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Effectiveness of the Verif EYE™ machine-vision technology for complying with reducing microbial indicator counts on beef carcasses

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Abstract

The slaughter process for cattle will inevitably transfer some bacteria onto the carcasses. The goal of food safety programs is to minimize and effectively remove this contamination. This study was attempted by the Verif EYE™ machine-vision technology that might be useful for reducing microbial indicator counts and could reduce the contamination chance of *E coli* O157:H7 and *Salmonella* spp on beef carcasses.

For the evaluation of the effectiveness of the Verif EYE ™ technology, 80 samples were examined by the inspection device over 15 days. On an examination of FDS-positive samples compared to negative controls from the same carcasses, aerobic plate counts were bigger than the negative control samples (5.26 vs 4.60 log). *Enterobacteriaceae* counts were greater on the positive samples than the corresponding negative control samples (2.07 vs 1.17log). There was a consistent correlation between samples detected by the Verif EYE™ system with detectable counts. For example, 100% of positive samples had detectable APC and 91.2% of positive samples had detectable TCC. Therefore, if areas detected as positive for contamination by the Verif EYE™ system were removed from the carcasses, significant sources of microbial contamination will be reduced for objective compliance with HACCP.

This results suggest that the use of Verif EYE™ machine-vision technology might be useful for reducing microbial indicator counts (APC, TCC) and could help reduce the risk of presence of *E coli* O157:H7 *and Salmonella* spp on Beef carcasses.

Key word: Verif EYE™ system, Organic contamination, Beef carcasses

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Introduction

The slaughter process for cattle and other animals involves the removal of pathogenic bacteria from contaminated surfaces of the hide and the gastro-intestinal tract. All healthy muscles and organ tissues within an animal were bacteria-free until slaughtering if they were not contaminated by outside source. Unfortunately, however, slaughter process will inevitably transfer some bacteria onto the carcasses even if there were high levels of cautions. There are many methods used to control these bacterial contaminants, but using a combination of methods does not guarantee a product safety. Regardless of the many efforts to eliminate the incidence of illness and death caused by food-borne pathogens, outbreaks of bacteria-related disease still have occurred every year and cause the dramatic loss on the US economy. The outbreaks cause 76 million illnesses and 5 thousand deaths each year, and according to the USDA Economic Research Service (ERS), the cost US pays in medical service is $6.9 billion with productivity loss, and premature death[1]. Additionally, the CDC estimates that approximately 70% (over 500,000 illnesses annually) of food-borne illnesses originate in the food processing and food service stage, with an estimated 40% of these incidences are occurred as a result of poor hand-washing and cross contamination.[2-4]

There are a number of different measures that can reduce the likelihood of *E coli* being present on the carcasses. These measures are applied to a carcasses after slaughter and quite costly. Verif EYE technology was allowed for a means of detection and reduction of the organic causing contamination of beef carcasses[1,5]. The Verif EYE ™ technology is based on light energy used to expose any evidence of fluorescence, indicating the presence of organic contamination. They have gallium housing with filters and lenses to screen out un necessary UV and IR energy and focus only on the specific wavelength needed to search the contaminants from the carcasses for any presence of specific fluorescence. The Verif EYE ™ technology gives special range wave. Ultraviolet to fresh eatable material is not react but respond to contaminants, therefore we can see them on surface of fecal and digestive material with chlorophyll (Fig 1).

By utilizing wavelength-specific spectroscopy and image processing, the easy to use Verif EYE tool can provide instant location-specific verification of the presence or absence of fecal material on meat and other surfaces without the use of chemicals or radiation.[6]

Materials and Methods

Sampling

Eighty samples were analyzed by using the solo handled inspection device over 15 days for the evaluation of the effectiveness of the Verif EYE technology.

In a day of sample collection, conditions for predominant weather conditions and general cleanliness of cattle used in analyzing organic-matter detection rates were recorded. In addition we recorded some informations such as the location of the collected samples, carcasses number, and any other relevant comments including whether the organic material was visible to the naked eye or not. Contaminated samples were collected and analyzed, as shown in Fig 3.

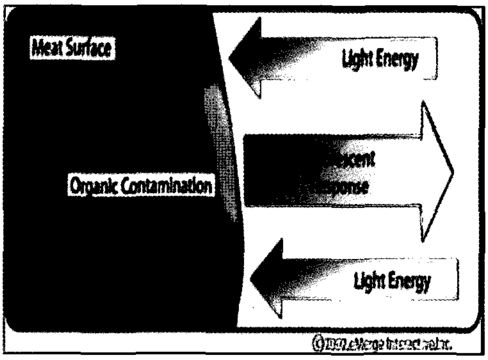

Fig 1. Detective base of VerifEYE™ technology

Fig 2. By wavelength-specific spectroscopy and image processing

Fig 3. Surface contaminated samples taken

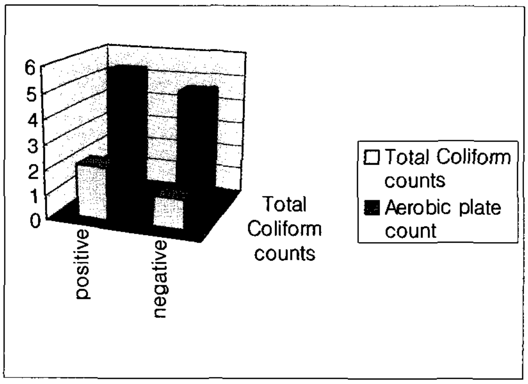

Fig 4. Average log10 value by test and sample type

Counting of colonies

Effectiveness of the Verif EYE technology as a tool to assist in reducing microbial indicator counts on the carcass surface was examined by enumeration of APC and *E coli* for two site (FDS−positive and FDS negative site). When a FDS−positive spot was detected, a sterile gauze of 100 ㎠ template (10 ㎝ width × 10 ㎝ length) was used. A record of any applicable observation was made immediately. Microbial indicator counts including aerobic plate counts (APC) and total coliform counts (TCC) using Petri Film™ were determined for scrape gauze sample by adding Butterfield's phosphate water (BPW) 40 ㎖ shaking for 1 min. To enumerate APC levels, the appropriate dilution was transferred (1 ㎖) to Petri Film™ ACP (3M Health Care. St. Paul. MN). Following aerobic incubation at 35 ± 1℃ for 48h, APC was counted with all colonies (stain in various shades of red) in countable range 30-300 colonies. The appropriate dilutions were transferred (1㎖) to Petri Film™ TCC count plate (3M Health Care, St Paul, MN,) and following a 24 ± 2 hours incubation period at 35 ± 2℃, colonies were manually counted[4]. *E coli* colonies appear as a blue colonies associated with gas bubbles with one colony diameter. All other coliforms with red colonies have one or more gas bubbles associated. Plates with 10-150 colonies were selected[7]. Microbiological counts for each enumerated set (APC and TCC) were averaged for comparative purposes.

Correlation of APC and TCC

To compare the correlation of the APC and TCC levels detected among for FDS-positive samples, the samples were divided into three: visibly, not visibly, and fecal materials. Of the 80 samples detected as contaminated by the Verif EYE ™ system were marked as visibly contaminated, and they were marked as not visibly contaminated if the system could not detect the contamination. There were also 20 fecal materials on the carcasses as control.

Results and Discussion

The raw plate count data was summarized in Table 1. The contrast between microbial indicator counts on the beef carcasses were notable. Range of APC was 4,000 to 1,576,000 CFU/gauze on FDS- positive sites and 225 - 238,000 CFU/gauze on adjacent FDS-negative site. In total coliform count, range was 15-675 CFU/gauze on FDS-positive sites and from undetectable levels to 186 CFU/gauze on adjacent FDS-negative sites. The arithmetic mean of positive and negative sites were 115 and 15, respectively.

APC of FDS-positive samples (log 5.26) was greater than that of the negative control samples (log4.60). *Enterobacteriaceae* counts were greater on the positive samples (log2.07) than on the negative control samples (log1.17).

Table 1. Count of CFU per gauze in FDS positive and negative samples

	FDS positive		FDS negative	
	Range	average	Range	average
APC	4,000- 1,576,000	182,970 (log 5.26)	225- 238,000	40,506 (log 4.60)
TCC	15- 675	119 (log 2.07)	11- 186	15 (log 1.17)

The above results were similar to other reports. For example, Kennedy et al[6] reported that FDS positive sites had higher APC (4.9 vs 3.0 log), TCC (4.1 vs 1.5log) and TCC (4.1 vs 1.1 log) than FDS negative sites. Other scientific study on the Verif EYE ™ technology conducted by Wendy[5] for the carcass-samples from FDS positive sites had higher APC (3.56 vs 2.46 log) TCC (2.22 vs 1.24 log) than FDS negative to detect apparent fecal contamination and correspondingly higher microbial indicator counts.

A correlation of APC and TCC levels detected in FDS−positive samples was shown in Tables 2 and 3. All APC positive samples had detectable levels of APC (Table 2). An average of 91.2% of the positive samples had detectable levels of TCC (Table 3). The lower recovery rate of TCC may be because of a lower percentage of this subpopulation.

This can be associated with the source of the contamination on the carcasses surface and/or the ability to compete for growth nutrients within the entire microbial population present.

The use of the Verif EYE^{TM} system can result in a significant reduction of numbers of general, aerobic bacteria and total coliform bacteria from areas of visible and nonvisible contamination on beef carcasses, providing that subsequent interventions are applied correctly and throughly. In an examination of 80 FDS-positive samples, when compared to negative controls from the same carcass, aerobic plate counts were an average of 0.66 logs higher than the negative control samples. Total coliform counts were an average of 0.9 logs higher on the positive samples than the corresponding negative control samples. Further, a consistent correlation between samples detected as positive by the Verif EYE^{TM} system with detectable counts was made during this evaluation as 100% of positive samples had detectable APC and 91.2% of positive samples had detectable TCC. Therefore, if areas detected as positive for contamination by the Verif EYE^{TM} system are removed from the carcass, significant sources of microbial contamination will be removed, for objective compliance with HACCP.

Table 2. Results of APC counts on positive samples

	Visibly contaminated	Not visibly contaminated	Fecal matter present
Total Samples	80	80	20
Positive APC count	80	58	20
%	100	72.5	100

Table 3. Results of TCC Counts on positive samples

	Visibly contaminated	Not visibly contaminated	Fecal matter present
Total Samples	80	80	20
Positive TCC count	73	21	20
%	91.2	26.2	100

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