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Effect of Altitude on Heavy Metal Accumulation in Sambucus Nigra L. along Mountainous Roadside

Neslihan Karavin[1], Nursel Duran[2]
[1,2]Amasya University, Arts and Science Faculty, Department of Biology, Amasya, TURKEY

Abstract: In most environments, heavy metals are important pollutants. Heavy metals usually accumulate in organisms, soil and water and cause damages. Because of differences in species and habitats, heavy metal accumulation may vary. The objective of this study was to determine the effect of altitude on heavy metal concentrations. Sambucusnigra L. leaves were used as study materials. Leaf samples collected from 1100 m, 1300 m and 1500 m above sea level along a highway. Concentrations of heavy metals (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) were determined by atomic absorption spectrophotometer. Results showed that all the examined elements were varied based on altitude. Differences in heavy metal concentrations among different altitudes were significant. While Cu and Pb concentrations increased in direct proportion to increased altitude, concentrations of other elements a bit decreased at 1800 m after increasing. Except Mn, negative linear relationships between heavy metal concentrations and altitude indicated effect of altitude on heavy metal accumulation. There were significant correlations between some elements.
Keywords: Altitude, heavy metal, plant, pollution, Sambucusnigra

I. INTRODUCTION

In recent years, heavy metal pollution became an important problem in most ecosystems. Heavy metal pollution increased in direct proportion to population growth and industrialization. Sources of heavy metals are large variety but they usually derived from domestic and industrial waste, agricultural treatments and traffic.

Although some of them are required for plant growth, higher concentrations of heavy metals damage organisms, and soil structure. Heavy metals tend to accumulate in organisms. Moreover, these elements are transferred to organism to organism so heavy metal pollution is survival for healthy of organisms and sustainability of ecosystems. Because of these, scientist focused on heavy metal pollution.

Effects of heavy metals on organisms are not only related with element type but also related with genetic and physiological features of organisms and environmental conditions [1, 2]. Because plants can't move, they are directly exposed to environmental conditions of their habitat. So, they are used as biomonitor in order to determine the pollution levels.

Numerous studies were conducted on heavy metal pollution and organisms. These are in wide range of subjects [3, 4, 5, 6, 7]. But, effects of site conditions such as altitude and direction are less-studied[8].Although there are several studies conducted in many cities and regions to investigate the roadside heavy metal contamination [9, 10, 11], a few study was carried out on heavy metal pollution in mountainous areas according to altitude [8, 12, 13, 14].The objective of this study was to determine the effect of altitude on heavy metal concentrations in Sambucusnigra L. leaves. The study was conducted along a highway in a mountainous region. The typical elements Cd, Pb, Zn, and Cu in the roadside soils coming from traffic activity can be transported through the food chain into the human body and thus be very toxic to people.Understanding of site effects is important in terms of prediction of the heavy metal content of organisms and environments and sustainability of ecosystems. By this information, it can be predicted that which plant individuals may contain more heavy metal or in which area heavy metal pollution may be higher. These are useful data for some important fields such as agricultural activities, collection of plants as drugs and urbanizing.

II. MATERIAL AND METHODS

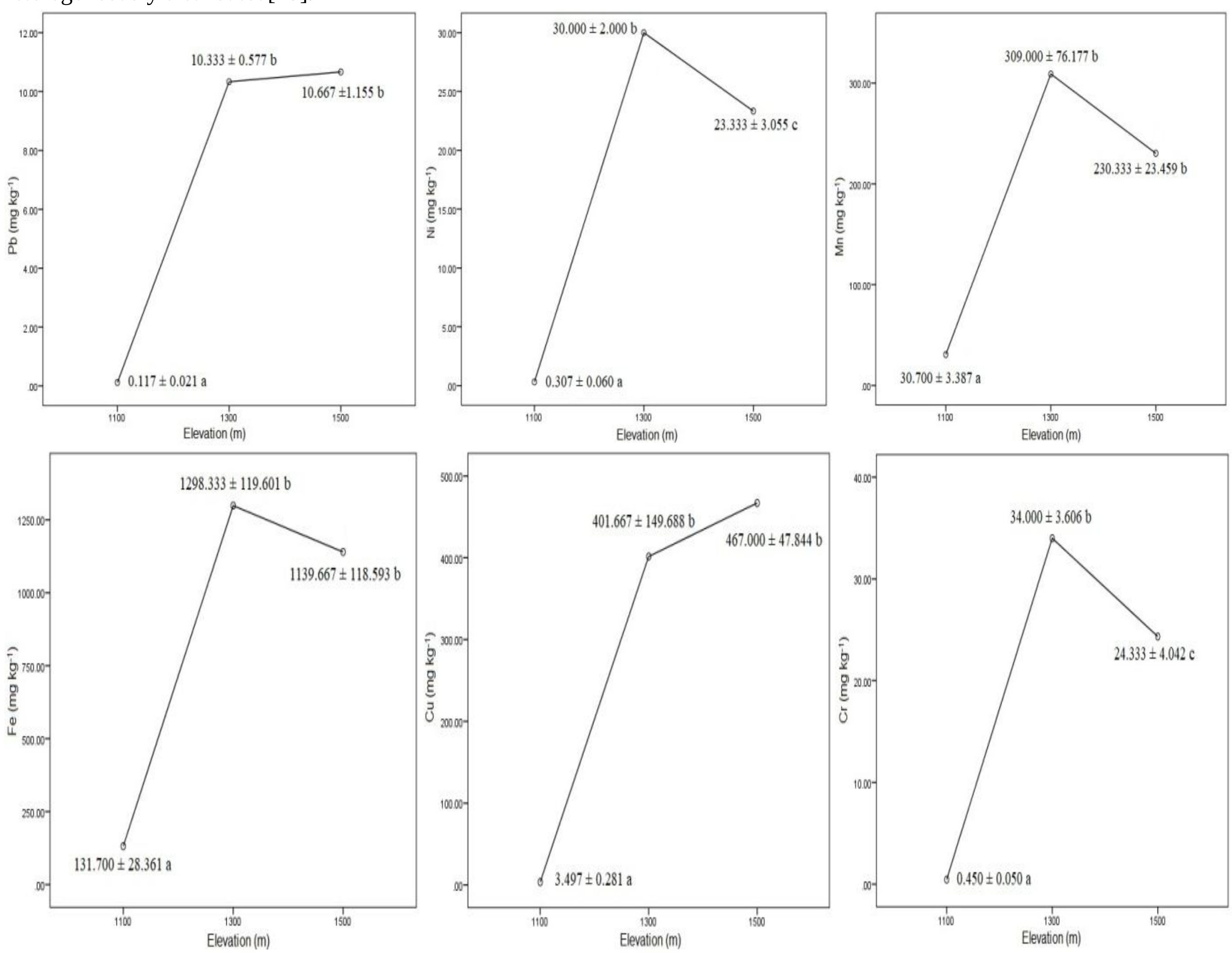
The study was carried out in Aybastı-Niksar highway, in Aybastı Perşembe highland, Ordu in the Middle Black Sea Region of Turkey. The Sambucusnigra leaves were collected from individual plants near the highway at three different altitudes, 1150. 1300. 1500 m asl. All of the leaf samples were dried at 75 °C until constant weight reached and then they were milled. The microwave method was applied to the milled plant samples for dissolution. Atomic absorption spectrophotometer was used in order to determine heavy metal concentrations and concentrations were calculated as mg kg-1 dry weight.

SPSS 20 were used for statistical analyses. Differences in heavy metal concentrations among altitudes were examined by one-way ANOVA. Relationships between heavy metal concentrations and altitude were determined by regression analysis.

III. RESULTS and DISCUSSION

Mean element concentrations and differences among sampling sites were indicated in Fig. 1. All the examined element concentrations in Sambucusnigra leaves were significantly varied based on altitude. Heavy metal concentrations were considerably lower in 1100 m than others. UcunÖzer and Özer[13] determined decreased heavy metal concentrations (Pb, Zn, Ni, Cu, Cd, Mn, Cr, and Fe) with the increase in altitude but this study didn't carried out along a roadside. This result was explained by that there were some heavy metal pollutionsources near low altitude and there were strong precipitation and wind in the higher altitudes. Zhang et al. [14] reported that there wasn't any linear trend due to the altitude. Except Cu and Pb, trends in heavy metal concentrations based on altitude in the current study were similar with Zhang et al. [14] (Fig. 1). These elements tended to increase up to 1300 m and than a bit decreased at 1500 m. However, in contrast with the study of Zhang et al. [14], Cu and Pb proportionally increased with increasing altitude. In the current study, there wasn't any urban site near the study areas. So, urbanization effect as a pollution source was beside the point.

Lovett and Kinsman [15] explained the increased heavy metal content in high altitudes like this. It was explained by wet deposition (i.e. precipitation input) of SO_4^{2-} NO_3^-, H^+ and Pb tends to increase with elevation, primarily because of the orographic increase in precipitation amount. Cloud water deposition of these substances can be very significant for mountain forests, but is highly variable spatially because of its strong dependence on wind speed, cloud characteristics, and vegetation canopy structure, which are all heterogeneously distributed[15].



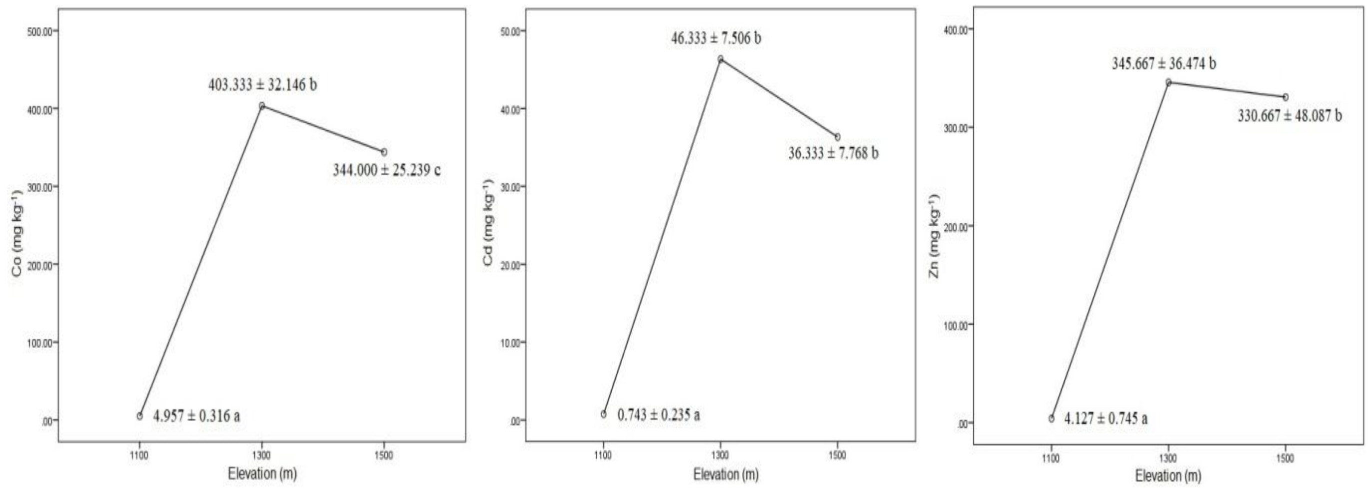
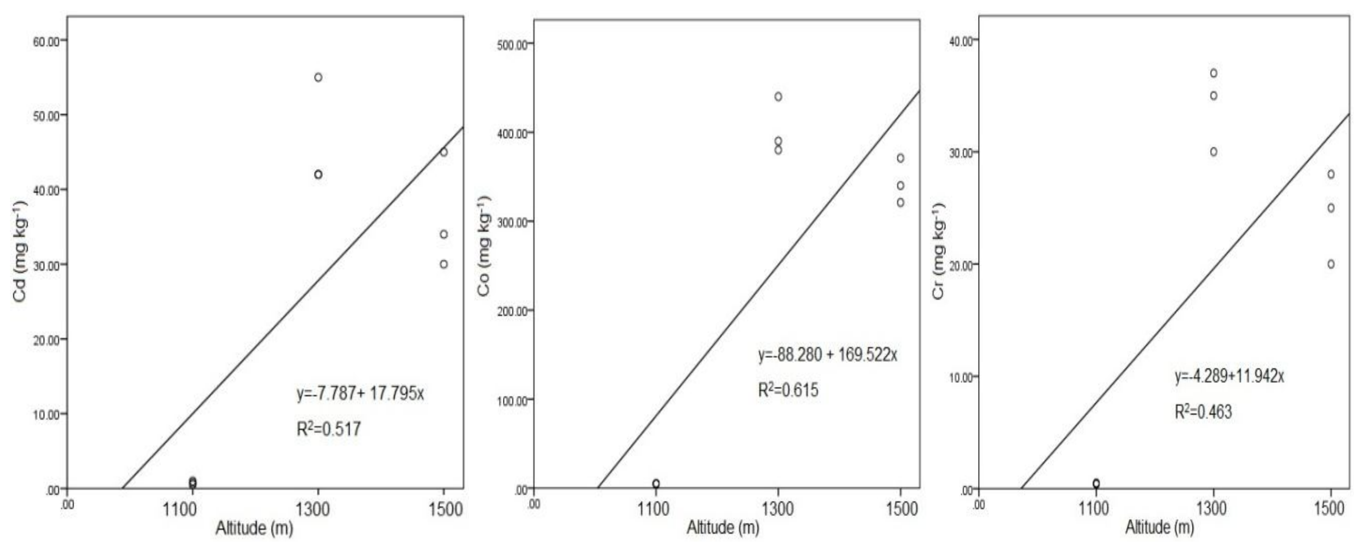


Fig. 1. Differences in Element Concentrations in Sambucus nigra Leaves Among Sampling sites.

The regression analyses showed significant negative linear relationship between heavy metal concentrations and altitude, except Mn (Fig 2.). In the study of Zechmeister[8], mosses have been collected from transects along altitudinal gradients on five mountain ranges within the northern and eastern Alps. The results show a remarkable increase of heavy metal concentrations with rising altitude. High levels of precipitation are strongly correlated with heavy metal deposition, and seem to be the main source of heavy metal fallout at higher altitudes.

Dry deposition has not been quantified sufficiently to draw empirical generalizations, but the processes involved are discussed with regard to expected elevational trends. The amount of elevational increase depends largely on the amount of cloud water deposition at the mountain site. However, in the study of Gerdol et al. [12] element concentrations were varied with altitude even in the absence of any precipitation pattern related to elevation. However, in the study of Gerdol et al. [12] element concentrations were varied with altitude even in the absence of any precipitation pattern related to elevation. In particular, concentrations of anthropogenic pollutants (especially Cd and Pb) peaked at mid altitude (1400-1800 m) where frequency of cloud cover was the highest. The percentage of oxygen in the atmosphere decreasing with the increment of altitude can influence the efficiency of gas consumption and vehicular emission mechanism [14]. Previous researches focusing on the effect of altitude on vehicle on-road emissions indicated that vehicular emissions at high altitude can be much higher than observed at sea level [16, 17, 14].



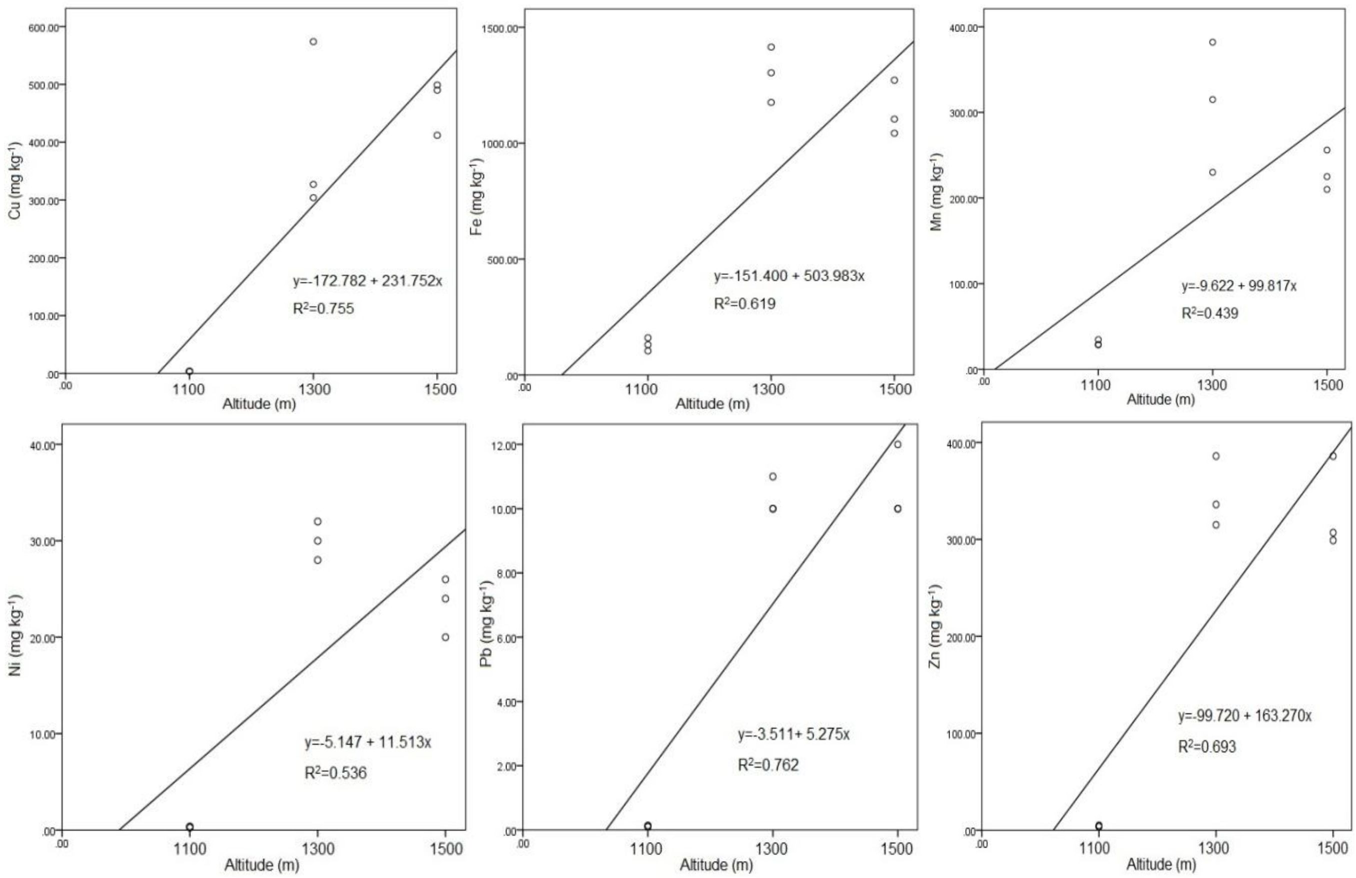


Fig. 2. Relationships Between Heavy Metals and Altitude

Significant correlations were found between some elements (Table 1). There were strong relationships between Pb and Co , Ni and Fe, and Mn and Zn in 1100 m, between Mn and Ni in 1500 m, and between Fe and Cd, and Zn and Cu in 1800 m.

Table I: Correlation Between Elements in Sampling sites

1100 m	Cd	Cr	Cu	Co	Ni	Zn	Fe	Mn
Pb	-.252	-.961	.988	1.000^{**}	.784	-.601	.739	-.638
Cd	1	.511	-.101	-.265	.404	.925	.465	.906
Cr	.511	1	-.907	-.964	-.581	.799	-.524	.827
Cu	-.101	-.907	1	.986	.869	-.472	.834	-.513
Co	-.265	-.964	.986	1	.775	-.612	.730	-.648
Ni	.404	-.581	.869	.775	1	.025	$.998^{*}$	-.022
Zn	.925	.799	-.472	-.612	.025	1	.094	$.999^{*}$
Fe	.465	-.524	.834	.730	$.998^{*}$	.094	1	.046
Mn	.906	.827	-.513	-.648	-.022	$.999^{*}$	.046	1
1500 m								
Pb	-.500	.240	-.565	-.359	.866	-.728	.845	-.898
Cd	1	.721	-.432	-.629	.000	.958	-.886	.068
Cr	.721	1	-.937	-.992	.693	.490	-.317	-.643
Cu	-.432	-.937	1	.973	-.902	-.154	-.036	.870
Co	-.629	-.992	.973	1	-.778	-.378	.196	.733
Ni	.000	.693	-.902	-.778	1	-.288	.464	$-.998^{*}$
Zn	.958	.490	-.154	-.378	-.288	1	-.982	.353

Fe	-.886	-.317	-.036	.196	.464	-.982	1	-.523
Mn	.068	-.643	.870	.733	-.998*	.353	-.523	1
1800 m								
Pb	.966	-.929	.579	-.789	.756	-.570	.966	.948
Cd	1	-.993	.350	-.921	.562	-.340	1.000**	.833
Cr	-.993	1	-.235	.961	-.459	.225	-.993	-.761
Cu	.350	-.235	1	.043	.972	-1.000**	.350	.809
Co	-.921	.961	.043	1	-.195	-.054	-.921	-.551
Ni	.562	-.459	.972	-.195	1	-.969	.562	.926
Zn	-.340	.225	-1.000**	-.054	-.969	1	-.340	-.803
Fe	1.000**	-.993	.350	-.921	.562	-.340	1	.833
Mn	.833	-.761	.809	-.551	.926	-.803	.833	1

Correlation is significant at the 0.01 level, *correlation is significant at the 0.05 level

IV. CONCLUSIONS

This study provided information about variation in heavy metal content according to altitude. The increase in heavy metal concentrations may have resulted from all of these explained factors such as precipitation or differences in exhaust emissions. In order to clarify the reasons, detailed studies should be carried out by measuring exhaust gases and climatic parameters. This poorly examined subject is important for healthy and sustainability of species and environment. Understanding the factors that affect heavy metal accumulation provides us to estimate heavy metal concentrations and cope with pollution.

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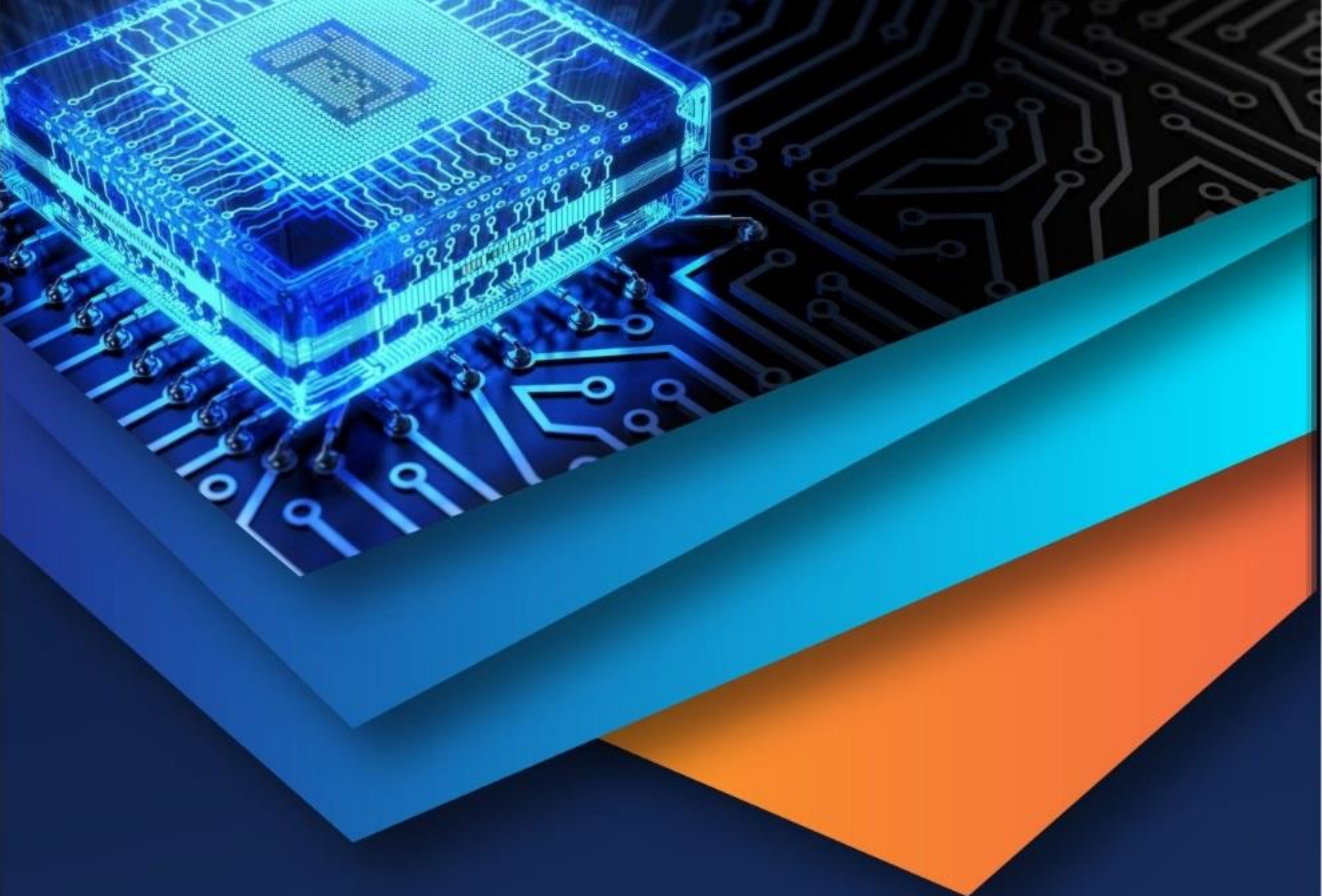

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