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Differentiation between Irradiated and Non-Irradiated Dates Using Color Intensity and Viscosity Value Method

Mohammed M. Mohammed Rushdy*, Hameed O. Abed, Ali M. Maire, Alaa K. Ismaeel, Mustafa G. Farhan, Hassen A. Abed

Agricultural Research Directorate/ Ministry of Science and Technology – Iraq

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Corresponding Author:
Mohammed M. Mohammed Rushdy
mohakim2007@gmail.com

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Abstract

New method has been applied recently in our Laboratories to distinguish between irradiated and non-irradiated dates. The method depends on the measurement of color intensity and viscosity values for dates sugar water extracts for five different stages of treatments. Doses of (0 .5, 0.75, 1.00 and 1.5 kGy) were applied. A considerable increase and decrease of irradiated and non-irradiated dates in color intensity and viscosity values were found between the stages; the results obtained showed that there is a significant increase and decrease in the values of irradiated dates Samples at stages 3, 4 and 5 as compared to non-irradiated Samples (control). At stage 3 the results showed a drop in color intensity of the solution sample from 8701 (control) to 1009 at dose of 1.00 kGy, the results also showed an increase in color intensity (Stage 4) from 2046 (control) to 2712 as the doses increased from 0.50 to 1.50 (kGy), while the results of the viscosity at stage 5 showed a significant increase from 5.605 (Control) to 7.914 as the doses increased from 0.50 to 1.50 (KGy).The method appears to be promising to discriminate irradiated from non-irradiated dates. Further developments are needed for this method to increase its accuracy and reliability in measuring the actual dose used in the treatment**.**

1. Introduction

Iraq is considered one of the major producers of dates. Global dates production over the past 30 years has increased from 2.659.513 million tons in 1977 to 8.166.014 million tons in 2020 [1]. Date production in Iraq for 2020 was 735.353 tons and Zahdi dates make about 70% of date production [1]. A large quantity of dates is usually infested with insects causing considerable damage [2, 3] Fumigants currently used in Food irradiation are considered suitable preservation technology [4, 5], which can significantly contribute by reducing food losses and assuring the hygienic and nutritional quality of food [6]. An important aspect of food technology from the standpoint of safety and quality is the development of a convenient and reliable method for determining whether food has been irradiated or not and if irradiated, at which dose. Such tests should be clear-cut, reproducible, relatively rapid, and inexpensive [7]. A number of possible methods were described which can be divided into physical, chemical, and biological methods [8, 9, 10]. Dates have been irradiated previously in Iraq for the purpose of insect disinfestations [11]. The acceptable dose for disinfestations as approved by the joint FAO/IAEA/WHO expert committee on the wholesomeness of irradiated food is 1 kGy [12], therefore, a method

to detect the irradiated dates is needed. The present study was conducted to use the viscosity and color of the extract of date as markers for detecting irradiated dates.

2. Experimental Procedure

2.1. Sample Preparation

This study has been performed in Agricultural Research Directorate labs, Ministry of Science and Technology 2021. Matured zahdi Date cultivar was purchased from the local market. Samples (50g. each) were packed in polyethylene bags, sealed, and irradiated at a dose of 0.5, 0.75, 1.00, and 1.50 kGy using gamma rays emitted from the cesium (137Cs) source (Dose rate 0.026 kGy/min) at the University of Baghdad. All samples (non-irradiated and irradiated) were stored under refrigerated conditions at storage temperature (7 ºC) until work started.

2.2. Preparation of Date Sugar Extract

Fifty grams of pitted dates were homogenized for 3 minutes with boiled distilled water (190 ml at 85 ºC) using a mixer at 1500 rpm. The extract was then filtered using Buchner funnel fitted with filter paper (15-40 µm, micron pore size), the fiber obtained was washed with boiled water (400 ml, 85 ºC). Three measurements were taken for the sugar extract at this stage (color and viscosity, stage 1). The sugar extract obtained from stage 1 was then filtered with filter paper (5-15 µm pore size) to remove the fine particles. The extract was then concentrated to 200 ml using a rotary evaporator at 50 ºC and reduced pressure. Two measurements were taken at this stage (viscosity, stage 2). The 200 ml sample was then divided into two equal portions in which the first portion (100 ml) was centrifuged at 1400 rpm for 20 min, and the supernatant was checked for (color and viscosity, stage 3). The second 100 ml portion of the sugar extract sample was refluxed with ethanol (250 ml) for 20 min. in water in order to precipitate the soluble materials (fiber, protein, and pectin substances), followed by filtration on a 15-40 µm filter. Ethanol was evaporated completely using a rotary evaporator at 50ºC and reduced pressure, distilled water was added to the syrup obtained to make a total volume of 200 ml. Two measurements were taken at this stage (color, stage 4). The syrup from stage four was then evaporated to a volume of 25 ml. One measurement was taken at this stage (viscosity, stage 5), Figure (1). Disinfection. However, it is recognized now that food irradiation is a promising means to reduce losses of food caused by infestation, bacterial spoilage [3,4]. Despite the availability of many preservation technologies, food losses are still enormous. Processed and preserved food is more needed because food must be transported over longer distances and kept for a longer time [5]. Therefore, any new technology keeping food for a longer time fresh should receive ample attention.

2.3. Determination of Total Soluble Solids (Brix)

Total soluble solids were determined at 20°C using a digital Refractometer

2.4. Color Measurement

The following procedures were used to measure the color of date sugar extract:

Procedure A: the color was measured using the ICUMSA unit according to the method mentioned by [13]. The following equation was used:

$$\textbf{Color intensity} = \frac{1000 \times 720\text{nm (O.D)} - 420\text{nm (O.D)}}{\text{Lcm} \times \text{CBx}} \qquad (1)$$

The color of samples from stages 1 and 4 was checked by this procedure.

Procedure B: clear solution obtained after the centrifugation was adjusted to pH 9 using 0.1 N sodium hydroxide solution, color was checked according to [13]. The following equation was used:

$$\textbf{Colour Intensity (ICUMSA)} = \frac{(420\text{ nm (O.D) light intensity})}{\text{Lcm} \times \text{CBx}} \qquad (2)$$

2.5. Viscosity Measurements

Viscosity Measurements of Date concentrations were performed a U-tube Ostwald viscometer made by (Poulten self & Lee), According to the following equation:

$$N = \frac{\mathcal{D}1\ t1}{\mathcal{D}2\ t2} \qquad (3)$$

2.6. Statistical Analysis

Statistical analysis was carried out by Minitab® 17.1.0 (ANOVA, Tukey) to find differences between the experimental treatments with a probability level of 5%.

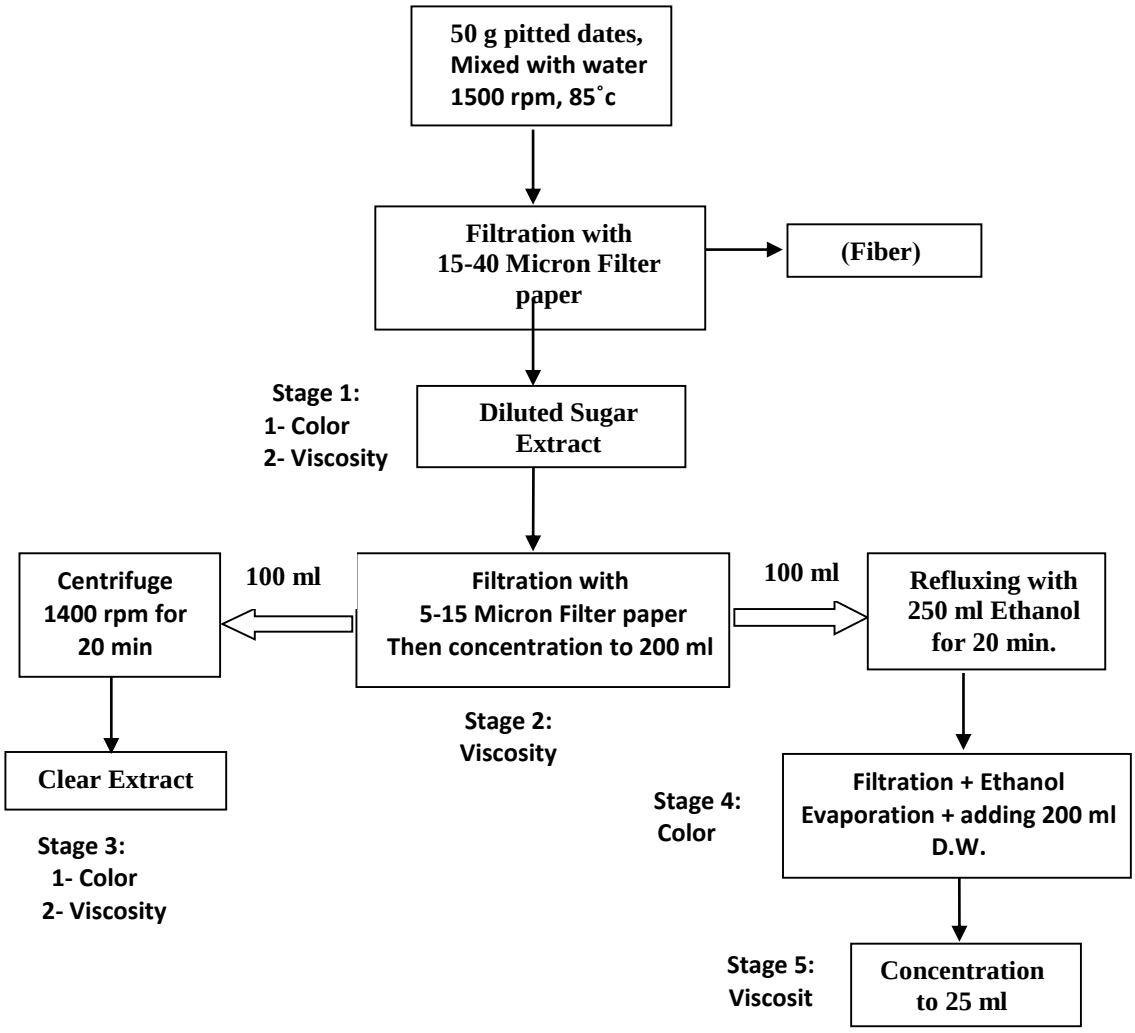

Figure (1). Illustration of the 5 stages preparation methods for Sugar Extracts.

3. Results and Discussion

From Table (1), it is clear that at (stage 1) treatment with gamma irradiation, there is a significant decrease ($p \leq 0.05$) in color intensity measurements solutions as compared to the control, as well as the presence of a gradual increase between the irradiated samples was directly proportional to the increase in the radiation dose. While the viscosity measurements for the same stage indicated that there was **a** slight decrease in the viscosity of the sugar solution for irradiated dates at a dose of 0.50, 0.75 and 1.00 kGy as compared to control, while the dose of 1.50 kGy showed a clear significant increase ($p \leq 0.05$) as compared to control, as well as a simple gradual increase among the treated samples by increased radiation dose.

The reason for the convergence of the measurements of color intensity and viscosity between the samples can be attributed to the exposure of dates to low and close doses. As it is clear from the table that there is a slight increase in the viscosity of the sugar solution for treated samples with 0.50 kGy for (stage 2) as compared to the

control. As well as a little gradual decrease among the treated samples by increasing the radiation dose (the color intensity measurements were not recorded in this stage because there were no significant differences as in stage 1). While (stage 3), despite the slight decrease in color intensity of the sugar solution samples which exposed to the dose 0.50, 0.75 kGy as compared to the control, there is a high significance decrease ($p \leq 0.05$) for samples exposed to the dose 1.00 and 1.50 kGy as compared to control. In the other hand the viscosity measurements at this stage showed a significant difference in the values of the sugar solutions of the treated samples as compared to the control, these differences can be used as an indicator to distinguish between irradiated and non-irradiated dates. This phenomenon was diagnosed in a study done by [14] as he observed a decrease in the viscosity of samples of ginger, black pepper and white pepper treated with ionizing radiation as compared to non-irradiated samples. It is also possible to benefit from the measurements of the color intensity in (stage 4) as an indicator to distinguish between irradiated and non-irradiated dates. As the results showed a significant increase ($p \leq 0.05$) in the color intensity of the sugar solution samples as compared to the control, as well as a gradual increase among the treated samples with increased radiation dose, as for the (stage 5), there is a significant increase ($p \leq 0.05$) in the viscosity of the treated solutions as compared to the control which can be relied upon in the diagnosis, this phenomenon was also observed in another study [15], where it was noted that there is a clear increase in the viscosity of samples of onion, lemon peels, mustard seeds, celery and leeks compared to the untreated samples. The results obtained from this study showed the possibility of using some measurements of color intensity and viscosity of sugar extract solutions for irradiated samples of dates as an indicator to distinguish between irradiated and non-irradiated dates, and that the method needs some development for the purpose of Obtaining readings with high differences between irradiated samples in order to identify the real radiation dose in which the dates were exposed to, as the current method gave few differences in the measurements between the treated samples as a results of the simple differences in the radiation doses that the samples were exposed to.

Table (1). Some parameter measurements for Identification of Irradiated dates.

Treatments kGy	Stage 1		Stage 2	Stage 3		Stage 4	Stage 5
	Color Intensity (ICUMSA)	Viscosity	Viscosity	Color Intensity (ICUMSA)	Viscosity	Color Intensity (ICUMSA)	Viscosity
Control	8874 ^{a}	1.277 ^{b}	1.326 ^{a}	8701 ^{b}	1.875 ^{a}	2046 ^{c}	5.605 ^{c}
0.50	8303 ^{b}	1.230 ^{b}	1.387 ^{a}	8503 ^{b}	1.387 ^{b}	2152 ^{bc}	7.201 ^{b}
0.75	8426 ^{b}	1.233 ^{b}	1.308 ^{a}	8402 ^{b}	1.316 ^{b}	2310 ^{b}	7.348 ^{b}
1.00	8436 ^{b}	1.258 ^{b}	1.050 ^{a}	1009 ^{a}	1.230 ^{b}	2645 ^{a}	7.880 ^{a}
1.50	8576 ^{b}	1.397 ^{a}	1.020 ^{a}	1050 ^{a}	1.054 ^{b}	2712 ^{a}	7.914 ^{a}

*Values with the same letters in the same column have no significant differences between them according to Tukey ($p \leq 0.05$).

4. Conclusions

The method used in our studies appeared to be suitable to distinguish between the irradiated and non-irradiated dates. Further developments are needed for this method to increase its accuracy and reliability in measuring the actual dose used in the treatment.

Nomenclature

O.D: Optical Density
Bx: Total Soluble Solids
CBx: Concentration (Brix) of the soluble material at 20 ºC
Lcm: Length of the cuvette used for the Sample (1 cm)
N: Viscosity
Ɗ1: Density of the sugar extract
t1: Flow time of the sugar extract
Ɗ2: Density of water ($1 g/cm^3$)
t2: Flow time of the water

Conflict of Interest: The authors declare that there are no conflicts of interest associated with this research project. We have no financial or personal relationships that could potentially bias our work or influence the interpretation of the results.

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