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Impact of Water Pollution from Various Sources on the Concentration of Amino Acids in *Silybum marianum* and *Xanthium strumarium* L. Plants

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ABSTRACT

This study was conducted in Nineveh Governorate, Iraq, where four different sites were identified. Plants in these sites receive water from various sources, including domestic sewage, industrial wastewater, and waste from electric generators. These sites are Wadi Aqab Industrial Area, Al-Khosr, the Old Bridge, and Al-Faisalia (control). The aim of this study was to determine how polluted water from different sources affect the chemical composition of selected wild plants, namely *Silybum marianum* and *Xanthium strumarium* L. The results showed that the amino acids most affected in *Silybum marianum* by polluted water are Serine and Glycine, with concentrations of 389 and 317mg/l, respectively, in the Al-Khosr area, compared to other amino acids in the study areas. For *Xanthium strumarium*, the results indicated that the amino acid most affected by polluted water is Histidine, with a concentration of 198mg/l in the Old Bridge area, compared to other amino acids in the study areas.

INTRODUCTION

In recent decades, concern about environmental pollution has increased due to the growing global population and the acceleration of industrial and urban development. This has led to the accumulation of pollutants and toxins, such as pesticides, petroleum products, and heavy metals, in natural resources like soil, air, and water consequently, there has been a decline not only in environmental quality but also in the health of both animal and plant life **(Kanwar *et al*., 2020)**. The presence of pollutants in water prevents plants from reaching their full potential in terms of growth and reproduction. Once these pollutants settle on the ground, plants can absorb them from the soil. This introduces them into the food chain, increasing the risk of toxicity to humans and animals **(Priya *et al.*, 2023)**. The presence of pollutants negatively affects plant growth. This, in turn, impacts amino acids **(Al-Rashedy, 2021)**. Environmental pollution is a growing global concern. This is because of its negative impact on human health and ecosystems. Water pollution results from the discharge of industrial waste, agricultural waste, as well as domestic waste into water resources. It is considered one of the most widespread and hazardous types of pollution. These wastes can contain heavy metals such as pesticides— leading to significant changes in water quality— and organic pollutants that also affect plants and other living organisms **(Bhat *et al.,* 2022)**. A number of past researches have reported that water pollution has a significant effect on plant growth, as well as on the amount of amino acids found in plants. This results in physiological and chemical adjustments that are adverse to the growth and functioning of plants. The presence of heavy metals such as cadmium, lead, copper, and zinc in soils and water can cause plant toxicity and alter their chemical composition **(Alengebawy *et al.*, 2021)**. Sources of these contaminants include industrial activities such as mining, chemical industries, and the use of fertilizers and pesticides **(Fu & Xi, 2020)**. Oil pollution, resulting from spills or discharges into soil or water bodies during industrial activities, is particularly detrimental. It reduces oxygen uptake capacity, inhibits root growth, and exposes plants to acid storms **(Zahermand *et al.*, 2020)**. This pollution adversely affects biochemical processes in plants, leading to decreased photosynthetic efficiency and growth capacity **(Hung *et al.*, 2020)**.

Our research focused on wild medicinal and agriculturally important species. *Silybum marianum*, commonly known as milk thistle, is an annual herb from the Asteraceae family. It features large white-veined leaves and bright purple flowers, growing to a height of 30-200cm. Known for its medicinal properties, especially in treating liver and digestive disorders, it contains flavonolignans called silymarin, which have antioxidant and anti-inflammatory effects **(Wang *et al.*, 2020)**.

Xanthium strumarium, or common cocklebur, is another herbaceous annual plant in the Asteraceae family. It thrives in damp temperate regions and is widespread across North America, Europe, and Asia. This plant, growing 30-120cm tall, has a thick stem, broad leaves, and small green flowers that develop into spiny fruits. These fruits cling to clothing and fur, aiding seed dispersal. *Xanthium strumarium* is used in herbal medicine to treat skin problems and respiratory inflammations, and it contains coumarins and flavonoids with anti-inflammatory and antimicrobial effects **(Chavan & Kulkarni, 2017)**.

Our research aimed to investigate the impact of water pollution from various sources on the amino acid content in *Silybum marianum* and *Xanthium strumarium*.

MATERIALS AND METHODS

Site selection

In Nineveh Governorate, four different sites were selected where plants are watered with different sources, such as domestic sewage, industrial wastewater, and waste from electric generators. The sites are:

1. Wadi Aqab Industrial Area: Located on the right side of Nineveh Governorate; this industrial zone exposes plants to wastewater from industrial activities.

2. Old Bridge Area: Situated near the Old Bridge in Nineveh Governorate; this area has plants irrigated with domestic sewage and wastewater from local markets.

3. Al-Khosr Area: This site, also within Nineveh Governorate, is characterized by irrigation with wastewater from electric generators. It provides an additional

perspective on the impact of different waste sources on plant health and amino acid content.

4. Al-Faisalia Area (Control): This area is located on the left side of Nineveh Governorate , and the plants found there rely on rainwater.

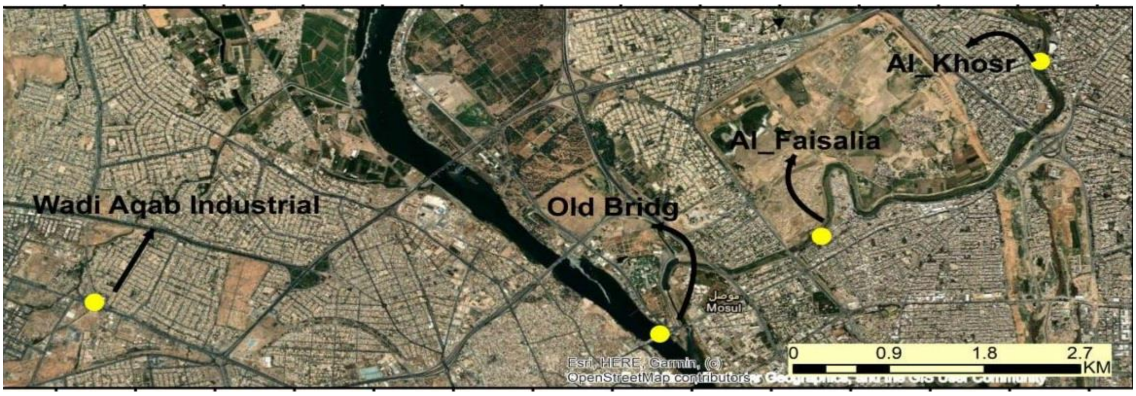

Image 1. Plant sample collection sites

Collection of plant samples

After conducting a field survey of the study sites, the wild plants present were identified. Subsequently, the common plants across these sites were selected. Two plant species were chosen that were present at all study sites: *Silybum marianum* (Milk Thistle) and *Xanthium strumarium* (Common Cocklebur). Three replicates of each plant (shoot group) from each site were collected and stored in special bags until they could be dried and grounded into a fine powder using an electric grinder. The grounded samples were then sent to the laboratory. The samples were collected from the study sites between April 30, 2024, and May 1, 2024 .

Image 2. the *Silybum marianum* (Milk Thistle) plant

Image 3. the *Xanthium strumarium* (Common Cocklebur) plant

Measurements made for the plant

Amino acid concentration determination in leaf tissues

The concentration of amino acids in the plant leaves collected from the study sites was estimated as described by **Hill *et al.*(1979)** using an HPLC (High-Performance Liquid Chromatography) device of the Sykam type for amino acid analysis.

RESULTS AND DISCUSSION

1. Concentration of amino acids in the *Silybum marianum* plant

Table (1) and the Figs. (1, 2, 3 and 4) show that the amino acids most affected by polluted water in the study areas are Serine and Glycine, reaching 389 and 317mg/l, respectively, in the Al-Khosr area compared to other amino acids in the study areas. In the Wadi Aqab area, the amino acids most affected are Serine and Cystine, with concentrations reaching 368 and 188mg/l, respectively, compared to other amino acids in that area. Moreover, it has been noticed that in the Old Bridge area, the amino acids (Serine and Glycine) are the most affected, reaching a concentration of 320 and 301mg/l, respectively, compared to other amino acids in that area. The reason for the decreased amino acid concentrations in the areas of Al-Khosr, Wadi Aqab, and Old Bridge may be due to the fact that power plants (particularly those based on petroleum derivatives) generate waste with high levels of heavy metals like lead, mercury, cadmium, and chromium. These cause pollution of soil and water salinity, as well as harming biological processes in plants. They impact enzymes and proteins responsible for the synthesis of amino acids which causes changes in composition of amino acids **(Hassan *et al.*, 2019)**. This corresponds to what was mentioned by **Al-Rashedy and Al-Mtewti (2022)** that heavy metals have a negative effect on plant growth leading toward the decrease in the concentration of amino acids. The drop in the amino acid concentration in the study areas could also be owing to the polluted water from household waste and market waste, which may include toxic materials, such as heavy metals and organic compounds, which inhibit the biological processes of microorganisms breaking down proteins into amino acids. Moreover, these unhealthy items reduce the levels of dissolved oxygen as well as change the pH of water, thus causing imbalances in biological activity, which results in an amino acid concentration decrease **(Gonzalez-Martinez *et al.*, 2016)**.

Table 1. Concentrations of amino acids (mg/l) for *Silybum marianum* plant in the study areas

No.	**Amino acid**	**Studied areas**						
		Control	**Wadi Aqab**	**Difference with control**	**Al-Khosr**	**Difference with control**	**Old Bridge**	**Difference with control**
1	**Aspartic acid**	33	14	19	26	7	22	11
2	**glutamic acid**	380	370	10	307	73	343	37
3	**Serine**	2512	2144	368	2123	389	2192	320
4	**Histidine**	1262	1173	89	1018	244	1065	197
5	**Glysine**	960	885	75	643	317	659	301
6	**Arginine**	555	510	45	504	51	505	50
7	**Alanine**	242	169	73	224	18	190	52
8	**Cystine**	1202	1014	188	1084	118	1181	21
9	**Valine**	324	274	50	298	26	288	36
10	**Methionine**	577	556	21	526	51	478	99
11	**Tyrosine**	597	561	36	549	48	523	74
12	**Phenylalanine**	356	255	101	272	84	232	124
13	**Isoleucine**	380	296	84	327	53	354	26
14	**Leucine**	436	348	88	337	99	329	107
15	**Lysine**	1393	1335	58	1200	193	1325	68

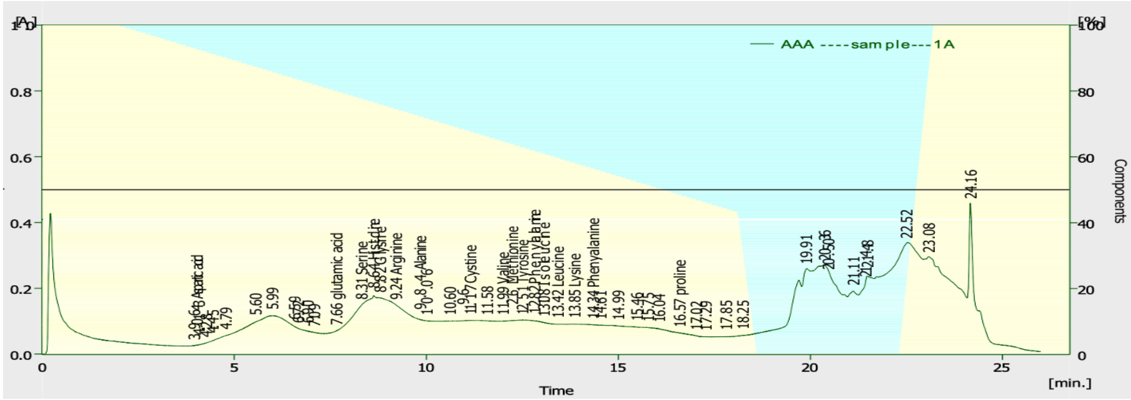

Fig.1. Concentration of amino acids (mg/l) in the *Silybum marianum* plant in the Wadi Aqab Industrial Area

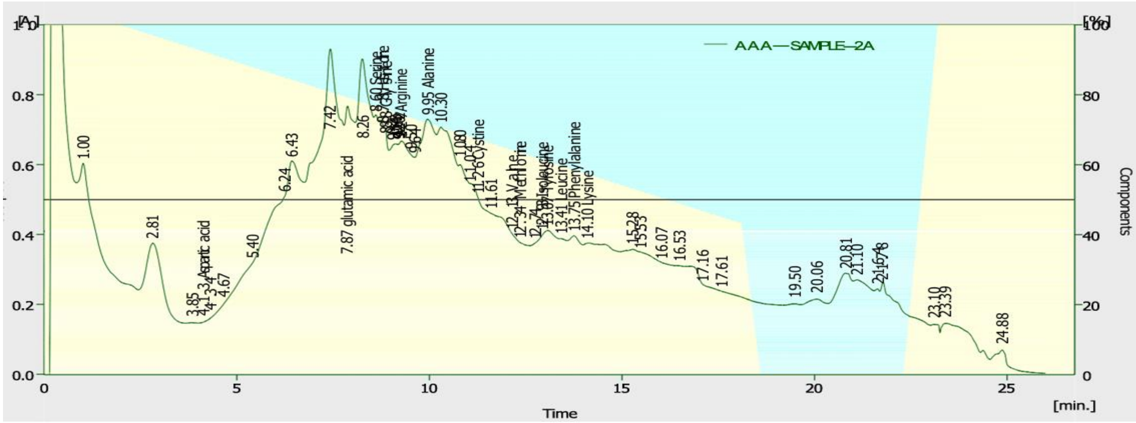

Fig. 2. Concentration of amino acids (mg/l) in the *Silybum marianum* plant in the Al-Khosr area

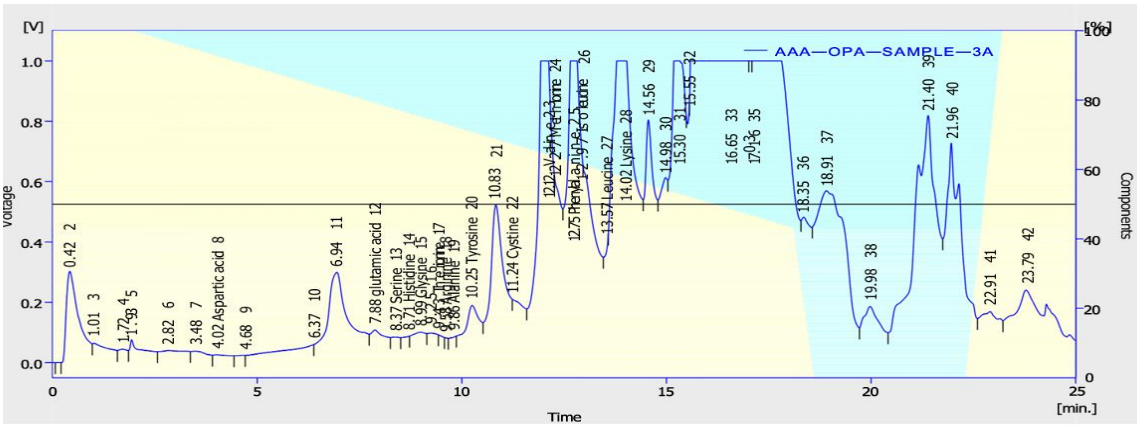

Fig. 3. Concentration of amino acids (mg/l) in the *Silybum marianum* plant in the Old Bridge area

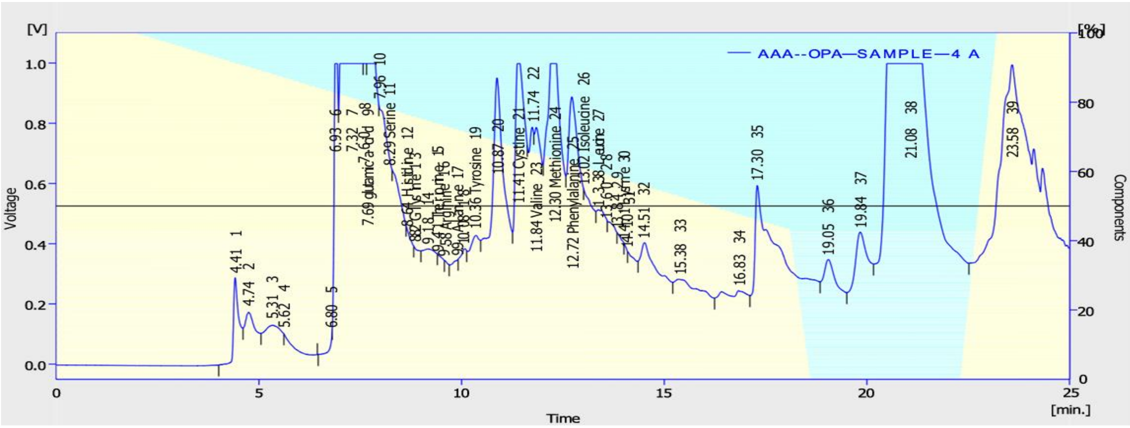

Fig. 4. Concentration of amino acids (mg/l) in the *Silybum marianum* plant in the Al-Faisaliah area (Control)

2. Concentration of amino acids in the *Xanthium strumarium* plant

Table (2) and the Figs. (5, 6 ,7 and 8) show that the most affected amino acid by polluted water in the Old Bridge area is Histidine, reaching a concentration of 198mg/l compared to other amino acids in the study areas. In the Al-Khosr area, the most affected amino acids are Valine and Tyrosine, with concentrations of 132 and 92mg/l, respectively, compared to other amino acids in that area. Additionally, in the Wadi Aqab area, the most affected amino acids are Valine and Glycine, with concentrations of 91 and 88mg/l, respectively, compared to other amino acids in that area. The decrease in amino acid concentrations in the Old Bridge, Al-Khosr, and Wadi Aqab areas may be due to the reason that household and market waste through the wastewater is highly rich in organic matters and chemical pollutants like soaps, detergents, and food residues that negatively affect the uptake of essential nutrients by the plant thus causing imbalance toward the production of amino acids **(Terrón-Camero *et al.*, 2019)**.This is in conformity with the findings of **Achuba and Ja-anni (2018)**, who suggested that the reduced amino acid concentrations might be attributed to hydrocarbons, oils, and other harmful chemical and organic substances in polluted water. The pollution reduces soil's absorption capacity of essential nutrients necessary for growth. As a result, the concentration of amino acids important for plant growth is decreased. Moreover, the decrease in amino acid concentrations observed in the research areas could be attributed to the presence of waterborne chemical and biological pollutants. These contaminants can induce environmental stress in plants, reducing their metabolic efficiency. As a result, amino acid concentrations may further decline due to the stress effects exerted by these pollutants **(Wang *et al*., 2019)**.

Table 2. Concentrations of amino acids (mg/l) for *Xanthium strumarium* plant in the study areas

No.	Amino acid	Studied areas						
		Control	Wadi Aqab	Difference with control	Al-Khosr	Difference with control	Old Bridge	Difference with control
1	Aspartic acid	97	73	24	78	19	70	27
2	glutamic acid	249	197	52	199	50	223	26
3	Serine	1245	1187	58	1231	14	1183	62
4	Histidine	803	738	65	729	74	605	198
5	Glysine	693	605	88	655	38	669	24
6	Arginine	905	886	19	878	27	815	90
7	Alanine	407	389	18	344	63	335	72
8	Cystine	255	205	50	186	69	175	80
9	Valine	454	363	91	322	132	409	45
10	Methionine	451	383	68	395	56	410	41
11	Tyrosine	490	450	40	398	92	377	113
12	Phenylalanine	267	234	33	238	29	200	67
13	Isoleucine	604	556	48	574	30	587	17
14	Leucine	501	456	45	447	54	438	63
15	Lysine	1787	1771	16	1712	75	1723	64

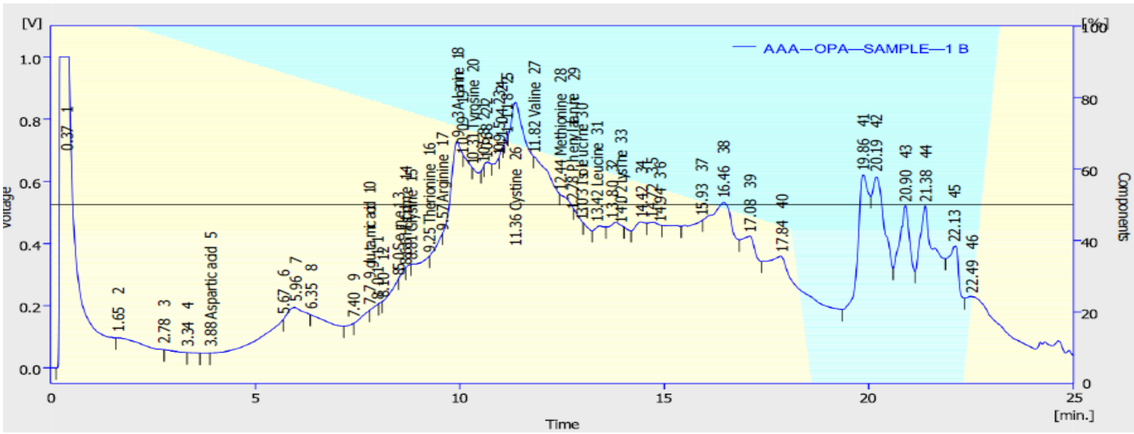

Fig. 5. Concentration of amino acids (mg/l) in the *Xanthium strumarium* plant in the Wadi Aqab Industrial area

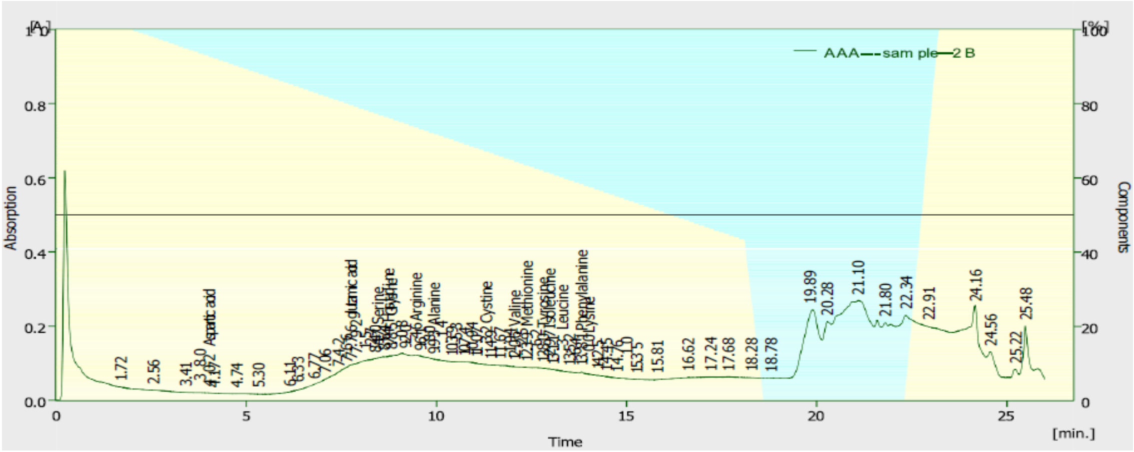

Fig. 6. Concentration of amino acids (mg/l) in the *Xanthium strumarium* plant in the Al-Khosr area

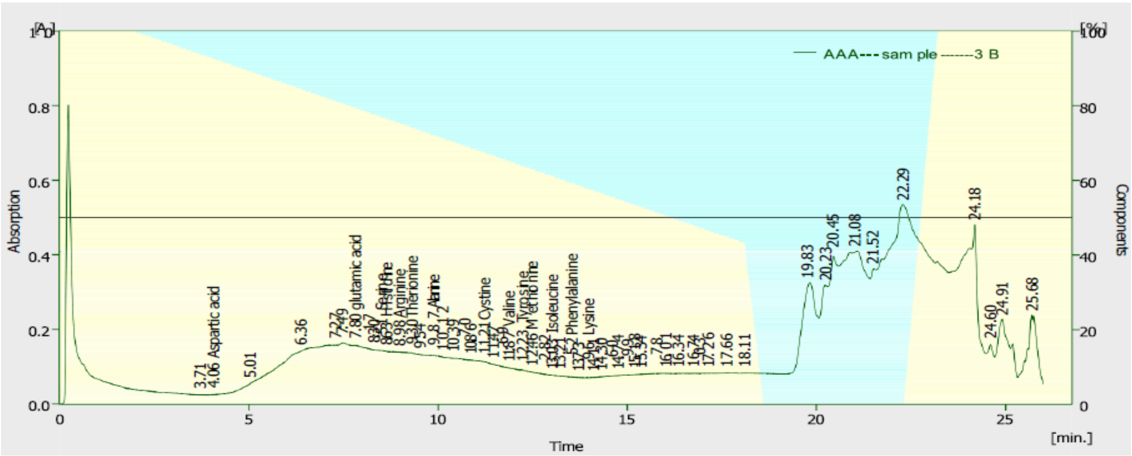

Fig. 7. Concentration of amino acids (mg/l) in the *Xanthium strumarium* plant in the Old Bridge area

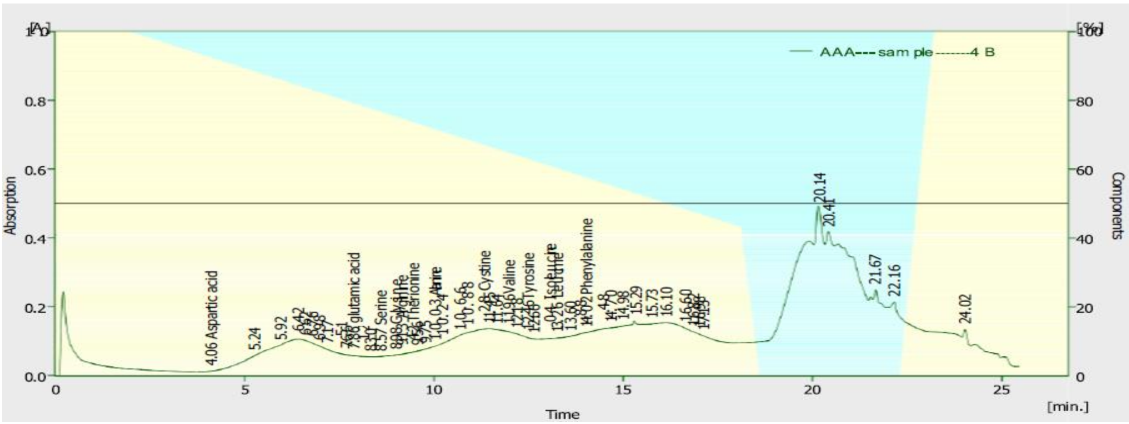

Fig. 8. Concentration of amino acids (mg/l) in the *Xanthium strumarium* plant in the Al-Faisaliah area (Control)

In general, we noticed that the *Xanthium strumarium* plant was more affected than the *Silybum marianum* plant by watering with water coming from different sources, through the clear decrease in the total amino acids in the *Xanthium strumarium* plant compared to their content in the *Silybum marianum* plant.

CONCLUSION

It has been shown that polluted water significantly affects the concentration of amino acids in both plants, with a more pronounced effect on *Silybum marianum* compared to *Xanthium strumarium*. The reduction in the total amino acid concentrations was higher in the polluted environments for *Silybum marianum*. Certain amino acids, such as Serine and Glycine, exhibit greater sensitivity to polluted water in *Silybum marianum*, while Histidine shows a higher impact on *Xanthium strumarium*. Additionally, the areas of Al-Khosr and Old Bridge were found to be the most polluted for the studied plants. It was observed that the Al-Khosr area had the greatest impact on *Silybum marianum*, whereas for *Xanthium strumarium*, the most polluted area was recorded to be the Old Bridge, based on the total amino acid concentration as an indicator of pollution.

REFERENCES

Achuba, F.I.andJa-anni, M.O. (2018). Effect of abattoir waste water on metabolic and antioxidant profiles of cowpea seedlings grown in crude oil contaminated soil. Int. J. of Recycling of Organic Waste in Agri., 7**:**59–66. https://doi.org/10.1007/s40093- 017-0190-6.

Alengebawy, A.;Abdelkhalek, S.T.;Qureshi, S.R. and Wang, M-Q (2021). Heavy Metals and Pesticides Toxicity in Agricultural Soil and Plants: Ecological Risks and Human Health Implications. Toxics, 9(42)., https://doi.org/10.3390/toxics9030042.

Al-Rashedy, H.S.M.A. (2021). Effect of Soil Treatment with Heavy Metals on the Concentration of Na, K, and Cl in the Shoot and Root Parts of Fenugreek and Spinach Plants., AIP Conference Proceedings, 2404(1).,https://doi.org/10.1063/5.0070049.

Al-Rashedy, H.S.M.A. and Al-Mtewti,W.A.A. (2022). Effect of adding Silybum and Licorice Powder on Carbohydrate and Protein Concentration in Beans Grown in Soil Treated with Cobalt and Copper., Sarhad Journal of Agriculture, 38 (1): 260-265, https://dx.doi.org/10.17582.

Bhat, S.A.; Bashir, O.; Ul Haq, S.A.; Amin, T.; Rafiq, A.; Ali, M.; Américo-Pinheiro, J.H.P.and Sher, F. (2022). Phytoremediation of Heavy Metals in Soil and Water: An Eco-Friendly, Sustainable and Multidisciplinary Approach., Chemosphere, 303(1), Article ID 134788. DOI: 10.1016/j.chemosphere.2022.134788.

Chavan, S.T. and Kulkarni, A.U. (2021). Morphological and Phytochemical Studies on Xanthium strumarium L. Plantae Scientia., Vol. 04 Iss. 06:287-290. DOI:10.32439/ps.v4i6.287-290.

Fu, Z., and Xi, S. (2020). The effects of heavy metals on human metabolism., Toxicology mechanisms and methods, 30(3):167-176. PMID: 31818169 DOI: 10.1080/15376516.2019.1701594.

Gonzalez-Martinez, A.; Calderón, K.and Gonzalez-Lopez, J. (2016). New concepts of microbial treatment processes for the nitrogen removal: effect of protein and amino acids degradation. Amino Acids., 48(5). DOI:10.1007/s00726-016-2185-4.

Hassan, M. U.; Chattha, M. U.; Khan, I.; Chattha, M. B.; Aamer, M.; Nawaz, M.; Ali, A.; Khan, M. A. U. and Khan, T.A. (2019). Nickel toxicity in plants: reasons, toxic effects, tolerance mechanisms, and remediation possibilities—a review., Environmental Science and Pollution Research, vol. 26, pp. 12673-12688. doi: 10.1007/s11356-019-04892-x.

Hill, D.W.; Walters, F.H.; Wilson, T.D. and Stuart, J.D. (1979). High performance liquid chromatographic determination of amino acids in the picomole range. Analytical Chemistry., 51(8):1338–1341.https://doi.org/10.1021/ac50044a055.

Hung, C-M.; Huang, C-P.; Chen, C-W.; Wu, C-H.; Lin, Y-L.and Dong, C-D. (2020). Activation of percarbonate by water treatment sludge–derived biochar for the remediation of PAHcontaminated sediments, Environmental Pollution.,Volume 265, Part B, 114914. PMID: 32806443. DOI: 10.1016/j.envpol.2020.114914.

Kanwar, V.S.; Sharma, A.; Srivastav, A.L. and Rani, L. (2020). Phytoremediation of Toxic Metals Present in Soil and Water Environment: A Critical Review. Environ., Sci. Pollut. Res. 27(36):44835–44860. [CrossRef]. PMID: 32981020. DOI: 10.1007/s11356-020-10713-3.

Priya, A.K.; Muruganandam, M.; Ali, S.S. and Kornaros, M. (2023). Clean-Up of Heavy Metals from Contaminated Soil by Phytoremediation: A Multidisciplinary and Eco-Friendly Approach., Journal /Toxics, 11, 422. https://doi.org/10.3390/toxics 11050422.

Terrón-Camero, L. C.; Peláez-Vico, M. A.; Val, C. D.; Sandalio, L. M. and Romero-Puertas, M. C. (2019). Role of nitric oxide in plant responses to heavy metal stress: exogenous application versus endogenous production., Journal of Experimental Botany, 70(17): 4477–4488. doi:10.1093/jxb/erz184.

Wang, L., Zhang, H. and Chen, F. (2019). Oxidative stress responses in plants exposed to pollution: Mechanisms and mitigation strategies., Plant Physiology, 181(2): 403-418. doi:10.1104/pp.19.00275.

Wang, X.; Zhang, Z. and Wu, S-C. (2020). Health Benefits of *Silybum Marianum*: Phytochemistry., Pharmacology and Applications. J. Agric Food Chem,68(42):11644-11664. PMID: 33045827. doi: 10.1021/acs.jafc.0c04791.

Zahermand, S.; Vafaeian, M. and Hosein Bazyar, M. (2020). Analysis of the physical and chemical properties of soil contaminated with oil (petroleum) hydrocarbons., Earth Sciences Research Journal, 24(2): 163-168. DOI:10.15446/esrj.v24n2.76217.