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EFFECT OF MICROWAVE RADIATION ON THE VIABILITY OF ESCHERICHIA COLI AND STAPHYLOCOCCUS AUREUS

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Abstract:

Sterilization and decontamination of food like dairy products from bacteria that cause food poisoning is the paramount goal of food industry. Recently microwave ovens have been widely used for heating of food. This study was carried out in order to show the effect of microwave radiation on the viability of E.coli and Staphylococcus aureus in the milk. Known concentrations of E.coli and Staph,aureus in the local sheep milk were exposed to microwave radiation at 40%, 80% and 100% power levels at different time durations in seconds (0,5,30,60,120) and 0 time regarded as a control. A significant reduction in the number of colonies was detected with increasing the time of exposure for three power levels of microwave radiation compared to control. The killing effect of radiation was more associated with increasing the power level and time of exposure, in which the percentages of bacterial reduction were 12.1, 48.4 and 95.1 for E. coli at power level 40%,80% and 100% respectively while for Staph. aureus were 55.9, 92.7 and 80.7. Staph. aurues. The reduction percentages of E. coli after 120 seconds of exposure to power levels 40%,80% and 100% were 96.6, 100.0 and 98.7 respectively, while for Staph. aureus were 82.5, 99.08 and 99. It can be concluded from the results of this study that microwave radiation can be used as effective method for removing of bacteria that can cause food poisoning.

Keywords: Microwave Radian, Bacterial Growth, E. Coli.

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1- Introduction

Microwaves can be defined as non-ionizing electromagnetic waves with frequencies ranged from 0.3 to 300 GHz which enter various industrial generators including television, microwave communications, microwave ovens, medical diathermy, radar technology from heating used in industrial food to communicational tools [1]. Recently microwave radiation becomes popular in food industry as well as in house kitchens [2,3]. A growing body of researches had been published on the effect of such radiation on the growth of different microorganisms which due to either thermal and non- thermal effect. Most of the researchers are with thermal effect in which the exposed cells absorb microwave energy and leading to heating that cause denaturation of cellular enzymes and proteins [3-10]. On the other hand, some of the researchers concluded that the bacterial growth was increased when exposed to low power levels of radiation [11]. The thermal effect of microwaves on microorganisms depends mainly on the frequency of the radiation, the total absorbed energy and sufficient period of exposure time. Several studies done on the effect of microwave radiation on various bacterial and yeast cultures in a wet environment like water did not show additional killing effect when compared to conventional heating to the same temperature [1,12,13]. The aim of this study was to study the effect of different power levels of microwave radiation on the viability of both *E. coli* and *Staphylococcus aureus* at various time intervals in order to elucidate whether the effect is to kill or enhance bacteria growth.

2. Material and Methods

2.1 Materials

2.1.1 Bacteria

A strain of *E.coli* was obtained from microbiology laboratory/ Duhok technical Institute, while *Staphylococcus aureus* strain was obtained from Microbiology research laboratory/ Department of Biology/College of Science/ University of Duhok. These two pathogenic bacteria were isolated from human clinical infections such as urinary tract infection and burn infection and represent both Gram negative and positive bacteria.

2.1.2 Microwave oven

Gosonic microwave oven (GMO-330) with 50 Hertz, 230 Volt and 1400 Watt was used.

2.1.3 Preparation of contaminated milk

A sheep milk was obtained from local market and sterilized by filtration using Millipore filter (Sigma-Aldrich, USA) with 0.45 µl porosity to become free from any bacteria, then a known concentration (2 x 10^3 CFU/ml) of *E.coli* and *Staph. aureus* was prepared by making decimal dilution of each bacterial suspension. After serial dilutions, each dilution was spread over nutrient agar plate (Oxoid, UK) and incubated at 37 °C for 24 h and colonies were counted after each incubation period, then added to milk samples in separated glass test tubes.

2.2 Methods

Three replicates of contaminated milk samples were exposed to three power levels (40%, 80% and 100%) of microwave radiation for five times durations in seconds (0, 5, 30,60, and 120). Zero time was regarded as a control. After each time of exposure, 1 ml of the sample was decimally diluted in a new sterile test tube and cultured by pour plate method on nutrient agar (Oxoid, UK) to determine total count of bacteria per milliliter and the reduction percentages were calculated according to the following equation: Bacterial count after exposure to radiation / Initial bacterial count x 100.

3. Statistical analysis

ANOVA test was used to find out the effect of microwave radiation power levels on the viability of *E. coli* and *Staph. aureus* and p value <0.05 considered significant.

4. Results and discussion

The effect of microwave radiation at power level 40% on the viability of *E. coli* and *Staph. aureus* in milk is shown in Figure 1-1. The reduction percentages of *E. coli* growth were 12.1, 46.9, 94.7 and 96.6 at 5, 30, 60 and 120 seconds respectively, while were 55.9, 64.0, 73.6 and 82.5 for *Staph. aureus* compared to control. Significant statistical differences were found between radiation power level 40% and increasing of the time of exposure on the growth of both bacteria. Although the effect was more prominent on the growth of *E. coli* than on *Staph. aureus* because the chemical structure of the cell wall of these two bacteria is different in which the cell wall of *E. coli* is mainly composed of lipid while those of *Staph. aureus* mainly composed of peptidoglycan which is a polymer of amino sugars.

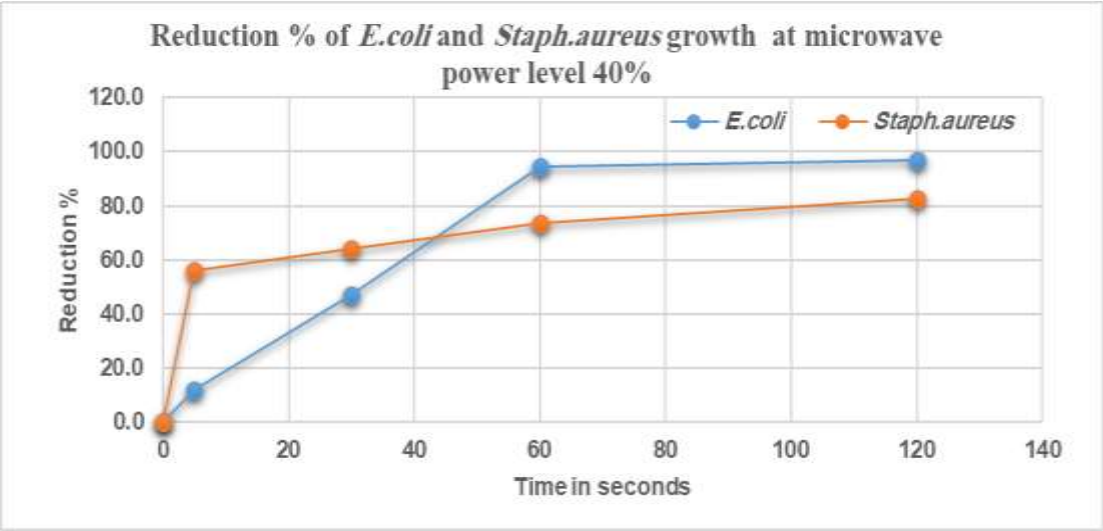

Figure 1-1 Effect of microwave radiation power level 40%

The reduction percentages of microwave radiation at power level 80% for *E. coli* growth were 48.4, 90.1, 97.8 and 100 at 5,30,60 and 120 seconds respectively compared to control, while were 92.7,97.2,98.2 and 99.08 for *Staph. aureus* growth as shown in Figure 1-2. Significant statistical differences were found between radiation power at 80% and increasing of the time of exposure to the growth of both bacteria. The effect of power level at 80% was more effective on the viability of both bacteria in which after 30 seconds of exposure more than 90% of both bacteria were killed compared to power level 40% in which 46.9% of *E. coli* and 64.0% of *Staph. aureus* was killed. *Staph. aureus* is one of the hardy bacteria among Gram positive bacteria which resistant to dryness, high temperature and antibacterial drugs.

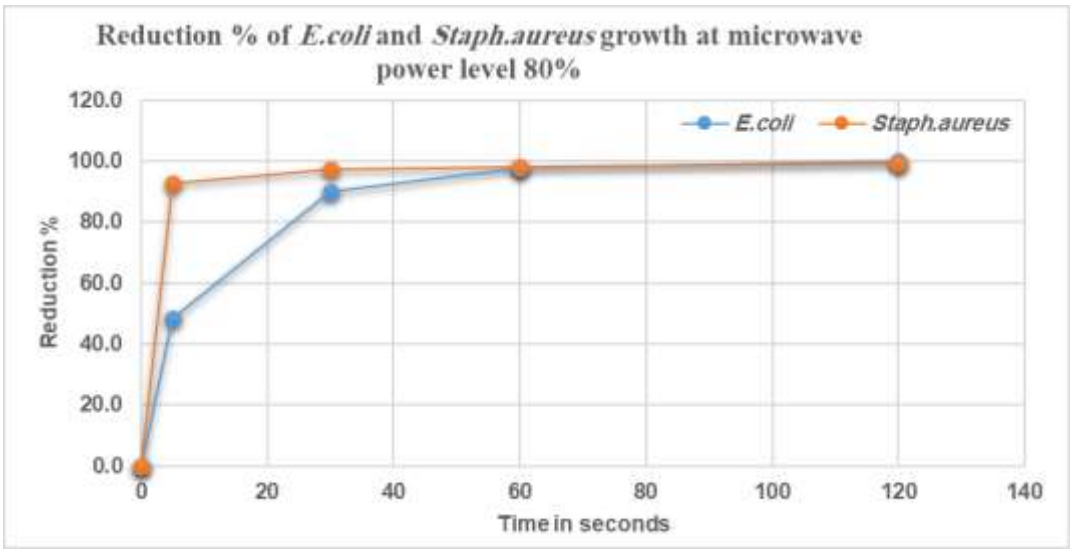

Figure 1-2 Effect of microwave radiation at power level 80%

The reduction percentages of microwave radiation at power level 100% were 95.1, 96.4, 98.7 and 100 at 5,30,60 and 120 seconds respectively for *E. coli* growth compared to control and were 80.7, 95.7,98.6 and 99.1 for *Staph. aureus* growth as shown in Figure 1-3. Significant statistical differences were found between radiation power level and increasing of the time of exposure on the viability of both tested bacteria. The effect of microwave power level at 100% was more destructive on the viability of both bacteria in which 95.1% of *E. coli* and 80.7% of *Staph. aureus* was killed after 5 seconds of exposure compared to power levels 40% and 80%. These results were similar to those found by [14] who concluded that when microwaves were applied at certain frequencies, with high energy and for a sufficiently long period of time, their thermal effect was most likely dominant and killed bacteria; cells and yeasts. The study showed that more than 99.0% reduction was obtained on the viability of *Staph. aureus* colonies after 120 seconds at both microwave levels 80% and 100% which dissimilar to those found by Abdulla (2016) [15] who found that the total reduction percentage in *Staph, aureus* viability occurred after 7 minutes of exposure but the authors didn't mention the level of power. The results of this study clearly

demonstrated that both microwave power levels and exposure times have destructive effect on the viability of bacteria which can prevent foodborne infections but still their effects on the bacterial toxins as well as chemical properties of the food remain unknown.

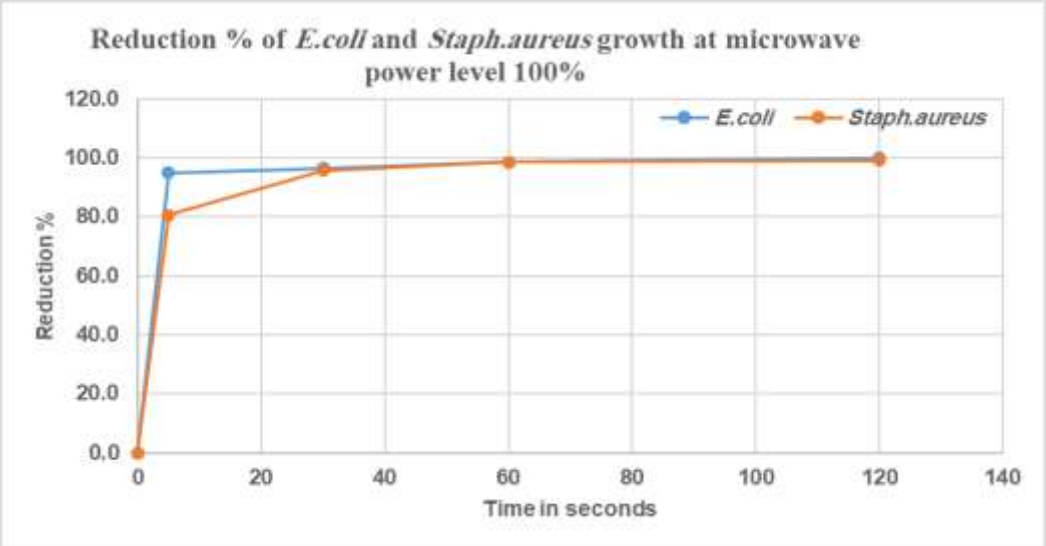

Figure 1-3 Effect of microwave radiation at power level 100%

It can be concluded from the results of this study that microwave radiation can be used as effective method for removing of bacteria that can cause food poisoning.

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