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(54) **Title**: EXPRESSION OF A SINGLE CHAIN ANTIBODY AGAINST SALMONELLA IN LACTOBACILLUS

(57) **Abstract**: The present disclosure relates to camel id antibodies that inhibit growth, and colonization of Salmonella serovars. The present disclosure also relates to a modified *Lactobacillus* as a delivery vehicle for controlling salmonella in a host organism.

EXPRESSION OF A SINGLE CHAIN ANTIBODY AGAINST SALMONELLA IN LACTOBACILLUS

FIELD OF INVENTION

[0001] The current disclosure relates to the field of microbiology and genetic engineering. The current disclosure provides recombinant chimeric proteins and antibodies directed against salmonella.

BACKGROUND OF THE INVENTION

[0002] Fermented food products have been developed and used by mankind with the aid of lactic acid bacteria (LAB), which have been classified as probiotics and are categorized as generally recognized as safe (GRAS) by the United states Food & Drug Administration (USFDA). In addition to be considered as the powerhouses for the food industry, LAB continue to be the focus of considerable interest as probiotic organisms, since they have also been conferred with specific health promoting functions which they execute by modulating the gut environment of the host.

[0003] Their ability to adhere to certain areas of the gastrointestinal tract has created interests to tap the potential of such microbes as vehicles for the delivery of biologically active compounds & vaccines (Pouwels *et al.*, *Int J Food Microbiol.*, 1998, *41*, 155-157).

[0004] Most infectious organisms gain entry at the mucosal surfaces, there is a great deal of interest in developing vaccines that elicit effective mucosal immune responses against various pathogens. LAB, which are safe and nonpathogenic, are excellent mucosal delivery vehicles for heterologous antigens and therapeutic proteins. Many LABs produce extracellular polysaccharides and these have been extensively studied in terms of their biosynthesis, structure & function and engineering , including the importance of these molecules in host microbe interactions (Leeber *et al.*, *Microbial Biotechnology*, 2011, *4(3)*, 368-374).

[0005] Camelids produce functional antibodies devoid of light chains of which the single N-terminal domain is fully capable of antigen binding and could be delivered on mucosal surfaces by the lactic acid bacteria for various therapeutic interventions. The unique physicochemical and pharmacological properties of these camelid heavy chain antibody (VHH) fragments have led to its prospective use as new generation therapeutic agents. The remarkable preference of VHH fragments to bind clefts and cavities on protein surfaces offers the possibility to develop selective therapeutics (Paalanen *et al.*, *Eur J Pharm Sci.*, 2011, *42(4)*,332-9) by activity modulation of cell surface proteins, such as receptors, ion channels involved in various biological activities (Wei *et al.*, *PLoS ONE*, 2011, *6(12)*. Moreover, VHH fragment molecules recognize cryptic epitopes hidden deeply in clefts of various pathogens (Forsman *et al.*, *J. Virol.*, 2008, *82(24)*, 12069-12081) and have high structural stability and solubility (Muyldermans *et al.*, *Biochem Sci.*, 2001, *26*, 230-235; Philipp *et al.*, *Nat. Biotechnol.*, 2005, *23(9)*, 1126-1136).

[0006] Salmonellosis is the most common food borne disease and gastrointestinal infection across the world. Salmonella is the second major cause of food borne diseases in U.S, Europe & in the world causing as many as 1.3 billion cases of diseases annually. In addition to the health consequences, Salmonella species with about 2600 existing serovars are being identified belonging to six subspecies (Coburn *et al.*, *Immunology and Cell Biology*, 2007, *85*, 112-118; Ochman *et al.*, *EXS*, 1994, *69*, 479-493). Sub species are further sub divided into serovars that are differentiated by their flagellar, carbohydrate and lipopolysaccharide (LPS) structures. S. enteric species are typically orally acquired pathogens that cause one of the four major syndromes, Enteric fever (typhoid) enterocolitis/diarrhea, bacteremia and chronic asymptomatic carriage. The disease manifestation depends on both host susceptibility and the infectious. S. enteric serovar (Fierer *et al.*, *J Clin Invest.*, 2001, *107*,775-780). Prominent inflammatory disease outcomes are a common feature of typhoid & enterocolitis. The various patho-biological outcomes of infection are mainly due to

the interaction of the salmonella species with host defence mechanisms at various tissues in different stages of infection. This results in significant host immunopathology, morbidity and mortality.

[0007] Salmonella is a significant pathogen for food producing animals and these animals are the primary source of salmonellosis. It is one of the most commonly isolated food borne pathogens associated with poultry, raw meats, eggs, milk and dairy products, fresh farm produce like fruits & vegetables etc. In recent years, the incidence of food borne outbreaks caused by the contamination of fresh fruits and vegetables has increased and become a great concern in industrialized countries.

[0008] The major types of vaccines used to control salmonellosis are the killed bacteria vaccine, subunit vaccines and live attenuated vaccines. Comparative analysis of live and killed vaccines revealed that killed vaccines are usually less effective as they comprise of surface antigens that give rise to inadequate protective immune response, they fail to elicit secretory immune response at the mucosal surfaces which is critical in inhibiting the colonization of the pathogens at the mucosal surface. Attempts to overcome all these shortcomings by the use of various adjuvants has led to only partial success (Smith, *J Hyg.*, 1956, *54*, 419-432; Singh *et al.*, *Haryana Vet.*, 2005, *44*, 1-12; Baljer *et al.*, *J Med Vet.*, 1986, *33*, 206-212).

[0009] The utility of live vaccines in eradication of salmonellosis is limited, as there are multiple serovars of salmonella and vaccines made from any one serovar do not confer cross protection against another serovar. The organisms are capable to adapt in different animal species whilst still maintaining their zoonotic and interspecies transfer potential. Moreover, effective vaccines against some host adapted and common serovars in the primary source of host have been developed but their use has led to the emergence of other serovars. This has been further compounded by the international trade and movement of animal and farm products which has led various serovars to cross continental boundaries. Thus, there is a need in the art to develop anti-salmonella biological and it is desirable to develop and provide an alternative means for the control and management of enteropathogenic salmonella, by therapy and/or prophylaxis.

[0010] EP1066375B1 relates to use of transformed *Lactobacillus* species as vaccine delivery vehicles.

[0011] US2008/0206233 A1 relates to heavy chain immunoglobulins or fragments thereof of the VHH or VNAR type or domain antibodies (dAbs) suitable for use in the management of infections, particularly of the gastrointestinal tract.

[0012] US2009/0226418 A1 relates to food products or pharmaceutical preparations comprising antibodies or antibody fragments which are active in the gut and probiotic microorganisms independent from their antibodies or antibody fragments.

SUMMARY OF THE INVENTION

[0013] An aspect of the present disclosure relates to a single chain antibody or a fragment thereof against salmonella surface proteins, comprising of 3 complementarity determining regions.

[0014] An aspect of the present disclosure relates to a recombinant host cell expressing on the surface one or more chimeric proteins, wherein the chimeric protein comprises of (a) at least one single chain antibody or a fragment thereof against salmonella surface proteins, comprising of 3 complementarity determining regions, and (b) at least one protein that is expressed on the surface of the recombinant host cell, wherein the surface protein expressed in the recombinant host cell is MuB or CnBP.

[0015] An aspect of the present disclosure relates to a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against salmonella surface proteins, comprising of three complementarity determining regions.

[0016] An aspect of the present disclosure relates to a recombinant DNA vector comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions.

[0017] An aspect of the present disclosure relates to a recombinant host cell comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions.

[0018] An aspect of the present disclosure relates to a recombinant host cell comprising a recombinant DNA vector comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions.

[0019] An aspect of the present disclosure relates to a chimeric protein comprising amino acid sequence selected from the group consisting of SEQ ID NO:93, 95, 97, 99, 101, 130, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195, 197, 199, 201, 203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227 , 229, 231, 233, 235, 237, 239, 241, and 243.

[0020] An aspect of the present disclosure relates to a food product comprising a recombinant host cell comprising of a single chain antibody or a fragment thereof against salmonella surface proteins, comprising of 3 complementarity determining regions.

[0021] An aspect of the present disclosure relates to a food product comprising a recombinant host cell comprising a recombinant DNA vector comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against salmonella surface proteins, comprising of three complementarity determining regions.

[0022] An aspect of the present disclosure relates to a food product comprising a recombinant host cell comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof

against salmonella surface proteins, comprising of three complementarity determining regions.

[0023] An aspect of the following disclosure relates to a formulation comprising a single chain antibody or a fragment thereof against salmonella surface proteins, comprising of 3 complementarity determining regions, additionally consisting of a diluent, excipient or a carrier.

[0024] An aspect of the present disclosure relates to a method of inhibiting the growth of salmonella, said method comprising contacting a food product comprising a single chain antibody or a fragment thereof with a sample containing salmonella.

[0025] An aspect of the present disclosure relates to a method of inhibiting activity of salmonella, said method comprising contacting a food product comprising a single chain antibody or a fragment thereof with sample containing salmonella.

[0026] An aspect of the present disclosure relates to an isolated lactobacillus strain, *Lactobacillus reuteri* 1LB7 deposited with Microbial Type Culture Collection and Gene Bank (MTCC) having accession number 5894 for management of enteric Salmonella population in animal husbandry.

[0027] This summary is not intended to identify essential features of the claimed subject matter nor is it intended for use in determining or limiting the scope of the claimed subject matter.

BRIEF DESCRIPTION OF ACCOMPANYING DRAWINGS

[0028] The following drawings form part of the present specification and are included to further illustrate aspects of the present disclosure. The disclosure may be better understood by reference to the drawings in combination with the detailed description of the specific embodiments presented herein.

[0029] Figure 1 depicts the effect of secreted anti-salmonella camelid VHH antibody fragments in a milk based formulation on growth of salmonella, in accordance with an embodiment of the present disclosure.

[0030] Figure 2 depicts the effect of secreted anti-salmonella camelid VHH antibody fragments in an egg based formulation on growth of salmonella, in accordance with an embodiment of the present disclosure.

[0031] Figure 3 depicts the effect of heat inactivated modified *Lactobacillus reuteri* expressing on its surface anti-salmonella camelid VHH antibody fragment on growth of salmonella, in accordance with an embodiment of the present disclosure.

[0032] Figure 4 depicts the effect of secreted anti-salmonella camelid VHH antibody fragments on growth of *Salmonella typhimurium*, in accordance with an embodiment of the present disclosure.

[0033] Figure 5 depicts the effect of secreted anti-salmonella camelid VHH antibody fragments on growth of *Salmonella gallinarium*, in accordance with an embodiment of the present disclosure.

[0034] Figure 6 depicts the effect of secreted anti-salmonella camelid VHH antibody fragments on growth of *Salmonella newport*, in accordance with an embodiment of the present disclosure.

[0035] Figure 7 depicts the effect of secreted anti-salmonella camelid VHH antibody fragments on growth of *Salmonella abony*, in accordance with an embodiment of the present disclosure.

[0036] Figure 8 depicts the vector map used to clone, in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

[0037] Those skilled in the art will be aware that the invention described herein is subject to variations and modifications other than those specifically described. It is to be understood that the invention described herein includes all such variations and modifications. The invention also includes all such steps, features, compositions and methods referred to or indicated in this specification, individually or collectively, and any and all combinations of any two or more of said steps or features.

Definitions

[0038] For convenience, before further description of the present invention, certain terms employed in the specification, examples are collected here. These definitions should be read in light of the remainder of the disclosure and understood as by a person of skill in the art. Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by a person of ordinary skill in the art. The terms used throughout this specification are defined as follows, unless otherwise limited in specific instances.

[0039] As used in the specification and the claims, the singular forms "a", "an", and "the" include plural referents unless the context clearly dictates otherwise.

[0040] The present disclosure is not to be limited in scope by the specific embodiments described herein, which are intended for the purposes of exemplification only

[0041] Functionally-equivalent processes and methods are clearly within the scope of the disclosure, as described herein.

Brief description of sequences

[0042] SEQ ID NO: 1 shows the CDR1 amino acid sequence of antibody A, I, J, K, and L.

[0043] SEQ ID NO: 2 shows the CDR2 amino acid sequence of antibody A.

[0044] SEQ ID NO: 3 shows the CDR3 amino acid sequence of antibody A, B, I, J, K, and L.

[0045] SEQ ID NO: 4 shows the CDR1 amino acid sequence of antibody B.

[0046] SEQ ID NO: 5 shows the CDR2 amino acid sequence of antibody B.

[0047] SEQ ID NO: 6 shows the CDR1 amino acid sequence of antibody C.

[0048] SEQ ID NO: 7 shows the CDR2 amino acid sequence of antibody C, E, F, and G.

[0049] SEQ ID NO: 8 shows the CDR3 amino acid sequence of antibody C, E, F, and G.

[0050] SEQ ID NO: 9 shows the CDR1 amino acid sequence of antibody D.

[0051] SEQ ID NO: 10 shows the CDR2 amino acid sequence of antibody D.

[0052] SEQ ID NO: 11 shows the CDR3 amino acid sequence of antibody D.

[0053] SEQ ID NO: 12 shows the CDR1 amino acid sequence of antibody E, F, and G.

[0054] SEQ ID NO: 13 shows the CDR1 amino acid sequence of antibody H, N, and O.

[0055] SEQ ID NO: 14 shows the CDR2 amino acid sequence of antibody H, N, and O.

[0056] SEQ ID NO: 15 shows the CDR3 amino acid sequence of antibody H, N, and O.

[0057] SEQ ID NO: 16 shows the CDR2 amino acid sequence of antibody I.

[0058] SEQ ID NO: 17 shows the CDR2 amino acid sequence of antibody J, and L.

[0059] SEQ ID NO: 18 shows the CDR2 amino acid sequence of antibody K.

[0060] SEQ ID NO: 19 shows the CDR1 amino acid sequence of antibody M.

[0061] SEQ ID NO: 20 shows the CDR2 amino acid sequence of antibody M.

[0062] SEQ ID NO: 21 shows the CDR3 amino acid sequence of antibody M.

[0063] SEQ ID NO: 22 shows the CDR1 amino acid sequence of antibody P.

[0064] SEQ ID NO: 23 shows the CDR2 amino acid sequence of antibody P.

[0065] SEQ ID NO: 24 shows the CDR3 amino acid sequence of antibody P.

[0066] SEQ ID NO: 25 shows the CDR1 amino acid sequence of antibody Q, R, and S.

[0067] SEQ ID NO: 26 shows the CDR2 amino acid sequence of antibody Q, R, and S.

[0068] SEQ ID NO: 27 shows the CDR3 amino acid sequence of antibody Q, R, and S.

[0069] SEQ ID NO: 28 shows the CDR1 nucleotide sequence of antibody A, I, J, K, and L.

[0070] SEQ ID NO: 29 shows the CDR2 nucleotide sequence of antibody A.

[0071] SEQ ID NO: 30 shows the CDR3 nucleotide sequence of antibody A, B, I, J, K, and L.

[0072] SEQ ID NO: 31 shows the CDR1 nucleotide sequence of antibody B.

[0073] SEQ ID NO: 32 shows the CDR2 nucleotide sequence of antibody B.

[0074] SEQ ID NO: 33 shows the CDR1 nucleotide sequence of antibody C.

[0075] SEQ ID NO: 34 shows the CDR2 nucleotide sequence of antibody C, E, F, and G.

[0076] SEQ ID NO: 35 shows the CDR3 nucleotide sequence of antibody C, E, F, and G.

[0077] SEQ ID NO: 36 shows the CDR1 nucleotide sequence of antibody D.

[0078] SEQ ID NO: 37 shows the CDR2 nucleotide sequence of antibody D.

[0079] SEQ ID NO: 38 shows the CDR3 nucleotide sequence of antibody D.

[0080] SEQ ID NO: 39 shows the CDR1 nucleotide sequence of antibody E, F, and G.

[0081] SEQ ID NO: 40 shows the CDR1 nucleotide sequence of antibody H, N, and O.

[0082] SEQ ID NO: 41 shows the CDR2 nucleotide sequence of antibody H, N, and O.

[0083] SEQ ID NO: 42 shows the CDR3 nucleotide sequence of antibody H, N, and O.

[0084] SEQ ID NO: 43 shows the CDR2 nucleotide sequence of antibody I.

[0085] SEQ ID NO: 44 shows the CDR2 nucleotide sequence of antibody J, and L.

[0086] SEQ ID NO: 45 shows the CDR2 nucleotide sequence of antibody K.

[0087] SEQ ID NO: 46 shows the CDR1 nucleotide sequence of antibody M.

[0088] SEQ ID NO: 47 shows the CDR2 nucleotide sequence of antibody M.

[0089] SEQ ID NO: 48 shows the CDR3 nucleotide sequence of antibody M.

[0090] SEQ ID NO: 49 shows the CDR1 nucleotide sequence of antibody P.

[0091] SEQ ID NO: 50 shows the CDR2 nucleotide sequence of antibody P.

[0092] SEQ ID NO: 51 shows the CDR3 nucleotide sequence of antibody P.

[0093] SEQ ID NO: 52 shows the CDR1 nucleotide sequence of antibody Q, R, and S.

[0094] SEQ ID NO: 53 shows the CDR2 nucleotide sequence of antibody Q, R, and S.

[0095] SEQ ID NO: 54 shows the CDR3 nucleotide sequence of antibody Q, R, and S.

[0096] SEQ ID NO: 55 shows the amino acid sequence of antibody A.

[0097] SEQ ID NO: 56 shows the nucleotide sequence of antibody A.

[0098] SEQ ID NO: 57 shows the amino acid sequence of antibody B.

[0099] SEQ ID NO: 58 shows the nucleotide sequence of antibody B.

[00100] SEQ ID NO: 59 shows the amino acid sequence of antibody C.

[00101] SEQ ID NO: 60 shows the nucleotide sequence of antibody C.

[00102] SEQ ID NO: 61 shows the amino acid sequence of antibody D.

[00103] SEQ ID NO: 62 shows the nucleotide sequence of antibody D.

[00104] SEQ ID NO: 63 shows the amino acid sequence of antibody E.

[00105] SEQ ID NO: 64 shows the nucleotide sequence of antibody E.

[00106] SEQ ID NO: 65 shows the amino acid sequence of antibody F.

[00107] SEQ ID NO: 66 shows the nucleotide sequence of antibody F.

[00108] SEQ ID NO: 67 shows the amino acid sequence of antibody G.

[00109] SEQ ID NO: 68 shows the nucleotide sequence of antibody G.

[00110] SEQ ID NO: 69 shows the amino acid sequence of antibody H.

[00111] SEQ ID NO: 70 shows the nucleotide sequence of antibody H.

[00112] SEQ ID NO: 71 shows the amino acid sequence of antibody I.

[00113] SEQ ID NO: 72 shows the nucleotide sequence of antibody I.

[00114] SEQ ID NO: 73 shows the amino acid sequence of antibody J.

[00115] SEQ ID NO: 74 shows the nucleotide sequence of antibody J.

[00116] SEQ ID NO: 75 shows the amino acid sequence of antibody K.

[00117] SEQ ID NO: 76 shows the nucleotide sequence of antibody K.

[00118] SEQ ID NO: 77 shows the amino acid sequence of antibody L.

[00119] SEQ ID NO: 78 shows the nucleotide sequence of antibody L.

[00120] SEQ ID NO: 79 shows the amino acid sequence of antibody M.

[00121] SEQ ID NO: 80 shows the nucleotide sequence of antibody M.

[00122] SEQ ID NO: 81 shows the amino acid sequence of antibody N.

[00123] SEQ ID NO: 82 shows the nucleotide sequence of antibody N.

[00124] SEQ ID NO: 83 shows the amino acid sequence of antibody O.

[00125] SEQ ID NO: 84 shows the nucleotide sequence of antibody O.

[00126] SEQ ID NO: 85 shows the amino acid sequence of antibody P.

[00127] SEQ ID NO: 86 shows the nucleotide sequence of antibody P.

[00128] SEQ ID NO: 87 shows the amino acid sequence of antibody Q.

[00129] SEQ ID NO: 88 shows the nucleotide sequence of antibody Q.

[00130] SEQ ID NO: 89 shows the amino acid sequence of antibody R.

[00131] SEQ ID NO: 90 shows the nucleotide sequence of antibody R.

[00132] SEQ ID NO: 91 shows the amino acid sequence of antibody S.

[00133] SEQ ID NO: 92 shows the nucleotide sequence of antibody S.

[00134] SEQ ID NO: 93, 131, and 169 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody A and MuB.

[00135] SEQ ID NO: 94, 132, and 170 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody A and MuB.

[00136] SEQ ID NO: 95, 133, and 171 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody B and MuB.

[00137] SEQ ID NO: 96, 134, and 172 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody B and MuB.

[00138] SEQ ID NO: 97, 135, and 173 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody C and MuB.

[00139] SEQ ID NO: 98, 136, and 174 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody C and MuB.

[00140] SEQ ID NO: 99, 137, and 175 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody D and MuB.

[00141] SEQ ID NO: 100, 138, and 176 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody D and MuB.

[00142] SEQ ID NO: 101, 139, and 177 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody E and MuB.

[00143] SEQ ID NO: 102, 140 and 178 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody E and MuB.

[00144] SEQ ID NO: 103, 141, and 179 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody F and MuB.

[00145] SEQ ID NO: 104, 142, and 180 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody F and MuB.

[00146] SEQ ID NO: 105, 143, and 181 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody G and MuB.

[00147] SEQ ID NO: 106, 144, and 182 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody G and MuB.

[00148] SEQ ID NO: 107, 145, and 183 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody H and MuB.

[00149] SEQ ID NO: 108, 146, and 184 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody H and MuB.

[00150] SEQ ID NO: 109, 147, and 185 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody I and MuB.

[00151] SEQ ID NO: 110, 148, and 186 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody I and MuB.

[00152] SEQ ID NO: 111, 149, and 187 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody J and MuB.

[00153] SEQ ID NO: 112, 150, and 188 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody J and MuB.

[00154] SEQ ID NO: 113, 151, and 189 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody K and MuB.

[00155] SEQ ID NO: 114, 152, and 190 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody K and MuB.

[00156] SEQ ID NO: 115, 153, and 191 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody L and MuB.

[00157] SEQ ID NO: 116, 154, and 192 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody L and MuB.

[00158] SEQ ID NO: 117, 155, and 193 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody M and MuB.

[00159] SEQ ID NO: 118, 156, and 194 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody M and MuB.

[00160] SEQ ID NO: 119, 157, and 195 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody N and MuB.

[00161] SEQ ID NO: 120, 158, and 196 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody N and MuB.

[00162] SEQ ID NO: 121, 159, and 197 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody O and MuB.

[00163] SEQ ID NO: 122, 160, and 198 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody O and MuB.

[00164] SEQ ID NO: 123, 161, and 199 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody P and MuB.

[00165] SEQ ID NO: 124, 162, and 200 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody P and MuB.

[00166] SEQ ID NO: 125, 163, and 201 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody Q and MuB.

[00167] SEQ ID NO: 126, 164, and 202 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody Q and MuB.

[00168] SEQ ID NO: 127, 165, and 203 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody R and MuB.

[00169] SEQ ID NO: 128, 166, and 204 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody R and MuB.

[00170] SEQ ID NO: 129, 167, and 205 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody S and MuB.

[00171] SEQ ID NO: 130, 168, and 206 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody S and MuB.

[00172] SEQ ID NO: 207 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody A and CnBP.

[00173] SEQ ID NO: 208 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody A and CnBP.

[00174] SEQ ID NO: 209 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody B and CnBP.

[00175] SEQ ID NO: 210 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody B and CnBP.

[00176] SEQ ID NO: 211 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody C and CnBP.

[00177] SEQ ID NO: 212 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody C and CnBP.

[00178] SEQ ID NO: 213 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody D and CnBP.

[00179] SEQ ID NO: 214 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody D and CnBP.

[00180] SEQ ID NO: 215 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody E and CnBP.

[00181] SEQ ID NO: 216 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody E and CnBP.

[00182] SEQ ID NO: 217 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody F and CnBP.

[00183] SEQ ID NO: 218 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody F and CnBP.

[00184] SEQ ID NO: 219 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody G and CnBP.

[00185] SEQ ID NO: 220 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody G and CnBP.

[00186] SEQ ID NO: 221 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody H and CnBP.

[00187] SEQ ID NO: 222 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody H and CnBP.

[00188] SEQ ID NO: 223 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody I and CnBP.

[00189] SEQ ID NO: 224 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody I and CnBP.

[00190] SEQ ID NO: 225 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody J and CnBP.

[00191] SEQ ID NO: 226 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody J and CnBP.

[00192] SEQ ID NO: 227 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody K and CnBP.

[00193] SEQ ID NO: 228 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody K and CnBP.

[00194] SEQ ID NO: 229 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody L and CnBP.

[00195] SEQ ID NO: 230 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody L and CnBP.

[00196] SEQ ID NO: 231 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody M and CnBP.

[00197] SEQ ID NO: 232 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody M and CnBP.

[00198] SEQ ID NO: 233 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody N and CnBP.

[00199] SEQ ID NO: 234 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody N and CnBP.

[00200] SEQ ID NO: 235 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody O and CnBP.

[00201] SEQ ID NO: 236 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody O and CnBP.

[00202] SEQ ID NO: 237 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody P and CnBP.

[00203] SEQ ID NO: 237 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody P and CnBP.

[00204] SEQ ID NO: 239 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody Q and CnBP.

[00205] SEQ ID NO: 240 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody Q and CnBP.

[00206] SEQ ID NO: 241 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody R and CnBP.

[00207] SEQ ID NO: 242 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody R and CnBP.

[00208] SEQ ID NO: 243 shows the contiguous amino acid sequence within the chimeric protein comprising of antibody S and CnBP.

[00209] SEQ ID NO: 244 shows the contiguous nucleotide sequence within the nucleotide sequence encoding the chimeric protein comprising of antibody S and CnBP.

[00210] SEQ ID NO: 245 shows the forward primer sequence for identification of *lactobacillus.*

[00211] SEQ ID NO: 246 shows the reverse primer sequence for identification of *lactobacillus.*

[00212] SEQ ID NO: 247 shows the forward primer sequence for identification of *Lactobacillus reuteri.*

[00213] SEQ ID NO: 248 shows the reverse primer sequence for identification of *Lactobacillus reuteri.*

[00214] SEQ ID NO: 249 shows the forward primer sequence for amplification of a 1.7kb partial MuB gene fragment.

[00215] SEQ ID NO: 250 shows the reverse primer sequence for amplification of a 1.7kb partial MuB gene fragment.

[00216] SEQ ID NO: 251 shows the forward primer sequence for amplification of the complete 1.08kb CnBP gene.

[00217] SEQ ID NO: 252 shows the reverse primer sequence for amplification of the complete 1.08kb CnBP gene.

[00218] SEQ ID NO: 253 shows the forward primer sequence for amplification of the 900bp VHH large insert.

[00219] SEQ ID NO: 254 shows the reverse primer sequence for amplification of the 900bp VHH large insert.

[00220] SEQ ID NO: 255 shows the forward primer sequence for the 4.7kb MuB gene inverse PCR product.

[00221] SEQ ID NO: 256 shows the reverse primer sequence for the 4.7kb MuB gene inverse PCR product.

[00222] SEQ ID NO: 257 shows the forward primer sequence for 400bp VHH insert in to the MuB gene.

[00223] SEQ ID NO: 258 shows the reverse primer sequence for 400bp VHH insert in to the MuB gene.

[00224] SEQ ID NO: 259 shows the forward primer sequence for the 1.7kb *L.reuteri* MuB gene fragment without restriction sites.

[00225] SEQ ID NO: 260 shows the reverse primer sequence for the 1.7kb *L.reuteri* MuB gene fragment without restriction sites.

[00226] SEQ ID NO: 261 shows the forward primer sequence for the 4.1kb CnBP gene inverse PCR product.

[00227] SEQ ID NO: 262 shows the reverse primer sequence for the 4.1kb CnBP gene inverse PCR product.

[00228] SEQ ID NO: 263 shows the forward primer sequence for the 400bp VHH insert in to the CnBP gene.

[00229] SEQ ID NO: 264 shows the reverse primer sequence for the 400bp VHH insert in to the CnBP gene.

[00230] SEQ ID NO: 265 shows the phosphoryalted forward primer sequence for the 1.4kb CnBP gene.

[00231] SEQ ID NO: 266 shows the phosphoryalted reverse primer sequence for the 1.4kb CnBP gene.

[00232] SEQ ID NO: 267 shows the forward primer sequence for the 1kb nucleotide fragment encoding salmonella FimH protein.

[00233] SEQ ID NO: 268 shows the reverse primer sequence for the 1kb nucleotide fragment sequence encoding salmonella FimH protein.

[00234] SEQ ID NO: 269 shows the forward primer sequence for the 1.1kb nucleotide fragment encoding salmonella OmPD protein.

[00235] SEQ ID NO: 270 shows the reverse primer sequence for the 1.1kb nucleotide fragment encoding salmonella OmPD protein.

[00236] SEQ ID NO: 271 shows the nucleotide sequence of the amplicon generated by primers as set forth in SEQ ID NO: 267 and 268.

[00237] SEQ ID NO: 272 shows the nucleotide sequence of the amplicon generated by primers as set forth in SEQ ID NO: 269 and 270.

[00238] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of 3 complementarity determining regions having amino acid sequence selected from the group consisting of: (a)SEQ ID NO: :1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3; (b)SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3; (c)SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (d)SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3; (e)SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (f)SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3; (g)SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3; (h)SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3; (i)SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3; (j)SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3; (k)S EQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and (l)SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00239] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of 3 complementarity determining regions encoded by a polynucleotide sequence selected

from the group consisting of: (a)SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3; (b)SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3; (c)SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (d)SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3; (e)SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (f)SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3; (g)SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3; (h)SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3; (i)SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3; (j)SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3; (k)SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and (l)SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00240] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody A, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 55 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 56.

[00241] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody B, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 57 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 58.

[00242] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody C, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 59 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 60.

[00243] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody D, against whole cell salmonella,

having amino acid sequence as set forth in SEQ ID NO: 61 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 62.

[00244] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody E, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 63 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 64.

[00245] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody E, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 65 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 66.

[00246] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody F, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 67 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 68.

[00247] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody G, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 69 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 70.

[00248] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody H, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 71 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 72.

[00249] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody I, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 73 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 74.

[00250] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody J, against whole cell salmonella,

having amino acid sequence as set forth in SEQ ID NO: 75 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 76.

[00251] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody K, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 77 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 78.

[00252] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody L, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 79 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 80.

[00253] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody M, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 81 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 82.

[00254] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody N, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 83 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 84.

[00255] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody O, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 85 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 86.

[00256] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody P, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 87 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 88.

[00257] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody Q, against whole cell salmonella,

having amino acid sequence as set forth in SEQ ID NO: 89 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 90.

[00258] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody R, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 91 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 92.

[00259] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, designated antibody S, against whole cell salmonella, having amino acid sequence as set forth in SEQ ID NO: 93 encoded by a polynucleotide sequence as set forth in SEQ ID NO: 94.

[00260] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof having amino acid sequence as set forth in SEQ ID NO: 55, 57, 59, 63, 65, 67, 71, 73, 75, 77, or 79 that binds to FimH protein of salmonella.

[00261] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof encoded by a nucleotide sequence as set forth in SEQ ID NO: 56, 58, 60, 64, 66, 68, 72, 74, 76, 78, or 80 that binds to FimH protein of salmonella.

[00262] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof having amino acid sequence as set forth in SEQ ID NO: 61, 69, 81, 83, or 85 that binds to OmPD protein of salmonella.

[00263] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof encoded by a nucleotide sequence as set forth in SEQ ID NO: 62, 70, 82, 84 or 86 that binds to OmPD protein of salmonella.

[00264] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof having amino acid sequence as set forth in SEQ ID NO: 87, 89, or 91 that bind to whole cell salmonella.

[00265] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof encoded by a nucleotide sequence as set forth in SEQ ID NO: 88, 90, or 92 that binds to whole cell salmonella.

[00266] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence selected from the group consisting of SEQ ID NO: 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, and 91.

[00267] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence selected from the group consisting of SEQ ID NO:56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, and 92.

[00268] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO: 55, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 1 for CDR1, SEQ ID NO: 2 for CDR2, and SEQ ID NO:3 for CDR3.

[00269] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO: 57, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3.

[00270] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO: 59, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3.

[00271] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO: 61, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3.

[00272] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO: 63, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 12 for CDR1, SEQ ID NO: 7 for CDR2, and SEQ ID NO:8 for CDR3.

[00273] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO: 65, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3.

[00274] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO: 67, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 12 for CDR1, SEQ ID NO: 7 for CDR2, and SEQ ID NO:8 for CDR3.

[00275] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO: 69, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid

sequence as set forth in SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3.

[00276] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO:71, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3.

[00277] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO:73, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3.

[00278] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO:75, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3.

[00279] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO:77, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3.

[00280] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO:79, wherein the single chain antibody or a

fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3.

[00281] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO:81, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3.

[00282] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO:83, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3.

[00283] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO:85, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3.

[00284] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO:87, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00285] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino

acid sequence as set forth in SEQ ID NO:89, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00286] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, having amino acid sequence as set forth in SEQ ID NO:91, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00287] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:56, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3.

[00288] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:58, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3.

[00289] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:60, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3.

[00290] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:62, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3.

[00291] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:64, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3.

[00292] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:66, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3.

[00293] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:68, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3.

[00294] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:70, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded

by a polynucleotide sequence as set forth in SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3.

[00295] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:72, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3.

[00296] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:74, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3.

[00297] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:76, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3.

[00298] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:78, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3.

[00299] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:80, wherein the single chain

antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3.

[00300] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:82, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3.

[00301] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:84, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3.

[00302] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:86, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3.

[00303] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:88, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00304] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a

polynucleotide sequence as set forth in SEQ ID NO:90, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00305] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against Salmonella surface proteins, encoded by a polynucleotide sequence as set forth in SEQ ID NO:92, wherein the single chain antibody or a fragment thereof has 3 complementarity determining regions encoded by a polynucleotide sequence as set forth in SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00306] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof that binds to Salmonella.

[00307] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof that binds to FimH protein in Salmonella.

[00308] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof having amino acid sequence selected from the group consisting of SEQ ID NO:55, 57, 59, 63, 65, 67, 71, 73, 75, 77, and 79, wherein said single chain antibody or a fragment thereof binds to FimH protein in Salmonella.

[00309] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof encoded by a polynucleotide sequence selected from the group consisting of SEQ ID NO:56, 58, 60, 64, 66, 68, 72, 76, 78, and 80, wherein said single chain antibody or a fragment thereof binds to FimH protein in Salmonella.

[00310] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof that binds to OmPD protein in Salmonella.

[00311] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof having amino acid sequence selected from the group consisting of SEQ ID NO:61, 69, 81, 83, and 85, wherein said single chain antibody or a fragment thereof binds to OmPD protein in Salmonella.

[00312] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof encoded by a polypeptide sequence selected from the group consisting of SEQ ID NO: 62, 70, 82, 84, and 86, wherein said single chain antibody or a fragment thereof binds to OmPD protein in Salmonella.

[00313] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof that binds to a surface protein in Salmonella.

[00314] In an embodiment of the present disclosure, there is provided a recombinant host cell expressing on the surface one or more chimeric proteins, said chimeric protein comprising of: (a) at least one single chain antibody or a fragment thereof against Salmonella surface protein comprising of 3 complementarity determining regions, and (b) at least one surface protein that is expressed on the surface of the recombinant host cell, wherein the surface protein expressed in the recombinant host cell is MuB or CnBP.

[00315] In an embodiment of the present disclosure, the chimeric protein as described herein is encoded within the host genome.

[00316] In an embodiment of the present disclosure, there is provided a recombinant host cell as described herein, further comprising one or more exogenous nucleic acid sequences encoding another antibody or a fragment thereof against Salmonella surface proteins.

[00317] In an embodiment of the present disclosure, the protein expressed on the surface of the recombinant host cell is a chimeric protein comprising MuB, and a antibody or a fragment thereof as described herein.

[00318] In an embodiment of the present disclosure, the protein expressed on the surface of the recombinant host cell is a chimeric protein comprising CnBP, and an antibody or a fragment thereof as described herein.

[00319] In an embodiment of the present disclosure, the proteins expressed on the surface of the recombinant host cell are two different chimeric proteins, each comprising CnBP or MuB, and an antibody or a fragment thereof as described herein.

[00320] In an embodiment of the present disclosure, the recombinant host cell expressing on the surface one or more chimeric proteins is a member of the genera *Lactobacillus*.

[00321] In an embodiment of the present disclosure, the recombinant host cell expressing on the surface one or more chimeric proteins is selected from the group not limited to: *Lactobacillus acidophilus*, *Lactobacillus acidophilus* LAFTI L10, *Lactobacillus casei, Lactobacillus casei* LAFTI L26, *Lactobacillus acidophilus* DDS-1, *Lactobacillus acidophilus* LA-5, *Lactobacillus acidophilus* NCFM, *Lactobacillus acidophilus* CD 1285, *Lactobacillus casei* 431, *Lactobacillus casei* F19, *Lactobacillus casei* Shirota, *Lactobacillus paracasei*, *Lactobacillus paracasei* St11, *Lactobacillus johnsonii, Lactobacillus johnsonii* La1, *Lactobacillus lactis*, *Lactobacillus lactis* L1A, *Lactobacillus plantarum*, *Lactobacillus plantarum* 299v, *Lactobacillus reuteri*, *Lactobacillus reuteri* ATCC55730, *Lactobacillus rhamnosus*, *Lactobacillus rhamnosus* ATCC53013, *Lactobacillus rhamnosus* LB21, *Lactobacillus rhamnosus* GR-1, *Lactobacillus reuteri* RC-14, *Lactobacillus rhamnosus* R011, *Lactobacillus helveticus,* and *Lactobacillus helveticus* R0052.

[00322] In a preferred embodiment of the present disclosure, there is provided a recombinant host cell expressing on the surface one or more chimeric proteins, said recombinant host cell is *Lactobacillus reuteri*.

[00323] In an embodiment of the present disclosure, there is provided a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions having amino acid sequence selected from the group consisting of: (a)SEQ ID NO: :1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3; (b)SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3; (c)SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (d)SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3; (e)SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (f)SEQ ID NO:13 for CDR1, SEQ ID NO:14

for CDR2, and SEQ ID NO:15 for CDR3; (g)SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3; (h)SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3; (i)SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3; (j)SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3; (k)S EQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and (l)SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00324] In an embodiment of the present disclosure, there is provided a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions encoded by a polynucleotide sequence selected from the group consisting of: (a)SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3; (b)SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3; (c)SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (d)SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3; (e)SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (f)SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3; (g)SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3; (h)SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3; (i)SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3; (j)SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3; (k)SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and (l)SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00325] In an embodiment of the present disclosure, there is provided a recombinant DNA vector comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions having

amino acid sequence selected from the group consisting of: (a)SEQ ID NO: :1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3; (b)SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3; (c)SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (d)SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3; (e)SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (f)SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3; (g)SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3; (h)SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3; (i)SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3; (j)SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3; (k)S EQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and (l)SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00326] In an embodiment of the present disclosure, there is provided a recombinant DNA vector comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions encoded by a polynucleotide sequence selected from the group consisting of: (a)SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3; (b)SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3; (c)SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (d)SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3; (e)SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (f)SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3; (g)SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3; (h)SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3; (i)SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3; (j)SEQ ID NO:46 for CDR1, SEQ ID NO:47

for CDR2, and SEQ ID NO:48 for CDR3; (k)SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and (l)SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00327] In an embodiment of the present disclosure, there is provided a recombinant host cell comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions having amino acid sequence selected from the group consisting of: (a)SEQ ID NO: :1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3; (b)SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3; (c)SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (d)SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3; (e)SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (f)SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3; (g)SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3; (h)SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3; (i)SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3; (j)SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3; (k)S EQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and (l)SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00328] In an embodiment of the present disclosure, there is provided a recombinant host cell comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions encoded by a polynucleotide sequence selected from the group consisting of: (a)SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3; (b)SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3; (c)SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for

CDR3; (d)SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3; (e)SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (f)SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3; (g)SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3; (h)SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3; (i)SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3; (j)SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3; (k)SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and (l)SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00329] In an embodiment of the present disclosure, the recombinant host cell comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions is selected from the group not limited to: *Lactobacillus acidophilus*, *Lactobacillus acidophilus* LAFTI L10, *Lactobacillus casei, Lactobacillus casei* LAFTI L26, *Lactobacillus acidophilus* DDS-1, *Lactobacillus acidophilus* LA-5, *Lactobacillus acidophilus* NCFM, *Lactobacillus acidophilus* CD 1285, *Lactobacillus casei* 431, *Lactobacillus casei* F19, *Lactobacillus casei* Shirota, *Lactobacillus paracasei*, *Lactobacillus paracasei* St11, *Lactobacillus johnsonii, Lactobacillus johnsonii* La1, *Lactobacillus lactis*, *Lactobacillus lactis* L1A, *Lactobacillus plantarum*, *Lactobacillus plantarum* 299v, *Lactobacillus reuteri*, *Lactobacillus reuteri* ATCC55730, *Lactobacillus rhamnosus*, *Lactobacillus rhamnosus* ATCC53013, *Lactobacillus rhamnosus* LB21, *Lactobacillus rhamnosus* GR-1, *Lactobacillus reuteri* RC-14, *Lactobacillus rhamnosus* R011, *Lactobacillus helveticus,* and *Lactobacillus helveticus* R0052.

[00330] In an embodiment of the present disclosure, there is provided a recombinant host cell comprising a recombinant DNA vector comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three

complementarity determining regions having amino acid sequence selected from the group consisting of: (a)SEQ ID NO: :1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3; (b)SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3; (c)SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (d)SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3; (e)SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (f)SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3; (g)SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3; (h)SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3; (i)SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3; (j)SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3; (k)S EQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and (l)SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00331] In an embodiment of the present disclosure, there is provided a recombinant host cell comprising a recombinant DNA vector comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions encoded by a polynucleotide sequence selected from the group consisting of: (a)SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3; (b)SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3; (c)SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (d)SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3; (e)SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (f)SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3; (g)SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3; (h)SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3; (i)SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3;

(j)SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3; (k)SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and (l)SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00332] In an embodiment of the present disclosure, the recombinant host cell comprising a recombinant DNA vector comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions is selected from the group not limited to: *Lactobacillus acidophilus*, *Lactobacillus acidophilus* LAFTI L10, *Lactobacillus casei*, *Lactobacillus casei* LAFTI L26, *Lactobacillus acidophilus* DDS-1, *Lactobacillus acidophilus* LA-5, *Lactobacillus acidophilus* NCFM, *Lactobacillus acidophilus* CD 1285, *Lactobacillus casei* 431, *Lactobacillus casei* F19, *Lactobacillus casei* Shirota, *Lactobacillus paracasei*, *Lactobacillus paracasei* St11, *Lactobacillus johnsonii*, *Lactobacillus johnsonii* La1, *Lactobacillus lactis*, *Lactobacillus lactis* L1A, *Lactobacillus plantarum*, *Lactobacillus plantarum* 299v, *Lactobacillus reuteri*, *Lactobacillus reuteri* ATCC55730, *Lactobacillus rhamnosus*, *Lactobacillus rhamnosus* ATCC53013, *Lactobacillus rhamnosus* LB21, *Lactobacillus rhamnosus* GR-1, *Lactobacillus reuteri* RC-14, *Lactobacillus rhamnosus* R011, *Lactobacillus helveticus*, and *Lactobacillus helveticus* R0052.

[00333] In a preferred embodiment of the present disclosure, there is provided a recombinant host cell secreting a single chain antibody or a fragment thereof having amino acid sequence selected from the group consisting of SEQ ID NO: 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, and 91, wherein the recombinant host cell is *Bacillus subtilis*.

[00334] In an embodiment of the present disclosure, there is provided a recombinant host cell expressing a single chain antibody or a fragment thereof encoded by a polynucleotide sequence selected from the group consisting of SEQ ID NO:56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, and 92, wherein the

recombinant host cell secretes the said single chain antibody or a fragment thereof extracellularly.

[00335] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof, said single chain antibody or a fragment thereof is a camelid antibody.

[00336] In an embodiment of the present disclosure, there is provided a chimeric protein having at least a contiguous amino acid sequence as set forth in SEQ ID NO: 93, 95, 97, 99, 101, 130, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195, 197, 199, 201, 203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227 , 229, 231, 233, 235, 237, 239, 241, and 243.

[00337] In an embodiment of the present disclosure, there is provided a chimeric protein having at least a contiguous polynucleotide sequence as set forth in SEQ ID NO: 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198 , 200, 202, 204, 206, 208, 210, 212, 214, 216, 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, 240, 242, and 244.

[00338] In an embodiment of the present disclosure, there is provided a chimeric protein comprising of a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions having amino acid sequence selected from the group consisting of: (a)SEQ ID NO: :1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3; (b)SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3; (c)SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (d)SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3; (e)SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (f)SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3;

(g)SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3; (h)SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3; (i)SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3; (j)SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3; (k)S EQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and (l)SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00339] In an embodiment of the present disclosure, there is provided a chimeric protein comprising of a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions encoded by a polynucleotide sequence selected from the group consisting of: (a)SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3; (b)SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3; (c)SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (d)SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3; (e)SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (f)SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3; (g)SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3; (h)SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3; (i)SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3; (j)SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3; (k)SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and (l)SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00340] In an embodiment of the present disclosure, there is provided a food product comprising a recombinant host cell comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions having amino acid sequence selected from the group consisting

of: (a)SEQ ID NO: :1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3; (b)SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3; (c)SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (d)SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3; (e)SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (f)SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3; (g)SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3; (h)SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3; (i)SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3; (j)SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3; (k)S EQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and (l)SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00341] In an embodiment of the present disclosure, there is provided a food product comprising a recombinant host cell comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions encoded by a polynucleotide sequence selected from the group consisting of: (a)SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3; (b)SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3; (c)SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (d)SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3; (e)SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (f)SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3; (g)SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3; (h)SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3; (i)SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3; (j)SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3; (k)SEQ ID NO:49

for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and (l)SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00342] In an embodiment of the present disclosure, there is provided a food product comprising a recombinant host cell comprising a recombinant DNA vector comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions having amino acid sequence selected from the group consisting of: (a)SEQ ID NO: :1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3; (b)SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3; (c)SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (d)SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3; (e)SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (f)SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3; (g)SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3; (h)SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3; (i)SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3; (j)SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3; (k)S EQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and (l)SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00343] In an embodiment of the present disclosure, there is provided a food product comprising a recombinant host cell comprising a recombinant DNA vector comprising a recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions encoded by a polynucleotide sequence selected from the group consisting of: (a)SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3; (b)SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3; (c)SEQ ID

NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (d)SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3; (e)SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (f)SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3; (g)SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3; (h)SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3; (i)SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3; (j)SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3; (k)SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and (l)SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00344] In an embodiment of the present disclosure, there is provided a food product comprising a single chain antibody or a fragment thereof having amino acid sequence selected from the group consisting of SEQ ID NO:55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, and 91.

[00345] In an embodiment of the present disclosure, there is provided a food product comprising a single chain antibody or a fragment thereof encoded by a polynucleotide sequence selected from the group consisting of SEQ ID NO:56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, and 92.

[00346] In an embodiment of the present disclosure, there is provided a food product comprising a chimeric protein having at least a contiguous amino acid sequence selected from the group consisting of SEQ ID NO:93, 95, 97, 99, 101, 130, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195, 197, 199, 201, 203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227 , 229, 231, 233, 235, 237, 239, 241, and 243.

[00347] In an embodiment of the present disclosure, there is provided a food product comprising a chimeric protein having at least a contiguous polynucleotide sequence

selected from the group consisting of SEQ ID NO: 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198 , 200, 202, 204, 206, 208, 210, 212, 214, 216, 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, 240, 242, and 244.

[00348] In an embodiment of the present disclosure, there is provided a food product comprising of a chimeric protein comprising of a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions having amino acid sequence selected from the group consisting of: (a)SEQ ID NO: :1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3; (b)SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3; (c)SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (d)SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3; (e)SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (f)SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3; (g)SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3; (h)SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3; (i)SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3; (j)SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3; (k)S EQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and (l)SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00349] In an embodiment of the present disclosure, there is provided a food product comprising of a chimeric protein comprising of a single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of three complementarity determining regions encoded by a polynucleotide sequence selected from the group consisting of: (a)SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3; (b)SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ

ID NO:30 for CDR3; (c)SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (d)SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3; (e)SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (f)SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3; (g)SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3; (h)SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3; (i)SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3; (j)SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3; (k)SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and (l)SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00350] In an embodiment of the present disclosure, there is provided a food product comprising a chimeric protein, further comprising a carrier selected from the group consisting of a lubricant, a surfactant, solvent, emulsifier, wetting agent, animal feed, dye or oral solution.

[00351] In an embodiment of the present disclosure, there is provided a food product comprising a single chain antibody or a fragment thereof, further comprising a carrier selected from the group consisting of a lubricant, a surfactant, solvent, emulsifier, wetting agent, animal feed, dye or oral solution.

[00352] In an embodiment of the present disclosure, there is provided a formulation comprising a single chain antibody or a fragment thereof having amino acid sequence selected from the group consisting of SEQ ID NO: 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, and 91.

[00353] In an embodiment of the present disclosure, there is provided a formulation comprising a single chain antibody or a fragment thereof encoded by polynucleotide sequence selected from the group consisting of SEQ ID NO: 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, and 92.

[00354] In an embodiment of the present disclosure, there is provided a formulation comprising a single chain antibody or a fragment thereof comprising of three

complementarity determining regions having amino acid sequence selected from the group consisting of: (a)SEQ ID NO: :1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3; (b)SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3; (c)SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (d)SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3; (e)SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (f)SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3; (g)SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3; (h)SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3; (i)SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3; (j)SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3; (k)S EQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and (l)SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00355] In an embodiment of the present disclosure, there is provided a formulation comprising a single chain antibody or a fragment thereof comprising of three complementarity determining regions encoded by a polynucleotide sequence selected from the group consisting of: (a)SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3; (b)SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3; (c)SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (d)SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3; (e)SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3; (f)SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3; (g)SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3; (h)SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3; (i)SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3; (j)SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3; (k)SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51

for CDR3; and (l)SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

[00356] In an embodiment of the present disclosure, there is provided a formulation comprising a single chain antibody or a fragment thereof, further consisting of a diluent or an excipient or a carrier.

[00357] In an embodiment of the present disclosure, there is provided a method of inhibiting growth of Salmonella, said method comprising contacting a sample containing Salmonella with a food product comprising a single chain antibody or a fragment thereof comprising of three complementarity determining regions having amino acid sequence selected from the group consisting of: (a)SEQ ID NO: :1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3; (b)SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3; (c)SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (d)SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3; (e)SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (f)SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3; (g)SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3; (h)SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3; (i)SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3; (j)SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3; (k)S EQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and (l)SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00358] In an embodiment of the present disclosure, there is provided a method of inhibiting growth of Salmonella, said method comprising contacting a sample containing Salmonella with a food product comprising a chimeric protein with at least a contiguous amino acid sequence selected from the group consisting of SEQ ID NO: 93, 95, 97, 99, 101, 130, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161,

163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195, 197, 199, 201, 203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227 , 229, 231, 233, 235, 237, 239, 241, and 243.

[00359] In an embodiment of the present disclosure, there is provided a method of inhibiting activity of Salmonella, said method comprising contacting a sample containing Salmonella with a food product comprising a single chain antibody or a fragment thereof comprising of three complementarity determining regions having amino acid sequence selected from the group consisting of: (a)SEQ ID NO: :1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3; (b)SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3; (c)SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (d)SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3; (e)SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3; (f)SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3; (g)SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3; (h)SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3; (i)SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3; (j)SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3; (k)S EQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and (l)SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

[00360] In an embodiment of the present disclosure, there is provided a method of inhibiting activity of Salmonella, said method comprising contacting a sample containing Salmonella with a food product comprising a chimeric protein with at least a contiguous amino acid sequence selected from the group consisting of SEQ ID NO: 93, 95, 97, 99, 101, 130, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195,

197, 199, 201, 203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227 , 229, 231, 233, 235, 237, 239, 241, and 243.

[00361] In an embodiment of the present disclosure, there is provided a method of inhibiting activity of Salmonella *in-ovo*, said method comprising contacting a single chain antibody or a fragment thereof having amino acid sequence selected from the group consisting of SEQ ID NO: 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, and 91 with Salmonella present *in-ovo*.

[00362] In an embodiment of the present disclosure, there is provided a method of inhibiting growth of Salmonella *in-ovo*, said method comprising contacting a single chain antibody or a fragment thereof having amino acid sequence selected from the group consisting of SEQ ID NO: 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, and 91 with Salmonella present *in-ovo*.

[00363] In an embodiment of the present disclosure, there is provided a single chain antibody A or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 1 for CDR1, SEQ ID NO: 2 for CDR2, and SEQ ID NO: 3 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 28 for CDR1, SEQ ID NO: 29 for CDR2, and SEQ ID NO: 30 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 55, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 56.

[00364] In an embodiment of the present disclosure, there is provided a single chain antibody B or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 4 for CDR1, SEQ ID NO: 5 for CDR2, and SEQ ID NO: 3 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 31 for CDR1, SEQ ID NO: 32 for CDR2, and SEQ ID NO: 30 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 57, and the

nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 58.

[00365] In an embodiment of the present disclosure, there is provided a single chain antibody C or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 6 for CDR1, SEQ ID NO: 7 for CDR2, and SEQ ID NO: 8 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 33 for CDR1, SEQ ID NO: 34 for CDR2, and SEQ ID NO: 35 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 59, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 60.

[00366] In an embodiment of the present disclosure, there is provided a single chain antibody D or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 9 for CDR1, SEQ ID NO: 10 for CDR2, and SEQ ID NO: 11 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 36 for CDR1, SEQ ID NO: 37 for CDR2, and SEQ ID NO: 38 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 61, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 62.

[00367] In an embodiment of the present disclosure, there is provided a single chain antibody E or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 12 for CDR1, SEQ ID NO: 7 for CDR2, and SEQ ID NO: 8 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 39 for CDR1, SEQ ID NO: 34 for CDR2, and SEQ ID NO: 35 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 63, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 64.

[00368] In an embodiment of the present disclosure, there is provided a single chain antibody F or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 12 for CDR1, SEQ ID NO: 7 for CDR2, and SEQ ID NO: 8 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 39 for CDR1, SEQ ID NO: 34 for CDR2, and SEQ ID NO: 35 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 65, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 66.

[00369] In an embodiment of the present disclosure, there is provided a single chain antibody G or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 12 for CDR1, SEQ ID NO: 7 for CDR2, and SEQ ID NO: 8 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 39 for CDR1, SEQ ID NO: 34 for CDR2, and SEQ ID NO: 35 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 67, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 68.

[00370] In an embodiment of the present disclosure, there is provided a single chain antibody H or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 13 for CDR1, SEQ ID NO: 14 for CDR2, and SEQ ID NO: 15 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 40 for CDR1, SEQ ID NO: 41 for CDR2, and SEQ ID NO: 42 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 69, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 70.

[00371] In an embodiment of the present disclosure, there is provided a single chain antibody I or a fragment thereof comprising of 3 complementarity determining

regions having amino acid sequence as set forth in SEQ ID NO: 1 for CDR1, SEQ ID NO: 16 for CDR2, and SEQ ID NO: 3 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 28 for CDR1, SEQ ID NO: 43 for CDR2, and SEQ ID NO: 30 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 71, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 72.

[00372] In an embodiment of the present disclosure, there is provided a single chain antibody J or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 1 for CDR1, SEQ ID NO: 17 for CDR2, and SEQ ID NO: 3 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 28 for CDR1, SEQ ID NO: 44 for CDR2, and SEQ ID NO: 30 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 73, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 74.

[00373] In an embodiment of the present disclosure, there is provided a single chain antibody K or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 1 for CDR1, SEQ ID NO: 18 for CDR2, and SEQ ID NO: 3 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 28 for CDR1, SEQ ID NO: 45 for CDR2, and SEQ ID NO: 30 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 75, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 76.

[00374] In an embodiment of the present disclosure, there is provided a single chain antibody L or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 1 for CDR1, SEQ ID NO: 17 for CDR2, and SEQ ID NO: 3 for CDR3, wherein the nucleotide sequence

encoding the CDRs is as set forth in SEQ ID NO: 28 for CDR1, SEQ ID NO: 44 for CDR2, and SEQ ID NO: 30 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 77, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 78.

[00375] In an embodiment of the present disclosure, there is provided a single chain antibody M or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 19 for CDR1, SEQ ID NO: 20 for CDR2, and SEQ ID NO: 21 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 46 for CDR1, SEQ ID NO: 47 for CDR2, and SEQ ID NO: 48 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 79, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 80.

[00376] In an embodiment of the present disclosure, there is provided a single chain antibody N or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 13 for CDR1, SEQ ID NO: 14 for CDR2, and SEQ ID NO: 15 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 40 for CDR1, SEQ ID NO: 41 for CDR2, and SEQ ID NO: 42 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 81, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 82.

[00377] In an embodiment of the present disclosure, there is provided a single chain antibody O or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 13 for CDR1, SEQ ID NO: 14 for CDR2, and SEQ ID NO: 15 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 40 for CDR1, SEQ ID NO: 41 for CDR2, and SEQ ID NO: 42 for CDR3, wherein the amino acid sequence

of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 83, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 84.

[00378] In an embodiment of the present disclosure, there is provided a single chain antibody P or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 22 for CDR1, SEQ ID NO: 23 for CDR2, and SEQ ID NO: 24 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 49 for CDR1, SEQ ID NO: 50 for CDR2, and SEQ ID NO: 51 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 85, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 86.

[00379] In an embodiment of the present disclosure, there is provided a single chain antibody Q or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 25 for CDR1, SEQ ID NO: 26 for CDR2, and SEQ ID NO: 27 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 52 for CDR1, SEQ ID NO: 53 for CDR2, and SEQ ID NO: 54 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 87, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 88.

[00380] In an embodiment of the present disclosure, there is provided a single chain antibody R or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 25 for CDR1, SEQ ID NO: 26 for CDR2, and SEQ ID NO: 27 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 52 for CDR1, SEQ ID NO: 53 for CDR2, and SEQ ID NO: 54 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 89,

and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 90.

[00381] In an embodiment of the present disclosure, there is provided a single chain antibody S or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence as set forth in SEQ ID NO: 25 for CDR1, SEQ ID NO: 26 for CDR2, and SEQ ID NO: 27 for CDR3, wherein the nucleotide sequence encoding the CDRs is as set forth in SEQ ID NO: 52 for CDR1, SEQ ID NO: 53 for CDR2, and SEQ ID NO: 54 for CDR3, wherein the amino acid sequence of the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 91, and the nucleotide sequence encoding the single chain antibody A or a fragment thereof is as set forth in SEQ ID NO: 92.

[00382] In an embodiment of the present disclosure, there is provided an isolated lactobacillus strain, *Lactobacillus reuteri* 1LB7 deposited with Microbial Type Culture Collection and Gene Bank (MTCC) having accession number (5894) for management of enteric Salmonella population in animal husbandry.

[00383] In an embodiment of the present disclosure, there is provided a food formulation comprising anti-salmonella VHH antibodies or fragments thereof as described herein that inhibit Salmonella growth.

[00384] In an embodiment of the present disclosure, there is provided a milk based formulation comprising anti-salmonella VHH antibodies or fragments thereof as described herein that inhibit Salmonella growth.

[00385] In an embodiment of the present disclosure, there is provided an egg yolk based formulation comprising anti-salmonella VHH antibodies or fragments thereof as described herein that inhibit Salmonella growth.

[00386] In an embodiment of the present disclosure, there is provided a modified *Lactobacillus reuteri* having anti-salmonella camelid VHH antibody gene insert in the MuB gene as described herein that inhibits salmonella growth upon heat inactivation.

[00387] In an embodiment of the present disclosure, there is provided a modified *Lactobacillus reuteri* having anti-salmonella camelid VHH antibody gene insert in the CnBP gene as described herein that inhibits salmonella growth upon heat inactivation.

[00388] In an embodiment of the present disclosure, there is provided camelid VHH antibody fragments as described herein that inhibit growth of salmonella serovars.

[00389] In an embodiment of the present disclosure, there is provided camelid VHH antibody fragments as described herein that inhibit growth of *Salmonella typhimurium*.

[00390] In an embodiment of the present disclosure, there is provided camelid VHH antibody fragments as described herein that inhibit growth of *Salmonella gallinarum*.

[00391] In an embodiment of the present disclosure, there is provided camelid VHH antibody fragments as described herein that inhibit growth of *Salmonella newport*.

[00392] In an embodiment of the present disclosure, there is provided camelid VHH antibody fragments as described herein that inhibit growth of *Salmonella abony*.

[00393] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against salmonella surface proteins as described herein, or a recombinant host cell as described herein, or a recombinant DNA construct as described herein, or a recombinant DNA vector as described herein, or a chimeric protein as described herein, or a food product as described herein, or a formulation as described herein, or an isolated lactobacillus strain as described herein, for use in inhibiting Salmonella growth or infection.

[00394] In an embodiment of the present disclosure, there is provided a single chain antibody or a fragment thereof against salmonella surface proteins as described herein, for use in inhibiting Salmonella growth or infection.

[00395] In an embodiment of the present disclosure, there is provided a recombinant host cell as described herein, for use in inhibiting Salmonella growth or infection.

[00396] In an embodiment of the present disclosure, there is provided a recombinant DNA construct as described herein, for use in inhibiting Salmonella growth or infection.

[00397] In an embodiment of the present disclosure, there is provide a recombinant DNA construct as described herein, for use in inhibiting Salmonella growth or infection.

[00398] In an embodiment of the present disclosure, there is provided a chimeric protein as described herein, for use in inhibiting Salmonella growth or infection.

[00399] In an embodiment of the present disclosure, there is provided a food product as described herein, for use in inhibiting Salmonella growth or infection.

[00400] In an embodiment of the present disclosure, there is provided a formulation as described herein, for use in inhibiting Salmonella growth or infection.

[00401] In an embodiment of the present disclosure, there is provided an isolated lactobacillus strain as described herein, for use in inhibiting Salmonella growth or infection.

EXAMPLES

[00402] The disclosure will now be illustrated with working examples, which is intended to illustrate the working of disclosure and not intended to take restrictively to imply any limitations on the scope of the present disclosure. Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this disclosure belongs.

Example 1

Isolation and characterization of *lactobacillus*

[00403] Various organs (trachea, crop, gizzard, small intestine, large intestine, and ceacum) were collected from backyard poultry birds. Lactobacillus was isolated by inoculating the field sample in lactobacillus selective broth (LSB) (HiMedia/M1166-500G) and incubated at 37°C under anaerobic conditions. Selected colonies were enriched on MRS broth (HiMedia/M369-500G). Purity of the selected colonies was checked by Gram staining (gram positive short rods). The genetic identity of

lactobacillus was confirmed by carrying out a sequencing reaction of the 900bp amplicon produced by amplifying the 16S RNA gene using primers as set forth in SEQ ID NO: 245 (forward primer) and SEQ ID NO:246 (reverse primer). The genetic identity of *lactobacillus reuteri* was confirmed by carrying out a sequencing reaction of the 303bp amplicon produced by species specific primers as set forth in SEQ ID NO: 247 (forward primer) and SEQ ID NO: 248 (reverse primer). The *Lactobacillus reuteri* 1LB7 strain isolated from poultry bird crop and found in the entire gastrointestinal tract, was selected as the host strain for surface display of a camelid heavy chain antibody or a fragment thereof. The 1LB7 strain is devoid of any plasmids.

Example 2

Isolation of *lactobacillus reuteri* MuB, and CnBP

[00404] Genomic DNA was isolated from the 1LB7 strain by resuspending a bacterial pellet in 5ml TNE buffer containing lysozyme at a concentration of 10mg/ml. 500µl of 10% SDS and 250µl proteinase K at a concentration of 10mg/ml was added and incubated at 55°C for two hours with intermittent shaking. Genomic DNA was isolated using the phenol chloroform extraction method (Raya *et al*, *Food Microbiology Protocols*, 2001, *14*, 135-139) .

[00405] A partial 1.7kb region of the *MuB* gene was PCR amplified using primers as set forth in SEQ ID NO: 249 (forward primer) and SEQ ID NO: 250 (reverse primer). This 1.7kb region comprises the LPTQG motif. The amplicon was subsequently cloned in to pJet vector as per manufacturer's instructions (catalog number: K1231, Thermo Scientific) and sequenced.

[00406] The complete *CnBP* gene (1.08kb) was PCR amplified using primers as set forth in SEQ ID NO: 251 (forward primer) and SEQ ID NO: 252 (reverse primer). The amplicon was subsequently cloned in to pJet vector as per manufacturer's instructions and sequenced.

Example 3

Generation of camelid antibodies against whole cell salmonella

[00407] Immunization of camels with whole cell inactivated *Salmonella enteric*: Briefly, actively growing cultures of *Salmonella enteric* (log phase) was subjected to inactivation for 24 hours at 37^0 C by addition of 0.5% of formalin. The culture was kept under constant shaking at 20rpm. Subsequently the cultures were stored at 4^0 C and a representative sample was tested in enriched growth media for innocuity. On confirmation of the inactivation, the bacterial cultures were washed thrice in 1X PBS buffer and re-suspended at a concentration of 200µg/ml. 5ml of the suspension was mixed with adjuvant (Montanide ISA 206V) to form an emulsion.

[00408] Final bleeding of immunized camels was done at 60 days post immunization. Total RNA was isolated from isolated peripheral blood lymphocytes. PCR reaction was carried out for amplification of heavy chain antibody fragments using primers as set forth in SEQ ID NO: 253 (forward primer) and SEQ ID NO: 254 (reverse primer). {Amplicon size: 900 bps (comprising of the framework and CDR regions & CH1, CH2, CH3 including the hinge region of the camelid conventional heavy chain antibody pairing with the light chain) , 690bp (comprising of the framework and CDR regions & the long hinge, CH2, CH3 regions of the camelid heavy chain VHH antibody), 620bp (comprising of the framework and CDR regions & the short hinge, CH2, CH3 regions of the camelid heavy chain VHH antibody)}. PCR condition used are given below in Table 1:

Table 1

No. of cycles	Temperature	Time
1	94°C	4 mins
29	94°C	30 sec
	50°C	1 min
	72°C	90 sec
1	72°C	5 mins

[00409] The amplicons were subsequently cloned in to a *Bacillus subtilis* secretory vector, 3VE vector (Figure 8). Single colonies were isolated by limited dilution plating. Single colonies were plated on 2XYT agar plates for growth. Induction of

cloned antibodies was carried out by treating 3VE bacillus vector cultures with IPTG for secretion of antibodies.

[00410] The secreted antibodies were screened for anti-salmonella activity by assaying for anti-salmonella biological activity, and salmonella cell invasion inhibition assay.

[00411] Plasmids from clones showing anti-salmonella activity were isolated and the polynucleotide encoding the heavy chain antibody fragment showing anti-salmonella activity was digested with BamHI and AatII restriction enzyme and subsequently cloned in to pJet vector. The heavy chain antibody fragment was further sequenced to identify the complementarity determining regions.

[00412] The identified heavy chain antibody fragments showing anti-salmonella activity were further used for site specific insertion in to *Lactobacillus reuteri MuB* and *CnBP* genes.

Example 4

Generation of chimeric proteins

[00413] Insertion of specific camelid heavy chain antibody (VHH) within MuB repeat R-VI of the cloned MuB gene in pJet

[00414] Inverse PCR of the *MuB* gene cloned in pJet was carried out to introduce the flanking enzymes NdeI and BamHI at the VHH antibody insertion sites using primers as set forth in SEQ ID NO: 255 and SEQ ID NO: 256 (amplicon size 4.7kb). PCR conditions are given below in Table 2:

Table 2

No. of cycles	Temperature	Time
1	94°C	4 mins
29	94°C	30 sec
	58°C	30 sec
	72°C	8 mins
1	72°C	10 mins

[00415] PCR primers with flanking restriction enzyme sites BamHI and NdeI used to pull out the selected VHH cloned in to the secretory vector 3VE are as set forth in SEQ ID NO: 257 (forward primer) and SEQ ID NO: 258 (reverse primer) (amplicon size 400bp). The VHH PCR fragment with BamHI and NdeI restriction sites was ligated to the *MuB* gene inverse PCR product (pJet vector) and transformed in to *E.coli*. Clones harboring the *MuB* gene with the camelid VHH engineered within the *MuB* gene were screened and sequenced. PCR conditions are given below in Table 3:

Table 3

No. of cycles	Temperature	Time
1	94°C	4 mins
29	94°C	30 sec
	60°C	1 min
	72°C	1 mins
1	72°C	10 mins

[00416] A PCR product of the *MuB* gene harboring the camelid VHH was obtained using primers as set forth in SEQ ID NO: 259 (forward primer) and SEQ ID NO: 260 (reverse primer) that lack the BamHI or NdeI restriction sites (amplicon size 2.1kb). PCR conditions are given below in Table 4:

Table 4

No. of cycles	Temperature	Time
1	94°C	4 mins
29	94°C	30 sec
	57°C	1 min
	72°C	4 mins
1	72°C	10 mins

[00417] The amplicon obtained was electroporated in to *Lactobacillus reuteri* strain 1LB7 for host genome integration by double-cross over.

[00418] Insertion of specific camelid heavy chain antibody (VHH) within cloned CnBP gene in pJet

[00419] Inverse PCR of the *CnBP* gene cloned in pJet was carried out to introduce the flanking enzymes NdeI and BamHI at the VHH antibody insertion sites using primers as set forth in SEQ ID NO: 261 and SEQ ID NO: 262 (amplicon size 4.2kb). PCR conditions are given below in Table 5:

Table 5

No. of cycles	Temperature	Time
1	94°C	4 mins
29	94°C	30 sec
	52°C	30 sec
	72°C	7 mins
1	72°C	10 mins

[00420] PCR primers with flanking restriction enzyme sites BamHI and NdeI used to pull out the selected VHH cloned in to the secretory vector 3VE are as set forth in SEQ ID NO: 263 (forward primer) and SEQ ID NO: 264 (reverse primer) (amplicon size 400bp). PCR conditions are given below in Table 6:

Table 6

No. of cycles	Temperature	Time
1	94°C	4 mins
29	94°C	30 sec
	65°C	1 min
	72°C	2 mins
1	72°C	10 mins

[00421] The VHH PCR fragment with BamHI and NdeI restriction sites was ligated to the *CnBP* gene inverse PCR product (pJet vector) and transformed in to *E.coli*. Clones harboring the *CnBP* gene with the camelid VHH engineered within the *MuB* gene were screened and sequenced.

[00422] A PCR product of the *CnBP* gene harboring the camelid VHH was obtained using primers as set forth in SEQ ID NO: 265 (forward primer) and SEQ ID NO: 266 (reverse primer) (phosphorylated oligos) that lack the BamHI or NdeI restriction sites to form a circular DNA product (amplicon size 1.4kb). PCR conditions are given below in Table 7:

Table 7

No. of cycles	Temperature	Time
1	94°C	4 mins
29	94°C	30 sec
	50°C	1 min
	72°C	3 mins
1	72°C	10 mins

[00423] The circularized DNA product (full length *CnBP* gene) with the VHH insert was used for electroporation in to the *Lactobacillus reuteri* strain 1LB7 for host genomic integration by single Campbell like cross-over.

Example 5

Identification of antigenic salmonella surface proteins

[00424] Primers as set forth in SEQ ID NO: 267 (forward primer) and SEQ ID NO: 268 (reverse primer) for amplification of salmonella FimH protein encoding polynucleotide. The polynucleotide sequence of the amplicon is as set forth in SEQ ID NO: 271.

[00425] Primers as set forth in SEQ ID NO: 269 (forward primer) and SEQ ID NO: 270 (reverse primer) for amplification of salmonella OmPD protein encoding polynucleotide. The polynucleotide sequence of the amplicon is as set forth in SEQ ID NO: 272.

Whole cell (*Lactobacillus reuterii)* ELISA results

[00426] Briefly, *L.reuteri* parental host strain was transformed and modified for surface display of anti-salmonella specific camelid heavy chain antibodies on the

MuB and CnBP proteins present at the bacterial cell surface. Selection of the clones/constructs with surface display antibodies specifically against the Salmonella FimH and OmPD proteins was done on the basis of binding/attachment/baiting of the clones over the recombinant FimH and OmPD proteins immobilized on nitrocellulose membranes.

[00427] Subsequently, the positive binders were subjected to Lactobacillus whole cell ELISA, wherein the histidine tagged recombinant Salmonella FimH and OmPD was used as the cell surface displayed specific antibody tracers or binders. Subsequently, specific binding of the modified Lactobacillus reuteri cell surface displayed antibody molecules to recombinant Salmonella FimH and OmPD proteins was traced with mouse monoclonal anti-His antibodies. Table 8 and 9 shows the results of ELISA.

Table 8

RECOMBINANT SALMONELLA FimH PROTEIN TAGGED WITH HISTIDINE USED IN THE WHOLE CELL ELISA AS A TRACER MOLECULE FOR THE ANTIBODY FRAGMENTS DISPLAYED ON THE SURFACE OF THE MODIFIED *L. reuteri*.						
Sr. No	Lactobacillus reuteri bacterial sample	**O.D values**				
		Neat	1:2 dilution	1:4 dilution	1:8 dilution	1:16 dilution
1	Modified L. reuteri with surface displayed camelid antibodies specific against Salmonella	0.925	0.411	0.249	0.165	0.106
2	L. reuteri parental host control	0.79	0.232	0.124	0.088	0.069
3	Modified L. reuteri with surface displayed camelid antibodies specific against Salmonella	1.29	0.552	0.341	0.264	0.18
4	L. reuteri parental host control	1.15	0.262	0.191	0.17	0.166

Table 9

RECOMBINANT SALMONELLA OmPD PROTEIN TAGGED WITH HISTIDINE USED IN THE WHOLE CELL ELISA AS A TRACER MOLECULE FOR THE ANTIBODY FRAGMENTS DISPLAYED ON THE SURFACE OF THE MODIFIED *L. reuteri.*						
Sr. No	Lactobacillus reuteri bacterial sample	**O.D values**				
		Neat	1:2 dilution	1:4 dilution	1:8 dilution	1:16 dilution
1	Modified L. reuteri with surface displayed camelid antibodies specific against Salmonella	0.823	0.403	0.197	0.108	0.071
2	L. reuteri parental host control	0.832	0.139	0.073	0.053	0.047
3	Modified L. reuteri with surface displayed camelid antibodies specific against Salmonella	1.381	0.697	0.393	0.169	0.089
4	L. reuteri parental host Control	1.394	0.302	0.118	0.081	0.063

[00428] Based on the results in Table 8, camelid antibodies having amino acid sequence as set forth in SEQ ID NO: 55, 57, 59, 63, 65, 67, 71, 73, 75, 77, and 79 bind to salmonella FimH protein.

[00429] Based on the results in Table 9, camelid antibodies having amino acid sequence as set forth in SEQ ID NO: 61, 69, 81, 83, and 85 bind to salmonella OmPD protein.

[00430] Camelid antibodies having amino acid sequences as set forth in SEQ ID NO: 87, 89, and 91 bind to whole cell salmonella.

Example 6

Anti-salmonella biological activity

[00431] Briefly, *Bacillus subtilis* vector clones with the antibody gene fragment (polynucleotide encoding antibody having amino acid sequence as set forth in SEQ ID NO: 61) were induced with IPTG (1mM, 12 hours at 37°C on shaker at

180RPM) and the culture supernatant was collected by centrifugation (5000RPM for 10 minutes) and filtered through 0.45um filter. Similar treatment was given to the supernatant of the induced plasmid without any camelid heavy chain antibody gene fragment insert and the 2 xYT growth media in which the Bacillus cultures was grown and these were used as controls.

[00432] Test supernatant and the two controls were subsequently challenged with Salmonella bacterium inoculums of 25,000 cells in a total test volume of 2 mL and incubated at 37^0 C under shaking at 180 RPM. Representative samples from the test and the two control reactions were drawn at 2, 4, 6, 8 and 24 hours of incubation and were plated on selective XLT agar media to enumerate the Salmonella colony forming units. The results are summarized in the Table 10 below.

Table 10

	Colony forming units				
	Test supernatant from Induced secretory Vector having Camelid Antibody Gene fragment insert	**Test Control supernatant from Induced secretory empty vector without Antibody Gene insert**	**2xYT growth Media control**	**% reduction of test supernatant over induced empty vector control**	**% reduction of test supernatant over 2xYT growth media control**
0hr	98	95	97		
2hrs	60	850	901	92.94	93.34
4hrs	66	TNTC	TNTC	>95	>95
6hrs	53	TNTC	TNTC	>95	>95
8hrs	35	Mat	Mat	>95	>95
24hrs	0	Mat	Mat	100	100

TNTC : Colonies too numerous to count.

Mat : Complete Bacterial growth on the plate with merged colonies.

Example 7

Anti-Salmonella Biological Activity Titration

[00433] *Bacillus subtilis* vector clones with the antibody gene fragments (polynucleotide encoding antibody having amino acid sequence as set forth in SEQ ID NO: 61) were induced with IPTG (1mM, 12 hours at 37°C on shaker at 180RPM) and the culture supernatant was collected by centrifugation (5000RPM for 10 minutes) and filtered through 0.45um filter. This was then subjected to two-fold dilution in the 2xYT bacterial growth media and 1:2 and 1:4 along with the neat supernatant were subjected to anti-Salmonella biological activity testing. Similar treatment was given to the supernatant of the induced plasmid without any camelid heavy chain antibody gene fragment insert and the 2 xYT growth media in which the Bacillus cultures was grown and these were used as controls.

[00434] Test supernatant and the two controls were subsequently challenged with Salmonella bacterium inoculums of 25,000 cells in a total test volume of 2 ml and incubated at 37^0 C under shaking at 180RPM. Representative samples from the test and the two control reactions were drawn at 2 hours of incubation and were plated on selective XLT agar media to enumerate the Salmonella colony forming units. The results are summarized in the Table 11 below.

Table 11

Sample	Colony Forming units	% reduction of test supernatant over supernatant from induced empty vector control
Test Control supernatant from Induced secretory empty vector (neat)	991	–
Test Control supernatant from Induced secretory empty vector diluted (1:2)	889	–
Test Control supernatant from Induced secretory empty vector diluted (1:4)	868	–

Sample	Colony Forming units	% reduction of test supernatant over supernatant from induced empty vector control
Test supernatant from Induced secretory Vector having Camelid Antibody fragment Gene insert (neat)	94	90.51
Test supernatant from Induced secretory Vector having Camelid Antibody fragment Gene insert diluted (1:2)	223	74.91
Test supernatant from Induced secretory Vector having Camelid Antibody fragment insert in plasmid diluted (1:4)	402	53.68
2xYT growth Media control	983	

Salmonella cell invasion inhibition assay

[00435] The supernatant from the induced plasmid with camelid Heavy chain antibody gene fragment (polynucleotide encoding antibody having amino acid sequence as set forth in SEQ ID NO: 61) insert along with the supernatant from induced plasmid without any antibody gene fragment insert as control as well as 2xYT bacterial growth media as control was tested for the Salmonella cell invasion inhibitory properties. Cell substratum used was INT 407 intestinal cell line.

[00436] Challenge dose of $2.5X10^8$ Salmonella bacterium in 1 ml of MEM (Himedia cat no: AL047S was added in 1 ml of the test and control supernatant. On addition of challenge bacterium, supernatant mixtures were incubated at 37°C for 1 hour under shaking at 180rpm. Subsequently entire contents of each 2ml volume of test and control was seeded onto at least 90% confluent INT 407 cell monolayer in each of the six well culture plates and further incubated at 37°C for 2 hours to allow bacterial invasion to occur.

[00437] Upon completion of incubation, INT 407 monolayer cells in each well was washed twice with PBS and the INT 407 cell adhered bacterial cells, including

the remaining extracellular bacteria were killed by treating for 2 hours with 2 ml/ well of gentamycin at a concentration of 100 micrograms/ml. On completion of gentamycin treatment the cell monolayer in each well was again washed thrice with PBS and the infected INT 407 cells were lysed by treating with 1% of Triton X-100 in PBS at 37°C for 10 minutes in a total volume of 400 ul/ well to release the intracellular bacterium. Released bacterium was subsequently enumerated by plating on selective XLT agar media. Sample data is given in Table 14.

Table 14

	Test supernatant from Induced secretory Vector having Camelid Antibody fragment insert in plasmid	**Test Control supernatant from Induced secretory empty vector**	**2xYT growth Media control**
No. of INT 407 Internalized Salmonella Colonies (CFU)	4	TNTC	TNTC

TNTC: Colonies too numerous to count

Example 9

Salmonella inhibition by modified *L.reuteri*

Approximately $1.25x10^8$ CFU (Colony forming Units) of modified L.*reuteri* having surface expressed salmonella specific camelid heavy chain antibodies were mixed with approximately $1.25x10^8$ CFU of salmonella challenge dose.

[00438] One of the two controls comprised of approximately 1.25 $x10^8$ CFU of the host parental strain of *L.reuteri* mixed with approximately $1.25x10^8$ CFU of salmonella challenge dose and the second control comprised of only the same salmonella challenge dose mixed with blank cell culture media without any lactobacillus bacterium, all in a total volume of 2 ml each.

[00439] The test bacterial mixtures including the two controls were incubated at 37°C at 110RPM for two-hours. Subsequently, entire contents of 2 ml of each test mixture including the two controls were seeded onto at least 90% confluent INT 407 cell monolayer in each well of the six well culture plates and further incubated at 37°C for two-hours to allow bacterial invasion to occur.

[00440] Upon completion of incubation, INT 407 monolayer cells in each well was washed twice with 1XPBS and the INT 407 cell adhered bacterial cells, including the remaining extracellular bacteria were killed by treating for two-hours with 2 ml/ well of gentamycin (Abbott Healthcare Pvt. Ltd.) at a concentration of 100 µg/ml. On completion of gentamycin treatment, the cell monolayer in each well was washed thrice with 1XPBS and the infected INT 407 cells were lysed by treating with 1% Triton X-100 in PBS at $37^{\circ}C$ for 10 minutes in a total volume of 400 µl/ well to release the intracellular bacterium. Released bacterium was subsequently enumerated by plating on selective XLT agar media. Results are summarized in the Table 15 (polynucleotide encoding antibody having amino acid sequence as set forth in SEQ ID NO: 55),Table 16 (polynucleotide encoding antibody having amino acid sequence as set forth in SEQ ID NO: 61), and Table 17(polynucleotide encoding antibody having amino acid sequence as set forth in SEQ ID NO: 63 or 69) below.

Table 15

Sr. No	Sample	No. of INT 407 Internalized Salmonella Colonies (CFU)	Salmonella INT 407 Cell Invasion Reduction Percent
1	**Modified L. reuteri construct With antibody Expressed in MuB**	**186**	**83.91** by the modified construct
2	**Parental L. reuteri strain**	**1018**	**11.93** by the parental strain
3	**2xYT growth media Control.**	**1156**	-----

Table 16

Sr. No	Sample	No. of INT 407 Internalized Salmonella Colonies (CFU)	Salmonella INT 407 Cell Invasion Reduction Percent
1	**Modified L. reuteri construct With antibody**	**229**	**78.97** by the modified construct

Sr. No	Sample	No. of INT 407 Internalized Salmonella Colonies (CFU)	Salmonella INT 407 Cell Invasion Reduction Percent
	Expressed in CnBP		
2	**Parental L. reuteri strain**	**1089**	**12.94** by the parental strain
3	**2xYT growth media Control.**	**1251**	

Table 17

Sr. No	Sample	No. of INT 407 Internalized Salmonella Colonies (CFU)	Salmonella INT 407 Cell Invasion Reduction Percent
1	**Modified L. reuteri construct With antibody Expressed in CnBP& MuB**	**25**	**98.01** by the modified construct
2	**Parental L. reuteri strain**	**1093**	**13.32** by the parental strain
3	**2xYT growth media Control.**	**1261**	-----

Example 10

Co-culture assay of Salmonella and L. reuteri modified strain with VHH antibody insert in MuB

[00441] The antagonistic, aggregating and growth inhibitory effect of the modified *Lactobacillus reuteri* constructs in comparison with the parental strain 1LB7 *L.reuteri* strain on salmonella was observed on the basis of reduction in salmonella colony forming units (CFU), when grown (co-cultured) with the lactobacillus cultures. Growing cultures of salmonella and lactobacillus were cultured together with a fixed CFU of $1.5x10^4$ salmonella and $5x10^6$ lactobacillus, in equal volumes of PBS. Sampling was performed every 2 hours up to six hours and the samples were plated on salmonella selective XLT agar media, to enumerate the viable salmonella

bacterium in the sample of the test mixtures. The growth inhibitory effect is compared with the untransformed parental host *L.reuteri* 1LB7 and media control. Table 18 (polynucleotide encoding antibody having amino acid sequence as set forth in SEQ ID NO: 55) shows the results.

Table 18

Sampling Interval	Modified Test Strain Having Surface Displayed Camelid Antibody.	Untransformed Parental Host 1LB7 Control	Bacterial Growth Media Control	% Reduction Of Salmonella in Co-Culture With Parental Host Strain	% Reduction Of Salmonella in Co-Culture With Modified Strain.
0hr	42	64	74	----	----
2hrs	45	83	92	**9.78**	**51.08**
4hrs	115	204	299	**31.77**	**61.53**
6hrs	256	600	700	**14.28**	**63.42**

Example 11

Co-culture assay of Salmonella and *L.reuteri* modified strain with VHH antibody insert in MuB and CnBP.

[00442] Table 19 depicts the results of the effect of a modified *L.reuteri* strain having surface displayed camelid antibody in MuB and CnBP (polynucleotide encoding antibody having amino acid sequence as set forth in SEQ ID NO: 63 or 69).

Table 19

Sampling Interval	Modified Test Strain Having	Untransformed Parental Host 1LB7 Control	Media Control	% Reduction Of Salmonella	% Reduction Of Salmonella in Co-Culture

	Surface Displayed Camelid Antibody.			in Co-Culture With Parental Host Strain	With Modified Strain.
0hr	31	33	30	-----	-------
2hrs	30	42	64	**34.37**	**53.12**
4hrs	40	93	132	**29.54**	**69.69**
6hrs	130	291	365	**20.27**	**64.38**

24hrs observation:-

Example 12

Co-culture assay of Salmonella and L. reuteri modified strain with VHH antibody insert in CnBP.

[00443] Table 20 depicts the results of the effect of a modified *L.reuteri* strain having surface displayed camelid antibody in CnBP (polynucleotide encoding antibody having amino acid sequence as set forth in SEQ ID NO: 61).

Table 20

Sampling Interval	Modified Test Strain Having Surface Displayed Camelid Antibody.	Untransformed Parental Host 1LB7 Control	Media Control	% Reduction Of Salmonella in Co-Culture With Parental Host Strain	% Reduction Of Salmonella in Co-Culture With Modified Strain.
0hr	41	35	32		
2hrs	31	51	61	**16.31**	**49.18**

4hrs	53	108	128	**15.62**	**58.59**
6hrs	129	242	322	**24.84**	**59.93**

Example 13

Usage of anti-salmonella VHH antibodies and fragments thereof in milk based food preparation

[00444] To test the usage of anti-salmonella VHH antibodies and fragments thereof as described in the present disclosure in various food preparation formulations, a formulation was made by blending the VHH antibody fragments, obtained from the culture supernatant of the induced secretory bacillus vector into 70 % of skimmed milk powder dissolved in ultrapure water. Induced secretory bacillus vector culture supernatant solution was used as neat and as 1:2 dilution in PBS. The antibody solution was added at the rate of 10% in a volume of 1.5 ml of the 70% skimmed milk solution. After addition of the antibody solution, the skimmed milk solution was vortexed at 500 rpm for 30 seconds five times. Negative control comprised of 10% induced culture supernatant of secretory bacillus vector without the antibody gene fragment insert.

[00445] Subsequently, salmonella bacterium at a challenge dose of 10,000 organisms in 10µl was added to the skimmed milk solution having the antibodies, as well as the control without antibodies. Representative samples from the skimmed milk test solutions with added antibodies in two concentrations, i.e. the neat solution and the 1:2 diluted solutions, as well as the control were drawn and plated on XLT4 agar media to enumerate the salmonella colony forming units. Table 21 shows the results of the assay in tabulated format.

Table 21

Sampling Interval	Test- Culture supernatant from Induced secretory Vector having Camelid Antibody fragment insert in plasmid.	Test- Culture supernatant from Induced secretory Vector having Camelid Antibody fragment insert in plasmid , diluted 1:2 in PBS	Control- Culture supernatant from Induced secretory without antibody gene insert	Control- 2xYT growth media
0 hr.	68	68	58	49
2 hr.	118	350	945	1103
4 hr.	445	850	TNTC	TNTC

TNTC: colonies too numerous to count

[00446] Figure 1 depicts the graphical representation of salmonella colony forming units at various time points. It can be inferred from Figure 1 that the number of salmonella colony forming units is significantly less in samples that have the supernatant from the induced secretory vector having camelid antibody than samples with no antibody. The number of colonies in cultures without antibody were too numerous to count (TNTC). As Figure 1 suggests, by 4 hours, the fold inhibition of salmonella colony forming units in culture that has supernatant from the induced secretory vector is at least more than four-fold. This data suggests that the antibody fragments are stable and retain their function when incorporated into a food preparation, and is able to substantially reduce the salmonella colony forming units.

Example 14

Usage of anti-salmonella VHH antibodies and fragments thereof in an egg based food preparation

[00447] A formulation of egg yolk was developed with the culture supernatants of induced secretory bacillus vector having camelid VHH genes. Egg yolk was diluted 1:2 in PBS solution comprising of 2% Tween 80. To this egg yolk solution, VHH antibody test solution was added at a rate of 20% and the mixture was vortexed at 1000 rpm for 30 seconds five times. The culture supernatant from the induced empty

secretory bacillus vector was used as control. Representative samples were drawn from the test egg yolk formulation and the control at two hour intervals from the start till four hours and were immediately plated in XLT4 agar media to enumerate the salmonella colony forming units. Table 22 shows the results in tabulated format.

Table 22

Sampling Interval	Test- Culture supernatant from Induced secretory bacillus vector having Camelid aAntibody fragment gene insert in plasmid	Control – Culture supernatant from Induced secretory bacillus vector without Camelid antibody gene insert in plasmid	Control-2xYT growth Media control
0 hr.	363	373	362
2 hr.	620	1133	1456
4hr.	924	1960	2376

[00448] Figure 2 depicts the graphical representation of salmonella colony forming units at various time points. It can be inferred from Figure 2 that by four hours, the salmonella colony forming units is decreased by more than two-fold in case of the culture comprising supernatant from induced secretory vector having camelid antibody fragment insert in plasmid. This data suggests that the antibody fragments are stable and retain their function when incorporated into a food preparation, and is able to substantially reduce the salmonella colony forming units.

Example 15

Efficacy of heat-inactivated modified *Lactobacillus reuteri* on inhibition of salmonella growth

[00449] The antagonistic, aggregating and growth inhibitory effect of both the heat inactivated modified Lactobacillus construct and the parental *Lactobacillus reuteri* strain 1LB7 on Salmonella was observed on the basis of reduction in salmonella colony forming units (CFU) during co-culture.

[00450] Growing cultures of lactobacillus were inactivated by heating for 30 minutes at 85°C. Complete inactivation was checked by carrying out three blind passages of the inactivated cultures in MRS growth media. Growing cultures of Salmonella and the inactivated modified Lactobacillus, including the control host parental strain 1LB7 were mixed together at a rate of $1x10^4$ CFU of salmonella bacterium with $1.5x10^6$ CFU of lactobacillus bacterium. Representative culture samples starting from the 0 hour, were taken every 2 hours up to 6 hours, and then at 24 hours. The samples were plated on XLT4 agar media to enumerate the salmonella bacterium present in the samples. The antagonistic, aggregating and growth inhibitory effect against salmonella by the inactivated modified and transformed lactobacillus reuteri strain was compared with the inactivated untransformed parental host strain 1LB7.

[00451] Table 23 shows the results in tabulated format

Table 23

Sampling Interval	**Test- Inactivated Modified L. reuteri Strain having VHH antibody gene insert in MuB**	**Control-Inactivated Untransformed L. reuteri Parental Host strain 1LB7**
0hr	54	62
2hrs	35	120
4hrs	68	475
6hrs	78	752
24 hrs	121	Mat

Mat: complete bacterial growth on the plate with merged colonies

[00452] Figure 3 depicts the graphical representation of salmonella colony forming units when co-cultured with heat-inactivated modified Lactobacillus. It can be inferred from Figure 3 that even up to 24 hours, the inactivated modified Lactobacillus strain that displays on its surface the camelid VHH antibody is able to effectively inhibit the growth of Salmonella. This data suggests that the modified Lactobacillus is effective even when it is heat-inactivated and incapable of growth and self-replication.

Example 16

Anti-salmonella activity of camelid VHH antibodies against Salmonella serovars

[00453] Bacillus subtilis secretory vector with cloned camelid antibody gene fragments were induced with IPTG (1mM, 12 hours at 37°C on shaker at 180RPM) and the culture supernatant was collected by centrifugation and filtered through 0.45um filter. Similar treatment was given to the supernatant of the induced plasmid, devoid of camelid heavy chain antibody gene fragment insert and the 2xYT growth media in which the Bacillus cultures was grown and these were used as controls.

[00454] Test supernatant and the two controls were subsequently challenged with Salmonella serovars, having bacterium inoculums of approximately 10,000 cells in a total test volume of 2 ml and incubated at 37^0 C under 180 r.p.m shaking. Representative samples from the test and the two control reactions were drawn at 0, 2, 4, 6 and 24 hours of incubation and were plated on selective XLT4 agar media to enumerate the Salmonella colony forming units. Table 24-27 denote the results using different Salmonella serovars.

[00455] Table 24

Anti Salmonella Biological activity on Salmonella typhimurium			
Sampling Interval	**Test- Culture supernatant from Induced secretory bacillus vector having Camelid antibody gene fragment insert in plasmid**	**Control- Culture supernatant from Induced secretory bacillus vector without Camelid antibody gene insert in plasmid**	**Control- 2xYT growth Media**
0	98	109	114
2	91	295	398
4	63	TNTC	TNTC
6	48	TNTC	TNTC
24	1	Mat	Mat

TNTC : Colonies too numerous to count.

Mat : Complete Bacterial growth on the plate with merged colonies.

[00456] Table 25

Anti Salmonella Biological activity on Salmonella gallinarum			
Sampling Interval	**Test- Culture supernatant from Induced secretory bacillus vector having Camelid antibody gene fragment insert in plasmid**	**Control- Culture supernatant from Induced secretory bacillus vector without Camelid antibody gene insert in plasmid**	**Control- 2xYT growth Media**
0hrs	85	89	93
2hrs	63	119	166
4hrs	48	146	190
6hrs	49	TNTC	TNTC
24hrs	2	Mat	Mat

TNTC : Colonies too numerous to count.

Mat : Complete Bacterial growth on the plate with merged colonies.

[00457] Table 26

Anti Salmonella Biological activity on Salmonella newport			
Sampling Interval	**Test- Culture supernatant from Induced secretory bacillus vector having Camelid antibody gene fragment insert in plasmid**	**Control- Culture supernatant from Induced secretory bacillus vector without Camelid antibody gene insert in plasmid**	**Control- 2xYT growth Media**
0hrs	42	52	57
2hrs	20	100	149
4hrs	4	TNTC	TNTC
6hrs	3	Mat	Mat
24hrs	0	Mat	Mat

TNTC : Colonies too numerous to count.

Mat : Complete Bacterial growth on the plate with merged colonies.

[00458] Table 27

Anti Salmonella Biological activity on Salmonella abony			
Sampling Interval	**Test- Culture supernatant from Induced secretory bacillus vector having Camelid antibody gene fragment insert in plasmid**	**Control- Culture supernatant from Induced secretory bacillus vector without Camelid antibody gene insert in plasmid**	**Control- 2xYT growth Media**
0hrs	76	74	83
2hrs	43	100	324
4hrs	5	TNTC	TNTC
6hrs	2	Mat	Mat

24hrs	0	Mat	Mat

TNTC : Colonies too numerous to count.

Mat : Complete Bacterial growth on the plate with merged colonies.

[00459] Figure 4 show that the supernatant containing the secreted camelid VHH antibodies effectively inhibits *Salmonella typhimurium* growth upto 24 hours.

[00460] Figure 5 show that the supernatant containing the secreted camelid VHH antibodies effectively inhibits *Salmonella gallinarium* growth upto 24 hours.

[00461] Figure 6 show that the supernatant containing the secreted camelid VHH antibodies effectively inhibits *Salmonella newport* growth upto 24 hours.

[00462] Figure 7 show that the supernatant containing the secreted camelid VHH antibodies effectively inhibits *Salmonella abony* growth upto 24 hours.

[00463] Overall, Figures4-7 collectively show that the camelid VHH antibody is effective against a wide range of Salmonella species members, and can be used as a pan inhibitor of Salmonella growth and infection.

I/We claim:

1. A single chain antibody or a fragment thereof against salmonella surface proteins, comprising of 3 complementarity determining regions (CDR) having amino acid sequence selected from the group consisting of:

a. SEQ ID NO:1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3;

b. SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3;

c. SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3;

d. SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3;

e. SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3;

f. SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3;

g. SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3;

h. SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3;

i. SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3;

j. SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3;

k. SEQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and

l. SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

2. The single chain antibody or a fragment thereof as claimed in claim 1, wherein the cDNA sequence encoding the 3 complementarity determining regions is selected from the group consisting of:

a. SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3;

b. SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3;

c. SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3;

d. SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3;

e. SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3;

f. SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3;

g. SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3;

h. SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3;

i. SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3;

j. SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3;

k. SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and

l. SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

3. A recombinant host cell expressing on the surface one or more chimeric proteins, wherein the chimeric protein comprises of:

a. at least one single chain antibody or a fragment thereof against Salmonella surface proteins, comprising of 3 complementarity determining regions as claimed in any of the claims 1-2; and

b. at least one surface protein that is expressed on the surface of the recombinant host cell,

wherein the surface protein expressed in the recombinant host cell is MuB or CnBP.

4. The recombinant host cell as claimed in claim 3, wherein the host cell is *Lactobacillus* spp.

5.The recombinant host cell as claimed in any of the claims 3-4, wherein the chimeric protein is encoded within the host genome.

6.The recombinant host cell as claimed in any of the claims 3-5, further comprising one or more exogenous nucleic acid sequences encoding another antibody or a fragment thereof against Salmonella surface proteins.

7.The recombinant host cell as claimed in any of the claims 3-6, wherein the single chain antibody or a fragment thereof comprising of 3 complementarity determining regions having amino acid sequence selected from the group consisting of:

a. SEQ ID NO:1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3;

b. SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3;

c. SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3;

d. SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3;

e. SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3;

f. SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3;

g. SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3;

h. SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3;

i. SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3;

j. SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3;

k. SEQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and

l. SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

8. The recombinant host cell as claimed in any of the claims 3-7, wherein the cDNA sequence encoding the 3 complementarity determining regions is selected from the group consisting of:

a. SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3;

b. SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3;

c. SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3;

d. SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3;

e. SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3;

f. SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3;

g. SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3;

h. SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3;

i. SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3;

j. SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3;

k. SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and

l. SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

9. The recombinant host cell as claimed in any of the claims 3-8, wherein the surface protein of the recombinant host cell is MuB or CnBP.

10. A recombinant DNA construct comprising a polynucleotide sequence encoding a single chain antibody or a fragment thereof against salmonella surface proteins, comprising of three complementarity determining regions having amino acid sequence selected from the group consisting of:

a. SEQ ID NO:1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3;

b. SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3;

c. SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3;

d. SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3;

e. SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3;

f. SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3;

g. SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3;

h. SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3;

i. SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3;

j. SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3;

k. SEQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and

l. SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

11. The recombinant DNA construct as claimed in claim 10, wherein the cDNA sequence encoding the 3 complementarity determining regions is selected from the group consisting of:

a. SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3;

b. SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3;

c. SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3;

d. SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3;

e. SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3;

f. SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3;

g. SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3;

h. SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3;

i. SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3;

j. SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3;

k. SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and

l. SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

12. A recombinant DNA vector comprising a recombinant DNA construct as claimed in any of the claims 10-11.

13. A recombinant host cell comprising a recombinant DNA construct as claimed in any of the claims 10-11.

14. A recombinant host cell comprising a recombinant DNA vector as claimed in claim 12.

15. A chimeric protein comprising amino acid sequence selected from the group consisting of SEQ ID NO:93, 95, 97, 99, 101, 130, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195, 197, 199, 201, 203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227 , 229, 231, 233, 235, 237, 239, 241, and 243.

16. The chimeric protein as claimed in claim 15, wherein the chimeric protein polynucleotide sequence comprises polynucleotide sequence selected from the group consisting of SEQ ID NO:94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198 , 200, 202, 204, 206, 208, 210, 212, 214, 216, 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, 240, 242, and 244.

17. The chimeric protein as claimed in any of the claims 15-16, wherein said chimeric protein comprises of a single chain antibody or a fragment thereof against salmonella surface proteins, comprising of three complementarity determining regions having amino acid sequence selected from the group consisting of:

a. SEQ ID NO:1 for CDR1, SEQ ID NO:2 for CDR2, and SEQ ID NO:3 for CDR3;

b. SEQ ID NO:4 for CDR1, SEQ ID NO:5 for CDR2, and SEQ ID NO:3 for CDR3;

c. SEQ ID NO:6 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3;

d. SEQ ID NO:9 for CDR1, SEQ ID NO:10 for CDR2, and SEQ ID NO:11 for CDR3;

e. SEQ ID NO:12 for CDR1, SEQ ID NO:7 for CDR2, and SEQ ID NO:8 for CDR3;

f. SEQ ID NO:13 for CDR1, SEQ ID NO:14 for CDR2, and SEQ ID NO:15 for CDR3;

g. SEQ ID NO:1 for CDR1, SEQ ID NO:16 for CDR2, and SEQ ID NO:3 for CDR3;

h. SEQ ID NO:1 for CDR1, SEQ ID NO:17 for CDR2, and SEQ ID NO:3 for CDR3;

i. SEQ ID NO:1 for CDR1, SEQ ID NO:18 for CDR2, and SEQ ID NO:3 for CDR3;

j. SEQ ID NO:19 for CDR1, SEQ ID NO:20 for CDR2, and SEQ ID NO:21 for CDR3;

k. SEQ ID NO:22 for CDR1, SEQ ID NO:23 for CDR2, and SEQ ID NO:24 for CDR3; and

l. SEQ ID NO:25 for CDR1, SEQ ID NO:26 for CDR2, and SEQ ID NO:27 for CDR3.

18. The chimeric protein as claimed in any of the claims 15-17, wherein the polynucleotide sequence of the 3 complementarity determining regions is selected from the group consisting of:

a. SEQ ID NO:28 for CDR1, SEQ ID NO:29 for CDR2, and SEQ ID NO:30 for CDR3;

b. SEQ ID NO:31 for CDR1, SEQ ID NO:32 for CDR2, and SEQ ID NO:30 for CDR3;

c. SEQ ID NO:33 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3;

d. SEQ ID NO:36 for CDR1, SEQ ID NO:37 for CDR2, and SEQ ID NO:38 for CDR3;

e. SEQ ID NO:39 for CDR1, SEQ ID NO:34 for CDR2, and SEQ ID NO:35 for CDR3;

f. SEQ ID NO:40 for CDR1, SEQ ID NO:41 for CDR2, and SEQ ID NO:42 for CDR3;

g. SEQ ID NO:28 for CDR1, SEQ ID NO:43 for CDR2, and SEQ ID NO:30 for CDR3;

h. SEQ ID NO:28 for CDR1, SEQ ID NO:44 for CDR2, and SEQ ID NO:30 for CDR3;

i. SEQ ID NO:28 for CDR1, SEQ ID NO:45 for CDR2, and SEQ ID NO:30 for CDR3;

j. SEQ ID NO:46 for CDR1, SEQ ID NO:47 for CDR2, and SEQ ID NO:48 for CDR3;

k. SEQ ID NO:49 for CDR1, SEQ ID NO:50 for CDR2, and SEQ ID NO:51 for CDR3; and

l. SEQ ID NO:52 for CDR1, SEQ ID NO:53 for CDR2, and SEQ ID NO:54 for CDR3.

19. A food product comprising a recombinant host cell as claimed in any of the claims 13-14, or a single chain antibody or a fragment thereof as claimed in any of the claims 1-2, or a chimeric protein as claimed in any of the claims 15 18.

20. The food product as claimed in claim 19, further consisting of a carrier selected from the group consisting of a lubricant, a surfactant, solvent, emulsifier, wetting agent, animal feed, dye or oral solution.

21. A formulation comprising a single chain antibody or a fragment thereof as claimed in any of the claims 1-2, additionally consisting of a diluent, excipient or a carrier.

22. A method of inhibiting the growth of salmonella, said method comprising contacting a food product as claimed in any of the claims 19-20 or a formulation as claimed in claim 21 with a sample containing Salmonella.

23. A method of inhibiting the activity of salmonella, said method comprising contacting a food product as claimed in any of the claims 19-20 or a formulation as claimed in claim 21 with a sample containing Salmonella.

24. An isolated lactobacillus strain *Lactobacillus reuteri* 1LB7 deposited with Microbial Type Culture Collection and Gene Bank (MTCC) having accession number 5894 for management of enteric Salmonella population in animal husbandry.

25. A single chain antibody or a fragment thereof against salmonella surface proteins as claimed in any of the claims 1-2, or a recombinant host cell as claimed in any of the claims 3-9, or a recombinant DNA construct as claimed in any of the claims 10-11, or a recombinant DNA vector as claimed in claim 12, or a recombinant host cell as claimed in any of the claims 13-14, or a chimeric protein as claimed in any of the claims 15-18, or a food product as claimed in any of the claims 19-20, or a formulation as claimed in claim 21, or an isolated lactobacillus strain as claimed in claim 24 for use in inhibiting Salmonella growth or infection.

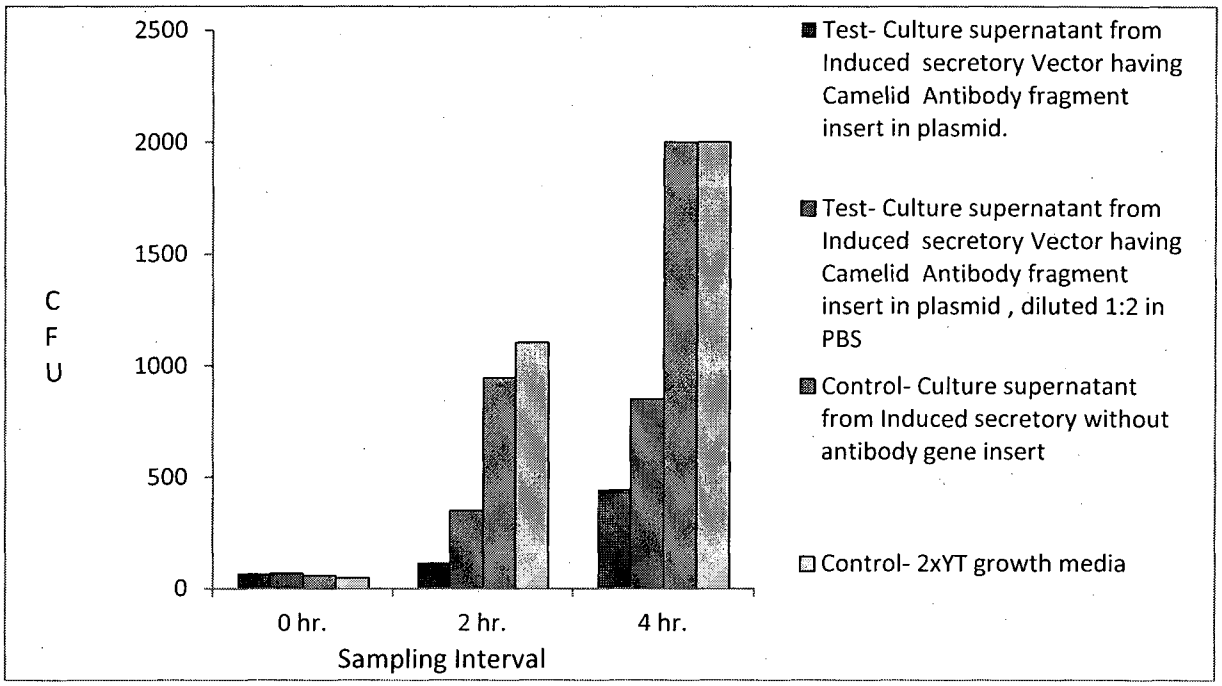

Figure 1

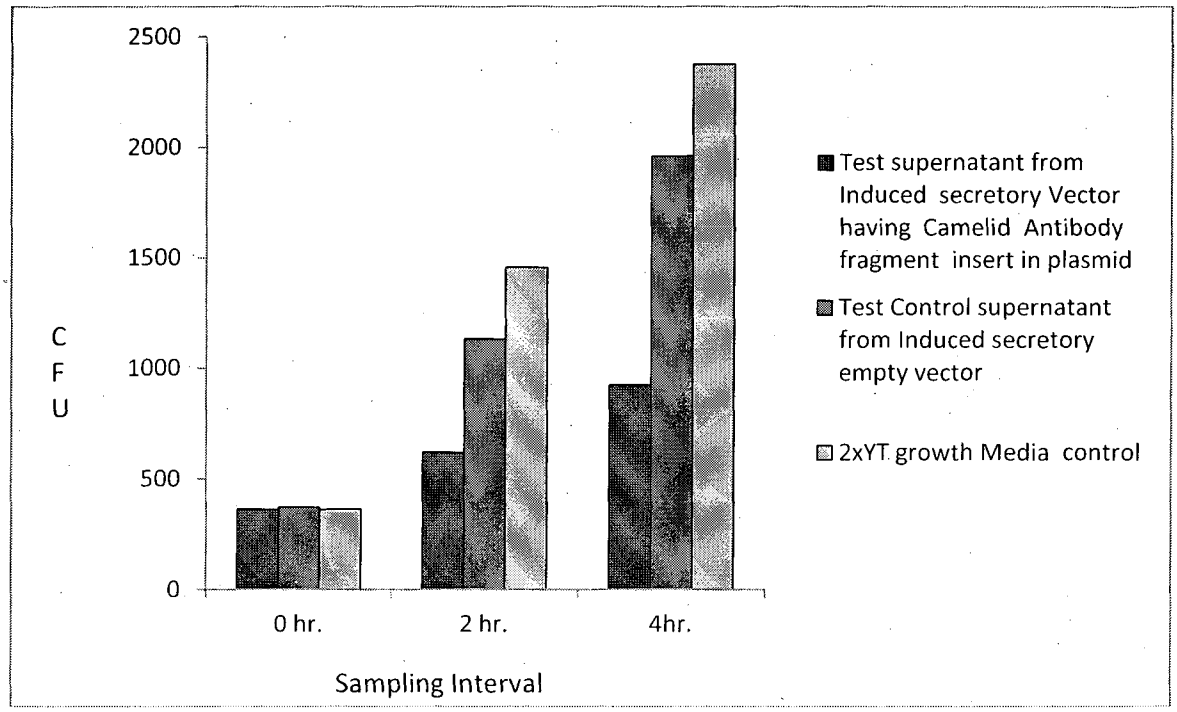

Figure 2

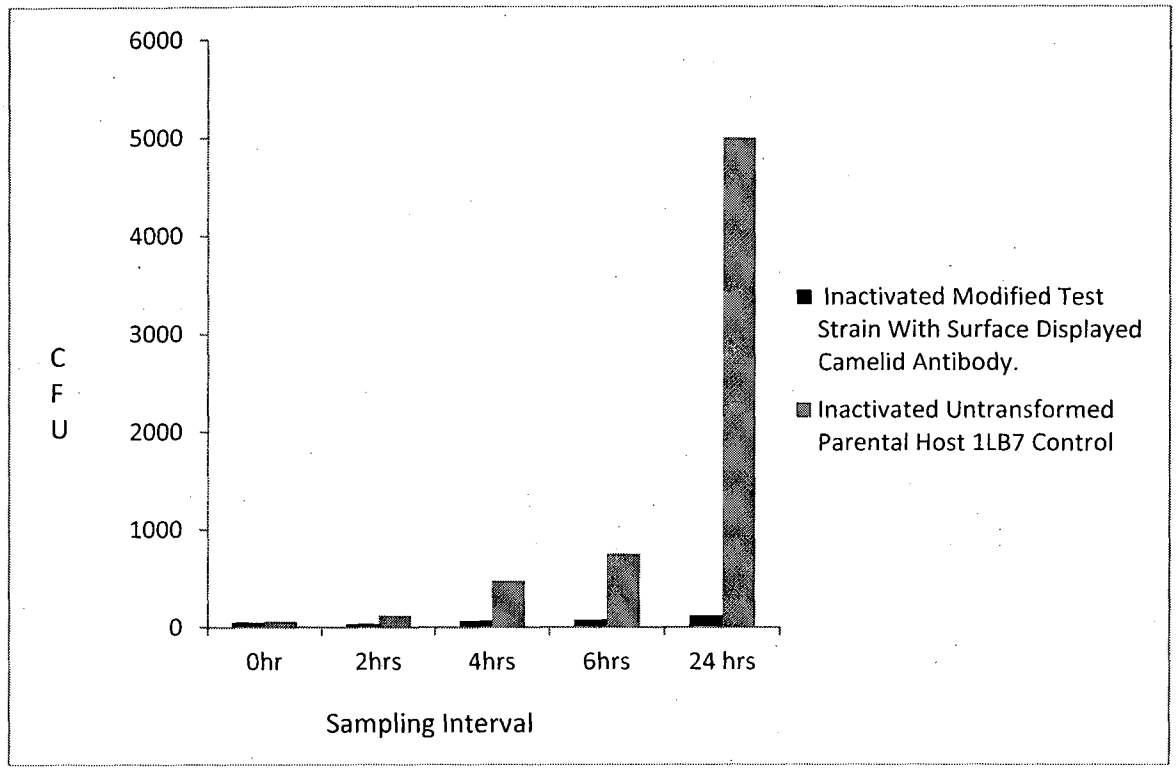

Figure 3

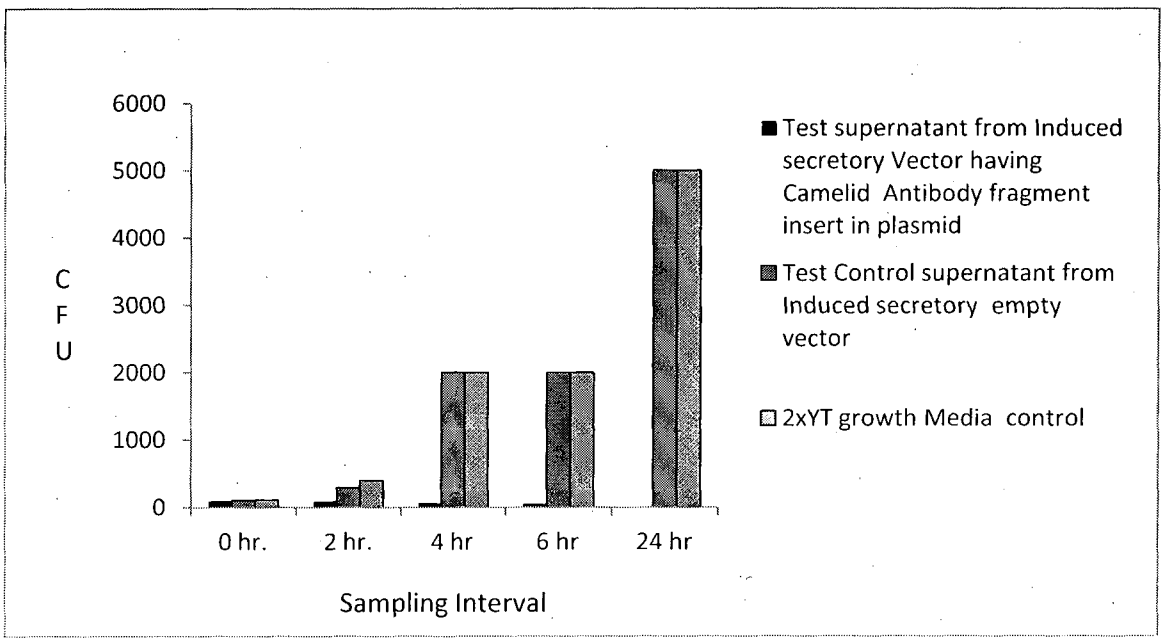

Figure 4

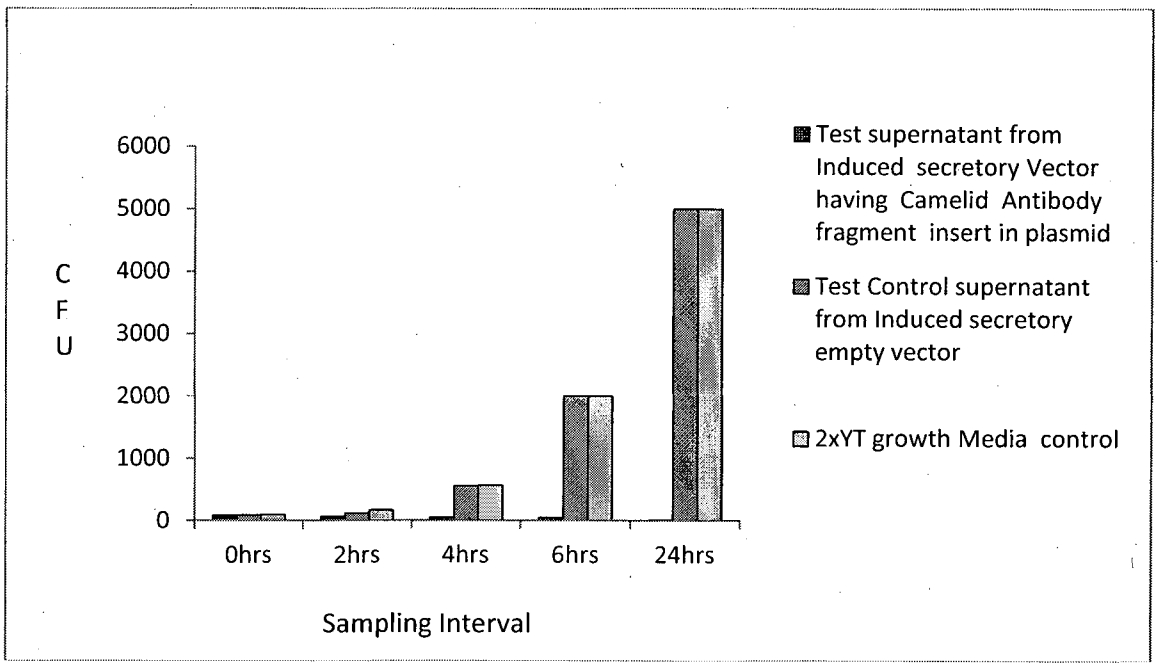

Figure 5

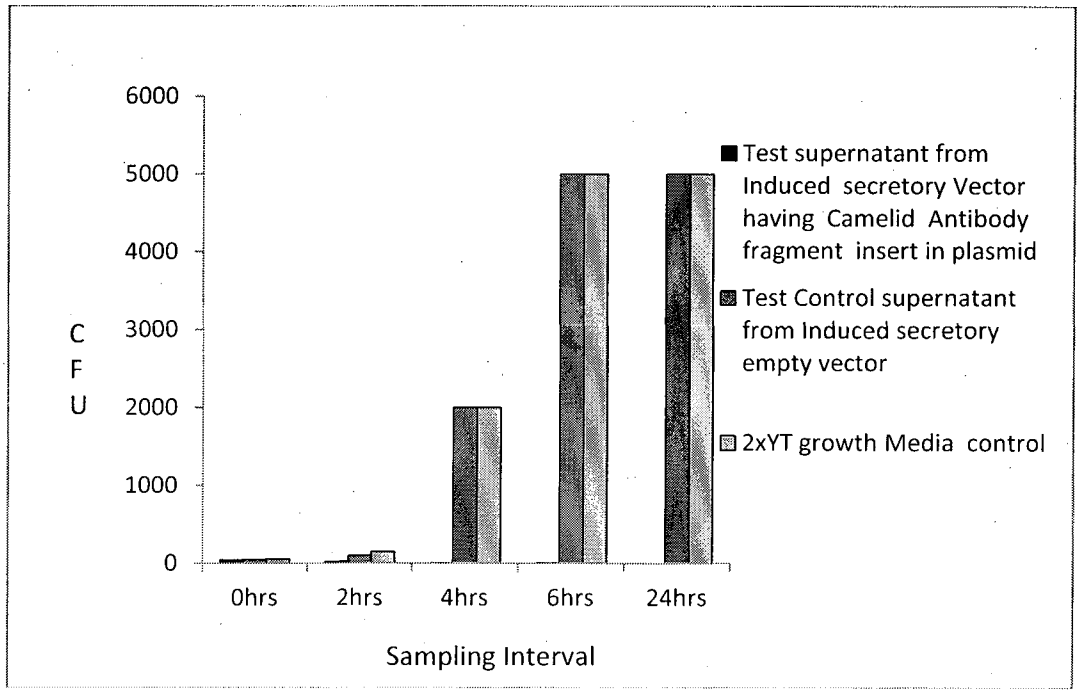

Figure 6

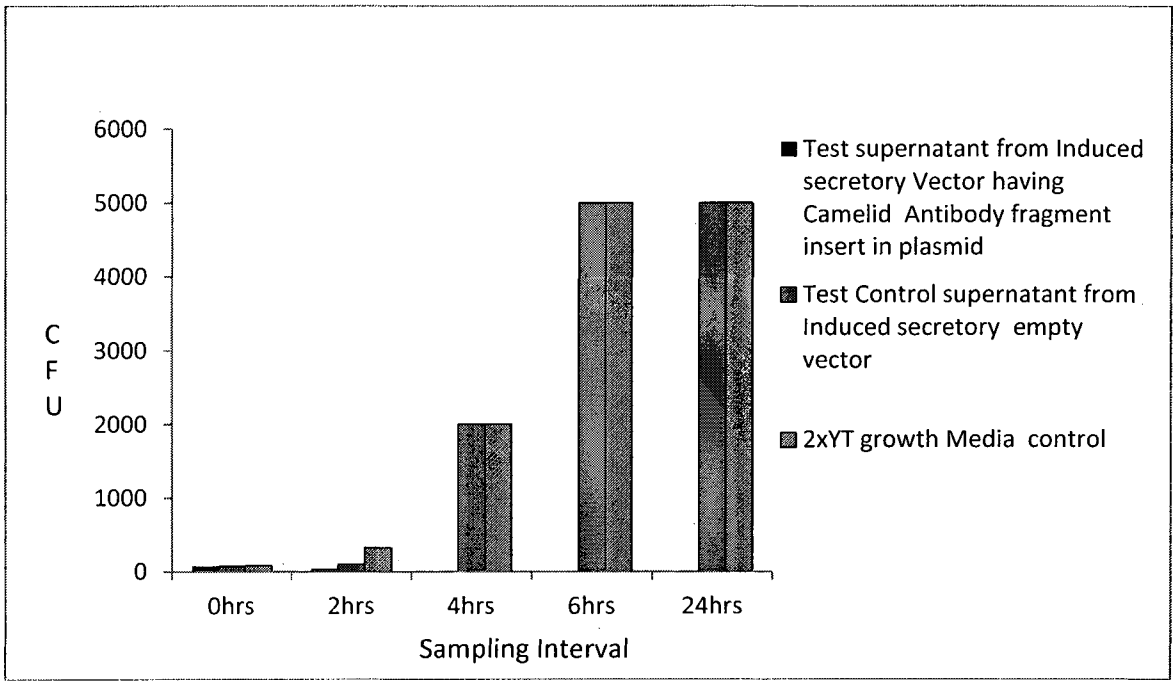

Figure 7

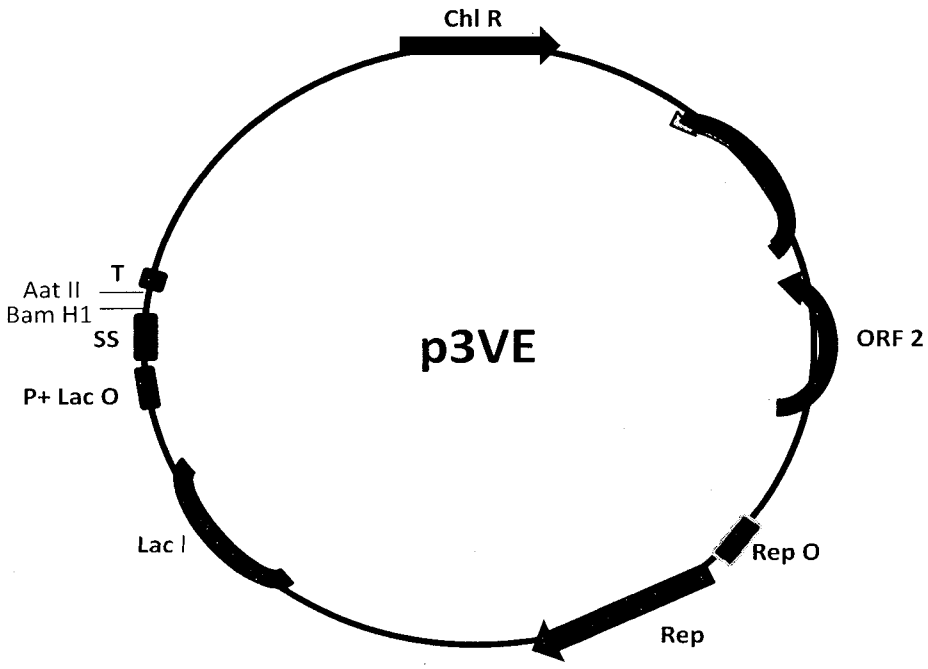

Figure 8