THERMAL INACTIVATION OF SALMONELLA ENTERITIDIS IN BEEF MEATBALLS IN CONVECTIVE OVEN

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Abstract – In this study, thermal inactivation of *Salmonella enteritidis* ATCC 1307 inoculated to beef meatballs was investigated. *S.enteritidis* adapted to 200 ppm nalidixic acid was inoculated to the center of the meatballs. The beef meatballs were inoculated with ≈6.5 log cfu/g *S.enteritidis.* Then, thermal treatment was applied at 190°C at the position of top and bottom fan cooking mode of convective oven. Enumeration of *S.enteritidis* was carried out at 0, 5, 7, 9, 12 and 30 minutes. 1.47 log cfu/g and 4.95 log cfu/g decreases in *S.enteritidis* counts were determined in the beef meatballs heat treated for 7 minutes and 9 minutes, respectively. After 7 minutes and 9 minutes of thermal treatment the center temperature of the meatballs reached 60.28°C and 73.23°C. *S.enteritidis* was not detected at 12 minutes and 30 minutes of the thermal process and the center temperature of the meatballs measured as 8.01°C and 95.13°C, respectively.

Key Words – Beef meatballs, Convective oven, *Salmonella enteritidis,* Thermal inactivation

- INTRODUCTION

Thermal treatment is an important step of food processing. It affects the sensory properties of foods and also provides food safety [1, 2]. Several foodborne diseases have been relevelant to inadequate time or temperature application of thermal treatment [3]. Inadequate cooking of meat products gives rise to foodborne infections such as Salmonellosis [4]. In order to decrease foodborne outbreaks, infections and also eliminate foodborne pathogens the United States Department of Agriculture-Food Safety and Inspection Service (USDA-FSIS) has implemented a regulation. According to the regulation, thermal treatment should achieve 6.5 log reduction of *Salmonella* spp. in ready to eat meat products [5]. Ready to eat cooked meat products should reach internal temperature of at least 71.1°C [6].

In this study, thermal inactivation of *S.enteritidis* inoculated to the beef meatballs at 190°C at the position of top and bottom fan cooking mode of convective oven was investigated. The thermal treatment duration providing 6.5 log cfu/g *S.enteritidis* reduction at 190°C was investigated.

- MATERIALS AND METHODS

Salmonella enteritis ATCC 13076 was used as a test culture. It was obtained from Ege University, Engineering Faculty, Food Engineering Department, Food Microbiology Laboratory, İzmir, Turkey. *S.enteritidis* was adapted to 200 ppm nalidixic acid [7]. For each trial *S.enteritidis* adapted to 200 ppm nalidixic acid was incubated at 37°C for 18–24 h in Tryptic Soy Broth containing 200 ppm nalidixic acid.

Minced round of beef was purchased from a local market in İzmir, Turkey. Meatballs were prepared using only round of beef and they were given a shape to a 1.4 cm thickness and 9.0 cm in diameter. *S.enteritidis* was inoculated to the geometric center of the meatballs with a sterile disposable injector. The beef meatballs were inoculated with ≈6.5 log cfu/g *S.enteritidis.* Then the meatballs were kept at 4°C for 30 min to provide cell attachment [8].

Thermal inactivation study was carried out in a convective oven (Vestel, Manisa, Turkey). A

disposable aluminium tray with 39.8 cm x 33.8 cm x 5.0 cm dimensions was used for thermal treatment. Thermal treatment was applied at 190°C at the position of top and bottom fan cooking mode for 5, 7, 9, 12 and 30 minutes. Temperature changes of meatballs were measured using type-J thermocouples with datalogger (Digi-Sense, Illinois, USA). The thermocouples were positioned at the central of meatballs. As soon as thermal treatment ended, meatballs were placed in a sterile stomacher bag immediately and submerged in ice-water mixture (0°C). Then, 10 g of samples were taken from the central of meatballs for the analysis. Enumeration of *S.enteritidis* was carried out at 0, 5, 7, 9, 12 and 30 minutes. Decimal dilutions were prepared and surface plated on Tryptic Soy Agar containing 200 ppm nalidixic acid. The plates were incubated at 37 °C for 48-72 h [9].

All the results were analyzed with SPSS 16.0 for Windows package program. ANOVA (Analyses of Variance) and Duncan multiple comparison tests were also applied (α=0.05).

- RESULTS AND DISCUSSION

Thermal inactivation of *S. enteritidis* ATCC 1307 inoculated to the beef meatballs is shown in Fig.1 and Fig.2. At the beginning of the thermal treatment ≈6.5 log cfu/g *S.enteritidis* were inoculated to the meatballs. At the 5, 7 and 9 minutes of the thermal treatment, *S.enteritidis* was detected in the meatballs. 0.41 and 1.47 log cfu/g reductions (P<0.05) in *S.enteritidis* counts were determined in the meatballs heat treated for 5 minutes and 7 minutes, respectively. The center temperature of the meatballs reached 39.68°C and 60.28 °C at 5 minutes and 7 minutes of the thermal treatment.

Figure 1. Time dependent thermal inactivation of *Salmonella enteritidis*

The thermal treatment ended at 9 minutes resulted in 4.95 log cfu/g *S.enteritidis* reduction (P <0.05) and at the end of the treatment the center temperature of the meatballs was measured as 73.23°C.

Figure 2. Temperature dependent thermal inactivation of *Salmonella enteritidis*

According to USDA-FSIS ready to eat cooked meat products should reach internal temperature of at least 71.1 °C (USDA-FSIS, 2011). Although the center temperature of the meatballs reached 73.23 °C, *S.enteritidis* was still detected in the meatballs.

Schnepf *et al*. [10], detected *Salmonella typhimurium* in three of two chicken samples when cooked in an oven until internal temperature reached 79°C. Murphy *et al*. [11], 7 log cfu/g *Salmonella senftenberg* and *Listeria innocua* inoculated to chicken meatballs. Then thermal treatment was applied in the oven. When the center temperature of the meatballs reached 80°C, 1 log cfu/g *S.senftenberg* and 3 log cfu/g *L.innocua* were detected. In the study of Yilmaz *et al*. [12], effect of cooking by observing the change of microflora of Tekirdağ meatballs was investigated in an oven. Thermal treatment applied at 160°C and ended when the center temperature of the meatballs reached 79°C. Before the thermal treatment 1.93 log cfu/g *Staphylococcus aureus* was detected in the samples In the thermal treated samples 1.17 log cfu/g *S.aureus* was detected. They determined that this thermal treatment application was insufficient for destroying pathogenic microorganisms.

In the present study, *S.enteritidis* was not detected 12 and 30 minutes thermal treated meatballs. The center temperature of meatballs measured as 81.01°C at end of 12 minutes of thermal

treatment and this application was sufficient to provide 6.5 log cfu/g *S.enteritidis* reduction. However, it was not adequate to provide acceptable sensory properties. On the other hand acceptable sensory properties were attained when the center temperature of meatballs reached 95.13°C with the thermal treatmet at 190°C for 30 minutes.

- CONCLUSION

As result of this study, 6.5 log cfu/g *S.enteritidis* reduction was satisfied when the temperature of meatballs reached 81.01°C. However when center temperature of the meatballs reached 81.01°C good sensory properties of meatballs were not achieved. Both USDA-FSIS requirement 6.5 log cfu/g reduction and acceptable sensory properties were provided with the thermal treatment at 190°C for 30 minutes and the center of meatballs temperature measured as 95.13°C at the end of 30 minutes. This study made a contribution to oven productions programs for having safe foods while cooking. According to USDA-FSIS ready to eat meat products should reach 71.1°C but this study proved that this temperature is not enough for food safety.

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REFERENCES

- Buchanan, R.L. & Edelson, S.G. (1999). Effect of pH-dependent, stationary phase acid resistance on the thermal tolerance of *Escherichia coli O157:H7*. Food Microbiology 16: 447-458.
- Pittia, P., Furlanetto, R., Maifreni, M., Tassan Mangina, F. and Dalla Rosa, M., 2008, Safe cooking optimisation by *F*-value computation in a semi-automatic oven, *Food Control,* 19:688-697.
- Chhabra, A.T., Carter, W.H., Linton, R.H. & Cousin, M.A. (2002). A predictive model that evaluates the effect of growth conditions on the thermal resistance of *Listeria monocytogenes.* International Journal of Food Microbiology, 78(3):235-243.
- CDC (Centers for Disease Control and Prevention), (2009). National Center for Emerging and Zoonotic Infectious Diseases, Salmonellosis, (http://www.cdc.gov/nczved/divisions/dfbmd/diseases/salmonellosis/#what)
- USDA-FSIS (United States Department of Agriculture-Food Safety and Inspection Services), (1999). Performance standards for the production of certain meat and poultry products, Fed. Reg., 64(3):732-749.
- USDA-FSIS (United States Department of Agriculture-Food Safety and Inspection Services), (2011). (http://www.fsis.usda.gov/News_&_Events/NR_052411_01/index.asp)
- Murphy, R.Y., Marks, B.P., Johson, E.R. & Johnson, M.G. (1999). Inactivation of *Salmonella* and *Listeria* in ground chicken breast meat during thermal processing. Journal of Food Protection 62:980-985.
- Pradhan, A.K., LI, Y., Marcy, J.A., Johnson, M.G. & Tamplin, M.L. (2007). Pathogen kinetics and heat and mass transfer-based predictive model for *Listeria innocua* in irregular shaped poultry products during thermal processing. Journal of Food Protection 70:607-615
- Murphy, R.Y., Beard, B.L., Martin, E.M., Keener, A.E. & Osaili, T. (2004). Predicting process lethality of *Escherichia coli* O157:H7, *Salmonella*, and *Listeria monocytogenes* in ground, formulated, and formed beef/turkey links cooked in an air impingement oven. Food Microbiology 21:493–499.
- Schnepf, M. & Barbeau, W.E. (1989). Survival of *Salmonella typhimurium* in roasting chickens

cooked in a microwave, convection microwave, and a conventional electrical oven. Journal of Food Safety 9: 245–252.

- Murphy, R.Y., Johnson, E.R., Marks, B.P., Johnson, M.G. & Marcy, J.A. (2001). Thermal inactivation of *Salmonella senftenberg* and *Listeria innocua* in ground chicken breast patties processed in an air convection oven. Poultry Science. 80:515–521.
- Yilmaz, I., Yetim, H. & Ockerman, H.W. (2002). The Effect of different cooking procedures on microbiological and chemical quality characteristics of Tekirdağ meatballs. Nahrung/Food 46:276-278.