Degradation intensity of disposable face masks in water of different salinity

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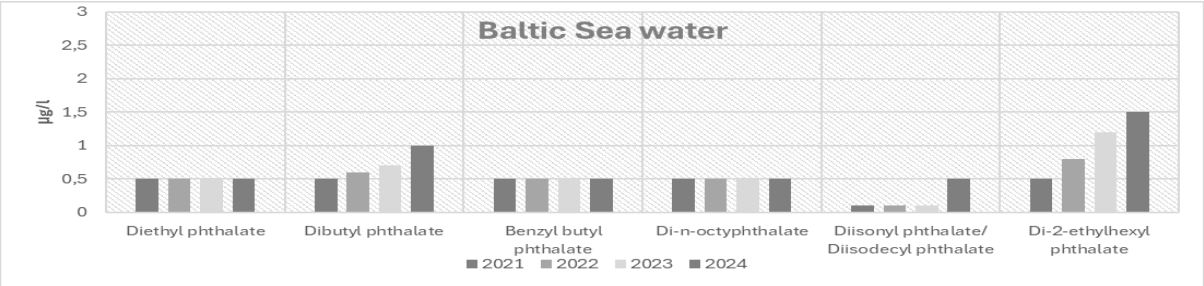
Introduction. 11 March 2020, the world has been declared a COVID-19 pandemic. In addition to that, the majority of heath organizations strictly recommended wearing face masks and other face coverings as the limiting factors for spreading virus (Cheng et. al., 2020; Wang et al., 2022). Scientific studies show that face masks substantially reduces the spread of aerosols containing the virus while sneezing, coughing or talking to suspected carrier of the virus or infected person (Li et al., 2022; Lindsley et al., 2020; Bartsch et al., 2022). Still, the global use of face masks raises concerns about the large amount of plastic waste that is likely to become a secondary source of microplastic or nanoplastic pollution in ecosystems (Neto et al., 2021; Shen et al., 2021). However, plastic particles released into the environment break down into smaller segments during the decomposition process, while particles less than 5 mm in size are called microplastics (Ageel et al., 2022) and particles smaller than 100 nm are called nanoplastics (Kiran et al., 2021). The wearing of face masks in many countries of the world has become mandatory. The results show that 2 million adult residents living in Lithuania during the pandemic period potentially generated about 15.24 tons of hazardous plastic waste (Cesoniene *et al.,* 2023). When assessing the intensity of degradation of disposable masks in solutions of different salinity, the Diethyl phthalate, Dibutyl phthalate, Benzyl butyl phthalate; Di-n-octyphthalate; Diisonyl phthalate/ Diisodecyl phthalate and Di-2-ethylhexyl phthalate concentration the trend of increasing the concentration of dissolved substances over a period of 4 years were determined. During the survey it was identified that disposable masks degrade in solutions of different salinity.

Material and methods. To assess the intensity of degradation of disposable masks in solutions of different salinity water were obtained disposable medical face masks, 30 units of disposable medical face masks were used in each sample, which are placed in a 30-liter solution of different salinity. The following solutions were used during the study: distilled water (0 SEC), fresh (pond) water (650µS/cm, SEC), salty (Water of the Baltic Sea; 1110 µS/cm, SEC). A long-term investigation was launched in May 2021 and analyses are carried out once per year – in December. This article presents the results of tests for 4 years. Water samples were analysed in the Environmental Research Laboratory of the Academy of Agriculture of Vytautas Magnus University, the Department of Environment and Ecology, where chemical and electrochemical indicators of water quality were determined.

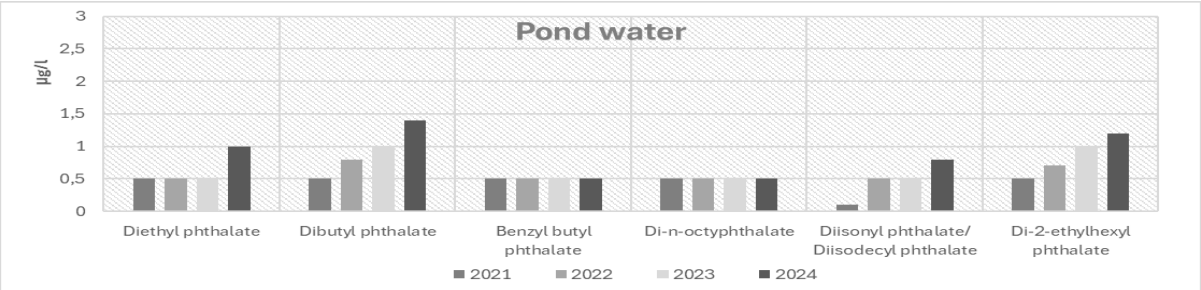
Results and discussion

To assess the intensity of degradation of disposable masks in solutions of different salinity, disposable masks are placed in waters of different salinity. The Diethyl phthalate, Dibutyl phthalate, Benzyl butyl phthalate; Di-n-octyphthalate; Diisonyl phthalate/ Diisodecyl phthalate and Di-2-ethylhexyl phthalate concentration of dissolved substances were determined.

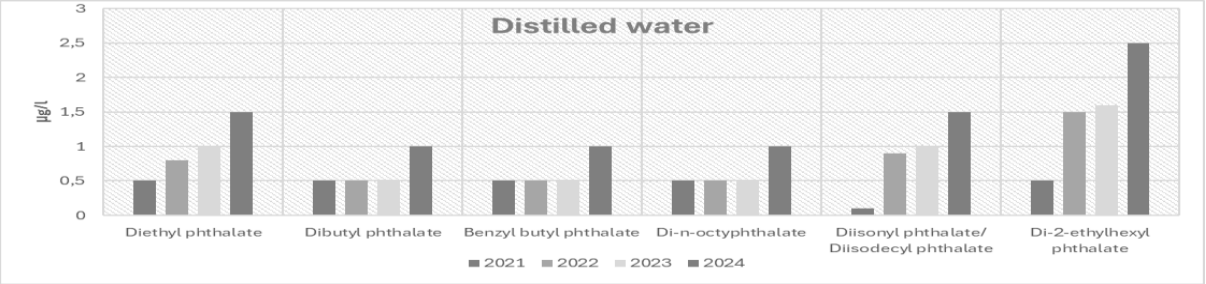
The dynamics of the phthalate concentration for 4 years in solutions of different salinity is shown in Figure 1-3.



1 Figure. Phthalate concentration in the Baltic Sea water



2 Figure. Phthalate concentration it the Pond water



3 Figure. Phthalate concentration it the Distilled water

The highest concentrations of phthalates were recorded in the fourth year of the study. The highest concentration of Di-2-ethylhexyl phthalate was found in distilled water in the fourth year of the study (2.5 µg/l) – an increase of 5 times. The concentration in Baltic Sea water increased three times. The concentration of Diethyl phthalate was also the highest in distilled water in the fourth year of the study (1.5 µg/l), as well as the concentrations of Benzyl butyl phthalate, Di-n-octyphthalate and Diisonyl phthalate/ Diisodecyl phthalate in distilled water.

Dibutyl phthalate was the highest in surface (pond) water (1.4 µg/l). Only the concentrations of Dibutyl phthalate and Di-2-ethylhexyl phthalate increased in Baltic Sea water. In pond water, the concentrations of Diethyl phthalate, Dibutyl phthalate, Diisonyl phthalate/ Diisodecyl phthalate and Di-2-ethylhexyl phthalate increased.

Conclusions

Disposable face masks generate the highest concentration of Di-2-ethylhexyl phthalate when dissolved in water. Disposable face masks dissolve more intensively in distilled water compared to the Baltic Sea and surface water.

References

1. Bartsch, S. M., O'Shea, K., Chin, K. L., Ferguson, U. S. M. C., Bottazzi, M. E., Wedlock, B. T., Cox, S. N., Siegmund, S. S., Lee, B. Y. (2022). Maintaining face masks use before and after achieving different COVID-19 vaccination coverege levels: a modelling study. The Lancet Public Health, Vol 7, Issue 4, E356-E365, https://doi.org/10.1016/S2468-2667(22)00040-8
2. Cheng, K.K., Lam, T.H., Leung, C.C. (2020). Wearing face masks in the community during the COVID-19 pandemic: altruism and solidarity. Lancet, Vol. 399, 10336, E39-E40, https://doi.org/10.1016/S0140-6736(20)30918-1
3. Cesoniene L. , Simanaviciute R., Sileikiene D., Bedla D. Predictions of hazardous plastic waste amounts based on disposable face mask wearing habits. JOURNAL OF WATER AND LAND DEVELOPMENT. DOI: 10.24425/jwld.2023.148452. 2023, No. 59 (X–XII): 275–282
4. Li, B., Huang, Y., Guo, D., Liu, Y., Liu, Z., Han, J.C., Zhao, J., Zhu, X., Huang, Y., Wang, Z., Xing, B. (2022). Science of the Total Environment, 825, 153880, http://dx.doi.org/10.1016/j.scitotenv.2022.153880
5. Lindsley, W. G., Blachere, F. M., Law, B. F., Beezhold, D. H., Noti, J. D. (2020). Efficacy of face maks, neck gaiters and face shields for reducing the expulsion of simulated cough-generated aerosols. Aerosol Science and Technology, 55:4, 449-457, https://doi.org/10.1080/02786826.2020.1862409
6. Neto, H.G., Bantel, C.G., Browning, J., Fina, N. D., Ballabio, T. A., Teles de Santana, F., de Karam e Britto, M., Barbosa, C. B. (2021). Mortality of a juvenile Magellanic penguin (Spheniscus magellanicus, Spheniscidae) associated with the ingestion of a PFF-2 protective mask during the Covid-19 pandemic. Mar. Pollut. Bull. 166, 112232, https://doi.org/10.1016/j.marpolbul.2021.112232
7. Wang, G., Li, J., Saberian M., Rahat, Md., H. H., Massarra, C., Buckhalter, C., Farrington, J., Collins, T., Johnson, J. (2022). Use of COVID-19 single-use face masks to improve the rutting resistance of asphalt pavement. Science of the Total Environment, 826, 154118, https://doi.org/10.1016/j.scitotenv.2022.154118.