Microbial update

herbs & spices

Dr Roy Betts, Head of Microbiology, Campden BRI, Chipping Campden, Gloucestershire, GL55 6LD, UK.
Produced as a service to the food industry by Thermo Fisher Scientific.

Throughout history, herbs and spices have been an integral part of foods and cooking. It is believed that trading in spices was going on in Asia and the Far East over 4000 years ago, and it is accepted that the Ancient Egyptians used herbs in embalming procedures because of their preservation characteristics. Over 3000 years ago medicines derived from herbs were thought to be used in the Far East. In the middle ages, spices became more widely available in Europe as expensive imported commodities only really available to the very rich. In more modern times, herbs and spices have become more widely available to all, and with the increase in consumption of ethnic foods in the western cuisine, most people now eat a considerable variety of herbs and spices as key ingredients within their foods.

With increased consumption, our interest in these products grows and they are of particular interest to the microbiologist. As their early uses show, many have antimicrobial properties, being used as preservatives or medicines. Indeed their widespread early use in Asia and the Far East was probably more to do with their ability to preserve foods than to impart flavour, the latter being a secondary benefit. We still see a great interest in the antimicrobial nature of these ingredients. Each year sees numerous research papers published considering the use of herb and spice oils as 'natural antimicrobials', their abilities to slow and stop the growth of a range of micro-organisms have been well proven. However, we also have to deal with some of the negative aspects of the microbiology of herbs and spices when we use them as food ingredients. They are natural ingredients growing in a natural environment, and the methods and environment of growth, harvest, and distribution give them a natural microflora which could include micro-organisms considered to be human pathogens. We need to be aware of this and take appropriate action to minimise any risks of illness arising from their use.

What are herbs and spices?

A wide variety of plant materials are categorised as herbs or spices. Culinary herbs tend to be considered as the leafy green parts of a plant, they differ from other plants used in foods in that they are used in small amounts to impart a flavour rather than substance to a food. Spices are differentiated from herbs in they are not produced from the green parts of the plant but from other structures such as seeds, fruits, roots or even the bark of a variety of plants.

Micro-organisms of concern

As noted previously, because herbs and spices are produced from natural materials and many may come from distant parts of the world, they will, in their native state, be contaminated with a wide variety of micro-organisms. On occasion, production methods may not be fully hygienically controlled.

Drying of spices can be done in an open environment in the sun, resulting in harvested materials becoming further contaminated as they are open to contact from insects, reptiles and other animals. It should be considered that untreated 'native' herbs and spices could contain high levels of bacteria and fungi, some of which may be considered pathogenic to humans.

Spore formers from the Genera Bacillus and Clostridium, will certainly be able to survive any normal drying process, whilst vegetative enteric pathogens such as salmonella and Escherichia coli must be considered a risk. Numerous studies have considered the contamination levels of herbs and spices. Aerobic Plate Counts (at 30°C) can be greater that 10^6 per gram, with countable levels of B. cereus, C. perfringens, enterobacteriaceae, yeasts and moulds all being noted. Psychotrophic organisms can be found, probably originating from materials harvested from more temperate climates, and the presence of mycotoxins must be considered in materials with a high mould count.

In a report to the UK Advisory Committee on the Microbiological Safety of Foods in 2008, Sagoo et al reported that the salmonella contamination rate of dried herbs and spices could be between 0.6% and 14%, with UK samples being contaminated at a rate of 1%. In more recent surveys conducted in the USA, the FDA sampled 2,844 imported dry spice shipments from 2007 through 2009 and found about 7% contained salmonella, twice the rate of other FDA regulated food products. The agency found the highest prevalence of salmonella in leaf-based seasonings like basil and oregano.

These issues of contamination mean that users of herbs and spices must be particularly careful with their risk assessments.

Any herbs and spices that are to be used in/on ready to eat foods must themselves be ready to eat and contain no pathogenic micro-organisms. If they are to be used in foods that are going to be cooked before eating, then the presence of sporeformers has to be considered, particularly if the cooked food has a long shelf life. Surviving spores may well become spoilage or safety risks within those foods.

Of course most herbs and spices are dried and their stability is dependent on their low water activity. This will ensure that micro-organisms cannot grow. However any viable organisms will survive within the material, potentially for long periods of time. Users must be aware of this; if such dried materials are rehydrated, for example by being added to higher water activity foods, then any micro-organisms could begin to grow, resulting in increased risks of spoilage or of the presence of higher levels of food poisoning organisms. We must also be aware that any organisms present in low water activity environments will become more resistant to a variety of antimicrobial treatments, including heat. As an example a reported heat resistance of salmonella contained in a microbiological broth (with a water activity of about 0.99) at 62°C would mean it would take 24 seconds to reduce the number of organisms by a factor of 10 (a one log

Continued on page 11

Continued from page 9
reduction). A similar organism contained in a wheat flour at a water activity of 0.5 take 100 minutes at 62°C to get a similar one log reduction, whilst at a water activity of 0.4 it would take 876 minutes to get a similar reduction in numbers. Food producers have to be aware that whilst dried herbs and spices are microbiologically very stable products, they could contain a hidden microbiological flora, that is also very stable.

Issues and outbreaks

A number of outbreaks of food poisoning have been attributed to herbs and spices by a number of authors. In a review published in 2013, Van Doren et al considered foodborne illness outbreaks occurring between 1973 and 2010. They identified 14 illness outbreaks attributed to the consumption of contaminated spices during this period.

These outbreaks were reported by countries including Canada, Denmark, England and Wales, France, Germany, New Zealand, Norway, Serbia, and the United States. Together, they resulted in 1946 reported human illnesses, 128 hospitalisations and two deaths. These authors reported that salmonella was identified as the causative agent in 71% (10/14) of outbreaks, accounting for 87% of reported illnesses. Bacillus spp. were identified as the causative agent in 29% (4/14) of outbreaks, accounting for 13% of illnesses.

Interestingly these authors also estimated that 70% of illnesses could be attributed to foods in which spices had been added to the food after the final microbial reduction step had been applied, highlighting the risks associated with contaminated herbs and spices.

Looking particularly at the USA, the US Food and Drug Administration considered food poisoning outbreaks occurring in the USA between 1973 and 2010. They identified 14 outbreaks that involved spices, these causing around 2000 individual illnesses.

Ten of the outbreaks noted by the FDA involved Salmonella enterica subtypes. Pepper spices – black, white, red, and unspecified – were implicated in nine of the outbreaks. Most of the spices they identified were imported.

Food producers must be constantly vigilant to new risks associated with all ingredients including herbs and spices. There appears to be a recent increase in interest in the production of flavoured oils. These may contain a range of herbs or spices and are often seen as a premium product.

One potential risk posed by such products is their potential to allow the growth of C. botulinum. This organism is an anaerobe and will not grow well in the presence of oxygen. However under anaerobic conditions, for example in oils, growth can occur and then there is the potential for the organism to produce a neurotoxin that could have very serious health implications.

Any food producer considering production of herb or spice flavoured oils, particularly if fresh herbs/spices are used, must be aware of the risks of C. botulinum growth in such products and take appropriate action to control and eliminate that risk.

Processing

The widespread acceptance of the potential for herbs and spices to be contaminated with human pathogens makes the processing of such ingredients a very important consideration for the industry. Processing can reduce or eliminate the presence of pathogens if applied correctly; however, it does pose some problems. Fresh leafy herbs can be difficult to process. Any form of heat processing could destroy the properties of fresh herbs and washing may be the only form of 'process' that can be applied.

Washing is routinely used on ready-to-eat salad produce. It can, if correctly applied, reduce the level of micro-organisms on such materials, it cannot be guaranteed to remove pathogens, however it will help improve the microbiological quality of these products. Drying also cannot be guaranteed to remove pathogens, it can prevent growth but may allow survival. A number of years ago dried spices were treated with gaseous ethylene oxide. This had a surface sterilising effect and was effective at reducing micro-organisms on spices. The ability to use ethylene oxide varies country by country, in some locations it is illegal to utilise this gas and local legislation must be consulted before considering its use.

Heat processing can be difficult to use due to the increased heat resistance of micro-organisms in dried materials. Even very high temperature may not be sufficient to guarantee elimination of organisms. However, in recent years a number of equipment manufacturers have developed systems that allow a mild steam treatment of dried materials, before removing the moisture and redrying the material. This procedure applies heat to a partially 'wet' product. This is much more effective at killing organisms and has the potential of considerably reducing microbial numbers whilst maintaining the sensory properties and providing a dry end product.

Large scale commercial producers of dried herbs and spices have done considerable research in order to develop production methods that ensure that their products have low levels of contamination, and a negligible risk of pathogen contamination.

Test methods

Microbiological criteria are often applied to herbs and spices. Laboratories testing these ingredients face two major issues. The first is that they are often in powder or dehydrated form. This means that a particular weight of sample contains a large amount of material. This can result in a standard one in 10 dilution becoming more of a slurry than a suspension, and thus difficult for laboratories to handle effectively. The second issue is their antimicrobial nature. As noted earlier, many herbs and spices have a potent antimicrobial effect and their addition to microbiological diluents and enrichment broths may inhibit the growth of, or kill contaminating organisms. This could mean that the presence of key contaminating organisms could be underestimated if routine or standard methods are used. There are various suggested ways to minimise such problems.

The first thing that a laboratory should do before testing herbs and spices is to check that the methods they intend to use can cope with these materials. Various standard or reference methods can suggest specific preparation methods to be used when testing herbs and spices. These methods are usually intended to attempt to overcome the issue of their antimicrobial nature, giving a greater chance of accurately assessing numbers of critical micro-organisms in such samples. Users of rapid methods should consult the kit insert or contact the method manufacturer to check that the sample preparation procedure is optimised for herb and spice samples and, if validated, that the method validation actually includes herbs and spices in the scope of the validation.

Conclusions

Herbs and spices have been used in foods for millennia. Originally, it is possible that one of the main reasons was to use their antimicrobial properties to help preserve the food, but it is certain that their characteristics soon made their inclusion in foods for reasons of flavour.

They were one of the first 'food' commodities used in worldwide trade, due to their high value. Today they are still major food ingredients used the world over.

Due to their methods of production, they are often contaminated with a wide variety of micro-organisms, some may be considered human pathogens. The users of herbs and spices tend to understand this potential problem and do their risk assessments with great care.

We can see that herbs and spices have been recorded as the cause of a number of outbreaks of food poisoning however, considering the amount of foods that contain herbs and spices, the number of recorded outbreaks is small.

It could be argued that this is because of the very small amounts of these ingredients that are used in a food, but it is also very likely that most food manufacturers understand the risks and source their herbs and spices from known high quality sources, who ensure that suitable interventions are used to render herbs and spices safe. ■

✉ food.testing.admin@thermofisher.com

References are available from the author on request