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DATE'S MOTH (*ECTOMYELOIS CERATONIAE*) EFFECTS ON BOTH PHYSICO-CHEMICAL AND MICROBIOLOGICAL PROPERTIES OF TWO DATE CULTIVARS (HMIRA AND FEGGOUS) COLLECTED FROM IGLI AND TAMTERT SOUTH WESTERN ALGERIA

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ABSTRACT

The aim of this study was to investigate chemical and microbial characteristics of date from two varieties cultivated in Igli, and Tamtert, region to assess the effect of date moth on their nutritional and microbiological quality.

The results show that date flesh of examined cultivars have a high content of sugars (85-64%) and low concentrations of protein (1,05-0,62%), ash(1,83-1,99%) and fats (0,22-0,54%) on dry matter basis. The protein content of infested dates was greater than that of unscathed. For mineral content, Potassium is the most abundant element (455,0mg/100g), followed by sodium (260,2mg/100g), and iron (204 mg/100g), while zinc is present in very small amounts (0,97 mg/100g). The results reveal that the bacteriological quality of both studied varieties, are conforms to international standards; additionally, there is no significant difference in bacterial quality between unscathed and infested dates. Furthermore, dates exposed to date moth infestation, which results in fungal contamination. The development of this fungal flora under suitable conditions (temperature, humidity, pH, etc.) can have negative effects by altering the organoleptic properties and decreasing the nutritive quality.

Keywords: Dates, *Ectomyelois ceratoniae*, physic-chemical characteristics, Microbiological characteristics, South Western Algeria.

Introduction

Date palms (*Phoenix dactylifera* L.) belong to the *Arecaceae* family, the saharienns' providence tree, is one of the oldest and most popular fruit trees in the world's hot arid regions (AL-Juhaimi *et al.*, 2014 ; Benmeddour, 2013, Nur Ashikin *et al.*, 2020).

It is well adapted to the harsh circumstances of the desert environment, and it serves as a source of food for the people of the south. The date palm's fruit has long been an important crop in the desert regions of Arabian countries, providing a means of survival for many ancient nomadic tribes (Al-Hootiads, 2002). Dates contain the majority of their complex carbohydrates in the form of fructose, glucose, and saccharose (Eman Abdul Rahman, 2015), all of which are easily absorbed by the human body. It's also high in oligo-elements, fibers, and a good source of carotene, amino acids, and important minerals such as potassium and magnesium (Al-msallem *et al.*, 2020). Dates face a number of national and international challenges, including fruit quality degradation caused by bio-aggressors such as the white scale of the date palm (*Parlatoria blanchardi* Targ), the Boufaroua (*Oligonychus afrasiaticus*) and the Date Moth (*Ectomyelois ceratoniae* Zeller), this is also presently

considered a permanent danger to Algerian phoenicculture (Omame *et al.*, 2017)..

Fruit quality of date is affected by various factors, such as irrigation, fertilization, pollination storage conditions and diseases. Infestation of dates in the field and in storage areas devalues the commercial quality of dates and jeopardizes exports. The degree of infestation varies from year to year, depending on the phytosanitary status of the palm grove and environmental conditions.

Ectomyelois ceratoniae Zeller (Lepidoptera; Pyralidae), also known as the carob moth, is a major pest in the Algerian oasis. Its larva consumes several fruits and causes enormous damage (Roumani *et al.*, 2018). It is extremely polyphagous, attacking a wide range of cultures and spontaneous plants at various bioclimatic stages (Boulanouar *et al.*, 2017). It affects both awaiting production and stored items. It can also cause significant damage, up to 30% of the production date (Mehaoua, 2013); its danger stems from its widespread geographic distribution across various bioclimatic stages and its polyphagia on various hosts (Nay, 2005).

This work is an attempt to provide information on the microbial and physico-chemical properties such as sugar

composition, mineral salts and fat content for two different date varieties (Feggous and Hmira), growing in Igli and Tamtert region. The analyses were carried out on dates unscathed and infested by the date moth in order to assess the effect of date moth on their nutritive (protein, fat, mineral, sugar and ash) compounds and microbial quality.

Material and Method

Samples

Date Samples Feggous and Hmira variety were collected from Igli (Latitude: 30.27, Longitude: -2.18 30° 16' 12" North, 2° 10' 48" . Altitude of Igli 571 m) and Tamtert region (Latitude : 29.9102, Longitude: -1.88918 29° 54' 37" North, 1° 53' 21" West. Tamtert altitude 448 m), south West of Algeria during the date production season.

The studied dates, listed in table 01, were harvested during the ripening stage, all the dates were coming from several palms, were harvested during the months of September-October 2019. First, a manual sorting had been carried out, the dates of good quality are selected for conservation, and those of low quality were excluded such as: dry dates, crushed dates, damaged dates, pitted dates or which were attacked by the birds.

Table 01: Dates sample description

Variety	Sampling Region	Abbreviation
Feggous	Igli	FI
Feggous	Tamtert	FT
Hmira	Igli	HI
Hmira	Tamtert	HT

Chemical analysis

Ash content, proteins, pH, moisture content, and dry matter, were measured according to association of official analytical chemists methods (AOAC, 1990).

Hydrogen potential measurements were performed using a pH meter at 20°C (NF V 05-108, 1970) (Titratable acidity, expressed as a percentage of malic acid equivalent, was determined by titrating with NaOH solution (0.01N) to endpoint pH of 8.1±0.20 (NF V 05-101, 1974).

The ash content was obtained by burning dates for 6 hours in a muffle furnace (Nabertherm GmbH, Germany) at 550 °C. The moisture content of 02 g of homogenized date fruits was determined using a ventilated oven (WTB Binder, 120 Tuttlingen, Germany) at 105°C until constant weight.

Table 02: Chemical composition of unscathed and infested date

	Moisture %	Ash %	pH	Acidity	Fat %	Total sugars	Protein %
FI unscathed	24.27±0.31	1.98±0.14	5.8±0.00	0.49±0.03	0.29±0.66	82±1.02	0.63±0.11
FT unscathed	21.44±1.04	1.99±0.23	5.85±0.01	0.43±0.04	0.29±1.12	64±1.26	0.62±0.24
HI unscathed	25.86±1.25	1.97±0.12	5.6±0.01	0.46±0.04	0.37±0.45	79±1.34	0.81±0.29
HT unscathed	26.48±0.42	1.93±0.11	5.7±0.00	0.49±0.01	0.50±0.43	85±1.47	0.74±0.21
HT infested	17.69±0.49	1.94±0.11	6.4±0.00	0.64±0.00	0.27±0.69	79±1.16	1.55±0.19
FT infested	17.30±0.21	1.91±0.42	6.3±0.01	0.49±0.04	0.22±0.83	68±1.35	1.31±0.12
HI infested	23.27±0.48	1.93±0.13	6.8±0.00	0.43±0.03	0.23±1.14	85±1.51	1.10±0.23
FI infested	22.36±0.43	1.89±0.29	7.6±0.00	0.53±0.03	0.30±1.25	76±1.29	1.05±0.27

For the mineral content, the residues of the ash content were dissolved in 50mL of 0.5M HNO₃ solution. Mg, Mn, Iron and Zn concentrations were determined using atomic spectrophotometer absorption; a calibration curve was created using standard metal solutions (AOAC, 2005).

Total carbohydrates were determined according to the phenol-sulfuric acid method according to Dubois *et al.* (1956). The diluted sample (0.5 ml) was mixed with 0.5 ml phenol solution (5%) followed by addition of 2.5 ml concentrated sulfuric acid. The mixture was left at 105°C for 5min prior to measuring absorbance at 490 nm using a spectrophotometer. The total sugars content was determined based on a standard calibration curve prepared using glucose.

Protein content (g protein/100 g sample) was analyzed according to the Kjeldahl method, using a factor of 6.25 for the conversion of nitrogen to crude protein. Lipid was determined from dried date macerated by Sox-therm Gerhard extractor (AFNOR., 2002) (NF EN ISO 734-1, 2000).

Microbial analysis

Total aerobic counts were counted on plate count agar (PCA) by pour-plating 1ml dilutions in duplicate; plates were then incubated aerobically for 72 hours at 30°C (Bourgeois *et al.*, 1991). Coliforms were counted by pour plating 1 ml of dilution in duplicate on Petri dishes of violet red bile lactose agar (VRBL). For 24 hours, the plates were incubated at 44°C. *Staphylococcus aureus* was counted on Baird Parker medium supplemented with a sterile emulsion of Egg Yolk and potassium tellurite solution. EN ISO 6888. Surfaces cultured on OGA (Oxy-tetracycline Glucose Agar) containing 10 g/ml of oxy-tetracycline was used to count moulds and yeasts. Plates were incubated for 5 days at 25°C in anaerobic conditions (Mossel, 1962).

Data analysis

All results are shown as the average of the measurements. The averages of the parameters of samples unscathed and infested are significantly different <0.05 using student Test.

Results and Discussions

Chemical composition of unscathed and infested date

Date fruits are considered a good source of energy and significant source of fiber (Parvin *et al.*, 2015). Flesh quality is an important parameter for consumers and food industry. Chemical and biochemical composition of unscathed and infested date on dry matter are presented in table 2.

Food spoilage is primarily determined by water activity and water content (Parvin *et al.*, 2015). The highest moisture content is obtained with unscathed date (FI, FT, HI, HT) it is about 24.27±0.31%, 21.44±1.04%, 25.86±1.25% and 26.48±0.42%, respectively. Although, the infested date the moisture content is about 17.69±0.49%, 17.30±0.21%, 23.27±0.48% and 22.36±0.43% for (HI, FI, HT, FT) respectively.

Our results are comparable to those obtained by Benyagoub *et al.* (2012) on the Hmira variety in Bechar region, which has moisture content in the range of 28.6%, Laouar *et al.* (2019) who obtained a moisture content of 25.42% and 26.91% for the Hmira and Feggous varieties, respectively from Abadla region.

The ash content in foods is thought to be an indicator of their nutritional value. The ash content of unscathed dates (FI, FT, HI, HT) was 1.98±0.14%, 1.99±0.23%, 1.97±0.12%, 1.93±0.11%, also the percentage of ash content of infested dates (FI, FT, HI, HT) was 1.94±0.11%, 1.91±0.42%, 1.93±0.13%, 1.89±0.29%, which is comparable to previous studies cited by Makhloufi (2012) as well as other researchers 1.69 % for the Cherka variety and 1.72 % for the Faggous variety. Because the moth uses some mineral elements in the synthesis of its secondary metabolites, the ash rate of the infested dates is lower than that of the unscathed dates (Boulanouar, 2017).

In terms of fat content, it was (0.29±0.66 %, 0.29±1.12%, 0.37±0.45%, 0.50±0.43%) in unscathed date (FI, FT, HI, HT) and (0.27±0.69%, 0.22±0.83%, 0.23±1.14%, 0.30±1.25%) in infested date (FI, FT, HI, HT). Our results are comparable to those of Boulanouar (2017), who found a lipid percentage of 1.55% and 1.09% in unscathed date and infested date Hmira varieties, and 1.15% and 0.78% in unscathed date and infested date Feggous varieties, respectively. Fruits have a lipid content of less than 0.1-0.5 percent (Belitz *et al.*, 2009).

Sap from unscathed dates (FI, FT, HI, HT) has acidity values of 0.49±0.03, 0.43±0.04, 0.46±0.04, 0.49±0.01 respectively. These values are comparable to those noticed by Mebrouki (2009) it ranged between 0.30% and 0.60% ,the infested date (FI, FT, HI, HT) variety has acidity values ranged between 0.64± 0.00, 0.49±0.04, 0.43±0.03, 0.53±0.03 respectively, The increase in acidity in infested

dates is caused by the presence of organic acids as a result of the borer's biological activity.

Sugar content, titratable acidity and pH are the main parameters affecting taste. Sap from unscathed dates (FI, FT, HI, HT) has a pH value of 5.8±0.00, 5.9±0.01, 5.6±0.01, 5.7±0.00, while sap from infested dates (FI, FT, HI, HT) has a pH value near neutrality of 6.4±0.00, 6.3±0.01, 6.8±0.00, 7.6±0.00; There's also a significant difference (p< 0.05) between the pH of various unscathed and infested samples.

The pH of sap indicates its quality; thus, the lactic acid produced by bacteria from the sap's natural microflora can significantly lower the pH in a few hours at ambient temperature (Imene Ben Thabet *et al.*, 2009). A pH value of less than 5.4 is considered a bad character for date quality, and a pH value greater than 5.8 is considered a good feature (Laouar *et al.*, 2019).

Date is primarily made up of sugars and other minor substances. The sugars composition of unscathed dates (FI, FT, HI, HT) variety were noticed to be (82±1.02%, 64±1.26%, 79±1.34%, 85±1.47%). However the sugar content of infested dates unscathed date varieties consists of (79±1.16%, 68±1.35%, 85±1.51%, 76±1.29%) sugar, respectively. which resemble those found by Makhloufi, (2012) which are of the order of 74%. The total sugar content of dates ranges from 55 to 85 percent, with glucose and fructose accounting for the majority of it (Makhloufi *et al.*, 2013; Zohri *et al.*, 2000).

The unscathed dates contains about 0.63±0.11 %, 0.62±0.24 %, 0.81±29 %, 0.74±21 % of protein. However, the level of infested dates is 1.10±0.19 %, 1.05±0.12 %, 1.55±0.23%, and 1.31±0.27% respectively. There are significant differences between protein content in unscathed and infested dates. The value of infested dates is higher than that of unscathed dates for the following reasons: Proteic enzymes, which are not consumable components during reactions, are secreted by the moth. Moths behave in a variety of ways but most live in tunnels or clumps of silk, or bind leaves together with silk threads (Boulanouar *et al.*, 2017).

The results in Table 03 show the level of metals in unscathed and infested dates. The presence of trace metals is an important factor in date quality; mineral elements such as Mg, Mn, Fe, and Zn are essential human nutrients, particularly for growth.

Table 03: Proximate composition of trace metals in unscathed and infested dates

mg/100g	Na ⁺	K ⁺	Mg	Mn	Fe	Zn
FI unscathed	162.0	381.7	40.55	1.99	167.96	0.24
FT unscathed	181.3	400.2	38.66	1.35	142.64	0.49
HI unscathed	255.0	443.2	40.96	1.27	200.4	0.97
HT unscathed	260.2	455.0	35.11	1,16	168.15	0.64
FI infested	106.1	311.5	34.10	1.17	181.46	0.39
FT infested	169.6	378.9	36.78	1.76	206.6	0.67
HI infested	143.2	401.2	39.12	0.68	162.14	0.48
HT infested	226.5	390.7	37.72	1.68	212.8	0.70

The mineral content varied widely. potassium being the most abundant element, with concentration ranged from 311.5 to 455.0mg/100g, followed by sodium (162.0-260.2

mg/100g), iron 142.64-200.4 mg/100g in unscathed date and 212.8-162.14 mg/100g in infested dates, magnesium 35.11-40.96 mg/100g in unscathed date and 34.10-39.12 mg/100g

in infested date; manganese 1.16-1.99 mg/100g for unscathed date (0.68-1.68 mg/100g) and zinc (0.24-0.97mg/100g) for unscathed date and 0.39-0.70mg/100g. The examined dates seem to be a less reliable source of micronutrients compared to our results, such as iron (0.3-6.03 mg/100g), zinc (0.20-2.41 mg/100g), magnesium (47-89.6 mg/100g), and manganese (02-1.20 mg/100g) (Manickavasagan *et al.*, 2012).

According to biochemical analyses, the date fruit is high in nutrients and contains a significant amount of minerals, carbohydrates, and proteins, with only a small amount of fat (Laouar *et al.*, 2019; Abdel-Naser *et al.*, 2000; Mortazavi *et al.*, 2015).

Microbiological test results on four different varieties of unscathed and infested dates

The microbiological quality of dates is critical because it is a technological and regulatory requirement. Figure 01 show the results of the enumeration of total mesophilic aerobic flora (FAMT), fungal flora (FF), total coliforms (CT), and *Staphylococcus aureus* (*S. aureus*) for unscathed and infested dates, respectively.

The hygienic quality analysis is based on knowledge of the existing microbial flora in the food product. This is still the best method for determining the quality of food. At the conclusion of this study, we used the principle of dilution up to 10^{-3} .

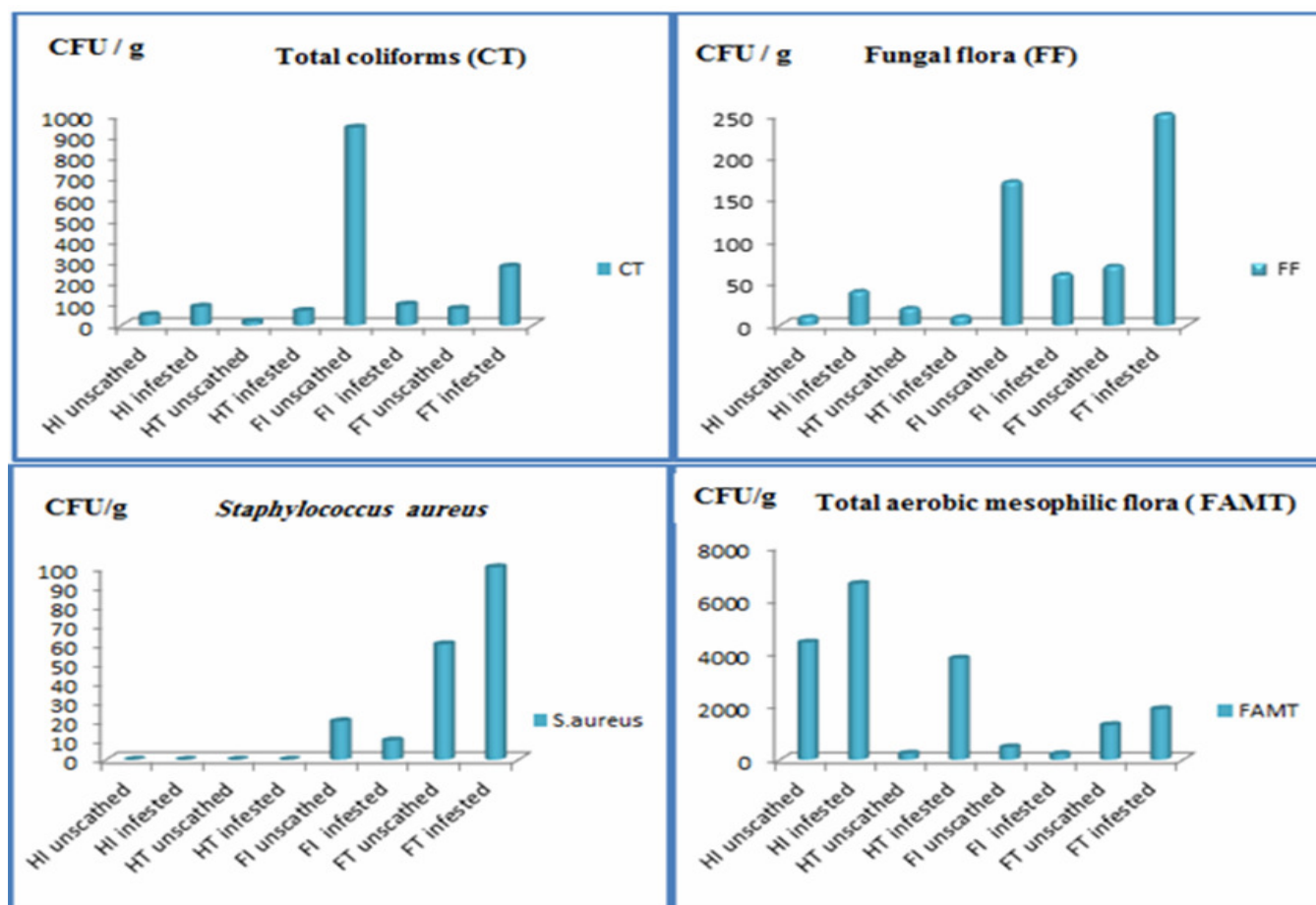


Figure 03: Microbiological test results on four different varieties of unscathed and infested dates, expressed in germs per gram (CFU/g)

The results show that the mean FAMT of the unscathed date (HT, FT, HI, FI) varieties were 4.4×10^3 , 4.7×10^2 , 2.3×10^3 , 1.3×10^3 CFU / g respectively and infested date (HT, FT, HI, FI) of Tamtert and Igli were 6.6×10^3 , 2.1×10^2 , 3.8×10^3 , 1.9×10^3 , 1.9×10^3 CFU / g respectively which are granted to international standards that set a limit by a number of FAMT 10^6 CFU / g. Thus, we notice that there is no significant difference in the count of FAMT of infested and free dates of the two varieties and the two regions; which is in agreement with those described by Belbahi, (2015).

The results show that the mean CT of the unscathed date (HI, FI, HT, FT) varieties were 50, 90, 20, 70 CFU / g respectively and the mean CT of the infested date (HI, FI, HT, FT) were 9.4×10^2 , 10^2 , 2.8×10^2 , 80 CFU / g respectively

which are granted to international standards that set a limit by a number of CFU /g. Coliforms are frequently used as a measure of food preparation hygienic practices. The acceptable limit value of aerobic germs in foods is 3×10^5 CFU/g (Mrabet *et al.*, 2008). These results corroborate the data given by Benyagoub *et al.* (2012) on the Hmira variety where the analyzed microbial parameters show a satisfactory quality.

Fungal Flora of unscathed date (HI, FI, HT, FT) ranged from 10 to 40, FU/g and ranges between 60, to 2.5×10^2 CFU /g for infested date .

Yeasts and molds are common contaminants of dates, according to several authors. These microorganisms attack the fruits earlier in their maturation, but at the Tamar stage,

their numbers decrease and only the xerophile fungi such as *Catenularia fuliginia* are able to grow on the dry dates. Until now, the harvest of dry dates in the south of Algeria takes place in autumn, a season marked by strong winds that contribute to the spread of spores (Abekhti *et al.*, 2013).

Staphylococcus aureus was absent in the unscathed date and ranges between 10 to 10², CFU/g in the infested date. The presence of such pathogens in dates indicates human contamination (Abekhti *et al.*, 2013).

The analysis of student test revealed a highly significant difference in microbial characteristics between unscathed and infested date from different regions of Saoura Algeria's south $p < 0.001$.

Conclusion

The production of dates in Algeria faces various threats from certain diseases of microbial and parasitic origin caused by animals and insects.

Our study seeks to demonstrate the relationship between some physicochemical parameters and the frequency of infestation by the moth. The infestation rate of the Feggous variety is higher compared to the Hmira variety. The results show that examined date fruits have a high content of sugars and low concentrations of protein and fats. The analysis test revealed a highly significant difference in mineral and protein content between unscathed and infested dates. The protein content of infested dates was greater than that of unscathed. The results reveal that the bacteriological quality of both varieties of dates studied, unscathed and infested, met international standards, and that there is no significant difference in bacterial quality between unscathed and infested dates. The stored dates are exposed to the infestation of date moth which consequently causes fungal contamination. The development of this fungal flora under suitable condition (temperature, humidity, pH, etc.) can have adverse consequences by altering the organoleptic properties and decreasing the nutritive quality. As a result, additional research should be planned to highlight interactions that exist between factors such as climatic conditions, the chemical composition of date paste, and active compounds found in medicinal plants in order to improve the quality and safety of this traditionally prepared food. This is a common misunderstanding.

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