Borneo Akademika
UiTM Cawangan Sabah

Volume 5 (2) December 2021, 100-109

A PRELIMINARY STUDY ON THE RELATIONSHIP OF ABIOTIC FACTORS TO THE ABUNDANCE OF BEACH MORNING GLORY (*IPOMOEA PES-CAPRAE*) BETWEEN TWO BEACH LOCATIONS

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ABSTRACT

The beach morning glory is utilized as traditional medicine by the public but studies about this plant are still lacking. This study aims to identify the effect of soil organic matter (SOM) and heavy metal concentration on the distribution and abundance of the beach morning glory between Lok Kawi Beach and Teluk Likas Beach in Sabah. Sampling was conducted in August 2020, prior to the implementation of Recovery Movement Control Order (RMCO). The field work experimental design for the sampling was based on line transect and quadrat sampling method. The plant abundance was determined by using the quadrat (point-intercept method). The soil organic matter was analysed by using the Loss on Ignition (LOI) method and the heavy metals concentration was analysed by using the Atomic Absorption Spectrophotometer (AAS). The results showed that the mean abundance of beach morning glory was higher in Teluk Likas Beach than in Lok Kawi Beach ($p = 0.001$). For the mean Lead (Pb) concentration, it was higher in Lok Kawi Beach than in Teluk Likas Beach ($p = 0.01$). The mean of soil organic matter ($p = 0.88$), zinc (Zn) ($p = 0.12$) and copper (Cu) ($p = 0.54$) did not differ much between both locations. For the correlation, the abundance of beach morning glory was not affected by the heavy metals' concentration (Pb, Zn and Cu). The relative abundance of beach morning glory was not affected by the SOM and heavy metals concentration. Further research is needed to determine its bioactive compounds and efficacy.

Keywords: Beach morning glory; Abundance; Soil organic matter; Heavy metals concentration

1. Introduction

According to Kumar et al. (2015), the World Health Organization (WHO) stated that the public that utilizes traditional medicine as their primary source of healthcare exceeds 80 % of the world's total population. This supports the findings by Kumar, Paul and Kumari (2014) who found that the beach morning glory is a medicinal plant that has long been incorporated into traditional medicine used by many due to its various properties (astringent, diuretic, anticancer, etc). Additionally, Abdullah, Hazwani and Abas (2016) stated that the beach morning glory is also an excellent indicator in studying heavy metal pollutants in the environment due to its ability to thrive in a wide range of environments.

Abiotic factors, such as heavy metals and soil properties, are defined as important non-living components, which help to shape the ecosystem (BBC, 2018). According to Li et al. (2018), soil is important in supporting the ecosystem such as being the foundation for primary productivity and in nutrient cycle. Li et al. (2018) stated that soil organic matter (SOM) plays an important role as major carbon storage, which also contributes to the bioavailability of heavy metals in the soil.

Heavy metals exist in the environment from natural sources such as weathering processes (Masindi & Muedi, 2018) while some are essential for optimal plant growth. However, Yan et al (2018), stated that various anthropogenic activities cause heavy metal pollution to the environment. Hence, the safety aspect of naturally sourced medicines may not always be the case today as rising heavy metals concentration in plants via nutrient uptake from polluted soils may then bring upon adverse effects towards human health and the medicine efficacy itself (rat., 2018) stated that various anthropogenic activities cause heavy metal pollution to the environment. Hence, the safety aspect of naturally sourced medicines may not always be the case today as rising heavy metals concentration in plants via nutrient uptake from polluted soils may then bring upon adverse effects towards human health and the medicine efficacy itself (rat., 2018).

Arif et al. (2016) stated that heavy metals can be found in the environment in two forms: essential and non-essential. According to Crichton (2016), both types of metal may cause toxic effects to plants and even to consumers. Hence, it is vital to strictly monitor the introduction of metals into our environment to ensure public health (Li et al., 2018). Therefore, this study is important in raising the community's awareness towards the safety in using and sourcing the beach morning glory as traditional medicine.

2. Methodology

2.1. *Study site*

This study was done at two different beaches, which were Lok Kawi Beach (N 05°51.378', E 116°02.521') and Teluk Likas Beach (N 05°59.653', E 116°06.169'). These two locations were chosen mainly due to the presence of beach morning glory (*Ipomoea pes-caprae*) and also due to the difference in terms of the frequency of human activities. The study location at Lok Kawi Beach is located approximately 15.9 km away from Kota Kinabalu and has a lower rate of human activity as it is far from the city and is usually vacant due to the absence of attractions and public amenities. It can be seen that the beach area is polluted with waste (garbage) as it is not managed by any respective municipal council. The study location at Teluk Likas Beach is located approximately 7.1km away from Kota Kinabalu and has a higher rate of human activity as it is quite near to the city centre and it provides attractions and public amenities for its visitors. The beach area is not polluted with waste as it is managed by Kota Kinabalu Municipal Council.

2.2. *Sampling method*

The field work experimental design for the samplings was based on line transect and quadrat sampling method. The samples of soil and beach morning glory were collected by using the quadrat sampling method (Wilson, 2007). Each beach location had three stations, which measured 9 m^2 that were 5.5 m away from each other and were located 5 m away from the shoreline. Each station had three quadrats, which measured 1 m^2 where the 50g of topsoil samples and approximately 200g of beach morning glory were collected separately from the said quadrats. The field work was done in August 2020. The samples of soil and beach morning glory were collected from both study locations during high tides as heavy metals concentration was found to be higher than during the low tides (Suresh Ramasamy, Sundarrajan & Paramasivam, 2015).

2.3. *Plant cover determination*

The distribution and abundance of beach morning glory was often determined by measuring their plant cover (Damgaard, 2014). The point-intercept method (Figure 1) is normally used to measure the distribution and abundance of plant species (Young & Johnstone, 2011). The proportion of points intercepted by the beach morning glory was measured as cover and calculated according to the following equation (Wilson, 2007).

$$Cover = \frac{Interceptions}{Points} \, x \, 100 \quad (1)$$

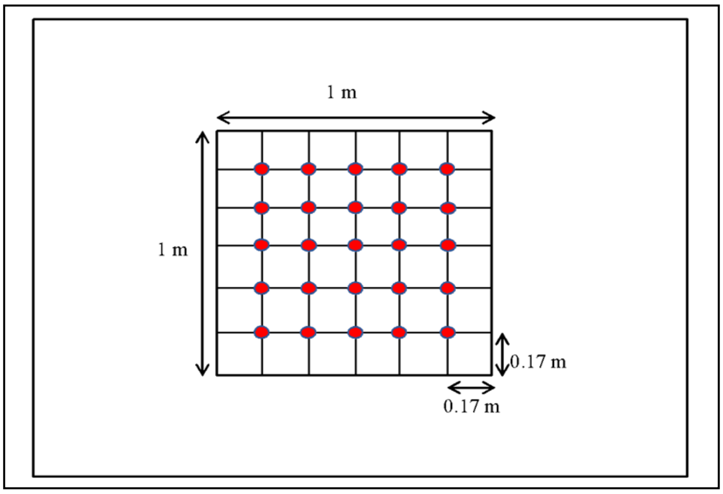

Figure 1: The measurement of quadrat using point intercept method.

2.4. *Soil organic matter*

The dried and sieved soil samples were analysed for soil organic matter (SOM) by using the loss on ignition (LOI) method. Initial weight was obtained from both the empty crucibles and 1 g of soil samples. Next, it underwent combustion for a period of five hours in a muffle furnace at 550˚C. After the combustion period, the crucibles and soil samples were transferred directly into a desiccator to avoid any humidity formed (Effendy & Natin, 2016) and to allow for the cooling process (Suresh et al., 2015). The final weight was obtained once the crucibles and soil samples have cooled down completely (Effendy & Natin, 2016). The soil organic content percentage was obtained by calculation according to the following equation (Jones, 1999).

$$\%\, SOM = \frac{initial\ weight - final\ weight}{initial\ weight} \, x \, 100 \quad (2)$$

2.5. *Heavy metal analysis*

The beach morning glory underwent a drying process in a dry oven for 24 hours at 60˚C until a constant weight was obtained, then it was grounded and sieved (Ratnasooriya et al., 2017). The dried beach morning glory samples were digested by using nitric-hydrochloric acid digestion (1:3) (Uddin et al., 2016). Heavy metals concentration of Lead (Pb), Zinc (Zn) and Copper (Cu) in the beach morning glory was analysed by using Atomic Absorption Spectrophotometer (AAS) (Nayak et al., 2016). Standard solutions with different concentrations (1ppm, 3ppm, 5ppm and 7ppm) were used in the heavy metal analysis.

2.6. *Statistical analysis*

Firstly, the data were examined by conducting the normality test (Shapiro Wilk test) since the test suits studies with small sample sizes of up to 2000 samples (Bluman, 2013). All variables were normally distributed except SOM and Cu. After log transformation ($\log_{10}$) was conducted on both SOM and Cu, the normality test for Cu remained not normally distributed. Independent

Samples *t* Test was used for abundance, SOM, Pb and Zn and Mann-Whitney *U* Test was used for Cu. For the correlation analysis, Pearson correlation was used for the correlation between the abundance and heavy metals (Pb and Zn), whereas Spearman rank correlation was used for the correlation between the abundance and heavy metal (Cu) (McDonald, 2009).

3. Results and discussion

3.1. *The abundance of beach morning glory between Lok Kawi Beach and Teluk Likas Beach*

The mean relative abundance (%) of beach morning glory at Lok Kawi Beach was 22.22 ± 10.02 whereas at Teluk Likas Beach, it was 64.89 ± 15.85 (Figure 2). The Independent Samples *t* Test for the mean relative abundance of beach morning glory shows a significant difference (p = 0.001) between both study locations. Therefore, the mean relative abundance of beach morning glory in Teluk Likas Beach was higher than in Lok Kawi Beach.

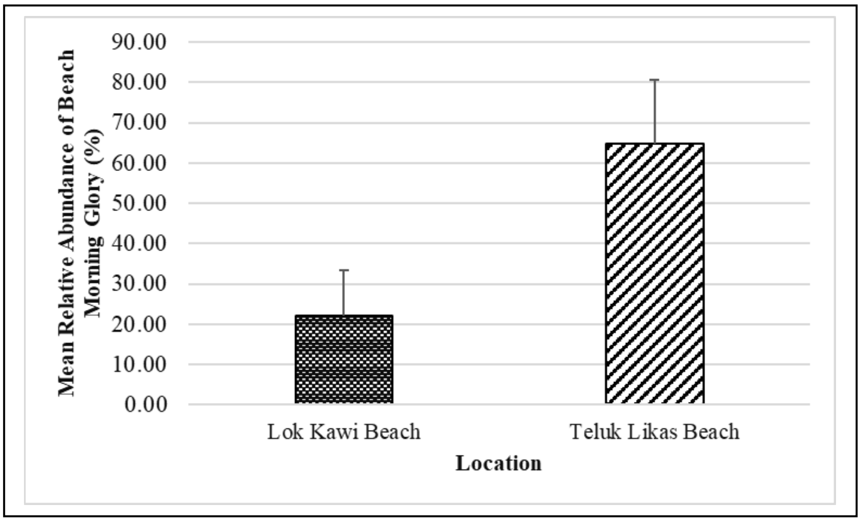

Figure 2: The mean relative abundance (%) of beach morning glory between the two beach locations.

Due to the lack of previous studies regarding the abundance of beach morning glory, there is no baseline information that can be used to compare the results of this study. According to Nilam, Jyoti and Sumitra (2018), the beach morning glory is known to thrive in harsh conditions. Zheng, Zhang, Su, Xia, Jian and Zhang (2018) supported and stated that the beach morning glory was able to survive high salinity and drought conditions. Meanwhile, according to Senevirathna, Edirisooriya, Uluwaduge and Wijerathna (2018), the degradation of coastal areas may have occurred naturally and also may have been caused by anthropogenic activities from the tourism sector and residential areas nearby the coastal areas due to the waste and pollution generated.

In this study, the higher abundance of beach morning glory at Teluk Likas Beach may not have been affected by the anthropogenic activities pertaining to waste (garbage) and pollution matters as the beach area is well managed by Kota Kinabalu Municipal Council. Meanwhile, the abundance of beach morning glory at Lok Kawi Beach was lower perhaps due to the beach area being highly polluted with waste as it is not managed by any respective Municipal Council, therefore, the pollution generated may have caused the degradation of the plants (Senevirathna et al., 2018).

3.2. *The soil organic matter (SOM) between Lok Kawi Beach and Teluk Likas Beach*

The mean SOM (%) at Lok Kawi Beach was -1.48 ± 0.24, whereas at Teluk Likas Beach it was -1.50 ± 0.30 (Figure 3). The negative values obtained for the mean SOM were due to the log transformation (log10) that was applied in order to normalize data that did not show normal distribution (McDonald, 2009). The Independent Samples *t* Test for SOM shows no significant difference ($p = 0.88$) between both study locations. Hence, the mean SOM between the two beach locations did not differ much from each other.

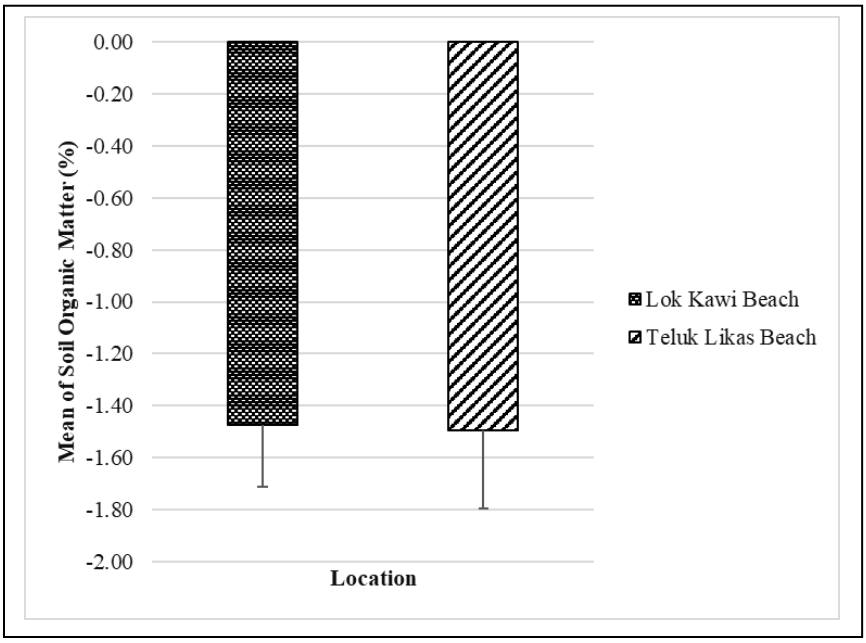

Figure 3: The mean soil organic matter (SOM) (%) at Lok Kawi Beach and Teluk Likas Beach.

Teluk Likas Beach is a busy location due to it being a recreational park and is visited frequently by many locals and tourists on a daily basis, whereas Lok Kawi Beach does not have many visitors. According to Asati, Pichhode and Nikhil (2016), the toxic effects of heavy metals such as Lead (Pb) may interfere in the activities of beneficial soil microorganisms, thus decreasing the amount of SOM. Lenntech (2020a) stated that wastewaters from industrial sectors are often contaminated by Zn, which then accumulates in the soil. Other than that, Copper (Cu) is not able to break down in the environment, yet manures containing Cu are still widely used (Lenntech, 2020b). The author also stated that soils polluted with Cu may cause the slowing down of organic matter decomposition.

In this study, perhaps the anthropogenic activities have affected the SOM at both study locations. Lok Kawi Beach is located near to the Lok Kawi army camp and also the housing and industrial areas and this can also be considered as being exposed to anthropogenic activities. Meanwhile, Teluk Likas Beach was exposed to anthropogenic activities caused by the emissions generated from the high amount of traffic that passes by the beach area daily. Hence, the toxic effect generated from the anthropogenic activities has reduced the SOM (Asati et al.,

2016) at both study locations. Neyestani et.al (2016) stated that the correlation between soil organic matter and heavy metals concentration are usually low.

3.3. *The heavy metals concentration in beach morning glory between Lok Kawi Beach and Teluk Likas Beach*

The mean Pb concentration at Lok Kawi Beach was 0.15 ± 0.65 mg/L and at Teluk Likas Beach was -0.80 ± 0.57 mg/L. The mean Zn concentration at Lok Kawi Beach was -0.24 ± 0.05 and at Teluk Likas Beach was -0.27 ± 0.03 and the mean concentration of Cu at Lok Kawi Beach was -0.12 ± 0.05 and at Teluk Likas Beach was -0.05 ± 0.17 (Figure 4). The raw data of heavy metals concentration in the beach morning glory obtained ranged between -2.00 mg/L – 1.07 mg/L for Pb, -0.33 mg/L – -0.16 mg/L for Zn and -0.18 mg/L – 0.38 mg/L for Cu. The negative concentrations obtained were due to the heavy metals' concentration being lower than the minimum detection limit (1 ppm). Heavy metals concentration that are below detection limit refers to their concentration that lies between the limit of detection and zero concentration (Bañares & Alvarez, 2015). Bañares and Alvarez (2015) also stated that these negative values may imply low heavy metals concentration but does not indicate the absence of these metals.

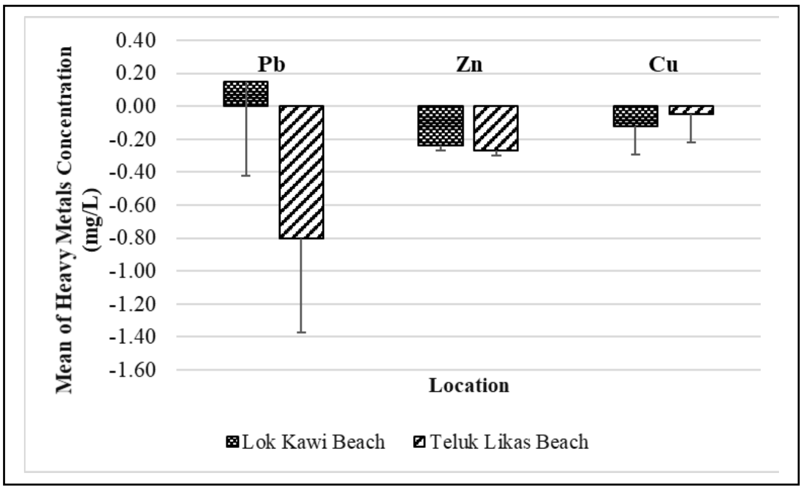

Figure 4: The mean of heavy metals concentration between two beach locations.

The independent samples *t* test for the mean Pb concentration shows a significant difference ($p = 0.01$) between both study locations. Therefore, the mean Pb concentration was higher at Lok Kawi Beach than at Teluk Likas Beach. According to Noori, Malayeri, Moosaei, Pakzad and Piriye (2012), Pb uptake by plants may be caused by industrial wastes. Nayak et al. (2016) stated that heavy metals such as Pb could also come from fishing boats. Perhaps the high Pb concentration at Lok Kawi Beach could be due to its location, which is situated nearby industrial areas. The passing cars from the main road could also contribute to the Pb contamination (Abdullah et al., 2016).

As for Zn, the independent samples *t* test for the mean Zn concentration shows no significant difference ($p = 0.12$) between both study locations. The mean Zn concentration between the two beach locations did not differ much from each other perhaps due to it being a micronutrient that occurs naturally in the environment and is vital for the metabolic processes in plants (Zoufan, Jalali, Karimiafshar & Motamedi, 2017). However, anthropogenic activities involving boats are also present at both locations. Bighiu, Eriksson-Wiklund and Eklund (2016) found that Zn pollution may also be derived from the leaching of boat paints into the wat.

For Cu, the Mann-Whitney *U* test for the mean Cu concentration also shows no significant difference (p = 0.54) between both study locations. Therefore, the mean Cu concentration between the two beach locations did not differ much from each other. According to Arif et al. (2016), Cu is an essential metal that is required by plants for optimal growth. Asati et al. (2016) stated that small amounts of Cu are able to enhance plant photosynthesis. Hence, the mean concentration of Cu did not differ much between both study locations perhaps due to natural circumstances instead of being caused by human activities (Zoufan et al., 2017).

3.4. ***The correlation of heavy metals concentration to the abundance of beach morning glory between Lok Kawi Beach and Teluk Likas Beach***

The Pearson correlation test between the relative abundance of beach morning glory and the concentration of Pb shows no correlation at both Lok Kawi Beach (N = 9, r = -0.08 and p = 0.83) and Teluk Likas Beach (N = 9, r = -0.45 and p = 0.23) (Figure 5). Therefore, the relative abundance of beach morning glory at both locations was not affected by the concentration of Pb.

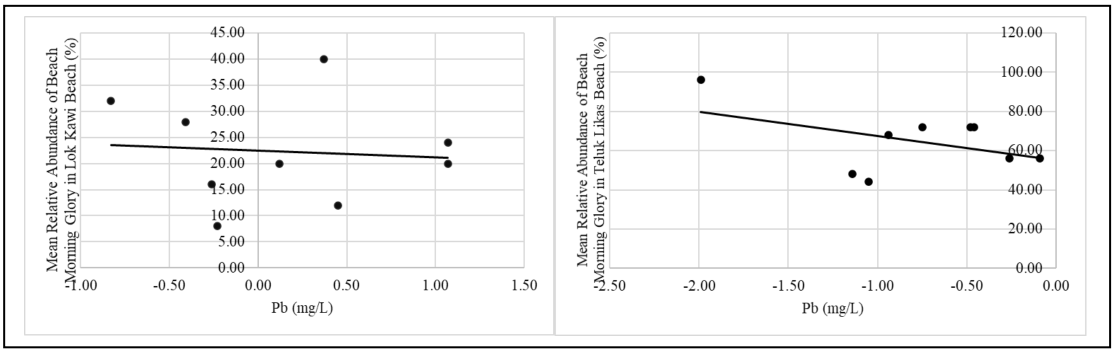

Figure 5: The correlation between the mean relative abundance of beach morning glory and the concentration of Pb at both locations.

Similarly, the Pearson correlation test between the relative abundance of beach morning glory and the concentration of Zn also shows no correlation at Lok Kawi Beach (N = 9, r = -0.66 and p = 0.06) and Teluk Likas Beach (N = 9, r = -0.18 and p = 0.64) (Figure 6). Hence, the relative abundance of beach morning glory at both locations was not affected by the concentration of Zn.

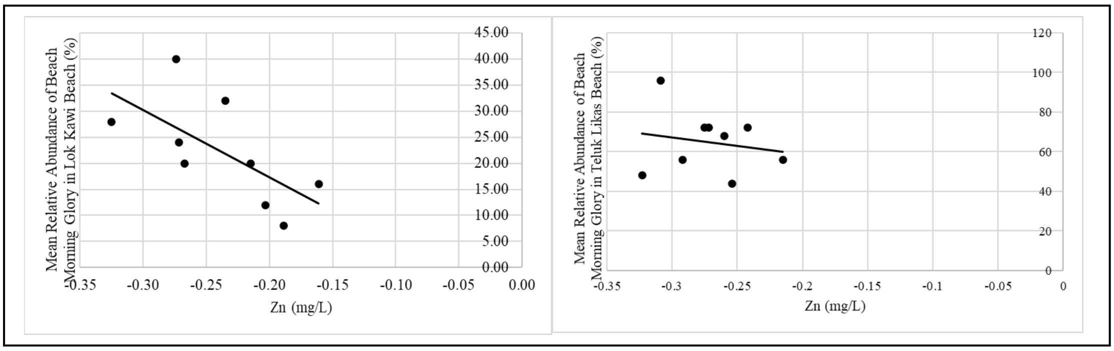

Figure 6: The correlation between the mean relative abundance of beach morning glory and the concentration of Zn at both locations.

The Spearman's rho correlation test between the relative abundance of beach morning glory and the concentration of Cu shows no correlation at Lok Kawi Beach (N = 9, r = -0.18 and p = 0.65) and Teluk Likas Beach (N = 9, r = 0.26 and p = 0.51) (Figure 7). Therefore, the relative abundance of beach morning glory at both locations was not affected by the concentration of Cu.

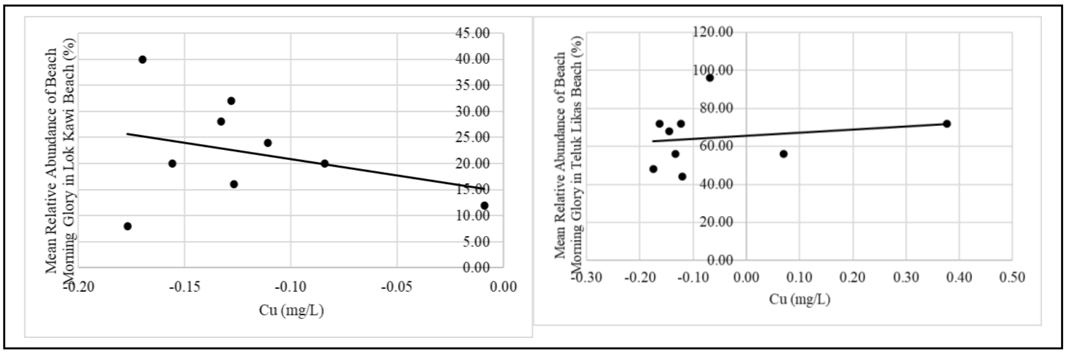

Figure 7: The correlation between the mean relative abundance of beach morning glory and the concentration of Cu at both locations.

To date, there is no previous study done with regards to the correlation between heavy metals concentration and the abundance of beach morning glory. Based on Abdullah et al. (2016), the beach morning glory are among the few plants that can withstand and thrive in porous soil structures and high salinity levels. The author also has successfully proven the ability of this plant to take up and accumulate heavy metals.

The ability of beach morning glory in accumulating heavy metals was even found to have improved by the addition of *Bacillus subtilis* which helped the plant to grow and become resistant towards Nickel (Ni) at a concentration of 100 ppm (Acinas, Bautista, Tagsip & Cuadrado, 2019). Nayak et al. (2016) stated that beach morning glory has the potential to be an accumulator of certain heavy metals (Pb, Zn and Cu). These previous studies have proven how the beach morning glory can withstand various environmental conditions and thrive even in habitats that were contaminated with heavy metals. However, its usage as a medicinal plant should be monitored as rising heavy metals concentration in plants via nutrient uptake from polluted soils may then bring upon adverse effects towards human health and the medicine efficacy itself (Li et al., 2018). In this study, the heavy metals (Pb, Zn and Cu) have no effects on the relative abundance of beach morning glory perhaps due to it being an excellent heavy metals accumulator and can withstand high concentrations.

4. Conclusion

The relative abundance of beach morning glory was higher at Teluk Likas Beach perhaps due to it being managed by Kota Kinabalu Municipal Council, hence, anthropogenic activities pertaining to waste (garbage) and pollution was regularly maintained. On the contrary, Lok Kawi Beach had a lower abundance of beach morning glory perhaps due to the absence of beach management, hence, the beach was highly polluted with waste that may have caused the degradation of the plants.

As for the soil organic matter (SOM), there was not much difference between both the beach locations perhaps due to the effects of anthropogenic activities. Lok Kawi Beach is located near the Lok Kawi army camp, housing and also industrial areas whereas Teluk Likas Beach is exposed to emissions from the high amount of daily traffic passing by.

Other than that, the Pb concentration of beach morning glory was higher at Lok Kawi Beach than at Teluk Likas Beach, which perhaps could be due to car emissions, industrial wastes and also from fishing boats activities. Next, both Zn and Cu concentrations at both beach locations did not differ much from each other perhaps due to being a micronutrient for optimal plant growth, hence, both metals perhaps occurred by natural circumstances. Furthermore, anthropogenic activities involving boats are also present at both locations, which might have caused the leaching of Zn into the waters from boat paints.

In terms of correlation, heavy metals concentration (Pb, Zn and Cu) did not affect the abundance of beach morning glory within both beach locations because they are excellent accumulators of heavy metals and can thrive in heavy metal contaminated environments. To conclude, the relative abundance of beach morning glory was not affected by soil organic matter and heavy metals concentration.

It is recommended that future studies should be conducted at a longer duration in order to obtain more significant results. Next, the beach morning glory could also be screened for its bioactive compounds and tested for the efficacy of its medicinal properties. Other than that, other variables such as soil pH can be used as independent variables for future studies in order to collect more baseline information as there are not many studies regarding beach morning glory as of today.

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