'Natural' Suppression of the Growth of Foodborne Pathogens in Meat Products

Daniel Y. C. Fung and Leslie K. Thompson, Kansas State University, United States of America

There has been an increase in interest in the value of "natural" foods in human health and wellbeing in recent years with the "Organic Food Movement" gaining interest worldwide. Many foods we eat daily actually have great benefits to our health besides the obvious good taste and nutritional values. Plum is a nutritious and delicious food. The US dried plum industry produces an average of 200,000 tons of dried plums per year. The industry is worth US$ 215 million domestically and US$ 138 million internationally. Retail sales grossed US$ 110 million domestically and US$ 100 million in exports. The industry consists of dried plums with and without pits, juices and concentrates, canned foods, baby food, puree, butter, diced dried plums and government purchased products. Commercial prunes and prune extracts (*Prumus domestica* cv French) contain phenolics, such as hydroxycinnamates, neochlorogenic acid and chlorogenic acid, which can inhibit the oxidation of low-density lipoprotein (Nakatani *et al.*, 2000).

Kreuzer (2001) reported that 3% dried plum puree worked comparably to BHA/BHT in the prevention of warmed-over flavour caused by lipid oxidation in precooked pork sausage. The effect of dried plum extracts on major foodborne pathogens in liquid and solid foods has not been reported. The objective this study was to evaluate the efficacy of different concentrations and various contact times of dried plum mixtures for controlling or killing *Salmonella enterica* serovar Typhimurium, *Listeria monocytogenes*, *Escherichia coli* O157:H7, *Yersinia enterocolitica* and *Staphylococcus aureus* in a liquid medium and in uncooked ground beef. All cultures in this study were from the culture collection of Food Safety Laboratory, Department of Animal Sciences and Industry, Kansas State University, Manhattan, Kansas, USA.

In this challenge study, the five foodborne pathogens were individually grown and then mixed as a cocktail and then inoculated into the liquid or raw ground beef products at 3–4 log CFU/ml or g of food. Sterilised Brain Heart Infusion (BHI) broth (Difco, Detroit, MI) was used as the liquid medium. Ground beef, obtained locally, was used as the solid food. Dried plum puree and related plum products were obtained from California Dried Plum Board and manufactured by Sunsweet Growers of Yuba City, California and were added into the BHI broth at 0%, 1%, 2.5%, 5% or 10%. The liquid samples were placed at 35°C incubation temperature with no agitation. At regular intervals samples were obtained aseptically and tested for viability of different pathogens using pathogen specific agars for differential enumeration of each pathogen. Uncooked ground beef, used as the solid food model, was obtained from a local retail store the day that the mixture was made. A 3% dried plum puree was added into the ground beef. The ground beef with plum puree was inoculated with the five pathogens cocktail at 4 log CFU/g and stored at 4°C until sampling time.

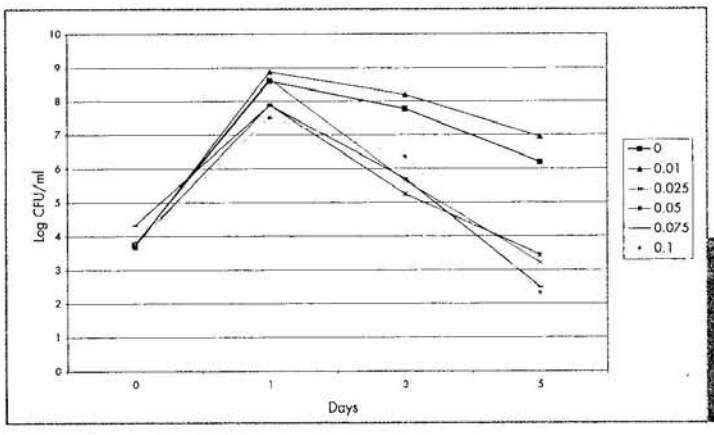

Fig. 1: Effect of dried plum puree concentrations and contact time on *Escherichia coli* O157:H7 in liquid medium.

Results and Discussion

Due to the massive amount of data only selected examples are presented in this article.

After initial growth of *E. coli* O157:H7 in day one in the liquid medium, a dramatic decline of counts was observed in day two and beyond as the concentration of dried plum puree increased (0–10%), indicating a killing effect of the dried plum on this important pathogen (fig. 1). Similar data were observed for total aerobic count and counts of *Salmonella* Typhimurium, *Listeria monocytogenes*, *Yersinia enterocolitica* and *Staphylococcus aureus* in liquid medium.

When the effect on *E. coli* O157:H7 of different forms of Plum Puree in liquid medium (3% and 6%) was evaluated, *E. coli* O157:H7 grew dramatically from Log 3 CFU/ml to Log 8 CFU/ml in the first day in all treatments but thereafter the control without treatment stabilized at a high count of Log 8 CFU/ml in the third and fifth day (fig. 2). However, *E. coli* O157:H7 died off dramatically in the third and fifth day in all treatments at both 3% and 6% indicating the killing power of these compounds on this important food pathogen. Similar data were obtained for other pathogens.

When 3% dried plum was added to uncooked ground beef, inoculated *Escherichia coli* O157 H7 increased 1 Log CFU/g over five days compared to a greater than 3 log increase with uncooked ground beef without dried plums (fig. 3). This shows the suppression effects of 3% dried plum puree on growth this food pathogen. Similar results were obtained for other pathogens in uncooked ground beef.

The results indicated the killing and suppression effects of various forms and con-

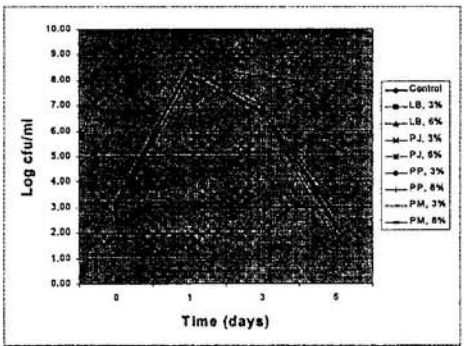

Fig. 2: Effect of dried plum mixtures and contact time on *Escherichia coli* 0157:H7 in liquid medium. The miniaturized procedures were performed for this study using a 96-well microtiter plates, multi-channel pipettor, and multi-point inoculator.

centrations of Dry Plum products on five important foodborne pathogenic bacteria in liquid and solid food systems, thus providing food safety benefits to these products besides their normal food values to the consumers. In a related issue in food science and technology, research work done by Professor Dr. Jim Keeton at Texas A&M University, indicated that dried plum extracts, which contain sorbitol naturally, actually act as a humectant and keep the ground pork sausages moist even after cooking, freezing the cooked products, and re-heating the products before serving to the consumers. This has practical implications as ground sausage when cooked and consumed immediately is moist and juicy. If the product is cooked, then shipped to the food service location, thawed and reheated it becomes hard and unappetising and may be rejected and discarded by consumers, resulting in a waste of valuable food products. In the presence of Dried Plum extract at 3% to 6% levels these pork sausages will remain moist and palatable even after cooking, freezing and reheating and are acceptable to consumers such as in school lunch programs. Thus dried plum extract can be used in many forms of food to help maintain moisture as well as have antimicrobial effects.

The future is bright for a variety of uses of dried plum products in the food industry as a food ingredient which has antimicrobial effects.

Acknowledgements

This research was partially supported by the California Dried Plum Board.

References

Kreuzer, H (2001) Research reveals the power of dried plums. Supplement to Food Product Design. Feb. 2001.

Nakatani N, Kayano S., Kikuzaki H, Sumino K, Katagiri K and T Mitani (2000) Identification, quantitative determination, and oxidative activities of chlorogenic acid isomers in prune (*Prunus domestica* L.). J. Agri. Food Chem. 48 (11): 5512–5516.

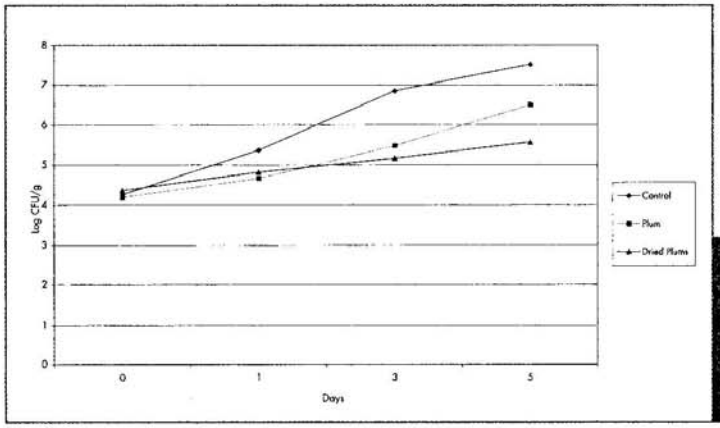

Fig. 3: Effect of 3% dried plum mixtures and contact time on *Escherichia coli* 0157:H7 in uncooked ground beef (20% fat).

BIOGRAPHIES

Professor Daniel Y. C. Fung is an internationally known microbiologist specialising in the field of rapid methods and automation in microbiology. He has published extensively on various aspects of microbiology. He obtained his first degree from the International Christian University, Tokyo, Japan and a PhD in Food Technology from Iowa State University, USA. He currently has both teaching and research roles as Professor of Food Science at Kansas State University, USA and he is University Distinguished Professor at Universitat Autonoma de Barcelona, Barcelona, Spain. Professor Fung is a Fellow of ASM, IFT and IAFoST and he has gained a number of professional awards and international recognition for his work in microbiology.

Dr Leslie K. Thompson is a Senior Scientist at Silliker Inc., Chicago, Illinois, USA.

CONTACT

Dr Daniel Y. C. Fung
Professor of Food Science and Professor of Animal Sciences and Industry
Animal Sciences and Industry
Kansas State University
Manhattan, Kansas
USA
dfung@ksu.edu