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Review

New trends in emerging pathogens

Niels Skovgaard

University of Copenhagen, Department of Food Science, Food Microbiology, Rolighedsvej 30, 1958 Frederiksberg C, Denmark

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Abstract

The emergence of pathogens is the result of a number of impact in all parts of the food chain.

The emerging technologies in food production explain how new pathogens can establish themselves in the food chain and compromise food safety. The impact of the food technology is analysed for several bacteria, such as *Yersinia*, *Campylobacter*, *Arcobacter*, *Helicobacter pullorum*, *Enterobacter sakazakii*, *Mycobacterium avium* spp. *paratuberculosis*, prions related to vCJD and others. The importance of the ability of many microbes to form VBNC forms is elaborated on. Research on culture independent methods may address this outstanding issue to the better understanding of emerging pathogens. The "demerging" of pathogens also occur, and examples of this are explained.

The reaction of bacteria to stresses and sublethal treatments, and how exposure to one stress factor can confer resistance to other stresses, literally speaking causing contagious resistance, are explained. The implication of this e.g. in modern approaches of food preservation, such as Minimally processed Foods, is considerable. Intestinal colonization of EHEC may be regulated by Quorum sensing, and this ability of microbes plays an important role in the colonization of microbes in food and on food processing equipment, an important factor in the emergence of pathogens.

The emergence of *Saccharomyces cerevisiae*, as an opportunistic human pathogen, used for centuries for food and production of alcoholic beverages, calls for research in molecular tools to distinguish between probiotic and clinical strains.

Cyclospora cayetanensis and *Norovirus* outbreaks can no longer be designated as emerging pathogens, they share however one characteristic in the epidemiology of emerging nature, the importance of the hygiene in the primary production stage, including supply of potable water, and the application of GMP and the HACCP principles in the beginning of the food chain.

Hepatitis E virus is a potential emerging food borne pathogen and swine may serve as a source of infection in human, a most challenging issue in greater part of the world raising pigs. *Tick-borne encephalitis virus* infection, either thick borne or caused by consumption of raw milk, is an increasing trend in the industrialized part of the world.

Consumer awareness, ethics of food, sustainability in food production, and trust in foods, are of growing importance to the consumer. The reaction of the consumer to new technology, such as nanotechnology, is unpredictable. Many efforts should be devoted to communication of non-biased information to both the food producers as well as the consumer.

Keywords: Farm-to-fork; "Demerging" pathogens; Stress response; Quorum sensing; Consumer awareness; Communication

Contents

E-mail address: niels-skovgaard@mail.tele.dk.

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1. Introduction

When analysing new trends in emerging pathogens it is important to apply a holistic viewpoint. The emergence of a new pathogens is a multiple factorial event involving in most cases impacts from all parts of the somewhat commonplace used concept farm to fork. Most of the so called emerging pathogens have been about for a long time but favoured by changes in environmental factors and abilities to modify their activities according to external influences, they provide a history of success for the microbe on the expense of food safety and mankind.

The emergence of a pathogen is in some cases easily explained by the simple fact that cultivation technique for their detection was not available. This was the case in the past but is equally relevant today. The answer to this challenge is important to improve the detection methods based upon molecular biology and culture independent methods. However the origin of most of the food borne diseases which has emerged over the last half century can be explained by analysing the elements of the food chain particular for the organism in question. This involves farming practices, animal husbandry, horticulture, transportation for further processing, changes in food technology, pattern of distribution, eating habits, and much more, as shall be described in this article.

2. Past and present picture and trends to be learned

At the beginning of the 1950s, only half a century ago, the main pathogens of concern transmitted through food, were *Salmonella*, *Staphylococcus aureus*, and *Clostridium perfringens*. *Bacillus cereus* was shortly after added to the list.

Yersinia enterocolitica came about in the mid 1960s and flourished in importance the following decades. It is of great interest to notice the factors which favoured the emergence of yersiniosis, since a number of similar multi-factorial influences on microbial communities in the very moment you read the present text are in full progress, along the food chain, to develop new microbes with the scope to challenge food safety. An important property of *Yersinia* is its ability to multiply at temperatures close to 0 °C. The flourish of the bacterium followed as a matter of fact, the development of the chilling chain both in retail handling of food as well as in households, hence the nickname “the bacterium which came in from the cold”. Other changes in food technology at the same time, foremost the application of vacuum packaging which made long keeping times for food kept at refrigeration temperatures possible, also supported the bacterium. The minimum infection dose of *Yersinia* is high, at least to be measured in hundred thousands or more. The new technologies mentioned favoured the growth of the bacterium to high levels, in many cases due to unrealistic long keeping times.

Also changes in livestock farming and industrialization of slaughtering of pigs played an important role. Transportation of live animals for slaughtering has in some studies been proved to be an important factor in dissemination of the bacterium from farm to farm (Nesbakken, 1992). In the overall picture of the dissemination of the bacterium and its disease in man also globalisation may have played a role. It has thus been maintained that import of chinchillas from Canada to Europe might have played a role. The current interest of the *Y. enterocolitica* started as a matter of fact in 1958 following a number of epizootics in chinchillas in Belgium imported from Canada (Mollaret et al., 1979).

The title of the article is emerging pathogens, but it might just as well be of interest to look into what one might call “demerging” *pathogens*, or vanishing pathogens. *Yersinia* is a good example of this, at least in Denmark. It was some twenty years ago the most important pathogen of concern, surpassing *Salmonella*, which tricked extensive research involving drastic changes in the technology of pig slaughtering in close corporation with the SMEs involved. Food safety management systems were at that time not well developed and the present trend to involve the SMEs in this is a very important activity.

Aeromonas spp. is another example of a “demerging” pathogen. It was some decades ago the pathogenic fashion research bacteria. Its importance as a food and water borne pathogen is very inconclusive and food and water borne outbreaks have not been definitely proven. It might uttermost be characterised as an opportunistic pathogen, but even this may be questioned. The isolation of the bacteria from cases of enteritis in developing countries is well documented but it might as well be a secondary invader of underlying diseases caused by virus e.g. rotavirus. It is ubiquitously present in the environment including water, and subsequently also prevalent in most raw foods, meat, milk, fish, fresh produce in which it is part of the normal psychrophilic spoilage microflora. It is quite often present in drinking water, ice cream, etc. If the bacteria had pathogenic abilities to any severe extent one would expect a high number of cases of disease in humans considering it is extremely common in food and water. The former applied phenotypic characterisation in 10 species has been bewildering and substituted by genotyping in at least 14 types (Sutherland and Varnam, 2000). The extensive research, e.g. on the