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(54) Title: POLYPEPTIDE DERIVED FROM ENTEROCOCCUS AND ITS USE FOR VACCINATION

(57) Abstract: A medicament for the treatment or the prevention of a bacterial infection is disclosed which contains a polypeptide having a contiguous sequence of at least six amino acids of SEQ ID NO:1. Said polypeptide can be used for the preparation of a vaccine against an *Enterococcus* infection.



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Polypeptide Derived From Enterococcus And Its Use For Vaccination

Enterococci are among the three most common nosocomial pathogens and due to their multiple antibiotic resistances cause substantial morbidity and mortality, especially among intensive care patients and the immunocompromised. While several new antibiotics have been introduced in the last decade, resistance against these new drugs is developing and spreading rapidly. Life-threatening systemic disease such as endocarditis caused by resistant strains may at times be untreatable. Therefore, alternative treatment and prevention strategies are desperately needed to counter the rise of multiply resistant clones in hospitals and nursing homes worldwide. A better understanding of the different enterococcal cell surface structures will help to target new therapeutic and prophylactic approaches.

It is known that all gram-positive bacteria (also those belonging to the genus of *Enterococcus*) contain in the cell wall several specific carbohydrates and proteins. In the course of the present invention one protein has been identified that plays a possible role in the dynamic equilibrium of a major component of the outer cell wall (i.e. peptidoglycan). Proteins belonging to this family may act as cell wall peptidases which degrade the peptidoglycan of the bacteria during growth and cell division. Surprisingly it has been found that a polypeptide which is probably located on the outer surface of the bacterial cell can be used for the production of vaccines since protective antibodies directed against parts of said polypeptide have been identified.

The humoral immune response is mediated by antibody molecules secreted by plasma cells. Antigen that binds to the B-cell antigen receptor signals B-cells and is at the same time internalized and processed into peptides that activate armed helper T-cells. Signals from the bound antigen and from the helper T-cell induce the B-cell to proliferate and differentiate into plasma cells secreting specific antibody. These antibodies protect the host from infection in three main ways. First, said antibodies can inhibit the toxic effects or infectivity of pathogens by binding to them. Such antibodies are termed neutralizing antibodies.

Second, by coating the pathogens, said antibodies can enable accessory cells that recognize the Fc portions of arrays of antibodies to ingest and kill the pathogen. This process is called opsonisation. Third, antibodies can trigger the activation of the complement system. Complement proteins can strongly enhance opsonisation or can directly kill certain bacterial cells.

For the production of vaccines it is important that the antigen elicits antibodies which inhibit the pathogenic activity of the pathogenic microorganism. Protective antibodies elicited by a vaccine have therefore the effect of neutralization, opsonisation and complement activation whereby antibodies induced by a specific antigen may also have two or even three of the protective activities.

It is therefore one object of the present invention to provide a polypeptide or part thereof which can be used to produce protective antibodies, preferably IgG antibodies against said polypeptide or parts of said polypeptide.

The present invention provides therefore a polypeptide having the following amino acid sequence:

MKKSLISAVMVCSMTLTAVASPIAAAADDFDSQIQQQDQKIADLKNQQADAQSQID
ALESQVSEINTQAQDLLAKQDTLRQESAQLVKDIADLQERIEKREDTIQKQAREAQV
SNTSSNYIDAVLNADSLADAIGRVQAMTTMVKANNDLMEQQKQDKKAVEDKKAE
NDAKLKELAENQALESQKGDLLSKQADLNVLKTSLAAEQATAEDKKADLNRQK
AEAEAEQARIREQQRLAEQARQQAAQEKAKEAREQAEAEAQATQASSTAQSSAT
EESATQSSMTEESSATQSSATEESTTPESSTEESTAPESSATEESTTAPESATEEST
TVPESSATEESTTVPESSSTEESTTPAPTTPSTDQSVDTGNGTGSSTPAPTPTPTPEQP
KPVTPAPAPSGSVNGAAIVAEAYKYIGTPYVWGGKDPGSGFDCSGFTRYVYMQVTG
RDIGGWTPVQESAGTKISVSQAKAGDLLFWGSQGGTYHVAIALGGGQYIHAPQPG
ESVKVGSVQWFAPDFAVSM (SEQ ID NO:1)

Fang Teng et al. (in: Fang Teng et al. An Enterococcus faecium Secreted Antigen, SagA, Exhibits Broad-Spectrum Binding to Extracellular Matrix Proteins and Appears Essential

for *E. faecium* Growth, Infection and Immunity, September 2003, p. 5033-5041, Vol. 71, No. 9) discloses the extracellular and secreted *E. faecium* SagA protein as apparently essential for growth, showing broad-spectrum binding to ECM proteins, forming oligomers, and antigenic during infection. Furthermore, antibodies produced against recombinant Sag A are described. Although the protein is described as secreted antigen, there is no disclosure of an actual antigenicity of Sag A in vivo, let alone the formation of opsonic and/or protective antibodies in a host. The publication merely describes a C-terminal domain of Sag A that is „similar to that found in various proteins“, including P60 (52% similarity) of *L. monocytogenes*, which has cell wall hydrolase activity, and has also been shown to be involved in virulence. The publication is thus limited to the functional characterization of Sag A.

Furthermore, the presence of a surface-exposed proteins does not automatically result in the formation of opsonic and/or protective antibodies in the host. In fact, to the knowledge of the inventors, only two protein antigens have been confirmed so far in *E. faecalis* as being the target of protective antibodies: an ABC transporter described by Burnie and colleagues (Burnie et al. Identification of ABC transporters in vancomycin-resistant *Enterococcus faecium* as potential targets for antibody therapy. FEMS Immunol Med Microbiol (2002) vol. 33 (3) pp. 179-89) and, only recently, the collagen adhesin ACE (Singh et al. Importance of the collagen adhesin ace in pathogenesis and protection against *Enterococcus faecalis* experimental endocarditis. PLoS Pathog (2010) vol. 6(1) pp. e1000716). Two other surface proteins have been shown to be *not* protective, namely the enterococcal aggregation substance (McCormick et al. Antibodies to a surface-exposed, N-terminal domain of aggregation substance are not protective in the rabbit model of *Enterococcus faecalis* infective endocarditis. Infect Immun (2001) vol. 69 (5) pp. 3305-14) and the enterococcal surface protein Esp (Sava et al., submitted). Studies on several other protein antigens have been reported in the literature as being involved in virulence, while no protective effect of either passive or active immunization has been documented. Therefore, to date, no vaccine targets, either proteinaceous or carbohydrates, have been identified in *E. faecium*. The present invention is therefore based on the surprising finding that the polypeptide of SEQ ID NO:1 can be used to provide such a vaccine target.

The person skilled in the art knows that not necessarily the whole polypeptide has to be used for the production of a vaccine. Even shorter fragments of the polypeptide can be used. Such fragments comprise an epitope that usually consist of at least six contiguous amino acids out of the SEQ ID NO:1. Preferably, however, said polypeptides have at least 10, more preferably at least 15 and more preferred at least 20 contiguous amino acids of the SEQ ID NO:1.

In a particularly preferred embodiment the polypeptide has at least 30, more preferred at least 50 and especially preferred at least 100 contiguous amino acids of SEQ ID NO:1.

The person skilled in the art is aware that with suitable computer programs the hydrophobicity and hydrophilicity of the areas of the polypeptide can be determined. Therefore, the preferred fragments are mainly hydrophilic since the parts of the polypeptide which are located on the outer areas of the folded polypeptide are preferred for the preparation of a vaccine.

Moreover, when longer parts of the polypeptide are used, it is more likely that not only linear epitopes are within the fragment but also conformational epitopes are present which occur in the course of three-dimensional folding of the polypeptide.

In a preferred embodiment the polypeptide of SEQ ID NO:1 or a fragment thereof is used as conjugate, whereby the antigen is covalently bound to an immunocarrier. Such immunocarrier may be a polypeptide or a protein or a carbohydrate-containing molecule (such as for example a capsular polysaccharide or glycoconjugate) which improves the interaction between T- and B-cells for the induction of an immune response against the antigen. This may be preferred for vaccines intended for use in patients with reduced activity of the immune system. Since infections of Enterococci are frequently a problem in hospitals and nursing homes such conjugates are particularly preferred for such patients. Suitable immunocarriers according to the present invention comprise tetanus toxoid, diphtheria toxoid, *Pseudomonas aeruginosa* toxin A or its derivatives thereof.

Carbohydrate-containing molecules such as capsular polysaccharides or teichoic acids may also serve as conjugation partner for the above-mentioned polypeptide or fragments thereof. In an especially preferred embodiment such fragments of the immunocarrier are used which stimulate the immune response in the patient to be treated without having, however, the undesired side effect which such proteins may elicit when used in an unmodified form.

The covalent bond between the antigen and the immunocarrier can be provided by a direct chemical bond or by a spacer. Sometimes short molecules having two reactive groups on both ends are reacted with the antigen and the immunocarrier in order to produce a covalently linked molecule.

In an alternative the molecule used as vaccine (antigen and immunocarrier) can be produced recombinantly wherein suitable gene fragments are linked together and inserted into a appropriate vector. The vector is introduced in a suitable host cell and the host cell (e.g. *E.coli*, bacillus, yeast, or insect cells) produces the polypeptide or fragment thereof as defined above together with the immunocarrier as one molecule.

The polypeptide or fragment thereof either alone or coupled to an immunocarrier may be used for the treatment or the prevention of bacterial infections. Another aspect of the present invention thus is a method for the treatment or the prevention of bacterial infections, in particular of Enterococci, more preferably *Enterococcus faecium* based on the medicament as described herein. Said medicament preferably is a vaccine which comprises preferably also a pharmaceutically acceptable adjuvant. The adjuvant promotes the protective IgG subtype antibodies. Typical adjuvants include complete Freund's adjuvant (CFA), incomplete Freund's adjuvant (IFA), alum and other adjuvants suitable for human use (e.g. virus-like particles). Polymers like dextran sulfate have been shown to be also a potent stimulator of IgG antibodies against bacterial cell surface antigen.

An active vaccine is administered to the patient preferably before an infection occurs. Such vaccination can therefore be applied regularly to patients at risk (e.g. elderly people,

patients before solid organ or bone-marrow transplants) in order to stimulate their immune response and to avoid an infection in a hospital or a nursing home.

Under specific circumstances it may, however, also be possible to apply the vaccine at early stages of the infection in order to elicit protective antibodies which inactivate the bacteria belonging to the genus *Enterococcus*. In a preferred embodiment the vaccine of the present invention provides protection against different *Enterococcus faecium* and possibly also against *Enterococcus faecalis* strains since there is extensive sequence homology between these species.

Antibodies induced by the protein of SEQ ID NO:1 or suitable fragments thereof are protective and facilitate phagocytosis. Since such protective, and in particular opsonic antibodies, are preferred it is desired to use those parts of the polypeptide of SEQ ID NO:1 which elicit antibodies having opsonic properties.

The pharmaceutical formulation of a medicament to be used as a vaccine is known to the person skilled in the art, and described in the respective literature. Usually, a solution of the antigen possibly coupled to an immunocarrier is dissolved in a physiologically acceptable solution like a buffer. The solution must be stabilized in order to avoid an undesired precipitation of the immunologically active compounds. The vaccine is preferably produced in the form of a solution adapted to injection, preferably intramuscular injection. Other forms of pharmaceutical formulations like plasters or sprays are also acceptable provided the antigen comes in sufficient contact with the immune system and the formation of specific antibodies is elicited.

On the other hand, it is sometimes not possible to treat patients with an active vaccine since the immune system is severely impaired. In those circumstances the polypeptide of SEQ ID NO:1 or fragments thereof as defined above can be used to produce either polyclonal antibodies or monoclonal antibodies that bind to or opsonize *Enterococcus*. The person skilled in the art is well aware how such antibodies can be prepared.

The inoculum for polyclonal antibody production is typically prepared by dispersing the antigen or the antigen-immunocarrier conjugate in a physiologically tolerable diluent such as saline, to form an aqueous composition. An immunostimulatory amount of the inoculum preferably with adjuvant is administered to a mammal and the inoculated mammal is then maintained for a time period sufficient for the antigen to induce protective anti-*Enterococcus* antibodies. After suitable periods of time, two weeks until four months, boosting doses of the antigen-immunocarrier may be applied and the antigen titer is monitored. At a suitable point, when the titer of the neutralizing or opsonic antibodies is at its peak, the antibodies are collected. Such antibodies can include antibody preparations from a variety of commonly used animals (such as mice, goats, primates, donkeys, rabbits or horses) and humans, whereby the antibodies are isolated from blood donations.

The antibodies induced in the mammal are harvested, isolated and purified to the extent desired by well-known techniques such as by alcohol fractionation and column chromatography or preferably by immunoaffinity chromatography whereby the antigen is bound to a chromatographic column. The antiserum passes the column whereby specific antibodies are retained and all other components of the serum are washed out. Then the purified antibodies are eluted with suitable gradients. A further purification may be required.

Alternatively, monoclonal antibodies can be prepared according to techniques well-known to the person skilled in the art. When a suitable monoclonal antibody is obtained, the binding regions can be identified and the whole antibody molecule as well as derivatives of the antibody like antibody fragments or subfragments can be provided. The general technique to produce monoclonal antibodies is amply described in textbooks. After having made the hybridomas or having selected the monoclonal antibody from libraries or genetically engineered animals it has to be determined to which part of the polypeptide of SEQ ID NO:1 the mAb binds. Then, it has to be checked whether the antibody is opsonic and/or protective, preferably in vivo.

The term antibody furthermore includes recombinant antibodies, such as recombinant human and humanized antibodies, as well as (recombinant) antibody fragments, such as scFv-fragments.

The present invention will now be described further in the following examples with reference to the accompanying Figures and the Sequence Listing, nevertheless, without being limited thereto. For the purposes of the present invention, all references as cited herein are incorporated by reference in their entireties.

Description of the Figures

Figure 1 shows opsonic killing of a polyclonal antiserum produced in rabbits against the strain *Enterococcus faecium* E155. Different serum dilutions were tested and even at high dilutions a substantial opsonic activity of the raised antibodies could be observed.

Figure 2 shows a Western Blot of antibodies against *Enterococcus faecium* strain E155 reacted with proteins derived from the homologous strain. Lane 1 is a molecular weight marker. In lane 2 a lysate of *E.faecium* E155 cells was applied. In lane 3 the supernatant of *E.faecium* E155 culture was applied.

Figure 3 is a Western Blot with a recombinantly expressed and purified polypeptide having SEQ ID NO:1. The purified polypeptide has been originally derived from strain *Enterococcus faecium* E155. Using appropriate primers the gene has been amplified by PCR and cloned into an expression vector for gram-negative bacteria. The protein produced by the host cells has been purified with a Ni-column through a His-Tag. The purified protein was used for the production of polyclonal antibodies in rabbits. The antibodies were used in the Western Blot as shown in Figure 3 and tested for opsonic activity. The specificity of the opsonic antibodies has been confirmed by absorption with the purified protein.

Figure 4 shows the results of an ELISA test performed with the purified polypeptide having SEQ ID NO:1 and in comparison thereto with serum raised against heat-inactivated bacteria (alpha E155) and normal rabbit serum (NSA).

Figure 5 shows the results of the opsonophagocytic inhibition obtained with the polypeptide having SEQ ID NO:1.

SEQ ID NO:1 shows the amino acid sequence of the polypeptide according to the invention derived from strain *Enterococcus faecium* E155.

Example 1:

In an attempt to identify targets of opsonic antibodies in *E. faecium* a rabbit was immunized with heat-killed *E. faecium* strain E155 [Leavis, H.L. et al. (2007). Insertion sequence-driven diversification creates a globally dispersed emerging multiresistant subspecies of *E. faecium*. PLoS Pathog 3:e7] belonging to the clonal complex 17 (CC17) that is associated with hospital outbreaks of vancomycin-resistant enterococci (VRE) [Top, J. et al., (2008). Emergence of CC17 *Enterococcus faecium*: from commensal to hospital-adapted pathogen. FEMS Immunol Med Microbiol 52:2997-308]. Bacteria were heat-killed at 65°C for 1 hour and a final concentration of 1.4×10^{12} cfu/dose was injected i.v. 3 times per week for a total of 3 weeks. The resulting sera were opsonic against the homologous strain (77.8% killing at a serum-dilution 1:100). The results are shown in Fig. 1.

Example 2:

Western blot analysis showed a distinct protein band of ca. 54 kDa that was present in cellular extracts and even more pronounced in the culture supernatant. (The results are shown in Fig. 2.).

Example 3:

All five tested *E. faecium* strains expressed a protein band of the same size that was detected by the immune rabbit serum (data not shown). Nano LC-ES-MS/MS analysis of the Coomassie blue stained gel band resulted in sequence data that were compared to NCBI

and MASCOT databases. The highest homology (score 1253) was obtained with NLP/P60, a 55 kDa protein from *E. faecium* DO (Accession No Gi | 69245436) [Anantharaman, V. et al. (2003). Evolutionary history, structural features and biochemical diversity of the NlpC/P60 superfamily of enzymes. *Genome Biol* 4:R11].

The gene was subsequently amplified from *E. faecium* E155 by PCR and cloned into a his-tag expression vector (Champion pET Directional TOPO Expression Kit, Invitrogen). The expressed protein was purified on nickel columns under denaturing conditions and the purified protein was shown to be reactive with the rabbit sera raised against whole *E. faecium* E155 cells. (The results are shown in Fig. 3).

Example 4:

A rabbit was immunized with the purified protein (2 times 10 µg subcutaneous (SC) mixed with incomplete Freud's adjuvant and given 2 weeks apart and in the third week 3 times 5 µg IV) without adjuvant. Two weeks after the last injection, titers were checked by ELISA (see Fig. 4), and by opsonophagocytic assay (see Fig. 5).

Example 5:

To confirm specificity an opsonophagocytic inhibition assay was done showing that 100 µg of purified protein was able to inhibit killing by almost 100%, while lower amounts inhibited killing in a dose-dependent fashion (see Fig. 5). The opsonophagocytic assay was done as described elsewhere [Theilacker, C. et al. Opsonic antibodies to *Enterococcus faecalis* strain 12030 are directed against lipoteichoic acid. *Infect Immun* (2006) 74: 5703-12]. In brief, baby rabbit serum (1:15 dilution), human PMNs, and appropriate serum dilutions were mixed with bacteria grown to logarithmic phase (ratio bacteria to PMNs 1:1). The mixture was incubated on a rotor rack at 37°C. After 90 min leukocytes were lysed and appropriate dilutions were plated onto tryptic soy agar plates. The plates were incubated over night and colonies were counted the following day.

In summary, these data confirm that the polypeptide having SEQ ID NO:1 from *E. faecium* is a vaccine candidate inducing opsonic antibodies against clinical isolates of vancomycin-resistant *E. faecium*.

Example 6:

Protective efficacy of antibodies against polypeptide having SEQ ID NO:1 was shown in a mouse bacteremia model. Female balb/c mice (8 mice per group) received 200 µl normal rabbit serum (NRS) or serum raised against polypeptide having SEQ ID NO:1 (IRS). The animals were challenged with *E. faecium* E155 after 24 hours (1.18×10^{10} cfu/mouse) and received a second dose of 200 µl rabbit serum (either NRS or IRS) 2h after inoculation. Mice were sacrificed 8 hours after infection and colony counts in the blood were determined. These results show a statistically significant reduction on colony counts from blood when mice received IRS.

E. faecium possesses a cell-surface associated protein of approximately 54 kD that is secreted into the culture medium and induces specific antibodies in rabbits immunized with heat-killed *E. faecium*. The protein was identified by Nano LC-ES-MS/MS analysis, amplified by PCR, and cloned into a gram-negative expression vector. Purified recombinant protein was used to immunize a rabbit and the resulting antiserum was shown by ELISA to bind specifically to the protein. Rabbit sera killed the homologous strain >50% at a serum dilution of 1:10 and the killing activity could be completely absorbed with the purified antigen. Two applications of serum (24h before and 2h after inoculation) statistically reduced colony counts in the blood of mice confirming that this antigen is a promising vaccine target for vancomycin resistant *Enterococcus* (VRE) bacteremia.

Claims

1. Medicament for the treatment or the prevention of a bacterial infection, characterized in that it contains a polypeptide having a contiguous sequence of at least six amino acids of SEQ ID NO:1.
2. Medicament according to claim 1 whereby the polypeptide is covalently bound to an immunocarrier, in particular a protein, a carbohydrate, and/or a glycoconjugate.
3. Medicament according to claim 1 or 2, characterized in that the bacterial infection is caused by *Enterococcus*.
4. Medicament according to any of claims 1 to 3, characterized in that it comprises a pharmaceutically acceptable adjuvant.
5. Medicament according to any of claims 1 to 4, characterized in that it is a vaccine.
6. Medicament according to claims 1 to 5, characterized in that it is a vaccine against an infection caused by a strain of *Enterococcus*, in particular *Enterococcus faecium* or *E. faecalis*.
7. Use of a polypeptide having a contiguous sequence of at least six amino acids of SEQ ID NO:1 for the preparation of a medicament for the treatment or prevention of a bacterial infection.
8. Use according to claim 7 wherein the polypeptide is covalently bound to an immunocarrier.

9. Use according to claim 7 or 8 wherein the infection is caused by *Enterococcus faecium* or *E. faecalis*.
10. Use of a polypeptide having a contiguous sequence of at least six amino acids of SEQ ID NO:1 for the preparation of antibodies.
11. Use according to claim 10 whereby the polypeptide is covalently bound to an immunocarrier.
12. Polyclonal antibodies which react specifically with a polypeptide having a contiguous sequence of at least six amino acids of SEQ ID NO:1, or said polypeptide covalently linked to an immunocarrier.
13. Monoclonal antibody which reacts specifically with a polypeptide having a contiguous sequence of at least six amino acids of SEQ ID NO:1, or said polypeptide covalently linked to an immunocarrier.
14. Antibody according to claim 12 or 13, characterized in that the antibody is opsonic.

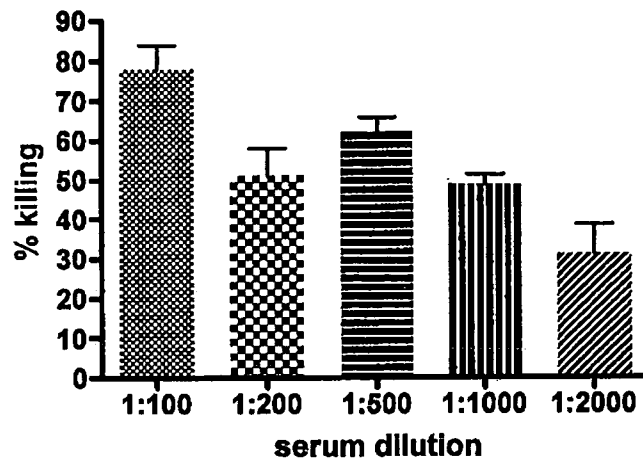
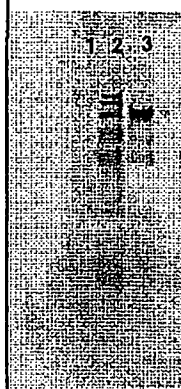
Fig. 1: Opsonic killing of rabbit serum against *E. faecium* E155

Fig. 2: Western blot with E155 serum against the homologue strain



1. Molecular weight marker
2. *E. faecium* E155 cells
3. *E. faecium* E155 supernatant

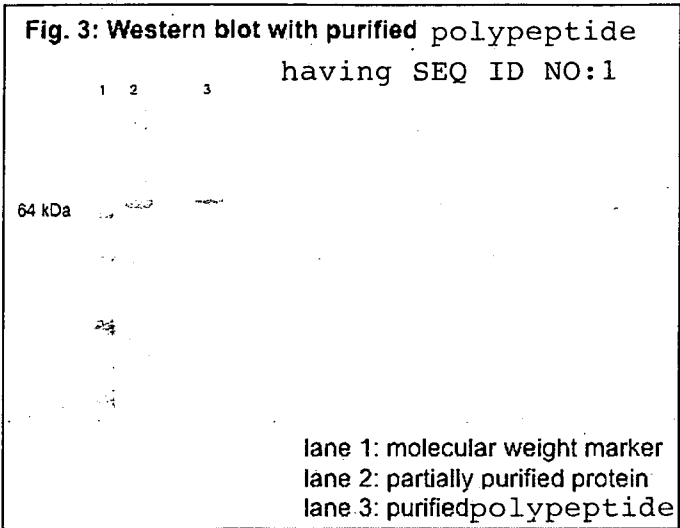
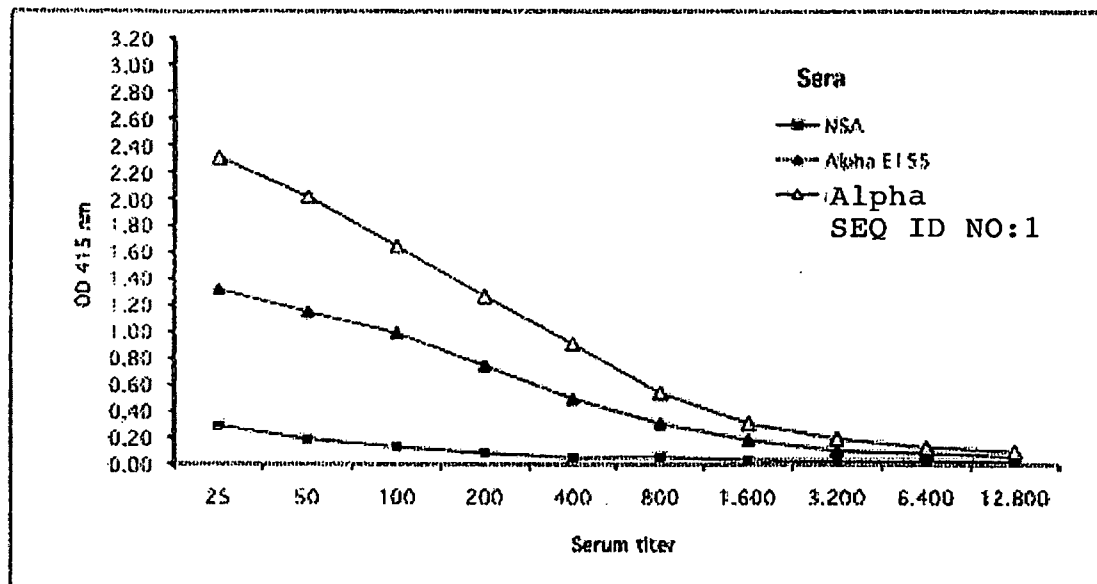


Fig. 4: ELISA with purified polypeptide having SEQ ID NO:1

NSA: rabbit serum before immunization
 alpha E155: serum raised against heat-killed bacteria
 alpha SEQ ID NO:1 serum raised against recombinant protein

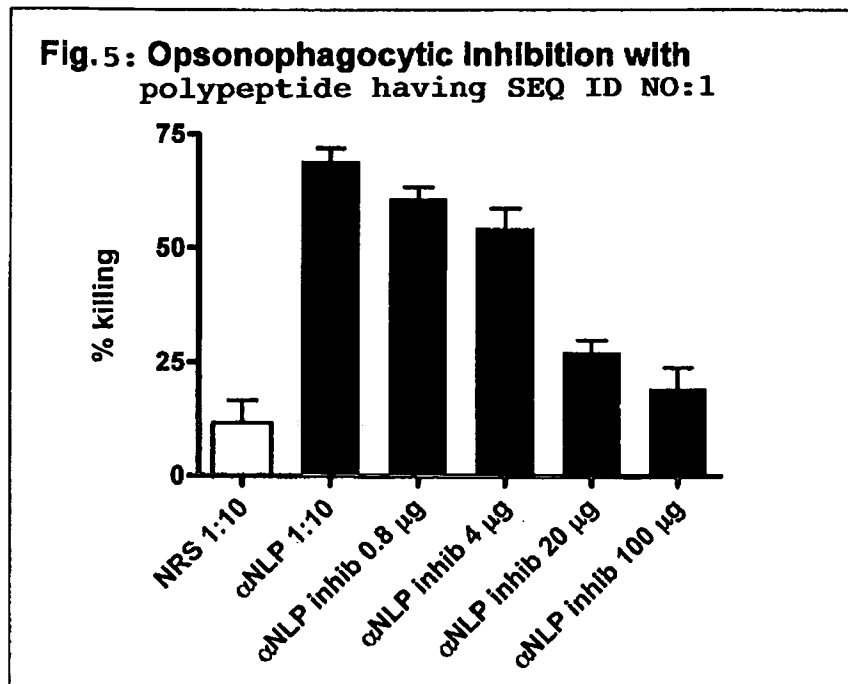
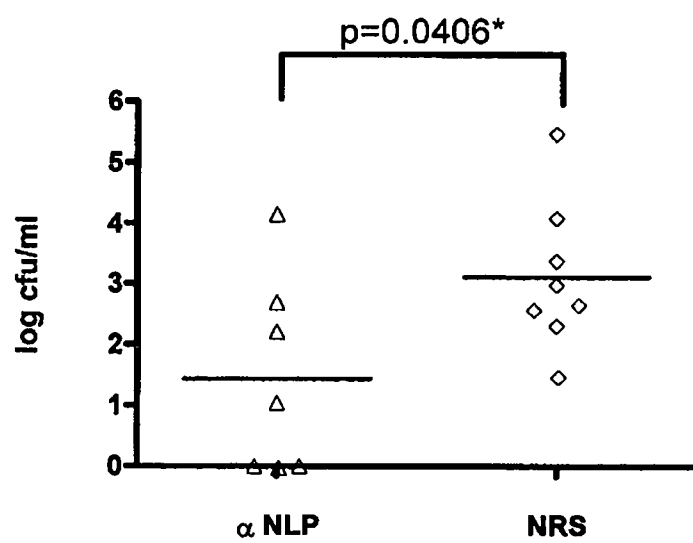


Fig. 6: Mouse Bacteremia with *E. faecium* E155

* unpaired t-test

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2010/002557

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61K39/02 C07K16/12
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61K C07K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, BIOSIS, Sequence Search, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>TENG FANG ET AL: "An Enterococcus faecium secreted antigen, SagA, exhibits broad-spectrum binding to extracellular matrix proteins and appears essential for E. faecium growth." INFECTION AND IMMUNITY, vol. 71, no. 9, September 2003 (2003-09), pages 5033-5041, XP002531569 ISSN: 0019-9567 see the whole document & DATABASE UniProt [Online] 1 October 2000 (2000-10-01), "SubName: Full=SagA; SubName: Full=Secreted antigen SagA;" retrieved from EBI accession no. UNIPROT:Q9K2J9 Database accession no. Q9K2J9 -----</p>	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

8 June 2010

Date of mailing of the international search report

18/06/2010

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

Grosskopf, Ruediger

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2010/002557

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-11

Medicament for the treatment or prevention of a bacterial infection characterized in that it contains a polypeptide having a continuous sequence of at least six amino acids of
SEQ ID NO: 1

2. claims: 12-14

Antibodies which react specifically with a polypeptide having a contiguous sequence of at least six amino acids of
SEQ ID NO: 1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/EP2010/002557

Box No. I Nucleotide and/or amino acid sequence(s) (Continuation of item 1.b of the first sheet)

1. With regard to any nucleotide and/or amino acid sequence disclosed in the international application and necessary to the claimed invention, the international search was carried out on the basis of:

a. (means)



on paper



in electronic form

b. (time)



in the international application as filed



together with the international application in electronic form



subsequently to this Authority for the purpose of search

2. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

3. Additional comments: