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Detection of Antibiotic Resistance in *Staphylococcus aureus* Strains Isolated from Various Foods

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Abstract: This study was performed to determine the antibiotic resistance patterns of 27 *Staphylococcus aureus* strains, isolated from different foodstuffs, to a range of antibiotics including methicillin, penicillin, ampicillin, cefotaxime, teicoplanin, gentamicin, kanamycin, erythromycin, tetracycline, ciprofloxacin, clindamycin, chloramphenicol, quinupristin/dalfopristin and linezolid. Antibiotic susceptibility testing revealed that 88.9% (24/27) of the strains was resistant to at least one of the antibiotics. Most of *S. aureus* strains showed the resistance to penicillin (62.9%) and ampicillin (59.3%). For other antibiotics, the resistance rates were 22.2% for erythromycin, 11.1% for cefotaxime, kanamycin and tetracycline, and 7.4% for methicillin and clindamycin. Moreover, 18 of the strains had resistance to multiple antibiotics. So that, 12 strains exhibited resistance to two antibiotics, four strains to three antibiotics, one strain to four antibiotics, and one strain to six antibiotics. However, all the strains were found to be susceptible to teicoplanin, gentamicin, chloramphenicol and linezolid.

Key Words: *Staphylococcus aureus*, food, contamination, antibiotic resistance.

Çeşitli Gıdalardan İzole Edilen *Staphylococcus aureus* Suşlarında Antibiyotik Dirençliliğinin Belirlenmesi

Özet: Bu çalışma, çeşitli gıda maddelerinden izole edilen 27 adet *S. aureus* suşunun, metisilin, penisilin, ampisilin, sefotaksim, teikoplanin, gentamisin, kanamisin, eritromisin, tetrasiklin, siprofloksasin, klindamisin, kloramfenikol, kinopristin/dalfopristin ve linezolid gibi antibiyotiklere dirençlilik özelliklerini belirlemek amacıyla gerçekleştirildi. Antibiyotik duyarlılık testi, suşlardan %88.9'unun (24/27) en az bir antibiyotiğe dirençli olduğunu ortaya koydu. *S. aureus* suşlarının çoğunluğu penisilin (%62.9) ve ampisiline (%59.3) dirençlilik gösterdi. Diğer antibiyotikler bakımından dirençlilik oranları, eritromisin için %22.2, sefotaksim, kanamisin ve tetrasiklin için %11.1, metisilin ve klindamisin için %7.4 idi. Üstelik, 18 suş birden fazla antibiyotiğe karşı dirençliliğe sahipti. Öyleki, suşlardan 12'si iki antibiyotiğe, 4'ü üç antibiyotiğe, biri dört antibiyotiğe ve bir suş da altı antibiyotiğe direnç gösterdi. Bununla birlikte, tüm suşların teikoplanin, gentamisin, kloramfenikol ve linezolid'e duyarlı olduğu bulundu.

Anahtar Kelimeler: *Staphylococcus aureus*, gıda, kontaminasyon, antibiyotik dirençliliği.

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Introduction

Staphylococci are ubiquitous Gram-positive bacteria that represent part of the normal bacterial microflora of the skin and mucosal surfaces of humans and animals[21]. *Staphylococcus aureus* is widely recognised as the causative pathogen of various infections, ranging from infections of the skin and soft tissues, to septicaemia and endocarditis[9].

Although *S. aureus* strains can harbour different virulence genes[22], the most notable virulence factors associated with this microorganisms are the heat-stable enterotoxins (SEs), that cause the sporadic food-poisoning syndrome or foodborne outbreaks, and the toxic shock syndrome toxin 1 (TSST-1), which diminishes the immune response of a colonized host[16]. It is relevant to consider that the transmission of *S. aureus* is possible either by direct contact with animals or through contaminated food[6]. Human handling of food products as well as infection/colonization of livestock or farm workers have been described as mechanisms for the contamination of food with this bacterium[3].

Among the factors contributing to the virulence of this pathogen, antibiotic resistance also plays an important role[22]. Antimicrobial resistance is an increasingly serious public health concern in the worldwide[7]. The development of resistance both in human and animal bacterial pathogens has been associated with the extensive therapeutic use of antimicrobials or with their administration as growth promoters in food animal production[1,13]. Increasing antimicrobial resistance and multiple resistance have resulted in increasing difficulties in the treatment of bacterial infections[5]. Among antibiotic resistant staphylococci, multidrug-resistant *S. aureus s*trains are of great public concern since resistances make more difficult the treatment of infections[21]. Worldwide, methicillin-resistant *S. aureus* (MRSA) is a significant and increasing cause of nosocomial infections. Cases of illness following the consumption of MRSA-contaminated food have been reported[10,11].

The purpose of this work was to determine the resistance profiles to various antimicrobial agents of 27 *S. aureus* strains isolated from food samples including milk and dairy products (cheese, kefir), meat products (raw meatball, sausage) and seafood (fish, shrimp, mussel).

Materials and Methods

Bacterial strains and culture conditions

A total of 27 *S. aureus* strains that had been isolated from various foodstuffs were used in the present study. The origins of the strains used are shown in Table 1. Working stock cultures were kept frozen at -20°C in a 20% glycerol supplemented with Brain-Heart Infusion (BHI, Oxoid CM1135) broth. The cultures were activated in BHI broth at 37°C before use.

Table 1. CLSI disk diffusion breakpoints for *S. aureus* (CLSI, 2011) and diameters of the inhibition zone obtained for 27 *S. aureus* strains in disk diffusion testing

Tablo 1. *S. aureus* için CLSI disk difüzyon sınır değerleri (CLSI, 2011) ve 27 *S. aureus* suşu için disk difüzyon testinde alınan inhibisyon zon çapları

Antimicrobial agents	Disk content	The range of zone diameters (mm) in this study	CLSI breakpoints (mm)		
			S	I	R
Methicillin	5 µg	6-38	≥14	10-13	≥9
Penicillin	10 U	9-46	≥29	-	≥28
Ampicillin	10 µg	8-48	≥29	-	≥28
Cefotaxime	30 µg	6-37	≥23	15-22	≥14
Teicoplanin	30 µg	15-24	≥14	11-13	≥10
Gentamicin	10 µg	18-26	≥15	13-14	≥12
Kanamycin	30 µg	11-28	≥18	14-17	≥13
Erythromycin	15 µg	6-30	≥23	14-22	≥13
Tetracycline	30 µg	10-31	≥19	15-18	≥14
Ciprofloxacin	5 µg	20-35	≥21	16-20	≥15
Clindamycin	2 µg	9-32	≥21	15-20	≥14
Chloramphenicol	30 µg	20-31	≥18	13-17	≥12
Quinupristin/ dalfopristin	15 µg	18-29	≥19	16-18	≥15
Linezolid	30 µg	24-35	≥21	-	≥20

S, susceptible; I, intermediate; R, resistant.

Antibiotic susceptibility testing

The antibiotic susceptibility of the strains was evaluated by the disk diffusion method according to the recommendations of the Clinical and Laboratory Standards Institute[2]. Single colony of *S. aureus* picked from fresh cultures on Tryptone Soya Agar (TSA, Oxoid CM131), incubated aerobically 37°C for 24 h, were inoculated into Mueller-Hinton Broth (MHB, Oxoid CM405). When broth culture reached the 0.5

Table 2. Antibiotic resistance profiles of *S. aureus* strains isolated from a variety of food
Tablo 2. Gıdalardan izole edilen *S. aureus* suşlarının antibiyotik dirençlilik profilleri

Strain no.	Source	Coagulase activity	ME	P	AMP	CTX	TEC	CN	K	E	TE	CIP	DA	C	QD	LIN
1	Goat milk	Negative	S	S	S	S	S	S	S	S	R	S	S	S	S	S
2	Goat milk	Negative	S	S	S	S	S	S	S	S	S	S	S	S	S	S
3	Shrimp	Positive	S	R	R	S	S	S	S	S	S	S	S	S	S	S
4	Raw meatball	Positive	S	S	S	S	S	S	S	R	S	S	S	S	S	S
5	Kefir	Negative	S	S	S	S	S	S	S	S	S	S	S	S	S	S
6	Kefir	Negative	S	S	S	S	S	S	S	S	R	S	S	S	S	S
7	Kefir	Negative	S	R	R	S	S	S	S	R	S	S	S	S	S	S
8	Shrimp	Positive	S	R	R	S	S	S	S	I	S	S	S	S	S	S
9	Shrimp	Positive	S	R	R	S	S	S	S	S	S	S	S	S	S	S
10	Fish	Positive	S	R	R	S	S	S	S	S	S	S	S	S	S	S
11	Fish	Positive	S	R	R	S	S	S	S	S	S	S	S	S	S	S
12	Shrimp	Positive	S	R	R	S	S	S	S	I	S	S	S	S	I	S
13	Mussel	Negative	S	R	R	S	S	S	S	S	S	S	S	S	S	S
14	Raw meatball	Positive	S	S	S	S	S	S	S	R	S	I	S	S	S	S
15	Cheese	Negative	S	R	R	S	S	S	S	R	S	S	S	S	S	S
16	Fish	Positive	S	R	R	S	S	S	S	S	S	S	S	S	S	S
17	Cheese	Positive	S	R	R	S	S	S	S	S	S	S	S	S	S	S
18	Shrimp	Positive	S	R	R	S	S	S	S	S	S	S	S	S	S	S
19	Fish	Positive	S	R	R	S	S	S	S	S	S	S	S	S	S	S
20	Cheese	Positive	S	S	S	R	S	S	S	I	S	S	R	S	S	S
22	Raw meatball	Positive	S	R	R	S	S	S	S	R	S	S	S	S	S	S
23	Raw meatball	Positive	S	R	R	S	S	S	S	R	S	S	S	S	S	S
24	Kefir	Positive	I	S	S	S	S	S	R	I	I	S	S	S	S	S
34	Sausage	Positive	R	R	S	R	S	S	R	S	R	S	R	S	S	S
35	Raw meatball	Positive	R	R	R	R	S	S	S	S	S	S	S	S	S	S
36	Raw meatball	Positive	S	S	S	S	S	S	S	S	S	S	S	S	I	S
37	Raw meatball	Positive	I	S	S	S	S	S	R	S	S	S	S	S	S	S

ME, methicillin; P, penicillin G; AMP, ampicillin; CTX, cefotaxime; TEC, teicoplanin; CN, gentamicin; K, kanamycin; E, erythromycin; TE, tetracycline; CIP, ciprofloxacin; DA, clindamycin; C, chloramphenicol; QD, quinupristin/dalfopristin; LIN, linezolid; R, resistant,, I, intermediate susceptible, S, susceptible

McFarland standard turbidity at 30ºC, each suspension was spread on the surface of Mueller Hinton Agar (MHA, Oxoid CM337) plates by a sterile ecuvion. Antibiotic disks were placed aseptically on the agar surface and plates were then incubated at 37ºC for 24 h. After incubation, the results were recorded by measuring the inhibition zones, and each organism was classified as resistant (R), intermediate (I) or susceptible (S) according to the guidelines of CLSI. *Staphylococcus aureus* ATCC 25923 was used as a reference strain. Table 1 shows CLSI breakpoints for disk diffusion susceptibility testing (zone diameter, mm) of *S. aureus*.

The following antimicrobial susceptibility test disks were used: methicillin 5 µg (Bioanalysis, Turkey), penicillin 10 U, ampicillin 10 µg, cefotaxime 30 µg, teicoplanin 30 µg, gentamicin 10 µg, kanamycin 30 µg, erythromycin 15 µg, tetracycline 30 µg, ciprofloxacin 5 µg, clindamycin 2 µg, chloramphenicol 30 µg, quinupristin/dalfopristin 15 µg, linezolid 30 µg (Oxoid, Basingstoke, UK).

Results

Susceptibility testing of the *S. aureus* strains isolated from different foodstuffs to 14 antimicrobials was carried out with disk diffusion method according to CLSI guidelines. Table 2 summarizes the antibiotic susceptibility profiles of the strains. All of 27 strains were found to be susceptible to teicoplanin, gentamicin, chloramphenicol and linezolid. The highest resistance percentage was obtained for penicillin (62.9%), followed by ampicillin (59.3%), erythromycin (22.2%), kanamycin (11.1%), tetracycline (11.1%), cefotaxime (11.1%), methicillin (7.4%) and clindamycin (7.4%.). Table 3 shows the numbers and incidence of resistant *S. aureus* strains to antibiotics tested. Additionally, resistance to multiple antibiotics was observed among the strains.

Discussion

Due to the intensive use of antibiotics in public health and animal husbandry and the risk

of transfer of antibiotic resistance determinants, the incidence of antibiotic resistances in food associated pathogenic bacteria including *S. aureus* has been an increasing problem during the last decades[17].

In the present study, 88.9% (24/27) of strains showed antimicrobial resistance properties to at least one of the antibiotics tested (Table 2). However, all 27 *S. aureus* strains were susceptible to teicoplanin, gentamicin, chloramphenicol and linezolid. The sensitivity of *S. aureus* strains to teicoplanin, gentamicin and chloramphenicol was similar to the antibiotic sensitivity of *S. aureus* isolated from rabbit meat by Rodriguez-Calleja et al.[18]. On the contrary, the resistance of *S. aureus* isolates was suggested to gentamicin by Pereira et al.[16], by Ezzeldeen et al.[4] and by Normanno et al.[14] and to chloramphenicol by Vazquez-Sanchez et al.[24] and by Umoh and Odoba[23].

As shown in Table 3, the overall antimicrobial susceptibility profiles revealed that the highest percentage of resistance among the strains was detected for penicillin (62.9%), followed by ampicillin (59.3%) and erythromycin (22.2%). The lower resistance rates was observed for kanamycin, tetracycline and cefotaxime (11.1%), methicillin and clindamycin (7.4%). Several authors have reported resistance of *S. aureus* strains obtained from different types of food to a variety of antibiotics. The rates of resistance to penicillin in our work compare with those found by Pereira et al.[16] and Umoh and Odoba[23], who, among *S. aureus* from different food origins, observed 73% and 56.7% of resistance to this antibiotic, respectively. Much lower prevalence rates of penicillin resistance were reported for *S. aureus* strains in studies conducted by Shahraz et al.[20] (18.7%), by Peles et al. (15) (30.5%), by Rodriguez-Calleja et al.[18] (26.9%) and by Spanu et al.[22] (18%). However, Vazquez-Sanchez et al.[24] found a high incidence of penicillin resistant *S. aureus* (100%) in fishery products from retail outlets in Galicia (Spain). We found that 59.3% of strains were resistant to ampicillin. Different rates of ampicillin resistance were suggested for *S. aureus* strains obtained from various food samples in Portugal (70%)[16], in Nigeria (50%)[23], in Italy (18%)[22] and in Italy (46.4%)[14].

In this investigation, it was found that six (22.2%) of the strains were resistant to erythromycin. Other some workers have also indicated erythromycin resistance with incidence rates of 20.3%[20] and 32.0%[14]. On the other hand, our result disagreed with Peles et al.[15] and Vazquez-Sanchez et al.[24] who reported that all of *S. aureus* strains from bovine milk in Hungary and fishery products in Spain, respectively, were susceptible to erythromycin.

In our study, 11.1% (3/27) of *S.aureus* strains exhibited resistance pattern to tetracycline, which is below (from 16.7% to 82.4%)[4,18,23,24] or above (from 0.7% to 6.0%)[16,22] the incidence rates of tetracycline resistance reported by some other groups.

Table 3. Numbers and incidence of resistant *S.aureus* strains isolated from foodstuffs

Tablo 3. Gıda maddelerinden izole edilen dirençli *S. aureus* suşlarının sayıları ve insidensi

Antibiotics	Resistant strains	
	Number	Incidence (%)
Methicillin	2	7.4
Penicillin	17	62.9
Ampicillin	16	59.3
Cefotaxime	3	11.1
Teicoplanin	0	0
Gentamicin	0	0
Kanamycin	3	11.1
Erythromycin	6	22.2
Tetracycline	3	11.1
Ciprofloxacin	0	0
Clindamycin	2	7.4
Chloramphenicol	0	0
Quinupristin/dalfopristin	0	0
Linezolid	0	0

Methicillin-resistant *S. aureus* (MRSA) was first reported in the United Kingdom (UK) in 1961[12], and MRSA infections had become a global health issue due to the severity of the illness they may cause[13]. MRSA, posing a potential threat to human health, in food samples analysed in several surveys from different parts of the world has been found, with following rates reported: Iran 89%[20], Malaysia 20%[19], Egypt 12.6%[4], Turkey 97.2%[8], Italy 3.7%[13]. The present survey also showed that two (7.4%) out of 27 *S.aureus* strains had resistance to methicillin. However, some early reports suggested the absence of meticillin-resistant *S. aureus* in bovine milk[15], fishery products[24], raw ewe's milk cheese[22], food samples implicated in suspected food poisoning complaints and foodborne outbreaks[3].

According to Table 2, only two strains had intermediate resistance to quinupris-

tin/dalfopristin and one strain to ciprofloxacin. All the remaining strains were shown to be susceptible to these antibiotic agents. Concerning ciprofloxacin contrary data were reported by Shahraz et al.[20] and Vazquez-Sanchez et al.[24] who recorded 14% and 100% of *S. aureus* isolates from packaged hamburgers and fishery products, respectively, were resistant for this antibiotic.

18 strains showed multidrug resistance: one was resistant to six antibiotics (methicillin, penicillin, cefotaxime, kanamycin, tetracycline, clindamycin), one strain to four antibiotics, four strains to three antibiotics and twelve strains to two antibiotics.

In conclusion, most of *S. aureus* strains were resistant to one or more antimicrobial agents. Our results showed that animal originated foods harboured the antimicrobial resistant strains of *S. aureus* and can be a likely vehicle for transmission of multidrug resistant strains. Therefore, the monitoring for the emergence of antibiotic resistance in foods and the prudent use of antibiotics in veterinary medicine and animal production is essential for public health.

References

1. Byarugaba, D.K., 2004. A view on antimicrobial resistance in developing countries and responsible risk factors. *Int. J. Antimicrob. Ag*., 24, 105-110.
2. Clinical and Laboratory Standards Institute (CLSI), 2011. Performance standards for antimicrobial susceptibility testing; twenty-first informational supplement M100-S21 (ISBN 1-56238-742-1), Wayne, PA, USA.
3. Crago, B., Ferrato, C., Drews, S.J., Svenson, L.W., Tyrrell, G., Louie, M., 2012. Prevalence of *Staphylococcus aureus* and methicillin-resistant *S. aureus* (MRSA) in food samples associated with foodborne illness in Alberta, Canada from 2007 to 2010. *Food Microbiol*., 32, 202-205.
4. Ezzeldeen, N.A., Mansour, H.A., Ahmed, A.A., 2011. Phenotypic and molecular identification of *Staphylococcus aureus* isolated from some Egyptian salted fish. *World Appl. Sci. J*., 15, 1703-1712.
5. French, G.L., 2005. Clinical impact and relevance of antibiotic resistance. *Adv. Drug Delivery Rev*., 57, 1514-1527.
6. Gharsa, H., Slama, K.B., Lozano, C., Gomez-Sanz, E., Klibi, N., Sallem, R.B., Gomez, P., Zarazaga, M., Boudabous, A., 2012. Prevalence, antibiotic resistance, virulence traits and genetic lineages of *Staphylococcus aureus* in healthy sheep in Tunisia. *Vet. Microbiol*., 156, 367-373.
7. Graham, J.P., Evans, S., Price, L.B., Silbergeld, E.K., 2009. Fate of antimicrobial-resistant enterococci and staphylococci and resistance determinants in stored poultry litter. *Environ. Res*., 109, 682-689.
8. Gündoğan, N., Citak, S., Turan, E., 2006. Slime production, DNase activity and antibiotic resistance of *Staphylococcus aureus* isolated from raw milk, pasteurised milk and ice cream samples. *Food Control*, 17, 389-392.
9. Hawser, S.P., Bouchillon, S.K., Hoban, D.J., Dowzicky, M., Babinchak, T., 2011. Rising incidence of *Staphylococcus aureus* with reduced susceptibility to vancomycin and susceptibility to antibiotics: a global analysis 2004-2009. *Int. J. Antimicrob. Ag.*, 37, 219- 224.
10. Jones, T.F., Kellum, M.E., Porter, S.S., Bell, M., Schaffner, W., 2002. An outbreak of community-acquired foodborne illness caused by methicillin-resistant *Staphylococcus aureus*. *Emerg. Infect. Dis*., 8, 82-84.
11. Kluytmans, J., van Leeuwen, W., Goessens, W., Hollis, R., Messer, S., Herwaldt, L., Bruining, H., Heck, M., Rost, J., van Leeuwen, N., et. al., 1995. Food-initiated outbreak of methicillin-resistant *Staphylococcus aureus* analyzed by pheno- and genotyping. *J. Clin. Microbiol*., 33 (5), 1121-1128.
12. Mirzaei, H., Farhoudi, H., Tavassoli, H., Farajli, M., Monadi, A., 2012. Presence and antimicrobial susceptibility of methicillin-resistant *Staphylococcus aureus* in raw and pasteurized milk and ice cream in Tabriz by culture and PCR techniques. *Afr. J. Microbiol. Res*., 6, 6224-6229.
13. Normanno, G., Corrente, M., La Salandra, G., Dambrosio, A., Quaglia, N.C., Parisi, A., Greco, G., Bellacicco, A.L., Virgilio, S., Celano, G.V., 2007. Methicillin-resistant *Staphylococcus aureus* (MRSA) in foods of animal origin product in Italy. *Int. J. Food Microbiol.*, 117, 219-222.
14. Normanno, G., La Salandra, G., Dambrosio, A., Quaglia, N.C., Corrente, M., Parisi, A., Santagada, G., Firinu, A., Crisetti, E., Celano, G.V., 2007. Occurence, characterization and antimicrobial resistance of enterotoxigenic *Staphylococcus aureus* isolated from meat and dairy products. *Int. J. Food Microbiol*., 115, 290-296.
15. Peles, F., Wagner, M., Varga, L., Hein, I., Rieck, P., Gutser, K., Kereszturi, P., Kardos, G., Turcsanyi, I., Beri, B., Szabo, A., 2007. Characterization of *Staphylococcus aureus* strains isolated from bovine milk in Hungary. *Int. J. Food Microbiol*., 118, 186-193.
16. Pereira, V., Lopes, C., Castro, A., Silva, J., Gibbs, P., Teixeira, P., 2009. Characterization for enterotoxin production, virulence factors, and antibiotic susceptibility of *Staphylococcus aureus* isolates from various foods in Portugal. *Food Microbiol.*, 26, 278- 282.

17. Resch, M., Nagel, V., Hertel, C., 2008. Antibiotic resistance of coagulase-negative staphylococci associated with food and used in starter cultures. *Int. J. Food Microbiol.*, 127, 99-104.
18. Rodriguez-Calleja, J.M., Garcia-Lopez, I., Santos, J.A., Otero, A., Garcia-Lopez, M.L., 2006. Molecular and phenotypic typing of *Staphylococcus aureus* isolates from rabbit meat. *Res. Microbiol*., 157, 496-502.
19. Sasidharan, S., Prema, B., Yoga Latha, L., 2011. Antimicrobial drug resistance of *Staphylococcus aureus* in dairy products. *Asian Pac. J. Tro. Biomed.*, 130-132.
20. Shahraz, F., Dadkhah, H., Khaksar, R., Mahmoudzadeh, M., Hosseini, H., Kamran, M., Bourke, P., 2012. Analysis of antibiotic resistance patterns and detection of mecA gene in *Staphylococcus aureus* isolated from packaged hamburger. *Meat Sci.*, 90, 759-763.
21. Siemoni, D., Rizzotti, L., Cocconcelli, P., Gazzola, S., Dellaglio, F., Torriani, S., 2008. Antibiotic resistance genes and identification of staphylococci collected from the production chain of swine meat commodities. *Food Microbiol*., 25, 196-201.
22. Spanu, V., Spanu, C., Virdis, S., Cossu, F., Scarano, C., De Santis, E.P.L., 2012. Virulence factors and genetic variability of *Staphylococcus aureus* strains isolated from raw sheep's milk cheese. *Int. J. Food Microbiol*., 153, 53-57.
23. Umoh, V.J., Odobab, M.B., 1999. Safety and quality evaluation of street foods sold in Zaria, Nigeria. *Food Control*, 10, 9-14.
24. Vazquez-Sanchez, D., Lopez-Cabo, M., Saa-Ibusquiza, P., Rodriguez-Herrera, J.J., 2012. Incidence and characterization of *Staphylococcus aureus* in fishery products marketed in Galicia (northwest Spain). *Int. J. Food Microbiol*., 157, 286-296.