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Control of the Oxides of Nitrogen in an Ambient Air by Performing Agnihotra Yajnya

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ABSTRACT
Agnihotra is a traditional domestic solemnity, performed to maintain harmony between living beings and nature, without harming and by giving respect. Agnihotra, the simplest forms of Yajnya performed at sunset/ sunrise in which cow dung is burned in the copper pot by using cow ghee and brown rice as oblations along with chanting of mantras of sun and fire. To study the effects of fumes generated during Agnihotra on the oxides of nitrogen (NOx), the ambient air samples were collected by using Handy Air Sampler and NOx was estimated by modified Jacobs-Hochheisermethod. The ambient air samples werecollected for consecutive 10 days for the estimation of NOx, before performing Agnihotra, during performance of Agnihotra and after the performance of Agnihotra, up to 40 feet apart from the source of Agnihotra. Our results revealed that the NOx levels in an ambient air can be significantly decreased up to 1% to 20% that of initial levels due the fumes generated after performance of the Agnihotra. Hence we can control the NOx levels in an ambient air by performing the Agnihotra.
***Key Words**: Agnihotra, Fumes, Oxides of Nitrogen, Handy Air Sampler, Jacobs-Hochheiser method*

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INTRODUCTION

The air we breathe is a vital ingredient for our wellbeing and a healthy life. Unfortunately polluted air is common throughout the world [1] especially in developed countries from 1960 [2]. Polluted air includes single, or more, pollutant, hazardous substance, or contaminant that generates a risk to the health [3]. The most important air pollutants found that we breathe include, polyhydroxy alkanoates (PAHs), particulate matter (PM), ground-level ozone, lead, sulphur dioxide or oxides of sulphur (SOx), nitrogen dioxide or oxides of nitrogen (NOx), heavy metals, benzene and carbon monoxide [1].
The increasing industrialization, urban overpopulation, and rising demands for energy and recourses are the worsening NOx levels [4]. The other causes of increase in NOx levels are less efficient production technology, pitiable environmental regulations, maintenance of vehicles, and congested roads, etc. Also, the NOx is a cause of death by man-made and natural sources; chief man-made sources of surrounding NOx include Automobiles, Construction equipments, industrial sources like power plants, boilers, cement kilns, turbines, etc. The natural sources include volcanoes, forest and agricultural fires, microbial processes, etc. [1].
The consequences of NOx are respiratory diseases [5], asthma [6], disruption of endocrine system [7], cancer [8], reduced energy levels, headaches, dizziness, irritation of eyes, nose, mouth and throat [9], neurobehavioral disorders [10], reduced lung functioning [11], infant mortality [12], cardiovascular problems [13], premature death with disruption of reproductive and immune systems [1].
The higher NOx levels can also ultimately influence the human health by acid rain, by entering into the food chain and food web, by polluting sources of drinking water, and through global warming and thereby linked climate change and rise in sea water level [4].The acid rain obliterates the fish life in streams and lakes, destroy the complete trees or the leaves of plants, make the soil unsuitable for nutrition and habitation by penetrating through soil, unprovoked ultraviolet radiation causes skin related diseases in wildlife, plant parts and thereof ecosystem, and the lower atmospheric ozone damages animals lung cells/tissues and prevents plant respiration with photosynthesis process which will inhibit plant growth[14].
Conventionally, there are three routes of addressing the problems of pollution: viz., prevention, control and remediation. These form a pecking order, in which the first priority or option is prevention, followed by the control actions, with remediation as a poor third. Though the hierarchy or pecking order of the three thoughts is in terms of priority or preference, this is not for all time so in practice: there may be

dictatorial pressures to choose one path rather than another; one stratagem may be less costly than another, or remediation may be the most imperative - for example, in the event of a major spill or the hazardous dissemination of contaminants from a contaminated location [15].
Agnihotra is a traditional domestic solemnity, performed to maintain harmony between living beings and nature, without harming and by giving respect. Agnihotra, the simplest forms of Yajnya performed at sunset/ sunrise in which cow dung is burned in the copper pot by using cow ghee and brown rice as oblations along with chanting of mantras of sun and fire [16]. Agnihotra is the process of removing toxic state of affairs from the atmosphere through the various energies coming through fire, which has positive effects on creatures [17,18].The desired spiritual, physiochemical and biological behoofs of Agnihotra can be achieved through combination of heat energy engendered during burning of Agnihotra raw material and sound energy generated by chanting of mantras while performing Agnihotra. The evolution of energies may be due to the raw materials used while performing Agnihotra, which may be accountable for chemical changes in an ambient environment[18].
The fumes produced by the Agnihotra has ascribed with remedial properties. The fumes generated due to the Agnihotra control the NOx, SOx as well as microbial load [19] in the ambient environment[20,21]. By considering above mentioned articles, here in this article we have recorded the studies on the control of NOx in an ambient air by using fumes generated after performing Agnihotrayajnya.

MATERIAL AND METHODS

The 100 g of dried dung of *Gir* cow (*Bos (primigenius) indicus*) [22] was lit in an inverted copper pyramid with specific dimensions (14.5 cm at top, 5.25 cm at bottom and 6.25 cm in height). The offerings of about 0.5 g of brown rice with 2 mL of pure cow ghee were given at the time of sunrise/sunset by chanting of sunrise mantra: - "Suryayaswáahá| Suryáyaidamna mama||Prajápatayeswáahá| Prajápatayeidamna mama||" and sunset mantra: "Agnayeswaáhá| Agnayeidamna mama|| Prajápatayeswaáhá| Prajápatayeidamna mama||"[18,23].
To study the effects of Agnihotra fumes on the levels of the oxides of Nitrogen (NOx), 1 hour air sampling was done before Agnihotra, during Agnihotra and after Agnihotra by using Handy Air Sampler(Spectralab, HDS-8) in absorbing media. Also air sampling was done at 0 feet, 10 feet, 20 feet, 30 feet and 40 feet apart from the source of the Agnihotrayajnya.
The NO_x was then estimated by modified Jacobs - Hochheiser method [24], in short, a known volume of air containing NOx was scrubbed, before and after burning of cow's dung, in 10 mL of an alkaline solution of arsenite by using air handy sampler. After scrubbing sample with produced nitrite ions was allowed to react with 1 mL of N-(1-naphthyl) ethylenediamine (NEDA) and 1 mL of sulfanilamide in weak acid i.e., ortho-phosphoric acid to form the azo dye having a color, which was then measured on spectrophotometer at 540 nm. The sodium nitrite ($NaNO_2$) standards were used for statistical standardization of method, which was based upon the empirical observation that 0.74 mole of $NaNO_2$ produces same color as 1 mole of NO_2. SO_2 was removed by adding H_2O_2. Then NO_x was calculated using following formula:

$$\mu\text{g NOx/m}^3 = \frac{\mu\text{g of NO}_2\text{/mL (from calibration curve)} \times \text{Volume of reagent}}{0.85 \times \text{Volume of air sampled in m}^3}$$

$$\text{NOx in ppm} = \mu\text{g of NOx/m}^3 \times 5.32 \times 10^{-4}$$

Statistical analysis was done with IBM SPSS software and the variation of data is expressed in terms of the standard error of mean (Mean ± SE) along with the number of observations (n).

RESULTS AND DISCUSSION

It is evident from Table 1, Photoplate 1 and Figure 1 that the NOx concentration in an ambient environment increased from 0.1499 ± 0.0335 ppm to 0.2099 ± 0.0469 ppm (i.e. about 40%) during performance of Agnihotrayajnya, but reduced to 0.1346 ± 0.0301 ppm (i.e. about 11%) after performance of Agnihotrayajnya.
The Agnihotra was performed regularly for 10 days in morning and evening time and concentrations of NOx were recorded (Table 2 and Figure 2) from the source of Agnihotra to 40 ft apart from the source of Agnihotrayajnya. Due to performance of Agnihotrayajnya, the NOx in an ambient atmosphere got increased up to 27.00%, 25.92%, 27.48%, 16.55% and 18.17% at the source of Agnihotra and 10 ft, 20 ft, 30 ft and 40 ft apart from the source of Agnihotrayajnya, respectively up to the day 3. While, regular performance of Agnihotra showed about 1% to 20% reductions in the concentrations of NOx in an ambient environment at the day 10 up to 40 ft apart from the source of Agnihotrayajnya. The present

work for reduction in the concentration of NOx in an ambient environment was found to be a pioneer, as there was no any research work done on the similar lines.

The various other forms of yajnyas viz. Somyagyajnya [25,26], Shrisuktayajnya [27] also showed decrease of NOx levels in the ambient air. The NOx levels get nurtured below threshold levels, within Agnihotra atmosphere, due to the fumes of Agnihotra. During the process of fumigation with offerings of various 324 plants and plant derived materials, the major air pollutants in an ambient environment get reduced. The Agnihotra performed with these 324 offerings, generated fumes may reduce the levels of NOx in the affectedly polluted area. Although the concentration of air contaminants not completely reduced, its concentrations are less than threshold standards and they are not to the extent of polluted circumstances [28]. As the smell or odor of Agnihotrayajnyaas fumes are acceptable, it can be used to purify the ambient environment.

The raw materials used during Agnihotra for burning are oxidized to form oxides of carbons and other volatile organic compounds, which may further induce the photochemical reactions like decomposition, reduction or oxidation due to solar and ultraviolet rays. The electrons and protons generated by infrared rays and organic matter, moisture respectively during the burning process may deoxidize the NOx into its nontoxic or less toxic molecular compounds [29]. Hence, generated electrons or protons during Agnihotra may purify or heal ambient environment by preventing air pollutants [30,31].

Table 1: The concentration of NOx before, during and after Performance of Agnihotra

The concentration of NOx		
Before Agnihotra in ppm	During Agnihotra in ppm	After Agnihotra in ppm
0.1499 ± 0.0335	0.2099 ± 0.0469	0.1346 ± 0.0301

*The results are expressed as Mean ± SE, n = 3

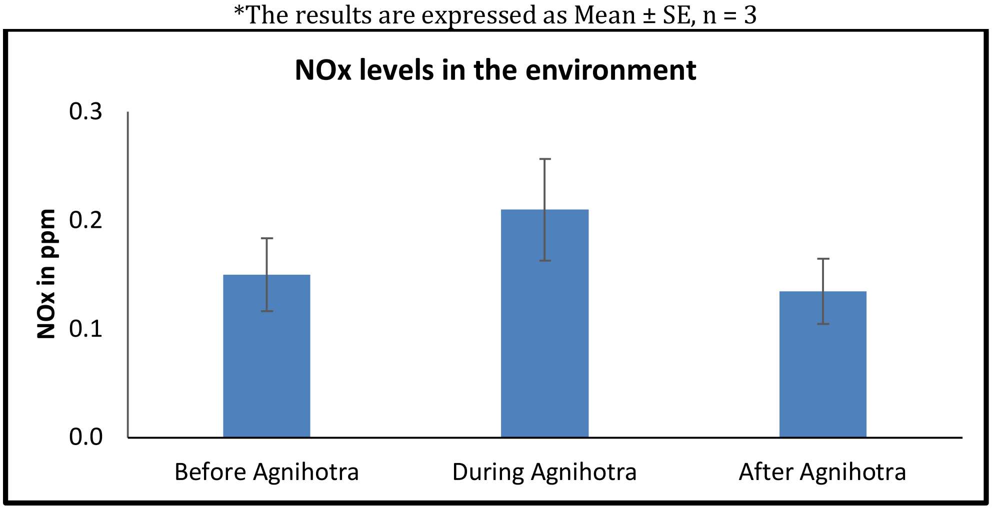

Figure 1: Concentration of NOx before, during and after performance of Agnihotra

Table 2: The Concentration of NOx in ppm in an Ambient Air

Day	The concentration of NOx in ppm in the environment									
	At source		10 ft apart		20 ft apart		30 ft apart		40 ft apart	
	M	E	M	E	M	E	M	E	M	E
-1	0.0157 ± 0.0030	0.0157 ± 0.0030	0.0156 ± 0.0030	0.0157 ± 0.0030	0.0157 ± 0.0030	0.0158 ± 0.0030	0.0157 ± 0.0030	0.0157 ± 0.0030	0.0156 ± 0.0030	0.0157 ± 0.0030
0	0.0157 ± 0.0030	0.0158 ± 0.0030	0.0156 ± 0.0030	0.0159 ± 0.0030	0.0157 ± 0.0030	0.0157 ± 0.0030	0.0157 ± 0.0030	0.0158 ± 0.0030	0.0157 ± 0.0030	0.0158 ± 0.0030
	(0.00%)		(0.00%)		(0.00%)		(0.00%)		(0.00%)	
1	0.0188 ± 0.0036	0.0193 ± 0.0037	0.0193 ± 0.0037	0.0195 ± 0.0037	0.0195 ± 0.0037	0.0197 ± 0.0038	0.0182 ± 0.0035	0.0184 ± 0.0035	0.0184 ± 0.0035	0.0187 ± 0.0036
	(-21.50%)		(-23.73%)		(-25.07%)		(-16.55%)		(-18.17%)	
2	0.0204 ± 0.0039	0.0195 ± 0.0037	0.0199 ± 0.0038	0.0197 ± 0.0038	0.0201 ± 0.0038	0.0199 ± 0.0038	0.0182 ± 0.0035	0.0182 ± 0.0035	0.0182 ± 0.0035	0.0185 ± 0.0035
	(-27.00%)		(-25.92%)		(-27.48%)		(-15.95%)		(-17.00%)	
3	0.0204 ± 0.0039	0.0188 ± 0.0036	0.0199 ± 0.0038	0.0193 ± 0.0037	0.0185 ± 0.0035	0.018 ± 0.0034	0.0182 ± 0.0035	0.0182 ± 0.0035	0.0182 ± 0.0035	0.0184 ± 0.0035
	(-25.00%)		(-24.82%)		(-16.28%)		(-15.84%)		(-16.72%)	

4	0.0173 ± 0.0033	0.0157 ± 0.003	0.019 ± 0.0036	0.0172 ± 0.0033	0.0178 ± 0.0034	0.0176 ± 0.0034	0.018 ± 0.0034	0.0178 ± 0.0034	0.0182 ± 0.0035	0.018 ± 0.0034
	(-5.00%)		(-15.29%)		(-12.66%)		(-13.90%)		-15.26%)	
5	0.0157 ± 0.003	0.0155 ± 0.003	0.0172 ± 0.0033	0.0171 ± 0.0033	0.0176 ± 0.0034	0.0176 ± 0.0034	0.0178 ± 0.0034	0.0178 ± 0.0034	0.018 ± 0.0034	0.018 ± 0.0034
	(0.50%)		(-9.25%)		(-12.00%)		(-13.17%)		(-14.46%)	
6	0.0149 ± 0.0029	0.0154 ± 0.0029	0.0164 ± 0.0031	0.0169 ± 0.0032	0.018 ± 0.0034	0.0176 ± 0.0034	0.0177 ± 0.0034	0.0177 ± 0.0034	0.0179 ± 0.0034	0.0179 ± 0.0034
	(3.50%)		(-5.96%)		(-13.17%)		(-12.77%)		(-14.03%)	
7	0.0149 ± 0.0029	0.0141 ± 0.0027	0.0164 ± 0.0031	0.0155 ± 0.003	0.018 ± 0.0034	0.0174 ± 0.0033	0.0177 ± 0.0034	0.0176 ± 0.0034	0.0179 ± 0.0034	0.0178 ± 0.0034
	(7.50%)		(-1.56%)		(-12.69%)		(-12.24%)		(-13.44%)	
8	0.0141 ± 0.0027	0.014 ± 0.0027	0.0155 ± 0.003	0.0153 ± 0.0029	0.0174 ± 0.0033	0.0174 ± 0.0033	0.0176 ± 0.0034	0.0185 ± 0.0035	0.0178 ± 0.0034	0.0177 ± 0.0034
	(10.50%)		(1.73%)		(-10.79%)		(-14.86%)		(-13.01%)	
9	0.014 ± 0.0027	0.0126 ± 0.0024	0.0153 ± 0.0029	0.0138 ± 0.0026	0.0169 ± 0.0032	0.0151 ± 0.0029	0.0157 ± 0.003	0.0157 ± 0.003	0.0157 ± 0.003	0.0157 ± 0.003
	(15.50%)		(7.22%)		(-1.87%)		(0.00%)		(0.00%)	
10	0.0126 ± 0.0024	0.0126 ± 0.0024	0.0138 ± 0.0026	0.0138 ± 0.0026	0.0151 ± 0.0029	0.0151 ± 0.0029	0.0155 ± 0.003	0.0155 ± 0.003	0.0155 ± 0.003	0.0155 ± 0.003
	(20.00%)		(12.16%)		(3.55%)		(1.00%)		(1.00%)	

*The results expressed as Mean ± SE, n = 3; M and E represents monitoring of air before sunrise and sunset timings during Agnihotra experiments; -1 is a day before starting Agnihotra experiment; 0 is the starting day of Agnihotra experiment.

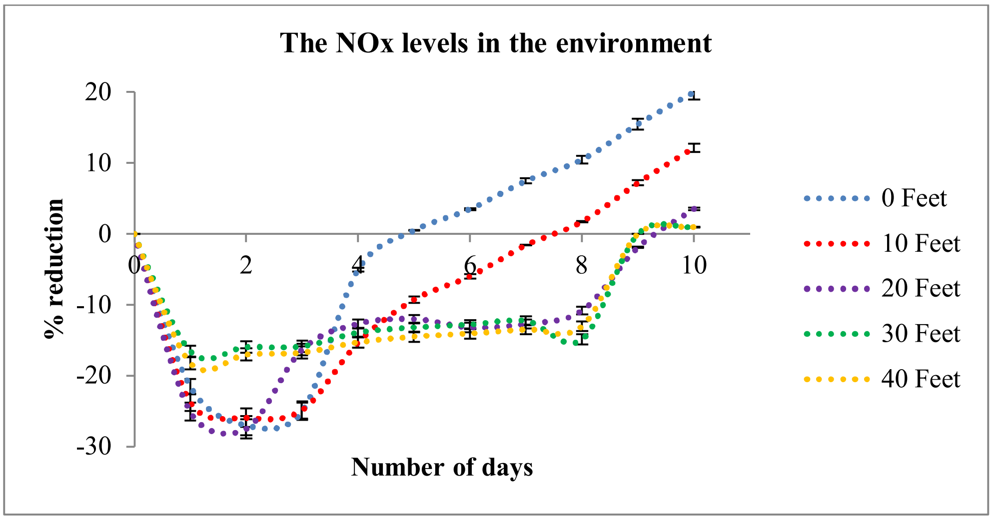

Figure 2: Reduction in the concentration of NOx after Agnihotra, monitored for 10 days and up to 40 ft apart from the source of Agnihotra

CONCLUSION

The present findings indicate that the oxides of the Nitrogen (NOx) in an ambient air can be controlled by performing the Agnihotrayajnya. The control of NOx levels in an ambient environment is due to the performance of Agnihotra and the fumes generated during Agnihotrayajnya and it is effective for few distances apart from the source of Agnihotrayajnya. The NOx levels in an ambient air can be significantly decreased up to 1% to 20% that of initial levels due the fumes generated after performance of the Agnihotrayajnya.The NOx present in the ambient air may get dispersed or may get converted into other forms due the generation of protons or electrons while performing the Agnihotrayajnya. As the fumes of Agnihotra can control the NOx levels in an ambient environment, this research may applicable in controlling highly NOx polluted areas, acid rain affected areas, vehicular polluted areas, industrially polluted areas, etc. Further research related to the composition of Agnihotra fumes and the mechanism of action for controlling NOx levels in an ambient air due to the emergence of Agnihotra fumes is needed to be studied.

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