Original Research Article

Use of Ultraviolet Light for Surface Decontamination of Raw Chicken Carcasses

Abstract

Aim : Fresh chicken meat is especially susceptible to surface contamination. The researchers are looking into non-thermal and non-chemical preservation techniques for meat. Therefore, the present study was planned to investigate the use of UV-C light for decontamination of raw chicken carcasses at refrigeration temperature (0-4^{O}C).

Study Design: The study was undertaken in two phases wherein, the first phase standardization of UV dose and later the comparative effect of selected UV light and sodium hypochlorite exposure on the shelf life of poultry carcasses (0-4 ^{O}C) was carried out.

Place and Duration of Study: The experiment was performed in the Department of Veterinary Public Health, Poultry and Goat Processing Unit, College of Veterinary and Animal Sciences, Parbhani (MH) India, from October 2021 to April 2022.

Methodology: We performed the microbial, physicochemical, and sensory (odour) evaluation of the chicken carcasses during storage up to 72 hrs. Amongst various UV doses with different exposure times and distances tested, UV-C light exposure generated 233.86, 103.93, 207.87, and 415.75 mJ/cm^2 energy for various groups.

Results : A microbial analysis in a standardization study revealed that a significantly ($p<0.05$) lower total viable count was observed in UV (415.75 mJ/cm^2) group. Similarly, counts of *Staphylococcus* spp. and *E.coli* were significantly ($p<0.05$) lower in UV-C light (207.87 mJ/cm^2 and 415.75 mJ/cm^2) groups. The shelf-life analysis indicated that UV-C light (415.75 mJ/cm^2) and sodium hypochlorite (50 ppm) were equally effective in reducing the microflora of carcasses. The pH and TBA values of both treatment groups did not differ significantly but an increasing trend was recorded for peroxide and tyrosine values throughout the storage period.

Conclusion : The findings of the present study indicate that UV-C light technology may be applied for surface decontamination of raw chicken carcasses.

Keywords: UV-C light, raw chicken carcasses, decontamination, quality, shelf life

1. Introduction

The fastest-growing segment of the world's meat demand is poultry meat, and India currently consumes 3.5 kg of chicken meat per person (USDA GAIN, 2021) with growth rates of 8.51 and 7.52 percent in egg and broiler output, respectively, India's poultry industry

is currently emerging as a sunrise sector after growing at an astounding rate ever since it began (BAHS, 2019). The adaptability of chicken meat, its low cost, and acceptance could be conducive to India's increased intake of chicken meat (Waghamare *et al.,* 2021).

However, because the skin, feathers, and intestines of live poultry birds harbour a range of bacteria, there are increased concerns about the microbiological safety of poultry products among consumers, producers, and public health officials (Kozacinski *et al.*, 2006). Bacterial contamination of chicken carcasses during slaughter is nearly unavoidable (Capita *et al.,* 2002). Instances of food poisoning, disease outbreaks, and product recalls have been reported often on a global scale (Castaeda-Gulla *et al.*, 2020). As a result, the safety of chicken products has emerged as a crucial global issue with consequences for public health.

Fresh chicken meat is especially susceptible to surface contamination by pathogenic microorganisms because of its high water and nutrient content (Phillip *et al.*, 2020). Following processing, the presence of spoilage microorganisms on the surface of fresh poultry meat can result in quality problems such as the development of discoloration, off-odour, and off-flavour during cold storage (Petracci and Fletcher, 2002). Utilizing a variety of physical and chemical techniques, such as ultraviolet (UV) light technology, high pressure processing (HPP), high voltage processing pulsed electric field (PEF), gamma irradiation, lactic acid, acetic acid, ozone, and chlorine treatments, pathogens and spoilage-causing microflora are eradicated from poultry carcasses and their products (Gould, 2001; Lynch, 2016 and Gunter-Ward, *et al.,* 2018). But even if they are quite effective, heat treatment and chemical antibacterial agents frequently ruin sensory qualities and valuable nutrients like protein and vitamins (Koutchma, 2009).

In the past few decades, researchers have looked into alternative non-thermal and non-chemical preservation techniques for food processing. For instance, sodium hypochlorite inhibits glucose oxidation to produce its bactericidal effects. However, excessive chlorine use can produce hazardous and cancer-causing tri-halo methane molecules by reacting with meat (Oguz and Guler, 2004). Ultraviolet (UV) light technology, high-pressure processing (HPP), high voltage processing pulsed electric field (PEF), and gamma rays are few more options for developing alternative preservation techniques. Non-ionizing radiation with germicidal qualities, UV light provides a number of benefits over competing technologies, including being simple to use and being more affordable. As an alternative to heat treatment, UV-C (200 to 280 nm) has been used to pasteurize food items such as fruit juice, milk, vegetables, raw meat, and cooked meat. The type of food, microbiota (load and type), and dose employed are the primary factors affecting the usage of UV-C for food preservation (Gunter-Ward *et al.,* 2018). The photochemical transformation of

DNA bases, which results in connections between succeeding bases to create dimers, is thought to be the cause of UV's bactericidal effects. DNA transcription and replication are therefore prevented, which compromises cellular functions and ultimately results in cell death.

Despite the advantages of UV-C in food processing and preservation, the technology's acceptance in meat preservation has lagged because there isn't enough published evidence to back up its usage in meat decontamination. The current study seeks to address this by examining the possibility of UV-C light exposure for surface disinfection of raw chicken carcasses and contrasting its effectiveness with sodium hypochlorite.

2. Material and methods

2. 1 Preparation of Ultraviolet-C (UV-C) chamber prototype

Raw chicken carcasses were exposed to UV light using a UV radiation device created by the Department of Veterinary Public Health and Epidemiology at the College of Veterinary and Animal Sciences (COVAS), Parbhani, India. It was created to clean the carcasses that were hung 144 cm off the ground on shackle lines (Figure 1). The device was made up of 2 distinct rectangular plywood frames attached with 2 UV tubes (each emitting UV-C light of 4.9 W and 254 nm). The interior side of plywood frames towards the carcasses received the tubes. The dorsal and ventral UV tubes were positioned so that the carcasses suspended from the shackles would receive the maximum exposure. By controlling the pace of the shackle line, the length of UV exposure on the carcasses was determined. The precautions were taken to prevent UV light exposure for people.

2.1.1 Calculation of UV dose

As described earlier by Semi (2016), the dosage (transmitted energy) in a UV radiation apparatus was calculated and expressed as J/cm^2 by the following equation

$$Dc = \frac{S}{4\pi d^2} \times t$$

Wherein,

Dc = Total dose of UV light expressed in J/cm^2,

S = power output from the source of light expressed in Watt,

d = distance of an object from the power source expressed in cm, and t is exposure time expressed in seconds.

2.2 Study plan and Sample collection:

There were two phases of the investigation. By examining its impact on the microbiota of processed poultry carcasses, the initial phase entails standardisation and selection of UV dose for shelf-life testing. The comparative effects of certain UV and sodium hypochlorite (CL) on poultry carcasses maintained at refrigeration temperature were studied in the second phase (0-4 OC). Raw skinned chicken carcasses were obtained immediately after evisceration from the institute's Poultry and Goat Meat Processing Demonstration Unit for study.

Six carcasses per group were treated with UV radiation (04 group), sodium hypochlorite treatment, and control in the study's initial phase. Dorsal and ventral swab samples were taken from the corpses immediately after treatment for sensory evaluation of the scent and additional microbiological examination (Total Viable Count (TVC), *Staphylococcus* spp., and *E. Coli*).

The shelf life of chicken carcasses was studied in the second phase using sodium hypochlorite group and one selected superior UV treatment from the first phase. The 06 duplicates of chicken carcass samples maintained at 4 ^{o}C were obtained by destructive method at 0, 24, 48, and 72 hours after treatment. Tempnote Data Logger was used to continuously monitor the refrigerator's temperature. The obtained samples were processed for microbiological (TVC and Pseudomonas spp.), physico-chemical (pH, TBA, Tyrosine value, and POV) examination, as well as sensory (odour) analysis.

2.3 Decontamination of chicken carcasses by *UV-light and Sodium hypochlorite*

The chicken carcasses were held on shackle line in the poultry processing unit and then passed through the UV chamber for various time intervals in seconds with variable distances in centimeter. Based on the time intervals and distances four groups, UV- I (30 sec &10 cm), UV-II (30 sec &15 cm), UV- III (60 sec &15 cm) and UV-IV(120 sec &15 cm) were prepared. Further, the poultry carcasses were decontaminated by sodium hypochlorite (CL) solution by individually dipping in 50 ppm for 60 seconds.

2.4 Microbial analysis

Collection of carcass surface swabs and microbial analysis for standardization of UV dose

Swab samples from carcasses were taken using the technique outlined in ISO 18593:2018. The 100 cm (10 cm^2) ventral and dorsal areas of each carcass were exposed using a 10 × 10 cm sterile template made of aluminium foil. The TVC, *Staphylococcus* spp.,

and *E. coli* counts were performed after the swab was aseptically put into 1ml of sterile peptone water and applied to the designated area of the carcasses.

Pouring the necessary dilutions onto plate count agar and spreading them onto sterilised Baired and Parker Agar and Eosin Methylene Blue (EMB) agar were the plating methods used (BAM, 1998; ISO- 6888-2:1999 and ISO 16649-2:2001). After that, all infected plates were incubated for 24-48 hours at 37 °C. As advised by Bailey and Scott (2007), Gram staining results and biochemical assays verified the presence of *Staphylococcus* spp. in the culture. For chicken carcasses, the data were expressed as cfu/cm^2.

2.4.1 Collection of carcass samples and microbial analysis in Shelf life study

Chicken meat samples weighing 10 grams (gm) were taken from the entire chicken carcass, along with the skin, and placed in 90 ml of normal saline solution. To obtain a 10-fold dilution, the homogenate sample was serially diluted in 9 ml of buffer peptone water that was 0.1% sterilised. The necessary dilutions were spread plated on sterilised Pseudomonas Isolation Agar then pour plated on plate count agar (BAM, 1998 and ISO 11059:2009). For chicken carcasses, the data were expressed as cfu/cm^2.

2.5 Physico-chemical analysis in Shelf life study

The AOAC method was used to determine the pH of chicken breast sample (1995). Using a digital pH meter (Green Genome LMPH-10), homogenates were made from 10 g of materials and 50 ml of distilled water. TBA value was calculated using a slightly modified version of the procedure outlined by Strange *et al.* (1977). Twenty gram of sample meat were blended for two minutes in fifty milliliters of cold, 20 percent trichloro acetic acid to create trichloro acetic acid (TCA) extract. The blended material was rinsed with 50 ml of distilled water, combined with Whatman No. 1 filter paper, and then filtered. The volume of filtrate was then measured and used to estimate the TBA number. Test tubes containing 5 ml of TCA extract and 5 ml of 0.01 M thiobarbituric acid were then put in a boiling water bath (100 0C) for 30 minutes. Along with the sample, a blank constitute of 5 ml of 10% trichloroacetic acid in another test tube was placed in a boiling water bath. The test tubes were removed after 30 minutes and chilled in running water for roughly 10 minutes. The generated colour was quantified as malonaldehyde (MDA)/kg and reported as an absorbance value at 532 nm.

The method used by Strange *et al.* (1977) for determining tyrosine value was followed with a little modification. 2.5 ml of TCA extract (as described above) was diluted with an equal amount of distilled water in a test tube, and 10 ml of sodium hydroxide solution

was then added. Finally, 3 ml of diluted folin-ciocalteu phenol reagent was added. Following a thorough mixing, the solution was left at room temperature for 15 minutes. Using a blank sample (5 ml of 5% TCA) as a standard, the generated blue hue was quantified as an absorbance value at 660 nm and reported as mg/g.

Peroxide value (POV) was determined according to the method of Sallam *et al*. (2004). In a 250 ml Erlenmeyer flask with a rubber cap, the sample (3 g) was weighed. It was then cooked in a water bath for three minutes at 600 C. After that, the flask was thoroughly stirred for three minutes with a 30 ml solution of acetic acid chloroform (3:2 v/v) to dissolve the fat. To filter out chicken particles from the filtrate, Whatman filter paper (Number 1) was employed. The filtrate was then mixed with 0.5 ml of saturated potassium iodide solution, along with starch solution as an indicator. The sodium thiosulfate standard solution was used to continue the titration. The following equation was used to compute the peroxide value (POV), which is represented as milli equivalents of peroxide per kilogram of sample:

Peroxide value (meq/ kg) = {(SxN)/W} x 100

Where

“S” = the volume of titration (ml),

“N” = normality of sodium thiosulfate solution (N=0.01) and “w” = the sample weight (g).

2.6 Sensory evaluation.

Prior to conducting a microbiological investigation of the samples, sensory characteristics in terms of odour were first observed. Graduate students and teaching staff from the institute were among the panelists who participated in the study's sensory examination of chicken meat. In the first stage of UV dose standardization, samples taken right after exposure were examined. While the shelf life study assessed the chicken sample storage for 0, 24, 48, and 72 hours. The panelists used an 8-point descriptive scale to rate the samples for odour (Keeton, 1983). A scale of 1–extremely unwanted, 8–extremely desired, 7–very desirable, 6–moderately desirable, 5–slightly desirable, 4–slightly unattractive, 3–moderately undesirable, 2–very undesirable, and 1–extremely unfavorable—was employed for the hedonic test.

2.7 Data Analysis

Using the WASP 1 and WASP 2 software created by ICAR, all the data were analyzed using a Randomized Block Design and the T-test. In regard to microbiological, physico-chemical, and sensory analysis, the "f" value and "CD" value were computed, and the means of various groups were compared both within and across groups.

3. Results and discussion

3.1 Calculating UV-C light exposure dose:

The energy generated during UV-C light exposure in mJ/cm^2 of various treatments was calculated. The UV-C light exposure generated energy in mJ/cm^2 for groups UV-I, UV-II, UV-III and UV-IV were 233.86, 103.93, 207.87 and 415.75 mJ/cm^2, respectively.

3.2 Standardization of dose of UV light

3.2.1 The comparative efficacy of various dosages of UV-C light (UV I - IV) and sodium hypochlorite (CL) on Microbial Quality

Table 1 compares how TVC, *Staphylococcus* spp., and *E. coli* counts of chicken carcasses were affected by UV - I, UV - II, UV - III, UV - VI, Sodium hypochlorite (CL), and Control. Average mean TVC showed that chicken at processing units was kept in the best possible hygienic conditions. In comparison to other treatments, "UV-IV" and "CL" treatments were found to be significantly more effective (p 0.05). It was found that TVC of raw chicken carcasses might be reduced by UV-C light as well. The findings were consistent with earlier research by Lázaro *et al*. (2014). Similarly, Phillip *et al.* (2020) observed a reduction with a UV-C dosage of 50 to 300 mJ/cm^2, the aerobic mesophilic count (AMC) ranged from 1.69 to 2.98 log cfu/cm^2. The results of several prior studies (Isohani and Lyhs, 2009; Haughton *et al.,* 2011) however, indicated lesser AMC (0.05 to 0.14 log cfu/cm^2) with exposure to UV-C dosages of 50–200 mJ/cm^2. It might be because the dosages utilised were lower in mJ/cm^2 than in the present investigation. The very uneven structure of chicken's surface may shield bacteria from UV-C rays (Haughton *et al.,* 2011). The effectiveness of UV-C technology for decontaminating carcasses may vary depending on a number of variables, including the initial bacterial density, bacterial strains and their growth rate, composition, skin-on and skinless chicken carcasses, and UV irradiation dosage (Gayan *et al,.* 2013).

Staphylococcus spp. (Plate 01) isolation from chicken carcasses points to insufficient sanitary conditions in poultry meat processing (Maharjan *et al.,* 2019). The observation of Table 1 clearly shows that the application of "UV-III," "UV-IV," and "CL" treatment might result in a significant (P<0.005) decrease in *Staphylococcus* spp. contamination. The results were consistent with earlier findings by Liu *et al*., (2019), who found that pulsed UV light irradiation at a distance of 11 cm, a power of 6 watts, and an exposure time of 5 minutes was sufficient to lower the *Staphylococcus* spp. count from 6.49 to 4.10 log cfu/gm. Even while some other studies supported the potential of UV-C irradiation to reduce the number of *Staphylococcus* spp. (Shen *et al.,* 2017), it was also reported that gram-positive bacteria

were found to be more resistant to the influence of UV irradiation than Gram negative bacteria (Sommers *et al.,* 2009)

Comparison of effect of various treatments on *E.coli* counts (Table 1; Plate 02) indicated that 'UV-III', 'UV-IV' and 'CL' were significantly ($P<0.005$) able to reduce *E.coli* count. These observations were in agreement with earlier studies wherein *E.coli* count was a reduction of 0.36 to 1.28 log was recorded with UV-C treatment at 500 µw/cm^2 for 3 minutes (Kim *et al.,* 2002). Besides, a significant reduction of 0.77 log cfu/gm was observed for *E.coli* on chicken skin after UV treatment up to 0.192 J/cm (Haughton *et al.,* 2011) which also corresponds to present observations.

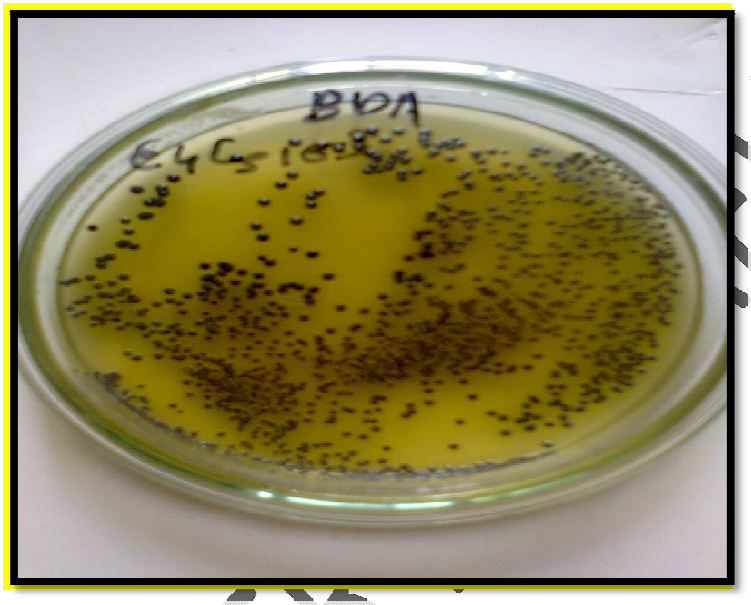

Plate 1: Colonies of *Staphylococcus* spp. on Baired and Parker agar

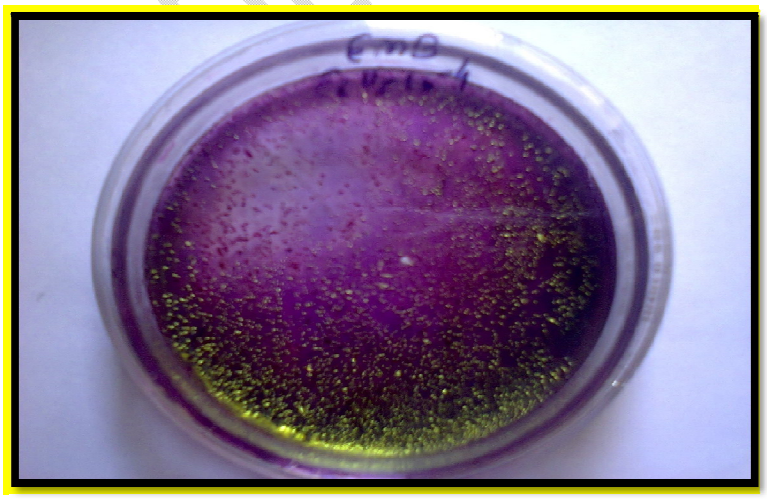

Plate 2: Colonies of *E. coli* on Eosin Methylene Blue agar

3.2.2 Effect of various doses of UV-C light and chlorine wash on Sensory property (odour) of raw chicken carcasses

The results of hedonic scale (Table 1) showed that the mean odour attributes of raw chicken carcasses were found to be 7.818±0.011, 7.967±0.010, 7.837±0.021, 7.777±0.096, 5.907±0.150 and 7.822±0.009 for 'C', 'UV-I', 'UV-II' 'UV-III', 'UV-IV' and CL groups, respectively. Raw chicken carcasses' odour was unaffected, although 'UV-IV' demonstrated substantially slight to moderately desirable grade due to light burnt odour following exposure. Except for "UV-IV," there was no difference between the control, "UV-I," "UV-II," "UV-III," and "CL" groups on the hedonic scale test for odour ($p<0.01$).

The findings are consistent with earlier research by Phillip *et al*. (2020), who also noted a burnt odour on chicken samples that had been exposed to UV-C radiation. Additionally, Mc Leod *et al.* (2018) noted an off-odour just after receiving UV-C treatment. Other investigations have shown no negative impact on the sensory quality of broiler meat after UV irradiation, including Stermer *et al* (1987), Wallner Pendleton, (1994), Lyon *et al.,* (2007), and Issohani, (2009).

3.3 Effects of Selected UV C Light (UV-IV group) and CL on shelf life of chicken carcass

Based on the findings of the standardisation of UV light exposure trial, the shelf life and decontamination of chicken carcasses stored at refrigeration temperature (0 –4 ºC) were studied using the UV-IV group (415.75 mJ/cm^2) and sodium hypochlorite group. The results are shown in Table 02.

3.3.1 Analysing Microbial Quality

It was found that the TVC of raw chicken carcasses treated with UV-C light and sodium hypochlorite and stored at refrigeration temperature (3.87±0.377 to 4.07±0.173□C) also increased with ambient increase in storage time (Table 02). For samples treated with UV-C light and sodium hypochlorite, the initial TVC of raw chicken carcasses at 0 hours was 4.33±0.105 and 5.30±0.16 log cfu/gm, respectively. After 72 hours, the TVC of beef samples that had been exposed to UV-C light and sodium hypochlorite was 6.17±0.02 and 6.55±0.124, respectively. These values fell within the FSSAI, New Delhi, legal parameters.

The microbial development of raw chicken carcass samples appeared to be slowed down by UV-light treatment. Throughout the storage period, raw chicken carcass samples treated with sodium hypochlorite and UV-C light showed significantly different microbial

counts ($p<0.05$). While samples from sodium hypochlorite-treated groups were shown to be advantageous for *Pseudomonas* spp. growth at 48 and 72 hours of storage, *Pseudomonas* spp. was not observed in the UV-C light treated group throughout the storage period.

The findings of this investigation indicated that TVC of raw chicken carcass samples exceeded the recommended limit on day 3 (72 hours). These findings demonstrated that the UV-C light decontamination approach is comparable to that of sodium hypochlorite. These results, however, differ from those published by Phillips (2020), who said that the shelf lives for the control and UV-C treated raw chicken samples, respectively, were 7 and 5 days. These variations in the results could be brought on by the initial microbial load, temperature swings, and storage conditions (Rouger *et al.,* 2017).

3.3.2 Sensory (Odour) analysis

During the 72-hour storage period, the sensory score for the odour of raw chicken carcasses treated with UV-C light and sodium hypochlorite significantly decreased ($p<0.05$). Among the treatments, the odour score differs significantly ($p<0.05$). The raw chicken carcasses treated with sodium hypochlorite received the highest score when compared to the raw chicken carcasses treated with UV-C light. After 72 hours of storage, there was discernible off-odour in both treatment groups, which may have been caused by microbial growth, lipid oxidation, or an enzymatic response. Some panelists mentioned having an irradiated odour the day after receiving UV-C light treatment. The surprising odour was not present in samples that had been treated with sodium hypochlorite, though. The findings of the current study agreed with those of the Park *et al.,* (2014) study. Meat exposed to UV light can develop off odour because of photochemical effects on lipid content of meat (Bintsis *et al.,* 2000)

3.2.3 Physicochemical parameters

Table 2 shows the findings on the physicochemical parameters of raw chicken carcasses treated with sodium hypochlorite and UV-C light at refrigeration temperature (3.870.377 to 4.070.173 0C) as a result of storage-related modifications.

pH

From the data presented in Table 2 it is evident that pH of raw chicken carcasses did not differ significantly throughout the storage period (72 hours) between both the treatment groups. It is clear from the data in Table 2 that over the storage period of 72 hours, the pH of raw chicken carcasses did not substantially differ between the two treatment groups. For samples that had been exposed to UV-C radiation or sodium hypochlorite, the initial pH of the chicken breast was 5.970.115 and 5.610.115, respectively. During the storage period,

the pH decreased in both treatment groups. The current research supported earlier findings by Chun *et al.* (2010) and Liu *et al.* (2019).

Lipid oxidation

Lipid oxidation is analyzed during the study to assess non-microbial quality characteristics in fresh beef products (Reitznerová *et al.,* 2017). Higher lipid oxidation is a sign of poor quality in meat and meat products (Gao *et al.,* 2019). The samples' level of lipid oxidation is indicated by the data on TBA and peroxide value. In order to determine how much lipid oxidation had occurred while raw chicken samples were stored in refrigerators after being exposed to UV-C light and sodium hypochlorite, respectively.

a) TBA

It was observed that the mean TBA of raw chicken carcasses ranged from 0.383±0.010 to 0.77±0.010 MDA/kg and 0.363±0.010 to 0.700±0.010 MDA/ kg of groups UV-C light and sodium hypochlorite treatment, respectively. When compared to a chicken sample that had been treated with sodium hypochlorite during the period of refrigeration, the TBA results revealed that UV-C light treatment had no discernible impact on the rate of lipid oxidation ($p>0.05$). Similar findings were made earlier by Chun *et al.* (2010), who reported that samples of chicken breasts kept at 4 °C for six days under UV-C exposure did not significantly increase the amount of lipid oxidation.

b) Peroxide value

Meat has been found to include a number of enzyme systems that can start the process of lipid oxidation, with microsomal enzyme peroxidase being one of these systems (Dominguez 2019). The greater peroxide value denotes the production of more intermediate lipid oxidation products (Liu *et al.,* 2019).

Despite UV-C light and sodium hypochlorite treatment, a growing trend in peroxide values was seen in the current investigation when raw chicken carcasses were stored at refrigeration temperature (Table 2). When compared to samples treated with sodium hypochlorite, the peroxide values in UV-C light-treated raw chicken carcasses were considerably ($p<0.05$) greater. Previously, after using UV-C to decontaminate chicken, Paskeviciute *et al* (2011) also reported significant changes in lipid oxidation.

c) Tyrosine value

Tyrosine levels in raw chicken carcasses at 0 hours were 0.169± 0.009 and 0.167 ±0.017 mg/kg for samples treated with UV-C light and sodium hypochlorite, respectively. Regardless of treatments, the tyrosine value of raw chicken carcasses increased as the storage period progressed. Tyrosine values of raw chicken carcasses after 72 hours of

storage ranged from 0.523±0.023 to 0.519±0.025 for samples treated with UV-C light and sodium hypochlorite, respectively.

Tyrosine value data revealed that, in contrast to samples treated with sodium hypochlorite, UV-C light therapy had no appreciable impact on proteolytic rate during storage. Biswas *et al.* (2017) have reported an increase in tyrosine value of meat with storage time but there are limited published data on effect of UV-C treatment on raw chicken carcasses with respect to tyrosine values.

4. Conclusion :

The results of this investigation lead us to the conclusion that raw chicken carcasses' surface microflora can be effectively reduced by UV-C light (207.87 and 415.75 mJ/cm^2). In comparison to sodium hypochlorite treatment, UV-C light (415.75 mJ/cm^2) and sodium hypochlorite are similarly effective at extending the shelf life of chicken while having little to no impact on the TBA, tyrosine, and pH values of raw chicken sample (50 ppm). However, it was discovered that the UV-C light (415.75 mJ/cm^2) and sodium hypochlorite (50 ppm) groups were on par with one another in reaching a 3-day shelf life for refrigeration storage (0–4 ºC). It is concluded that surface disinfection of raw chicken carcasses using UV-C light technology at a dosage of 415.75 mJ/cm^2 may be beneficial.

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Ethics approval: This is an observational study. The Research Committee (Resolution no27/2.9 dated 31/05/2021) has confirmed that no ethical approval is required.

Availability of data and material : The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Table 1 Standardizing the dose of UV-C light and sodium hypochlorite by microbial and sensory evaluation.

Sr. No	Parameters	Groups (n=6/groups)							Level of significance
			C	UV-I	UV-II	UV-III	UV-IV	CL	
		Carcass Side	Control	Exposure Times in Second/Distance in cm					
				30 sec / 10 cm	30 / 15 cm	60 sec/15 cm	120 sec/15 cm	Chlorine 50 ppm /**60 Second**	
				233.86 **mJ/cm^2**	103.93 **mJ/cm^2**	207.87 **mJ/cm^2**	415.75 **mJ/cm^2**		
Microbial count (log_{10} cfu/cm^2)									
1.	Total Viable Count	Ventral	6.26 ^{a} ±0.100	5.982 ^{ab} ±0.011	5.978 ^{ab} ±0.135	5.847 ^{b} ±0.099	5.31 ^{c} ±0.211	5.185 ^{c} ±0.083	*
		Dorsal	6.4 ^{a} ±0.096	5.988 ^{b} ±0.160	5.982 ^{b} ±0.055	5.942 ^{b} ±0.074	5.23 ^{c} ±0.191	5.163 ^{c} ±0.156	
2.	*Staphylococcus* spp.	Ventral	4.578 ^{a} ±0.125	4.207 ^{ab} ±0.273	4.003 ^{b} ±0.140	3.535 ^{c} ±0.062	3.47 ^{c} ±0.08	3.418 ^{c} ±0.096	*
		Dorsal	4.415 ^{a} ±0.197	4.39 ^{a} ±0.232	4.088 ^{a} ±0.087	3.48 ^{b} ±0.047	3.555 ^{b} ±0.05	3.51 ^{b} ±0.100	*
3.	*E. Coli*	Ventral	4.233 ^{a} ±0.360	3.533 ^{bc} ±0.209	3.805 ^{ab} ±0.281	3.045 ^{cd} ±0.234	2.86 ^{d} ±0.100	2.838 ^{d} ±0.084	*
		Dorsal	4.483 ^{a} ±0.295	3.425 ^{bc} ±0.341	3.798 ^{b} ±0.192	2.853 ^{cd} ±0.078	2.738 ^{d} ±0.084	2.838 ^{cd} ±0.084	*
Sensory Analysis									
1	*Odour*	Whole Carcass	7.818a±0.011	7.967a±0.010	7.837a±0.021	7.777a±0.096	5.907b±0.150	7.822a±0.009	*

a, b, c means with different superscripts in a row differ significantly $^{*}p<0.05$ * = Significant at 5 %

Table 2. Results of Microbial, Sensory and Physicochemical analysis of raw chicken carcasses treated with UV-C Light (415.75 mJ/cm^2) and Sodium Hypochlorite solution (50 ppm) during storage.

Sampling Time in Hours		**0**	**24**	**48.**	**72**
Temperature (□C)		**-**	**4.07±0.173**	**3.73±0.189**	**3.87±0.377**
A)Microbial count (log cfu/cm^2)					
TVC	**UV-C**	4.33±0.105	4.93±0.169	5.54±0.050	6.17±0.020
	CH	5.30±0.16	5.66±0.123	5.80±0.054	6.55±0.124
Level of significance		**	**	**	*
***Pseudomonas* spp.**	**UV-C**	-	-	-	-
	CH	-	-	1.033±0.008	1.32±0.005
Level of significance		-	-	-	-
B) Sensory parameter					
Odour	**UV-C**	5.740±0.173	5.573±0.180	5.375±0.115	4.742±0.221
	CH	7.822±0.009	7.395±0.271	6.847±0.320	4.110±0.043
Level of significance		**	**	**	*
C)Physicochemical parameters					
Hours		**0**	**24**	**48.**	**72**
Temperature (□C)		**-**	**4.07±0.173**	**3.73±0.189**	**3.87±0.377**
pH	**UV-C**	5.97±0.115	5.94±0.051	5.85±0.066	5.85±0.031
	CH	5.61±0.115	5.70±0.088	5.59±0.119	5.35±0.080
Level of significance		*	*	NS	**
TBA (MDA / kg)	**UV-C**	0.383±0.010	0.520±0.021	0.630±0.010	0.777±0.010
	CH	0.363±0.016	0.490±0.017	0.515±0.093	0.700±0.019
Level of significance		NS	NS	NS	**
Tyrosine (mg/g)	**UV-C**	0.169±0.009	0.308±0.021	0.358±0.031	0.523±0.023
	CH	0.167±0.017	0.297±0.041	0.314±0.041	0.519±0.025
Level of significance		NS	NS	NS	NS
Peroxide value (meq/ kg)	**UV-C**	1.378±0.021	1.453±0.029	1.555±0.020	1.821±0.063
	CH	1.14±0.057	1.257±0.053	1.329±0.023	1.449±0.028
Level of significance		**	**	**	**

**= 1% Level of significance *=5% Level of significance

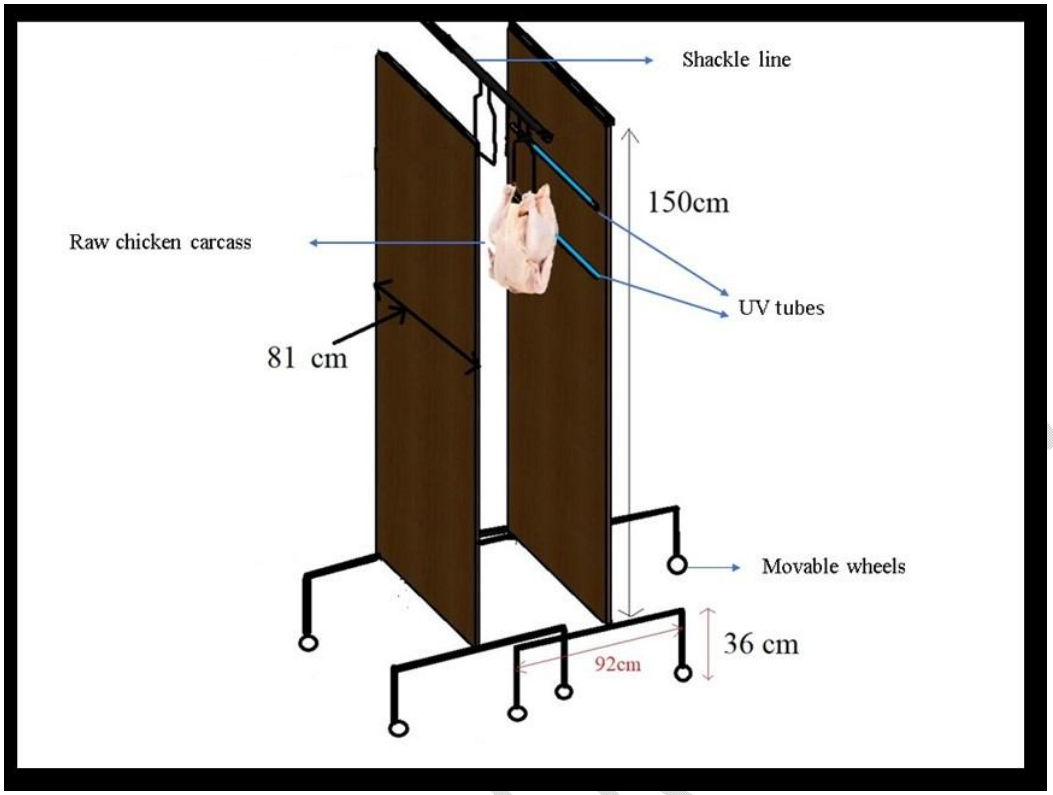

Fig 1: Ultraviolet-C (UV-C) chamber prototype device