

Studies on Effect of Sodium Hypochlorite on Microbial, Sensory and Physicochemical Characteristics of Buffalo Offal

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Abstract: A study was carried out to determine the influence of different concentration and contact time combinations of sodium hypochlorite (SHC) solutions on microbial, sensory and physico-chemical characteristics of buffalo offals viz., head meat, heart, liver and rumen. The following concentration and contact time combinations were used: 0.005% SHC for 15 sec, 0.01% SHC for 10 sec and 0.015% SHC for 5 sec. A total of 80 buffalo offal samples (20 numbers of each kind) were collected from a buffalo offal market and subjected to immersion treatments. Water washed offal pieces were used as controls. Sensory evaluations were conducted using a sensory panel comprising postgraduate students and scientists of Livestock Products Technology division, Indian Veterinary Research Institute (India). The data obtained were subjected to statistical analysis using the analysis of variance (ANOVA). Mean \log_{10} reductions (CFU g^{-1}) achieved, based on the different treatments and kinds of buffalo offal were between 0.24 and 1.23 for total viable counts; 0.15 and 1.07 for coliforms counts and 0.07 and 1.00 for staphylococcal counts. Immersion in 0.015% SHC solution for 5 sec gave the best overall reduction effect. Sensory evaluations recorded minimal effects of treatments on buffalo offals. These findings show that immersion in 0.015% SHC solution for 5 sec is suitable for decontamination of buffalo offals.

Key words: Buffalo offals, decontamination, microbial quality, sensory characteristics, sodium hypochlorite

INTRODUCTION

Edible offals that are available from slaughtered animals are of great value. Efficient utilization of these edible byproducts is essential to support an economical and viable meat production system. During slaughter and processing, all potentially edible tissues are subject to contamination from a variety of sources within and outside the animal (Ayres, 1955). Edible offals from animals present a heterogeneous collection of tissues. Thus, each kind of offal can be expected to exhibit some unique microbiological characteristics. In general, offals possess poor microbial quality due to the presence of readily available nutrients and poor hygienic conditions during their handling, collection and processing. Not much work has been done on microbial quality of offals.

However, several methods have been developed for bacterial reduction on different kind of carcasses which include trimming (Prasai *et al.*, 1995a, b), water washing (Hardin *et al.*, 1995; Reagan *et al.*, 1996), hot water spraying (Rheault and Quessy, 1999; Bosilevac *et al.*, 2006; Eggenberger-Solorzano *et al.*, 2002) and steam pasteurizing (Phebus *et al.*, 1997; Minihan *et al.*, 2003). In addition, an array of chemicals such as short chain organic acids, polyphosphates, chlorinated compounds and disinfectants have also been used for this purpose. Some researchers tried various

antimicrobial agents and found that efficient utilization of these agents resulted in the reduction total viable count of 10^3 and 10^4 cfu g^{-1} in beef and pork liver, Patterson and Gibbs (1979) and Woolthius *et al.* (1984).

Among these chemicals, chlorine (especially hypochlorites) is the most commonly used antimicrobial agent in food processing due to its availability, relative cost and efficacy (Tsai *et al.*, 1992). Various researchers have found that the use of chlorine interventions in the processing of carcasses or offals to be effective for reducing bacterial populations (Sinhamahapatra *et al.*, 2004; Delmore *et al.*, 2000; Whyte *et al.*, 2001; Fabrizio *et al.*, 2002; Fabrizio and Cutter, 2004). Hence these studies indicate that the microbial quality of meat or offals is generally inferior and reduction of such contamination is of great importance from public health point of view. In this context, the present study was envisaged to identify the optimum concentration and contact time combination of sodium hypochlorite for the decontamination of buffalo offals.

MATERIALS AND METHODS

A study to assess the effect of sodium hypochlorite on quality of buffalo offals was carried out in the Division of Livestock Products Technology, IVRI, Bareilly (India) during the period from November 2004 to January 2006.

Collection of Buffalo Offals Samples

Buffalo offals viz., head meat, heart, liver and rumen were collected from offal market of Bareilly city (India) and were packed individually in clean polyethylene bags. Then, they were brought in insulated, iced containers to microbiology laboratory of Livestock Products Technology (LPT) division, Indian Veterinary Research Institute, under hygienic condition for treatment and analysis. The time lag between slaughter of animal and commencement of treatment and analysis was about 3-4 h.

Selection of Contact Time for Sodium Hypochlorite Solutions

Each kind of offal was hygienically cut into pieces of 100 g. one piece was washed with sterile tap water and was maintained as control. The remaining pieces were separately dipped in glass beakers containing solutions of 0.005% sodium hypochlorite for 5, 10, 15, 20, 25 and 30 sec. After the specified periods of immersion, the offal pieces were removed, drained and placed individually in clean plates. Sensory analysis was conducted 45 min after the treatment by a sensory panel comprising postgraduate students and scientists of Livestock Products Technology Division, Indian Veterinary Research Institute. Sensory evaluation scale as described by Anna Anandh (2001) was suitably modified and used for the present study. The maximum contact time at which the solution of 0.005% sodium hypochlorite had minimal/no effect on colour and odour of offal pieces was selected for the further study. The description of scale used in the study is given below.

Score	Effect on odour	Effect on colour
6	Odour improved	Colour improved
5	No chemical odour	No bleaching
4	Traces of chemical odour	Mild bleaching
3	Slight chemical odour	Moderate bleaching
2	Moderate chemical odour	Severe bleaching
1	Strong chemical odour	Very severe bleaching

Similar procedure was repeated using solutions of 0.01 and 0.015% sodium hypochlorite to select a contact time for each. Sterile tap water was used for the preparation of different sodium hypochlorite solutions (vol/vol, pH adjusted to 6.5) and the sodium hypochlorite (Ranbaxy, Gurgaon, India) used was of analytical grade.

Treatment of Buffalo Offals with Sodium Hypochlorite Solutions

Each offal was hygienically cut into pieces of 100 g and the offal pieces were divided into four groups. Offal pieces from three groups were dipped in 0.005, 0.01 and 0.015% sodium hypochlorite (SHC) solutions at ambient temperature for standardized contact times, respectively. The fourth group was washed with sterile tap water and was maintained as a control. Then, the control and treated offal pieces were analyzed 45 min after the treatments for various quality characteristics viz., microbial, sensory and physico-chemical parameters.

Microbial Quality

Microbiological quality of control and treated offal pieces were determined based on total viable counts, coliform counts and staphylococcal counts. All microbial groups were assessed by pour plate method following the procedures of American Public Health Association (APHA, 1984). Five grams from each offal piece was aseptically blended with 45 mL of 0.1% sterile peptone water in a pre-sterilized mortar. Decimal dilutions were prepared from the blended samples using sterile 0.1% peptone water. For the counts, 1 mL of each of the serially diluted homogenate was inoculated in duplicate, to the appropriate growth media in sterile petri dishes using pour plate method. Inocula on plate count agar were incubated at $37\pm 1^\circ\text{C}$ for 48 h under aerobic conditions to assess the number of viable organisms per gram of sample i.e., Total Viable Counts (TVCs). Enumeration of coliforms was carried out on Violet Red Bile Agar (VRBA) incubated at $37\pm 1^\circ\text{C}$ for 24 h aerobically. *Staphylococci* were enumerated on Baird Parker Agar incubated at $37\pm 1^\circ\text{C}$ for 48 h under aerobic conditions. The average numbers of colonies were expressed as \log_{10} cfu g^{-1} of head meat. All the work was carried out in a clean UV sterilized laminar flow.

Sensory Characteristics

The effect of treatments on colour and odour of offal pieces were assessed 45 min after the treatments by a sensory evaluation panel comprising post graduate students and scientists of LPT division. The six point sensory scale as described by Anna Anandh (2001) was used for scoring colour and odour of offal pieces with suitable modifications.

Physicochemical Characteristics

The control and treated offal pieces were evaluated for pH. As the treatments has completed, sodium hypochlorite solutions used were collected and assessed for the residual chlorine concentrations.

pH

pH of the offal pieces were determined by homogenizing 10 g of sample from each offal piece (control and treated) with 50 mL distilled water in Ultra Turrex (IKA, Model T-25, Germany) homogenizer for 1 min at 3000 rpm. pH of the suspension was recorded by immersing the combined glass electrode of digital pH meter (Model CP-901, Century Instruments Ltd., India).

Residual Chlorine Estimation

After the treatment has completed, sodium hypochlorite solutions used for the treatment of buffalo offal samples were estimated for residual chlorine concentration as per the iodometric method I described by Rand *et al.* (1976).

Fifty milliliter of sample was poured in a flask containing 5 mL of acetic acid and 1 g of potassium iodide and was mixed with a stirring rod. The mixed sample was titrated with 0.01 N thiosulfate from a buret until the yellow colour of the liberated iodine was almost discharged. Then 1 mL of starch solution was added and again titrated until the blue colour was discharged. Blank titration was carried out to correct the result of sample titration.

Table 1: Buffalo offal samples processed to study the effect of sodium hypochlorite solutions on microbial count, sensory and physicochemical characteristics

Concentration and type of decontaminant used	Contact time	No. of samples processed				Total
		Head meat	Heart	Liver	Rumen	
Sodium hypochlorite (SHC) treatment						
Control	-	5	5	5	5	20
0.005% SHC solutions	15 sec	5	5	5	5	20
0.01% SHC solutions	10 sec	5	5	5	5	20
0.015% SHC solutions	5 sec	5	5	5	5	20
Total		20	20	20	20	80

Total available residual chlorine in used sodium hypochlorite solutions:

$$CI \text{ (mg L}^{-1}\text{)} = \frac{(A \pm B) \times N \times 35,450}{\text{mL sample}}$$

Where A = mL titration for sample,

B = mL titration for blank, which may be positive or negative,

N = Normality of sodium thiosulfate.

The number of samples processed for each sodium hypochlorite treatment is given in the Table 1.

Statistical Analysis

For statistical analysis, average counts of colonies on duplicate plates were transformed into log CFU g⁻¹. Then the data were analyzed using analysis of variance (ANOVA).

RESULTS

Standardizing Contact Time for Sodium Hypochlorite Solutions

As discussed earlier, series of preliminary trials were conducted to standardize the contact times for sodium hypochlorite solutions. Based on the results, 15, 10 and 5 sec were selected for 0.005, 0.01 and 0.015% sodium hypochlorite solutions, respectively. Effects of these combinations are compared in the following sections.

Effect of Sodium Hypochlorite Solutions on Microbial Quality of Buffalo Offals

Effects of tap water washing (control) as well as immersion in sodium hypochlorite solutions on total viable count, coliforms count and staphylococcal count of buffalo offals have been presented in Table 2.

Head Meat

Overall mean values of total viable count for control and head meat samples treated with 0.005, 0.01 and 0.015% Sodium Hypochlorite Solutions (SHC) were 6.10, 5.76, 5.40 and 4.87 (log cfu g⁻¹), respectively. 0.005% SHC treated samples did not differ significantly from control samples whereas 0.01 and 0.015% SHC treated samples have shown significantly (p<0.01) lower TVC while comparing with control. The levels of reduction in TVC were 0.70 and 1.23 (log cfu g⁻¹) for 0.01 and 0.015% SHC treatments, respectively. Among the treatment groups, there was no significant difference between 0.005 and 0.01% SHC treated samples, whereas 0.015% SHC treated samples have shown significantly lower (p<0.01) TVC while comparing with others.

Table 2: Effect of sodium hypochlorite (SHC) solutions on microbial quality of buffalo offals

Kind of offal	Treatments	Average microbial count (log cfu g ⁻¹)		
		Total viable count	Coliforms count	Staphylococcal count
Head meat	Control	6.10±0.13 ^a	5.27±0.19 ^a	5.43±0.16 ^a
	0.005% SHC/15 sec	5.76±0.18 ^{ab}	4.99±0.20 ^a	5.04±0.18 ^{ab}
	0.01% SHC/10 sec	5.40±0.14 ^b	4.70±0.21 ^{ab}	4.87±0.18 ^{bc}
	0.015% SHC/5 sec	4.87±0.20 ^c	4.20±0.12 ^b	4.43±0.13 ^c
Heart	Control	5.45±0.24	4.70±0.06 ^a	5.16±0.15
	0.005% SHC/15 sec	5.19±0.26	4.55±0.04 ^{ab}	4.90±0.19
	0.01% SHC/10 sec	5.02±0.25	4.39±0.05 ^b	4.76±0.20
	0.015% SHC/5 sec	4.57±0.24	3.82±0.06 ^c	4.56±0.16
Liver	Control	5.95±0.11 ^a	4.87±0.16 ^a	5.34±0.08
	0.005% SHC/15 sec	5.69±0.11 ^a	4.64±0.15 ^a	5.27±0.10
	0.01% SHC/10 sec	5.33±0.11 ^b	4.37±0.17 ^{ab}	5.11±0.13
	0.015% SHC/5 sec	4.95±0.13 ^c	4.06±0.18 ^b	4.90±0.17
Rumen	Control	6.54±0.15 ^a	5.26±0.18 ^a	5.42±0.17
	0.005% SHC/15 sec	6.30±0.07 ^{ab}	4.96±0.19 ^{ab}	5.19±0.18
	0.01% SHC/10 sec	6.05±0.09 ^b	4.72±0.19 ^{ab}	4.93±0.19
	0.015% SHC/5 sec	5.56±0.14 ^c	4.38±0.20 ^b	4.79±0.19

Means within a column for given offal sharing the same letter(s) did not differ significantly

Overall mean values of coliform count for control and head meat samples treated with 0.005, 0.01 and 0.015% SHC were 5.27, 4.99, 4.70 and 4.20 (log cfu g⁻¹), respectively. 0.005 and 0.01% SHC treated samples did not differ significantly from control whereas 0.015% SHC treated samples have shown significantly lower (p<0.01) coliform count while comparing with control. The level of reduction in coliform count was 1.07 (log cfu g⁻¹) for 0.015% SHC treatment. Among the treatment groups, there was no statistical difference between 0.005 and 0.01% SHC treated samples as well as between 0.01 and 0.015% SHC treated samples.

Overall mean values of staphylococcal count for control and head meat samples treated with 0.005, 0.01 and 0.015% SHC were 5.43, 5.04, 4.87 and 4.43 (log cfu g⁻¹), respectively. 0.005% SHC treated samples did not differ significantly from control whereas, 0.01 and 0.015% SHC treated samples have shown significantly (p<0.01) higher reduction in staphylococcal count while comparing with control. The levels of reduction in staphylococcal count were 0.56 and 1.00 (log cfu g⁻¹) for 0.01 and 0.015% SHC treatments, respectively. Within the treatment groups, no statistical difference was observed between 0.005 and 0.01% SHC treated samples as well as between 0.01 and 0.015% SHC treated samples. 0.015% SHC treated samples have shown significantly (p<0.01) higher reduction in staphylococcal count while comparing with 0.005% SHC treated samples.

Heart

Mean TVC for control and heart samples treated with 0.005, 0.01 and 0.015% SHC were 5.45, 5.19, 5.02 and 4.57 (log cfu g⁻¹), respectively. No significant difference was observed between treatment groups and control as well as within the treatment groups.

Mean coliform count for control and heart samples treated with 0.005, 0.01 and 0.015% SHC were 4.70, 4.55, 4.39 and 3.82 (log cfu g⁻¹), respectively. No statistical difference was observed between 0.005% SHC treated samples and control whereas, the 0.01 and 0.015% SHC treated samples have shown significantly (p<0.01) lower coliform count while comparing with control. The levels of reduction in coliform count were 0.31 and 0.88 (log cfu g⁻¹) for 0.01 and 0.015% SHC treatments, respectively. Within the treatment groups, there was no significant difference between 0.005 and 0.01% SHC treated samples but 0.015% SHC treated samples have shown significantly (p<0.01) lower coliform count while comparing with others.

Overall mean values of staphylococcal count for control and heart samples treated with 0.005, 0.01 and 0.015% SHC were 5.16, 4.90, 4.76 and 4.56 ($\log \text{cfu g}^{-1}$), respectively. No significant difference was observed between treatment groups and control as well as within the treatment groups.

Liver

Overall mean values of total viable count for control and liver samples treated with 0.005, 0.01 and 0.015% sodium hypochlorite solutions were 5.95, 4.95, 5.33 and 5.69 ($\log \text{cfu g}^{-1}$), respectively. 0.005% SHC treated samples did not differ significantly from control samples whereas 0.01 and 0.015% SHC treated samples have shown significantly ($p < 0.01$) lower TVC while comparing with control. The levels of reduction in TVC were 0.62 and 1.00 ($\log \text{cfu g}^{-1}$) for 0.01 and 0.015% SHC treatments, respectively. Among the treatment groups, there was a significant difference ($p < 0.01$) between them. 0.015% SHC treated samples have shown significantly lower ($p < 0.01$) TVC while comparing with other treatment groups.

Overall mean values of coliform count for control and liver samples treated with 0.005, 0.01 and 0.015% SHC were 4.87, 4.64, 4.37 and 4.06 ($\log \text{cfu g}^{-1}$), respectively. 0.005 and 0.01% SHC treated samples did not differ significantly from control whereas 0.015% SHC treated samples have shown significantly ($p < 0.05$) lower coliform count while comparing with control. The level of reduction in coliform count was 0.81 ($\log \text{cfu g}^{-1}$) for 0.015% SHC treatment. Within the treatment groups, there was no significant difference between 0.005 and 0.01% SHC treated samples as well as between 0.01 and 0.015% SHC treated samples. 0.015% SHC treated samples have resulted in significantly ($p < 0.05$) higher reduction of coliform count while comparing with 0.005% SHC treated samples.

Overall mean values of staphylococcal count for control and liver samples treated with 0.005, 0.01 and 0.015% SHC were 5.34, 5.27, 5.11 and 4.90 ($\log \text{cfu g}^{-1}$), respectively. No significant difference was observed between treatment groups and control as well as within the treatment groups.

Rumen

Mean TVC for control and rumen samples treated with 0.005, 0.01 and 0.015% SHC were 6.54, 6.30, 6.05 and 5.56 ($\log \text{cfu g}^{-1}$), respectively. 0.005% SHC treated samples did not differ significantly from control samples whereas 0.01 and 0.015% SHC treated samples have shown significantly ($p < 0.01$) lower TVC while comparing with control. The levels of reduction in TVC were 0.49 and 0.98 ($\log \text{cfu g}^{-1}$) for 0.01 and 0.015% SHC treatments, respectively. Among the treatment groups, no significant difference was observed between 0.005 and 0.01% SHC treated samples whereas, 0.015% SHC treated samples have shown significantly ($p < 0.01$) lower TVC while comparing with others.

Overall mean values of coliform count for control and rumen samples treated with 0.005, 0.01 and 0.015% SHC were 5.26, 4.96, 4.72 and 4.38 ($\log \text{cfu g}^{-1}$), respectively. 0.005 and 0.01% SHC treated samples did not significantly differ from control samples whereas, 0.015% SHC treated samples have shown significantly ($p < 0.05$) higher reduction in coliform count when compare to control. The level of reduction in coliform count was 0.88 ($\log \text{cfu g}^{-1}$) for 0.015% SHC treatment. Among the treatment groups, there was no significant difference between 0.005 and 0.01% SHC treated samples as well as between 0.01 and 0.015% SHC treated samples. 0.015% SHC treated samples have shown significantly ($p < 0.05$) higher reduction in coliform count while comparing with 0.005% SHC treated samples.

Overall mean values of staphylococcal count for control and rumen samples treated with 0.005, 0.01 and 0.015% SHC were 5.42, 5.19, 4.93 and 4.79 ($\log \text{cfu g}^{-1}$), respectively. No significant difference was observed between treatment groups and control as well as within the treatment groups.

Table 3: Effect of sodium hypochlorite (SHC) solutions on sensory attributes of buffalo offals

Kind of offal	Treatments	Sensory scores	
		Odour	Colour
Head meat	Control	5.00±0.00 ^a	5.00±0.00 ^a
	0.005% SHC/15 sec	4.86±0.14 ^a	4.57±0.13 ^b
	0.01% SHC/10 sec	4.52±0.11 ^b	4.62±0.13 ^b
	0.015% SHC/5 sec	4.38±0.15 ^b	4.67±0.11 ^b
Heart	Control	5.00±0.00	5.00±0.00 ^a
	0.005% SHC/15 sec	5.05±0.13	4.67±0.13 ^{ab}
	0.01% SHC/10 sec	4.90±0.10	4.57±0.15 ^b
	0.015% SHC/5 sec	4.90±0.14	4.57±0.15 ^b
Liver	Control	5.00±0.00 ^a	5.00±0.00
	0.005% SHC/15 sec	4.81±0.13 ^{ab}	4.81±0.13
	0.01% SHC/10 sec	4.62±0.13 ^b	4.81±0.15
	0.015% SHC/5 sec	4.52±0.15 ^b	4.76±0.17
Rumen	Control	5.00±0.00 ^a	5.00±0.00
	0.005% SHC/15 sec	4.76±0.14 ^{ab}	4.79±0.13
	0.01% SHC/10 sec	4.57±0.13 ^b	4.76±0.15
	0.015% SHC/5 sec	4.48±0.15 ^b	4.71±0.17

Means within a column for given offal sharing the same letter(s) did not differ significantly

Effect of Sodium Hypochlorite Solutions on Sensory Characteristics of Buffalo Offals

Effect of sodium hypochlorite treatments (0.005% SHC/15 sec, 0.01% SHC/10 sec and 0.015% SHC/5 sec) on odour and colour of buffalo offals have been presented in Table 3. Tap water washed buffalo offals were used as control.

Head Meat

Mean odour scores of control and 0.005, 0.01 and 0.015% SHC treated head meat samples were 5.00, 4.86, 4.52 and 4.38, respectively. 0.005% SHC treated samples did not differ significantly from control whereas, 0.01 and 0.015% SHC treated samples significantly ($p < 0.01$) differed from control. Among the treatment groups, 0.005% SHC treated samples significantly ($p < 0.01$) differed from 0.01 and 0.015% SHC treated samples. No statistical difference was observed between 0.01 and 0.015% SHC treated samples.

Mean colour scores of control and 0.005, 0.01 and 0.015% SHC treated head meat samples were 5.00, 4.57, 4.62 and 4.67, respectively. All the treatment groups significantly ($p < 0.05$) differed from control. No statistical difference was observed within the treatment groups.

Heart

Overall mean odour scores for control and 0.005, 0.01 and 0.015% SHC treated heart samples were 5.00, 5.05, 4.90 and 4.90, respectively. No statistical difference was observed between treatment groups and control. Similarly, there was no significant difference among the treatment groups.

Overall mean colour scores for control and 0.005, 0.01 and 0.015% SHC treated heart samples were 5.00, 4.67, 4.57 and 4.57, respectively. 0.005% SHC treated samples did not significantly differ from control whereas, 0.01 and 0.015% SHC treated samples significantly ($p < 0.05$) differed from control. No statistical difference was observed among the treatment groups.

Liver

Mean odour scores of control and 0.005, 0.01 and 0.015% SHC treated liver samples were 5.00, 4.81, 4.62 and 4.52, respectively. 0.005% SHC treated samples did not differ significantly from control whereas, 0.01 and 0.015% SHC treated samples have significantly ($p < 0.05$) differed from control. Among the treatment groups, there was no significant difference between them.

Table 4: Effect of sodium hypochlorite (SHC) solutions on physico-chemical characteristics of buffalo offals

Kind of buffalo offal	Treatments	Physicochemical characteristics	
		pH	Residual chlorine concentration [®]
Head meat	Control	6.41±0.04 ^a	0.00±0.00 ^d
	0.005% SHC/15 sec	6.35±0.05 ^{ab}	17.00±1.95 ^c
	0.01% SHC/10 sec	6.25±0.05 ^{bc}	45.60±2.01 ^b
	0.015% SHC/5 sec	6.18±0.05 ^c	65.00±1.84 ^a
Heart	Control	5.85±0.04 ^b	0.00±0.00 ^d
	0.005% SHC/15 sec	6.08±0.03 ^a	13.40±1.36 ^c
	0.01% SHC/10 sec	6.06±0.04 ^a	38.80±1.74 ^b
	0.015% SHC/5 sec	6.00±0.05 ^a	62.60±2.42 ^a
Liver	Control	6.42±0.05 ^a	0.00±0.00 ^d
	0.005% SHC/15 sec	6.32±0.04 ^{ab}	18.20±1.93 ^c
	0.01% SHC/10 sec	6.25±0.05 ^{bc}	44.00±3.32 ^b
	0.015% SHC/5 sec	6.15±0.05 ^c	59.00±3.05 ^a
Rumen	Control	6.42±0.04 ^a	0.00±0.00 ^d
	0.005% SHC/15 sec	6.32±0.04 ^{ab}	20.80±1.50 ^c
	0.01% SHC/10 sec	6.24±0.03 ^{bc}	51.40±3.01 ^b
	0.015% SHC/5 sec	6.14±0.04 ^c	67.20±1.83 ^a

Means within a column for given offal sharing the same letter(s) did not differ significantly, [®]Residual chlorine concentration of tap water and sodium hypochlorite solutions after used for treatments

Mean colour scores of control and 0.005, 0.01 and 0.015% SHC treated liver samples were 5.00, 4.81, 4.81 and 4.76, respectively. All the treatment groups did not differ significantly from control. Similarly, no statistical difference was observed among the treatment groups.

Rumen

Overall mean odour scores for control and 0.005, 0.01 and 0.015% SHC treated rumen samples were 5.00, 4.76, 4.57 and 4.48, respectively. 0.005% SHC treated samples did not differ significantly from control whereas, 0.01 and 0.015% SHC treated samples have significantly ($p < 0.05$) differed from control. Among the treatment groups, there was no significant difference between them.

Overall mean colour scores for control and 0.005, 0.01 and 0.015% SHC treated rumen samples were 5.00, 4.79, 4.76 and 4.71, respectively. No statistical difference was observed between all the treatment groups and control. Similarly, there was no significant difference among the treatment groups.

Effect of Sodium Hypochlorite Solutions on Physico-chemical Characteristics of Buffalo Offals

Effect of sodium hypochlorite treatments (0.005% SHC/15 sec, 0.01% SHC/10 sec and 0.015% SHC/5 sec) on pH of buffalo offals and the residual chlorine concentrations of sodium hypochlorite solutions after the treatment have been presented in Table 4. Tap water washed buffalo offals were used as control.

pH

Overall mean pH values of control and 0.005, 0.01 and 0.015% SHC treated head meat samples were 6.41, 6.35, 6.25 and 6.18, respectively. 0.005% SHC treated samples did not significantly differ from control whereas, 0.01 and 0.015% SHC treated samples differed significantly ($p < 0.05$) from control. Within the treatment groups, no statistical difference was observed between 0.005 and 0.01% SHC treated samples as well as between 0.01 and 0.015% SHC treated samples. However, 0.015% SHC treated samples significantly ($p < 0.05$) differed from control.

Mean pH values of control and 0.005, 0.01 and 0.015% SHC treated heart samples were 5.85, 6.08, 6.06 and 6.00, respectively. All the treatment groups significantly ($p < 0.01$) differed from control whereas no statistical difference was observed between the treatment groups.

Overall mean pH values of control and 0.005, 0.01 and 0.015% SHC treated liver samples were 6.42, 6.32, 6.25 and 6.15, respectively. 0.005% SHC treated samples did not significantly differ from control whereas, 0.01 and 0.015% SHC treated samples significantly ($p < 0.01$) differed from control. Within the treatment groups, no statistical difference was observed between 0.005 and 0.01% SHC treated samples as well as between 0.01 and 0.015% SHC treated samples.

Overall mean pH values of control and 0.005, 0.01 and 0.015% SHC treated rumen samples were 6.42, 6.32, 6.24 and 6.14, respectively. 0.005% SHC treated samples did not significantly differ from control whereas, 0.01 and 0.015% SHC treated samples differed significantly ($p < 0.01$) from control. Within the treatment groups, no statistical difference was observed between 0.005 and 0.01% SHC treated samples as well as between 0.01 and 0.015% SHC treated samples.

Residual Chlorine Concentration

The tap water used for washing control and different concentrations of sodium hypochlorite used for the treatment of offal samples were evaluated for residual chlorine concentration. Overall mean values of residual chlorine concentration of tap water and 0.005, 0.01 and 0.015% SHC solutions used for treatment of head meat samples were 0.00, 17.00, 45.60 and 65.00, respectively. All the treatment groups significantly ($p < 0.01$) differed from control. Similarly, treatments groups significantly differed ($p < 0.01$) among them.

Mean values of residual chlorine concentration of tap water and 0.005, 0.01 and 0.015% SHC solutions used for treatment of heart samples were 0.00, 13.40, 38.80 and 62.60, respectively. All the treatment groups significantly ($p < 0.01$) differed from control. Similarly, treatments groups significantly ($p < 0.01$) differed among them.

Overall mean values of residual chlorine concentration of tap water and 0.005, 0.01 and 0.015% SHC solutions used for treatment of liver samples were 0.00, 18.20, 44.00 and 59.00, respectively. All the treatment groups significantly ($p < 0.01$) differed from control. Similarly, treatments groups significantly ($p < 0.01$) differed among them.

Mean values of residual chlorine concentration of tap water and 0.005, 0.01 and 0.015% SHC solutions used for treatment of rumen samples were 0.00, 20.80, 51.40 and 67.20, respectively. All the treatment groups significantly ($p < 0.01$) differed from control. Similarly, treatments groups significantly ($p < 0.01$) differed among them.

DISCUSSION

From the above results, it has been found that 0.015% SHC appears to be more effective when compared to 0.005 and 0.01% for almost all kind of buffalo offals studied. The results of present study are in confirmation with the work done by Titus *et al.* (1978) who observed that spraying of exterior surfaces of beef plates with 100, 150 or 200 ppm hypochlorite solution for 12 sec resulted in less than one log reduction in initial aerobic mesophilic counts and one log or greater reduction in coliforms count. Similarly, Skelly *et al.* (1985) also found that the spraying of water washed pork carcasses with 200 ppm of sodium hypochlorite solution for 30 sec resulted in the reduction of total viable count from 2.50 to 2.21 cfu cm⁻². Present results indicate that sodium hypochlorite solutions were relatively ineffective against staphylococcal organisms. Correspondingly, Bolton *et al.* (1988) and Mead and Adams (1986) found the presence of chlorine resistant strains of *Staphylococcal aureus* in poultry processing plants and turkey products, respectively.

Traces of chemical odour were observed in buffalo offals of all the treatment groups when compared to their respective controls. Similarly, mild bleaching in colour was also observed in treated buffalo offal samples. Anna Anandh (2001) also reported that treatment of buffalo rumen meat with progressively higher concentrations of sodium hypochlorite resulted in bleaching, thereby reduction in natural colour.

CONCLUSIONS

Thus, from this study it can be concluded that immersion in 0.015% sodium hypochlorite solution for 5 sec is proved to be effective for the decontamination of buffalo offals.

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