

Effect of Brick Kiln Emission on Soil Enzyme Activity

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ABSTRACT

Brick kiln emissions contain toxic heavy metals which pose serious threats to soil enzyme activity. Present study was conducted for the evaluation of effect of brick kiln on four soil enzyme activity (dehydrogenase, phosphatase, urease and arylsulfatase). The selected brick kiln was situated in Sulindabad village of Saharsa district. Enzyme activity was tested as a distance of 100m, 200m, 300m, 400m and 500m away from brick kiln. For control, enzyme activity was tested in soil samples collected 1km away from brick kiln. The enzyme activity was lowest at a distance of 100m away from the brick kiln and remain poor up to 500m away from brick kiln.

Keywords: Brick kiln, Dehydrogenase, Phosphatase, Urease, Arylsulfatase.

INTRODUCTION

Rapid population increase, industrial expansion, and urban growth have led to a sharp rise in construction activities, resulting in an increased demand for bricks. Consequently, brick kiln industries are expanding rapidly in many regions. Emissions from brick kilns are among the major sources of environmental pollution and have a direct impact on soil enzyme activity. Air pollution and land degradation are common in areas where brick kilns are concentrated. Bricks, being the primary construction material, are produced in large quantities in these kilns to meet the demands of rapid urbanization and infrastructure development.

Brick kiln emissions contain toxic heavy metals such as lead (Pb), chromium (Cr), and nickel (Ni), which pose serious threats to biodiversity (Dey & Dey, 2017). The accumulation of these metals in soil negatively alters soil structure and fertility. According to Adrees et al. (2016), elevated levels of Ni, Pb, and Co reduce soil organic matter and decrease the availability of essential nutrients such as calcium, magnesium, and sodium. Studies have shown that soils in the vicinity of brick kilns exhibit nearly double the electrical conductivity and a marked decline in pH levels. Similarly, Saha et al. (2021) reported that soils surrounding brick kilns are characterized by very low pH and reduced organic matter content.

Brick kilns also release large quantities of gaseous and particulate pollutants. Skinder et al. (2014) estimated that for every 1,000 bricks produced, emissions range from 6.35–12.3 kg of carbon monoxide, 0.52–5.9 kg of sulfur dioxide, and 0.64–1.4 kg of particulate matter. Brick kilns are recognized as a significant source of black carbon, contributing substantially to air pollution. Thygerson and Thygerson (2016) reported that brick kilns account for approximately 31% of total suspended particulate matter in ambient air. Furthermore, Hossain et al. (2019) highlighted that acidic deposition resulting from sulfur and nitrogen oxides emitted by brick kilns adversely affects agricultural productivity.

Heavy metal accumulation in soil leads to a decline in soil enzyme activity, which is further aggravated by acidic conditions and increased electrical conductivity. Soils adjacent to brick kilns typically contain high concentrations of heavy metals, exhibit low pH, and show elevated electrical conductivity, all of which negatively influence enzymatic processes in soil.

Soil enzymes constitute the biologically active component of soil and are closely linked to its physicochemical and biological properties (Shukla & Verma, 2011). Enzyme activity serves as a sensitive biological indicator for assessing soil contamination, with higher activity reflecting better soil quality (Fazekasova & Fazekas, 2020). Enzymes such as dehydrogenase, urease, phosphatase, and arylsulfatase play vital roles in the cycling of carbon,

nitrogen, phosphorus, and sulfur. The introduction of heavy metals, black carbon, and other pollutants into the soil environment significantly suppresses the activity of these enzymes.

MATERIAL AND METHODS

For present study, brick kiln established in Sulindabad village of Saharsa district was selected. Soil samples were collected from 100m, 200m, 300m, 400m and 500m away from brick kiln. Soil samples were collected from 10 spots (0 to 10cm deep) covering all sides of brick kiln. All samples were mixed together to get a composition. For Control, soil samples were collected from 1km away from brick kiln. Soil samples were collected from 5 different spots (0 to 10cm deep). All soil samples were brought to the laboratory in polythene bags. Physicochemical parameters of soil near brick kiln and control were studied for moisture content, pH, E.C., organic carbon, phosphorus, nitrogen, potash and heavy metals (Pb, Cr, Cd). Moisture content of soil sample was measured by heating 5gm soil in a crucible till constant weight occurred. Moisture was estimated by deducting final weight of crucible from its initial weight and percentage moisture was calculated. pH and E.C. were measure by the methods described by Jackson (1973). Organic carbon was measured by the method described by Walkley and Black (1934). Nitrogen was estimated by Kjeldahl method. Phosphorus was estimated by Calorimetry method. Potash was estimated by flame photometer and heavy metals were estimated using atomic absorption spectrophotometer. Soil samples were air dried and sieved through 1mm filter.

Sieved soil was used for the determination of soil enzyme activity.

Dehydrogenase activity:

For dehydrogenase activity, method proposed by Casida et. al.-(1964) was applied. 10gm soil sample was mixed with 2.5ml phosphate buffer and 0.2 calcium carbonate. 1ml 3% V/W TTC (triphenyl tetrazolium chloride solution). It was then incubated at 37⁰C for 6 hours. Triphenyl formazan (TPF) was produced. TPF was extracted with 10ml methanol and its optical density was recorded as 485nm. A blank was prepared from phosphate buffer. Standard solution of TPF was prepared and its OD was also recorded at 485nm on Spectrophotometer. The value of enzyme activity was calculated by the formula:

$$\text{Enzyme Activity} = \frac{OD(\text{TPF extract}) - OD(\text{blank})}{OD(\text{standard}) - OD(\text{blank})}$$

Enzyme activity was calculated for per kg soil sample.

Urease activity:

For the measurement of Urease activity, method of Tabatabai and Bremner-(1972) was applied. In this method, soil sample was added with buffered urea solution and incubated at 37⁰C temperature for 2 hours. The content was filtered and distilled with magnesium oxide. The product was collected into boric acid indicator solution and titrated with dilute sulphuric acid.

Phosphatase activity:

For the measurement of Phosphatase activity, method of Eivazi & Tabatabai-(1977) was applied. Buffered p-nitrophenyl phosphate solution was added in the soil sample and incubated at 37⁰C for 1 hour. The released phosphomonoesterase was extracted and 1M NaOH was added. The optical density was measured at 400nm.

Arylsulfatase activity:

For the measurement of Arylsulfatase activity, Tabatabai & Bremner-(1970) method was applied. Buffered potassium p-nitrophenyl sulphate was added in the soil sample and incubated at 37⁰C for 1 hour. The released p-nitrophenol was extracted and 1M NaOH was added. The optical density was measured at 400nm.

RESULT

Physicochemical parameters near brick kiln and control site were estimated. All physicochemical parameters including moisture, pH, E.C., O.C., Nitrogen, potash and phosphorus were very low near brick kiln in comparison to the control. The lowest value of these parameters were observed within 100m distance from brick kiln. The value of moisture, pH and E.C. within 100m of brick kiln was measured as 4.3%, 5.8 and 0.16ms/cm respectively. Value of all these parameters gradually increased with increasing distance from brick kiln. Organic carbon, nitrogen, potash and phosphorus were also very low near brick kiln in comparison to control. Details of physicochemical parameters are mentioned in Table 01.

Table 01: Physicochemical parameters near brick kiln and control.

Site		Moisture (%)	pH	E.C.	O.C. (%)	(kg/ha)		
						N	K	P
Brick kiln	100m	4.3	5.8	0.16	0.67	98.4	86.4	82.7
	200m	6.5	6.1	0.18	0.84	102.3	98.5	86.8
	300m	9.7	6.4	0.19	0.86	140.6	132.7	95.6
	400m	10.8	6.4	0.19	0.94	180.5	140.5	103.5
	500m	12.5	6.7	0.20	0.98	185.6	165.3	103.7
Control	S1	17.3	7.3	0.34	3.20	212.5	235.5	140.5
	S2	22.5	7.2	0.31	3.60	208.3	228.3	132.8
	S3	18.5	7.6	0.43	5.50	282.5	262.4	180.6
	S4	27.3	7.2	0.38	4.30	210.6	242.6	128.3
	S5	25.5	7.4	0.41	4.80	240.7	253.5	135.7

Estimation of lead, cadmium and chromium (heavy metals) was performed in the soil samples of brick kiln and control. All these three heavy metals were in higher quantity with 100m range of brick kiln and gradually their quantity decreased. In control soil, all these heavy metals were absent. Details of heavy metal estimation in present in Table 02.

Table 02: Estimation of heavy metals

Site		Pb	Cr	Cd
Brick kiln	100m	22.5	25.5	0.63
	200m	20.3	23.3	0.59
	300m	18.7	22.5	0.53
	400m	18.9	21.8	0.48
	500m	16.3	19.7	0.43
Control	S1	0	0	0
	S2	0	0	0
	S3	0	0	0
	S4	0	0	0
	S5	0	0	0

All values are in mg/kg In the present study, enzyme activity of four enzymes: Dehydrogenase, phosphatase, urease and aryl sulfatase was measured in soil samples collected from a distance of 100m, 200m, 300m, 400m and 500m away from brick kiln and compared with soil enzyme activity in soil samples collected 1km away from brick kiln. It was observed that enzyme activity was very poor near brick kiln. Lowest enzyme activity was observed at 100m away from brick kiln. Dehydrogenase activity at 100m, 200m, 300m, 400m and 500m were

recorded as 250.2, 258.5, 284.3, 350.6 and 394.2 (mg formazan·kg soil⁻¹ 24⁻¹) respectively. In control, enzyme dehydrogenase activity was recorded as 643.7 mg formazan·kg soil⁻¹ 24⁻¹.

Phosphatase activity in soil samples collected from 100m, 200m, 300m, 400m and 500m away from brick kiln was recorded as 272.4, 298.6, 321.4, 364.7 and 421.5 (mg p-nitrophenol kg soil⁻¹ h⁻¹) respectively. Phosphatase activity in control was measured 732.8 mg p-nitrophenol kg soil⁻¹ h⁻¹.

Urease activity in soil samples of 100m, 200m, 300m, 400m and 500m away from brick kiln was recorded as 21.7, 26.4, 31.5, 37.6 and 42.5 (mg NH₄-N·kgsoil·2h⁻¹) respectively. In control, urease activity was recorded as 68.6 mg NH₄-N·kgsoil·2h⁻¹.

Arylsulfatase activity in soil samples of 100m, 200m, 300m, 400m and 500m away from brick kiln was recorded as 74.5, 83.6, 95.4, 112.3 and 121.5 (mg p-nitrophenol kg soil⁻¹ h⁻¹) respectively. In control, enzyme activity was recorded as 148.6 mg p-nitrophenol kg soil⁻¹ h⁻¹.

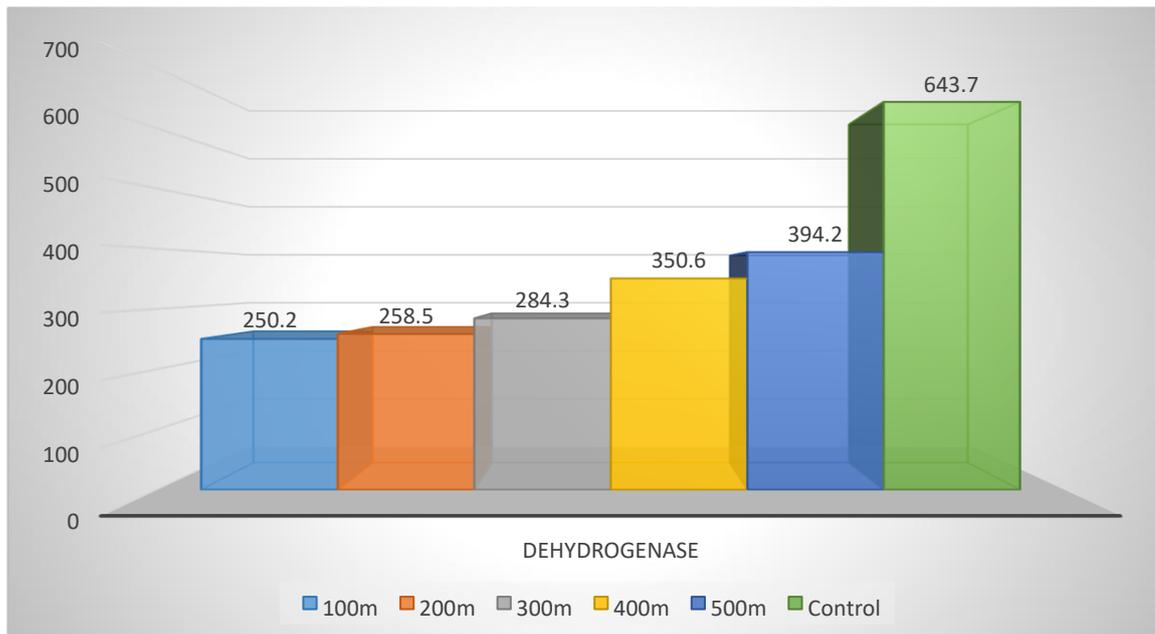


Fig. 01: Dehydrogenase activity near brick kiln and control

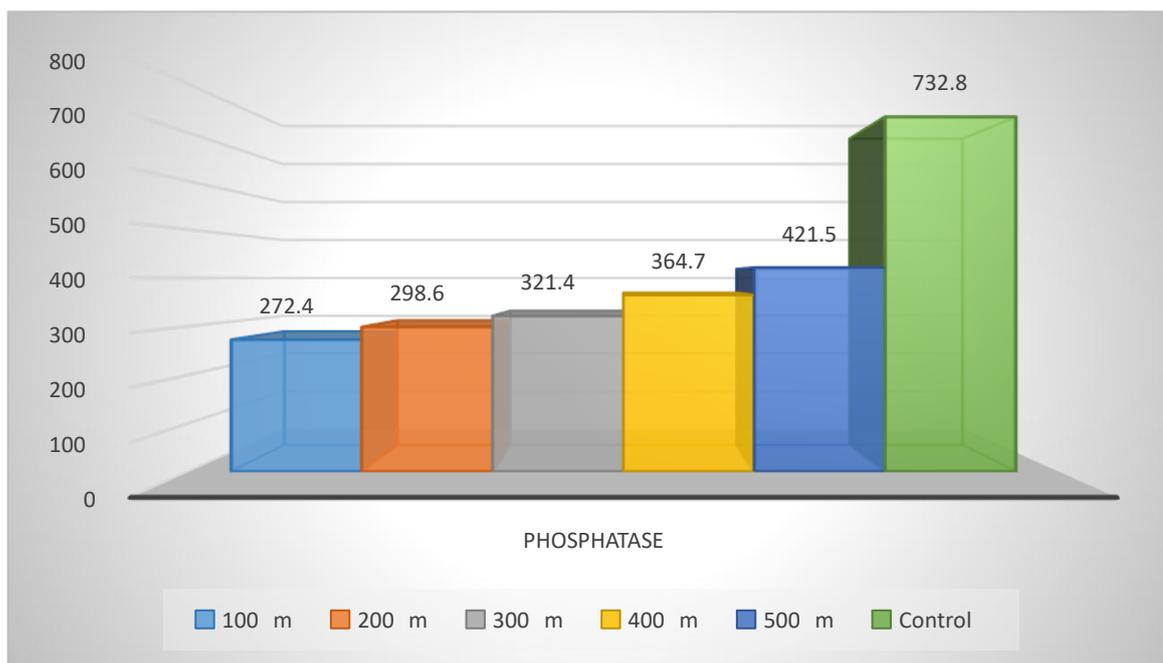


Fig. 02: Phosphatase activity near brick kiln and control

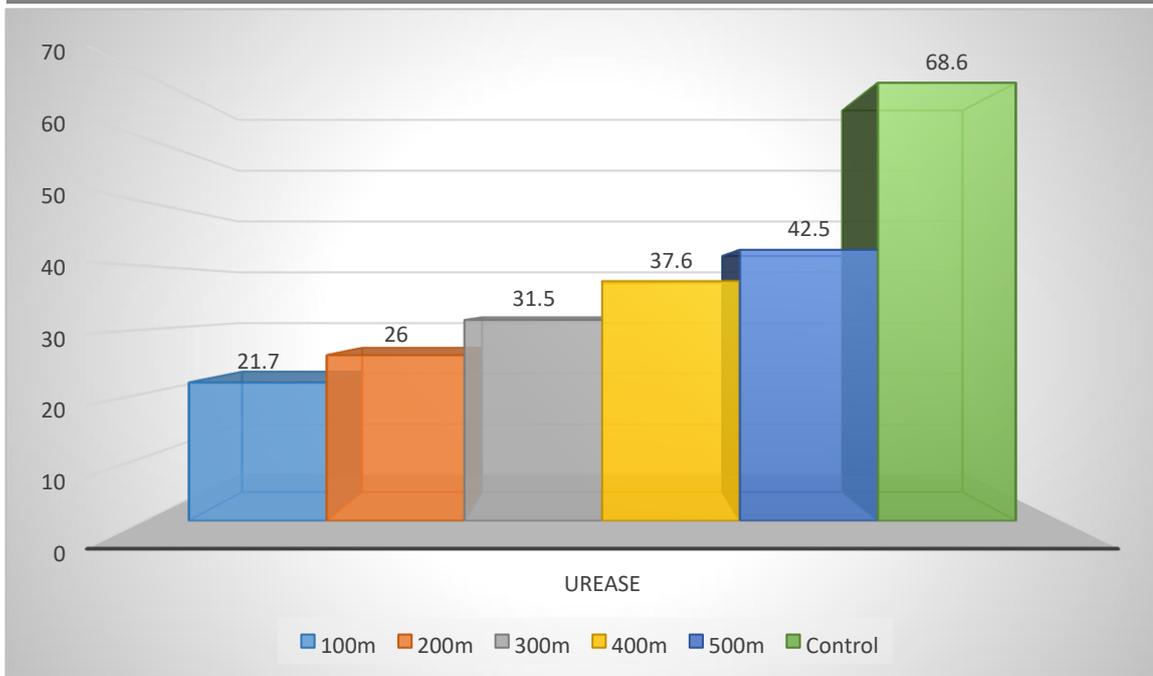


Fig. 03: Urease activity near brick kiln and control

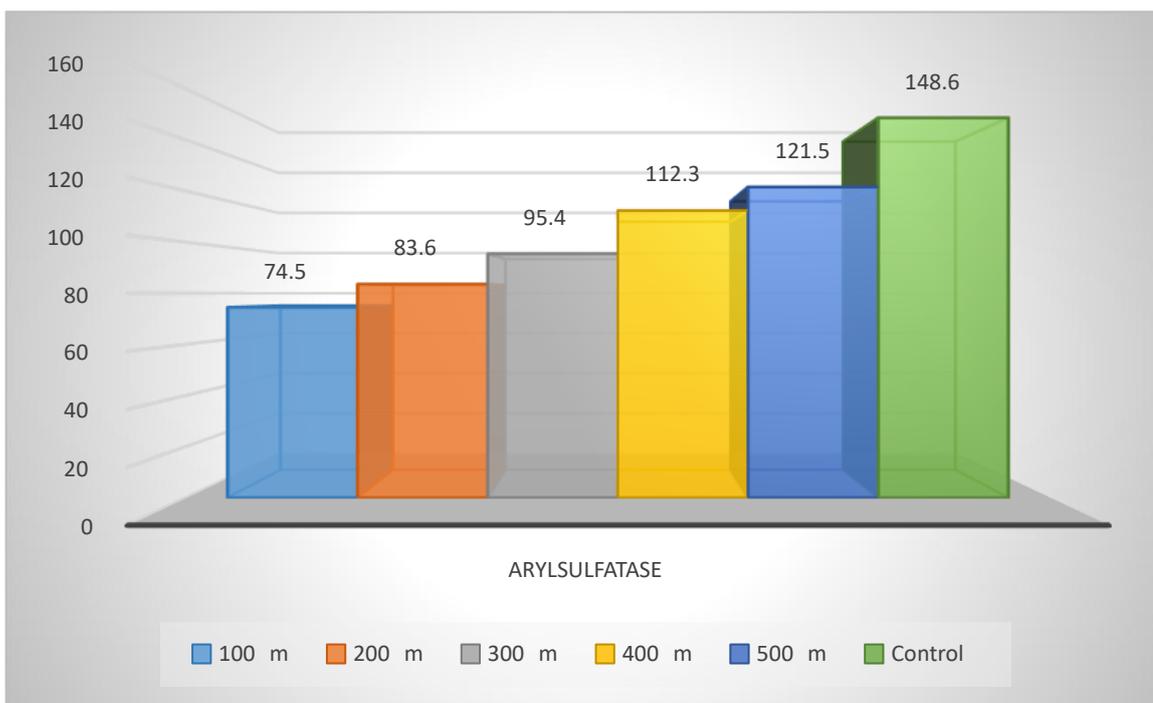


Fig. 04: Arylsulfatase activity near brick kiln and control

CONCLUSION

Physicochemical parameters near brick kiln and control site were estimated. All physicochemical parameters including moisture, pH, E.C., O.C., Nitrogen, potash and phosphorus were very low near brick kiln in comparison to the control. The lowest value of these parameters were observed within 100m distance from brick kiln. The value of moisture, pH and E.C. within 100m of brick kiln was measured as 4.3%, 5.8 and 0.16ms/cm respectively. Value of all these parameters gradually increased with increasing distance from brick kiln. Organic carbon, nitrogen, potash and phosphorus were also very low near brick kiln in comparison to control.

Estimation of lead, cadmium and chromium (heavy metals) was performed in the soil samples of brick kiln and control. All these three heavy metals were in higher quantity with 100m range of brick kiln and gradually their quantity decreased. In control soil, all these heavy metals were absent.

Brick kiln emission contain several pollutants including heavy metals which adversely affects soil enzyme activity. The soil enzyme activity near a brick kiln situated at Sulindabad village of Saharsa district was measured. It was observed that the soil enzyme activity of all studied enzymes (Dehydrogenase, Phosphatase, Urease and Arylsulfatase) was lowest at distance of 100m away from brick kiln. Gradually, enzyme activity increased but remain very poor up to a distance of 500m away from brick kiln.

Dehydrogenase activity at 100m, 200m, 300m, 400m and 500m were recorded as 250.2, 258.5, 284.3, 350.6 and 394.2 (mg formazan·kg soil⁻¹ 24⁻¹) respectively. In control, enzyme dehydrogenase activity was recorded as 643.7 mg formazan·kg soil⁻¹ 24⁻¹.

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