

Research Article



Comparative Effect of Different Types of Water used in Immersing Beef on Reducing their Bacterial Contamination

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Abstract | Meat manufacturing processes face numerous challenges, particularly the extended periods of preservation that can lead to various detrimental changes. Therefore, this study aimed to determine the most effective method of soaking water to reduce bacterial contamination on the surfaces of beef thighs. Forty samples of beef thighs were used, with each sample divided into five sections and assigned to five treatment groups: G1 (no wash), G2 (tap water), G3 (distilled water), G4 (magnetized water), and G5 (ozone water). Each treatment consisted of eight replications, with washing conducted at room temperature (22-25°C) for two durations: three minutes and six minutes. The results showed that meat treated with distilled water (4.11 cfu/g), magnetized water (4.06 cfu/g), and ozone water (3.36 cfu/g) had lower total counts of aerobic bacteria compared to those treated with no wash (4.09 cfu/g) and tap water (4.32 cfu/g). Interestingly, samples treated with ozone water (G5) exhibited significantly lower aerobic bacteria counts ($p < 0.05$) compared to all other treatments. Furthermore, the study found that longer washing times with tap water increased the degree of contamination. Based on these findings, it can be concluded that using ozonized water and reducing the washing time can effectively decrease the total aerobic bacteria count in meat. Therefore, the use of treated water, especially ozonized water, is highly recommended to mitigate bacterial contamination in beef and to safeguard public health.

Keywords | Magnetic water, Ozone water, Contamination, Bacterial count, Public health hazards.

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INTRODUCTION

Red meat and meat products are highly perishable foods susceptible to spoilage during manufacturing processes. Therefore, they must be stored at 4°C to maintain their hygienic quality and prevent spoilage (Kondratowicz et al., 2006; Muhlisin et al., 2015). The standard limits for bacterial counts in food products are established as 510 CFU/g, Coliform at 50×10^2 CFU/g, and psychophilic counts at 10^3 CFU/g (USDA, 2003). Various methods are available to reduce microbial contamination during freeze-thaw processes (Ismail et al., 2016), such as radiation and ozone treatments (Mahapatra et al., 2005). Proper storage con-

ditions and processing methods are essential to minimize spoilage and maintain meat quality, preventing physical and chemical changes caused by bacterial growth (Boonsumrej et al., 2007; Khan et al., 2013). Freezing and refrigeration are crucial methods for preserving meat quality. Additional preservation methods include chemical treatments such as salt (Lee and Yoon, 2001; Manousaridis et al., 2005; Al-obaidi, 2016), and preservatives like nitrates, sodium ascorbate, and sometimes smoking with antibacterial substances such as spices. Meat can also be exposed to irradiation or cooked using microwave and conventional methods (Rahman et al., 2014; Abed and Al-obaidi, 2017). Recently, ozone technology has been found effective in re-

ducing bacterial counts in food products with minimal side effects, as ozone quickly oxidizes and is preferred for water sterilization (Vieira et al., 2009; Xia et al., 2009).

Washing meat with water is a common practice in many meat markets and households, but this can actually be harmful, potentially increasing bacterial growth and spread (Abdulla and Al obaidi, 2020). Treating meat with water or exposing it to ozonized water has been shown to reduce bacterial growth (Olmez et al., 2009; María et al., 2016; Karamah et al., 2019; Suryaningsih et al., 2020). Given the significance of meat contamination during handling and the risk of increased contamination from washing meat, this study was designed in the local environmental conditions of Baghdad city. The aim of this study was to evaluate the effectiveness of different types of water—tap water, distilled water, magnetized water, and ozone-exposed water (O3)—in reducing total aerobic bacterial contamination of meat.

MATERIALS AND METHODS

ETHICAL APPROVAL

The Scientific Committee of the Public Health Branch, College of Veterinary Medicine approved this research (Approval No. S.M.10-2-2022).

STUDY DESIGN

This experiment was conducted using beef meat obtained from the local market in Baghdad, Iraq, during the period from May 15 to July 15, 2022. Forty samples weighing 50 grams each were randomly selected from different carcasses at various butcher shops in the local markets and transported to the Meat Hygiene Laboratory at the College of Veterinary Medicine.

SAMPLES PREPARATION

Meat samples were divided into five groups and individually placed in polyethylene bags specifically designed for samples: one group served as a control without washing. The second group was placed in a polyethylene bag with tap water, the third group in an appropriate amount of distilled water, the fourth group in magnetized water, and the fifth group in ozonized water. During the initial examination, soaking time was set at three minutes, which was extended to six minutes during the second examination. Subsequently, bacteriological tests described below were conducted after six hours, and bacterial cultures were incubated using an incubator for 24 hours as per BAM guidelines (1998).

MICROBIOLOGICAL ANALYSIS

Bacterial count examination was done by using indirect method (standard plate count) (Johnson et al., 2014). Be-

fore preparing serial dilutions of the meat samples, 1% peptone water and Nutrient agar were prepared following the instructions of the manufacturing company. The dilution bottles and the culture medium were sterilized in autoclave for 15 min at a temperature of 121°C and pressure of 15 pounds/inch². In order to count the total number of aerobic bacteria that might present in the meat samples, 1 mL from each bag containing a sample of meat was transferred by micropipette to the dilution bottles (with peptone water). Then, 1 mL of the dilution bottle was transferred to the next dilution and so on until completing all of the dilutions. and transferred to be cultured on the Nutrient agar plate which was incubated in an incubator at 35°C overnight on the next day, the number of developing colonies was counted by a bacterial counting device.

STATISTICAL ANALYSIS

The collected data were analyzed by Duncan's test as per the method suggested by de Smith (2021). The means were considered significantly different when p-values were found less than 0.05.

RESULTS AND DISCUSSION

The data revealed significant meat contamination, especially when washed with tap water or left unwashed, as depicted in Fig. 1. This study aimed to assess meat hygiene by soaking beef samples in various types of water—tap water, distilled water, magnetized water, and ozonized water—and investigating the total aerobic bacteria counts after 3 or 6 minutes of soaking. Significant differences were observed among the different types of water used for soaking meat at both time durations. Importantly, a significant difference ($P < 0.05$) was noted between beef samples that were not soaked and those soaked in sterilized water. Figures 1 and 2 illustrate the levels of total aerobic bacteria found in beef samples after 3 and 6 minutes of exposure to different washing waters (4.09, 4.32, 4.11, 4.06, 3.36 CFU/g meat), respectively. Notably, bacterial counts during the initial three minutes of water exposure were within the normal range (approximately 4 CFU/g meat) approved by the Iraqi Health Ministry (Ersoy et al., 2008; Maria et al., 2024).

Aerobic bacteria levels increased in meat samples in the current study when washed with tap water due to its lack of complete sterility. Additionally, fluctuations in tap water temperatures resulting from seasonal climate changes can contribute to increased water contamination, thereby leading to higher bacterial levels in the washed meat samples. This finding is supported by studies conducted by Suryaningsih et al. (2020), which similarly reported increased bacterial contamination when washing meat with tap water. Conversely, the results differed when using treated water for immersing beef. For instance, the bacterial load

was lower when using distilled water compared to tap water (4.32 versus 4.11 CFU/g of meat, respectively). This is attributed to distilled water typically being free of germs despite having a pH close to 7.0, which would otherwise support bacterial growth if cultured without distilled water. This finding aligns with Al-obaidi (2016), who noted that washing red meat surfaces with distilled water may lead to minor contamination over time.

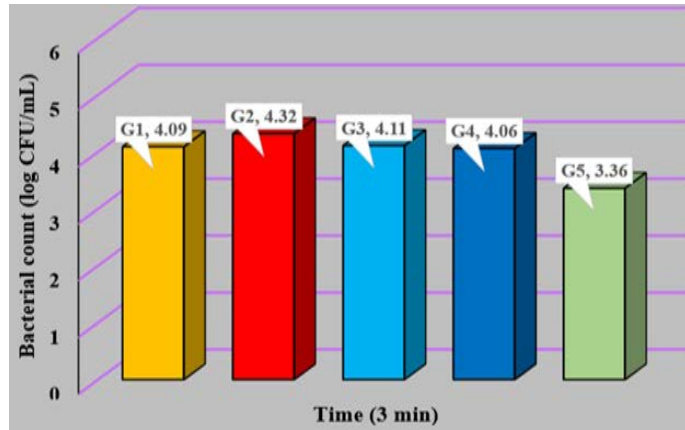


Figure 1: Rates of total aerobic bacteria present in beef samples after 3 minutes of exposure to different types of washing water. G1: without wash, G2: tap water, G3: distilled water, G4: magnetized water, G5: ozone water.

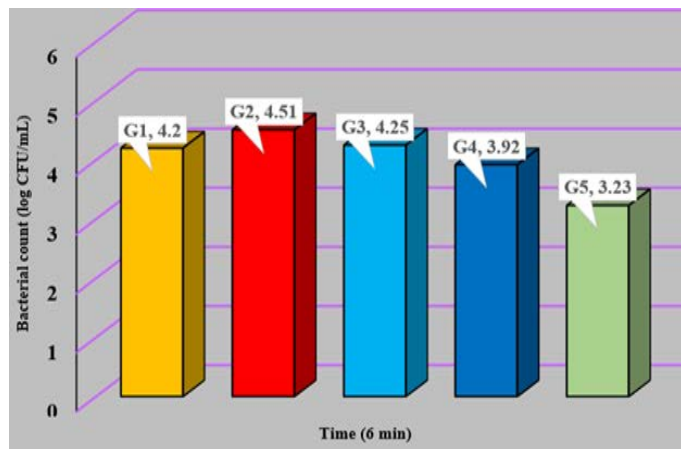


Figure 2: Rates of total aerobic bacteria present in beef samples after 6 minutes of exposure to different types of washing water. G1: without wash, G2: tap water, G3: distilled water, G4: magnetized water, G5: ozone water.

In the meat samples soaked in magnetized water, a significant ($P < 0.05$) decrease in aerobic bacteria count was observed. Similar results were noted in meat samples washed with ozonized and magnetized water compared to those washed with tap water or left unwashed. This can be attributed to magnetized water being exposed to a magnetic field, which induces the production of OH ions, thereby shifting the acidity towards alkalinity and weakening hydrogen bonds. This alteration reduces water viscosity and its effectiveness, thereby limiting bacterial growth and ac-

tivity compared to untreated samples (Suryaningsih et al., 2020; Lagarde et al., 2024). Several studies have shown that exposure to a magnetic field alters water properties, potentially inhibiting microbial growth. In our study, bacterial growth rates decreased by more than 1 log when treating beef samples with ozonized water. Ozone-treated water plays a crucial role in limiting bacterial growth, with enhanced effectiveness observed with longer exposure periods to ozone for thorough bacterial elimination (Ayranci et al., 2020; Kang et al., 2022).

The results of this study align with several previous studies (Rahman et al., 2014; Abdullah and Al-obaidi, 2020), demonstrating that washing meat with tap water has a detrimental effect on the total bacterial count, even more so than leaving the meat unwashed. In contrast, washing with magnetized water or ozonized water resulted in a decrease in the total bacterial count. Therefore, this study underscores an important factor in public health: washing meat with tap water poses risks due to its potential to increase bacterial contamination.

The findings of bacterial counts after soaking meat for 6 minutes are presented in Fig. 2, indicating that the bacterial numbers were within permissible limits (4.3 cfu/g of meat) according to ICOSQC (1992) and Ersoy et al. (2004). Additionally, this study revealed significant differences ($P < 0.05$) in bacterial counts between the types of water used for soaking meat samples. Extended soaking with tap water for a second period had a detrimental effect on meat, resulting in increased bacterial growth (4.51 cfu/g of meat) compared to the initial period (4.32 cfu/g of meat). This may be attributed to impurities in tap water requiring more time to adhere to the meat surface, thereby increasing bacterial growth. These findings align with previous studies (Abdullah and Al-obaidi, 2020) indicating that washing meat with tap water, especially with increased exposure time, negatively impacts bacterial contamination, which is not recommended compared to levels of total aerobic bacteria in unwashed beef samples. Conversely, treating meat with distilled and magnetized water for 6 minutes showed no significant differences (Fig. 2). Abdullah and Al-obaidi, (2020) reported that distilled water had no impact on bacterial growth, whereas magnetized water treatment resulted in a lower bacterial count (3.92 cfu/g of meat) in the samples.

Regarding the levels of total aerobic bacteria recovered in beef samples immersed in ozone-treated water for 6 minutes, a significant decrease ($P < 0.05$) in bacterial counts was observed compared to samples soaked in other types of water or left unwashed, with bacterial counts decreasing to below 3.23 cfu/g of meat. This finding is consistent with other studies (Abdullah and Al-obaidi, 2020), which

demonstrated ozone water's efficacy in reducing bacteria, with effectiveness increasing with prolonged exposure time. Ozone water functions by enhancing the oxidation process, which plays a crucial role in disrupting bacterial cell walls (Vieira et al., 2009; Hidenori et al., 2022), affirming its positive role in meat preservation and bacterial growth prevention. Figure 2 illustrates the levels of total aerobic bacteria in beef samples exposed to different types of washing water for 6 minutes. Figures 3 and 4 depict the culture media used for the first and second periods of meat soaking in water, respectively. This study indicates that immersing meat in ozone water is the most effective method due to its ability to significantly reduce bacterial contamination compared to tap water. Furthermore, the duration of meat washing impacts contamination levels. Thus, ozonized water can be recommended for use in restaurants and home kitchens to ensure high meat hygiene standards (Ismail et al., 2016; Koentadi et al., 2023).

without soaking, B2: soaking in tap water, C2: soaking in distilled water, D2: soaking in magnetic water, E2: soaking in ozonized water.

CONCLUSIONS

Paying attention to the type of water used for washing meat is crucial for meat handling and processing, as it directly impacts meat quality and human health by minimizing the risk of contamination. This study has demonstrated that tap water can lead to meat contamination, and the extent of contamination varies depending on the type of water used, such as ozone, magnetized, or distilled water. According to the current findings, ozone water was found to be the most effective for cleaning meat and ensuring it remains free from contamination. It is advisable to use ozone water when washing meat to reduce contamination levels. Another effective option is magnetically treated water, which also helps reduce the presence of harmful bacteria.

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CONFLICT INTEREST

The authors have not declared any conflict of interest.

NOVELTY STATEMENT

The novelty of the study lies in examining the efficacy of certain devices in producing safe, contamination-free water suitable for washing meat. Specifically, an ozone device was used to generate ozonated water, as indicated by the study's results, which demonstrated the effective cleansing of meat without contamination. This method holds potential for commercial applications, particularly in butcher shops and slaughterhouses, ensuring the production of clean, high-quality meat. Additionally, it can be utilized for cleaning floors and tools in slaughterhouses.

AUTHORS CONTRIBUTION

These authors Jassim E.Q.Al-Musawi, Dahfir A. Alobaidi and M.J.Al-Saadi each contributed equally.

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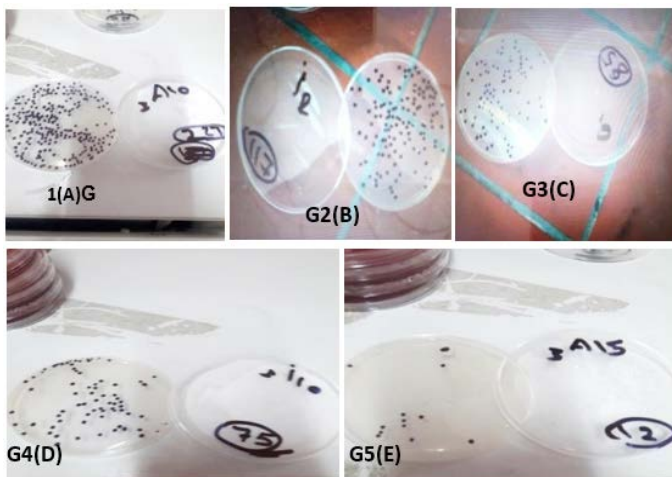


Figure 3: Bacterial counting following soaking of meat with different types of washing water for 3 minutes. A: without soaking, B: soaking in tap water, C: soaking in distilled water, D: soaking in magnetic water, E: soaking in ozonized water.

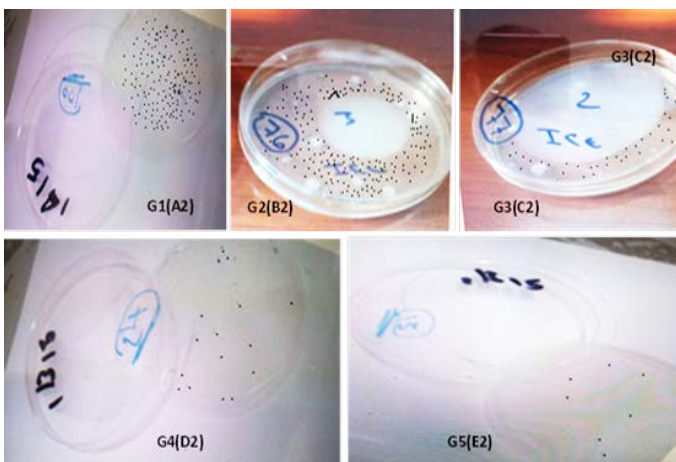


Figure 4: Bacterial counting following soaking of meat with different types of washing water for 6 minutes. A2:

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