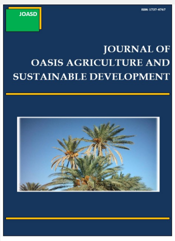

JOURNAL OF OASIS AGRICULTURE AND SUSTAINABLE DEVELOPMENT

www.joasdjournal.org

JOASD

p-ISSN: 2724 – 699X
e-ISSN: 2724-7007

Improving Quality of Arabic Dates by low Doses of Irradiation

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Article info

History:
Received 09 June 2021
Accepted 30 June 2021

Keywords: Gamma irradiation, Arabic dates, chemical analysis. ESR.

OPEN ACCESS

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Conflict of Interest: The authors declare no conflict of interest

Abstract

This work aim to select the optimum dose of γ-rays for keeping quality of semi dry dates(SDD) through studying physical, chemical ,microbiological characters besides disinfestations of dates. Three Arabic SDD varieties as Siwi (Egypt), Sukkary (Saudi Arabia) and Zahidi (Iraq) at 'Tamar' stage were irradiated with γ-rays (0.0,1.0, 3.0 5.0 kGy).The storage of packaged treated samples was extended eight months at room temperature (20 ~25 C°, 70~75%RH). The free radicals was monitored by Electron Spin Resonance (ESR), survey insects and microbes. Besides, tracking the changes of bioactive content (amino acid- AA, sugars and Soluble Solid Contents -SSC). Results revealed that ESR-signals of edible parts were completely disappeared after one month whereas it's present in kernels. Also, irradiation eliminated completely all stages of insects and reduced the microbial load either fungi or bacteria. HPLC- analysis of AA showed presence of seventeen one (μg/g dry weight), in all tested samples, the difference occurred due to variety and irradiation dose. Sugars were accumulated at end of storage (8 months), whereas negligible changes were recorded in total, reducing or non-reducing sugars but were significantly between varieties. Same trends were noticed in SSC. At the end, the preferability of using low dose of γ–irradiation are suitable on large scale, safe alternative for using pesticides and sufficient for keeping quality of tested Arabic semi dry dates without high losses in nutritive values.

1. INTRODUCTION

Date fruits (*Phoenix dactylifera L.*) are produced mainly in the Middle East, Northem Africa and Southern countries. The amount of dates world production has raised to 6.8 million tons (82.25%) are produce in Arabic countries (FAO STAT, 2012). Whereas, Egypt are the largest producer with an average of 1.5 million ton per year. In spite of increase, the date production losses postharvest (%) increased near 25 % of annual production in the world (Shenasi et al., 2002).

Semi dry dates (SDD) contain moderate level moisture content in the range 20-30% depend variety which attractive insects or pathogenic microbes during long storage (Emam et al., 1994, Farag et al., 2012). According to the regulation of exportation of dates must free from insects or chemicals residue (GSO 656, 2011). Some of the famous Arabic varieties of SDD are Siwi (Saeedy or Siwi) in Egypt, Sukkary and Khalas in Saudi Arabia, whereas in Iraq call Zahidi (EL-Sideek et al., 2014).

The nutritional value of dates are recommended as ideal fruit containing most valuable amounts of bioactive compounds (El- Sohaimy and Hafez, 2010, Farag et al., 2012). Dates contained all main human nutrients in balance of amino acids with suitable concentrations.

There are different methods for control the deterioration of dates as freezing, cold storage, control atmosphere, CO_2, pesticides and others. Farmers usually prefer the cheapest method and easily for application on large scale with high profit. Therefore, Farmers use pesticides as fumigation with methyl bromide (MB)-which prohibited, but now phosphine (PH_3) gas toxin as tablets per bags. In Saudi Arabia, frozen storage, drying, cold storage are common methods of preservation but it's too expensive and would need careful consideration (Farag et al., 2012 ; 2013). Recently, irradiation became the durable alternatives as safe alternative of food preservation to minimize food losses during storage, quarantine to control insects (Gado, 2008). Irradiation is considered today the only safe method, applicable and economical on large scale (Farag et al., 2012). It is considered safe, non-thermal methods for disinfestations, and no big changes were recorded on quality (Gado, 2008; Farag et al., 2012). More than 50 countries declared, applied irradiation for biological decontamination for different types of foodstuffs on an industrial scale (WHO, 1994; Farag et al., 2013). Now, in Egypt, different sources of irradiation have been commercially used for sterilization of dried foodstuffs, herbs, and medical goods.

The present work aim to evaluate the optimum applicable γ-irradiation dose for keeping quality of semi dry Arabic dates to control the infestation of dates with tracking the changes of nutritive content, Electron Spin Resonance (ESR) during long term of storage at room temperature.

2. MATERIAL AND METHODS

2.1. Sampling and irradiation process

Three Arabic varieties of SDD were selected from Egypt (Siwi), Saudi Arabia (Sukkary) and Iraqi (Zahidi) at 'Tamr' stage (the final of mature stage). All samples were not fumigated, collected after harvesting and sun drying completely as SDD samples. Ten kilograms per each variety were packaged in polypropylene bags, and then transferred to National Centre for Radiation Research and Technology (NCRRT), Nasr City, Cairo for irradiation process. These doses were selected according some authors (Gado, 2008; Farag et al., 2012).

γ-irradiation process was carried out at NCRRT, samples were irradiated with at different doses 0.0, 3.0 and 5.0 kGy per each date variety at room temperature (20-25 ^{0}C) using γ-source, Cobalt-60, Russian Model at dose rate 10 kGy.hr^{-1}. Every dose treatment contained four replicates (4x250gm). The irradiation source had been calibrated by Reference Laboratory at National Physical Laboratory (NPL, Teddington, UK). All irradiated samples or not were packaged, stored at room temperature (20-25 C°, RH: 70-75%) even 8 months at NCRRT.

2.2. Physical and chemical analysis

2.2.1. Physical analysis: ESR measurements

Dried samples of all treated three date varieties as edible part, kernel fragments separately were prepared .The treated samples were dried completely then were crushed, sieved, to homogenize in the range of 200 to 300 µm fractions. Only 100 mg of dried powdered for each sample was inserted in a Perspex phantom of 5 mm thickness as a buildup material. The preliminary of our work proved that grinding could produce signals, which disappear after two weeks. Therefore, ESR measurements were done after 2 weeks of irradiation to avoid any false signal.

The irradiation process was done at room temperature using a Co-60 γ-source at the National Center for Radiation Research and Technology (NCRRT) at the Egyptian Atomic Energy Authority at dose rate of ~ 3.75kGy/h (Farag et al., 2013). The measurements of free radicals in dry samples were carried out at zero time of storage even one month later.

2.2.2. ESR-spectroscopy measurements

ESR spectra were measured with an X-band ESR spectrometer (Bruker, EMX) at room temperature using a standard rectangular cavity (4102 ST) operating at 9.75 GHz. with a 100 kHz modulation frequency. The standard deviation was about 0.5% from the mean value. MgO doped with Mn2+, weak pitch and DPPH (a; a-diphenyl-b-picrylhydrazyl) was used as standard samples to calibrate the ESR intensity and the g-factor of the signal. ESR measurements and analysis were carried out at the methods of National Institute for Standards (NIS) (Farag et al., 2013).

2.3. Chemical analysis

2.3.1. HPLC analysis of amino acid

Dried and defatted samples were weighted in the range 50-100 mg then pushed through screw-capped tubes with addition 5 ml of 6.0 N HCl. The hydrolysis was done in closed system system, which allows the connection of nitrogen and vacuum lines without disturbing the sample. The tubes were transferred to oven at 110 °C for 24 hours (Nielson, 1998). Every treated sample inside tubes were opened, the solution contents were filtered and evaporated until dryness by using rotary evaporator. The dissolving of the dried film of the hydrolyzed sample was done by added suitable volume of sodium citrate buffer pH 2.2 then ultrafiltration was performed using a 0.2 µm membrane filter (Baxter, 1996). Amino acid analyzer Biochrom 20 (Auto sample version) Pharmacia Biotch constructed was used at high performance at NCRRT. Then the obtained data of each chromatogram was analyzed by EZ Chrom TM chromatography data system tutorial and user Guide-Version 6.7.

2.3.2. Sugars content (%)
It was performed calorimetrically using method as recommended by Dubois et al. (1956), the values expressed as g /100 g fresh pulp weight. Reducing, non-reducing then total sugars were determined as Official Methods of analysis (AOAC, 1990).

2.3.3. Moisture Content
The moisture content was determined according AOAC (1990).

2.3.4. Total Soluble Solid Content
The value of Soluble Solid Contents SSC (°Brix) was measured by using General Purpose Automatic Refractometer (Index instruments GPR 11-37 Refractometer). Few drops of extracted juice from homogenized pulp are filtrated through what man No.1 filter paper, by calibrating temperature at 20°C.

2.4. Microbiological analysis
Under sterile area, 25 g per each sample was blended with 225 ml of sterile saline solution (0.85% NaCl) for one minute then the mixture was diluted ten-fold with the sterile saline solution. Potato Dextrose Agar (PDA) was prepared to containe: Potato extract (200 g) /l, Dextrose (20g)/l, Agar (15g) / Water 1l (Difco). The counting of fungi and isolation per each sample was carried out according to Ichinoe and Rehberger (1983). The plate count agar medium using pour plate technique was used to count bacteria as total aerobic bacteria (TAB) and spore-forming bacteria (SFB). The inoculated plates were incubated at 30^0 C for 5 d. Total yeasts and molds were counted in Czapek agar medium through the pour plate technique (Oxoid, 1982).

2.5. Insect Disinfestations
The calculation of infested dates, were done by binocular after 6 months of post-irradiation treatments according besides the observations and examinations according method of Farag et al. (2012). Selection of four replicates were done each treatment, were examined for the presence of a live insects or traces as larvae or faces. Ten fruits were chosen at random per each box, each one was cut, opened and faces were counted per each fruit.

2.6. Statistical analysis
The average of four replicates was calculated per each sample and the figures were then averaged. SAS program was used for the statistical analysis (SAS, 1990**)**. Whereas, the analysis of variance (ANOVA) and means were separated by Duncan's multiple range tests with a probability p ≤ 0.05 (Steele and Torri, 1990).

3. RESULTS

3.1. Free radicals determination :
Generally, ESR–free radicals in presence of moisture like food tissues are disappear quickly, whereas, the dried parts of fruits are requires in official method.

As a result, European Committee of Standardization issued several standards, the irradiated plant tissues as dates can characterized by signal spectroscopically splitting factor (g-factor) of $g^{\perp}$ = 2.00559. This ESR signal ascribed to induced free radicals in cellulose. Usually, used parts are dry solid parts of the food to analyze, EN 1787 refers (EN Protocol EN 1787) to the presence of ``cellulose-type'' radical with a separation of about 6 mT and centered around g=2.004 (Yordanov and Aleksieva, 2009).

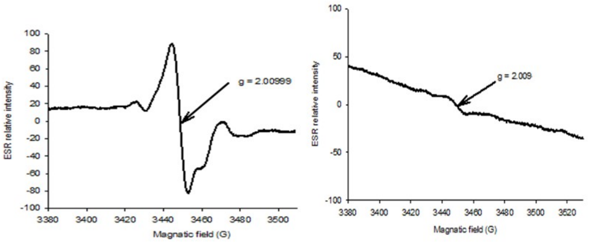
ESR signals of Arabic dates are summarized in Table 1. A big difference in shape and intensity were recorded after irradiation in kernels of date fruits. But the shape of signals are similar like in Fig. 2 and 3 with around g- value = 2.00999 for cellulose. For example, as shown in Fig. 2 and 3, Saudi Arabia-date variety (Sukkari) for edible parts and kernel. The intensity of ESR-edible parts was very low, short time not extend more one month in all irradiated Arabic dates. ESR-singlet of edible parts recorded low values which fading gradually and lost near 50% of initial values as 48.54%, 50% for irradiated edible parts by 1.0 kGy, 3.0 kGy and 5.0 kGy respectively (Table 2, Fig.2). The explanation of fading ESR–signal of edible parts due to presence moisture content (20-30%) in fruits consequently, causes disappearance of free radicals and fading in signal. Like same results were noticed by workers (Yordanov & Pachova 2006, Mladenova *et al*, 2010).

Table 1: ESR Intensity of Arabic dates at zero time and one month of storage.

Date variety-irradiation dose (k Gy)	At zero time		After one month	
	Edible part	Kernel	Edible part	Kernel
Saudi Arabia - Sukkary				
0.0	15.8±1.2	66±0.9	16.0±1.3	63±1.4
1.0	44±1.1	132±1.4	23±1.3	92±1.0
3.0	65±1.4	235±1.0	30±0.9	135±1.2
5.0	70±1.5	243±1.5	35±0.5	200±1.4
Egyptian - Sewi				
0.0	28.8±0.8	76±0.6	27.8±0.8	65±0.6
1.0	44±0.5	232±0.5	28.0±0.5	111±0.5
3.0	60±0.7	235±0.6	25±0.7	135±0.6
5.0	66±0.5	390±0.7	34±0.5	243±0.7
Iraqi - Zahedi				
0.0	30.8±0.4	86±0.6	28.8±0.8	76±0.6
1.0	44±0.5	242±0.5	33±0.5	102±0.5
3.0	65±0.7	355±0.6	43±0.7	235±0.6
5.0	67±0.5	443±0.7	45±0.5	243±0.7

Mean ± standard deviation. Values sharing same letters differ non-significantly (P>0.05)

Whereas ESR- signals of kernel recorded high values of signals with stability even after one month of storage. Kernels considered an ideal stone parts due to its hardens, low water content to use for detection of irradiated dates as proved by many workers (Yordanov and Pachova 2006; Attia *et al*, 2009). ESR –signals of irradiated kernels of date samples increased gradually with increasing doses compared with unirradiated samples (Fig 2. and 3.). These signals can be detected after more than one year with modification methods as showed by Egyptian workers (Farag and Shams, 2010).



A -Irradiated edible parts. B-Irradiated kernel

Fig 1. ESR spectra of irradiated 1.0 kGy of date parts after 1 month of storage.

Table 2. Effect of γ- irradiation on contamination (%) of Arabic dates after 8 months of storage at room temperature (20-25⁰C, 70-75 % RH).

Irradiated fruits (kGy)	Microbiological test		Infested dates %
	Total fungi(CFU/g)	Total bacteria	
Egyptian variety (Siwi)			
0	3.4×10^3	5.0×10^5	88
1	1.3×10^3	1.3×10^5	13
3	$1.0x10^2$	$1.0x10^4$	9
5	ND	$1.0x10^3$	ND
Saudi variety (Sukkary)			
0	1.4×10^2	4.0×10^3	40
1	0.4×10^2	1.1×10^3	10
3	1.0×10	$2.0x10^2$	ND
5	ND	$1.0x10^2$	ND
Iraqi variety (Zahdi)			
0	4.6×10^3	3.0×10^5	60
1	2.3×10^2	2.3×10^4	20
3	0.6×10^2	$3.0x10^3$	11
5	0.4×10^2	$2.0x10^2$	ND

3.2. Control contamination and Infestation of dates

Insects are the main danger of stored dates, spoilage of fruits which penetrate inside fruits, fragments and faces then encourage the microbial contamination as reported by workers (Emam *et al*, 1994; Gado, 2004). As shown in Table 3, high losses were recorded in all control samples of tested varieties by insects after 9 months of storage at room conditions. Insects were identified as *Ephestia sp., Oryzaephilus sp* and *Tribolium sp.* Whereas, irradiation dose 1-3kGy eliminated completely all stages of insects. Same results were obtained by workers (Emam *et al*, 1994; Gado, 2008).

Six pathogenic geniuses of fungi were identified in tested samples as *Aspergillus* sp., *Fusarium* sp., *Penicillium sp., Cladosporium sp., Alternaria sp.,* and *Mucor sp.* All unirradiated samples were contaminated with most of fungi depending on variety as shown in Table 3. The Fungal count averages of control samples was higher in Siwi, Zahdi (3.4×10^3, 4.6×10^3 CFU/g) but Sukkary was less (1.4×10^2 CFU/g) respectively. Also, same trends were observed in Total Bacteria, whereas, irradiation treatment reduced the microbial contamination with increasing dose. Using 1.0-3.0 kGy was sufficient to reduce microbes and fungi contamination to safe levels, whereas, high dose (5.0 kGy) eliminated the microbes completely in Egyptian variety (Siwi) but not in the others (Table 3). Like these data were obtained by investigators (Emam *et al*, 1994; Ragab *et al*, 2001; Gado, 2008).

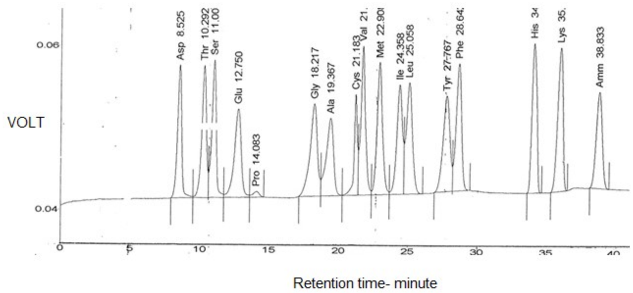


Fig 2. HPLC-chromatogram of amino acid standard.

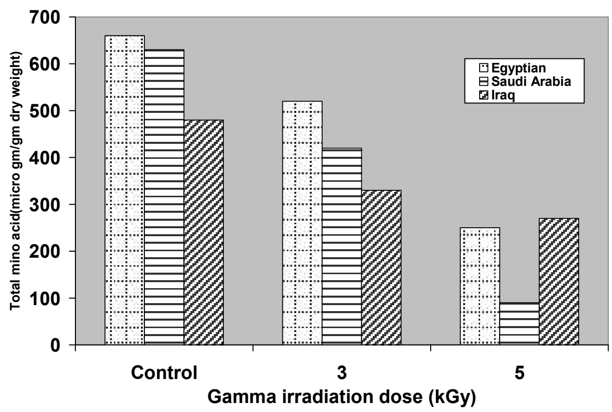


Fig 3. Effect of irradiation doses on total amino acid content (µg/gm dry weight) of semi dry date fruits of Arabic varieties.

3.3. Chemical analysis

SDD contain moderate level moisture content near 20% depend on variety (Hussein *et al.*, 1976) which activate infestation and microbe contamination during long storage (Emam *et al*, 1994, Farag *et al*, 2013). The nutritional value of dates are recommended as ideal fruit containing most valuable amounts of nutrients in balance of amino acids (El- Sohaimy and Hafez, 2010).

3.3.1. Amino acid (AA)

The profile standard of AA as shown in Fig 3. AA content of the tested Arabic dates and its changes after irradiation process as in Table 4.The total AA of un-irradiated samples of Egyptian, Saudi Arabian, Iraqi varieties at zero time of storage contained 660,630 and 480 (µg/gm dry weight) respectively. Whereas, seventeen AA were detected in all tested samples (Fig 3.), essential amino acid (EAA) were occupied high concentration as 370, 360 and 240 (µg/gm DW) for same varieties, respectively. Also, same trend was observed in total non-essential amino (NEAA), which contained 290, 270 and 240 (µg/gm DW) for same varieties respectively. Its, necessary to mention that analysis was done after irradiation in tested varieties, whereas some of AA were traces consequently became undetectable levels as observed in irradiated samples or not. For the profile of EAA individually (Table 2), as observed in the Egyptian SDD contained 8, Saudi Arabian had 7 against 5 in Iraqi (Zahidi) wherever missed Methionin, Lysine and Threonin. Also, same trend was observed in NEAA individuals for tested varieties as shown in Table 2. Only Prolin was undetectable in Egyptian dates, whereas four NEAA were absent in Saudi Arabian, Iraqi dates as Arginine, Cysteine, Tyrosine and Prolin. Like these results were obtained by workers (AL-Farsi and Lee, 2008, Bouaziz *et al*., 2008).whereas, eighteen free and bound amino acids were detected in three commercially packed varieties of Iraqi dates (Bouaziz *et al*., 2008). Besides, fifteen amino acids were identified in Sukkary and Khals dates by Nassef and Jobair (2004).

Table 3: Amino acid content of irradiated Arabic dates (µg/gm dry weight) after irradiation process.

	Egyptian- Siwie			Saudi Ara. Sukkary			Iraq-(Zahidi)		
Dose (kGy)	0.0	3.0	5.0	0.0	3.0	5.0	0.0	3.0	5.0
EAA:									
Isoleucine	20	10	10	30	30	ND	30	ND	ND
Leucine	150	100	70	120	90	ND	60	60	60
Threonine	30	30	10	30	ND	ND	ND	ND	ND
Lysine	40	30	10	30	ND	ND	ND	ND	ND
Phenylalanine	50	40	30	60	60	30	60	60	60
Methionine	10	10	ND	ND	ND	ND	ND	ND	ND
Valine	30	20	20	60	30	ND	60	30	30
Histidine	40	30	20	60	30	ND	30	30	ND
Total (EAA)	370	270	170	360	270	30	240	180	150
Non-EAA:									
Arginine	20	10	10	ND	ND	ND	ND	ND	ND
Alanine	40	30	10	90	60	30	60	60	ND
Aspartic	60	40	ND	90	60	30	90	60	60
Cysteine	30	30	ND	ND	ND	ND	ND	ND	ND
Glycine	40	40	20	30	30	ND	30	30	30
Glutamic	50	50	30	30	ND	ND	30	30	30
Serine	40	40	20	30	ND	ND	30	ND	ND
Tyrosine	10	10	ND	ND	ND	ND	ND	ND	ND
Proline	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total (NEAA)	290	250	90	270	150	60	240	180	120
Total AA	660	520	250	630	420	90	480	360	270

3.3.2. Sugars

The main components in dates are sugars which are the main characteristics of each variety as shown in Tables 5-7.The high content of total sugars are recorded in Siwey, then Sukkary and Zahidi respectively. A negligible changes were observed on sugars either reducing or non-reducing as resulted during storage period (8 months) but nothing observed due to irradiation treatments. Generally, a negligible changes were observed in total sugars after irradiation but sugars accumulated at end of storage (8 month). Also, high content of total sugars was clear in Siwey, Sukkary, Zahidi, as 31.5, 26.4, 22.5 mg/100g (at zero time of storage) which increased to 38.38, 30.0 and 30.45mg/100gm) at end of storage. Whereas, insignificant increase was observed by γ–irradiation on total sugars for all tested samples. In our work, no changes resulted after irradiation treatment may be due to use low dose (3.0 kGy). In the same time, some reduction by irradiation were observed as in Table 6, in Reducing sugars of Egyptian dates, besides reduction in irradiated dates for all tested samples as in Table 7. Same trends were observed by Emam *et al*, (1994).

Table 4. Effect of γ- irradiation on total sugars (mg/100gmDW) of Arabic dates during long storage period.

	Storage period (months)		
	0.0	3.0	8.0
Egyptian (Siwiee var.)			
Un-irradiated	31.50 ± 1.2 ab	36.40 ± 0.4 a	38.38 ± 2.6 bc
3.0 kGy	33.03 ± 1.3 a	36.87 ± 2.3 a	41.10 ± 2.3 ab
5.0 kGy	33.96 ± 1.4 a	35.43 ± 1. 8 ab	43.80 ± 4.0 a
Iraqi (Zahidi var.)			
Un-irradiated	22.47 ± 1.0 f	26.17 ± 1.3 d	30.0 ± 1.6 c
3.0 kGy	24.10 ± 4.3 f	28.50 ± 1.2 cd	30.17 ± 2.3c
5.0 kGy	25.9 ± 2.9 ef	28.77 ± 1.4 bc	29.2 ± 1.3 c
Saudi (Sukkary var.)			
Un-irradiated	26.40 ± 2.2 ef	28.33 ± 1.3 cd	30.45 ± 2.7 c
3.0 kGy	29.13 ± 1.8 bc	30.77 ± 1.6 de	31.70 ± 2.1 bc
5.0 kGy	29.27 ± 0.7 bc	30.80 ± 2.1 c	34.30 ± 3.6 dc

Mean ± standard deviation. Values sharing same letters differ non-significantly (P>0.05)

Table 5. Effect of γ- irradiation on reducing sugars (mg/100gmDW) of Arabic dates during long storage period.

	Storage period (months)		
	0.0	3.0	8.0
Egyptian (Siwiee var.)			
Un-irradiated	12.63 ± 0.8 ab	20.27 ± 1.8 ac	24.90 ± 3.8 a
3.0 kGy	14.46 ± 1.4 a	22.00 ± 1.1 a	23.93 ± 2.8 a
5.0 kGy	13.77 ± 18.8 a	21.30 ± 0.4 ab	21.6 ± 3.5 ab
Iraqi (Zahidi var.)			
Un-irradiated	9.67 ±1.2 c	13.57 ± 2.0 e	15.00 ± 1. 3 d
3.0 kGy	12.17 ± 1.4 ab	17.90 ± 1.3 cd	19.00 ± 1.5 bc
5.0 kGy	12.03 ± 0.8 ac	18.07 ± 1.8 bc	19.30 ± 0.8 bc
Saudi (Sukkary var.)			
Un-irradiated	10.50 ± 1.7 bc	12.40 ± 1.7 d	13.73 ± 1.3 e
3.0 kGy	10.03 ± 1.0 bc	13.3 ± 0.3 e	16.07 ± 1.7 cd
5.0 kGy	10.20 ± 0.7 bc	15.60 ± 0.7 de	19.37 ± 1.3 d

Mean ± standard deviation. Values sharing same letters differ non-significantly (P>0.05)

Table 6. Effect of γ-irradiation on non-reducing sugars (mg/100gmdw) of Arabic dates during long storage period.

	Storage period (months)		
	0.0	3.0	8.0
Egyptian (Siwiee var.)			
Un-irradiated	18.86 ± 0.2 a	14.60 ± 0.9 a	13.53 ± 5.6 bc
3.0 kGy	18.73 ± 0.6 a	14.80 ± 1.8 a	17.17 ± 3.2 ab
5.0 kGy	20.20 ± 0.7 a	11.20 ± 2.4 a	22.20 ± 5.8 a
Iraqi (Zahidi var.)			
Un-irradiated	16.50 ± 0.0 b	16.43 ± 0.1 a	7.47 ± 0.8 cd
3.0 kGy	16.6 0± 1.4 b	17.80 ± 1.4 a	4.90 ± 4.7 d
5.0 kGy	16.46 ± 0.6 b	12.20 ± 2.1 a	6.60 ± 2.1 cd
Saudi (Sukkary var.)			
Un-irradiated	18.63 ± 0.6 a	18.00 ± 1.7 a	18.37 ab ± 0.21
3.0 kGy	19.20 ± 1.4 a	17.50 ± 2.0 a	18.23 ab ± 5.11
5.0 kGy	18.13 ± 2.0 ab	14.90 ± 3.3 a	7.03 cd ± 3.16

Mean ± standard deviation. Values sharing same letters differ non-significantly (P>0.05)

Table 7. Effect of γ-irradiation on SSC (%) of Arabic dates fruits during long storage period.

	Storage period (months)		
	0.0	3.0	8.0
Egyptian (Siwiee var.)			
Un-irradiated	39.25 ± 2.0 ab	40.63 ± 0.4 a	48.93 ± 3.0 a
3.0 kGy	41.17 ± 1.9 a	43.36 ± 0.8 a	53.53 ± 2.2 a
5.0 kGy	42.30 ± 1.9 a	47.43 ± 0.4 a	53.17 ± 3.5 a
Iraqi (Zahidi var.)			
Un-irradiated	32.70 ± 1.7 dc	32.5 ± 2.7 a	30.73 ± 0.4 d
3.0 kGy	32.00 ± 4.5 d	36.30 ± 4.2 a	33.50 ± 4.6 cd
5.0 kGy	36.37 ± 2.4 bc	37.63 ± 2.0 a	33.03 ± 3.6 d
Saudi (Sukkary var.)			
Un-irradiated	34.33 ± 0.7 dc	38.0 ± 2.1 a	35.80 ± 3.3 cd
3.0 kGy	36.40 ± 0.8 bc	38.13 ± 2.7 a	38.80 ± 2.2 bc
5.0 kGy	36.47 ± 2.8 bc	39.03 ± 1.6 a	43.30 ± 2.3 b

Mean ± standard deviation. Values sharing same letters differ non-significantly (P>0.05)

3.3.3. Soluble Solide Contents SSC (°Brix)

Generally, irradiation or storage period caused significant increase of SSC for tested samples. The high content of SSC was recorded in Siwi-variety (39.3), then Sukkry (34.33) and Zahidi (30.73) respectively. Generally, irradiation or storage period caused significant increase of SSC for tested samples. The high content of SSC was recorded in Siwi variety (39.3), then Sukkry (34.33) and Zahidi (30.73) respectively. These values increased after irradiation gradually with increasing doses. Also, storage period increased these values as shown in Table 8. These results are in parallel with increasing sugars during storage or irradiation doses. The explanation of reduction of sucrose content during the storage period can cause by invertases enzymes during fully matured stage (late stage of Rutab of Zahdi) dates consequently increasing glucose and fructose then increase SSC (Gado, 2008; Sohaimy and Hafez, 2010; Farag *et al*, 2013).

4. DISCUSSION

Increasing production and exportation of dates (*Phoenix dactylifera* L.) in Arabic countries force these countries to improve the quality and quantity besides avoiding the losses during post-harvesting. All producers search for new safe methods to preserve this nutritious fruit for a long time in spite of high losses during its long trip from tree to consumers during post-harvest by spoilage and insect infestation (Emam *et al*, 1994). Egyptian workers showed that contamination of stored dates with insects, insect fragments, fungi, and mycotoxins is a major concern of the date's industry (EL-Sideek *et al*, 2014). The losses of dates in Egypt during post-harvested recorded high values at end of storage (8-9 months) at room temperature recorded near 70% as resulted by infestation (Emam *et al*, 1994). Insects are the dominant damage of dates besides microorganisms as proved by the present work (Table 3). Using irradiation 1.0kGy-3.0 kGy are sufficient to keep quality of dates free from insects stages or moulds in all tested Arabic dates during long storage period which extend to even 8 months at room temperature. The rank of untreated dates quality due to damaged rate are Saudi Arabian (Sukkary), Egyptian (Siwi) then Iraqi (Zahidi) respectively. Sukkary was the lower one in contamination may be due to high content of sugar in Sukkary than the other varieties. Same results were obtained by Egyptian workers (EL-Sideek *et al*, 2014).

Using ESR to tractability the free radicals-not toxic- in irradiated date fruits showed that edible parts which consume by human became free from any radicals after one month (Fig 1., Table 2) . ESR-signals were disappeared in edible part due to moisture, which produced free radical with short life, but low water content caused stability of signal of hard parts as kernels, which used as part to recognize the detected irradiated part (Attia et al, 2009).

The nutritional value of dates are recommended as ideal fruit containing most valuable amounts of nutrients in balance of amino acids (AL-Farsi and Lee, 2008; El-Sohaimy and Hafez, 2010). The total AA of un-irradiated samples of Egyptian, Saudi Arabian, Iraqi varieties at zero time of storage contained 660, 630 and 480 (μg/gm dry weight) respectively. In the same time, seventeen AA were detected in all tested samples, these AA became more radiosensitive which affected clearly (as shown in Table 3 and Fig.3). Irradiation dose 3.0 kGy was less affected near control samples for every variety except Sukkry which was more affected. The explanation of degradation of amino acid by irradiation can occur especially in presence of moisture (near 20%), in semi-dry date fruits as showed by workers (Nine *et al*, 1975; Emam, *et al*, 1994).

Whereas, in the absence of oxygen, deamination and decarboxylation can activate the degradation. Besides, some radiolytic products may be formed depending the dose of irradiation treatment. Activation of orbital molecules or amino acids structure by irradiation can became more affecting blocking reductive deamination. Some amino acids are more sensitive especially contain thiol or disulfide group besides aromatic, heterocyclic amino acids hydroxylation mainly the aromatic ring (Auda *et al*, 1976; 1977; Urbain, 1986).

Concerning sugars content, which were less affective and no significant changes were clearly in all sugars content. Same results were obtained on several date varieties in Iraq and Saudi Arabia (Auda*et al.* 1976; 1977, EI-Sayed and Baeshin, 1983; Nassef and Jobair, 2004; Bouaziz *et al*, 2008).

In the same time, some reduction by irradiation were observed as in Table 5, in Reducing sugars in Egyptian dates, besides reduction in irradiated dates for all tested samples as in Tables 6. The reduction of sugars immediately following irradiation could be due to the formation of some radiolytic products of carbohydrates. Thomas (1986) showed that no sucrose was found in Khalas dates, and this is in agreement with workers earlier on tamr (Jaddou and AI-Hakim, 1980; Ahmed *et al*, 1981,). Irradiation has many advantages for keeping quality of dates after 8 months especially no residues, good acceptability, no high losses in nutrients of amino acids sugars and free from infestation.

5. CONCLUSION

Finally, it could be concluded that using low dose (3.0 kGy) irradiation can achievement for different purpose, i.e. disinfestation besides keeping quality without high losses of nutritive content as amino acids, sugars content and SSC. Concerning, the economic value, irradiation became more efficient and economic in comparing with other treatments for using on large scale for different products. These findings are supported by obtained results which showed that irradiated SDD from different Arabic countries at 3.0 kGy was high quality free from contamination, less nutritive changes even 8 months of storage at room temperature and nothing free radicals after one month at room temperature.

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