Microbial Profile of Raw Spices

Introduction

Many spices are grown in tropical climates where they are subjected to excess heat and humidity and poor sanitary conditions. The producers are usually small farmers who are not fully aware of the need to protect crops from conditions that lead to microorganism growth. There are microorganisms indigenous to the soil, but other sources of contamination include dust and dirt, insects, and fecal materials from birds, rodents and other animals. Therefore, spices commonly harbor large numbers of bacteria and fungi, including organisms that cause spoilage and food born pathogens such as Salmonella. Many studies over the past 30 years report spices with high microbial loads.

Literature Review

A study sponsored by ASTA at the University of Wisconsin (Julseth and Deibal 1974) showed the following levels of microbial contamination in spices (Table 1).

Table 1. Microbial Profile of Raw Spices (count per gram (g) of spice)

	Aerobic Plate Count	Aerobic Mesophilic Sporeformer	Anaerobic Thermophilic Sporeformer	Yeast & Mold Count
Black pepper	$5.5x10^6$ to $5.0x10^7$	$5.5x10^6$ to $5.0x10^7$	$5.0x10^2$ to $3.0x10^5$	$1.0x10^1$ to $1.5x10^5$
Cassia	$1.0x10^3$ to $3.0x10^7$	$1.0x10^3$ to $5.5x10^6$	$1.0x10^1$ to $5.0x10^2$	$1.0x10^1$ to $3.5x10^5$
Celery seed	$7.5x10^4$ to $7.5x10^5$	$7.5x10^4$ to $7.5x10^5$	$1.0x10^1$ to $3.0x10^4$	0 to 9
Ginger	$5.5x10^3$ to $5.5x10^6$	$5.5x10^3$ to $5.5x10^6$	$1.0x10^1$ to $5.5x10^3$	$1.0x10^1$ to $3.0x10^4$
Mace	$5.5x10^3$ to $7.5x10^4$	$5.5x10^3$ to $7.5x10^4$	$1.0x10^1$ to $5.5x10^3$	0 to 9
Mustard seed	$1.0x10^3$ to $7.5x10^5$	$1.0x10^3$ to $3.0x10^4$	$1.0x10^1$ to $5.0x10^2$	0 to 9
Nutmeg	$1.0x10^3$ to	$1.0x10^3$ to $5.5x10^3$	$1.0x10^1$ to $5.5x10^3$	$1.0x10^1$ to

	$3.0x10^4$			$5.0x10^2$
Oregano	$5.5x10^3$ to $1.5x10^5$	$1.0x10^3$ to $7.5x10^4$	$1.0x10^1$ to $5.5x10^3$	$1.0x10^1$ to $5.0x10^3$
Paprika (domestic)	$3.0x10^4$ to $5.5x10^6$	$5.5x10^3$ to $5.5x10^6$	$1.0x10^1$ to $5.5x10^3$	$1.0x10^1$ to $5.0x10^2$
Paprika (imported)	$5.5x10^6$ to $3.0x10^7$	$5.5x10^6$ to $3.0x10^7$	$1.0x10^1$ to $3.0x10^4$	$1.0x10^1$ to $5.0x10^2$
Rosemary	$5.5x10^2$ to $1.5x10^5$	$5.5x10^3$ to $3.0x10^4$	$1.0x10^1$ to $5.5x10^3$	$1.0x10^1$ to $3.0x10^4$

Since 1974, many additional studies have been conducted. Most of these studies indicate that raw spices can be highly contaminated with microorganisms. McKee (1994) conducted an extensive literature review on the microbial contamination of spices and reported the following:

- 1982, South Africa: A study of 36 different spices showed that the microbial contamination was $>10^6$ CFU/g in black pepper, coriander, pimento, paprika, and white pepper. *Salmonella* was found in paprika.[4] CFU/g was found in white pepper and ginger. [7] CFU/g in ground black pepper and a coliform count of $2.0x10^6$ CFU/g in whole white pepper. [1] was detected in black pepper at 35 μg/kg and in white pepper at 22 μg/kg. Aflatoxin B_1 and G_1 were also detected in turmeric (12 μg/kg B_1 and 8 μg/kg G_1) and coriander (8 μg/kg B_1 and 2 μg/kg G_1).

- 1983, Netherlands: A study of 54 different spices showed that 43 of 54 spices were positive for *Clostridium perfringens*. Curry, paprika, white pepper, black pepper, ginger, basil and curcuma were reported to have total aerobic plate counts of $>10^7$ CFU/g. *Enterobacteriaceae* were detected in oregano, tarragon, parsley, basil, and chervil at $>10^3$ CFU/g. *Bacillus cereus* at >10

- 1986, Japan: A study of nine spices showed an aerobic plate count of 4.6x10

- 1986, Australia: A study of 32 spices showed an aerobic plate count of $2.0x10^8$ CFU/g in black pepper. *Clostridium perfringens* levels up to $1x10^3$ CFU/g were detected in black and white peppercorns, broken mace, oregano, cinnamon, turmeric, and ginger. *Salmonella* was isolated from both black and white peppercorns.

- 1987, India: A study of cumin seed and chili pepper showed that the aerobic plate counts were $1x10^8$ CFU/g in cumin seed and $2x10^8$ CFU/g in chili pepper. *Bacillus cereus* and *E. coli* were found in chili pepper.

- 1988, Nigeria: A study of 230 samples of red pepper, black pepper, thyme and curry powder showed total aerobic plate counts up to $1.1x10^8$ per g and high loads of *Bacillus cereus*.

- 1989, USA: A study of black pepper, white pepper, coriander seeds and fennel seeds showed aerobic plate counts of 10^7 CFU/g for black and white peppers and 10^5 CFU/g for coriander and fennel seeds. Black pepper tested positive for *Salmonella*.

- 1991, USA: A study of prepackaged spices in commercial containers was conducted. The study reported an aerobic a plate count of $8.3x10^6$ CFU/g in black pepper and $6.9x10^6$ CFU/g in white pepper. Yeast and mold counts of $4.7x10^3$ CFU/g in black pepper and $9.5x10^4$ CFU/g in white pepper were also reported.

- 1991, Egypt: An examination was conducted for aflatoxigenic molds in 130 samples of spices used in meat products. The most commonly isolated mold was *Aspergillus flavus*. Aflatoxin B

Summary

The high levels of microorganisms in spices reported by these studies suggest a need for better control in all aspects of the production, processing, packaging and storage of spice products to prevent potential food spoilage and food-borne illness due to contaminated spices. Under current practices, micronial reduction processes such as steam, irradiation, and ethylene oxide/propylene oxide are effective procedures for reducing microbial contamination to safe level.

References

1. Julseth RM, Deibel RH. 1974. Microbial Profile of Selected Spices and Herbs at Import. J. of Milk and Food Technol. 37:414-419.

2. McKee LH. 1994. Microbial Contamination of Spices and herbs: A Review. Lebensm.-Wiss. U.-Technol. 28:1-11.

3. Garcia SF, Iracheta GF, Heridia N. 2001. Microbiological Survey of Retail Herbs and Spices from Mexican Markets. J. of Food Protection. 64: 90-103.