Quantification of Microplastics in Sea-salt using SWIR Hyperspectral Imaging

Hwanjo Jeong [1], Hoonsoo Lee [1] *

[1] Department of Biosystems Engineering, College of Agriculture, Life & Environment Science,Chungbuk National University, 1 Chungdae-ro, Seowon-gu, Cheongju-si, Chungbuk 28644, Korea

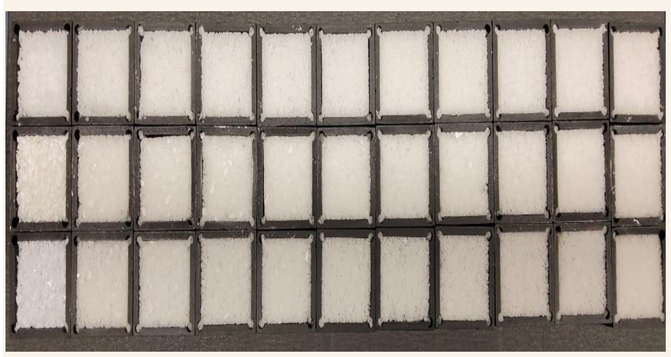
Introduction

- Since plastic was developed, consumption has been steadily increasing, which has also had a significant impact on pollution in the marine environment.
- Plastic entering the ocean undergoes physical and chemical processes to produce microplastics of 5mm or less in size.
- These microplastics are not decomposed by microorganisms, and after being eaten by marine organisms, adverse effects such as organ damage, nutrient reduction, lung function degradation, inflammatory reactions, and reproductive complications were observed in the human body.
- Need to detect microplastics quickly and accurately.

Objective

- The purpose of this study is to quickly detect and distinguish microplastics in sea salt using a SWIR hyperspectral imaging system.

Data Set



100% 5% → 0.005%

Microplastic

- Polycarbonate(PC), Polyethylene(PE) ,Polystyrene (PS), Polyvinyl chloride (PVC), Polypropylene(PP). Teflon, Polyethylene terephthalate(PET), Fomex, Acrylic

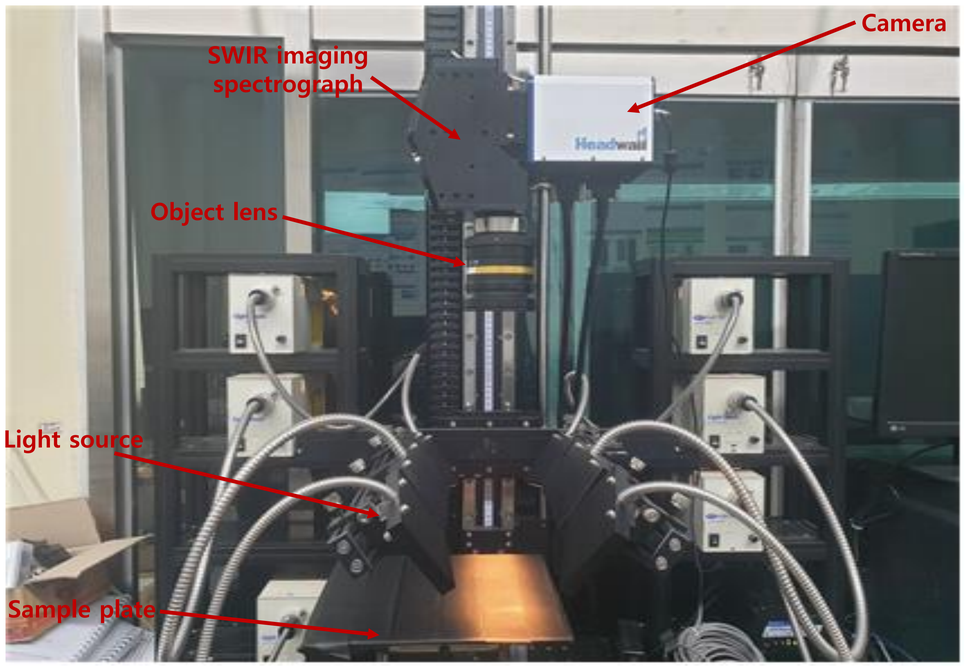
Sea-salt

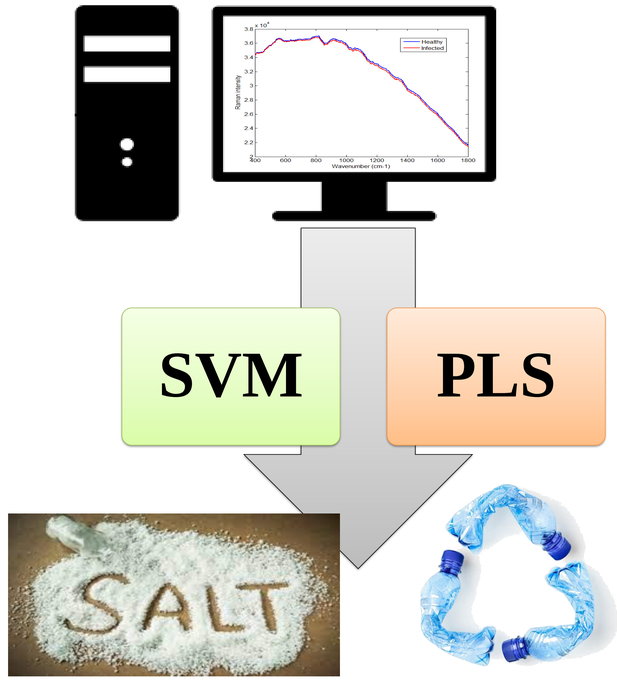
- 1 type of Sea-salt produced in Sinan area on the market

Mixed sample manufacturing

- Using a shredder to crush plastic samples by 1mm or less
- Manufacturing concentration
  -0.005%, 0.01%, 0.05%, 0.1%, 0.5%, 1%, 2%, 3%, 4%, 5%

Methods

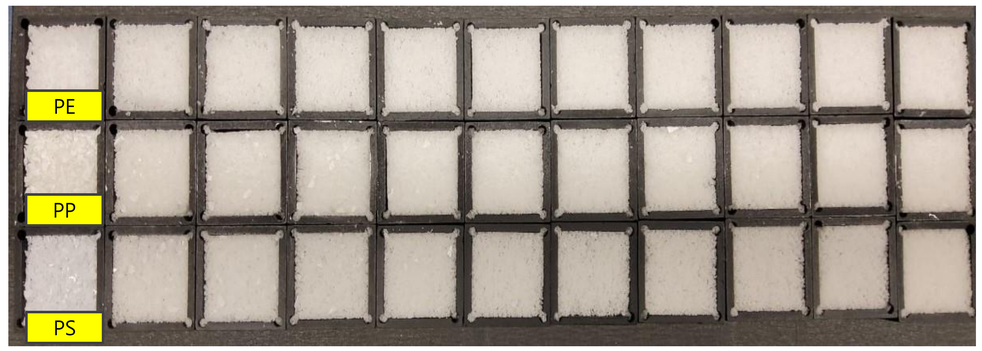




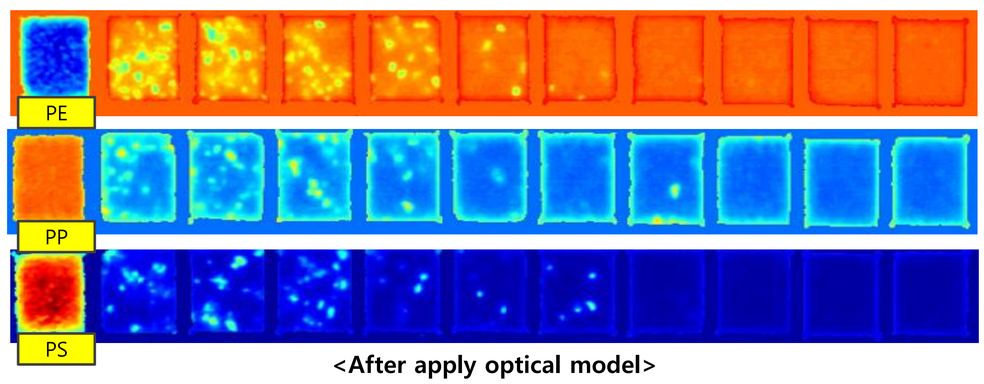
Results

Data pre-processing		Calibration			Validation		Prediction	
		Rc2	SEC (%)	No. of PCs	Rv2	SEV (%)	Rp2	SEP (%)
Smoothing		0.999	0.013	14	0.999	0.014	0.999	0.014
Normalization	Mean	0.999	0.011	9	0.999	0.012	0.999	0.012
	Maximum	0.999	0.010	10	0.999	0.011	0.999	0.011
	Range	0.999	0.007	8	0.999	0.008	0.999	0.008
MSC		0.999	0.017	7	0.999	0.018	0.998	0.019
SNV		0.999	0.007	10	0.999	0.009	0.999	0.008
Savitzky-Golay	1st deri.	0.999	0.012	17	0.999	0.015	0.999	0.015
	2nd deri.	0.999	0.012	20	0.999	0.015	0.999	0.015
Raw		0.999	0.012	10	0.999	0.014	0.999	0.014

<PLS result>



<Before apply optical model>



<After apply optical model>

Conclusion

- The quantitative detection limit has been confirmed to be at least 1%, and the detection accuracy may vary depending on the depth of the sample holder and it affects the particle size of the salt, so additional research is needed.
- It is believed that near-infrared hyperspectral images can be used not only for the detection of microplastics in Sea-salt, but also for the qualitative and quantitative detection of microplastics in agricultural products and foods.
- Therefore, we could suggest that the SWIR hyperspectral imaging used potential to detect microplastic in sea salt

Future works

- Additional experiments using deep learning such as CNN and RNN will be performed.
- The optimal model will be found using other methods (VIS/NIR, Raman imageie, Raman Spectroscopy, etc.).