

Effect of Trisodium Phosphate on Quality of Buffalo Offals

¹P. Selvan, ¹S.K. Mendiratta, ²K. Porteen and ²K.N. Bhilegaonkar

¹Division of Livestock Products Technology,

²Division of Veterinary Public Health, IVRI, Izat Nagar, Bareilly, UP, India

Abstract: A study was carried out to determine the influence of different concentration and contact time combinations of Trisodium Phosphate (TSP) 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: 6% TSP for 15 min, 8% TSP for 10 min and 10% TSP for 5 min. 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 0.23 and 1.16 for total viable counts; 0.2 and 1.11 for coliforms counts and 0.17 and 0.95 for staphylococcal counts. Immersion in 10% TSP solution for 5 min gave the best overall reduction effect. Sensory evaluations recorded minimal effects of treatments on buffalo offals. These findings show that immersion in 10% TSP solution for 5 min is suitable for decontamination of buffalo offals.

Key words: Buffalo offals, trisodium phosphate, microbial quality

INTRODUCTION

Meat by its very nature and origin is not only highly susceptible to spoilage but also frequently implicated to the spread of food borne diseases. In normal healthy animal, most of the tissues which ultimately become meat and meat products, including muscle, fat and various edible organs like heart, liver, kidney and brain, are sterile. A few products such as tongue and tripe naturally carry microbial contamination on the surface. During slaughter and processing, all potentially edible tissues are subjected to contamination from a variety of sources within and outside the animal (Ayres, 1955). Due to readily available nutrients and poor hygienic conditions during handling, collection and processing, offals generally possess poor microbial quality. Few studies have described the level of contamination and types of bacteria on organ meats. Such microbial contamination of offals is an economic loss to meat industry and may also lead to public health problems. Hence, hygienic processing of these edible byproducts is essential to ensure food safety. In addition, application of decontaminants can also substantially reduce the initial microbial load; as a result, fewer microorganisms are present, which are then more easily inhibited in subsequent processing steps. Delmore *et al.* (2000) reported that use of decontamination treatments as microbiological hurdles during processing of beef variety meats improved quality and safety.

Similarly, several researchers have developed strategies for bacterial reduction on carcasses using an array of decontaminants (Prasai *et al.*, 1995a,b; Hardin *et al.*, 1995; Reagan *et al.*, 1996; Rheault and Quessy, 1999; Bosilevac *et al.*, 2006; Eggenberger-Solorzano *et al.*, 2002; Phebus *et al.*, 1997;

Corresponding Author: P. Selvan, Division of Livestock Products Technology, IVRI, Izat Nagar, Bareilly, UP, India

Minihan *et al.*, 2003; Sinhamahapatra *et al.*, 2004; Whyte *et al.*, 2001; Fabrizio *et al.*, 2002; Fabrizio and Cutter, 2004) including certain chemicals such as polyphosphates. Of the various phosphates available, Trisodium Phosphate (TSP), a non acid compound has been reported to be the most effective antimicrobial agent (Gudmundsdottir *et al.*, 1993; Hwang and Beuchat, 1995) and was originally used in the United States for the control of *Salmonella* on poultry. TSP has been approved for use as a food ingredient (Federal Register, 1982) and also for poultry processing (Federal Register, 1994). Possible modes of action of trisodium phosphate include exposure of microorganisms to high pH, which might particularly affect cell membrane components, sequestration of metal ions and its role as a surfactant by enhancing the detachment of bacteria from food surfaces (Alexandra *et al.*, 1998). At higher concentrations, it has been demonstrated to kill gram negative organisms artificially inoculated on surfaces of foodstuffs. However, there are conflicting reports on the sensitivities of Gram-positive and Gram-negative bacteria to polyphosphates. It has been reported that Gram-positive bacteria are generally more sensitive to polyphosphates than Gram-negative bacteria (Lee *et al.*, 1994). Since several researchers have found that the use of TSP intervention in the processing of carcasses to be effective for reducing bacterial populations (Alexandra *et al.*, 1998; Kim and Slavik, 1994; Kim *et al.*, 1994; Dickson *et al.*, 1994; Capita *et al.*, 2003), the present study has been undertaken to determine the optimum concentration and contact time combination of TSP for the decontamination of buffalo offals.

MATERIALS AND METHODS

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

Collection of Buffalo Offal Samples

Buffalo offals viz, head meat, heart, liver and rumen were collected from offal market of Bareilly city 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.

Standardizing Contact Time for TSP Solutions (Preliminary Trials)

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 6% TSP for 5, 10, 15, 20, 25 and 30 min. 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 treatments 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 6% TSP 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 8 and 10% TSP to select a contact time for each. Sterile tap water was used for the preparation of different TSP solutions (wt/vol) and the trisodium phosphate (Merck, Darmstadt, Germany) used was of analytical grade.

Treatment of Buffalo Offals with TSP 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 6, 8 and 10% trisodium phosphate 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 total viable counts. 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 hrs under aerobic conditions. The average numbers of colonies were expressed as $\log_{10}\text{CFU g}^{-1}$ 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 and weight loss/gain.

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 one 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).

Weight Loss or Gain

The offal samples were weighed 45 min after the treatments in electronic weighing balance. The weight loss or gain in offal samples was recorded.

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

Statistical Analysis

For statistical analysis, average counts of colonies on duplicate plates were transformed into $\log\text{CFU g}^{-1}$. Then the data were analysed using Analysis of Variance (ANOVA).

Table 1: Buffalo offal samples processed to study the effect of trisodium phosphate 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	
Trisodium phosphate (TSP) treatment						
Control	-	5	5	5	5	20
6% TSP	15 min	5	5	5	5	20
8% TSP	10 min	5	5	5	5	20
10% TSP	5 min	5	5	5	5	20
Total		20	20	20	20	80

RESULTS

Standardizing Contact Time for TSP Solutions

Based on the results of preliminary trials conducted to standardize the contact time for TSP solutions, 15 min, 10 min and 5 min were chosen for 6, 8 and 10% TSP solutions, respectively.

Head meat

Eight and ten percent TSP treated head meat samples have shown significantly ($p < 0.01$) lower TVC and coliforms count when compare to control. Among the treatment groups, 10% TSP treated samples have shown significantly ($p < 0.01$) lower TVC and coliforms count. The level of reduction in TVC and coliforms count was 1.16 and 1.11 ($\log \text{CFU g}^{-1}$), respectively (Table 2).

Only 10% TSP treated samples have shown significantly ($p < 0.01$) lower staphylococcal count when compare to control. Among the treatment groups, 10% TSP treatment resulted in significant ($p < 0.01$) reduction of staphylococcal count when compare to 6% TSP treatment. The level of reduction in staphylococcal count was 0.83 ($\log \text{CFU g}^{-1}$) for 10% TSP treatment.

Heart

Eight and ten percent TSP treated heart samples have shown significantly ($p < 0.01$) lower TVC, coliforms and staphylococcal counts when compare to control. Similarly, 10% TSP treated samples have shown significantly ($p < 0.01$) lower TVC, coliforms and staphylococcal counts among the treatment groups. The level of reduction in TVC, coliforms and staphylococcal counts was 0.96, 1.01 and 0.95 ($\log \text{CFU g}^{-1}$), respectively.

Liver

Similar trend as observed in the heart samples were noticed with the liver samples. However, microbial counts differed significantly among the treatment groups for all the microorganisms studied. Ten percent TSP treated samples have shown significantly ($p < 0.01$) lower TVC, coliforms and staphylococcal counts. The level of reduction in TVC, coliforms and staphylococcal counts was 0.99, 0.99 and 0.79 ($\log \text{CFU g}^{-1}$), respectively.

Rumen

Eight and ten percent TSP treated rumen samples have shown significantly ($p < 0.01$) lower TVC, coliforms and staphylococcal counts when compare to control. Similarly, 10% TSP treated samples have shown significantly ($p < 0.01$) lower TVC, coliforms and staphylococcal counts among the treatment groups. The level of reduction in TVC, coliforms and staphylococcal counts was 0.96, 1.02 and 0.74 ($\log \text{CFU g}^{-1}$), respectively.

Head Meat

Mean odour and colour scores of all treatment groups were significantly ($p < 0.01$) lower than control. No statistical difference was observed among the treatment groups (Table 3).

Table 2: Effect of Trisodium Phosphate (TSP) solutions on microbial quality of buffalo offals

Kind of offals	Treatments	Average microbial count (log CFU g ⁻¹)		
		Total viable count	Coliforms count	Staphylococcal count
Head meat	Control	5.62±0.18 ^a	5.05±0.16 ^a	5.33±0.16 ^a
	6% TSP/15 min	5.34±0.15 ^{ab}	4.78±0.15 ^{ab}	5.15±0.15 ^a
	8% TSP/10 min	4.97±0.17 ^b	4.46±0.15 ^b	4.83±0.16 ^{ab}
	10% TSP/5 min	4.46±0.16 ^c	3.94±0.15 ^c	4.50±0.15 ^b
Heart	Control	5.44±0.14 ^a	4.93±0.17 ^a	5.17±0.14 ^a
	6% TSP/15 min	5.19±0.11 ^{ab}	4.69±0.15 ^{ab}	4.98±0.14 ^{ab}
	8% TSP/10 min	4.95±0.07 ^b	4.40±0.14 ^b	4.70±0.14 ^b
	10% TSP/5 min	4.48±0.10 ^c	3.92±0.08 ^c	4.22±0.12 ^c
Liver	Control	5.47±0.08 ^a	4.95±0.07 ^a	5.18±0.06 ^a
	6% TSP/15 min	5.24±0.09 ^a	4.73±0.08 ^a	5.01±0.05 ^a
	8% TSP/10 min	4.88±0.08 ^b	4.35±0.08 ^b	4.73±0.06 ^b
	10% TSP/5 min	4.48±0.09 ^c	3.96±0.08 ^c	4.39±0.07 ^c
Rumen	Control	5.94±0.09 ^a	5.21±0.07 ^a	5.55±0.07 ^a
	6% TSP/15 min	5.70±0.09 ^a	5.01±0.07 ^a	5.35±0.08 ^{ab}
	8% TSP/10 min	5.35±0.07 ^b	4.67±0.06 ^b	5.10±0.09 ^b
	10% TSP/5 min	4.98±0.08 ^c	4.19±0.06 ^c	4.81±0.10 ^c

Means within a column for a given offal sharing the same letter did not differ significantly ($p < 0.01$)

Table 3: Effect of Trisodium Phosphate (TSP) solutions on sensory quality of buffalo offals

Kind of buffalo offal	Treatments	Sensory scores	
		Odour	Colour
Head meat	Control	5.00±0.00 ^a	5.00±0.00 ^a
	6% TSP/15 min	4.48±0.11 ^b	4.62±0.15 ^b
	8% TSP/10 min	4.24±0.12 ^b	4.48±0.13 ^b
	10% TSP/5 min	4.19±0.12 ^b	4.57±0.16 ^b
Heart	Control	5.00±0.00 ^a	5.00±0.00 ^a
	6% TSP/15 min	4.33±0.14 ^b	4.71±0.14 ^{ab}
	8% TSP/10 min	4.19±0.11 ^b	4.57±0.14 ^b
	10% TSP/5 min	4.10±0.14 ^b	4.57±0.16 ^b
Liver	Control	5.00±0.00 ^a	5.00±0.00 ^a
	6% TSP/15 min	4.19±0.13 ^b	4.19±0.13 ^b
	8% TSP/10 min	4.00±0.12 ^b	4.10±0.14 ^b
	10% TSP/5 min	3.93±0.11 ^b	4.19±0.13 ^b
Rumen	Control	5.00±0.00 ^a	5.00±0.00 ^a
	6% TSP/15 min	4.38±0.11 ^b	4.24±0.10 ^b
	8% TSP/10 min	4.05±0.11 ^c	4.24±0.10 ^b
	10% TSP/5 min	4.00±0.14 ^c	4.14±0.17 ^b

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

Heart

Mean odour scores of all treatment groups were significantly ($p < 0.01$) lower than control. No statistical difference was observed among the treatment groups. Mean colour scores of 8% and 10% TSP treated samples was significantly lower ($p < 0.05$) when compared to control. No statistical difference was observed among the treatment groups.

Liver

Mean odour and colour scores of all treatment groups were significantly ($p < 0.01$) lower than control. No statistical difference was observed among the treatment groups.

Rumen

Mean odour scores of all treatment groups significantly ($p < 0.01$) differed from control. Within the treatment groups, 6% TSP treated samples have shown significantly ($p < 0.01$) higher odour score when compare to 8% as well as 10% TSP treated samples. No statistical difference was observed

Table 4: Effect of Trisodium Phosphate (TSP) solutions on certain physicochemical characteristics of buffalo offals

Kind of buffalo offals	Treatments	Physicochemical characteristics	
		pH	Weight loss/gain
Head meat	Control	6.37±0.03 ^d	100.42±0.41 ^b
	6% TSP/15 min	7.65±0.06 ^e	103.63±0.17 ^a
	8% TSP/10 min	8.37±0.05 ^b	103.85±0.48 ^a
	10% TSP/5 min	9.29±0.08 ^a	104.65±0.37 ^a
Heart	Control	5.84±0.04 ^d	99.15±0.41 ^b
	6% TSP/15 min	7.05±0.06 ^e	104.46±0.21 ^a
	8% TSP/10 min	7.87±0.05 ^b	104.53±0.22 ^a
	10% TSP/5 min	8.88±0.05 ^a	105.20±0.12 ^a
Liver	Control	6.35±0.04 ^d	100.56±0.54 ^b
	6% TSP/15 min	7.41±0.05 ^e	104.03±0.25 ^a
	8% TSP/10 min	8.46±0.06 ^b	104.11±0.40 ^a
	10% TSP/5 min	9.37±0.04 ^a	104.87±0.26 ^a
Rumen	Control	6.45±0.04 ^d	100.93±0.34 ^b
	6% TSP/15 min	7.42±0.07 ^e	105.08±0.17 ^a
	8% TSP/10 min	8.38±0.05 ^b	105.15±0.36 ^a
	10% TSP/5 min	9.33±0.03 ^a	105.98±0.50 ^a

Means within a column for a given offal sharing the same letter did not differ significantly ($p < 0.01$)

between 8 and 10% TSP treated samples. Mean colour scores of all treatment groups were significantly ($p < 0.01$) lower than control. No statistical difference was observed among the treatment groups.

Effect of TSP Solutions on Physicochemical Characteristics of Buffalo Offals

Effect of TSP treatments (6%/15 min, 8%/10 min and 10%/5 min) on pH and weight of buffalo offals have been presented in Tap water washed buffalo offals were used as control.

Mean pH values of all TSP treated head meat samples were significantly ($p < 0.01$) higher than control. Similarly, there was a significant ($p < 0.01$) statistical difference among the pH values of the treatment groups Table 4.

All TSP treated head meat samples had significantly ($p < 0.01$) higher weight when compared to control. However, no statistical difference was observed in the weights of treatment groups.

Similar findings are also observed with TSP treatment of heart, liver and rumen samples.

DISCUSSION

In general, immersion in 10% TSP solution for 5 min resulted in higher reduction of total viable count, coliforms count and staphylococcal count when compared to control and other treatment groups for almost all kinds of buffalo offals studied. Fabrizio *et al.* (2002) also observed that immersion chilling of broiler carcasses in 10% TSP solution resulted in 2.16 log reduction in aerobic plate count and greater than three log reductions in total coliform count. Delmore *et al.* (2000) also reported that immersion in 12% TSP solution for 10 sec were effective in reducing aerobic plate counts by 0.6 log CFU g⁻¹ or more and total coliform counts by 1.4 log CFU g⁻¹ or more in five of six variety meats studied. Dorsa *et al.* (1998) also found that the spray washing of experimentally inoculated beef carcass tissue with 12% TSP for 15 sec resulted in 1.3 log CFU cm⁻² reduction in aerobic plate count.

Overall, TSP treated offal samples had significantly lower score when compared to their respective controls. However, treatment groups did not differ significantly among them. In contrast, Ellerbroek *et al.* (1997) indicated that the results obtained from sensory evaluation showed that the organoleptic properties of poultry carcasses were not affected by treatments with TSP (10% for 6 sec). In other study (Hathcox *et al.*, 1995) no differences in acceptability and colour scores and purchase intent for control and treated (12% TSP solutions for 15 sec) raw chicken thighs were

detected. Hollender *et al.* (1993) reported that the external appearance of fresh broiler carcasses dipped in 12% TSP solution for 15 sec did not differ significantly from that of control on day one of storage at 4°C. The differences between present results and the aforementioned authors' ones could be explained taking into account the longer time of treatment and or concentration of TSP used in our experiments.

Overall, significantly higher ($p < 0.01$) pH was observed in TSP treated offals than control. The alkaline nature of TSP solutions might be contributed to the pH increase of treated offal samples. Kondaiah *et al.* (1985) also reported that addition of alkaline polyphosphates increased the pH of meat. Dorsa *et al.* (1998) also observed similar increase in surface pH of beef carcass tissues treated with 12% TSP for 15 sec. In general, all the treatment groups had significantly ($p < 0.01$) higher weight than control. Hamm (1970) and Trout and Schmidt (1983) reported that incorporation of phosphates improved the water hold capacity of meat by enhancing the pH of meat. So, TSP treatments might be increased the water hold capacity of offals thereby resulted in higher weight of treated offals.

CONCLUSIONS

Overall, immersion of buffalo offals in 10% trisodium phosphate solution for 5 min significantly reduced the levels of total viable count, coliforms count and staphylococcal count. Hence, this treatment would result in buffalo offals of improved quality and safety.

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