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Bacteriological parameters of some farmed fish species marketed in Egypt

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Abstract

Fish is considered a valuable source of protein in Egypt. In this study ninety fish samples were collected from farmed fish marketed in Zagazig City, Egypt. The samples were *Mugil cephalus, Oreochromis niloticus and Claris lazera*. In each case, 30 samples were subjected to bacteriological analysis and compared with Egyptian standards for chilled fish. The mean value of aerobic plate count (APC) was $3.17\times10^4 \pm 0.42\times10^4$, $2.41\times10^5 \pm 0.28\times10^5$ and $5.63\times10^5 \pm 0.61\times10^5$ CFU/g and the acceptability according to APC was 100%, 86.7%, and 80% of examined *M. cephalus*, *O. niloticus* and *C. lazer*a, respectively. The total coliform counts were $1.33\times10^2 \pm 0.19\times10^2$, $3.52\times10^2 \pm 0.46\times10^2$ and $6.10\times10^2 \pm 0.54\times10^2$ CFU/g and the acceptability were 90%, 83.3%, and 73.3% for *M. cephalus*, *O. niloticus* and *C. lazer*a, respectively. Staphylococcal enterotoxin (SE) producing *S. aureus* was detected in 1(3.3%) from *M. cephalus* as (SEA+SEC), 1(3.3%) of *O. niloticus* as SEB and in 3 (10%) of *C. lazera* as SEA, SED, (SEA+SEC). *Escherichia. coli* and Salmonellae were detected in 2/30 (6.7%) and 3/30(10%), 6/30(20%) and 4/30(13.3%), 7/20(23.3%) and 6/30(20%) of *M. cephalus*, *O. niloticus* and *C. lazer*a tested, respectively. Meanwhile, *Listeria monocytogenes* was detected in only one sample of the examined *C. lazera* 1/30 (3.3%). The results obtained should point the way to the importance of implementing food safety systems from the beginning of production to the consumer's hand.

1. Introduction

Fish is one of the most important foods in Egypt as it provides consumers with high-quality animal protein while compensating for the lack of red meat. When a healthy fish is caught, it is usually sterile as the immune system easily prevents the spread of bacteria. After death, the immune system of fish is deactivated, so pathogens can easily enter the meat (Hussein *et al*., 2019). The total fish production in Egypt was 2.2 MMT in 2021 with aquaculture share at 1.7 MMT of total production. Egypt has a promising plan to raise fish production to 3 MMT by 2025 (USDA, 2020). Many food poisoning germs can be transmitted through seafood. In underdeveloped countries, faecal contamination of natural water is an issue (El-Kowrany *et al*. 2015). Due to the production of staphylococcal enterotoxins (SEs), *S. aureus* is one of the most dangerous organisms responsible for food poisoning outbreaks, posing a public health risk (Le Loir *et al*., 2003; Vasconcelos *et al.* 2010). Many foodborne illness outbreaks associated with seafood are caused by consumption of raw or undercooked fish, which could be contaminated with bacterial pathogens such as *Salmonella* spp., *E. coli*, and *S. aureus* from water sources, or the fish and fish products could be contaminated after the various processing stages (Pal *et al.* 2014). Food poisoning can be caused by handling diseased fish or contact with contaminated water or other components of the aquatic environment (Gauthier, 2015). *S. aureus* can grow in foods due to a wide range of growth parameters, including temperature ranging from 7 to 48.5°C, with an optimum of 30 to 37°C (Schmitt *et al*. 1990), pH ranging from 4.2 to 9.3, with an optimum of 7 to 7.5 (Bergdoll, 1983), and the ability to tolerate sodium chloride concentrations up to 15%. Staphylococcal enterotoxins (SEs) are responsible for staphylococcal food poisoning (Le Loir *et al*., 2003). SEs are produced during the exponential phase of *S. aureus* growth, with the quantity varying by strain. When *S. aureus* is counted in food with at least 10^5–10^8 CFU/g, SE causes food poisoning in humans (Seo and Bohach 2007). Although most *E. coli* strains are nonpathogenic, certain pathogenic serotypes of intestinal *E. coli* are opportunistic and can cause disease in the

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gastrointestinal tract, urinary system, or central nervous system. To date, more than 400 *E. coli* serotypes have been found, with 200 serotypes recognized as toxin-producing *E. coli* (Fadel *et al*., 2017). Although *E. coli* does not naturally exist in the microbiome of fish, it can be transmitted to them through contaminated aquatic environments (Guzmán *et al*., 2004; Cardozo *et al*., 2018). According to the Centers for Disease Control and Prevention, nontyphoidal Salmonella foodborne disease accounts for 1,341,873 cases, 15,608 hospitalizations, and 553 fatalities (30.6% of all foodborne deaths) in the United States each year (Mead *et al*., 1999). Salmonella outbreaks in which fish or shellfish were the vehicles of transmission accounted for 8 of the 160 outbreaks (7.42%) (Bean *et al*., 1997). Contamination of seafood with zoonotic bacteria could happen during slaughter, refrigeration, or processing, resulting in bacterial transmission to consumers (Gonzalez-Rodriguez *et al*., 2002). Since 1929, *L. monocytogenes* has been identified as a significant opportunistic human disease, and since 1981, as a food borne pathogen (Jeyasekaran *et al*., 1996). Lennon *et al.* (1984), who argued that intake of shellfish and raw fish was responsible for an epidemic of prenatal listeriosis in New Zealand in 1980, suggested that seafood may have a role in the transmission of listeriosis. *L. monocytogenes* primarily affects children, the elderly, and immune-compromised persons, causing serious infections such as septicemia, encephalitis, and meningitis (Schuchat *et al*., 1991). This study aimed to evaluate the bacteriological profile of some farmed fish species marketed in Zagazig fish market in Egypt.

2. Materials and methods

2.1 Collection and preparation of fish samples

A total of 90 random samples of ice chilled farmed fish represented by *M. cephalus, O. niloticus and C. lazera* (30 of each) were collected from certain fish market in Zagazig City, Egypt. The collected samples were kept in a separated sterile plastic bag, labeled and preserved in an ice box then transferred to the laboratory to evaluate APC, coliforms, *E. coli*, Salmonellae, S. *aureus* and *L. monocytogenes* in examined fish samples. The samples were prepared according to International Organization of Standardization (ISO) 4833-1:2013 (ISO, 2013).

2.2 Aerobic plate count

Aerobic plate count (APC) was performed according to ISO 4833-1:2013 (ISO, 2013). Approximately, 1 mL from each of the previously prepared dilutions was transferred into two separate sterile Petri dishes to which approximately 15 mL of sterile melted and tempered standard plate count agar (Oxiod CM325) at 45°C were added. After thorough mixing, the inoculated plates were allowed to solidify before being incubated at 37°C for 24 hrs. The colony forming unit (CFU) per gram was calculated on plates containing 30-300 colonies and each count was recorded separately.

2.3 Total coliform count

The procedure to estimate the total coliform count was according to ISO 4832:2006 (ISO, 2006). The procedure recommended using Violet Red Bile agar medium (Oxoid CM0107) pour plate method was applied. The plates were incubated at 37°C for 24 hrs. All dark red colonies measuring 0.5 mm in diameter on the plates were then counted and the average number of colonies was determined.

2.4 Determination for Enteropathogenic Escherichia coli

Pre-enrichment and Enrichment on broth according to ISO 16649-2:2001 (2001) then Loopfuls from positive MacConkey broth (Oxoid CM0005) tubes were separately streaked onto Eosin Methylene Blue agar medium (Oxoid CM0069), which was then incubated at 37°C for24 hrs. Suspected colonies were metallic green in color. Suspected colonies were purified and inoculated into slope nutrient agar tubes for further identification according to MacFaddin (2000). The Serological identification of *E. coli* according to Kok *et al*. (1996) by using rapid diagnostic *E. coli* antisera sets (DENKA SEIKEN Co., Japan) for diagnosis of the Enteropathogenic types.

2.5 Determination for Salmonella

From the original dilution, 1 mL was inoculated into sterile peptone water and incubated at 37°C for 18 hrs. Then, one mL was inoculated into a 9 mL Rappaport Vassilidis broth (Oxoid CM0669) tube and incubated at 43°C for 24 hrs (Harvey and Price, 1981). Loopfuls from the inoculated tubes were separately streaked onto Xylose lysine desoxycholate agar (XLD) (Oxoid CM0469) and incubated at 37°C for 24 hrs. Suspected colonies were red with or without black centers. The suspected colonies were serologically identified according to Kauffman – White scheme (Kauffman, 1974) for the determination of Somatic (O) and flagellar (H) antigens using *Salmonella* antiserum (DENKA SEIKEN Co., Japan).

2.6 Determination of Staphylococcus aureus count

The technique of *S. aureus* count was applied according to ISO 6888-1:(1999). Briefly, 0.1 mL from each of the prepared dilutions was spread onto duplicate plates of Baird Parker (BP) agar (Oxoid CM 275), supplemented with egg yolk tellurite emulsion (50 mL/L,

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Oxoid SR54) and incubated at 37ºC for 24-48 hrs. Typical colonies of *S. aureus* were circular, black, shiny colonies surrounded by a clear halo zone extending into the opaque medium, and were counted and recorded. These colonies were confirmed by conducting gram staining, coagulase test, catalase test and anaerobic utilization of glucose and mannitol. Isolated *S. aureus* strains were inoculated in a 10 mL portion of tryptone soy broth (CM 129, Oxoid, England) with 1% yeast extract and incubated at 37°C for 18–24 hrs. The broth culture was centrifuged at 900 g for 30 mins maintaining temperature of 4°C (Rotofox 32, Zentrifugen, Germany). The supernatant was used for the assay of toxin content. The enterotoxin production in the supernatant was assayed using *Staphylococcal* enterotoxin reversed passive latex agglutination (SET-RPLA) kit (Oxoid, England) according to the manufacturer's instructions. The analysis involves the use of four staphylococcal enterotoxins (SE's), one each for enterotoxins A (SEA), B (SEB), C (SEC) and D (SED). Micro titer plates were sealed with a plate sealer and shaken to mix the contents of the wells. Immediately after that, the plates were incubated at room temperature on a vibration-free surface and the agglutination reactions were read after 22 –24 hrs by holding the plates against a dark background with indirect lighting. According to the manufacturer's instructions, the agglutination reactions were classified as +++ (complete agglutination), ++, + (small pellet visible in the centre of the agglutination latex), +/- (just detectable difference from negative control well) and - (negative). Reactions scoring +++, ++, and + were considered positive.

2.7. Determination of Listeria monocytogenes

Listeria monocytogenes was determined according to ISO 11290-1:2017 (ISO, 017). The homogenate was transferred to a sterile bottle jar and was incubated at 30° C for 24 hrs. Approximately 1 mL of the incubated homogenate was added to 9 mL of Listeria selective broth (Himedia, 569-500G) and further incubated for 48 hrs at 30°C. Thereafter, the homogenate was streaked onto the Oxford agar plates (Himedia, MV1145-500G with Listeria Oxford supplement Himedia, FD071), and incubated for 48 hrs at 37°C. Grey colonies surrounded by black zone (suspected *L. monocytogenes*) were picked up and purified on nutrient agar plates for further identification via test kit (Oxoid, Basingstoke, Hampshire, England).

2.8 Statistical analysis

The obtained results were statistically evaluated by the application of Analysis of Variance (ANOVA) test according to (Feldman *et al*., 2003).

3. Results and discussion

Fish is one of the food categories with the shortest shelf life, and its quality is influenced by many factors such as the source, cooling methods, processing and storage conditions (Stratev *et al*., 2015). Aerobic plate counts on fish generally do not correlate to food safety hazards, but sometimes can be useful to indicate quality, shelf-life and post heat processing contamination. The data recorded in Table 1 declared that the mean values of APC were $3.17\times10^4\pm 0.42\times10^4$, $2.41\times10^5\pm 0.28\times10^5$ and $5.63\times10^5\pm 0.61\times10^5$ CFU/g of examined *M. cephalus*, *O. niloticus* and *C. lazer*a, respectively. The obtained APC results were comparable to the finding in Spain 5.27 $\log_{10}$ CFU/g (Gonzalez-Rodriguez *et al*., 2001). Also, 5.7±2.1 and 6.0±1.98 $\log_{10}$ CFU/g in the examined *T. nilotica* and *M. cephalus* respectively in fish from Egypt (Hussein *et al*.,2019). Meanwhile, lower APC in Italy as 31% contained 10^3-10^4 CFU/g, 34 % in the range of 10^4-10^5 CFU/g, and 24% higher than 10^5 CFU/g (Armani *et al.*, 2016). The International Commission on Microbiological Specifications for Foods sets the limit for total aerobic plate counts in fresh and frozen fish at 10^7 CFU/g and as stated by Broekaert *et al.* (2011), loads

Table 1. analytical results of aerobic plate count, coliform count, and *Staphylococcus aureus* count of examined fish species (n = 30).

	Fish species	Minimum	Maximum	Mean ± SE
APC	*M. cephalus*	6.5×10^3	9.8×10^4	$3.17\times10^4\pm 0.42\times10^{4b}$
	O. niloticus	3.2×10^4	1.5×10^6	$2.41\times10^5\pm 0.28\times10^{5ab}$
	C. lazera	8.7×10^4	2.9×10^6	$5.63\times10^5\pm 0.61\times10^{5a}$
Coliform count	*M. cephalus*	2.0 ×10	5.0×10^2	$1.33\times10^2\pm 0.19\times10^2$
	O. niloticus	4.0× 10	9.0×10^2	$3.52\times10^2\pm 0.46\times10^2$
	C. lazera	7.0× 10	1.2×10^3	$6.10\times10^2\pm 0.54\times10^2$
S. aureus	*M. cephalus*	1.0×10^2	1.7×10^3	$8.14\times10^2\pm 1.16\times10^{2b}$
	O. niloticus	3.0×10^2	5.0×10^3	$1.95\times10^3\pm 0.27\times10^{3ab}$
	C. lazera	4.0×10^2	8.0×10^3	$3.30\times10^3\pm 0.41\times10^{3a}$

Values are presented as mean±SD. Values with different superscript within the same column are statistically significantly different (P<0.05).

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of 10^7-10^8 CFU/g make spoilage organoleptically detectable. The results in Figure 1 declared that the acceptability rate according to APC load was 100%, 86.7%, and 80 in *M. cephalus*, *O. niloticus* and *C. lazer*a, respectively according to the Egyptian standard No 3494/2005 which permit the load of chilled fish not more than 10^6/g.

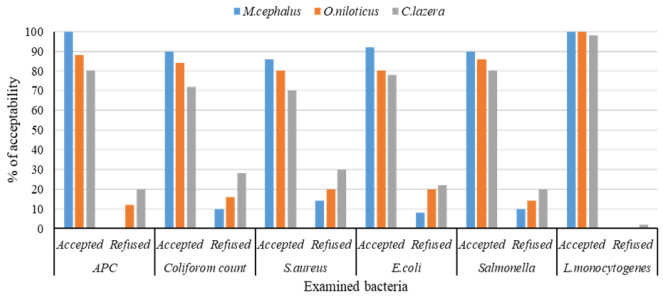

Figure 1. Acceptability of fish species according to bacteriological load in relation to Egyptian standard.

The presence of coliform is an indicator of sewage contamination, which may also occur during different farming of fish or processing steps such as transport and handling. Moreover, the contamination may also be caused by the water used for washing or icing (Queiroz and Boyd, 1998). The more accurate indicator of fecal contamination is fecal coliforms that is *E. coli* (Suvanich *et al*., 2000). The lower number of coliforms can be beneficial for pointing out the effectiveness of safety procedures during processing and handling (Elhadi *et al*., 2004). The obtained results in Table 1 revealed that mean values of total coliform count were $1.33\times10^2\pm 0.19\times10^2$, $3.52\times10^2\pm 0.46\times10^2$ and $6.10\times10^2\pm 0.54\times10^2$ CFU/g of examined *M. cephalus*, *O. niloticus* and *C. lazer*a, respectively. Nearly similar coliform count < 10^2 was obtained in Bangladesh (Sanjee and Karim 2016) and Kordiovská *et al*. (2004) who recorded 7.6×10^2 CFU/g in fish samples from Slovakia. Meanwhile higher coliform count 10^3-10^4CFU/g was detected by Cwiková (2016) in Czech Republic. The acceptability according to ES No 3494/2005 for total coliform count was 90%, 83.3% and 73.3% for *M. cephalus*, *O. niloticus* and *C. lazer*a, respectively (Figure 1). The lower acceptability in *C. lazera* examined samples may be attributed to the habitat of feeding as bottom feeders.

Microorganisms of the genus *S. aureus* are found in the environment and are linked to human sources. As a result, the count of *S. aureus* is regarded as a crucial indicator of fish processing sanitation (Hazariwala *et al*., 2022). The *S. aureus* count was $8.14\times10^2\pm 1.16\times10^2$, $1.95\times10^3\pm 0.27\times10^3$ and $3.30\times10^3\pm 0.41\times10^3$ CFU/g in examined *M. cephalus, O. niloticus and C. lazera, respectively* as shown in Table 1. Nearly similar counts were obtained in Spain as 3 $\log_{10}$ CFU/g (Gonzalez-Rodriguez *et al*., 2001) and in Egypt from 2-4 $\log_{10}$CFU/g (Hussein *et al*., 2019). However, *S. aureus* was not detected in fish samples collected from Italy (Armani *et al*., 2016). The results in Figure 1 declared that the acceptability was 86.7%, 80% and 70% for examined *M. cephalus, O. niloticus* and *C. lazera,* respectively according to the Egyptian standard (2005). This established that 10^3CFU/g of fish flesh is usually considered the limit, beyond that frozen fish unfit for human consumption. The data in Table 2 declared that Staphylococcal enterotoxin (SE) producing *S. aureus* detected in 1(3.3%) from *M. cephalus* as (SEA+SEC), 1 (3.3%) from *O. niloticus* as SEB and in 3 (10%) from *C. lazera* as SEA, SED, (SEA+SEC). The obtained results in this work may support the assumption of cell density which may play only a minor role in the enterotoxin expression because SE production does not always accompany growth (Schelin *et al*., 2011). Various authors have reported the incidence of enterotoxigenic *S. aureus* in seafood. Sanjeev *et al.* (1986) reported 68% from frozen fishery products, 48% from ready-to-eat foods including fish (Sokari, 1991), 8% from fish and shellfish (Ayulo *et al*., 1994),7% from shrimps, 4% from frozen cuttlefish and 4% from fish (Rodma *et al*., 1991) and 21 out of 51 strains (41%) isolated from fish products were found to be enterotoxin producer (Simon and Sanjeev, 2007).

Table 2. Prevalence of various enterotoxins producing *S. aureus* strains isolated from fish species.

	M. cephalus		*O. niloticus*		*C. Lazera*	
Enterotoxin	No.	%	No.	%	No.	%
A	-	-	-	-	1	3.3
B	-	-	1	6.7	-	-
D	-	-	-	-	1	3.3
A+C	1	3.3	-	-	1	3.3
Total	1	3.3	1	3.3	3	10

The recorded data in Table 3 revealed that *E. coli* confirmed 2/30 (6.7%), 6/30(20%) and 7/20(23.3%) of examined *M. cephalus, O. niloticus and C. lazera, respectively*. These results partial agree with Saqr *et al.* (2016) reporting incidences (18.3%). Higher incidences of *E. coli* were recovered by Amr *et al.* (2012), David *et al.* (2009), Galal *et al.* (2013) and Gupta *et al.* (2013) who reported incidences of *E. coli* 50%, 57.1%,29.34% and 36% respectively. But Atwa (2017) isolated *E. coli* from muscle with incidence 22.5%. The isolated *E. coli* identified serologically into O44: H18, O91: H21, O103: H2, O113: H4, O121: H7, O126: H21, O127: H6, O159 and O163: H. Nearly similar serotypes O121:H7, O44:H18 and O158:H2 were obtained from fish (Barbosa *et al*., 2014). The occasional presence of *E. coli* is a clear indication of fecal contamination in fish processing. The pool water might have been contaminated by the waste of grazing ruminants, birds

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Table 3. Prevalence and serotyping of *Escherichia coli* isolated from examined fish species (n = 30).

	M. cephalus		*O. niloticus*		*C. lazera*		Strain Characteristics
	No.	%	No.	%	No.	%	
O44:H18	-	-	1	3.3	-	-	EAEC
O91:H21	-	-	2	6.7	1	3.3	EHEC
O103:H2	-	-	-	-	1	3.3	EHEC
O113:H4	-	-	1	3.3	-	-	EPEC
O121:H7	1	3.3	-	-	1	3.3	EHEC
O126:H21	-	-	-	-	3	10	ETEC
O127:H6	-	-	1	3.3	-	-	ETEC
O159	1	3.3	-	-	-	-	EIEC
O163:H2	-	-	1	3.3	1	3.3	EPEC
Total	2	6.7	6	20	7	23.3	

EPEC: Enteropathogenic *E. coli,* ETEC: Enterotoxigenic *E. coli,* EIEC: Enteroinvasive *E. coli,* EHEC: Enterohaemorrhagic *E. coli,* EAEC: Enteroadherant *E. coli.*

and humans around the fish farm. The presence of these bacteria in fish may also arise from the uncontrolled activity of flies in the study locations. Moreover, poor handling practices by fishermen and retailers and cross-contamination with fish feed and handler's hands could be incriminated for transmission (Cardozo *et al*., 2018). The results in Figure 1 declared that the acceptability was 93.3%, 80% and 76.7% for examined *M. cephalus, O. niloticus and C. lazera,* respectively according to the Egyptian standard No 3494/ 2005. This established that chilled fish must be free from pathogenic *E. coli*.

Salmonellosis is one of the major causes of human bacterial enteritis in many countries of the world. Salmonella frequently colonizes the gastrointestinal track of animals without producing any clinical signs. The microbiota of recently captured fish reflects that of the water they inhabited, and the more polluted the water, the more varied the microbiota (Fernandes *et al.,* 2018). Therefore, environmental factors such as water quality play a significant role in the incidence of Salmonella in fish and a great risk for those consuming fish caught in contaminated waters without sanitary control (Fernandes *et al.,* 2018). The recorded data in Table 4 declared that Salmonella were detected in 3/30(10%), 4/30(13.3%) and 6/30(20%) in examined *M. cephalus, O. niloticus and C. lazera*, respectively. In addition, the Salmonellae were serologically identified as *Salmonella enterica* serovar Anatum, *S. enterica* serovar Derby, *S. enterica* serovar Enteritidis, *S. enterica* serovar Rissen, *S. enterica* serovar Parathphi A, *S. enterica* serovar Typhimurium, and *S. enterica* serovar Virchow. Previous studies have pointed to 2.6% of fresh fish samples collected from Iran being contaminated with Salmonella (Basti *et al.*, 2006). In, Brazil, a 5% occurrence of this bacterium in fish and captive crustaceans has been reported (Duarte *et al*., 2010). In Iran, a 10.4% (19/384) prevalence of Salmonella in fresh fish, the isolated serotypes were *S. enterica* ser. Typhimirium, *S. enterica* ser. Enteretidis, *S. enterica* ser. Typhi, *S. enterica* ser. Paratyphi B and *S. enterica* ser. Newport (Rahimi *et al*., 2013). In Egypt, *Salmonella* was detected in 10% and 15% in *M. cephlaus* and *O. niloticus*. The common serotypes were *S. enterica* ser. Enteritidis, *S. enterica* ser. Typhimurum, *S. enterica* ser. Virchow and *S. enterica* ser. Infantis (Saad *et al*., 2019). The results in Figure 1 declared that the acceptability was 90%, 86.7% and 80% for examined *M. cephalus, O. niloticus* and *C. lazera,* respectively according to the Egyptian standard No 3494/ 2005. This established that chilled fish must be free from *Salmonella*.

The occurrence of *L. monocytogenes* in a farm environment has been shown by Skovgaard and Morgen

Table 4. Prevalence and serotyping of Salmonellae isolated from examined fish species (n = 30).

Serovars of *Salmonella*	*M. cephalus*		*O. niloticus*		*C. lazera*		Group	Antigenic structure	
	No.	%	No.	%	No.	%		O	H
Anatum	-	-	1	3.3	-	-	E1	3,10,15,34	e,h : 1,6
Derby	-	-	1	3.3	-	-	B	1,4,5,12	f,g : 1,2
Enteritidis	1	3.3	-	-	2	6.7	D1	1,9,12	g,m : -
Rissen	1	3.3	1	3.3	1	3.3	C1	6,7,14	f,g : -
Parathphi A	-	-	-	-	1	3.3	A	1,2,12	i : 1,5
Typhimurium	-	-	1	3.3	2	6.7	B	1,4,5,12	i : 1,2
Virchow	1	3.3	-	-	-	-	C1	6,7,14	r : 1,2
Total	3	10	4	13.3	6	20			

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(1988) who found the presence of the organism in 51% of cow faeces and 33% of poultry faeces. Therefore, it is not surprising that *L. monocytogenes* was found in farmed fish since the faeces of cow is commonly used for fertilizing fish farms. The data recorded in Table 5 revealed that *L. monocytogenes* was detected only in one sample of examined *C. lazera* 1/30(3.3%). The obtained results were nearly similar to Basti *et al.* (2006) who found listeria in 2.6% of fresh fish collected from Iran. Meanwhile, a higher isolation rate (20%) in *M. cephalus* (Ahmed *et al*., 2013). Water should be considered the source of *L. monocytogenes* contamination in seafood because it is frequently found in coastal waters and lake surface waters (Food Agricultural Organization (FAO), 1999). Soiled surfaces, cartons, and contamination from human and avian sources are other potential factors for seafood contamination (Parihar *et al*., 2008). Although *L. monocytogenes* does not present a concern to consumers when seafood is processed, it does present a risk to populations that are vulnerable when consumed raw or minimally cooked. Additionally, the potential for cross-contamination in the kitchen, processing facility, or food service company is a worry (Wan Norhana *et al.*, 2010). Regarding the acceptability Figure 1 declared that 100%, 100% and 96.7% for examined *M. cephalus, O. niloticus and C. lazera,* respectively accepted according to the Egyptian standard No 3494/ 2005. This established that chilled fish must be free from *L. monocytogenes.*

Table 5. Prevalence of *L. monocytogenes* isolated from examined fish species (n = 30).

Farm fish	No. of ex. Samples	No.	%
Mugil cephalus	30	0	0
Oreochromis niloticus	30	0	0
Clarias lazera	30	1	3.3
Total	90	1	1.1

4. Conclusion

Marketed fish hide many food poisoning bacteria that can lead to health problems for the consumer, especially when eaten undercooked. Therefore, fish breeders and traders must deal with the principles of food safety stipulated in the HACCP and ISO.

Conflict of interest

The authors declare no conflict of interest.

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