Chapter 19: *Staphylococcus aureus*

Updated:

Potential Food Safety Hazard

Top

Staphylococcus aureus is highly vulnerable to destruction by heat treatment and nearly all sanitizing agents. Thus, the presence of this bacterium or its enterotoxins in processed foods or on food processing equipment is generally an indication of poor sanitation. *S. aureus* can cause severe food poisoning. It has been identified as the causative agent in many food poisoning

outbreaks and is probably responsible for even more cases in individuals and family groups than the records show (Bennett and Lancette, 1998).

Control Measures

Top

Hazards from *S. aureus* can be controlled by: minimizing time/temperature abuse of seafood, especially after cooking, and requiring that food handlers engage in proper hygiene (Ward et al., 1997).

Guidelines

Top

FDA Guidelines

Top

FDA guidelines for *S. aureus* in fish.

State Guidelines

Top

State Guidelines for *S. aureus* in seafood.

State	Products	Maximum coagulase positive *S. aureus*
Alabama	-	-
Alaska	-	-
Arizona	-	-
Arkansas	-	-
California	-	-
Colorado	-	-
Connecticut	-	-
Delaware	-	-
Florida	Blue crab	100/g
Georgia	-	-
Hawaii	-	-
Idaho	-	-
Illinois	-	-
Indiana	-	-
Iowa	-	-

Kansas	-	-
Kentucky	-	-
Louisiana	-	-
Maine	-	-
Maryland	-	-
Massachusetts	-	-
Michigan	-	-
Minnesota	-	-
Mississippi	Oysters, clams, mussels, fresh or frozen	Positive for enterotoxigenic or 10^4/g
Missouri	-	-
Montana	-	-
Nebraska	Oysters, clams, mussels, fresh or frozen	0
	Deli foods (shrimp salad, etc.)	0
Nevada	-	-
New Hampshire	-	-
New Jersey	"Potentially hazardous" (tuna, shrimp salad)	100/g
New Mexico	-	-
New York	-	-
North Carolina	-	-
North Dakota	-	-
Ohio	-	-
Oklahoma	-	-

Oregon	-	-
Pennsylvania	-	-
Rhode Island	-	-
South Carolina	-	-
South Dakota	-	-
Tennessee	-	-
Texas	Crabmeat	30/g (in 20% or more of samples)
Utah	-	-
Vermont	-	-
Virginia	-	-
Washington	-	-
West Virginia	Deli items (seafood salads)	<10/g
Wisconsin	-	-
Wyoming	-	-

(NFI, 1998)

ICMSF Recommended Microbial Limits

Top

Recommended microbiological limits for *S. aureus* in fish (ICMSF, 1986).

			Bacteria/gram or/cm^2	
Product	**n**[1]	**c**[2]	**m**[3]	**M**[4]
Fresh and frozen fish and cold-smoked fish	5	2	10^3	10^4
Precooked breaded fish	5	1	10^3	10^4
Frozen raw crustaceans	5	2	10^3	10^4

Frozen cooked crustaceans	5	0	10^3	-
Cooked, chilled, and frozen crabmeat	5	0	10^3	-

[1]Number of representative sample units.
[2]Maximum allowable number of sample units which exceed microbial level *m*.
[3]Maximum recommended bacterial level for *c* samples out of *n*.
[4]Maximum recommended bacterial level for remaining (*n* - *c*) samples.

Plate counts below "m" are considered good quality. Plate counts between "m" and "M" are considered marginally acceptable quality, but can be accepted if the number of samples does not exceed "c." Plate counts at or above "M" are considered unacceptable quality (ICMSF, 1986).

Canadian Food Inspection Agency Bacteriological Guidelines for Fish and Fish Products Top

Growth and Toxin Production Top

Limiting conditions for *S. aureus* growth and toxin production.

Heat Resistance Top

Heat resistance of *S. aureus* vegetative cells.

Temp.		D-Value	Medium	Reference
(ºC)	(ºF)	(min.)		
55	131	3.0	Buffer	Halpin-Dohnalek and Marth, 1989

Heat resistance of *S. aureus* toxin.

Temp.		D-Value	Medium	Reference
(ºC)	(ºF)	(min.)		
98.9	210	68.5	Milk	Read and Bradshaw,

				1966
104.4	220	46.2	Milk	Read and Bradshaw, 1966
110	230	26.1	Milk	Read and Bradshaw, 1966
115.6	240	16.6	Milk	Read and Bradshaw, 1966
121.1	250	9.4	Milk	Read and Bradshaw, 1966
126.7	260	6.2	Milk	Read and Bradshaw, 1966

Analytical Procedures

Top

Food sampling and preparation of sample homogenate (USFDA) Top

Definition of Terms (HC Appendix A); Collection of samples (HC Appendix B); Supplement to All Methods in the HC Compendium: General Microbiological Guidance (HC Appendix I) Top

Staphylococcus aureus (USFDA) Top

Staphylococcal enterotoxins: micro-slide double diffusion and ELISA-based methods (USFDA) Top

Electrophoretic and immunoblot analysis of staphylococcal enterotoxins in food (USFDA) Top

Enumeration of *Staphylococcus aureus* in foods (HC MFHPB-21)
Enumeration of *Staphylococcus aureus* in foods (HC MFHPB-21 *supplement*) Top

Determination of *Staphylococcus aureus* thermostable nuclease in foods (HC MFHPB-28) Top

Determination of enterotoxin production by *Staphylococcus aureus* in foods and broth media (the reversed passive latex agglutination (RPLA) method) (HC MFLP-67) Top

Detection of enterotoxins produced by *Staphylococcus aureus* in foods (the enzyme-linked immunosorbent assay (ELISA) using the Tecra Kit) (HC MFLP-68) Top

Detection of enterotoxins produced by *Staphylococcus aureus* in foods (Ridascreen SET A, B, C, D, E Enzyme Immunoassay) (HC MFLP-69) Top

Identification Of *Staphylococcus aureus* by Accuprobe™(Accuprobe rapid DNA probe test) (HC MFLP-79) Top

Other analytical procedures

Top

- *Staphylococcus aureus* in foods: Most probable number method for isolation (AOAC, 1995c).
- *Staphylococcus aureus* in foods: Surface plating method for isolation and enumeration (AOAC, 1995d).
- *Staphylococcus aureus* isolated from foods: Latex agglutination test method (AOAC, 1995e).
- Staphylococcal enterotoxin in foods: Extraction and separation methods (AOAC, 1995f).
- Staphylococcal enterotoxin in foods: Microslide gel double diffusion test (AOAC, 1995g).
- Staphylococcal enterotoxin in selected foods: Polyvalent enzyme immunoassay method (AOAC, 1995h).

Commercial Test Products

Top

Table 19-11. Commercial test products for *S. aureus*.

Test Kit	Analytical Technique	Approx. Total Test Time[1]	Supplier
3M Petrifilm ™ Rapid *S. aureus* Count Plate	An indicator of the presence of a thermostable nuclease. Dry rehydratable film method.	26-30 h	3M Microbiology Products 3M Center, Building 275-5W-05 St. Paul, MN 55144-1000 Phone: 800/228-3957; 651/737-6501 E-mail: innovation@mmm.com Web: www.3m.com/microbiology/
AccuPROBE® Culture *Staphylococcus aureus* Culture Identification Test	Nucleic acid hybridization	Up to 72 h	Gen-Probe Contact: Customer Service 10210 Genetic Center Dr. San Diego, CA 92121 Phone: 858/410-8000 Web: www.gen-probe.com
API RAPIDEC Staph [Used to identify *Staphylococcus aureus*]	Fluorescent test for *S. aureus*. Biochemical identification of *Staphylococcus*	2 h	bioMérieux Inc. Contact: bioMérieux Industry 595 Anglum Rd. Hazelwood, MO 63042 Phone: 800/638-4835; 314/731-8500 E-mail: usa@na.biomerieux.com Web: www.biomerieux.com
API Staph [Used to identify *Staphylococcus aureus*]	Biochemical reaction	24 h	bioMérieux Inc. Contact: bioMérieux Industry 595 Anglum Rd. Hazelwood, MO 63042 Phone: 800/638-4835; 314/731-8500 E-mail: usa@na.biomerieux.com Web: www.biomerieux.com
BACTiStaph [Used to identify	Latex agglutination	After a 24 h plate culture,	Remel Contact: Customer Service

Staphylococcus aureus]		60 s	12076 Santa Fe Dr. Lenexa, KS 66206 Phone: 800/255-6730; 913/888-0939 E-mail: remel@remelinc.com Web: www.remelinc.com
CHECK 3 Staph aureus	Chemical, visual detection	4-18 h	Contamination Sciences LLC Contact: Robert Steinhauser 4230 East Towne Blvd., Suite 191 Madison, WI 53704 Phone: 608/825-6125 E-mail: bsteinha@contam-sci.com Web: www.contam-sci.com
GENE-TRAK *Staphylococcus aureus* Assay [Used to detect *Staphylococcus aureus*]	Nucleic acid hybridization	28 h	Neogen Corporation 620 Lesher Pl. Lansing, MI 48912 Phone: 517/372-9200 E-mail: NeogenCorp@aol.com Web: www.neogen.com/genetrakback.htm
ISO-GRID Method for *Staphylococcus aureus* Count using Baird-Parker Agar	Membrane filtration with selective and differential culture medium	48-54 h	QA Life Sciences, Inc. 6645 Nancy Ridge Dr. San Diego, CA 92121 Phone: 800/788-4446; 858/622-0560 E-mail: bugsy@qalife.com
RIDASCREEN SET (R4101) (R-Biopharm GmbH) [Used to identify *S. aureus* enterotoxins A, B, C, D, or E]	ELISA	3 h	R-Biopharm, Inc. Contact: Sean Tinkey 7950 US 27 South Marshall, MI 49068 Phone: 877/789-3033 E-mail: sales@r-biopharm.com Web: www.r-biopharm.com
RIDASCREEN *Staphylococcus aureus* Thermonuclease (R4001) (R-Biopharm GmbH) [Used to identify *S. aureus* at levels to identify intoxication]	Immunodiffusion inhibition assay	4 h	R-Biopharm, Inc. Contact: Sean Tinkey 7950 US 27 South Marshall, MI 49068 Phone: 877/789-3033 E-mail: sales@r-biopharm.com Web: www.r-biopharm.com
SET-RPLA (Oxoid) [Used to identify staphylococcal enterotoxin A, B, C, D and E]	Reversed passive latex agglutination	18 h	Oxoid, Inc. Contact: Jim Bell 217 Colonnade Rd. Nepean, Ontario K2E 7K3 Canada Phone: 613/226-1318 E-mail: jbell@oxoid.ca
Slidex Staph Kit [Used to identify *Staphylococcus aureus*]	Latex agglutination	Once organism grown (24 h), 20 s test	bioMérieux Inc. Contact: bioMérieux Industry 595 Anglum Rd. Hazelwood, MO 63042 Phone: 800/638-4835; 314/731-

			8500 E-mail: usa@na.biomerieux.com Web: www.biomerieux.com
Staph. Aureole Plates [A coagulase positive test for *S. aureus*]	Baird-Parker Media with coagulase test	24 h	Biomedix Contact: Claver Bundac 1105 #F North Golden Springs Dr. Diamond Bar, CA 91765 Phone: 800/674-8648 #4282; 909/396-0244 E-mail: cb4biomedx@aol.com
Staphytect Plus (Oxoid) [Used to confirm the presence of coagulase positive or coagulase negative staphylococci. Confirms the presence of *Staphylococcus aureus*]	Latex agglutination	After a 24 to 48 h plate culture, approx. 60 s	Oxoid, Inc. Contact: Jim Bell 217 Colonnade Rd. Nepean, Ontario K2E 7K3 Canada Phone: 613/226-1318 E-mail: jbell@oxoid.ca
TECRA *Staphylococcus aureus* Visual Immunoassay [Used to identify *Staphylococcus aureus*]	ELISA	26 h	InternationalBioProducts Contact: Mike Yeager PO Box 0746 Redmond, WA 98041 Phone: 800/729-7611; 425/883-1349 E-mail: myeager@intlbioproducts.com Web: www.intlbioproducts.com or www.tecra.net
TECRA Staphylococcal Enterotoxin Identification Visual Immunoassay [Used to identify Staphylococcal enterotoxin A, B, C, D, or E in food.]	ELISA with a visual end-point	4 h Analysis of Staphylococcal cultures for toxin production: 4 h	InternationalBioProducts Contact: Mike Yeager PO Box 0746 Redmond, WA 98041 Phone: 800/729-7611; 425/883-1349 E-mail: myeager@intlbioproducts.com Web: www.intlbioproducts.com or www.tecra.net
TECRA Staphylococcal Enterotoxin (SET) Visual Immunoassay[2] [Used to identify Staphylococcal enterotoxins A, B, C1, C2, C3, D, E and enterotoxin producing staphylococci]	ELISA with a visual end-point	Thermally processed foods: 21 h All other foods: 4 h Analysis of Staphylococcal cultures for toxin production: 4 h	InternationalBioProducts Contact: Mike Yeager PO Box 0746 Redmond, WA 98041 Phone: 800/729-7611; 425/883-1349 E-mail: myeager@intlbioproducts.com Web: www.intlbioproducts.com or www.tecra.net
Transia Plate *Staphylococcal Enterotoxins*	ELISA	90 min	Diffchamb AB FO Petersons Gata 32 SE-421 31 Västra Frölunda, Sweden Phone: +46 -31-742 33 50

			E-mail: market.dept@diffchamb.se Web: www.diffchamb.se
Transia Tube *Staphylococcal Enterotoxins*	ELISA	90 min	Diffchamb AB FO Petersons Gata 32 SE-421 31 Västra Frölunda, Sweden Phone: +46 -31-742 33 50 E-mail: market.dept@diffchamb.se Web: www.diffchamb.se
Vidas SET [Used to identify *Staphylococcus aureus*]	Enzyme linked fluorescent assay	2 h	bioMérieux Inc. Contact: bioMérieux Industry 595 Anglum Rd. Hazelwood, MO 63042 Phone: 800/638-4835; 314/731-8500 E-mail: usa@na.biomerieux.com Web: www.biomerieux.com

[1]Includes enrichment

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