STAPHYLOCOCCI IN FOOD

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The staphylococci are natural inhabitants of human or animal bodies, air, water, milk, and sewage. There bacteria are important as pathogens and as food-poisoning agents. As pathogens, they enter the body through breaks, cuts, and abrasions in the skin and are responsible for many suppurative processes ranging from boils, pimples, inflammations, carbuncles, and abscesses on the lung and brain. Although staphylocci are pathogens, they cannot cause an infection in the intestinal tract. Every tissue and every organ is susceptible to invasion by these bacteria. However, with the exception of one species, the disease is sporadic, not epidemic.

The most common occurring true food poisoning is caused by the ingestion of a toxin formed in food during growth of certain strains of Staphylococcus aureus. The toxin is termed an enterotoxin because it causes gastroenteritis or inflammation of the lining of the stomach and intestines. The sources from which the food-poisoning staphylocci enter foods are, for the most part, animal or human. The nasal passages of many persons are laden with these organisms which are a common cause of sinus infections. Also, boils and infected wounds may be sources. The human skin apparently is a source of these bacteria only when they have come from nasal passages or local infections. Ordinarily, air is a relatively unimportant source of the cocci, except when they are being introduced there from human sources.

RESISTANCE OF THE ORGANISM

Staphylocci are among the most resistant of nonsporeforming bacteria. Some are able to withstand heating up to 140°F. for half an hour. Staphylocci have remained alive under refrigeration temperatures for several months. At one time, most types of staphylocci were sensitive to penecillin, but with its increased use, the occurrence of resistant strains has become quite common.
EXOTOXINS

There are four distinct toxins that are produced by the staphylococcus. These are able to rupture red blood cells in the human body. Some of the toxins are able to kill white blood cells. This toxin is not to be confused with the enterotoxin that causes food poisoning. This enterotoxin does not correspond to the exotoxin and will be discussed in the preceding section.

ENTEROTOXIN

Staphylococci (Staphylococcus aureus), under certain conditions, are able to liberate a soluble toxin in the food before the food is eaten. However, appreciable levels of enterotoxin are produced only after considerable growth of the organism has occurred. It usually takes a plate count of at least several million per milliliter (ml) or gram (g) before the consumer of the ingested food will exhibit the particular symptoms. It should be remembered that the conditions that favor the toxin production are those best for optimum growth of staphylococcus. It has been reported that toxin is produced at an appreciable rate at temperatures between 60 and 115°F. Under ideal conditions, the toxin may be detected within 4 to 6 hours after growth of the organism. The lower the temperature during growth, the longer it will take to produce enough enterotoxin to cause poisoning. Enterotoxin has been demonstrated in a good culture in 3 days at 64°F. but not in

A) 3 days at 59°F.
B) 7 days at 48°F.
C) 4 weeks at 39-44°F.

It has been observed that production of the enterotoxin by the staphylococci is more likely when competing microorganisms are absent or are few in number, or their growth is inhibited for some reason. Therefore, a food that has been contaminated with the staphylococci after a heat process would be favorable for toxin production. The type of food has been shown to influence the amount of enterotoxin produced - little toxin production has been observed in canned salmon while bakery and meat products usually contain large amounts of the toxin if the bacteria are allowed to grow.

HEAT RESISTANCE OF THE ENTEROTOXIN

An important characteristic of the enterotoxin is its stability toward heat. It has been shown that the toxin is able to withstand boiling (212°F.) for 20 to 60 minutes and even survive treatment in the retort. However, the toxin gradually looses its potency when boiled or heated in the retort. Unfortunately, the cooking usually given most foods will not destroy the toxin that was formed before the heat was applied. It is possible that some foods might cause poisoning even though they contain no living staphylococci.
INCIDENCE OF THE DISEASE

There are no reliable figures on the number of cases of staphylococcus poisoning. The poisoning is usually not reported unless the outbreak is relatively large as at a picnic or convention.

FOODS INVOLVED

The foods that have been involved in the largest number of cases are:

A) Custard and cream filled bakery goods
B) Hams
C) Poultry

Other foods that have been involved to a lesser degree are:

A) Meat and meat products
B) Fish and fish products
C) Milk and milk products
D) Cream sauces
E) Custards
F) Pies
G) Salad dressings

Growth and toxin production by staphylococci may take place in steam tables in faceterias and restaurants and in food-vending machines that keep foods heated for extended periods.

DETECTION OF ENTEROTOXIN IN FOODS

The presence of enterotoxin in food cannot be detected since it does not impart an odor which is usually associated with spoilage and there is no alteration in the normal taste of the food.

THE DISEASE

Individuals differ in the susceptibility to staphylococcus poisoning, so that in a group of people eating food containing toxin some may become ill and a few fortunate people will be little affected, if at all. Because most animals are not susceptible (humans and monkeys are the only animals usually affected by the disease), it is difficult to test for the toxin without human volunteers.

The time between consumption of the food and appearance of the first symptom for staphylococcus poisoning is usually 2 to 3 hours. However, the time may vary from 1 to 6 hours. This food poison differs with other food poisons and infections in that it takes less time for the toxin to affect the individual.
The most common symptoms are nausea, vomiting, abdominal cramps, and diarrhea. Blood and mucus may be found in stools and vomiting in severa cases. Headaches, cramps, sweating, and chills may also occur. These disorders are usually brief, lasting only 1 or 2 days. Mortality is extremely low, less than 1%. For the most part, no treatment is given.

CONDITIONS NECESSARY FOR AN OUTBREAK

The following conditions are necessary for an outbreak of staphylococcus food poisoning:

A) The food must contain enterotoxin-producing staphylococci
B) The food must be a good culture medium for growth and toxin production by staphylococci
C) The temperature must be favorable to growth of the staphylococci and enough time must be allowed for production of enterotoxin
D) The enterotoxin must be ingested

PREVENTION OF OUTBreaks

The means of prevention of outbreaks of staphylococcus food poisoning include:

A) Prevention of contamination of the food with the staphylococci.

Prevention is accomplished by:

1) general methods of sanitation
2) use of ingredients free of staphylococci
3) keeping employees away from foods when these workers have staphylococcal infections in the forms of colds (caused by coughing and sneezing on the food), boils, carbuncles, sinus infections, and cuts on the hands and arms.

B) Prevention of the growth of the staphylococci

1) use of adequate refrigeration. The lower the temperature the safer the food. Food held below 45°F. is usually safe.
2) addition of bacteriostatic substances

C) Killing staphylococci in foods

1) foods may be pasteurized to kill the staphylococci before the toxin is produced

COAGULASE POSITIVE STAPHYLOCOCCUS

In the course of this paper, it was mentioned that the presence of staphylococci enterotoxin is difficult to detect for three reasons:
A) Of all the staphylococci organisms, only certain varieties of *Staphylococcus aureus* are able to produce the disease.

B) The toxin does not impart an off-odor or taste to the food.

C) Most animals can ingest food containing the enterotoxin and not get sick. Only man and monkey is highly susceptible to the toxin.

You may now ask the logical question that if the enterotoxin cannot be detected by our senses or by feeding the suspected food to laboratory animals or that all varieties of staphylococci are not capable of producing the enterotoxin, is there any test that can be performed to prevent us from possible food poisoning? Fortunately, there is one test that can be utilized to determine if the staphylococci present is one that does produce the enterotoxin and hence be a potential cause of food poisoning. Those staphylococci that do produce the protein enterotoxin also produce another protein called coagulase. Coagulase derives its name from the fact that it will coagulate or clot blood.

Public health officials of the FDA or various state health departments will examine food for the presence of staphylococcus organisms capable of producing the enterotoxin. If the food was found to contain coagulase positive organisms, the total number of the organisms in the food will be considered. If the organism count is excessive, the food will then be seized. If the count is low, then a letter from the health department will usually be sent to the food processor stating that although the food could not legally be seized for the presence of coagulase positive staphylococcus, they question the food's safety.

Although a food may not have exceeded the minimum staphylococci count, the processor may now realize why the presence of this bacteria was brought to his attention. As previously discussed in this paper, a food containing staphylococcus may be sent to a cafeteria or restaurant where they do not heat the food item sufficient to destroy the staphylococci organisms and the food after preparation may be subsequently placed in a steam table where the food will be kept warm and ready for serving allowing conditions for the bacteria to multiply and produce the enterotoxin which may lead to illness if ingested. It may also happen that the product will not be properly refrigerated by food wholesalers, retailers, and consumers and the bacteria may again multiply and produce toxin. Since the toxin is very stable to heat, it may survive the cooking process and cause illness after ingestion of the contaminated food item.
