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River water classification pattern in Malang city based on electronic tongue for identification of environmental pollution

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Abstract. The e-tongue in this study was developed in 16 lipid membrane-based sensor channels. Each membrane lipid arranged by different polymer membranes. Membranes are made by combining polyvinyl chloride (PVC) as a matrix. Four different types of plasticizers (2-NPOE, bis (2-Ethylhexyl) Phthalate, bis (2-Ethylhexyl) phosphate, bis (1-butyl pentyl) adipate). Four types of lipids (octadecylamine, oleyl alcohol, methyltrioctylammonium chloride, and oleic acid) for active ingredients. This electronic tongue is used to classify river water pollution in Malang City from various sources. The data obtained were analysed using the PCA (Principal Component Analysis) method. Based on the PCA score plot shows the value of PC1 = 49.18%, and PC2 = 20.09%. Based on the loading plot shows the sensors that have the greatest contribution in classifying river water pollution are sensor 5, sensor 6. The PCA pattern shows that the river in front of UIN Malang, the river around Summersari and the river around Landungsari have a very close pattern. The data obtained show that the source of pollution of the three rivers is almost the same. The river around Soekarno Hatta and the river around Merjosari have a different pattern from the other three rivers. It can be concluded that using the PCA method can distinguish the classification of river water in different places.

1. Introduction

Water is a natural resource needed for the life of living things. Water sources are generally divided into two, groundwater and surface water [1]. The river is a surface water source that provides many benefits for the community, including washing, bathing, irrigation, and others. The river around the settlement is an alternative to the surrounding community as a place to dispose of waste; this habit causes the river water to become polluted. Water pollution is defined as an indication of decreased water quality from water quality standards. Pollution in each river is different depending on the waste that pollutes [2].



The taste sensor or electronic tongue (E-tongue) is a system that has global selectivity [3], [4], [5]. The electronic tongue is built on a sensor array based on ion-selective membranes. Each membrane is made by combining lipids and polymers. The selective nature of each membrane is determined by the type of lipid used [6], [7], [8], [9].

The membrane is made by combining polyvinyl chloride (PVC) as a matrix, 4 different types of plasticizers (2-NPOE, bis (2-Ethylhexyl) sebacate, bis (2-Ethylhexyl) phosphate, bis (1-butyl pentyl) adipate), and 4 types of lipids (octadecylamine, oleyl alcohol, methyltrioctylammonium chloride, oleic acid) for active ingredients. All of these ingredients are dissolved in tetrahydrofuran (THF) [10], [11], [12], [13].

The purpose of this study was to determine the pattern of river water classification in Malang based on the electronic tongue as identification of environmental pollution. The response of the electronic tongue is evaluated using the PCA (Principal Component Analysis) pattern recognition method.

2. Experimental Methods

The sensor is prepared using polyvinyl chloride (PVC) as a matrix, with the active ingredient octadecyl amine, oleyl alcohol, methyltrioktilamonium chloride, and oleic acid. PVC used as a membrane matrix is prepared with a composition of around 30%. Furthermore, 2-NPOE, Bis (2-Ethylhexyl) sebacate, Bis (2-Ethylhexyl) phosphate, and Cis (1-Butyl Pentyl) Adipate are used as plasticizers. Plasticiser is used to make the membrane elastic and able to respond to sample ions. The plasticizer is mixed with a composition of about 65%. The main ingredient of the membrane is a lipid that will interact directly with the sample. This material is dissolved in a composition of about 3%. These lipid ingredients include octadecyl amine, oleyl alcohol, methyl trioctylammonium chloride, and oleic acid. Patterned gold plates are deposited on acrylic substrates, and all membrane materials are dissolved in a tetrahydrofuran (THF) solvent.

River water taken in the city of Malang comes from 5 different places. The river water includes Summersari River water, UIN riverfront water, Soekarno Hatta River water, Metro River water and Landungsari River water. River water is taken in the range of 5 days as much as four times. For each Summersari River water, UIN riverfront water, Soekarno Hatta River water, Metro River water, and Landungsari River water were repeated five times, with $20 \times 5 = 100$ measurements.

3. Result and Discussion

A score plot of five river water samples is shown in Figure 1. The number of principal components is the number of patterns between variables that are not correlated. PC1 value was 49.18% of the total variation of data and PC2 was 20.09%. These two PCs represent 69.27% of the overall data.

Figure 1 represents five different types of river water. Summersari, Landungsari, and UIN riverfront water show an adjacent pattern, and this indicates that what pollutes the three rivers comes from the same waste, namely household waste. Based on the validation of the river flow path, this river is a series of river paths. Pollution that occurs in the upstream area of the river will flow towards space below. From the social side, this area is a series of student settlements such as boarding houses, rented houses, and also households. Geographical and social similarities have similar impacts on the surrounding river water pollution. This is evidenced by the taste patterns based on the electronic tongue of the river water that has similarities.

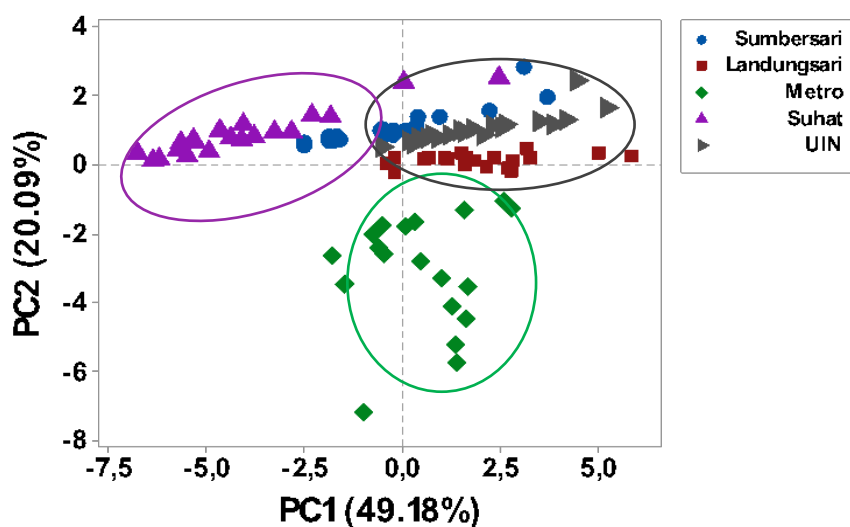


Figure 1. Score plot of five types of river water

The river in the Sukarno Hatta region is a Brantas river flow. This river is a large river that runs along East Java. The upstream area of the river starts from the Batu mountains. The area around the river is relatively protected from household waste. There are also many environmental conservation activities carried out by the government on this riverbank. The pattern produced by the electronic tongue indicates a different design compared to other river water patterns.

The taste patterns of Metro river water also indicate their differences. This pattern is due to geographical location, and the environment around the river has a difference compared to other streams. These differences produce pollution and different taste patterns.

4. Conclusions

The electronic tongue can classify the taste patterns in some river water around Malang. The taste patterns indicate different types of pollution. Based on the electronic tongue, all types of river water used in this study can be known for their classification patterns. From the PCA, PC1 and PC2 score plots contributed 69.27% of the overall data. Further experiments are needed to find out the types of waste that pollute river water and water pollution quality standards.

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