eISSN 2255-0569

ORIGINAL

Antimicrobial resistance of *Staphylococcus aureus* isolated from dental plaques

Resistencia a los antimicrobianos de Staphylococcus aureus aislado de placas dentales

Nima Khamisi[1], Amirhossein Fathi[2], Amir Yari[3]

1. Faculty of Dentistry, Khorasgan Branchg, Islamic Azad University, Isfahan, Iran. 2. Dental Material Research Center, Department of Prosthodontics, School of Dentistry, Isfahan University of Medical Sciences, Isfahan, Iran.
3. Doctor of Dental Surgery, School of Dentistry, Dental Research Center, Tehran University of Medical Sciences, Tehran, Iran.

Corresponding author
Amirhossein Fathi
Dental Material Research Center, Department of Prosthodontics,
School of Dentistry, Isfahan University of Medical Sciences, Isfahan, Iran
E-mail: amir_alty@yahoo.com

Received: 24 - X - 2021
Accepted: 18 - XII - 2021

doi: 10.3306/AJHS.2022.37.01.136

Abstract

Background: *Staphylococcus aureus* is considered the pathogenic agent of dental implant infections. The present survey was performed to assess the prevalence and antimicrobial resistance of *S. aureus* strains amongst the swab samples taken from the site of dental implant infection and also periimplant sulcular fluid (PISF).

Methods: A total of 70 individuals were included in this survey. Swab samples of the site of infection and also PISE fluid were taken and applied for microbial culture. Disk diffusion was used to assess the antimicrobial resistance of *S. aureus* isolates. Twenty out of 70 (28.57%) swab samples taken from the site of dental implant infection and PISF.

Results: The mean age of the studied population was 50.4 years, with a male to female ratio of 45/25. A history of alcohol and smoking was found in 25.71% and 77.5714 of the studied population. Statistically significant differences were found between male to female ratio (P <0.05), distribution of non-alcoholic and alcoholic individuals (P <0.05), and smokers with non-smoker individuals (P <0.05). *S. aureus* strains harbored the highest resistance levels toward penicillin (90%), gentamicin (85%), tetracycline (85%), and ciprofloxacin (75%). Resistance toward rifampin (25%) and trimethoprim-sulfamethoxazole (45%) was lower than other antimicrobials.

Conclusion: The role of antibiotic resistant-*S. aureus* strains was found as a reason of dental implant infections. However, some additional studies are needed to found more epidemiological aspects of antibiotic resistant-*S. aureus* in dental implant samples.

Keywords: Staphylococcus aureus, antimicrobial resistance, dental implants, prevalence.

Resumen

Antecedentes: El *Staphylococcus aureus* se considera el agente patógeno de las infecciones de los implantes dentales. El presente estudio se realizó para evaluar la prevalencia y la resistencia a los antimicrobianos de las cepas de *S. aureus* en las muestras tomadas de la zona de infección de los implantes dentales y del líquido sulcular periimplantario de la infección de los implantes dentales y del líquido sulcular periimplantario (PISF).

Métodos: Se incluyó a un total de 70 individuos en este estudio. Se tomaron muestras de hisopos del lugar de la infección y del líquido periimplantario y se aplicaron para el cultivo microbiano. Se utilizó la difusión en disco para evaluar la resistencia antimicrobiana de los aislados de *S. aureus*. Veinte de 70 (28,57%) muestras de hisopo tomadas del lugar de la infección del implante dental y del PISF.

Resultados: La edad media de la población estudiada fue de 50,4 años, con una proporción de hombres y mujeres de 45/25. Los antecedentes de alcohol y tabaquismo en el 25,71% y 77,5714 de la población estudiada. Se encontraron diferencias estadísticamente significativas entre la proporción de hombres y mujeres (P <0,05), la distribución de individuos no alcohólicos y alcohólicos (P <0,05), y los fumadores con los no fumadores (P <0,05). Las cepas de *S. aureus* presentaron los niveles más altos de resistencia a la penicilina (90%), la gentamicina (85%), tetraciclina (85%) y ciprofloxacino (75%). La resistencia a la rifampicina (25%) y al trimetoprim-sulfametoxazol (45%) fue menor que a otros antimicrobianos.

Conclusión: Se constató el papel de las cepas de *S. aureus* resistentes a los antibióticos como motivo de las infecciones de los implantes dentales. Sin embargo, se necesitan estudios adicionales para encontrar más aspectos epidemiológicos del *S. aureus* resistente a los antibióticos en muestras de implantes dentales.

Palabras clave: Staphylococcus aureus, resistencia antimicrobiana, implantes dentales, prevalencia.

Introduction

Dental implant treatment is important for the recovery process in patients with developmental and acquired dental defects. Dental implants directly improve the oral cavity function and esthetics as well as a patient's speech and general well-being[1]. In recent years, medical professionals have increasingly used dental implant procedures for tooth replacement. Consequently, there has been an increase in the number of patients with systemic diseases requesting dental implants to replace their missing teeth. However, the increase in demand for dental implants is also associated with an increase in complications associated with the procedure[2,3].

One of the major issues regarding dental implants is the infections occurrence in the site of dental plants[4]. In this regard, a small proportion of implants are not successful and may fail due to infection. The microbiota of implants is similar to that of teeth in similar clinical states. Implants that fail because of mechanical stress are colonized by species associated with healthy teeth. Infected implants are colonized by subgingival species, including Staphylococcus aureus (*S. aureus*)[5-7].

S. aureus is a Gram-positive and catalase-positive bacterium responsible for different kinds of infections, including Urinary Tract Infections (UTIs), Respiratory Tract Infections (RTIs), wound and burn infections, soft tissue infections, food-borne infections and etc[8]. *S. aureus* has been reported to be a common cause of infection-related implant failure, which involves multiple stages, including adherence, maturation, and dispersal of bacteria[9].

Dental implant *S. aureus* is able to cause several soft tissue infections and also infection expansion through head and neck[10]. Research reports that *S. aureus* bacteria harbor high resistance to diverse kinds of antibiotic drugs, particularly penicillins, cephalosporins, tetracyclines, aminoglycosides, macrolides, and fluoroquinolones[11-13]. Resistant strains cause more severe infections for a longer period of time with higher economic losses owing to the costs of control and treatments[14-16].

Rendering the high importance of this matter, the present survey was done to assess the prevalence and antimicrobial resistance of *S. aureus* strains isolated from dental implant infections.

Materials and methods

Study criteria

The present cross sectional survey was conducted between January 2020 to January 2021 on 200 individuals who were treated with dental implants at least 12 months ago. All individuals had signs of inflammation, pain, and redness in the site of dental implant. The inclusion and exclusion criteria were as follow:

The inclusion criteria:
1. Dental implant treatment at least 12 months ago
2. Presence of inflammation, pain and redness in the site of dental implant
3. Age > 18
4. No relevant medical conditions
5. Lack of antibiotic therapy in the past 2 months

The exclusion criteria:
1. Presence of the coronavirus diseases 2019 (COVID-19)
2. Presence of hepatitis viruses
3. Antibiotic uses in the past 2 months
4. Pregnancy or lactation
5. Malignant diseases or other diseases
6. Treated with radiotherapy or chemotherapeutic agents (chemotherapy) during the past five years
7. A history of head and neck radiation treatment owing to certain medical conditions

Written informed consents were taken from all individuals and their personal information kept secret.

Samples

Seventy out of 200 individuals were included into the study. Swab samples were taken from the site of dental implant infection without any contact with other parts of the oral cavity. Swabs were taken from both implant surfaces with inflammation and periimplant sulcular fluid (PISF) of each implant. All swabs were separately transferred to laboratory in cool boxes using the nutrient broth media.

S. aureus isolation and identification

A loopful sample of each broth media were transferred to blood agar media and incubated at 37ºC for 24 h in aerobic atmosphere. *S. aureus* identification was done using some biochemical tests, including Gram staining, , catalase activity, coagulated test (rabbit plasma), oxidase test, glucose O/F test, resistance to bacitracin (0.04 U), mannitol fermentation on Mannitol salt agar (Merck, Germany), urease activity, nitrate reduction, phosphatase, deoxyribonuclease (DNase, Merck, Germany) test, voges-proskaver (Merck, Germany) test and carbohydrate (xylose, sucrose, trehalose and maltose, fructose, lactose, mannose) fermentation tests[17].

Antimicrobial resistance

Patterns of antibiotic resistance of the *S. aureus* isolates were studied using the simple disk diffusion technique. The Mueller-Hinton agar (Merck, Germany) medium was used for this purpose. Susceptibility of *S. aureus* isolates were tested against several types of antibiotic groups including penicillin (10 µg/disk), methicillin (5 µg/disk), gentamicin (10 µg/disk), azithromycin (15 µg/disk), erythromycin (15 µg/disk), tetracycline (30 µg/disk), ciprofloxacin (5 µg/disk), levofloxacin (5 µg/disk), clindamycin (2 µg/disk), trimethoprim-sulfamethoxazole (25 µg/disk), and rifampin (5 µg/disk) antibiotic agents (Oxoid, UK) using the instruction of Clinical and Laboratory Standards Institute. The plates containing the discs were allowed to stand for at least 30 min before incubated at 37°C for 24 h. The diameter of the zone of inhibition produced by each antibiotic disc was measured and interpreted using the CLSI zone diameter interpretative standards. *Staphylococcus aureus* ATCC 25923 was used as quality control organism in antimicrobial susceptibility determination[19-21].

Data analysis

SPSS software and chi-square test were used for data analysis. At first, obtained data were kept at the Microsoft Excel software and then transferred to the SPSS[22,23]. P value > 0.05 was recognized as a significant level[24, 25].

Results

S. aureus distribution

A total of 70 swab samples were taken from the site of dental implant and assess for the prevalence and antimicrobial resistance of *S. aureus* isolates. **Table I** shows the distribution of *S. aureus* amongst the examined samples. Twenty out of 70 (28.57%) swab samples taken from the site of dental implant infection and PISF.

Table I: *S. aureus* distribution amongst the examined samples.

Samples	N. collected	N. positive (%)
Dental implant swab	70	20 (28.57)

Demographical characters

Table II shows the demographical characters of the examined individuals. As shown, the mean age of the studied population was 50.4 years, with a male to female ratio of 45/25. A history of alcohol and smoking was found in 25.71% and 77.5714 of the studied population. Statistically significant differences were found between male to female ratio (P <0.05), distribution of non-alcoholic and alcoholic individuals (P <0.05), and smokers with non-smoker individuals (P <0.05).

Table II: Demographical characters of the examined individuals.

Demographic characters	Individuals (n= 70)
Mean age (SD)	50.4 (13.5)
Sex (M/F)	45/25
Mean weight (SD)	70.6 (12.2)
Mean BMI (SD)	25.6 (3.8)
Alcohol (%)	18 (25.71)
Smoking (%)	54 (77.14)

Antimicrobial resistance

Table III shows the antimicrobial resistance of *S. aureus* strains isolated from dental implants. *S. aureus* strains harbored the highest resistance levels toward penicillin (90%), gentamicin (85%), tetracycline (85%), and ciprofloxacin (75%). Resistance toward rifampin (25%) and trimethoprim-sulfamethoxazole (45%) was lower than other antimicrobials. Statistically differences were found for the resistance levels between diverse antimicrobials (P <0.05).

Discussion

Several infections have been threated the human life in recent years[26-30]. *S. aureus* is considered one of the most prevalence causes of hospital infections, globally[31,32]. It is also considered the reason of some infectious cases in the dental implants[33].

The present survey showed that the *S. aureus* was isolated from 28.57% of the swab samples taken from the sites of the implant infections. Isolates were resistant to diverse classes of antimicrobial agents, particularly penicillin, gentamicin, tetracycline, and ciprofloxacin. A study conducted on Yemen[34], reported that 4.10% of examined samples of dental infections. Reports of this survey showed that isolates were resistant toward vancomycin (22.20%), clindamycin (26%), ciprofloxacin (29.70%), ceftizoxime (40.70%), clarithromycin (37%), augmentin (55.60%), tetracycline (74%), and erythromycin (23.30%). Minkiewicz-Zochniak et al. (2021)35 reported that *S. aureus* isolates of dental implants samples were resistant toward cefoxitin (9%), gentamycin (15.20%), tobramycin (18.20%), ciprofloxacin (33.30%), levofloxacin (15.20%), erythromycin (66.70%), clindamycin (54.50%), tetracycline (12.10%), and trimethoprim-sulfamethoxazole (3%).

Unauthorized and improper use of antibiotics and disinfectants in medical clinics, self-medication of patients with antibiotics, over-the-counter sales of antibiotics, over-prescribing of antibiotics are the main reasons for the high incidence of antibiotic resistance in bacteria.

About the main sources of dental implant infections, antibiotic-resistant bacteria can transmit from food[36-41], dental interventions, ear, nose and throat infections, sore throats, bloodstream infections, and finally imported infections from the outside of the mouth. The main important reality about these infections are their main

Table III: Antimicrobial resistance of *S. aureus* strains isolated from dental implants

	Resistance toward antimicrobials (%)										
Samples (N. positive)	P10	Met	Gen	Az	Ert	Tet	Cip	Lev	Cln	Tr-Sul	Rif
Dental implants (20)	18 (90)	14 (70)	17 (85)	13 (65)	14 (70)	17 (85)	15 (75)	10 (50)	8 (40)	9 (45)	5 (25)

*P10: penicillin (10 µg/disk), Met: methicillin (5 µg/disk), Gen: gentamicin (10 µg/disk), Az: azithromycin (15 µg/disk), Ert: erythromycin (15 µg/disk), Tet: tetracycline (30 µg/disk), Cip: ciprofloxacin (5 µg/disk), Lev: levofloxacin (5 µg/disk), Cln: clindamycin (2 µg/disk), Tr-Sul: trimethoprim-sulfamethoxazole (25 µg/disk), Rif: rifampin (5 µg/disk), roles in the expansion of infections into other parts of the body, such as sinuses, head and neck, blood, root canals, and other parts of the body[42]. Thus, it is essential to know and understand other epidemiological aspects of the dental implants infections.

Conclusion

To put it in a nutshell, the present work show the role of antibiotic-resistant *S. aureus* is one of the main sources of dental implant infections. Isolates had a high resistance toward some kinds of antimicrobials and low resistance toward others. It seems that, rifampin and trimethoprim-sulfamethoxazole owing to their low prevalence of resistance level can be suitable choices for the treatment of dental implant infections. Male was more prone to implant infections than females. Additionally, smoking is maybe the predisposing factor. However, the role of alcohol is not determined. Thus, more epidemiological surveys are needed to found more details about the *Staphylococcal* implant infections.

Interests conflict

The authors declare no conflict of interest.

References

1. Dewan, S.; Khullar, A.; Sehgal, M.; Arora, A. Implant failures: A broader perspective. J. Dent. Implants 2015, 5, 53.

2. Missika, P.; Bessade, J. Dental implants. Rev. Prat. 2018, 68, 827–830.

3. Manor, Y.; Simon, R.; Haim, D.; Garfunkel, A.; Moses, O. Dental implants in medically complex patients—A retrospective study. Clin. Oral Investig. 2016, 21, 701-708.

4. Mayta-Tovalino F, Rosas J, Mauricio-Vilchez C, Luza S, Alvitez-Temoche D, Mauricio F. Management of Postsurgical Complication in Multiple Implant-Infected Postextraction Sites in the Lower Arch. International Journal of Dentistry. 2020 Sep 29;2020.

5. Minkiewicz-Zochniak A, Jarzynka S, Iwańska A, Strom K, Iwańczyk B, Bartel M, Mazur M, Pietruczuk-Padzik A, Konieczna M, Augustynowicz-Kopeć E, Olędzka G. Biofilm Formation on Dental Implant Biomaterials by Staphylococcus aureus Strains Isolated from Patients with Cystic Fibrosis. Materials. 2021 Jan;14(8):2030.

6. Pye AD, Lockhart DE, Dawson MP, Murray CA, Smith AJ. A review of dental implants and infection. Journal of Hospital infection. 2009 Jun 1;72(2):104-10.

7. Aguayo S, Donos N, Spratt D, Bozec L. Nanoadhesion of Staphylococcus aureus onto titanium implant surfaces. Journal of dental research. 2015 Aug;94(8):1078-84.

8. Madahi H, Rostami F, Rahimi E, Dehkordi FS. Prevalence of enterotoxigenic Staphylococcus aureus isolated from chicken nugget in Iran. Jundishapur journal of microbiology. 2014 Aug;7(8).

9. Abdolmaleki Z, Mashak Z, Dehkordi FS. Phenotypic and genotypic characterization of antibiotic resistance in the methicillin-resistant Staphylococcus aureus strains isolated from hospital cockroaches. Antimicrobial Resistance & Infection Control. 2019 Dec;8(1):1-4.

10. Rokadiya S, Malden NJ. An implant periapical lesion leading to acute osteomyelitis with isolation of Staphylococcus aureus. British dental journal. 2008 Nov;205(9):489-91.

11. Momtaz H, Dehkordi FS, Rahimi E, Asgarifar A, Momeni M. Virulence genes and antimicrobial resistance profiles of Staphylococcus aureus isolated from chicken meat in Isfahan province, Iran. Journal of Applied Poultry Research. 2013 Dec 1;22(4):913-21.

12. Rahi A, Kazemeini H, Jafariaskari S, Seif A, Hosseini S, Dehkordi FS. Genotypic and phenotypic-based assessment of antibiotic resistance and profile of staphylococcal cassette chromosome mec in the methicillin-resistant Staphylococcus aureus recovered from raw milk. Infection and drug resistance. 2020;13:273.

13. Hasanpour Dehkordi A, Khaji L, Sakhaei Shahreza MH, Mashak Z, Safarpoor Dehkordi F, Safaee Y, Hosseinzadeh A, Alavi I, Ghasemi E, Rabiei-Faradonbeh M. One-year prevalence of antimicrobial susceptibility pattern of methicillin-resistant Staphylococcus aureus recovered from raw meat. Trop Biomed. 2017;34(2):396-404.

14. Ranjbar R, Seif A, Dehkordi FS. Prevalence of antibiotic resistance and distribution of virulence factors in the shiga toxigenic Escherichia coli recovered from hospital food. Jundishapur Journal of Microbiology. 2019;12(5):8.

15. Ranjbar R, Yadollahi Farsani F, Safarpoor Dehkordi F. Antimicrobial resistance and genotyping of vacA, cagA, and iceA alleles of the Helicobacter pylori strains isolated from traditional dairy products. Journal of Food Safety. 2019 Apr;39(2):e12594.

16. Abdolmaleki Z, Mashak Z, Safarpoor Dehkordi F. Molecular and virulence characteristics of methicillin-resistant Staphylococcus aureus bacteria recovered from hospital cockroaches. Jundishapur Journal of Microbiology. 2019 Dec 31;12(12).

17. Dehkordi FS, Gandomi H, Basti AA, Misaghi A, Rahimi E. Phenotypic and genotypic characterization of antibiotic resistance of methicillin-resistant Staphylococcus aureus isolated from hospital food. Antimicrobial Resistance & Infection Control. 2017 Dec;6(1):1-1.

18. CLSI. Performance Standards for Antimicrobial Susceptibility Testing; Twenty-Fifth Informational Supplement. In: CLSI document M100-S25, Wayne: Clin and Laboratory Standards Institute. 2015.

19. Mashak Z, Jafariaskari S, Alavi I, Shahreza MS, Dehkordi FS. Phenotypic and genotypic assessment of antibiotic resistance and genotyping of vacA, cagA, iceA, oipA, cagE, and babA2 alleles of Helicobacter pylori bacteria isolated from raw meat. Infection and drug resistance. 2020;13:257.

20. Ranjbar R, Farsani FY, Dehkordi FS. Phenotypic analysis of antibiotic resistance and genotypic study of the vacA, cagA, iceA, oipA and babA genotypes of the Helicobacter pylori strains isolated from raw milk. Antimicrobial Resistance & Infection Control. 2018 Dec;7(1):1-4.

21. Abdolmaleki Z, Mashak Z, Dehkordi FS. Phenotypic and genotypic characterization of antibiotic resistance in the methicillin-resistant Staphylococcus aureus strains isolated from hospital cockroaches. Antimicrobial Resistance & Infection Control. 2019 Dec;8(1):1-4.

22. Rahimi E, Yazdanpour S, Dehkordi FS. Detection of Toxoplasma gondii antibodies in various poultry meat samples using enzyme linked immuno sorbent assay and its confirmation by polymerase chain reaction. J Pure Appl Microbiol. 2014;8(1):421-7.

23. Dehkordi FS, Saberian S, Momtaz H. Detection and segregation of Brucella abortus and Brucella melitensis in Aborted Bovine, Ovine, Caprine, Buffaloes and Camelid Fetuses by application of conventional and real-time polymerase chain reaction. The Thai Journal of Veterinary Medicine. 2012 Mar 1;42(1):13.

24. Nejat S, Momtaz H, Yadegari M, Nejat S, Safarpour Dehkordi F, Khamesipour F. Seasonal, geographical, age and breed distributions of equine viral arteritis in Iran. Kafkas Univ Vet Fak Derg. 2015 Jan 1;21(1):111-6.

25. Dehkordi FS. Prevalence study of Coxiella burnetii in aborted ovine and caprine fetuses by evaluation of nested and real-time PCR assays. American Journal of Animal and Veterinary Sciences. 2011.

26. Mirzaie A, Halaji M, Dehkordi FS, Ranjbar R, Noorbazargan H. A narrative literature review on traditional medicine options for treatment of corona virus disease 2019 (COVID-19). Complementary therapies in clinical practice. 2020 Aug 1;40:101214.

27. Halaji M, Farahani A, Ranjbar R, Heiat M, Dehkordi FS. Emerging coronaviruses: first SARS, second MERS and third SARS-CoV-2: epidemiological updates of COVID-19. Infez Med. 2020;28(suppl):6-17.

28. Sheikhshahrokh A, Ranjbar R, Saeidi E, Dehkordi FS, Heiat M, Ghasemi-Dehkordi P, Goodarzi H. Frontier therapeutics and vaccine strategies for sars-cov-2 (COVID-19): A review. Iranian Journal of Public Health. 2020 Jul 11.

29. Ranjbar R, Mahmoodzadeh Hosseini H, Safarpoor Dehkordi F. A review on biochemical and immunological biomarkers used for laboratory diagnosis of SARS-CoV-2 (COVID-19). The Open Microbiology Journal. 2020 Dec 15;14(1).

30. Ranjbar R, Dehkordi FS, Heiat M. The frequency of resistance genes in Salmonella enteritidis strains isolated from cattle. Iranian Journal of Public Health. 2020 May;49(5):968.

31. Momeni Shahraki M, Shakerian A, Rahimi E, Safarpoor Dehkordi F. Study the frequency of enterotoxin encoding genes and antibiotic resistance pattern of methicillin-resistant Staphylococcus aureus isolated from vegetable and salad samples in Chaharmahal Va Bakhtiari province. Journal of Food Microbiology. 2020 Jun 21;7(2):55-69.

32. Madahi H, Rostami F, Rahimi E, Safarpoor Dehkordi F, Jalali M. Detection of classical enterotoxins of Staphylococcus aureus isolates from chicken nugget and ready to eat foods in Esfahan province by ELISA technique. Food Hygiene. 2013 Nov 22;3(3 (11)):1-0.

33. Harris LG, Richards RG. Staphylococcus aureus adhesion to different treated titanium surfaces. Journal of Materials Science: Materials in Medicine. 2004 Apr;15(4):311-4.

34. Al-Akwa A, Zabara AQ, Al-Shamahy HA, Al-labani MA, Al-Ghaffari KM, Al-Mortada AM. Prevalence of Staphylococcus aureus in dental infections and the occurrence of MRSA in isolates. Univers J Pharm Res. 2020;5(2):23-7.

35. Minkiewicz-Zochniak A, Jarzynka S, Iwańska A, Strom K, Iwańczyk B, Bartel M, Mazur M, Pietruczuk-Padzik A, Konieczna M, Augustynowicz-Kopeć E, Olędzka G. Biofilm Formation on Dental Implant Biomaterials by Staphylococcus aureus Strains Isolated from Patients with Cystic Fibrosis. Materials. 2021 Jan;14(8):2030.

36. Hosseini SS, Makkie SA, Far BT, Dehkordi FS. Genotypic and phenotypic assessment of antibiotic resistance of MRSA bacteria isolated from food stuffs. Academic Journal of Health Sciences: Medicina balear. 2021;36(3):76-80.

37. Shakerian A, Rahimi E, Dehkordi FS. Identification and characterization of resistant Arcobacter spp. isolated from meat products. Online Journal of Veterinary Research. 2017;21(12):766-76.

38. Mousavi S, Safarpoor Dehkordi F, Valizadeh Y. Genotyping of Helicobacter pylori strains isolated from raw milk and dairy products. Journal of Food Microbiology. 2017 Nov 22;4(3):41-53.

39. Mashak Z, Banisharif F, Banisharif G, Reza Pourian M, Eskandari S, Seif A, Safarpoor Dehkordi F, Alavi I. Prevalence of listeria species and serotyping of Listeria monocytogenes bacteria isolated from seafood samples. Egyptian Journal of Veterinary Sciences. 2021 Apr 1;52(1):1-9.

40. Ghorbani F, Gheisari E, Dehkordi FS. Genotyping of vacA alleles of Helicobacter pylori strains recovered from some Iranian food items. Tropical Journal of Pharmaceutical Research. 2016 Sep 5;15(8):1631-6.

41. Mousavi S, Dehkordi FS. Virulence factors and antibiotic resistance of Helicobacter pylori isolated from raw milk and unpasteurized dairy products in Iran. Journal of Venomous Animals and Toxins including Tropical Diseases. 2015 Jan 20;20:1-7.

42. Dehkordi FS, Tavakoli-Far B, Jafariaskari S, Momtaz H, Esmaeilzadeh S, Ranjbar R, Rabiei M. Uropathogenic Escherichia coli in the high vaginal swab samples of fertile and infertile women: virulence factors, O-serogroups, and phenotyping and genotyping characterization of antibiotic resistance. New Microbes and New Infections. 2020 Nov 1;38:100824.