: by immersion in hot water, by hot air or by steam [16,19], or by rinsing with hot water with brushing [20]. The main objective of our study is to define a heat treatment capable of eliminating the infestation rate without affecting the quality of the dates, and to study the effect of two environmental factors (temperature of storage, and heat treatment) on the rate of this infestation, in order to define the storage conditions intended for these dates.

Materials and Methods

Plant Material and Constitution of Experimental Batches

The Deglet Nour variety dates, from the Tolga palm grove (Wilaya of Biskra-Algeria), were harvested on different regimes at the end of October (at Tamar stage), then transported and kept in cold rooms at 4°C±1°C. The dates were sorted and separated from their branches and the infested or crushed dates were eliminated.

The date samples were divided into two groups divided in six kind of samples each, corresponding to the different storage periods (0, 1, 2, 3, 4 and 5 months). At least thirty dates were used in each treatment.

The first group was left at room temperature (22°C±1°C) with a relative humidity of 75% to 80% and the second group was kept at low temperature of (10°C±1°C) with a relative humidity of 85% to 90%. After 1, 2, 3, 4 and 5 month of storage all samples were subjected to infestation rate test after 1, 2, 3, 4 and 5 months of storage.

Table 1 Experimental batches

Ambient Temperature (AT=22°C) **(Test I)**	Low Temperature (LT=10°C) **(Test II)**
C1: (Control) Preserved by freezing	**C2:** (Control) Preserved by freezing
Lot 1: Not Heat Treated: (NHT)	**Lot 1:** Not Heat Treated: (NHT)
Lot 2: Heat Treated: (HT)	**Lot 2:** Heat Treated: (HT)

Heat Treatment

As an alternative disinsectisation treatment on the infestation rate of the date we used a physical treatment. The dates were treated at 55°C±2°C for 20 min in a ventilated oven set. A control batch was left untreated. Both treated and untreated dates were subsequently conserved at either 10°C±1°C or at 22°C±1°C (room temperature) over a period of five months.

Infestation Rate Measurement

The dates tested are infested with eggs and larvae of Ectomyelois ceratoniæ, the main pest of dates.

The infestation rate was determined by the following relationship [21]:

Infestation rate = Number of infested dates / Number of observed dates × 100

Statistical Analysis

Results were expressed as mean ±standard deviation; variability between samples of dates was determined by the ANOVA test, using STATISTICA software (STATISTICA V6.1). Significance was accepted at 0.05 level of probability ($p<0.05$).

Results and Discussions

The infestation rate of the heat untreated Deglet Nour dates increases without significant difference ($p>0.05$) with storage at room temperature. As a result, in the 5th month the dates were fully infested (97.42%) [Figure 1]. This same trend was observed in the heat untreated dates stored at 10°C. However, a significantly lower level of infestation rate was observed in the 5th month compared to the rate observed for room temperature storage date (90.78% versus 97.42% in the 5th month) [Figure 2]. Heat treated batches continue to be infested during storage, particularly at room temperature (95.74% in the 5th month), unlike batches stored at 10°C, which despite the continuation of the infestation but at significantly lower levels. This is more pronounced in the 4th and 5th month of storage at 10°C (46.52% and 58.97% respectively) of heat treated dates.

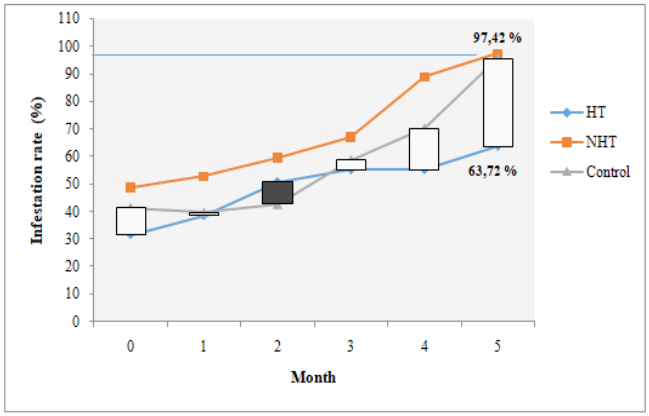

Figure 1. Evolution of the infestation rate (%) of dates stored at 22°C (**Test I**).

NHT: Not Heat Treated; **HT:** Heat Treated

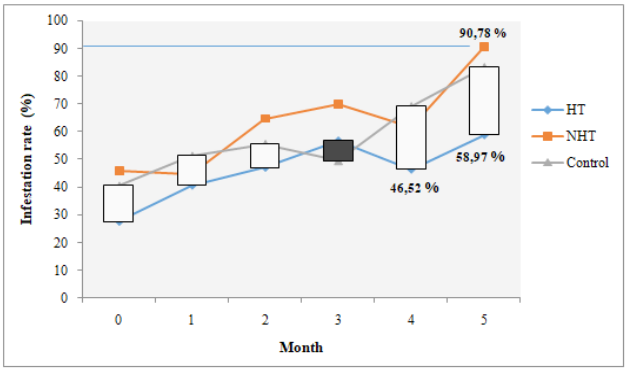

Figure 2. Evolution of the infestation rate (%) of dates stored at 10°C (**Test II**).

NHT: Not Heat Treated; **HT:** Heat Treated

Heated air at 50-55°C for 2-4 hours (from the time the fruit temperature reaches 50°C or higher) is effective for insect disinfestation [22].Time of harvest is based on the date fruit's appearance and texture (related to moisture and sugar content). Proper timing of harvest reduces incidence and severity of cracking or splitting of dates, excessive dehydration, insect infestation, and attack by microorganisms [13]. The heat treatment of dates has shown a remarkable effect in limiting the infestation of date stocks, even not heat treated, both at room temperature and at 10°C. Significantly lower levels of infestation ($p<0.05$) were thus observed (40.65% and 41.03% respectively in the 5th month at Ta and at 10°C). Dates are very resistant to low temperature, and thus can significantly reduce insect infestation [3,23]. In national and international trades, the channels of commodities that are infestation free are essential to avoid rejections [24]. Khali and Selselet-Attou (2007) [25] investigated the effects of heat treatment (55°C/20 min) on polyphenol oxidase and peroxidase activities as well as total phenolic compounds in the Deglet Nour variety at the Tamar (fully ripe) stage from dates stored for 5 months at ambient temperature and in cold storage (10°C). The lowest infestation rates were observed in the heat- treated batches and in each month of storage. These differences were significant compared to all batches heat treated at room temperature. However, the heat treated-refrigerated batches at 10°C differed from those maintained at room temperature, by remarkably lower levels of infestation ($p>0.05$) lower than all the other batches (26.96% in the 3rd month) . These results agree with those of Hofman et al. for whom conditioning at low temperature alone in combination with heat treatment has potential for disinsection [26]. Munier, Ahmed et al., Reynes Donahaye et al., reported that low temperatures hinder the development of weeds [27-30]. The raisin moth and the Indian meal moth are associated with each other and their infestation starts on fruit bunches [31]. Insect infestation is one of the primary causes of postharvest losses in quality and quantity. Several insects can cause serious damage to dates at different developmental stages [32-34]. These results clearly indicate the interest of the combination of refrigeration and heat treatment in reducing the infestation rate. Similarly, according to Al Azawi, heat treatment is more effective to obtain a total mortality of insects [35]. Our results confirm those of Jang et al., who reported that heat treatment combined with cold is a very good means of insect control [36].

Conclusion

Preserving the quality of the date for consumption after harvesting poses major problems for national operators. Proper storage depends on both the condition of the fruit at harvest and the storage conditions. The quality control of dates is largely conditioned by the homogeneity of their degree of maturity. The harvest period at the Tamar stage is an important factor because the date of Deglet Nour is a ripe, staggered fruit. In order to reduce the heterogeneity of the batches of fruit used in our studies, we have selected the most homogeneous fruits possible from the point of view of color and general external appearance. The first major objective of our study was to demonstrate the feasibility and the advantages of this technological alternative. The heat treatment of dates has shown a remarkable effect in limiting the infestation of date stocks, even not heat treated, both at room temperature and at 10°C.

Heat treatments are more and more accepted as replacement treatments for methyl bromide; however, determining the most sensitive stages of biological development is essential to the development of disinsection protocols based on thermal energy. The profitability at the industrial level of such a disinfestation treatment, remains to be demonstrated taking into account the heterogeneity of the dates delivered to the packaging plant (variable degree of humidity, different varieties, irregular feeding of the packaging tunnel, etc.) and the thermal scale applied.

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