EFFECTS OF ULTRA VIOLET LIGHT EXPOSURE TO THE AEROBIC BACTERIAL LOADS OF BALI BEEF

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SUMMARY

Reduction of bacterial loads of Bali beef as influenced by UV light exposures (26.4 Watts UV lamp, wavelength 336 nm, 30 cm from object surfaces was studied. By 5, 10, 15, 30, 25 and 40 min exposures (equal to 792 x 10^6; 1584 x 10^6; 2376 x 10^6) 3168 x 10^6 and 4572 x 10^6 ergs per cm^2) the aerobic bacterial loads from initial content of 5110 went down to 4800, 4730, 4200, 3800, 2680 and 2510 cells per cm^2 respectively. There was a highly significant negative correlation between duration of exposures to the aerobic bacterial loads of beef (r = -0.97) with a regression equation of y = 5375 - 93 x (y = aerobic bacterial load per cm^2; x = duration of exposures in min). Calculated to reduce the aerobic bacterial load into zero needed a 57.8 min exposure (equal to 9156 x 10^6 ergs/cm^2).

It was concluded that the prolongation of UV light exposures effectively reduced the aerobic bacterial loads of beef. By nearly an hour exposure a moderate initial aerobic load would reduce into zero. UV light exposures could be introduced and applied to slaughterhouses, wholesalers and retailers to maintain wholesomeness of beef. As an analogy, it is also applicable to the other foodstuff distribution channels for reduction of their aerobic bacterial loads.

INTRODUCTION

Beef on the island of Bali is produced from the single species of Bali cattle (*Bos sondaicus*). This species has been reared in Indonesia for centuries. It is believed to be the descendant of domesticated bantengs which are farmed and reproduced by a purebred policy.

A major limiting factor in beef distribution and storage is the surface bacterial load. Most bacterial growth takes place on the surface of meat (Mossel et al. 1975). Superficial contamination of meat was caused mostly by contamination during transport, cuttings and storage (Thornton 1960).

The initial bacterial contamination (both type and numbers) affects the stability of beef during distribution and storage. The bacterial loads of beef at tropical room temperatures will multiplicate progressively. Beef usually becomes unacceptable when spoilage organisms reach populations around 10^8 per cm^2 (Strange and Benedict 1978).

Refrigeration has not been commonly practiced along distribution channel of beef in Bali. Ultra violet (UV) light exposure is one alternative to reduce surface bacterial loads of beef for maintaining meat hygiene and sanitation. Factors influencing effectiveness of exposures are duration, intensity of power and distance from object surface. UV light has wavelength within the range of 13.6-390 nm, during exposures will be absorbed by purine and pyrimidine groups of nucleic acids in the bacterial cells, and mutation or death results (Frazier 1967).

This paper reports and discusses the mode of reduction of aerobic bacterial loads of Bali beef which have been transferred on to nutrient agar upon the influence of UV light exposures. Correlation coefficient and regression equation between amount of aerobic bacterial load to the duration of exposure were explored.

MATERIALS AND METHODS

<u>Beef</u> -- Semimembranosus muscle of Bali cattle was purchased (500 g) as source of aerobic bacterial population.

<u>Nutrient agar</u> -- Media with formula : yeast extract (2.5 g), trypotone (5.0 g), dextrose (1.0 g), agar (9.0 g), dissolved into 1000 ml distilled water, with final pH 7.0 (Oxoid).

<u>UV lamp</u> -- Model UVL-56, wavelength 336 nm, 220 V, 50 Hz, 0.12 Amps (26.4 Watts).

<u>Aerobic bacterial population</u> -- Isolated by swab method from 100 cm^2 the semimembranosus muscle surface, dissolved into a 50 ml sterile physiological saline solution. The isolate was used as source of surface loads.

<u>Laboratory technique</u> -- 10^{-2} dilutions of the aerobic bacterial isolates were transferred 1 ml respectively onto the surfaces of 28 plates of nutrient agar as simulation of beef surfaces in order to get equal numbers of initial loads before treatments. The plates were divided into 7 plots for UV light exposures treatments. Each treatment consisted of 4 plates as replications. The distance of the UV lamp to nutrient agar surface was 30 cm. During exposures, the cover of the plates were opened, to avoid glass barrier for the UV light effectiveness.

<u>Incubation and colony counting</u> -- All plates after treatments were incubated at 37°C for 48 hours. Colonies were counted using a Quebec Colony Counter.

<u>Survival of aerobic bacterial loads after treatments</u> -- Calculated by formula: a = bc/de. a = numbers of survival on beef surface per cm^2; b = numbers of colonies on plate; c = 50 (ml) i.e. volume of original suspension of beef aerobic bacterial isolate; d = 10^{-2} (dilution factor of isolate plated); e = 100 (cm^2) i.e. area of beef surface swabbed.

<u>Experimental design</u> -- A completely Randomized Design was employed with 7 treatments as independent variable i.e. 0, 5, 10, 15, 20, 25 and 30 min UV light exposures, survival numbers of aerobic bacterial loads as dependant variable with 4 replications.

<u>Statistical analysis</u> -- Analysis of variance followed by least significant difference test were used. Correlation coefficient (r) and linear regression equation between the two variables were explored (Chang 1972).

RESULTS

The longer duration of UV light exposures, the smaller survival numbers of the aerobic bacterial loads of beef. As an equivalency, the dose of the exposures were also transformed into erg values (1 erg = 0.1 microwatt second) as were shown in Table 1.

Five to 10 min exposures did not significantly reduce the aerobic bacterial loads of beef compared to the initial

Table 1. Effects of UV light exposures to the aerobic bacterial loads of Bali Beef

Duration of exposures (minutes)	Dose of exposures ($x10^6$ ergs per cm^2)	Aerobic bacterial loads (cells per cm^2)
0	0	$5110^{a1)}$
5	792	4800^{ab}
10	1584	4730^{ab}
15	2376	4200^{bc}
20	3168	3800^{c}
25	3960	2680^{d}
30	4752	2510^{d}

1) Values bearing different superscripts to column have a high significant difference (P<0.01).

load. But by 15 to 30 min exposures the survivals would be highly significantly reduced (P<0.01) compared to the initial load. By 30 min exposure the initial load would reduced 50.9%.

Survival numbers of the aerobic loads were negatively correlated with the duration of UV light exposures, with coefficient correlation (r) = -0.97 (P<0.01). The regression equation was : number of aerobic bacterial load (per cm^2) = 5,375 - 93 x UV light exposure duration in min, as shown in Figure 1.

Calculated to reduce the aerobic bacterial load into zero from the above equation would need a 57.8 min UV light exposure, which is equal to 9,156 x 10^6 ergs per cm2.

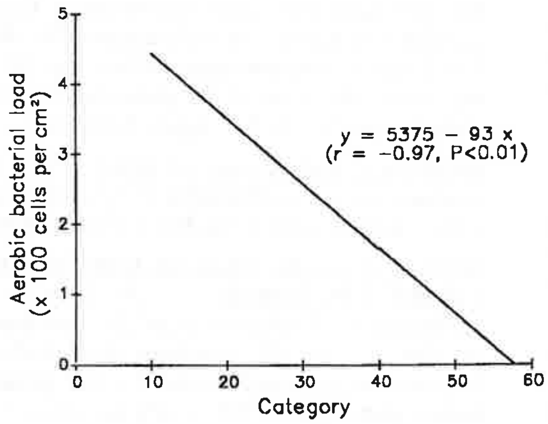

Figure 1. Regression relationships between aerobic bacterial load and duration of UV light exposure.

DISCUSSIONS

By 5, 10, 15, 20, 25 and 30 min exposures the reductions of the aerobic loads were 6.1, 7.4, 17.8, 25.6, 47.7 and 50.9% from the initial content, respectively. For a 100% reduction of the aerobic load needed a 57.8 min exposures, which was equal to 9.2 x 10^9 ergs per cm^2. This value seemed to be higher than earlier reports by some authors.

Lawrie (1966) and Mossel et al. (1975) suggested for decontamination and for lethal dose of vegetative bacteria needed treatment of 0.1 - 0.2 Mrad, which was equal to (1-2 x 10^7) ergs per g of meat. Toyoda (1986) suggested to destroy totally of *Bacillus proteus* needed 63 microwatts.min/cm2, and *Bacillus subtilis* needed 360 microwatts.min/cm2, which were respectively equal to 3.8 x 10^3 ergs and 2.2 x 10^5 ergs per cm^2. Toyoda used UV lamp with a wavelength of 253.7 nm, by 100 cm distance from the object surfaces.

The bactericidal effect of the UV wavelength was reported between 13.6 - 390 nm, inversely related to the distance of the objects. The most germicidal effect have been reported between 265 - 266.6 nm wavelength (Frazier 1967).

A larger lethal dose value for the aerobic bacterial load of the present experiment occurred in line with the longer wavelength of UV lamp used (336 nm) compared to Toyoda (253.7 nm), although the distance was 0.3 time closer to the object. The consequence occurred was that, the germicidal power apparently weaker.

CONCLUSIONS

Prolongation of UV light exposures effectively reduced the aerobic bacterial loads of Bali beef. After nearly an hour exposure from a moderate initial aerobic load would reduce into zero. UV light exposures could be introduced and applied to slaughterhouses, wholesalers and retailers to maintain wholesome and high quality beef. As an analogy, it is also applicable to the other foodstuff distribution channels for reduction of their aerobic bacterial loads.

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