

# The Microbiology of Salt Rising Bread

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## Abstract

Salt rising bread (SRB) is an Appalachian traditional bread made without yeast, using a starter derived from flour, milk and potatoes. The “rising agent” has been identified as *Clostridium perfringens*, not salt, and is presumably derived from the environment. Although no cases of illness have been attributed to SRB, *C. perfringens* type A is a common cause of food poisoning from meats and gravies. Other *C. perfringens* isolates may cause enteritis necroticans (pig-bel disease) and gas gangrene. Past research documents that pathogenic strains derived from wounds may be used to produce bread and that bacteria isolated from this bread retain their pathogenicity. SRB starter samples were cultured at the University of Pittsburgh and abundant *C. perfringens*, type A grew out of all samples. However none of the cultures were positive for enterotoxin and thus would be unlikely to cause human food borne disease. While this does not preclude the possibility of other starter mixes containing enteropathogenic strains, the baking process appears to reduce bacterial contamination to safe levels and SRB has not been implicated in causing any human disease.

## Introduction

The baking of salt rising bread (SRB) is a long-standing Appalachian tradition that may have originated when pioneer women, lacking yeast, discovered that an alternative “rising agent” is spontaneously created when a mixture of flour and milk is kept overnight in a very warm (38-45°C) location. This yeast-less bread uses a starter of

corn or wheat flour, milk and (often) potatoes. Despite its name, salt is not an essential ingredient and not all starters generate the necessary bacteria for success. However when the “rising” or starter works, this bread is characterized by a distinctive cheese-like taste and odor with a dense white “crumb” or structure. SRB keeps well and can be enjoyed either plain or toasted. Although less popular today due to its extensive preparation time, SRB still survives as primary fare in rural settings and as a specialty or artisan bread in more urban environments.

For many years the identity of the rising agent was a mystery. In 1898, Wiley et al. noted “*Bacillus levens*” had been isolated from salt rising dough. (1) Heineman isolated a lactic acid forming bacteria similar to *Bacillus bulgaricus* from cornmeal in 1909. (2) Then in 1912, Kohman concluded that a spore-forming anaerobic bacteria, rather than a yeast, was the responsible leavening agent. (3,4) In the 1920s, Koser identified *Bacillus welchii* (now known to us as *Clostridium perfringens*) in the SRB starter as well as in the interior of SRB loaves. Koser then made SRB from a culture of these bacteria and, in what was perhaps the most macabre experiment in culinary history, successfully created bread from *B. welchii* derived from an infected wound. When the virulence of these bacteria was tested in guinea pigs, only the wound-derived bacteria proved fatal. (5) Subsequent research in 1949 confirmed that Kohman’s 1912 starter did indeed contain *Clostridium perfringens* (*welchii*). (6)

More recently, in 2002, various SRB starters from authors Brown and Bardwell were cultured at the Univ. of Pittsburgh and *C. perfringens* grew out of all the starter samples. A few colonies also grew

from the baked bread indicating that some bacteria do survive, most likely as spores. PCR testing was positive for the alpha toxin gene but negative for the beta, epsilon or iota toxin genes, confirming the identity of these colonies as *C. perfringens*, type A. PCR testing for the enterotoxin gene, however, was negative for all colonies, indicating that these *C. perfringens* were a non-enteropathogenic strain (unable to cause *C. perfringens* type A food poisoning). Of course, this sampling never excluded the very real possibility that other batches of starter could not involve enterotoxin positive *C. perfringens*. (7)

The presence of a known food borne pathogen as a leavening agent for bread raises some obvious concerns—even though most of the bacteria are killed or sporulate during the baking process. *C. perfringens* is an anaerobic gram positive, spore-forming rod common in the soil and in the intestines of both humans and animals. Enterotoxigenic type A isolates are a very common cause of food-related illness characterized by cramping and diarrhea 8-22 hours post ingestion and usually resolving within 24 hours, except in the elderly and immunocompromised, where they can cause more significant morbidity or even death. (8) *C. perfringens* is usually a food-borne infection with only one episode being ascribed to pre-formed toxin. (8) The CDC estimates that well over 10,000 cases occur annually in the U.S. with 10-20 documented outbreaks occurring annually for the past 2 decades. Most cases go undiagnosed but diagnosis can be confirmed by finding *C. perfringens* enterotoxin in the feces of victims. (8)

The much rarer type C isolates of *C. perfringens* cause a potentially fatal condition called enteritis necroticans or pig-bel disease. Epidemics of

type C illness involving intestinal necrosis and death have been described in post war Germany and in developing countries such as Papua New Guinea. Today, however, pig-bel is quite rare in the developed world.<sup>(8,9)</sup> *Clostridium perfringens* is also capable of infecting wounds, resulting in cellulitis, gas gangrene, sepsis and death. <sup>(10)</sup>

Fortunately, there are no reported cases of illness or death reported from SRB consumption in the literature. However since each starter presumably obtains its bacteria from the environment, there is always the potential for enteropathogenic strains to appear. It is also very possible that sporadic non-fatal outbreaks of diarrheal disease could either escape detection or be attributed to other factors like viral gastroenteritis. Should SRB be viewed as the Appalachian equivalent of fugu, the poison-laden pufferfish of Japanese gourmards? There appear to be reasons to hope otherwise. First, no enteropathogenic strains have been found in the starters tested thus far. Most strains

do not produce the enterotoxin necessary to cause the common human foodborne disease. Even if they did, *C. perfringens* enterotoxin is inactivated at temperatures above 175°F and the temperature of baking bread is usually over 220°F. (Most *C. perfringens* type A food poisoning outbreaks have been associated with the mishandling and partial reheating of infected meat products and gravy.) Finally, the infective dose for this condition is > 10 (5) vegetative cells per gram of food and most bacteria in bread would be destroyed by baking. <sup>(9)</sup>

Thus it seems reasonable to continue the consumption of this delicious old fashioned bread with a long and apparently safe culinary history. More adventurous readers may be interested in trying several SRB recipes available on the internet.<sup>11</sup> The authors, of course, disavow all responsibility for any attendant health risks!

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