Sushi rice acidification

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<th>Fraser Health Authority</th>
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<td>Date of request:</td>
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<td>Issue (brief description):</td>
<td>Current guidance for sushi white rice is to acidify below pH 4.6, and to refrigerate acidified brown rice. Should pH be lowered to control for pH paper and why is refrigeration needed for brown rice?</td>
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Summary of search information:

1. Internet sources: general search for sushi HACCP plans of government sites
3. Contacted Drs. O. Peter Snyder, Jr. and K.R. Schneider via e-mail for further clarification and advice.

Background information:

When reviewing the available information about sushi HACCP plans from on-line sources, an Environmental Health Officer (EHO) noticed that some jurisdictions in the U.S. request operators to acidify sushi rice to a pH of 4.0 to 4.4, a value much more stringent than the normal pH barrier quoted to render foods non-potentially hazardous, which is a pH value of 4.6. The rationales in these jurisdictions was this was a control for the inherent inaccuracies of pH paper1-3 as pH paper is only accurate to a value of ± 0.2 to 0.3 log units. To allow room temperature storage of the rice, therefore, the recommendation was that the pH must read below the possible inaccuracy of the pH strip paper.

Other concerns raised included a rationale for the different behaviour of brown rice, and a review of the bacterial hazards associated with sushi rice, specifically research that indicates bacterial hazards are tolerant to acidic conditions.

What are the risks associated with sushi rice

The principal hazards associated with room temperature storage of cooked rice include Bacillus cereus and Staphylococcus aureus bacterial growth and toxin production. B. cereus is a ubiquitous soil bacterium commonly associated with grain products and any foods grown in soil.4 S. aureus is principally a concern with extensively handled foods from food handlers carrying this bacterium. Healthy people can carry S. aureus in their nasal cavity, estimated at 20 to 50% of the population.5
If food handling practices are poor, contamination of food left unrefrigerated may lead to growth and production of toxin. Both *B. cereus* and *S. aureus* can produce heat-stable toxins in sushi rice that has not been adequately acidified. It is important to point out that once toxins are formed, further heating will not inactivate them.

A literature search for outbreaks and illnesses associated with sushi revealed issues associated with (1) poor hygiene and handling, (2) with contaminated ingredients other than the rice, and (3) with rice. Poor hygiene and worker handling was linked to an outbreak of norovirus involving prosciutto wrapped sushi in New Zealand; to enterotoxigenic *E. coli* in sushi restaurants in Nevada; and to Hepatitis A in a revolving sushi bar in Japan, although it is not known whether this was linked to a food handler.

Salmonella illnesses associated with contaminated ingredients include a large outbreak in over 28 U.S. states affecting 425 people with *S. Bareilly* and *S. Nchanga* caused by imported tuna scrape from India and contaminated mayonnaise in sushi rolls made with raw shell eggs in Australia. Fish and shellfish used in sushi foods can be contaminated with *Bacillus cereus*, *Campylobacter*, *Clostridium perfringens* and parasites. *Bacillus* spp. have been found in surveys of take-away cooked ready-to-eat rice, and are the principal hazard of concern in (un-acidified) rice cake manufacture. *Staphylococcus aureus* contaminated rice products have caused many illnesses in Japan and Korea. Unfortunately, we could find no outbreaks of sushi that reported on the pH of the rice.

Clearly, sushi is a potentially hazardous food, and contamination of sushi can occur from poor handling and contact with other contaminated ingredients used to make sushi. Sushi, once assembled, must be either served or held refrigerated as a ready-to-eat food. Sanitary handling and care to avoid cross-contamination of cooked rice with raw ingredients prior to sushi assembly will limit the possibility of pathogens contaminating cooked sushi rice. Proper acidification of the cooked rice is a critical step to ensure that this ingredient can be safely held at room temperature during sushi making. What is the minimum pH to limit conditions for pathogen growth? According to one FDA source, *B. cereus* can be controlled at a minimum pH of 4.3, *S. aureus* and *E. coli* at a minimum pH of 4.0, and *Salmonella* requiring a pH of 3.7.

**Previous guidance on sushi rice from British Columbia**

BCCDC guidance for operators making sushi rice is summarized in a food safety note that recommends (1) to acidify white rice to a pH of ≤ 4.6; (2) to make sushi rice fresh daily, and discard at the end of the day (acidification allows for room temperature storage); and (3) to refrigerate brown sushi rice regardless of acidification.

**Previous guidance on sushi rice from elsewhere**

**Brown rice acidification and refrigeration.** This latter recommendation, to acidify brown rice, was based on a document from 2004, *Guidance for Processing Sushi in Retail Operations* by AFDO, which stated “Brown Rice. Typically this rice is not acidified since the harder surface coating on the brown rice is difficult to penetrate with typical acid solutions. In the non-acidified condition, cooked rice is considered

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a potentially hazardous food...”. This document appears to be quoted in many on-line sources that recommend brown rice be refrigerated.

We investigated the literature to review this belief, including contacting the author of this statement. There is no peer-reviewed research that suggests brown rice is more resistant to acidification than white rice. The source of this information was based on an operator application that found their process of acidification was inconsistent, therefore to control for the hazard, they chose to supplement with an additional barrier of refrigeration. In the U.S., variances for foods are submitted to outline the process to allow for room temperature storage, termed non-TCS, or non-Time/Temperature controlled for Safety Food. In subsequent variances received by our source (Dr. K.R. Schneider), operators also chose to acidify to a pH of less than 4.2 to ensure an adequate acidification barrier. In one unpublished report from 2009, Dr. O. Peter Snyder Jr., who is a process authority in the U.S., validated acidification of multi-grain and brown sushi rice, and reported “this experiment has shown that multi-grain rice and brown rice can be treated in the same way as white rice for the production of sushi. The pH equilibrium of the rice is not significantly affected by the protein in the rice, and the cooked multi-grain rice and brown rice are very stable products that can be stored at room temperature with no hazard.”

**Sushi rice acidification.** Neither *Bacillus cereus* nor *Staphylococcus aureus* are particularly acid-tolerant organisms. One experiment found acetic acid (vinegar) inhibited growth of *S. aureus* at a pH of 4.5, and another experiment found that acid-tolerant *S. aureus* strains would not survive in a variety of foods stored at room temperature at a pH of 4. Similarly, *B. cereus* vegetative cells rapidly decrease when exposed to a pH of 4.2 in simulated gastric fluids, and were unable to grow at pH of <4.5 in carrot juice. Specific peer-reviewed literature for rice acidification and microbial tolerance was not found. One study that assessed Seattle area restaurant sushi found pH in rice samples were all below 4.6, and although *B. cereus* and *S. aureus* were detected in some samples, counts were less than 100 CFU/g. In an unpublished survey of pH tests on sushi rice conducted between 1997 and 2002 at BCCDC, the median pH of sushi rice found in 53 samples was 4.3. Of these, four samples exceeded a pH of 4.6, and 22 exceeded a pH value of ≥4.4. A more recent review in Burnaby, BC found a median pH of 4.1 in 30 samples of sushi rice, with 100% compliance with acidification below pH 4.6. This appears to be an improvement in practice and compliance.

The standard practice for most sushi recipe HACCP documents (of U.S. sources) is to acidify sushi rice to a pH that is less than 4.2 to control for a few strains of *B. cereus* that begin growing at this condition, in addition to acid tolerant *Salmonella* and *Listeria* (pers. comm. Dr. Snyder).

**pH paper and operator verification of acidification.** Commercial suppliers of pH paper provide wide range paper (read between pH 0 to pH 14) and narrow range paper (for e.g., pH 0 to pH 6 or pH 2.9 to pH 5.2). Increments, depending on the paper chosen vary between 0.3 to 1.0 pH units. No matter what type of pH paper is chosen, pH paper is not an accurate tool, at best it will vary between 0.2 to 0.3 units. pH paper may provide a quick spot check, and is suitable to verify an existing process. However, it

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should not be relied upon to validate a process or recipe. pH meters with an accuracy of ±0.01 pH units are recommended to validate a sushi rice recipe.

Recommendations from BCCDC:

As there are many hazards of concern with sushi-based products, and as the most recent survey of BC sushi restaurants suggests that compliance with achieving a sushi rice pH of below 4.2 is achievable, we believe that increasing the hurdle by lowering the pH requirement is supportable. This would also align our approach with U.S. sushi processing and guidance. Based on the above information, BCCDC recommends the following:

1. All sushi rice varieties, white rice, brown rice and multi-grain rice may be managed in the same way, as there is no evidence to suggest acid penetration varies between types;

2. Acidification of rice should achieve a pH of less than 4.2 to control for hazards to allow for room temperature storage. This represents 4X more acidic conditions. Acidified sushi rice should be made fresh daily (no leftovers).

3. All operators should validate their recipe for making sushi rice. This would include providing a result with a method capable of accuracy to 0.01 log units (i.e. with a pH meter). Daily verification of the recipe may be conducted using pH paper.

4. BCCDC should review this recommendation with Food Safety managers.

5. BCCDC should update the sushi safety note and other educational documentation accordingly.

6. We recommend that a BCIT student project could verify the work done in 2009 by Dr. Snyder, and ensure there is no variation between white rice and brown rice. A future project could repeat the survey of sushi rice acidity in restaurants to assess compliance if the recommendation to lower pH requirements is accepted.
References


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22. Schneider KR (University of Florida). Guidance for processing sushi in retail operations. Personal communication with: Pablo RomeroBarrios (Senior Scientist with the Environmental Health Services Division at the BC Centre for Disease Control), 2016 Jan.


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