Effect of gamma radiation and laser exposure on color properties of sesame oil during storage

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Abstract: The aim of the present study was measurement of the color properties as Hue degree, Saturation value, and Brightness value (HSB). Three samples of Sesame oil was exposure by laser (diod laser with wavelength 450 nm) with three times (0.5, 1.0 and 1.5 h) and three samples of sesame oil were irradiated by Gamma Rays with three dosses (2, 4, 8 kGy) and one sample without any treatment (control). The processing of an image starts with the transfer of the image to the Personal Computer, where the image analysis process is applied. After that, it is performed the segmentation to watermark determine if each pixel belongs to bottom, skin or color. The parameters obtained from each Sesame oil sample (in each image are the pixel number of lighter oil (Stage 1), of darker or sesame oil profile (Stage 2). Taking image of each Sesame oil samples, a total number of 6 parameters can be obtained.Color properties {Hue, Saturation and brightness (HSB)}, color component {Red, Green and Blue (RGB)} of sesame oil. The obtained results were showed that by increasing Gamma radiation doses and exposure time of Laser, Hue degree was increased, that mean the color of sesame oil may be improved to be less quality. While, Hue degree was decreased by increasing storage period. Also, by increasing Gamma radiation doses and exposure time of Laser, the value of saturation was decreasing, that means that the color of sesame oil may be improved to be high quality. Meanwhile, the value of saturation was decreased by increasing storage period. As well as, by increasing Gamma radiation doses, exposure time of Laser and by increasing storage period the value of brightness was decreasing.

Keyword: quality, image analysis gamma radiation, sesame oil, laser, storage

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1 Introduction

Vibhute and Bodhe (2012) reported that the image processing has been proved to be effective tool for analysis in various fields and applications. Image processing along with availability of communication network can change the situation of getting the expert advice well within time and at affordable cost since image processing was the effective tool for analysis of parameters. The analysis of the parameters has proved to be accurate and less time consuming as compared to traditional methods. Application of image processing can improve decision making for vegetation measurement, irrigation, fruit sorting, etc.

Raji and Alamutu (2005) mentioned that the

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computer vision and image processing were nondestructive, accurate and reliable methods to achieve target of grading. Image processing in agriculture and food industries has been applied in the areas of sorting, grading of fresh products, detection of defects such as dark spots, cracks and bruises on fresh fruits and seeds, etc. Same kinds of concepts were explored by many researchers with different image processing approaches.

Sun (2000) reported that image analyses involve a series of steps, which can be divided into three levels: low level processing, intermediate level processing and high level processing. These steps provide the information necessary for the process/machine control for quality sorting and grading.

Loudiyi et al. (1984) showed that the two cultivars were sampled from an immature stage through ripeness to over ripeness. Olives were picked according to skin color from all round the perimeter of the trees. The color sequence was green (G), light-green (LG), small reddish spots (SRS), turning-color (TC), purple (P) and black (B) from the first to the last sampling, respectively.

Faustman et al. (1992) **s**howed that the color has three quantitatively definable dimensions. Hue is the name of the color and is that quality by which we distinguish color families (red, green, blue, etc.). Value is the lightness of color and is that quality by which we distinguish lighter and darker colors. Chroma is the strength of a color and is that quality by which we distinguish strong and weak colors.

McCormick (2001) reported that there are different colors of sesame like, creamy-white to charcoal-black. This crop is best suited in tropical climates, sandy, well-drained soil with hot climate and moderate rainfall particularly in India, China, South America and Africa. The leaves vary from ovate to lanceolate and are hairy on both sides. The flowers are purple to whitish, resembling foxglove, followed by 3 cm capsules/ fruits containing numerous seeds. The plant has an unpleasant odor. Each plant may bear 0-15 fruits, which contain 70-100 seeds. It matures in 80-180 days when the stems are cut and hung upside down for the ripe seeds to fall out to be collected on mats.

Vercet et al. (2001) reported that the color intensity of the oils before and after sonication treatment. The results for tallow olein were different at an ultrasound intensity of 100% where the Hunter *L*, *a*, and *b* values increased significantly ($p < 0.05$) as the ultrasound amplitude increased. Maillard reactions were probably responsible for the increase in the intensity of yellowness and redness in the oil. Darker colors have also been observed in the ultrasound-assisted preparation of chocolate mousse compared with conventional preparation because of the formation of browning pigments.

Alos et al. (2006) declared that the color is a sensory property with a strong influence on food acceptance as it contributes decisively to the initial perception that one can acquire of the condition, ripeness, degree of processing, and other characteristics of foods. Oil appearance might be an indicator of a quality problem having occurred during blending, storage, crushing, and extraction or the refining process. The American Oil Chemists' Society (AOCS) has proposed four official methods for the color determination of fats and oils. Related methods are Lovibond color, Wesson color, spectrophotometer color and chlorophyll color. Presently, CIE L*a*b*, XYZ, Hunter Lab, and RGB (Red, Green, Blue) are the alternative color models that might be used in objective oil color evaluation. L*a*b* is an international standard for color measurements, adopted by the Commission Internationale d'Eclairage (CIE) in 1976. L* is the lightness component ranging from 0 to 100. a* refers to the color ranges from green to red and b* displays the colors from blue to yellow. These two chromatic components range from -120 to 120.

Hsu and Yu (2002) reviewed that the color would probably be due to the presence of carotenoids, coloring substances currently used in the industries of fatty corpses. The value of the coordinates of Cie Lab (L*, a*, b*) of such other vegetable oils as palm oil, soya seed, sunflower, olive and corn oils vary, from

63.4 to 69.5; from 3.8 to 4.4 and from 9.2 to 10.45 respectively.

Heuzé et al. (2017) mentioned that the white and other lighter-colored sesame seeds are common in Europe, the Americas, West Asia, and the Indian subcontinent. The black and darker-colored sesame seeds are mostly produced in China and south East Asia.

Elleuch et al. (2007) studied Cie Lab coordinates (L*, a*, b*) of the oil extracted from the raw sesame seed, sesame paste and olive oils. Raw sesame oil exhibited higher *L**, *a** and *b** values. This means that raw sesame oil was lighter, more red and yellow-colored than sesame paste oil, and reported that de hulling as well as roasting causes an increase in the dark, red and yellow units of color. The color formation in sesame oil during heat treatment is probably due to non-enzymatic browning (Maillard reaction) that occurs during roasting. Furthermore, olive oil was darker and yellower than raw sesame and sesame paste oils.

Fariku et al. (2007) mentioned that Nigeria, the notable colors for sesame seed are white, yellow and black). The lighter varieties of sesame which are considered to be of higher quality are generally more valued in the West and Middle East, while both the pale and black varieties are prized in the Far East.

Tao et al. (1995) used linear discriminate analysis in a grading system to classify fruits in different classes, while other were used nonlinear discriminate analysis for the classification of peach, because of One of the techniques most used for the classification process of images is discriminate analysis.

Diaz et al. (2000) showed that olives have been characterized identifying the most common defects and its colorimetric properties. Then, a capture and color images processing system was used to extract the information from each olive. Afterwards, a grading system which is able to learn from the characteristic parameters of the olives previously. Classified by experts, was used to determine to which category each olive was more likely to belong and the processing of an image starts with the transfer of the image to the specific buffers of the RAM memory of the PC, where the image analysis process is applied. After that, it is performed the segmentation to watermark determine if each pixel belongs to bottom, skin or defect.

Roca and Mínguez-Mosquera (2001) mentioned that during the fruits' color change from green to yellowish, there is an unusual carotene genesis, besides a process of carotenoid esterification. This indicates a different pigment accumulation in the Arequipa variety. Chlorophyll and carotenoid profile during the life cycle of olive fruits of different varieties.

Narendra and Hareesh (2010) observed that the methods or techniques in image processing such as image segmentation, shape analysis and morphology, texture analysis, noise elimination, 3D vision, invariance, pattern recognition and image modality were applied for grading these categories. Automated system of sorting food and agriculture products provides rapid and hygienic inspection with computer vision.

The Objectives of the present work are studying the effect of gamma rays doses of 2,4and 8 kGy and Laser radiations exposure time (0.5, 1, 1.5 hour) on color properties of sesame oil.

Evaluate the quality of the sesame oil color using the image processing technique.

2 Materials and methods

This work was carried out in the Laboratory of Laser Applications in Agricultural Engineering at the National Institute of Laser Enhanced Science (NILES), Cairo University, for quality evaluation of sesame oil during pantry storage.

2.1 Sample preparation of sesame seed (SESAME INDICUM L.)

Sesame seed sample (Shindwell 3 variety) was obtained from the Agricultural Research Center, Field Crops Research Institute - Department of Oil Crops Research. Sesame oil was extracted on cold press by Extraction Unit, at National Research Center.

2.2 Irradiation treatment by gamma rays

Three samples of sesame oil were irradiated by Gamma Rays with doses 2, 4, and 8 kGy and one sample without any treatment (control). All samples of sesame oil were analyzed.

2.3 Irradiation treatment by laser

Theses samples of sesame oil were exposure to visible light Laser Irradiation with wavelength 450 nm (diod laser) with power 1000 mW were used with 3 times (0.5, 1.0 and 1.5 h) in the dark at the laboratory.

2.4 Image processing

The processing of an image starts with the transfer of the image to the PC, where the image analysis process is applied, as shown in figure 2.

After that, it is performed the segmentation to watermark determine if each pixel belongs to bottom, skin or color. The parameters obtained from each Sesame oil sample (in each image are the pixel number of lighter oil (Stage 1), of darker or sesame oil profile (Stage 2). Taking image of each Sesame oil samples, a total number of 6 parameters can be obtained.

Color properties {Hue, Saturation and brightness (HSB)}, color component {Red, Green and Blue (RGB)} of sesame oil.

Hue degree is the name of the color and is that quality by which we distinguish color families (red, green and blue). Value is the lightness of color and is that quality by which we distinguish lighter and darker colors. It was noticed that the hue degree (0-360), hue degree of color properties is determine color degree of sesame oil. Hue degree is the dominant wavelength of the color. Hue and saturation together determines the color, and we call these two chromaticity. Hue: An angle from red (H = 0). So, HSB more useful for color description and color image processing.

Saturation value (0-100). The saturation value support the hue degree of the color of sesame oil. Saturated the color is with white light, from a pure color (no white) to fully saturated (white). The chromaticity determines both the dominating wavelength and the saturation of the color. Saturation: Distance from center axis. From the CIE, saturation is the colorfulness of an area judged in proportion to its brightness. Saturation runs from neutral gray through pastel to saturated colors. The more saturation value is concentrated at one wavelength, the more saturated will be the associated color and can desaturation a color by adding light that contains power at all wavelengths.

Brightness value as it is described only to relative values within a source. It is also called lightness (HSL). The distinction between levels of high brightness is actually logarithmic, not linear as the HSB scale would imply. The brightness value was found in (0-100).The brightness value support the hue degree of sesame color. Chromaticity and brightness together fully describes a color.

The HSI (HSB) values can be achieved from the RGB color model. The conversion notations from RGB to HSB are as shown below (Equations 1, 2 and 3):

$$I = \frac{1}{3}(R + G + B) \quad (1)$$

$$S = 1\frac{3}{R+G+B}[\min(R, G, B)] \quad (2)$$

$$H = cos^{-1}\left[\frac{\frac{1}{2}(R-G)+(R-B)}{\sqrt{(R-G)^2+(R-B)(G-B)}}\right] \quad (3)$$

The values of 'I' and 'S' range from 0 to 1 while the value of H range from 0 to 3600.

However H = 3600 – H, when B > G

I: Intensity (0-100) value

S: Saturation (0-100) value

H: Hue degree (0- 360) degree

3 Results and discussions

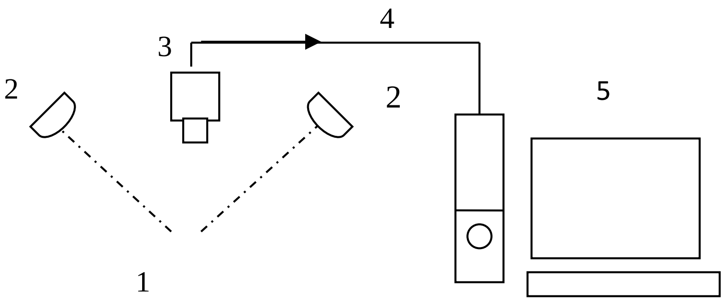
3.1. Effect of Gamma radiation on color properties of sesame oil during pantry storage

3.1.1 Hue degree of sesame oil

Value is the lightness of color and is that quality by which we distinguish lighter and darker colors, according about this value, the quality of sesame oil was determined.

Figure 3 declared that the Hue Degree of sesame oil which affected by using Gamma Rays during storage, it was noticed that the hue degree was increased (53.2, 57.2, 57.9 and 60.2 degree) at 3 months. Therefore, Hue Degree was (52.4, 55.8, 57.5 and 59.2) degree at 6 months. While, Hue Degree was 48.5, 49.7, 49.8 and 52.2 degree was for control 2, 4 and 8 kGy respectively during 9 months. It was noticed that Hue Degree was increased by increasing irradiation doses of from control to 2 to 4 to 8 degree. But Hue Degree was decreased by increasing storage time from 3 to 6 to 9 months. From previous results, it was showed that by increasing Gamma radiation doses, the Hue Degree was increased, that mean the color of sesame oil may be improved to be high quality. While, Hue Degree was decreased by increasing storage period. That mean, the color of sesame oil will be less quality.

Figure 1 Photo of image processing



1- Sesame oil 2- Light source 3- Digital camera 4- Connecting wire 5-Computer

Figure 2 Vision, illumination and color analysis systems

3.1.2. Saturation value of sesame oil

The saturation value support the hue degree of the color of sesame oil. Saturated the color is with white light, from a pure color (no white) to fully saturated (white). So, this value can be used in color systems and devices to evaluate quality of sesame oil.

Figure 4 show the Saturation value of sesame oil which affected by using Gamma Rays during storage, it was observed that the Saturation value was decreased. It was (80.3, 79.9, 78.5 and 77.7 value at 3 months). Therefore, Saturation value was (66.8, 76.8, 67.2 and 66.8 value at 6 months) for control, 2, 4 and 8 Kg, respectively. While, Saturation Degree was 52.4, 66.1, 61 and 55.7 value during 9 months. It was noticed that Saturation value was decreased by increasing irradiation doses of from control to 2 to 4 to 8 kGy. And Saturation value was decreased (from 80.3 to 52.4 value), (from 79.9 to 66.1 value), (from 78.5 to 61.0 value) and (from 77.7 to 55.7 value) by increasing storage time from 3 to 6 to 9 months. From previous results, it was noticed that by increasing Gamma radiation doses, the value of saturation was decreasing, that mean that the color of sesame oil may be improved to be high quality. Meanwhile, the value of saturation was decreased by increasing storage period that mean the color of sesame oil may be more less quality.

3.1.3 Brightness value of sesame oil

Brightness value called lightness. This value was distinct between levels of high brightness of sesame oil, according to this value, can be measure quality of sesame oil.

Figure 5 declared the Brightness value of sesame oil which affected by using Gamma Rays during storage, it was noticed that the Brightness value was (56, 54.9, 50.2 and 48.3 value) at 3 months, (44.9, 48.2, 44.4 and 44.2 value at 6 months), (36, 44, 38.7 and 38.6 value at 9 months respectively. It was noticed that Brightness value was decreased by increasing irradiation doses of from control to 2 to 4 to 8 kGy. And Brightness value was decreased by increasing storage time from 3 to 6 to 9 months. From previous results, it was noticed that by increasing Gamma radiation doses, the value of brightness was decreasing, that mean that the color of sesame oil may be improved to be high quality. Meanwhile, the value of brightness was decreased by increasing storage period that mean the color of sesame oil may be more less quality.

3.2 Effect of exposure time of Laser on color properties of sesame oil during pantry storage

3.2.1 Hue degree of sesame oil

Figure 6 show the Hue Degree of sesame oil which affected by using Laser technique with different exposure time during storage, it was noticed that the hue degree was(53.2, 61.8, 63.3 and 64.2 degree) at 3 months, (52.4, 55.7, 57.7 and 64 degree) at 6 months, (48.5, 52.9, 53.2 and 59.4 degree) at 9 months respectively. It was noticed that Hue Degree was increased with increasing exposure time of laser from control to 0 to 0.5 to 1 and 1.5 h. But Hue Degree was decreased by increasing storage time from 3 to 6 to 9 months. From previous results, it was showed that by increasing exposure time of laser, the Hue Degree was increased, that mean the color of sesame oil may be improved to be less quality. While, Hue Degree was decreased by increasing storage period. That mean, the color of sesame oil will be less quality.

3.2.2. Brightness value of sesame oil during pantry storage

Figure 7 explain the Brightness Value of sesame oil affected by using Laser technique with different exposure time during storage, it was noticed that the Brightness Value was (56, 81.3, 79.4 and 70.1 value) at 3 months, (44.9, 58.8, 54.9 and 48.3 value) at 6 months, (36, 49.6, 49.6 and 42.3 value) at 9 months respectively. It was noticed that Brightness Value was decreased by increasing exposure time of laser from control to 0 to 0.5 to 1 and 1.5hour and Brightness Value was decreased by increasing storage time from 3 to 6 to 9 months. From previous results, it was showed that by increasing exposure time of laser, the value of brightness was decreased, that mean the color of sesame oil may be improved to be less quality. But, at 0.5 hr of exposure time of laser, the value of brightness was increased. While, the value of brightness was decreased by increasing storage period. That means, the color of sesame oil will be less quality.

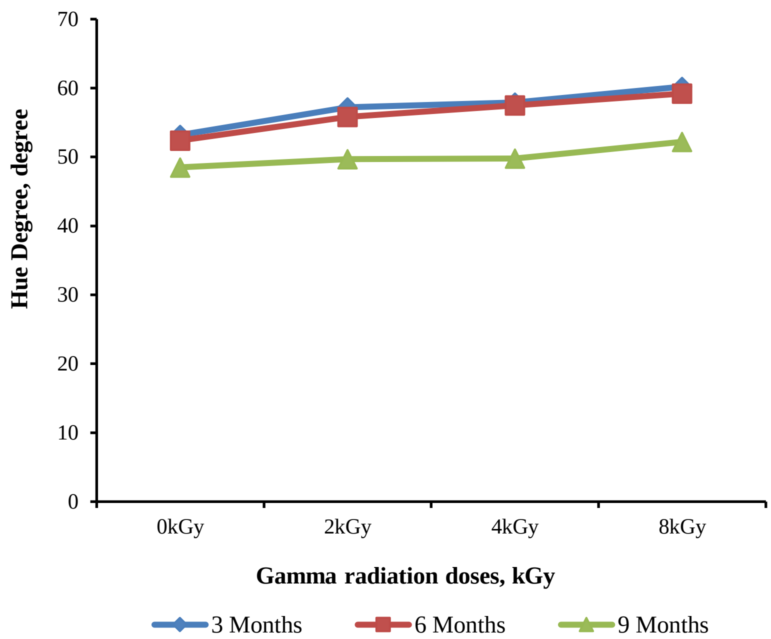


Figure 3 Effect of Gamma radiation on Hue degree of sesame oil during pantry storage

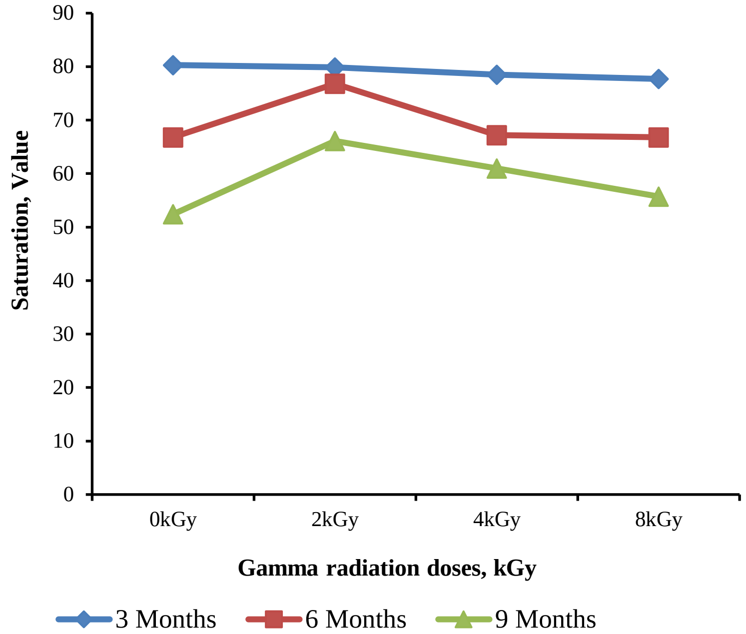


Figure 4 Effect of Gamma radiation on saturation value of Sesame oil during pantry storage

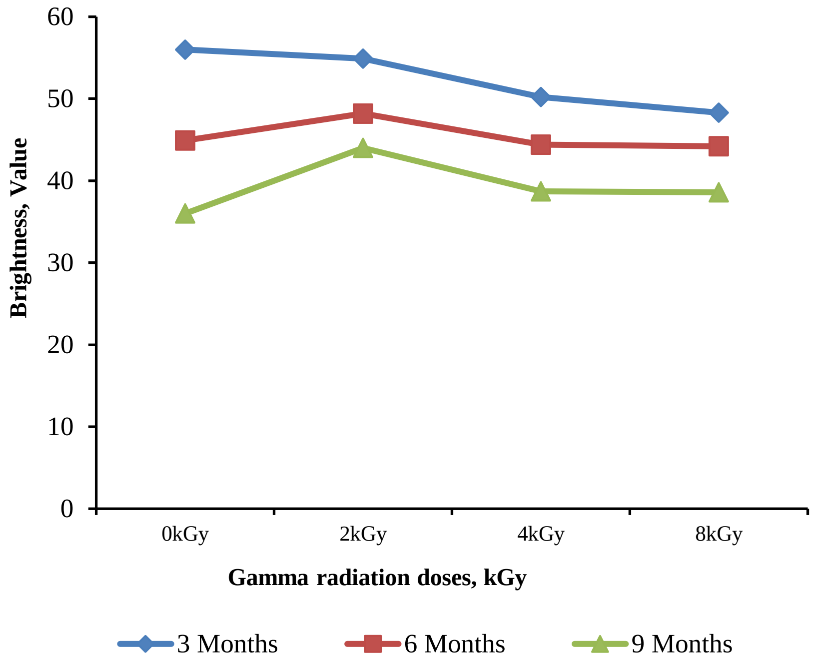


Figure 5 Effect of Gamma radiation on brightness value of sesame oil during pantry storage

3.2.3 Saturation value of sesame oil during pantry storage

Figure 8 declare the saturation value of sesame oil which affected by using Laser technique with different exposure time during storage, it was noticed that the saturation value was (80.3, 97.7, 89.8 and 83.4 value) at 3 months, (66.8, 76.8, 72.1 and 55.7 values) at 6 months, (52.4, 52, 29.8 and 27.7 value) at 9 months respectively. It was noticed that saturation value was decreased by increasing exposure time of laser from control to 0 to 0.5 to 1 and 1.5 hour and saturation value was decreased by increasing storage time from 3 to 6 to 9 months. From the previous results, it was showed that by increasing exposure time of laser, the value of saturation was decreased, that mean the color of sesame oil may be improved to be less quality. While, the value of saturation was decreased by increasing storage period. That mean, the color of sesame oil will be less quality.

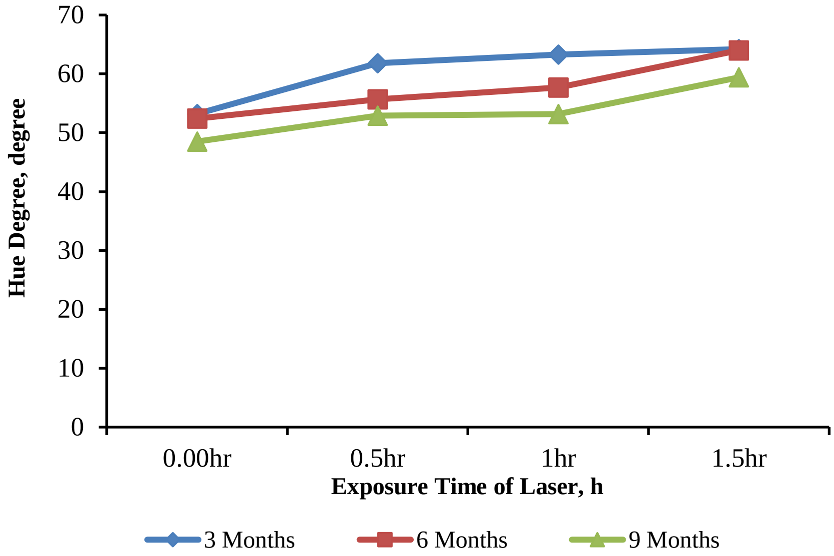


Figure 6 Effect of exposure time of Laser on Hue degree of Sesame oil during storage

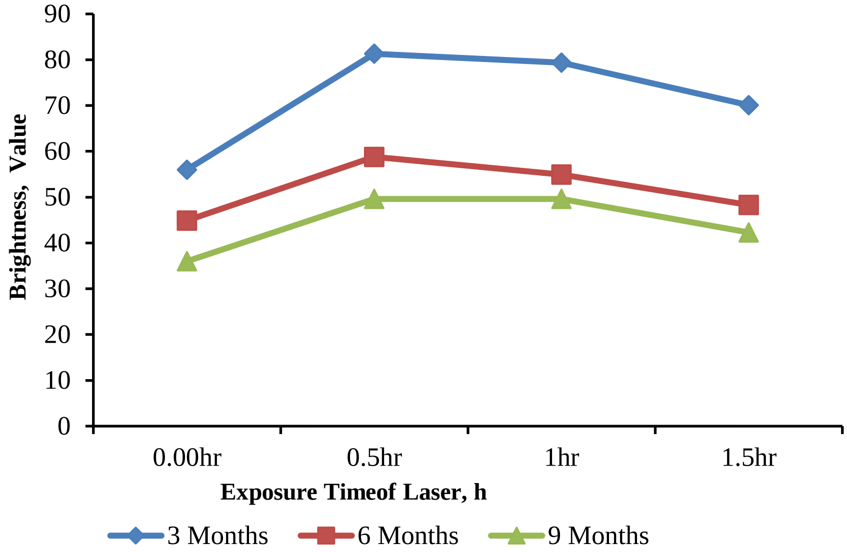


Figure 7 Effect of exposure time of laser on brightness value of sesame oil during pantry storage

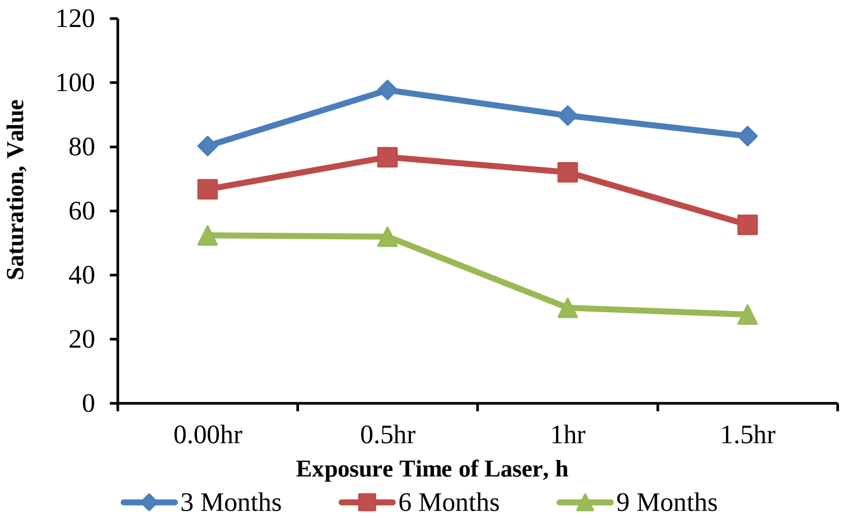


Figure 8 Effect of exposure time of laser on saturation value of sesame oil during pantry storage

4 Conclusions

The concluded results from the effect of Gamma radiation and exposure time of Laser on color properties during storage period

The Hue Degree was increased by increasing Both of Gamma radiation and Laser exposure time that mean the color of sesame oil may be improved to be less quality. While, Hue Degree was decreased by increasing storage period. Hue Degree is the lightness of color and is that quality by which we distinguish lighter and darker colors.

By increasing exposure time of laser and Gamma radiation, the value of brightness was decreased, that mean the color of sesame oil may be improved to be less quality. But, at 0.5h of exposure time of laser, the value of brightness value was increased. While, the value of brightness value was decreased by increasing storage period for both treatments.

Saturation value was decreased by increasing exposure time of laser and Gamma radiation while saturation value was decreased by increasing storage time from 3 to 6 to 9 months for both treatments.

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