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Bacteriological Quality of Eatable Mussels from the Sea of Split Area

Bakteriološka kakvoća jestivih školjkaša iz mora splitskog područja

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Summary

*Pollution effects on the sanitary quality of mussels (**Mytilus galloprovincialis**) were studied at nine stations in the coastal area of Split during the period 1984–1992.*

*The coastal sea of Split area has continuously been under influence of faecal pollution. Recorded number of faecal coliforms in mussels was highly correlated with the pollution of marine environment. It caused the completely unsatisfactory bacteriological quality of **Mytilus galloprovincialis** species all over the investigated area. The observations of seasonal means of faecal coliform concentrations in mussels showed defined regular pattern. Maximum concentrations were recorded in summer, minimum in winter. This points to the fact that consumption of shellfish from the Split area, especially in the summer season, may cause serious risks for human health.*

Sažetak

*Utjecaj onečišćenja mora na bakteriološku kakvoću školjkaša (**Mytilus galloprovincialis**) ispitivan je na devet postaja u priobalnom području Splita u razdoblju od 1984. do 1992. godine.*

*Broj fekalnih koliforma u školjkašima na cijelom ispitivanom području prelazi dopuštene, a često dostiže i ekstremno visoke vrijednosti. Utvrđeno je da broj fekalnih koliforma u školjkašima jako ovisi o stupnju onečišćenja mora u kojem su školjkaši živjeli. Sezonske promjene u broju fekalnih koliforma u školjkašima pokazuju određenu pravilnost. Maksimalne vrijednosti koncentracije fekalnih koliforma u školjkašima utvrđene su u ljetnom, a minimalne u zimskom razdoblju. Rezultati upućuju na zaključak da je s higijensko-epidemiološkoga gledišta vrlo opasno jesti školjkaše vrste **Mytilus galloprovincialis** iz priobalnog mora područja Splita, posebice ljeti.*

Introduction

The problem of faecal pollution in the coastal seawater, present in urban centers, has an effect on the sanitary quality of organisms living in such areas. Filter feeding shellfish concentrates coliforms from its marine environment. The concentration of faecal coliforms in eatable shellfish tissue gives an indication of the potential health hazard to consumers of shellfish due to pathogens of faecal origin which may be present in the marine environment surrounding the shellfish. An oyster, for instance, may remove the suspended material from about 4 liters of seawater each hour, so that the bacterial content of its gut is considerably greater than that of the seawater in which it is found *(1)*. The subject of our investigations was *Mytilus galloprovincialis* species because they are widely spread and they form the bulk of shellfish taken for human consumption. *Mytilus galloprovincialis* live in mediolitoral which makes it easily noticed and accessible for collecting. Being sessile organisms they are permanently present in a certain area, and can not avoid stress situations by active moving. All this means that using mussels as food from the faecal polluted area is very risky for human health from the hygienic-epidemiological point of view.

This paper reports the results of 9-year investigation aiming at assessing the sanitary quality of mussels (*Mytilus galloprovincialis*) in Split coastal area.

Experimental

Mussel samples and their growing seawater were collected from 9 stations of Split area, from the easternmost part of the Kaštela Bay (Vranjic basin) to Stobreć (Fig. 1) with different frequency during the period 1984–1992 (Table 1). It should be emphasised that the investigations at all the stations were made in all four seasons. Faecal coliform (FC) determination in mussels was performed by the multiple test tube method *(2)*, and in the seawater by membrane filtration method *(3)*.

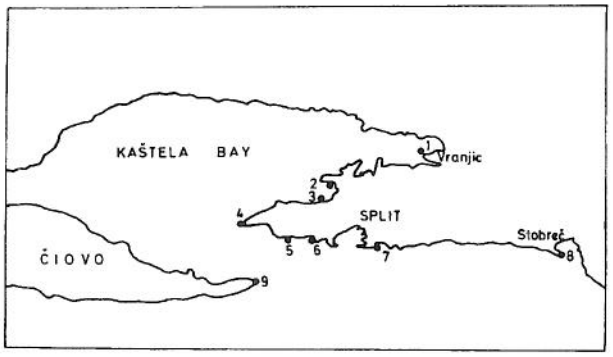

Fig. 1. Investigated area with sampling sites
Slika 1. Područje istraživanja i mjesta uzimanja uzoraka

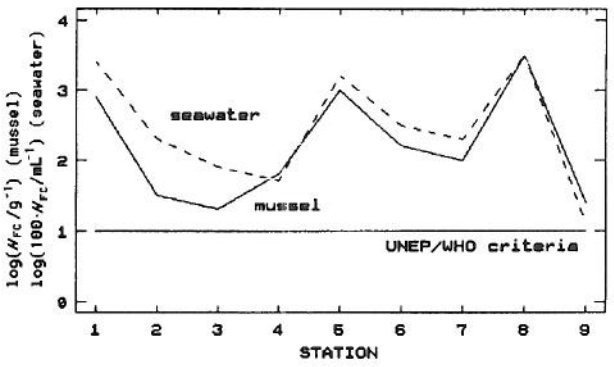

Fig. 2. Mean values of FC concentration in mussels and seawater for the whole investigated period
Slika 2. Srednje vrijednosti koncentracije FC u školjkašima i morskoj vodi za cijelo istraživano razdoblje

The sanitary quality of mussels and shellfish growing waters was evaluated according to UNEP/WHO criteria for the faecal coliforms presence *(4)*.

Results and Discussion

The coastal sea of Split area has continuously been under influence of faecal pollution *(5-7)*. As a result, bacteriological quality of *Mytilus galloprovincialis* species all over the investigated area was completely unsatisfactory. Faecal coliform (FC) concentration in mussels and seawater surrounding them during the whole investigated period exceeds permissible limits according to the UNEP/WHO criteria. These criteria allow at most 10 FC per gram of mussel ($N_{FC} = 10\ g^{-1}$) for human consumption. In certain localities (closer to the source of pollution) faecal coliform concentrations in mussel reach extremely high values (more than 100 times above the permissible limit). Fig. 2, with average values of faecal coliform concentration during the whole investigated period shows that the highest FC concentrations were at stations 1, 5 and 8. Station 1 is situated in the easternmost part of the Kaštela Bay (Vranjic basin) were most of surface outfalls are located. Station 5 (Ježinac) is relatively close to the town port and station 8 is in Stobreć where a great number of local sewage effluents flow directly into the sea. The second group of stations where the FC concentrations are still high are stations 6 and 7, probably because they are very near the town port. The third group of stations with the lowest values but still above the permissible UNEP/WHO criteria are stations 2, 3, 4 and 9 which are at a distance from the source of faecal pollution. So, the Vranjic basin and town port are the main sources of pollution since municipal sewage effluents are deposited there. The adverse effects originating from these areas are reflected on all the monitored areas close to them.

Mussel sanitary quality reflects the seawater sanitary quality in which they live. The data from 127 mussel and 127 seawater samples were statistically analysed. FC concentrations in mussel are in a high correlation with the FC concentrations in the shellfish growing water (Fig.3). Similar results were recorded in previous investigations *(8,9)*.

The observations of seasonal means of FC concentrations for the entire period of our research showed defined regular pattern. Maximum FC concentrations were regularly recorded at all the stations in the summer season, and minimum ones in the winter season (Fig.4). The only cases of satisfactory quality of mussels for consumption were recorded at station 2 in the winter season, and at stations 3, 4 and 9 both in the winter and

Table 1. Frequency of sampling during the investigated period
Tablica 1. Učestalost uzorkovanja u istraživanom razdoblju

Station number*	Year									
	84	85	86	87	88	89	90	91	92	Total
1	4	4	4	6	–	–	–	–	–	18
2	–	–	2	4	–	–	–	–	–	6
3	–	–	2	4	–	–	–	–	–	6
4	–	–	2	3	4	2	3	2	2	20
5	–	–	2	3	–	–	–	–	–	5
6	4	4	4	6	4	2	4	2	2	32
7	–	–	2	3	–	–	–	–	–	5
8	4	4	4	6	4	2	4	2	–	30
9	–	–	2	3	–	–	–	–	–	5

*All the stations, except station 1, are located in the recreational areas

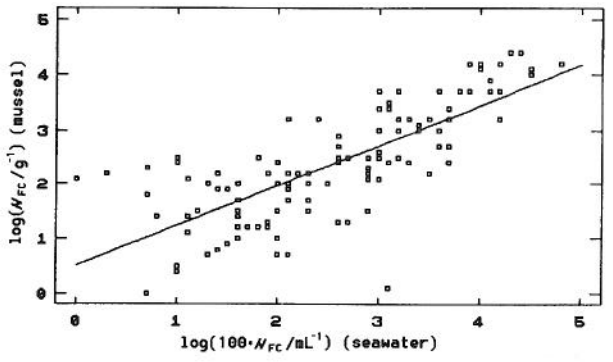

Fig. 3. Relation between the FC concentration in mussels and seawater (r = 0.76; P < 0.01; n = 127)
Slika 3. Odnos koncentracije FC u školjkašima i morskoj vodi (r = 0,76; P < 0,01; n = 127)

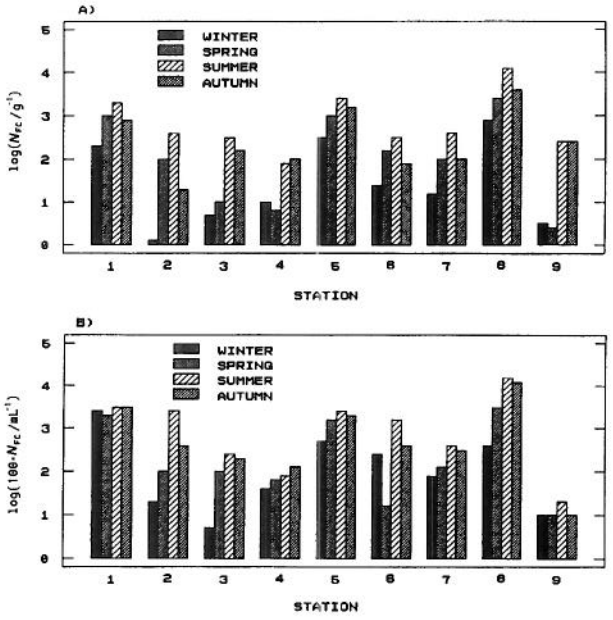

Fig. 4. Mean seasonal values of FC concentration during the whole investigated period in mussels (A) and in the seawater (B)
Slika 4. Srednje sezonske vrijednosti koncentracije FC za cijelo istraživano razdoblje u školjkašima (A) i morskoj vodi (B)

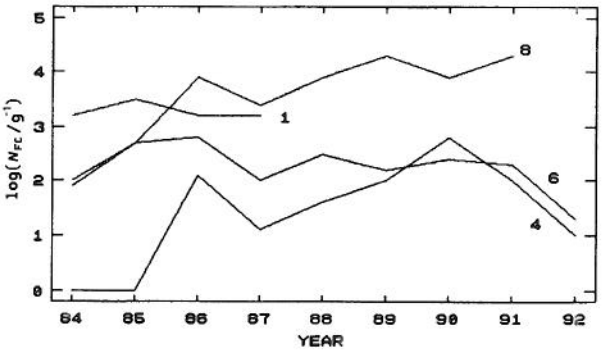

Fig. 5. Mean annual values of FC concentration in mussels (at stations 1, 4, 6 and 8)
Slika 5. Srednje godišnje vrijednosti koncentracije FC u školjkašima (na postajama 1, 4, 6 i 8)

spring seasons. During the summer season the quantity of sewage effluents increases due to a significantly higher number of people who stay in town for the summer. On the other hand, more stable meteorological conditions (less wind and rain) and hydrological conditions (forming thermocline in the water column) in the summer season result in poorer dynamics of the sea, and therefore in poorer spreading and dilution of sewage effluents. This can probably explain seasonal differences in the sea FC concentrations, and consequently in the shellfish. Moreover, higher temperature causes higher physiological activities in shellfish, which result in higher quantity of filtered water and higher concentrating factor. Investigation of oysters showed that *E. coli* concentrating factor increased by about 10 times for the temperature increase from 5 °C to 15 °C *(1)*.

Pollution trend of investigated organisms during the 9-year period is presented for the stations where the results of at least 4 years were available (Fig.5). It is evident that the sanitary quality of mussels collected at station 8 has been increasingly worse, probably caused by input of an increased number of local sewage effluents directly into the sea. At station 6 slight variations of values from year to year is evident while at station 4 variations are higher but without a distinctive trend.

So, constantly high values of the FC concentrations found at the most of the monitored stations indicate that consumption of shellfish from the Split area, especially in the summer season, may cause serious risks for human health.

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