The Effect of *Chlorella Vulgaris* Microalgae on Some Characteristics of Storage Time of Date Fruit (*phoenix dactylifera*)

Ali Hashemi *, Abdolali Hesami, Abdolhosein Ghasemi

(Department of Horticulture, faculty of Agriculture and natural resources , Persian Gulf University, Bushehr, Iran, postal code: 7516913817)

Abstract: The unsuitable storage conditions and the type of date pack are one part of the biggest challenges in the palm industry. In this research, two date cultivars: *Kabkab* and *Khasoui*, microalgae with the name of *Chlorella vulgaris* at four levels, 0, 25%, 50% and 100% and time of storage in three levels 1, 2 and 3 months (90 days) were carried out as factorial experiment in a completely randomized design with three replications. Dry weight, moisture content, pH and rate of decay of fruits of both cultivars were measured in every 30 days. Based on the results, the effect of microalgae and different months sampling for all traits were significant at ($p \leq 0.01$) level. The effects of *Chlorella vulgaris* at 25% level were higher than the other concentrations on the most traits and were stable until the second month, and then its effect was decreased. Results revealed that the effects of all treatments on the *Khasouei* cultivar were higher than the *Kabkab* date cultivar.

Keywords: storage time, dates, *Chlorella Vulgaris*, algae extract

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1 Introduction

Kabkab dates are also grown in large quantities in Dashtestan city, in the Borazjan area of Bushehr province, where they are the only exported produce and are therefore extremely important to the city's economy. *Kabkab* dates are considered as a wet variety of date due to their high moisture content of around 18%. They are long, oval and around 3.5 － 4 cm in size and vary from yellow to dark brown in color, depending on ripeness. *Kabkab* dates have a soft and fine texture and a hard skin due to their long and grey pit that clings to the flesh. They are popular for their delicious, sweet, and syrupy taste. *Khasouei* dates are light brown in color so they are smaller than the dates available in Bushehr province. Storage with the high quality is the final stage in the process of post harvesting of dates. Being able to keep a level of freshness from the field to the dinner table, there appears many challenges. The most important goals of postharvest handling are keeping the product cool, to avoid moisture loss, slow down undesirable chemical changes, and avoid physical damage such as bruising, to delay spoilage (El-Ramady et al., 2015). Storing dates at low temperatures is the most important way of maintaining quality because it minimizes loss of color, flavor, textural quality, delays development of sugar spotting, incidence of molds and yeasts, insect infestation, and prevents development of syrupiness (due to conversion of sucrose into reducing sugars) and souring of excessively moist dates. *Khalal* dates should be stored at 0°C and 85% – 95% RH to reduce water loss, delay

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***Corresponding author: Ali Hashemi,** The Effect of Chlorella Vulgaris Microalgae on Some Characteristics of Storage Time of Date Fruit (phoenix dactylifera), Department of Horticulture, faculty of Agriculture and natural resources, Persian Gulf University, Bushehr, Iran. Tel: +98 7731221337. Email: Hashemi@pgu.ac.ir

ripening to the Rutab stage, and maintain their textural and flavor quality (Siddiq and Greiby, 2014). In order to reduce moisture loss and improve shelf life, packaging in moisture-barrier plastic bags or use of plastic liner in the box is helpful. Optimal temperature for *Tamar* dates is 0°C for 6 – 12 months, depending on cultivar (semi-soft dates, like *Deglet Nour* and *Halawy*, have longer storage-life than soft dates, like *Medjhool* and *Barhee*). For extended storage, the use of temperatures below the highest freezing temperature of –15.7°C is recommended. Dates with 20% or lower moisture can be kept at –18°C for more than one year, at 0°C for one year, at 4°C for 8 months, and at 20°C for one month; RH should be kept at 65% – 75% for all cases (Kader and Hussein, 2009).

Date palm is the most important in the world, about the 35 international date palm conference and symposiums which have been held in 14 different countries, beginning with the initial event in Algeria in 1931 (Johnson, 2014). Postharvest decay caused by fungal contamination of cherry tomato fruit has been primarily controlled by the application of synthetic fungicidal agents in the field and during the postharvest period (Barreto et al., 2016). Several changes might develop after harvesting of fruits and vegetable because of the exposure of tissues to the outer, atmospheric conditions which govern the rate of deterioration.

Some of factors which are responsible for the deterioration of fruits and vegetable includes the moisture content of the product, relative humidity of the environment, product temperature, environment temperature and heat of respiration of the produce, physical, mechanical and physiological damages and the decay of microorganisms (Vivek et al., 2019). Date flesh is found to be low in fat and protein but rich in sugars, mainly fructose and glucose, high source of energy, as 100 g of flesh dates can provide an average of 314 kcal. Some minerals were reported, with the major being selenium, copper, potassium, and magnesium (Mohamed and Chang, 2008). Due to high evaporation, bacteria and fungi rate in non-coated fruits and proximity to each other, the quality, tissue, taste, marketability and other components are changed. Transpiration has various adverse effects on postharvest quality and the shelf-life of fresh fruit and vegetables. If not controlled, the water released through this process would result in direct mass loss (Bovi et al., 2016).

During different physiological stages of palm fruit growth, the color, taste, textures, and moisture content depending on the variety of date are changed. When the moisture of the dates is between 30% and 35%, the texture is softer and tastes due to microorganisms such as bacteria, molds and yeasts that are spoiled. There is a close relationship between moisture and spoilage, fermentation and mold spoilage (King and Bolin, 1972). Decay and weight loss due to transpiration are important and limiting factors for fruit storage.

During harvesting and transportation if the fruits are wounded, they are contaminated by green and blue molds, if not effectively controlled, then get wasted before it reaches for consumption. The use of herbal essential oils in the control of postharvest diseases has been proposed as a new method in recent years. These compounds not only have side effects, but also increase the quality and shelf life of fruits due to their antioxidant properties (Tadayon et al., 2015). The use of natural compounds is to inhibit the growth of microorganisms and reduce quantitative and qualitative of fruits and vegetables in response to consumer pressure to reduce or stop, and the use of synthetic chemicals for agricultural products is increasing. Agrochemicals are commonly used in agricultural production to control or prevent diseases, pests and weeds in order to maintain high quality of agricultural products and eliminate or reduce yield losses.

With this industrialized system, food is produced at reduced costs and farmers therefore get higher profits from their farm but serious concerns were being raised about health risks resulting from residues in drinking water and food and from occupational exposure (Alori and Babalola, 2018). The application of heat treatment is used in a wide range of products to control the damage caused by cold storage (Sams, 1994). Heat treatment can have several advantages. It can delay ripening and control decay and insects attack, and it can be applied in the form of dry, hot air, humid hot air or hot water. Hot water treatment should be applied at the beginning of the packing or packing process. However, these treatments should not be used when fruit is harvested over-mature or with serious bruises or mechanical injury, since that heat would increase these injuries (Wills et al., 2007).

Use of low temperature during storage and transport is the most important way of maintaining quality of dates because it minimizes loss of color, flavor, and textural quality, delays development of sugar spotting, reduces incidence of molds and yeasts, insect infestation, and prevents development of syrupiness (due to conversion of sucrose into reducing sugars) and souring of excessively moist dates (Elhadi et al., 2013). *Chlorella vulgaris* is a unicellular microalga that grows in fresh water and has been present on earth since the pre-Cambrian period 2.5 billion years ago and since then its genetic integrity has remained constant. *Chlorella vulgaris* and their products are also used for different purposes like dyes, pharmaceuticals, animal feed, aquaculture and cosmetics. Nowadays a promising sustainable energy resource due to its capacity to accumulate large quantities of lipids is suitable for biodiesel production that performs much like petroleum fuel. They are also proved to be the source of products such as proteins, carbohydrates, pigments, vitamins and minerals. In addition, microalgae capture sunlight and perform photosynthesis by producing approximately half of atmospheric oxygen on earth and absorbing massive amounts of carbon dioxide as a major feed. Therefore, growing them next to combustion power plants is of major importance due to their remarkable capacity to absorb carbon dioxide that they convert into potential biofuel, food, feed and highly added value components (Carl et al., 2014).

Chlorella vulgaris is unicellular green algae and has been widely used as human food supplements. The protein content (8% – 50% dry weight) generally contains all the essential amino acids (Uchechukwu, 2017). Date Palm *(Phoenix dactylifera* L.) is one of the oldest fruit trees in the world and is mentioned in the Qur'an and Bible. It produces a berry fruit (date) that represents the basic food for North Africa, Arabia, and Iranian peoples, where hundreds of varieties are grown for commercial purposes and are deeply rooted in their economy, history and culture (Wrigley, 1995). Patil et al. (2015) worked on plant growth stimulating activity of fresh water micro algae, and they explained that algae, particularly the seaweeds, are used as fertilizers, resulting in less nitrogen and phosphorous runoff than the other from the use of livestock manure. Microalgae is a source of natural products and has been recently studied for biotechnological applications.

The diversity of microalgae makes a potentially rich source for various chemical products with applications in nutritional, cosmetic, pharmaceutical, and medicinal industries. Extracts from marine microalgae are rich sources of proteins, vitamins, and minerals. Chlorella, a unicellular green algae, contains various valuable proteins (40% – 60%) and has been widely used in aquaculture, food and biotechnology industries.

The extract from Chlorella contains various biologically active compounds including growth factors, anti-inflammatory and wound healing substances, antioxidants, and emollient compounds (Danielli et al., 2015). Mashhadinejad et al. (2016) reported that *Chlorella Vulgaris* was moderate to high antimicrobial activity which could be influenced by growth condition and extraction solvents. They showed that heterotrophic and mixotrophic growth significantly increased antimicrobial activity. They concluded that chloroform mediated extracting the highest antimicrobial potential that was observed when chloroform was used as extraction solvent. The objective of this study was to investigate the effect of algae concentration on the time of storage in *Kabkab* and *Khasouei* cultivar dates.

2 Materials and methods

The experiments were conducted at Persian Gulf University, Borazjan, Bushehr, Iran from 2018 to 2019. The site was located at longitude 51°13'54, 38"E, latitude 29°16'2, 38 N, and 80 m above sea level. In this research, two date cultivars *Kabkab* and *Khasouei*, microalgae with the name of *Chlorella vulgaris* at four levels 0, 25%, 50% and 100% and time of storage in three levels 1, 2 and 3 months (90 days) were carried out as factorial experiment in a completely randomized design with three replications. At first, 400 g of *Rutab* from both cultivars were counted and weighted. *Chlorella vulgaris* microalgaes were used to be the control of date storage placed in the freezer for frozen and then located at room temperature until liquefied and the concentrations 25%, 50% and 100% were obtained. The prepared fruits were immersed in these solutions for two minutes and were allowed to dry for two hours at room temperature and then re-packed in a refrigerator at 5°C. In this experiment some characteristics, such as pH of fruit, dry weight, and decay percentage, were evaluated. To measure dry weight, the samples were kept at 70°C for 72 hours and then weighed with a digital weighing accuracy of 0.01 g. To calculate the average cubic weight after sample weighing, the number of cubes was calculated. Equation 1 was used to calculate the average weight of the cubes.

$$A_{wn} = \frac{W_s}{N} \qquad (1)$$

Where, A_{wn}(g) = average weight of the cubes, W_s (g) = weight of sample and N = number of samples.

During the storage period, the samples were evaluated daily, and percentage of the decayed were weighted and separated. Equation 2 was used to calculate the percentage of decay monthly.

$$D\% = \frac{W_D}{W_T} \times 100 \qquad (2)$$

Where, D% = percentage of decay, W_D (g) = decayed weight and W_T (g) = total weight of samples. A pH meter was used to measure the pH of fruit extract. The analyses of variance and mean comparison test were used in Statistical Analysis System (SAS) program and Duncan's new multiple test respectively.

3 Results

Analyses of variance of pH, dry weight, rate of fruit decay are shown in Table 1. Analyses of variance showed that the main effects of sampling time and algae levels on all measured traits were significant at ($p \leq 0.01$) level.

Table 1 Analyses of variance of levels of algae concentration, date type and storage time

S.O.V	df	pH	Dry weight	Decay
Storage Time (month)	2	27.93^{**}	166.7^{**}	13075.6^{**}
Date type	1	1.87^{**}	62.7^{**}	603.4^{*}
Algae levels	3	1.61^{**}	10.5^{**}	2754.3^{**}
Month × date	2	0.02^{ns}	4.73^{ns}	4158.7^{**}
Month × algae levels	6	0.43^{*}	7.57^{*}	845.8^{**}
Date × algae levels	3	0.8^{**}	16.15^{**}	88.2^{ns}
Month × date × algae levels	6	0.93^{*}	14.47^{**}	45.03^{ns}
Error	72	0.13	2.55	34.65
C.V (%)		0.69	5.05	26.14

** Significant difference at ($p \leq 0.01$) level, *significant difference at ($p \leq 0.05$) level and ^{ns} not significant

Table 2 Comparison of means of different months, date type and percentage of algae concentration on pH, dry weight and decay of date fruits

S.O.V	pH	Dry weight (g)	Decay (g)
Khasouei date	6.45^{a}	30.537^{a}	19.958^{b}
Kabkab date	6.17^{b}	28.92^{b}	25.083^{a}
Algae (0%)	5.98^{b}	29.92^{ab}	36.375^{a}
Algae (25%)	6.5^{a}	30.583^{a}	24.458^{b}
Algae (50%)	6.53^{a}	29.25^{b}	18^{c}
Algae (100%)	5.99^{b}	29.162^{b}	11.25^{d}
Storage (1 month)	7.27^{a}	31.25^{a}	-
Storage (2 onth)	6.23^{a}	31.68^{a}	28.469^{b}
Storage (3 months)	5.41^{a}	27.094^{a}	39.094^{a}

According to Duncan's test, the different letters in each column showed a significant difference at the ($p \leq 5\%$) probability level.

The effect of date palm on pH and dry weight was significant at ($p \leq 0.01$) but their effect on fruit decay at ($p \leq 5\%$) was significant. Interaction between storage time and date type was significant at ($p \leq 0.01$) level but not significant for other traits. Interaction between storage time and algae levels on decay rate was significant at ($p \leq 0.05$) level, but significant at ($p \leq 0.01$) level for other traits. Interaction effects of type of date and different algae concentrations on pH and dry weight were significant at ($p \leq 0.01$) level but their effect on fruit decay was not significant. Results showed interaction among algae concentration, type of date and storage time per month which were significant for pH at ($p \leq 0.05$) level, for dry weight at ($p \leq 0.01$) and were not significant at fruit decay (Table 1). Independent effect of storage per month on pH showed that the highest pH (7.27) was found in the first month and the lowest (5.41) was obtained in the third month that presented a decrease of 25.6% (Table 2).

The differences in pH results among different studies may be related to differing effects of elevated O_2 on the respiratory rates of the commodities (Zheng et al., 2007). Samad and Moshfeghifar (2016) reported that oxygen is essential for the respiration of fresh horticultural commodities. The removed O_2 can be replaced with N_2, usually recognized as an inert gas, or CO_2, which is a competitive inhibitor of ethylene action and can lessen the pH or prevent the growth of some bacteria and fungi. When the O_2 level is decreased to below 12 kPa, and levels commonly used for most fresh horticultural commodities are about 3 – 5 KPa, the respiration rate starts to decrease. The absence of O_2 can produce anaerobic respiration, accelerating deterioration and spoilage. High CO_2 levels effectively prevent bacterial and fungal growth. However, levels more than 10 KPa are needed to suppress fungal and bacterial growth significantly.

The effect of type of date on the pH of fruit extract showed that the pH of *Khasouei* date was 4% higher than the pH of *Kabkab* dates. The highest pH of fruit extract (6.53) was observed in 50% concentration of algae and the lowest (5.98%) was obtained in non-algae treatment. Also, 25% and 50% of the algae concentration were located in one statistical group and 100% with non-algae concentration were placed in another statistical group (Table 2). The results is in agreement with the results of Martinez-Romero et al. (2005) and disagrees with, Nikos G. Tzortzakis (2007). There was a significant difference effect observed at statistical level ($p \leq 0.01$) according to the results of analysis of variance, independent effect of date type, time of storage (months) and different levels of algae on dry weight of date (Table 1). Comparison of the means of date type showed that the *Khasouei* dates with (30.537 g) had the highest and *Kabkab* date with (28.92 g) had the lowest dry weight (Table 2).

The possible reason for the significant difference between *Kabkab* and *Khasouei* cultivars varieties might be due to their metabolic processes, since *Kabkab* cultivars has higher intensity of internal reactions than that of *Khasouei* cultivar, thus causing a reduction in weight in this cultivar. According to Michal et al. (2018), weight reduction is mostly influenced by the concentration of the osmotic solution and the temperature. There was no significant difference between the first and second months of storage time on dry weight, but there was a significant difference in the third month.

The highest fruit dry weight (31.68 g) and the lowest fruit dry weight (27.094 g) was observed in the second month and third month, respectively. According to the analysis of variance (Table 1), the effects of storage time of fruits per month, date type (*Khasouei* and *Kabkab* cultivars), levels of algae concentration, interaction of storage time per month on date type (*Khasouei* and *Kabkab* cultivars), interaction of storage time per month, date type (*Khasouei* and *Kabkab* cultivars), and different levels of density of algae were significant at ($p \leq 0.01$) level on fruit decay (Table 1). Independent effect of different storage time per month showed that the highest amount of decay of fruit (39.094) was observed in the third month of storage time and the lowest amount of decay of fruit (zero) was found in the first month of storage time (Table 2).The highest amount of decay was observed in *Kabkab* date cultivar at zero percentage of algae concentration after three months of storage time (Table 2).

Results showed the highest decay (25.083 g) and the lowest (19.958 g) were observed in *Kabkab* and *Khasouei* dates, respectively. Similarly, Al-Redhaiman (2004) reported the highest weight loss, least fruit firmness and highest fruit decay percent of fruit control are firmly related to each other and they usually have a common effect on each other. Also researcher reported that fruit weight loss during storage period is accompanied by some disruption of the fruit tissues, which may facilitate the penetration of the decaying organisms. The attack of fungi and other microorganisms would result in more destruction of the tissues which in turn would cause softness and reduction in fruit firmness. Baraka et al. (1987) reported that date fruits deterioration could be attributed to the activity of the fungus in producing pectinolytic and cellulolytic enzymes. Nihad et al. (2019) reported that the best ranges of moisture content of date palm fruit for storage are 23% to 25% and moreover they suggested decreased moisture content below this level led to fruit shrinkage during drying and negative changes in physical properties of fruits such as firmness, colour and total soluble solids. Shelf life can be extended by storage at lower temperatures, but in general, deterioration (darkening and loss of flavor) increases with increasing moisture content. According to Kader and Yahia (2011) souring can occur in dates with moisture contents above 25% when kept at temperatures above 20℃. Its severity increases with duration and temperature of storage. Storage at low temperatures reduces the incidence and severity of souring.

Therefore, more decay in *Kabkab* dates may be related to higher moisture content in this cultivar. The highest decay (36.375 g) and lowest decay (11.25 g) were observed in non-algae and algae with 100% density treatment, respectively (Table 2). Interaction effects of different storage of months on different levels of algae concentration showed that the highest pH (7.665) of fruit extract was obtained at 25% concentration of algae in the first month of storage time, and the lowest (5.095) was found in the third month of storage time at non-algae concentration. A decreasing trend for pH was observed at all different levels of algae concentration with increasing of storage time (Table 3).

Table 3 Comparison of mean interactions of different levels of algae in different months of storage of date on the pH, dry weight and decay of fruit extract

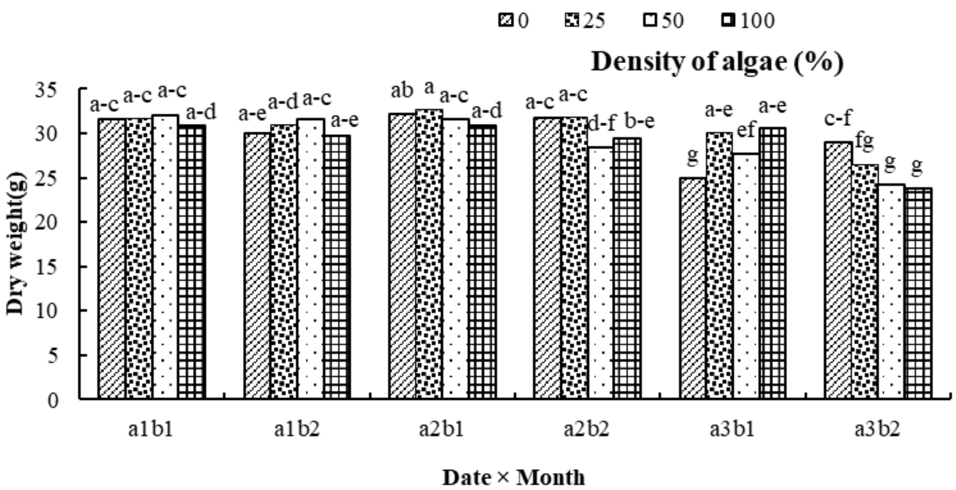
	Density (%)	Kabkab date	Khasouei date	First month	Second month	Third month
pH	0	6.104^{de}	5.87^{e}	6.841^{c}	6.025^{e}	5.095^{g}
	25	6.35^{b-d}	6.652^{ab}	7.665^{a}	6.462^{d}	5.37 $^{f-g}$
	50	6.37^{cd}	6.752^{a}	7.333^{ab}	6.568^{cd}	5.7^{ef}
	100	5.9^{e}	6.51^{a-c}	7.266^{b}	5.88^{e}	5.477 ^{fg}
Dry weight	0	30.266^{ab}	29.575^{ab}	30.755 ^{ac}	31.9875^{a}	27de
	25	29.733^{b}	31.433^{a}	31.275^{ac}	32.225^{a}	28.25^{d}
	50	28.066^{c}	30.433^{ab}	31.775^{ab}	29.975^{c}	26^{e}
	100	27.616^{c}	30.708^{c}	30.275^{bc}	30.087^{c}	27.125^{de}
Decay	0	-	-	-	43.75^{b}	65.375^{a}
	25	-	-	-	29.875^{cd}	43.5^{b}
	50	-	-	-	24^{c-e}	30^{c}
	100	-	-	-	16.25^{f}	17.5^{f}
Khasouei date		-	-	-	24.812 ^{c}	35.062^{b}
Kabkab date		-	-	-	32.125 ^{b}	43.125^{a}

According to Duncan's test, the different letters in each column of group (pH, dry weight and decay) showed a significant difference at ($p \leq 0.05$) probability level.

Interaction between different levels of algae concentration and date type showed that the highest pH of fruit extract (6.752) was observed in 50% of algae concentration for *Khasouei* cultivar dates. There was no statistically significant difference between 50% and 100% algae concentration for type of *Khasouei* date cultivar. The lowest pH (5.87) was observed in the *Khasouei* cultivar and non-use of algae concentration. There was no significant difference observed between *Kabkab* date cultivar at 100% and non-algae concentration, and it can be concluded that they were placed in the same statistical group (Table 3). Based on comparison table of means, interaction effects of different levels of algae concentration at different storage time per months showed that the highest dry weight of date fruit (32.225 g) was obtained at 25% algae density treatment in the second month and the lowest dry weight (26 g) was observed at 50% algae density in the third month of storage time (Table 3). Those were not statistically significant differences with algae (0%

concentration). Results showed that there were not statistically significant differences observed in dry weight at algae with 50% and 100% density. There was a statistically significant difference at ($p \leq 0.01$) level observed in interaction effect of different levels of algae and dates on the dry weight of date fruit (Table 1). Based on comparison table of means, the highest fruit dry weight (31.43 g) was observed for *Khasouei* date cultivar at 25% density of algae and the lowest dry weight (27.616) was found for *Kabkab* date cultivar at 100% concentration of algae (Table 3). Interaction between different levels of algae and different storage time per months showed that no decay was observed at all algae levels in the first month of storage time, although the interaction between date type and storage time was statistically significant at ($p \leq 0.01$) level. The highest decay (43.125 g) was observed in *Kabkab* dates cultivar in the third month of storage time (Table 3). The membrane by phospholipase and lipoxygenase enzymes affects weight loss and membrane permeability, which is seen as wrinkling and damage to the skin tissue (staining) on the fruit surface. In the present study, storage of dates in the refrigerator caused an increase in the decay rate. The interaction effect between different levels of algae concentration and different time of storage per months is showed in Table 3.

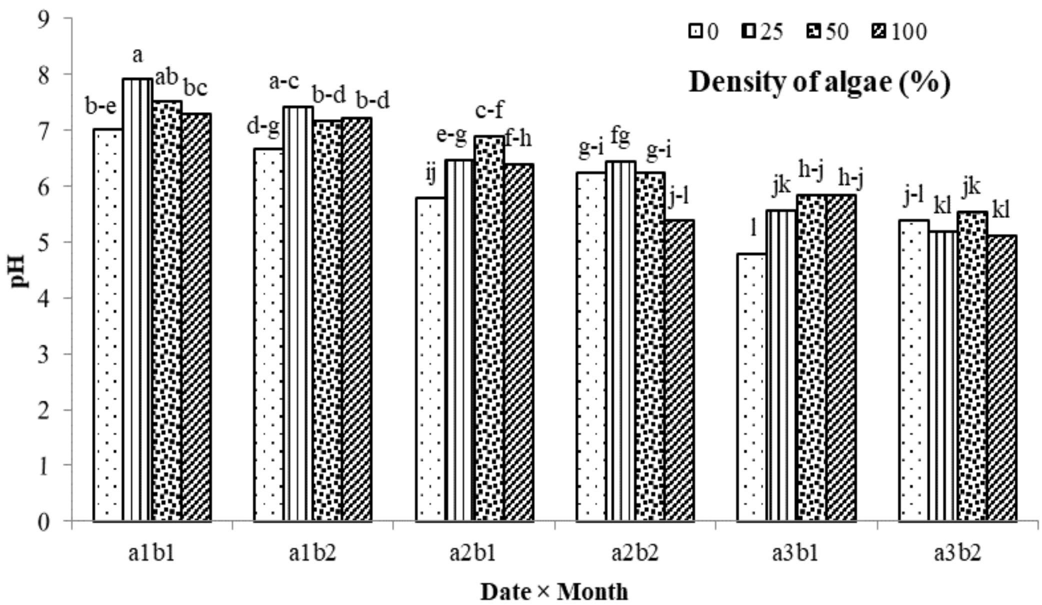
Results indicated that the highest rate of decay (65.375 g) and lowest rate of decay (16.25g) were obtained in the third month of storage time with zero percent of algae consumption and 100% of algae concentration in the first and second month, respectively. It seems that substances such as steroids, terpenoids and phenolic compounds have antimicrobial properties in the extract of this microalgae, which confirms the antimicrobial properties of chlorella algae and reduced fruit decay caused by the use of this extract. Bhagavathy et al. (2011) reported that green algae *Chlorococcum humicola* is a rich and varied source of pharmacologically active and natural products and nutraceuticals. While nutraceutical and pharmaceutical content in the baseline algae strain is very small, they showed that the algae is an excellent effect against the microbial pathogens. There was a significant difference at ($p \leq 0.01$) level in interactions effect among time of storage, type of dates and concentration of algae (Table 1). The highest dry weight of fruit (32.675 g) was observed at 25% of algae density at the second month of storage time in *Khasouei* cultivar, and the lowest dry weight was achieved at 100% concentration of algae in the third month storage in the *Kabkab* dates (Figure1). Also, there was no significant difference observed in algae with 50% concentration and non-algae density for *Kabkab* date cultivar after three months of storage time.



(a1 = the first month of storage time, a2 = the second month of storage time, a3 = the third month of storage time, b1 = *Khasouei* date and b2 = *Kabkab* date). According to Duncan's test, the different letters showed a significant difference at the ($p \leq 0.05$) probability level.

Figure 1 Comparison of the average interaction effect of storage time per month, type of date and levels of density of algae on dry weight of fruits

Interaction among concentration of algae, date type and time of storage showed that the highest pH (7.90) was obtained in *Khasouei* date, at the first month of storage and at 25% algae concentration. Also the lowest value of pH (4.79) was observed in *Khasouei* date at the third month of storage at zero percent (no use) algae density (Figure 2).



(a1 = the first month of storage time, a2 = the second month of storage time, a3 = the third month of storage time, b1 = Khasouei date, b2 = Kabkab date). According to Duncan's test, the different letters showed a significant difference at the ($p \leq 0.05$) probability level.

Figure 2 Comparison of the average interaction effect of storage time per month, type of date and levels of density of algae on pH of fruits

The pH of the fruit extract during the storage period increases with time, probably due to the breakdown of organic acids in the respiratory and ripening process of fruits. The lower pH in the treated fruits is possibly due to the reduction of the breakdown of carbohydrates, pectic materials, prevention of hydrolysis of proteins and glycol saccharides into smaller units during respiration. Similar findings were reported by Yadav and Chakarvarty (2013) in which pH decreased during storage time of fruits.

4 Conclusions

The most challenge is in date's industry are unsuitable storage conditions, alteration of physical and chemical properties during storage time, and undesirable type of date packaging. Due to the importance of this product, it is necessary to increase the shelf life, preserve the quality of fruit, and therefore increase the export rate, the suitable packaging and proper storage conditions that need be used. In this study, results showed that the effect of algae density and different time of storage per months was significant for all treatments at ($p \leq 0.01$) level. Regarding the type of date's cultivar, results showed that the effects of treatment on *Khasouei* cultivar for all characteristics were better and higher than the *Kabkab's* cultivar. Moreover, it can be generally stated that the effect of *Chlorella vulgaris* with 25% concentration was more effective to compare with other concentrations. Based on this research, the effect of density of selected algae was decreased after two months of storage time of *Khasouei* and *Kabkab* cultivars.

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