Toxins Produced by *Staphylococcus aureus*

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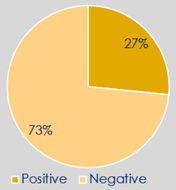
ABSTRACT

The focus of this study was to analyze the presence of toxin genes from *Staphylococcus aureus,* such as alpha toxin and toxic shock syndrome toxin-1 (TSST-1). The bacteria's genomic DNA was amplified via Polymerase Chain Reaction (PCR) and visualized through DNA gel electrophoresis. Clinical isolates that were known to be positive for the specific toxin genes were used as positive controls.

STUDY OVERVIEW

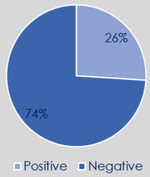
Our data collection **so far** for nasal carriage rate of *S. aureus* is displayed in the charts below:

Nasal Carriage Rate of Campus Participants



1,065 nasal swabs have been collected from campus participants with 880 swabs processed. **27% tested positive for *S. aureus*.**

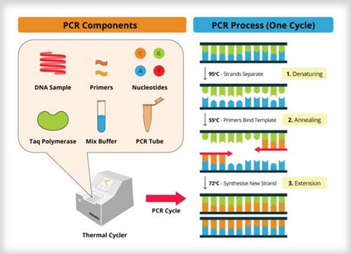
Nasal Carriage Rate of Minnesota State Fair Participants



567 nasal swabs have been collected from Minnesota State Fair participants with 527 swabs processed. **26% tested positive for *S. aureus*.**

METHODS

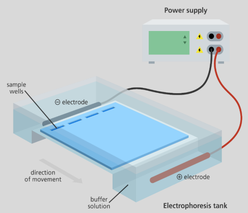
Polymerase Chain Reaction (PCR):



- PCR was used to amplify target genes like Alpha toxin and TSST-1.
- Annealing temperatures:
  - Alpha Toxin: 57°C
  - TSST-1: 57°C

DNA Gel Electrophoresis:

- Gel electrophoresis was used to separate the DNA mixture based on molecular size in base pairs (bp).
- A 2% agarose gel was created for each gel run.



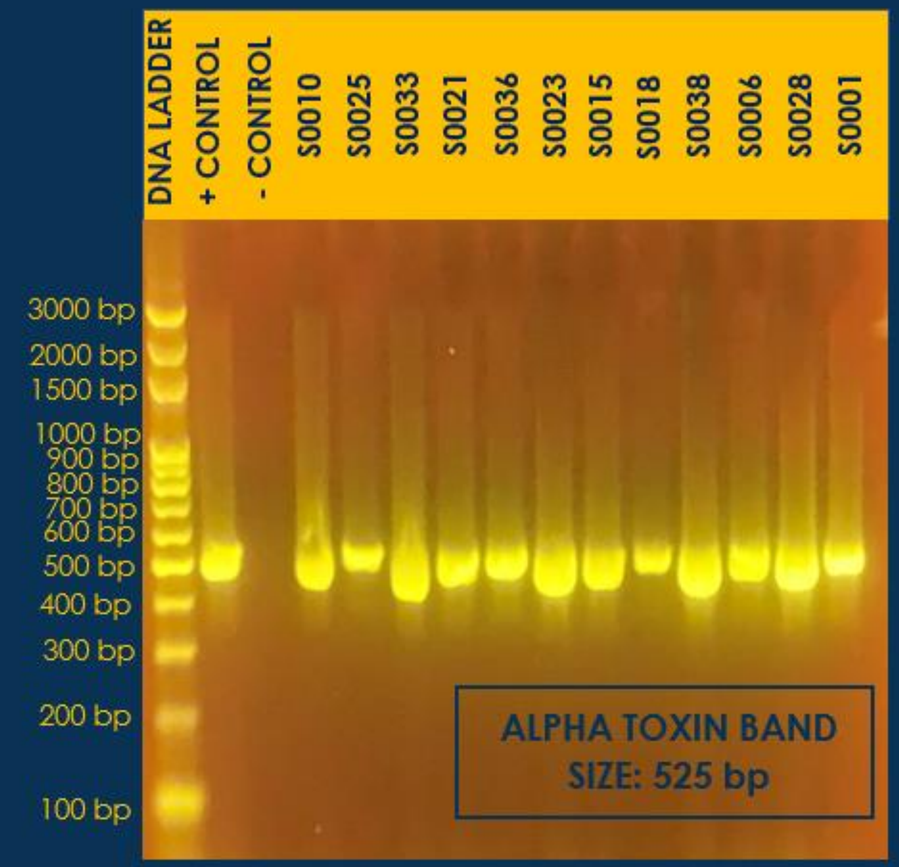
RESULTS

12 *S. aureus* samples were collected from human nostrils and tested for alpha toxin and TSST-1. All 12 samples tested positive for alpha toxin, while only 3 samples tested positive for TSST-1.

SAMPLE	0001	0006	0010	0015	0018	0021	0023	0025	0028	0033	0036	0038
TSST-1	−	−	−	+	−	+	−	−	−	+	−	−
ALPHA	+	+	+	+	+	+	+	+	+	+	+	+

+ Positive **− Negative**

ALL *STAPHYLOCOCCUS AUREUS SAMPLES* TESTED **POSITIVE** FOR **ALPHA TOXIN.**



Gel electrophoresis of alpha toxin from *S. aureus.* Positive control was a known clinical isolate MNPE that carries the alpha toxin gene. Negative control contains the forward and reverse primer for alpha toxin with no genomic DNA.

WHY STAPH?

S. aureus is commonly found on the skin and in the nose. **About 30% of healthy adults carry *S. aureus* in their nose** and about 20% on their skin (Tenover, 2008). Many people can carry it without any symptoms; however it can become dangerous when it enters the body. It most commonly causes skin infections, but it can also cause infections of the heart, lungs, bones, and blood. All of which could be life threatening. Understanding the prevalence of these toxic genes that cause illness can help lead to greater discoveries of the pathogenesis of *S. aureus*.

VIRULENCE FACTORS

S. aureus toxins can be divided into three major groups:

- Pore forming toxins (PFTSs)
- Exfoliative toxins (ETs)
- Superantigens (SAgs)

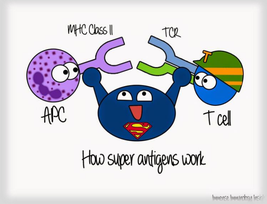
Alpha toxin is a pore-forming toxin and TSST-1 is a superantigen. The function of these toxin genes includes degrading the host cells, manipulating the immune responses, and degrading intercellular junctions (Oliveira 2018). All these functions assist in *S. aureus* proliferation and disease.

ALPHA TOXIN

Alpha toxin can be found in 95% of clinical *S. aureus* strains (Oliveira 2018). Alpha toxin is a major cytotoxic agent that causes cell lysis. It does this by forming pores into the host's cell membrane, eventually causing cell death. It also alters cell signaling pathways including cell proliferation, inflammatory responses, cytokine secretion, and cell-cell interactions. This toxin has been demonstrated to affect many human cells including epithelial cells, endothelial cells, T cells, monocytes, and macrophages (Hildebrand 1991).

TSST-1

TSST-1 is one of the many superantigens *S. aureus* can produce. TSST-1 is known for causing both menstrual and nonmenstrual toxic shock syndrome (TSS). The symptoms of TSS include high fever, low blood pressure, vomiting, and a skin rash. As a superantigen, TSST-1 alters the host's immune response by binding to both the antigen presenting cell and the T cell. This triggers a massive cytokine release, as well as a large production of T cells and monocytes (Wahlsten 2020). This causes a "false" immune response by the host, which is one of the many mechanisms of *S. aureus* to survive and cause detrimental diseases like TSS and sepsis.



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References:

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