Impact of ultraviolet irradiation processing on quality of fresh beef meat during cold storage

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Abstract: Meat is an excellent source of nutrients, especially protein, B vitamins, iron and zinc. As a nutrient dense food, meat provides major nutritive contributions to the diet relative to the amount of calories it contains. The objective is to study the effect of ultraviolet (UV) radiation on the fresh beef quality during cold storage with respect to survival and growth of bacteria, shelf-life, chemical, physical and color properties. Fresh beef was exposed to three doses (12.7, 25.5 and 38.2W.s/cm2) of ultraviolet (254nm). The obtained results indicated that: 1) the UV radiation was leaded to reduce the total number of microorganisms3.7x104,5.8x103 and 103 CFU/g. Meanwhile, the shelf lives of the treated samples increased 10, 15 and 20 d in the irradiated beef samples at UV radiation doses of 12.7, 25.5and 38.2W.s/cm2 respectively. 2) For the chemical properties the moisture content decreased from77.63% to 74.8%,73.82%and73.6%; protein content decreased from 21.31% to 19.61%, 19.22% and 18.15%; collagen content decreasedfrom2.29% to 1.7%,1.58% and 1.55% and fat content decreased form 2.87% to2.67%,2.53%and 2.41%. Meanwhile, pH values increasedfrom5.86 to 6.73,6.79 and 6.74,and TBA values increased from 0.73 to1.86,2.45 and 2.53mg malonaldehyde/1kgby UV radiation during cold storage period days for control and UV radiation doses 12.7, 25.5 and 38.2W.s/cm2 respectively. 3) The physical parameters like cooking loss slightly decreased from 46.44% to 35.21%, 36.28% and 35.39%; share force from 2.86 to 1.01, 0.93 and 1.22 kg fand water holding capacity from 77.69% to 73.61%, 73.51% and 72.91% for control and UV radiation doses 12.7, 25.5and 38.2W.s/cm^2 of treated beef samples during cold storage respectively. 4) For color properties UV irradiated samples had higher Hue degree from 25.04 to 31.7, 32.51 and 33.07 degree. Meanwhile, lightness values decreased from 37.21 to 28.76, 29.05 and 28.66 and saturation values decreased from 31.05 to 19.67, 19.92 and 20.03 for control and UV radiation doses 12.7, 25.5 and 38.2W.s/cm^2 respectively. It was concluded that UV radiation had obviously impacts on microbial quality, shelf-life of fresh beef, chemical and physical parameters and color attributes of fresh beef during cold storage.

Keywords: beef quality, cold storage, ultraviolet radiation, chemical, physical and color properties

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1 Introduction

Meat quality has assumed a greater consumer significance and public attention, where there is growing awareness between healthy and high quality products. The hot and humid climate of Egypt is quite favorable for the growth of numerous insects and microorganisms that destroy stored food and cause spoilage of it. Spoilage can also occur due to chemical and physiological changes during storage of foods especially beef. The fresh meat and meat products are commonly marketed at refrigerated temperatures (2 °C–5 °C).However, many undesirable changes of the products can occur during refrigeration due to microbial growth and lipid oxidation, which give the rise to quality reduction, meat spoilage, and economic loss. (U.S. Department of Agriculture and foreign agriculture service, 2013). UV light was effective in reducing bacteria on the surface of round beef-steak, but the authors found that the rough surfaces of fresh

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meat-tended to shield the bacteria from the radiation. Also they added that greater reduction in bacteria on smooth surfaces such as stainless steel, rather than on chicken meat(Kim et al., 2002). The pulsed UV-light has a potential to decontaminate ready-to-eat (RTE) poultry based food product without any significant changes on its quality(Keklik et al., 2009).

The ultraviolet (UV) treatments of egg white did not induce any significant change on the rheological properties, sulfhydryl content and on the foam properties. The UV technology proved to cause minimal changes on the quality of egg white(De Souza and Fernandéz, 2010).The factors affecting the quality of meat can be divided into ante-mortem (genetic background, housing, nutrition, disease, etc) and post-mortem (slaughtering procedure, storage and cooling of meat) (Aleksić et al., 2011).Most quality traits such as drip loss, cooking loss, tenderness, lightness, redness, and moisture content were affected by freeze-thawing. Exudates were positively correlated with total protein content and total plate count but negatively correlated with pH and cooking loss(Gap-Don et al., 2013) UV-C radiation can be an effective agent reducing the risk of spreading vegetative forms of pathogenic microorganisms that cause secondary contaminations of fish meals. This is of particular importance in view of the frequently signaling threats related to a possible contamination of fish meal products with Salmonella the direct cause of the dangerous infections in humans and animals (Skowron et al., 2014).

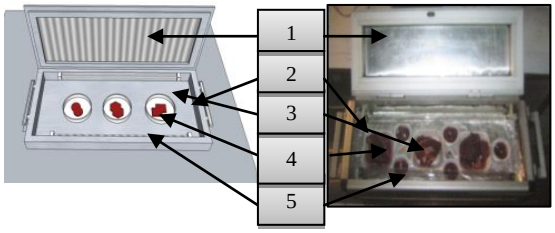
The objective of the study was to determine the UV irradiation effect upon the chemical, physical and color changes in beef meat during cold storage period and to evaluate microbiological quality of UV irradiated beef samples during cold storage period.

2 Materials and methods

The fresh beef samples were obtained from local slaughter house. It was taken from a single male beef carcass of Egyptian native cattle (Baladi Bullocks), healthy, fed with traditional method (Egyptian feed). With(approximately 22 months of age/430kg live weight). The beef samples were taken from the right carcass side (top round)and were brought to laboratory in cold iced foam box within (24h post-mortem). Beef samples were collected and prepared by trimmed off external fat, ligament and connective tissues at the laboratory. It was divided into portions about 200 g weights (3cm thickness) and packed in tightly sealed polyethylene pouches (15cm L x10cm W) under atmospheric condition and stored at 1℃±4℃ for 5, 10, 15 and 20d of cold storage, which carried out through -2014.

UV irradiationof beef samples:

Ultraviolet experiment was conducted at the laboratory of laser application in agriculture engineering at National Institute of Laser Enhanced Science (NILES), Cairo University, Egypt. The rectangular chamber utilized for the UV irradiation of beef as shown in Figure (1) was fabricated from aluminum in the laboratory of laser application in agriculture engineering at National Institute of Laser Enhanced Science (NILES), Cairo University, Egypt with dimensions (80cm length x 40cm width x 20cmheight) and access through a hinged bifold door. It contains two low-pressure lamps (20W/each; 115VAC/60Hz with length 60cm), that emit 90% continuous UV light with specific wavelength 254nm, where it was mounted on the chamber walls with equidistant (40cm) from each other at 10cm height from the chamber's bottom. The interior area of the photoreactor was lined with a highly reflective material designed to increase the UV intensity and to minimize any shadowing effect on irregular shaped of beef samples. The UV irradiator was turned on or off by disconnecting the plug from the socket inside the chamber. The UV photoreactor was ignited about 30 min prior to UV treatment, to allow the germicidal light to reach its maximum intensity and to stabilize.



1-Hinged bifold door, 2-Chamber' handle holder, 3-Highly reflective material, 4-Beef samples and 5-UV lamps.

Figure 1 theassembled designed and ultraviolet photoreactor for UV irradiation of beef.

Ultraviolet treatment:

Beef samples were subjected to different doses of UV light. UV intensity was determined prior to treatment by measuring the output of the light (W/cm^2) and UV dose is determined by the intensity of the light source and the time that the light is in contact with the beef surface and calculated from the following Equation1 according to (Bachmann, 1975).

$$D = I(T) \quad (1)$$

Where: ***D*:** Applied dosage inW.sec/cm^2; ***I***: Applied intensity in W/cm^2 and ***T*:** Irradiation time in seconds.

The actual applied intensity of UV radiation (**I**) was calculated in line with the Equation2 as the following:

$$I = \frac{P}{6.28\, rL} \quad (2)$$

Where: ***I***: Applied intensity in W/cm^2;***P*:** Intensity of UV lamp(W); ***r*:**Distance of UV source from beef sample (cm) and ***L*:** Length of UV lamp (cm).

As intensity was kept constant, variable exposure times were then employed to allow for different doses ranging from of 12.7, 25.5 and 38.2 W.s /cm^2 to be applied to the surface of the beef samples. Light intensity was evaluated several times during the experiments to ensure consistent output.

Relatively beef samples were treated on each side, therefore 2 × 6.35 W.s/cm^2 = a total UV dose of 12.7 W.s/cm^2 according to (Sommers et al., 2010) and (Escalona et al., 2010).

Storage process:

The UV irradiated and non-irradiated beef samples were immediately refrigerated stored at 4℃±1℃ and subjected to the periodical analysis at 0, 5, 10,15 and20d intervals.

Chemical analysis:

Chemical analyses consisted of total moistures, crude protein, collagen, fat, pH value and thiobarbituric acid value (TBA), were measured as the following:

Moisture content, protein, fat and collagen percentages:

Beef chemical analysis was performed using Food Scan™ Pro meat analyzer (Foss Analytical- A/S, Model 78810, and Denmark). According to the manufacturer's instructions about 50 - 100 g of raw beef samples' were minced and put in the meat analyzer cup. The cup was inserted into the meat analyzer for scanning sample with infrared to determine the chemical components.

pH measurement:

The pH was measured after 24h post-chilling using 5g of meat according to the following methodology described by (Abdul-Aziz, 2006). The pH of the obtained suspension was measured by Micro- processor pH meter (pH211, Hanna instruments, Italy).

Thiobarbituric acid value:

The 2-thiobarbituric acid test (TBA) was used to determine the extent of lipid oxidation in chilled beef samples, and the average values were reported as (mg malonaldehyde per kg beef sample). The method for analysis was described by (Vyncke, 1970).

Physical characteristics:

Water holding capacity (WHC) percentage:

Water holding capacity (%) was measured according to (Sami, 2001).Meat sample of about 0.3g (W1) was placed on a filter paper (Whatman No.1) and then subjected to a pressure of 1000 g for 10 min. The sample was weighed again (W2) and the expressible fluid was estimated as the difference between the two weights divided by W1 multiplied by 100. Water holding capacity (%)can be calculated by the following Equation3:

a): The assembled setupdesigned for light

$$\text{Water holding capacity, \%} = \frac{W1-W2}{W1} \times 100 \quad (3)$$

Where: ***W1*** = Weight of meat sample before measuring, *g* and ***W2*** = Weight of meat sample after measuring, g.

Cooking loss percentage:

Cooking loss was determined using two cubes of beef about 100 g, (W3). The samples were boiled in saline (0.09 % Nacl) for 45 min, and also to attainment the correct target core temperature of 76.6 ℃, a meat thermometer (Weston model 2261, 5 in. stem, calibrated from 0 °C to 100 °C) was inserted into the most central position (depth, height and width being considered) of the beef samples for use in recording initial and final internal temperature of 76.6°C was reached, immediately before the cessation of cooking (Bouton and Fisher, 1973). Then beef cooked samples were left to be cool at room temperature. Samples were re-weighed (W4) to calculate the cooking loss percentage as the difference between W3 and W4 divided by W3 multiplied by 100 according to the method described by (Sami, 2001).The Cooking loss (%) content can be calculated by the following Equation4:

$$\text{Cooking loss, (\%)} = \frac{W3-W4}{W3} \times 100 \quad (4)$$

Where: ***W3*** = Weight of meat sample before measuring, g and ***W4*** = Weight of meat sample after measuring, g.

Shear force:

After measuring cooking loss, the cooked beef samples were used for determining the shear force (Kgf). Samples were kept in refrigerator (4 ℃-5 ℃) for about 12 h, before estimating shear force using Instron Universal Testing Machine (Model 2519-105, USA)according to the procedure outlined by (Shackelford et al., 2004).

Beef color properties:

Meat color was measured using Croma meter (Konica Minolta, model CR 410, Japan). Color was expressed using the CIE L, a, and b color system (CIE, 1976).A total of three spectral readings were taken for each sample on different locations of the muscle. L (lightness) values measure (higher L value indicates a white color, while lower L value indicates a black color); a values measure redness (positive a value indicates a reddish color, while negative value measures greenish); and b values measure yellowness (positive b value indicates a more yellowish color, while negative value measures blueish). Higher values of lightness and positive one of redness and yellowness indicate that color meat was better that lower values of lightness and negative values of redness and yellowness.

Color measurements:

Hue degree (φ),defined as the angle between the hypotenuse and 0° on the (blue-green / red-yellow) axis, however, positive values use in the first and third, while negative values in the second and fourth the quadrants, according to (Balkeniues et al., 2003).Hue angle degree can be computed from the following Equation5:

$$\varphi = \tan^{-1}(b/a) \quad (5)$$

Where: ***φ*:** is the hue angle degree, ***a*:** is the (red-green) axis, values and ***b*:** is the (yellow-blue) axis, values.

Saturation (σ) was referred to color saturation according to (Balkenius et al., 2003).

This can be calculated from the following Equation 6 and represents the hypotenuse of a right triangle created by joining points (0, 0), (a, b) and (a, 0).

$$\sigma = \sqrt{(a)^2 + (b)^2} \quad (6)$$

Where: ***σ*:** is the saturation value, ***a*:** is the (red-green) axis, values, and ***b*:** is the (yellow-blue) axis, values.

Microbiological analysis:

The standard method and suitable culture media were used for the microbiological analysis, where the thirty grams of beef sample were taken and transferred into 90 ml 0.1% peptone water (Difco, 0118-17-0) and homogenized. From the 10^{-1} dilution, other decimal dilutions were prepared. Total plate count was determined by using the dilution plate count method. Plate count agar (PCA) was used as medium. Plates were incubated at 30 ℃. The counting of microbial colonies was carried out

after 48 h incubation and results were expressed as log values and reported before exceeding acceptable limits, (ISO 4833, 2003).

3 Results and discussion

The influence of ultraviolet (UV) radiation on the chemical composition of beef meat sample.

Effect of UV radiation on the moisture content, protein, collagen content and Mc/P ratio of meat during cold storage.

Figure 2 shows that the moisture content percentages of control meat sample decreased during cold storage period from 77.63%, 77.23% and 75.68% for 0, 5th and 10th d respectively; at 12.7W.s/cm^{2}dose, it was 77.33%, 77.01%, 75.57% and 74.8% for 0, 5th, 10th and 15th d respectively; at 25.5W.s/cm^{2}dose, it was 76.4%, 75.8%, 74.9%, 74.31% and 73.82% for 0, 5th,10th,15thand 20thd and at the 38.2W.s/cm^{2}dose, it was 75.8%, 75.1%, 74.2%, 73.93% and 73.6% for 0, 5th, 10th 15th and 20th d of cold storage respectively.

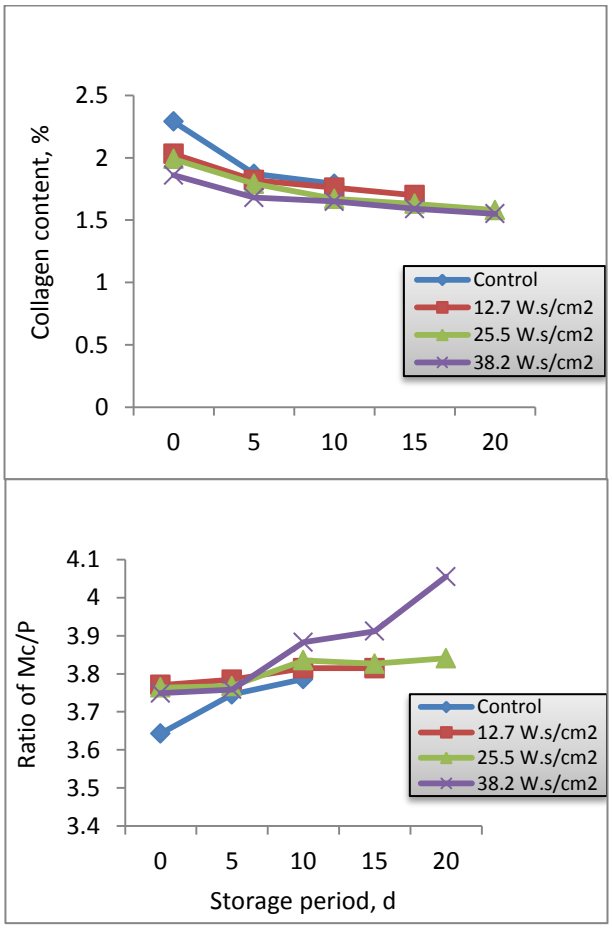


Figure3 Effect of UV radiation on collagen content and Mc/P ratio of beef meat during cold storage

The moisture content/protein (MC/P) ratio of meat samples proportionally related to the applied UV irradiation doses and storage time; by increasing the storage time and UV irradiation dose level. The MC/P ratio of control meat sample increased from 3.64, 3.74 to 3.78 for 0, 5th and 10th d respectively; at 12.7W.s/cm^2 dose, it was 3.77, 3.78, 3.8 to 3.81 for 0, 5th, 10th and 15th d respectively; at 25.5W.s/cm^2 dose, the MC/P ratio was 3.76, 3.77, 3.83, 3.82 and 3.84for day 0, 5th, 10th15th and 20thd respectively and at 38.2W.s/cm^2 dose, it was 3.75, 3.76, 3.88, 3.91 to 4.05for 0, 5th, 10th, 15th and 20th d of cold storage respectively.

From the above results, it was found the higher UV irradiation dose leads to the lower moisture content, protein, collagen percentage and MC/P ratio of treated beef meat samples. According the borderline of the (EC Regulation N°1441, 2007) the maximum values of total bacterial count allowed in ground meat is 6.69 logs CFU/g, the shelf life of the control meat samples and 12.7W.s/cm^2 dose were about 10and15 d so the control and 12.7W.s/cm^2 dose beef sample rejected at 15 and 20 d of cold storage periods.

Effect of UV radiation on the fat content, pH and Lipid oxidation of beef meat during cold storage.

Figure 4 indicates that the pH values of control meat sample increased from 5.86, 5.67 and 6.74 for 0, 5th and 10th d respectively; at 12.7W.s/cm^2 dose, it was 5.77, 5.46, 6.63 and 6.73 for 0, 5th, 10th and 15th d of respectively; at 25.5W.s/cm^2 dose, it was 5.68, 5.37, 6.52 ,6.68 and 6.79 for 0, 5th, 10th, 15th and 20th d respectively and at 38.2W.s/cm^2 dose, it was 5.61, 5.31, 6.4, 6.57 to 6.74 for 0, 5th, 10th, 15th and 20th d of cold storage respectively

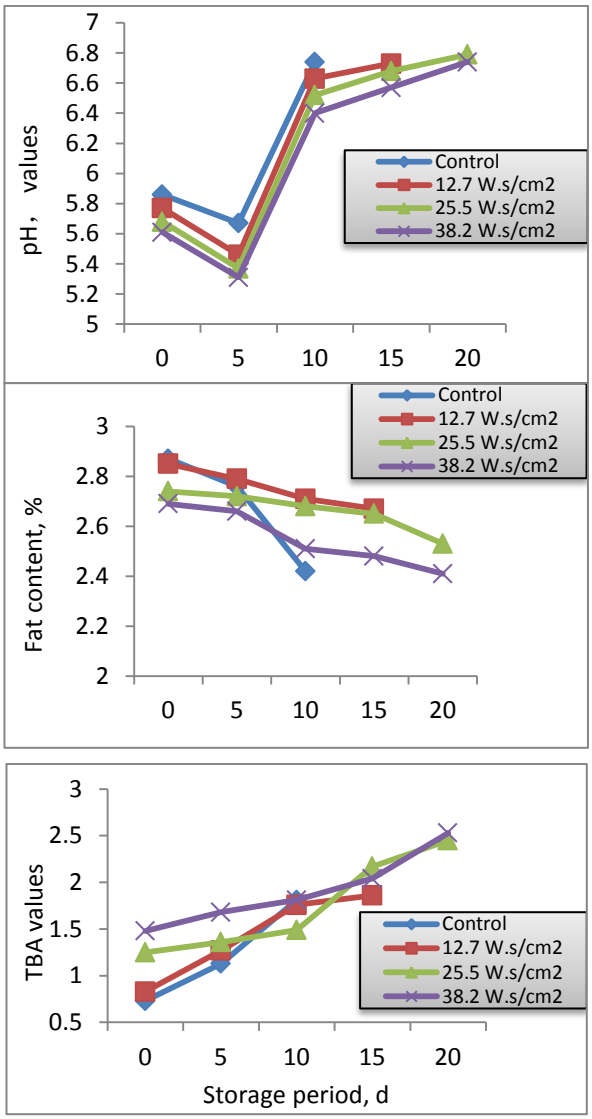


Figure 4 Effect of UV radiation on pH, fat content and TBA of beef meat during cold storage

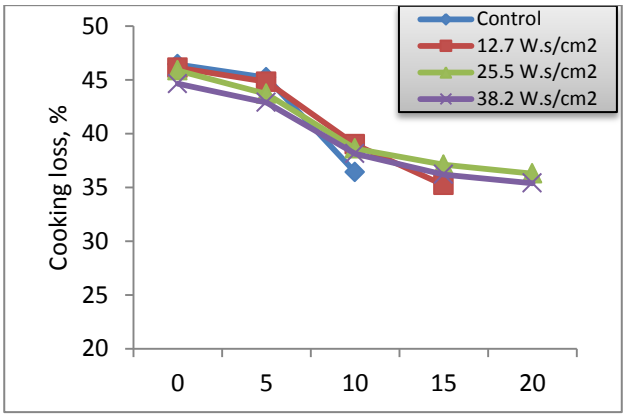
The fat content percentages of control meat sample decreased from 2.87%,2.76%and 2.42% for 0, 5th and 10th drespectively; at 12.7W.s/cm^2 dose, it was 2.85%, 2.79%, 2.71% and 2.67% for 0, 5th, 10th and 15th d of respectively; at 25.5W.s/cm^2 dose, it was2.74%, 2.72%, 2.68%, 2.65% and 2.53% for 0, 5th, 10th, 15th and 20thdrespectively and at 38.2W.s/cm^2 dose,it was2.69%, 2.66%, 2.51%, 2.48% and 2.41% for 0, 5th, 10th, 15th and 20th d of cold storage respectively.

Thiobarbituric acid values (TBA)(mg malonaldehyde/1kg meat sample)of the UV irradiated meat samples increased as compared with unirradiated samples, where the TBA values of control meat sampleincreased from 0.73,1.13and 1.81for 0, 5th and 10th d respectively; at 12.7W.s/cm^{2}dose, it was 0.83,1.27,1.76and 1.86for 0, 5th, 10th and 15th d respectively; at 25.5W.s/cm^2 dose, it was 1.25, 1.36,1.49,2.17and 2.45for 0, 5th, 10th, 15th and 20thd respectively and at 38.2W.s/cm^2 dose, it was1.48,1.68,1.81,2.04to 2.53at 0, 5th, 10th , 15th and 20thd of cold storage respectively.

From the above results, it was clear that the higher UV irradiation dose leads to the lower fat content percentages, pH values and higher TBA values of treated beef meat samples.

The influence of UV radiation on the physical characteristics of beef meat during cold storage.

Figure 5 shows that the cooking loss percentages of control meat sample decreased from 46.44%, 45.21% and 36.41% for 0, 5th and 10th d respectively; at 12.7W.s/cm^2 dose, it was 46.12%, 44.81%, 39%and 35.21% for 0, 5th, 10th and 15th d respectively; at 25.5W.s/cm^2 dose, it was 45.87%, 43.7%, 38.6%, 37.1% and 36.28% for 0, 5th, 10th , 15th and20thd respectively and at the 38.2W.s/cm^2 dose, it was 44.63%, 42.9%, 38.13%, 36.19% to 35.39% for 0, 5th, 10th , 15th and 20th d of cold storage respectively.



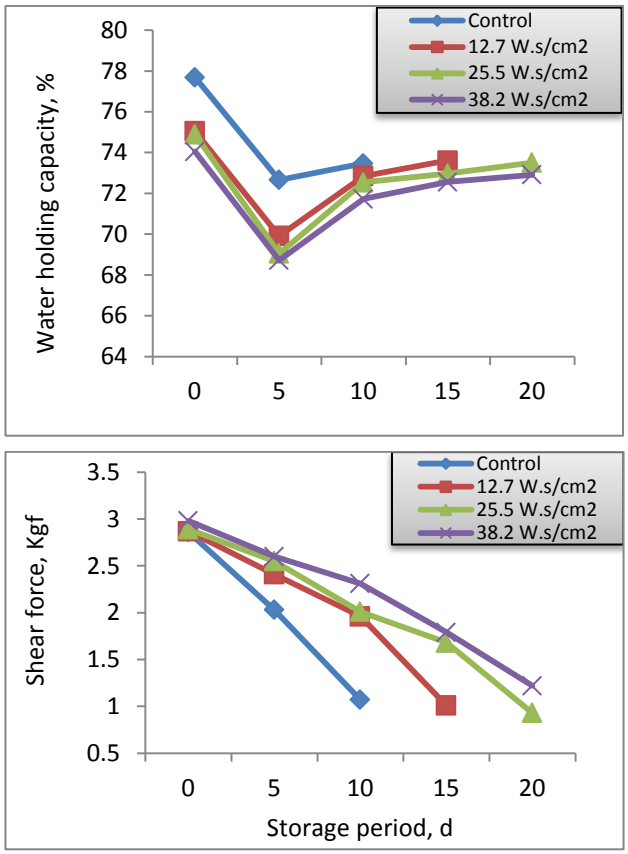


Figure 5 Effect of UV radiation on cooking loss, water holding capacity and shear force of beef meat during cold storage

The water holding capacity (WHC) percentages as shown in Figure5 of UV irradiated meat samples during cold storage, were lower than the unirradiated and decreasing by storage time, where the WHC percentages of control meat sample decreased from 77.69%, 72.66% and 73.47% for 0, 5th and 10th d respectively; at12.7W.s/cm^{2}dose,it was 75.05%, 69.91%, 72.85% and 73.61% for 0, 5th, 10th and 20th d respectively.

Analysis of shear force measurements by (kgf) revealed that shear force taken at directly at post-mortem and after UV irradiation process had information on the tenderness of beef during the experiment process.The data obtained from Figure 5 indicated that the decreases in shear force values by kg for irradiated and unirradiated samples at the cold storage. It notices that the shear force values of control meat samples decreased from 2.86, 2.03 and 1.07kgf at 0, 5th and 10th d respectively; at 12.7W.s/cm^{2}dose,it was 2.87,2.41,1.96 and 1.01kgf for 0, 5th, 10th and 15th d respectively; at 25.5W.s/cm^2 dose, it was 2.89, 2.55,2.01,1.68and 0.93kgffor 0, 5th, 10th , 15th and 20thd respectively and at 38.2W.s/cm^2 dose, it was 2.98,2.6,2.31,1.79to1.22kgf at 0, 5th, 10th, 15th and 20th d of cold storage respectively.

From the above results, it was found the higher UV irradiation dose leads to the lower cooking loss, WHC percentages and the higher share force values of UV irradiated beef meat samples.

At 25.5W.s/cm^2 dose, it was 74.89%, 69.05%,72.54%,72.97%and 73.51% for 0, 5th, 10th ,15th and 20th d respectively and at 38.2W.s/cm^2 dose, it was 74.05%,68.72%,71.73%,72.56%to 72.91% for0, 5th, 10th, 15th and20thd of cold storage respectively.

Analysis of shear force measurements by (kgf) revealed that shear force taken at directly at post-

From the above results, it was found the higher UV irradiation dose leads to the lower cooking

Color attributes of beef meat as affected by UV radiation during cold storage.

Figure 6 showed that the light intensity values of meat samples decreased upon storage time and by UV irradiation, where that the light intensity values of control meat sample decreased from 37.21,29.72 and 29.03value for 0, 5th and 10th d respectively.

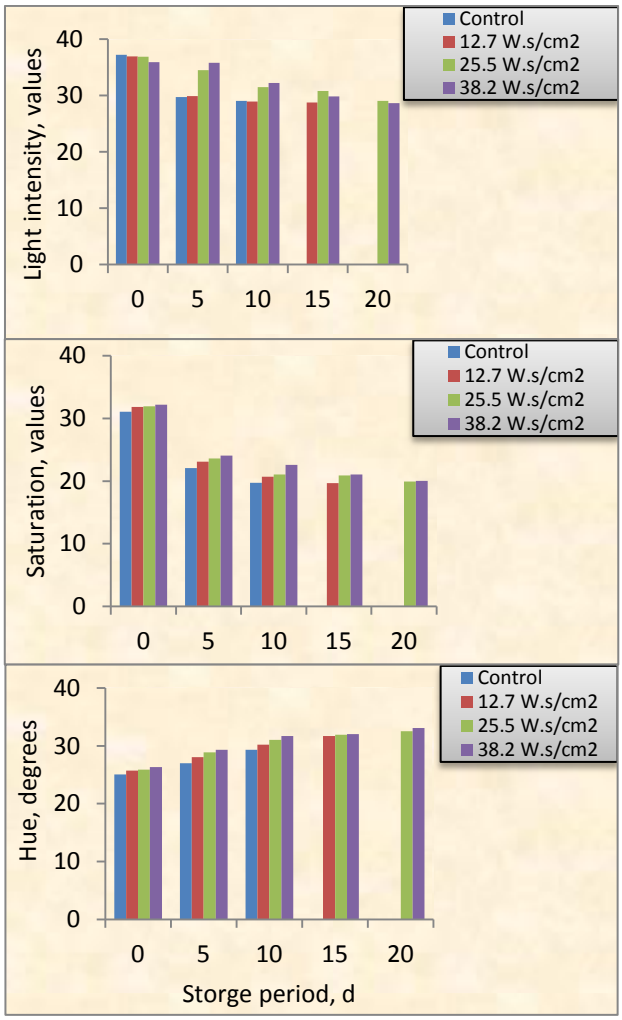


Figure 6 Effect of UV radiation on color attributes (light intensity, saturation values andHue degree)of beef meat during cold storage

At 12.7W.s/cm^{2}dose, it was 36.92,29.9,28.95and 28.76 value at 0, 5th, 10th and 15th d respectively; at 25.5W.s/cm^2 dose, it was 36.89, 34.49,31.51,30.82 and 29.05value for 0, 5th, 10th, 15th and 20th d respectively and at the 38.2W.s/cm^2 dose, it was 35.9, 35.81, 32.21, 29.82 to 28.66 value for 0, 5th, 10th, 15th and 20th d of cold storage respectively.

Also, the obtained results showed that the saturation value increased by the UV irradiation technique and decreased during storage time, the saturation values of control meat sample decreased from 31.05,22.05and 19.72 value for 0, 5th and 10th d respectively; at 12.7W.s/cm^2 dose, it was 31.85, 23.11, 20.71and 19.67 value for 0, 5th, 10th and 15th d of respectively; at 25.5W.s/cm^{2}dose, it was 31.95, 23.62,21.05,20.88and 19.92value for 0, 5th, 10th, 15th and 20th d respectively, and at 38.2W.s/cm^{2}dose, it was 32.17, 24.05, 22.6, 21.05 to 20.03 value for 0, 5th, 10th, 15th and 120th d of cold storage respectively.

The Hue degrees steadily increased by UV irradiation process and cold storage, where that the Hue degree of control meat sample increased from 25.04,27.01and 29.31degree for 0, 5th and 10th d respectively; at 12.7W.s/cm^{2}dose,it was 25.72,28.06,30.21and 31.7degree for 0, 5th, 10th and 15th d respectively, at 25.5W.s/cm^2 dose, it was25.91, 28.88,31.02,31.92and 32.51degree for 0, 5th, 10th, 15th and 20th d respectively and at the 38.2W.s/cm^2 dose it 26.32,29.34,31.72,32.05to 33.07degree for0, 5th, 10th, 15th and20th d of cold storage respectively.

From the above results, it is obviously that the higher UV irradiation dose leads to the lower light intensity values, the higher saturation values and Hue degrees of UV irradiated beef meat samples.

The microbiological quality of beef meat affected by UV radiation during cold storage.

Figure 7shows the immediate effect of UV irradiation (12.7, 25.5 and 38.2W.s/cm^2) for meat samples in the total microbial counts with the concomitant benefits of prolong refrigerated shelf life of samples during storage.

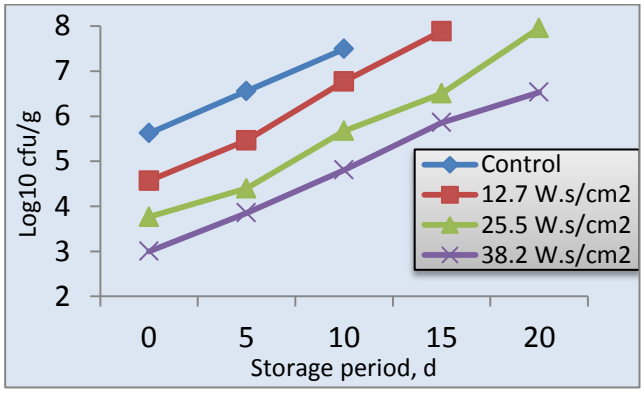


Figure 7 Effect of UV radiation on total bacterial count of beef meat during cold storage

The total bacterial count (TBC) of UV irradiated and unirradiated meat samples during cold storage at 4^{o}C+1^{o}C gradually increased, according to the borderline of the (EC Regulation N°1441, 2007) the maximum values allowed in ground meat is 6.69 logs CFU/g, the shelf life

of the unirradiated meat samples(control) was about 10 days, where the total bacterial count was increased sharply from $4.2x10^5$,$3.6x10^6$and $3.1x10^7$CFU/g for 0, 5^{th} and 10^{th} days respectively; at 12.7W.s/cm^{2}dose,it was $3.7x10^4$, $2.9x10^5$, $5.9x10^6$ and $7.7x10^7$CFU/g for 0, 5^{th}, 10^{th} and 15^{th} d respectively.

At 25.5W.s/cm^2 dose, the total bacterial count was $5.8x10^3$, $2.5x10^4$, $4.7x10^5$, $3.2x10^6$and $9.1x10^7$CFU/g for 0, 5^{th}, 10^{th}, 15^{th} and 20^{th}d of respectively, whereas the 38.2W.s/cm^{2}dose extend beef meat shelf life more than 20 days and the total bacterial count (TBC) was raising from10^3, $7.1x10^3$, $6.4x10^4$, $7.2x10^5$ to $3.4x10^6$ CFU/g for 0, 5^{th}, 10^{th}, 15^{th} and 20^{th} days of cold storage respectively.

4 Conclusions

The results of the present study can be summarized as follows:

1)UV irradiation reduced the number of microorganisms in the irradiated beef meat samples from $4.2x10^5$,$3.7x10^4$, and $5.8x10^3$ and less 10^3CFU/g, moreover, the shelf lives of the UV irradiated samples increased considerably from 10, 15 and 20 d during cold storage period days for control, 12.7, 25.5and 38.2 W.s/cm^2 respectively.

2) The chemical properties of the UV irradiated beef meat samples like moisture content decreasing from 77.63%, 74.8%, 73.82% and 73.6%; protein content from 21.31%, 19.61%, 19.22% and 18.15%; collagen content from 2.29%, 1.7%, 1.58%and 1.55%, whereas fat content form 2.87%,2.67%,2.53%and 2.41%; meanwhile, there were increasing in the pH values from5.86,6.73,6.79and6.74; the lipid oxidation from 0.73,1.86,2.45 and 2.53mg malonaldehyde/kg during cold storage period days for control, 12.7, 25.5and 38.2 W.s/cm^{2}respectively.

3)The physical characteristics like cooking loss decreasing from46.44,35.21,36.28and 35.39%; share force form2.86, 1.01,0.93and 1.22kgf while water holding capacity decreasing from 77.69,73.61,73.51 and 72.91% during cold storage period days for control, 12.7, 25.5and 38.2 W.s/cm^2 respectively.

4)The color attributes of UV irradiated samples had higher Hue degree from25.04,31.7,32.51and 33.07degree; lightness values decreased from37.21,28.76, 29.05 and 28.66,whileSaturation values decreased from31.05, 19.67, 19.92 and 20.03duringcold storage period days for control, 12.7, 25.5and 38.2 W.s/cm^{2}respectively.It was concluded that UV radiation had obvious impacts on microbial quality, extend shelf-life of fresh beef, chemical characteristics, physical parameters and color attributes of fresh beef meat during cold storage.

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6الملخص العربى

"تأثير عملية التشعيع بالأشعة الفوق بنفسجية على جودة لحم البقر الطازج خلال التخزين المبرد"

تعبراللحوممن أهم العناصر الغذائية للأنسان لكونها ضروريةللنمو والمحافظة على الصحة الجيدة. وبدراسة تأثير الأشعة الفوق بنفسجية على جودةلحوم البقرالطازجة المخزنة على(4±1درجة مئوية) وتأثيرها على النموالبكتيري،ومدة الصلاحية للأستهلاك ، والمحتوى الكيميائي و الفيزيائى.أظهرت النتائج المتحصل عليها الاتى:1) أنالأشعة الفوق بنفسجيةتخفض العدد الكلى للكائنات الحية الدقيقةفي جميععيناتلحم البقرالمعاملة بجرعاتالأشعة الفوق بنفسجية12.7 ’ 25.5’38.2وات.ثانية/سم^2. 2)زادتمدة الصلاحية للاستهلاكفى العيناتالمشععة من10 الى 20 يوم.3) بالنسبة للخصائص الكميائية فأن هناك انخفاضكبيرفي محتوى الرطوبةمن 77.63% الى75.8%؛ البروتين من 21.31% الى 20.22% والكولاجين من 2.29 الى1.86%بينمازادتقيمةارقام الحموضةوأكسدة الدهونحتى أعلى جرعة مستخدمة(38.2 وات.ثانية/سم^2).4) بالنسبة للخصائص الفزيائية فأن نسبة الفقد بالطبخفقدانخفضت من 46.44% الى44.63%بينما زادت قوةالقطع كمقياس للطراوةنتيجةتأثيرالإشعاع ولكن انخفضت بالتخزين من 2.86 الى2.98حتى1.22كجم.قوة، فى حين أن القدرة على الاحتفاظ بالماءانخفضتبزيادة الجرعةالإشعاعيةمن 77.69% الى 74.05%حتىأعلىفترة تخزينية (20 يوم). 5) أظهرت العيناتالمشععة بالأشعة الفوق بنفسجية ارتفاعقيمالتشبع اللونية عنها عن الغير مشععة التى انخفضت بالتخزين من31.05الى 20.03وأيضا انخفضت قيمةالسطوع اللونى للحوم البقرية بالمعاملة الاشعاعية من 37.21الى 35.9حتى أعلى جرعة مستخدمة(38.2 وات.ثانية/سم^2).بينما درجة زاوية اللون زادت بالاشعاع حتى اعلى فترة تخزنية (20 يوم)من 25.04الى 26.32درجة.6) لذلك نستنتج أنالأشعة الفوق بنفسجيةذات تاثير واضح على خفض المحتوى البكتيري واطالة عمر المنتج وفترة الصلاحية، والمحتوى الكيميائي والخصائص الفيزيائيةواللونيةللحوم البقرالطازجة والمخزنة بالتبريد.

7) يوصى باستخدام الأشعة الفوق بنفسجية كطريقة غير تقليدية لحفظ اللحوم المبردة لما لها من أثر ملحوظ على جودة اللحوم البقرية وخفض الحمل الميكروبى الكلى و اطالة فترة صلاحيتها.