

Staphylococcus aureus food poisoning

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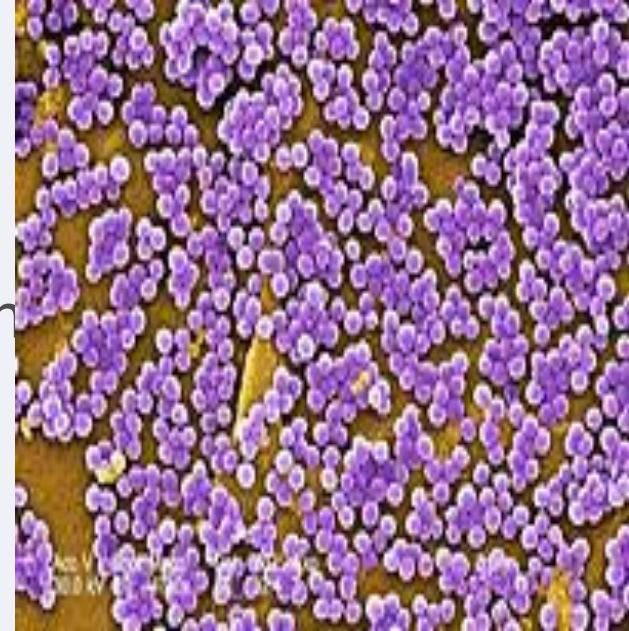
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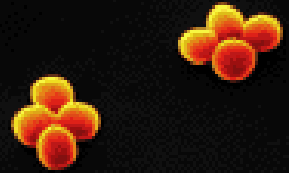
- History
- General characteristics
 - *S. aureus*
 - Staphylococcal enterotoxins
- Growth of *S. aureus* and SE production
- Occurrence, Pathogenesis and Characteristics of disease
- Incidence of SE food poisoning
- Foods involved in SE food poisoning
- Detection of *S. aureus* and SE
- Control and Prevention



History

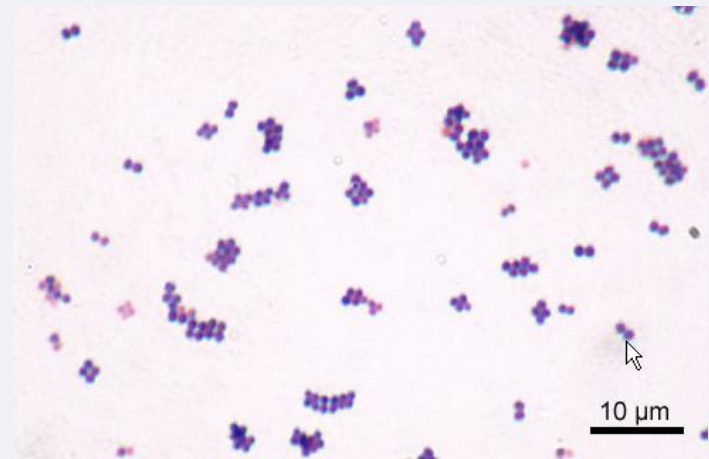
- First time described by Sir Alexander Ogston, Scottish Surgeon as the cause of pyogenic infectious in humans
- 1882: named as staphylococcus (staphyle: bunch of grapes; coccus: a grain of berry).
- First staff food poisoning: consumption of cheese in Michigan, USA.
- 1914: First approved case of SFP after consumption of milk
- 1930: Dr. Dack rediscovered SFP and described SFP with Christmas cakes





General characteristics - *S. aureus*

- >32 species in staphylococci genus
- Gram-positive
- spherical bacterium (coccus)
- diameter 1-1.3 μm
- clusters like bunches of grapes
S. aureus
- catalase-positive
- oxidase-negative
- facultative anaerobes
- typical mesophile



Limits of growth for *S. aureus*

<u>Parameter</u>	<u>Values</u>
Temperature	
Minimum temp	7°C
Optimum temp	35-37°C
Maximum temp	48°C
Water activity (a_w)	
Minimum a_w	0.86-0.84
pH	
Minimum pH	4.5
Optimum pH	7.0-7.5
Maximum pH	9.3
NaCl	5-7% (20%)

Characteristics of *Staphylococcus* species

Property	<i>S. aureus</i>	<i>S. intermedius</i>	<i>S. hyicus</i>	<i>S. delphini</i>	<i>S. epidermidis</i>
Pigment	+	-	-	-	-
Coagulase	+	+	±	+	-
Thermonuclease (TNase)	+	+	+	-	-
Mannitol (aerobic)	+	±	-	+	-
Mannitol (anaerobic)	+	-	-	-	-
Hemolysins	+	±	-	+	±
Clumping factor	+	±	-	-	-
Aceton production	+	-	-	-	+



Heat resistance and survival of *S. aureus*

<u>Survival</u>	<u>Time</u>
Frozen products	Years
Dry products	Weeks, up to a few months

Resistance to heating

Heat D ₅₀	9.5-42 min
Heat D ₅₅	3 min
Heat D ₆₂	0.4-1.1 min



General characteristics - *Staphylococcal enterotoxins (SE)*

SE	Emetic (+/-)	Food poisoning outbreaks
SEA	+	Chocolate milk, low fat milk, chicken, halloumi cheese, lasagne, sheep milk cheese
SEB	+	Milk, Pork, Ham, Eggs
SEC1-3	+	Goat milk cheese, Unsp. food
SECbovine	nd (not done)	Goat milk cheese, Unsp. food
SECovine	nd	Goat milk cheese, Unsp. food
SED	+ (tested on cat)	Chicken and rice dish
SEE	+	Ham sandwiches
SEG	+	Unsp. food
SEH	+	Cheese
SEI	+(weakly)	Unsp. food
SEJ	nd	
SEK	nd	
SEL	-	
SEM	nd	
SEN	nd	
SEO	nd	
SEP	nd	
SEQ	-	
SER	nd	Lunch box, Unsp. food
SEU	nd	



Limits for SE production

<u>Parameter</u>	<u>Values</u>
Temperature	
Minimum temp	10°C
Optimum temp	37-40°C
Maximum temp	45°C
Water activity (a_w)	
Minimum a_w	0.86
Optimum a_w	0.99
pH	
Minimum pH	5.15
Optimum pH	7.0-7.5
Maximum pH	9.0
NaCl	
Minimum	0%
Optimum	0.5%
Maximum	20%



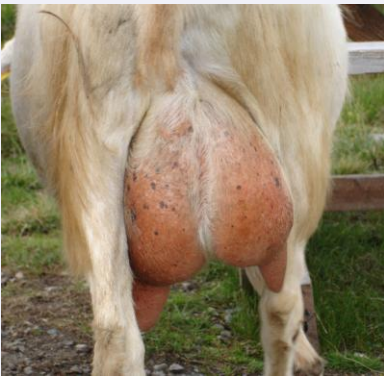
Resistance of toxin to heating

<u>Resistance</u>	<u>Time</u>
Heat D ₁₀₀ (milk)	70 min
Heat D ₁₁₀ (milk)	26 min
Heat D ₁₂₀ (milk)	9.4 min



Occurrence, Pathogenesis and Disease Characteristics

- ubiquitous
- human carries (nose and throat, hands; 20-50%)
- animal carries
- persistent organism in slaughterhouses
- food contamination by contaminated hands, materials, surfaces and by air



SFP symptoms

- Quite rapid; incubation period 1-6 h.
 - nausea
 - vomiting
 - retching
 - abdominal cramps
 - diarrhoea
- Amount of SE is less than 1 μg
- Recovery within 1-2 days



Incidence of SFP

- True estimates are not available:
 - poor response to physicians
 - misdiagnosis
 - not reportable disease
- Mostly reported outbreak cases



Milk and milk products staphylococcal outbreaks

Country	Year	No. people	Milk product
Norway	1951	12	Mashed potato with raw cow's milk
USA	1973-1992	15	Milk from unknown species
Scotland	1984	25-27	Sheep milk cheese
Scotland	1985	2	Goat's milk
Israel	1987	3	Goat's milk
Norway	1987	13	Goat milk cheese
England	1988	155	Stilton cheese
Norway	2001	8	Goat's milk cheese



SFP cases reported to WHO, 2003

- SFP is the 3. most common cause of food-borne poisoning in Europe (1993-2003)
- 610 outbreaks and 10899 cases reported
- France: 402 outbreaks
- Poland: 72 outbreaks
- Spain: 36 outbreaks
- Norway: 40; Sweden: 19; Finland:13; Denmark: 12; Island 4.

Foods involved in SE food poisoning

- Cooked, protein-rich products contaminated by handling, equipment and environmental



- Key factor in SFP is:

- improper food holding temperature
- poor personal hygiene
- contamination
- inadequate cooking



Type of food involved in SFP depend of country:

- France: milk and milk products
- USA and England: Meat and meat products
- Finland: Smoke fish and ham
- Japan: rice balls
- Hungary: rice cream



National Veterinary Institute in Oslo

**Norwegian reference laboratory
for *S. aureus* and SEs in food**



SEs analyses during 2000-2007

- 223 food samples involved in suspected human cases of SFP
- 225 *S. aureus* isolates from humans and food



Occurrence of *S. aureus* and SE in food in Norway from 2000-2007

Type of food	Number of samples	Coag.posit.staph.		SE Ridascreen			SE Transia		
		Negative (%)	Positive (%)	Negative (%)	Positive (%)			Negative (%)	Positive (%)
					A	B	C		
Cheese	67	10	4	20		1	2	30	12
Other milk products	3			2				1	
Smoked fish	3			2					1
Raw fish	1								1
Other fish products	8			5				3	
Shellfish	13	2		9				4	
Raw meat	7	2		6				1	
Heat treated meat	34	3		21				11	2
Raw chicken	3			1					2
Heat treated chicken	9			7				2	
Cacao/chocolate	12	1		11	1				
Champignon	18							18	
Sauces	5			1				4	
Other	15			12				3	
Ready-to-eat food	25	1	3	14	1			10	
Total %	223	19 (73)	7 (27)	111 (95)	2 (2)	1 (1)	2 (2)	90 (85)	16 (15)



SE production in SA isolates involved in SFP in Norway from 2000-2007 I

Type of food	No of samples	<i>S. aureus</i>		SET RPLA		Type of SE			
		Neg (%)	Pos (%)	Neg (%)	Pos (%)	A (%)	B (%)	C (%)	D (%)
Milk	3	0	3	3	-	-	-	-	-
Cheese	67	8	59	30	29	25	-	4	-
Other milk pr.	23	2	21	7	14	-	6	8	5*
Total	93	10 (11)	83 (89)	40 (48)	43 (52)	25 (58)	6 (14)	12 (28)	5 (11)*
Smoked fish	2	2	-	-	-	-	-	-	-
Other fish prod.	4	2	2	-	2	2	2	-	-
Total	6	4 (67)	2 (33)	-	2 (100)	2 (100)	2 (100)	-	-
Raw meat	6	5	1	1	-	-	-	-	-
Heat tr.meat	43	19	24	20	4	3	-	1	-
Total	49	24 (49)	25 (51)	21 (84)	4 (16)	3 (75)	-	1 (25)	-



SE production in SA isolates involved in SFP in Norway from 2000-2007. II

Raw chicken	4	0	4	1	3	-	3	-	-
Heat treated chicken	16	4	12	8	4	-	4	-	-
Total	20	4 (20)	16 (80)	9 (56)	7 (44)	-	7 (100)	-	-
Cacao/chocolate	1	1	-	-	-	-	-	-	-
Other	32	21	11	10	1	-	-	1	-
Ready-to-eat food	3	2	1	-	1	-	1	-	-
Human	21	12 (57)	9 (41)	3 (33)	6 (67)	4 (67)	2 (33) **	1 (17)	1 (17)
Totall	225	78 (35)	147 (65)	83 (56)	64 (44)	34 (53)	18 (28) **	15 (23)	6 (9)*



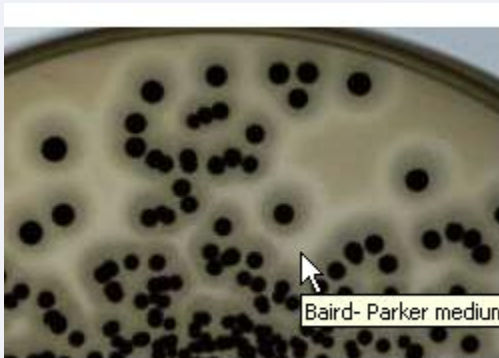
Conclusion

- occurrence of SEs in food products in Norway is low
- the number is probably underestimated:
 - many cases remain unreported both from patient to physician and from physician to the public health authorities
 - unsolved cases due to limitation of methods to detect toxins



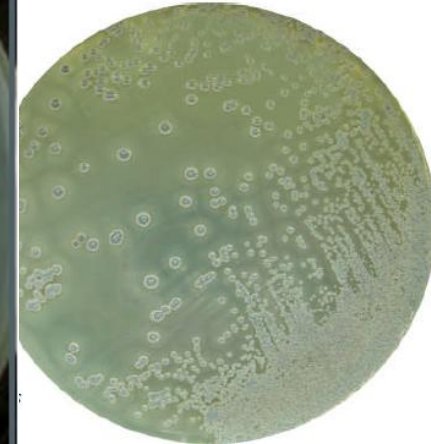
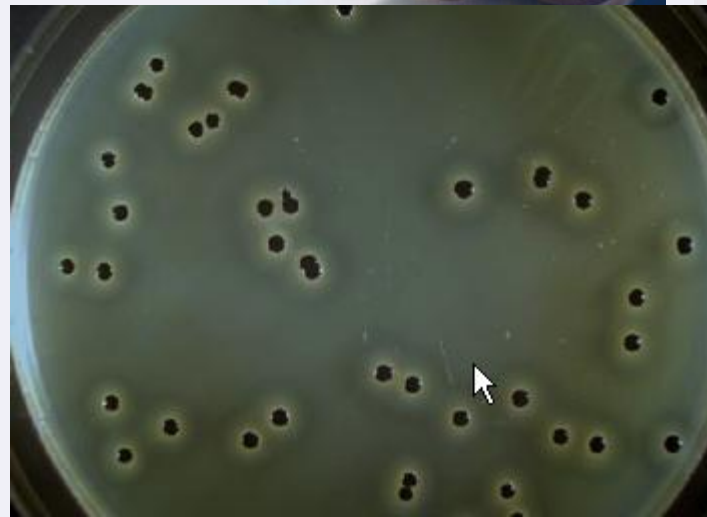
Methods for detection of *S. spp* and *S. aureus*

- ISO method
- NMKL method
 - BP
 - BP+RPF



Baird-Parker medium

S. aureus on Baird-Parker Medium (ISO)



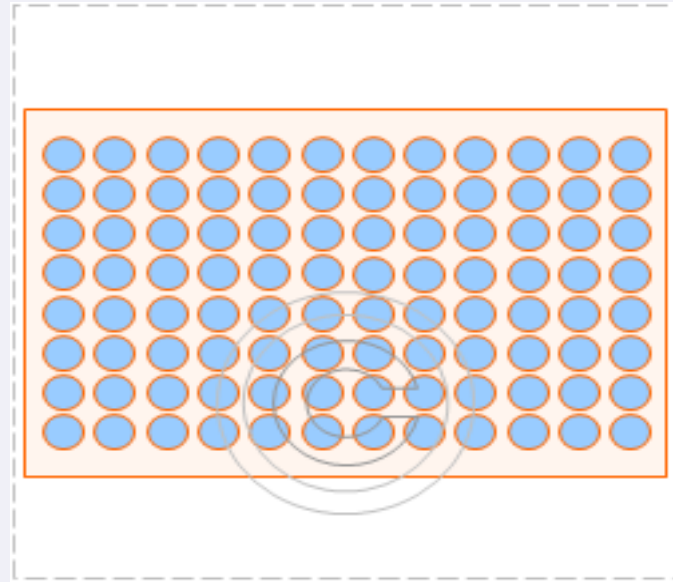
Test for differentiate *S. aureus*, *S. intermedius* and *S. hyicus*

	Growth on peptone agar with acriflavine	Anaerobic fermentation of mannitol	B-galactosidase	Acetoin	Haemolysis on chocolate agar
<i>S. aureus</i>	+	+	-	+	-
<i>S. intermedius</i>	-	-	+	±	-
<i>S. hyicus</i>	-	-	-		+



Detection of SEs

- Detection of *SEs* from food by ELISA:
 - RIDASCREEN kit,
 - Transia kit
- Detection of *SEs* from bacterial culture:
 - SET-RPLA
- Detection of *ses* by multiplex PCR technique



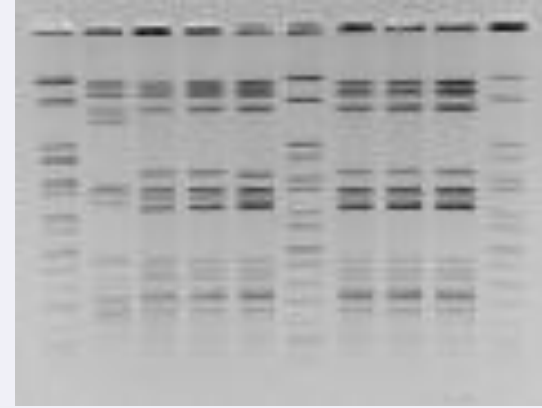
Typing of *S. aureus*

■ Phenotypic typing methods

- biotyping
- antibiogram typing
- serotyping
- phage typing
- MLEE

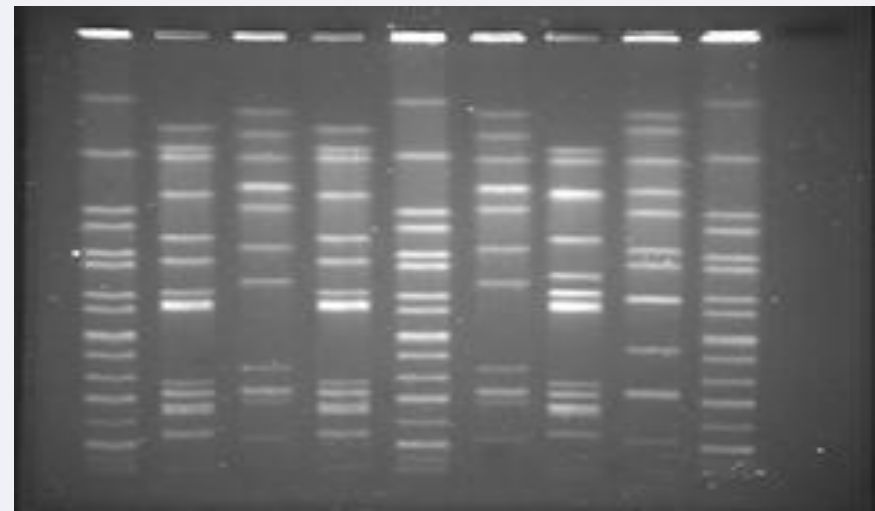
● Genotypic typing methods

- REA
- RFLP
- Binary typing
- PFGE



PCR typing methods

- AFLP
- MLST



Control and prevention

- Humans and animals are the main reservoir and vector of *S. aureus*
- Food handlers are the primary source for food contamination by *S aureus*.
- Food handlers should practice good personal hygiene, be healthy and be educated in proper food handling practice.
- Rapid cooling of hot foods and refrigeration of food may reduce the risk of SFP

