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Purification of ambient air by performing Somyag Yajnya

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ABSTRACT

Yajnya is the ritual performed for the purification of the atmosphere through the agency of fire according to the Vedas (Vedic literature). Somyag Yajnya is one of the types of Yajnya, which is a ritual of chanting of mantras derived from the practice in Vedic times accompanied by various offerings. Fumes created by performing Somyag Yajnya, positively affect environmental elements; hence its effects on major air pollutants i.e. oxides of sulphur and nitrogen were studied. Microbial count was also considered during Yajnya. Surrounding air samples were collected from cities in Maharashtra (India) i.e. Beed, Pune and Ratnagiri by using handy air sampler and the effects of Somyag Yajnya were studied by estimating and comparing SOx and NOx levels before Yajnya, during Yajnya and after Yajnya. For microbial count active as well as passive air collection methods were used. As per our results, microbial count significantly reduces up to 95% due to Somyag fumes and SOx levels decreases almost up to 40-90% that of initial levels due to Somyag Yajnya however, the NOx levels increase at the beginning to10-20 % that of initial levels but at the end of Yajnya NOx level also found reduced as compared to initial. Hence it seems that by performing Somyag Yajnya air pollution due to SOx, NOx and microbes can be controlled and ambient air can be purified.

Keywords: Somyag Yajnya, Oxides of Sulphur (SOx), Oxides of nitrogen (NOx), Microbial Count, Ambient Air, Pollution

1. Introduction

Somyag is a sacrificial ritual of fire ceremony in which *soma* (stalks of *Ephedra*) or *somawali* juices oblations to the deities due to which five elements i.e. Earth, Fire, Air, Water and Ether in the universe get energizing, in order restore natural equilibrium and to bestow prosperity (Vaidya V. B., Kale Nanaji, 2014 and Wojciech Puchalski, 2009). The Natural cycle of six seasons is regulated and accelerated by the performance of Somyag fire ceremony (Somyag Yajnya) and plays major role in refining the human thoughts and life process in accordance with the Nature (S. Sushrutha et al., 2014). During the Somyag, *Somawali* is particularly esteemed. The stalks woven in a cloth have been conditioned in a special way by exposing them to energies of the ceremony for some days. Then they were ground in stone mortars with water to pour such a juice into wooden holders of various shapes and to use it for offerings to fire as well as to drink during the culminant phase of the ceremony, apparently exhaustive for performers (Wojciech Puchalski, 2009). Apart from soma various dried twigs of members of *Ficus* genus (woody plants) (Figure 1) e.g. *Ficus benghalensis (Vad), Ficus religiosa Linn. (Pimpal), Acacia catechu (Khair), Butea monosperma Kuntze (Palas), Aegle*

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marmelos Correa (Bel), Ficus racemose (Umbar), Prosopis cineraria (Shami). Fumes generated due to burning of these twigs during the Somyag, alter the chemical composition of ambient air (Pranay A. et al., 2016). The main goal of such a large ceremony is said to be clearing and healing of atmosphere, water and soils with use of this special fire (P. Abhang et al., 2015). To study the healing of atmosphere one need to do survey on aero-microbiology as well as aero-chemistry of an ambient air (Abhang P. and Pathade G., 2015).

Aero-microbiology and aero-chemistry both are interlinked, as microbes (bio-aerosols) are also involved in various biochemical cycles. Previous studies done of Somyag fumes suggest that fumes are having antimicrobial properties and alter the levels of oxides of sulphur and nitrogen. One need to also consider that apart from Somyag fumes; microbes also contribute to convert oxides of sulphur and nitrogen into its various forms. Though there are significantly small numbers of atmospheric microorganisms (Bio-aerosols) than there are in oceans as well as in soil, they mainly emerge from terrestrial and aquatic environments and are typically renounced by air fluster. These bio-aerosols are ecologically accentuated because they may be associated with illness in humans, animals and plants. There are many factors that affect the launching, transport and deposition of bio-aerosols during Somyag due to its fumes. Winds are the primary means of transport for fumes and which may interact with bio-aerosols by means of number of mechanisms including gravity, direct contact, or combining with particles which acts as a mediator. (C. E. Morris et al., 2011 and Pranay, A. et al., 2016).

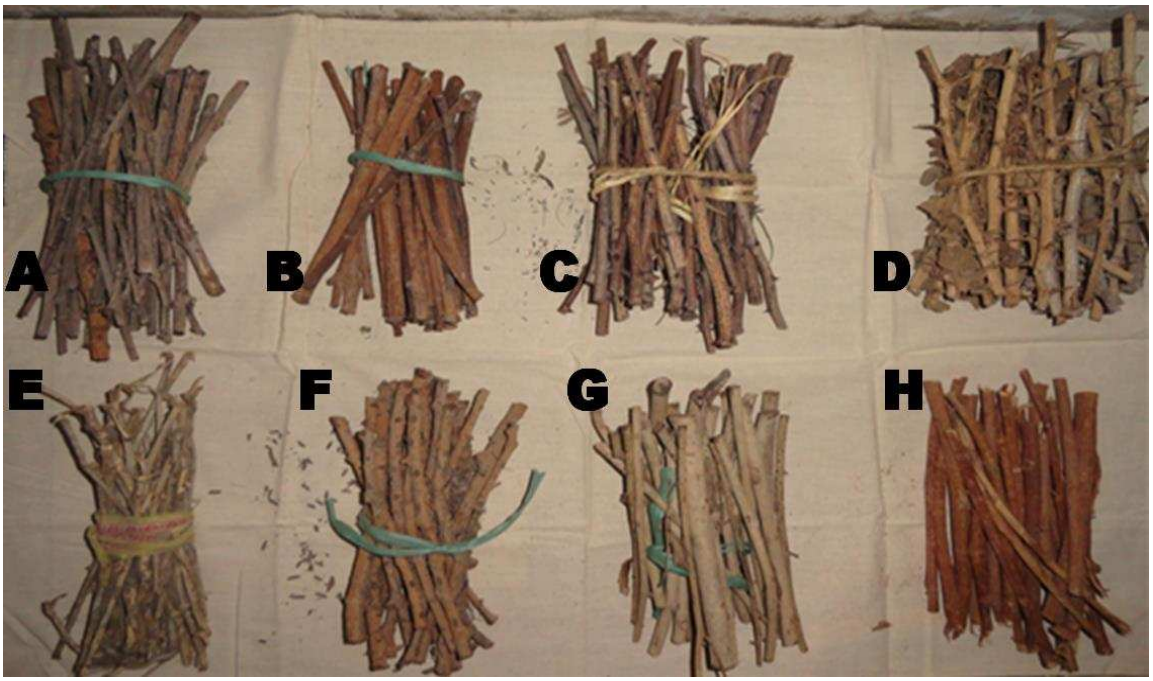


Figure 1: Plant materials (dried twigs) used in Somyag Yajnya

Common names for dried twigs of woody plants: **A** – *Palas*, **B** – *Umbar*, **C** – *Khair*, **D** – *Bel*, **E** – *Somvalli*, **F** – *Shami*, **G** – *Pimparni*, **H** – *Pimpal*

As Somyag Yajnya heals atmosphere, one need to study its effects at elemental level. During this study effect of Somyag fumes on microbial count, SOx and NOx level were estimated. For that purpose, air samples were collected from Somyag ceremony performed at various

cities in Maharashtra (India) viz. Beed, Pune and Ratnagiri. '*Poundrik Mahavrat Mahasomyag Yajnya*' was organized by Yajnya Samiti in Beed from 28/1/2013 to 8/2/2013. Air samples were collected before and after Yajnya. '*Ahin Dwadash Ratra Somyag'* Yajnya was organized by Yadnyaraj Pratishthan in Uruli (Devachi), Hadapsar, Pune from 7/2/2014 to 1/3/2014. Air samples were collected beforeYajnya, during Yajnya and after Yajnya. Somyag Yajnya performed in Patwardhan wadi, Ratnagiri from 16/1/2015 to 20/1/2015. Also in Ratnagiri air samples were collected before, during and after Yajnya.

2. Material and methods

Considerations and precautions during air sampling –

1. For the collection air samples from Beed, Pune and Ratnagiri, specific locations were marked and the samples were collected from the fixed point as in Figure 2.
2. These fixed points are selected where no any tree, house or wooden pole around it.
3. Source was selected where human activities are less
4. Sample collection timings were adjusted before sweeping, watering or other activities.
5. Sterile handling conditions were maintained during transport, storage and sampling of used mediums and apparatus.

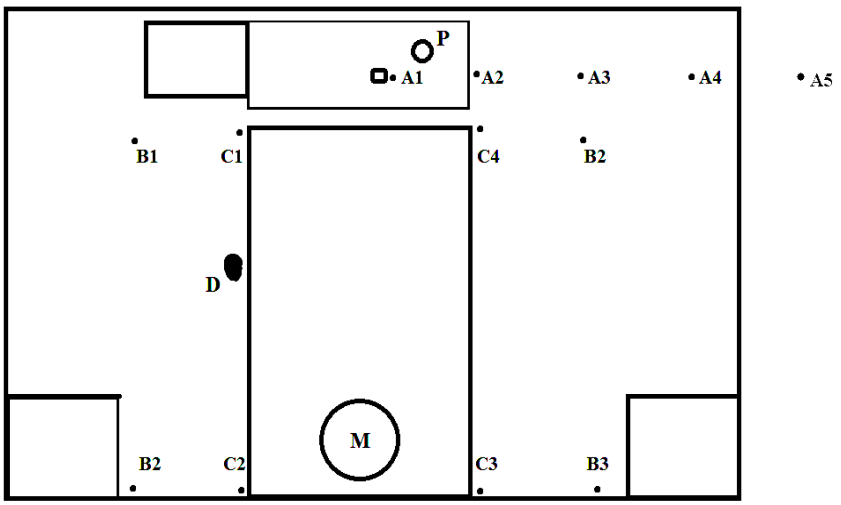


Figure 2 - Diagrammatic representation of Yajnya map and positions form which samples were collected (adopted from Abhang Pranay, 2015).
M- Place of Mahasomyag Yajnya. **P**- Pravargya aahuti.
A1, A2, A3, A4, A5 - Places at 0 ft, 10 ft, 20 ft, 30 ft and 40 ft respectively apart from Yajnya from which bacterial count was taken.
B1, B2, B3, B4- Place 10 ft apart from the corners where bacterial count was taken.
C1, C2, C3, C4 - Four corners (known as *vedi*) where bacterial count was taken.
D- Place where air samples for NO_x and SO_x were collected.

2.1. Study the effects of fumes on bacterial count in the surrounding air–

A. Bacterial count by Passive air collection –

Passive air monitoring by using settle plate method according to Pathade G. and Abhang P. (2014) was used to calculate bacterial count. 100 cm^2 of Petri-plates containing sterile

nutrient agar were opened and kept 1m apart from ground for 10 minutes to settle microbes on it. Plate was incubated for 24 hour at 37 °C. Bacterial count was calculated and recorded as CFU/m^2/min.

B. Bacterial count by Active air collection –

Active air monitoring was done by using Handy Air sampler (Spectralab, HDS-8) to calculate bacterial count. Surrounding air was impinged in 10 ml of sterile nutrient broth using specific flow rate. Bacterial count was taken by using serial dilution of media and spread plate techniques and was expressed in terms of CFU/m^3 of air.

2.2. Estimation of SOx –

SO_x was estimated by improved West and Gaeke method (1956), in short, SO_2 presentin the surrounding air stream was absorbed in a absorbing medium of sodium tetra-chloromercurate by using Air Handy Sampler (Spectralab, HDS-8), it forms a stable dichloro-sulpho-mercurate $(HgCl_2SO_3)^{2-}$complex, which then effectively behaves as a fixed SO_3^{-2} in solution. The amount of SO_2 was then estimated by the color produced when p-rosailine-hydrochloride and formaldehyde was added in the solution, which can be measured on spectrophotometer at 560 nm. Standard calibration curve of sodium meta-bi sulphate was used for SOx estimation by using following formula-

$$SOx\ in\ ppm\ (by\ volume) = \frac{\mu g\ of\ SO_2/mL\ (from\ calibration\ curve)}{Volume\ of\ air\ sampled\ /L}$$

$$\mu g/m^3\ of\ SOx\ =\ (ppm\ by\ volume\ \times\ 64\ \times\ 10^6)\ /\ 24470$$

2.3. Estimation of NOx –

NOx was estimated by modified Jacobs - Hochheiser method (1972), in short, NO_2 present in the surrounding air was collected by scrubbing a known volume of air using Air Handy Sampler (Spectralab, HDS-8), through an alkaline solution of arsenite. The nitrite ions thus formed was allowed to react with sulfanilamide and N-(1-naphthyl) ethylenediamine (NEDA) in ortho-phosphoric acid to form the colored azo dye, which can be measured on spectrophotometer at 540 nm. The method was standardized statistically by using $NaNO_2$ standards which is based upon the empirical observation that 0.74 mole of $NaNO_2$ produces same color as 1 mole of NO_2. SO_2 can be removed by adding H_2O_2. (J. H. Blacker and R. S. Brief, 1972). Then NOx was calculated using following formula-

$$\mu g\ NOx/m^3 = \frac{\mu g\ of\ NO_2/mL\ (from\ calibration\ curve)\ \times\ Volume\ of\ reagent}{0.85\ \times\ Volume\ of\ air\ sampled\ in\ m^3}$$

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

3. Results and discussion

3.1. Effect of Somyag fumes on bacterial count

Air samples for the estimation of bacteria were collected from all 3 cities (i.e. Beed, Pune and Ratnagiri) from ambient air by passive as well as active air collection methods and calculated bacterial count is recorded in Table 1. Before air monitoring temperature of surrounding area were recorded, as mentioned in Table 2.

Table 1 - Bacterial count in ambient air from the source of Yajnya to 40 feet apart from Yajnya taken at Beed, Pune and Ratnagiri.
P = Bacterial count by Passive air Monitoring in CFU/m^2/min
A = Bacterial count by Active air Monitoring CFU/m^3
NC = Not Countable
E = Bacterial count taken in the evening time
M = Bacterial count taken in the morning time

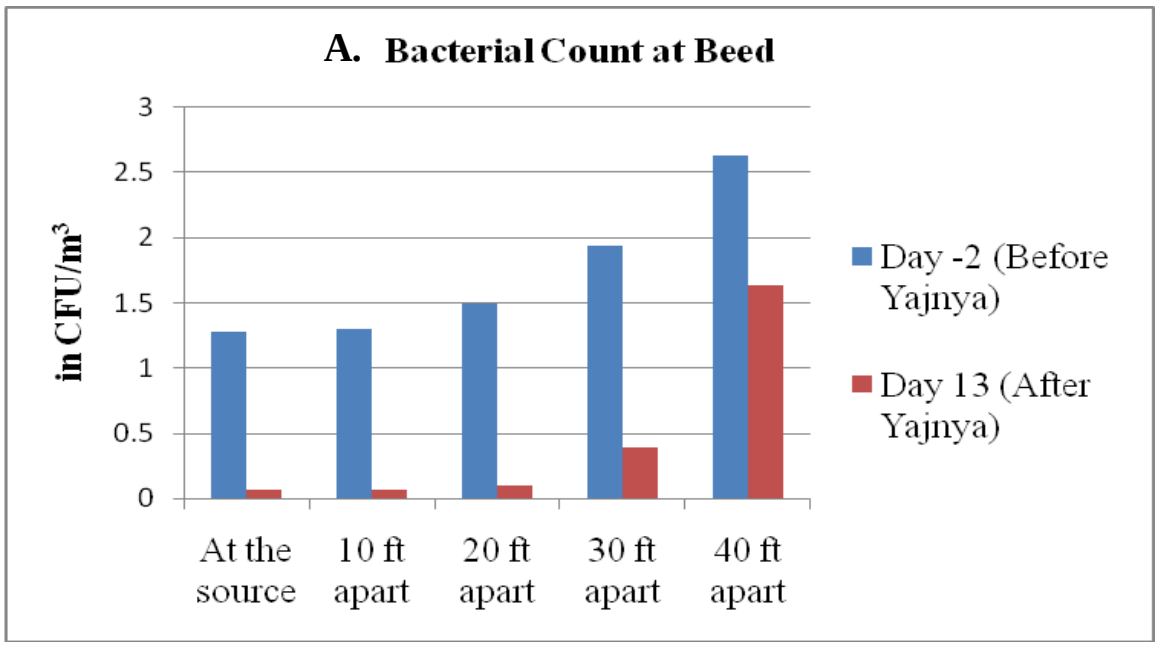
Date and time	Day	At source		10 feet apart		20 feet apart		30 feet apart		40 feet apart	
		P	A	P	A	P	A	P	A	P	A
Somyag Yajnya Performed at Beed											
26/1/2013	-2	0.132	1.280	0.148	1.300	0.161	1.490	0.189	1.940	0.248	2.630
10/2/2013	13	0.006	0.060	0.010	0.060	0.012	0.100	0.038	0.390	0.150	1.630
Somyag Yajnya Performed at Pune											
06/2/2014E	-1	0.340	3.920	0.392	3.44	0.332	3.080	0.316	3.440	NC	NC
07/2/2014M	0	0.240	2.600	0.272	3.400	0.260	2.480	0.308	2.680	NC	NC
07/2/2014 E	0	0.308	2.480	0.344	2.720	0.308	3.920	0.340	3.920	NC	NC
08/2/2014M	1	0.268	2.760	0.332	2.480	0.248	2.400	0.272	3.080	NC	NC
12/2/2014 E	5	0.087	0.890	0.098	1.010	0.130	1.350	0.160	1.660	NC	NC
14/2/2014M	7	0.065	0.720	0.073	0.810	0.097	1.080	0.120	1.330	NC	NC
16/2/2014 E	9	0.060	0.590	0.067	0.660	0.090	0.880	0.111	1.090	NC	NC
18/2/2014M	11	0.042	0.310	0.047	0.350	0.063	0.460	0.077	0.570	NC	NC
20/2/2014 E	13	0.029	0.340	0.033	0.380	0.043	0.510	0.053	0.630	NC	NC
22/2/2014M	15	0.027	0.200	0.030	0.200	0.040	0.270	0.050	0.330	NC	NC
24/2/2014 E	17	0.016	0.090	0.018	0.100	0.024	0.130	0.030	0.170	NC	NC
26/2/2014M	19	0.006	0.180	0.017	0.200	0.023	0.270	0.028	0.330	NC	NC
28/2/2014 E	21	0.009	0.100	0.010	0.110	0.013	0.150	0.017	0.180	NC	NC
02/3/2014M	23	0.007	0.030	0.008	0.040	0.005	0.020	0.014	0.060	NC	NC
03/3/2014 E	24	0.062	0.720	0.070	0.810	0.093	1.080	0.114	1.330	NC	NC
04/3/2014M	25	0.240	2.480	0.272	3.400	0.260	2.480	0.308	2.680	NC	NC
Somyag Yajnya Performed at Ratnagiri											
16/1/2015M	-1	0.341	2.747	0.381	3.013	0.341	4.342	0.377	4.342	NC	NC
16/1/2015 E	0	0.297	3.057	0.368	2.747	0.275	2.658	0.301	3.412	NC	NC
17/1/2015M	1	0.096	0.986	0.109	1.119	0.144	1.495	0.177	1.839	NC	NC
17/1/2015 E	1	0.072	0.798	0.081	0.897	0.107	1.196	0.133	1.473	NC	NC
18/1/2015M	2	0.066	0.654	0.074	0.731	0.100	0.975	0.123	1.207	NC	NC
18/1/2015 E	2	0.047	0.343	0.052	0.388	0.070	0.510	0.085	0.631	NC	NC
19/1/2015M	3	0.032	0.377	0.037	0.421	0.048	0.565	0.059	0.698	NC	NC
19/1/2015 E	3	0.030	0.222	0.033	0.222	0.044	0.299	0.055	0.366	NC	NC
20/1/2015M	4	0.018	0.100	0.020	0.111	0.027	0.144	0.033	0.188	NC	NC
20/1/2015 E	4	0.007	0.199	0.019	0.222	0.025	0.299	0.031	0.366	NC	NC

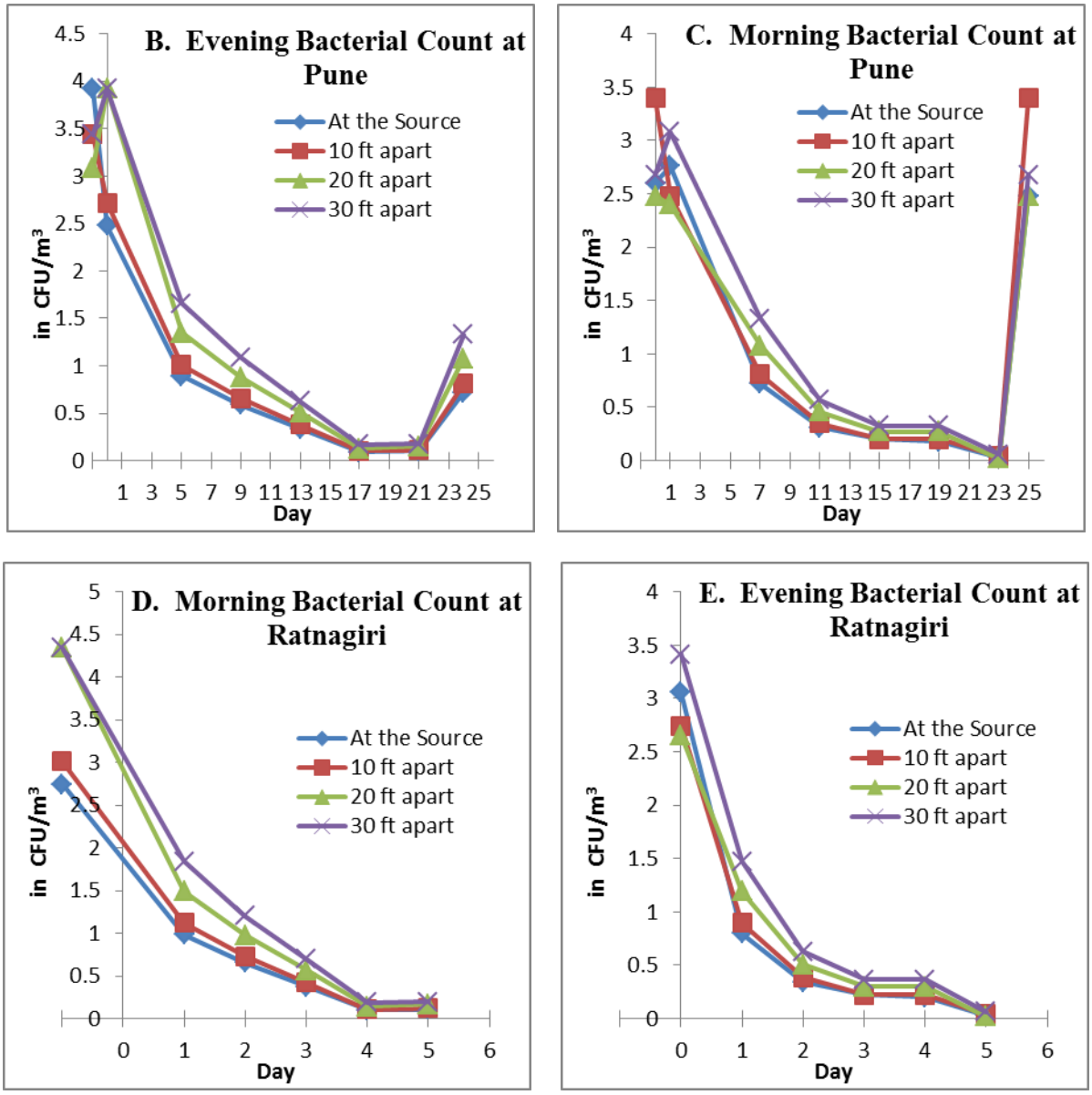
21/1/2015M	5	0.010	0.111	0.011	0.122	0.014	0.166	0.019	0.199	NC	NC
21/1/2015E	5	0.008	0.033	0.009	0.044	0.006	0.022	0.016	0.066	NC	NC

As bacterial count by using passive and active air monitoring methods shows similar results, graphical representation is mentioned for bacterial count by using active air collection (Graph 1). Graphical representation for bacterial count by passive air collection method is not mentioned in this paper.

Estimation of bacteria from ambient air, collected at Beed shows, bacterial count after Yajnya reduces to 95%, 93%, 80% and 38% up to 10 feet, 20 feet, 30 feet and 40 feet respectively from the source of Yajnya as compare to the bacterial count before Yajnya, due to the fumes of Somyag and the whole Somyag ceremony (Graph 1A).

Estimation of bacteria from ambient air, collected in the morning as well as in the evening at Pune and Ratnagiri shows, bacterial count reduces up to 95% during the Somyag ceremony. The effect is not long lasting, as soon as Yajnya finished bacterial count increases and reach at maximum (as seen in Pune Somyag, Graph 1B and 1C). Also effect is up to the 30 feet from the source of Yajnya, there is gradual increase in bacterial count as distance from source increases (Graph 1B, 1C, 1D and 1E).





Graph 1 – Bacterial count in ambient air by active monitoring of air
1A – Bacterial count from Beed Somyag
1B, 1C – Evening and Morning Bacterial count respectively from Pune Somyag
1D, 1E – Morning and Evening Bacterial count respectively from Ratnagiri Somyag

Fumes generated during Somyag ceremony by burning of woody materials in Yajnya shows antimicrobial activity. Possible antimicrobial agents get released in ambient air during burning of woody materials and which may affect on microbial cells by inhibiting its growth or by killing them or reduces bacterial population by diffusion phenomenon or by nanoparticles present in fumes or by changing ambient air chemical composition. One needs to identify antimicrobial compounds present in fumes and their possible mechanism of action on microbes. One needs to also consider changes in other environmental factors such as temperature, pressure, moisture and diversity of bacteria etc. in an ambient air during Somyag ceremony to study reduction in bacterial count.

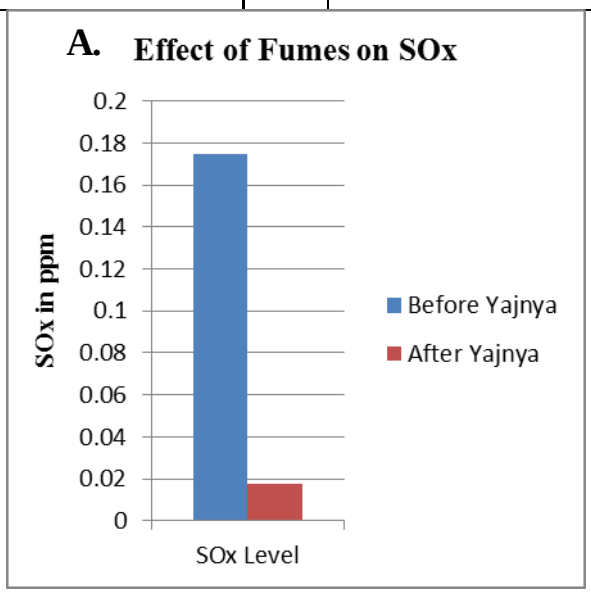
3.2. Effect of Somyag fumes on SOx and NOx levels –

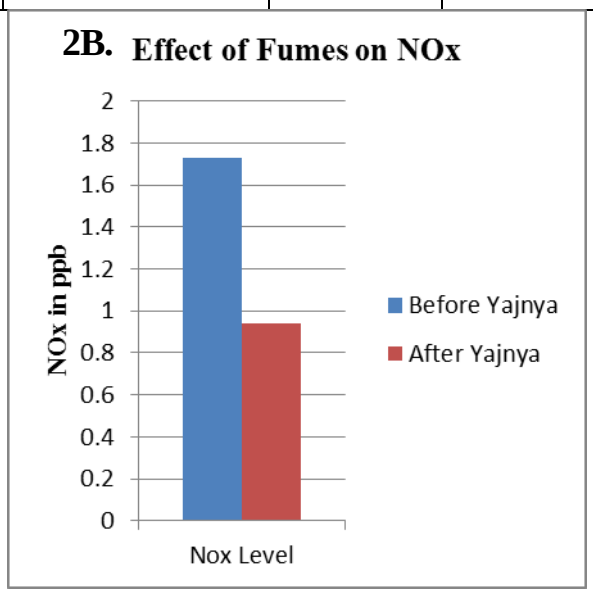
Ambient air samples in the area of Somyag ceremony was collected, SOx and NOx levels were estimated, and calculated levels are recorded in Table 2. Temperature is also measured before air sampling and recorded.

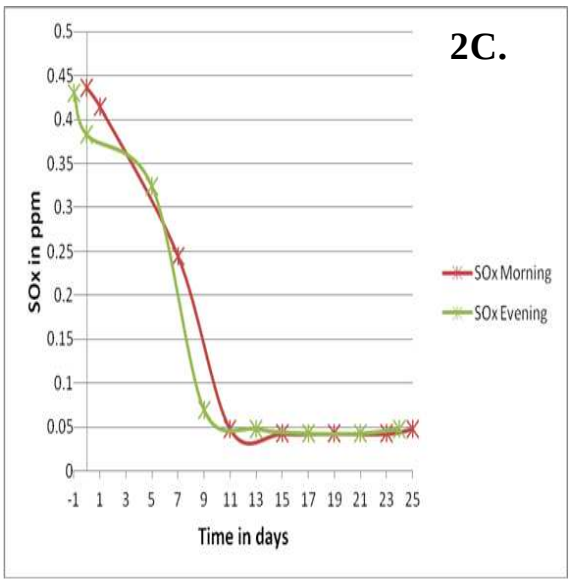
Table 2 – SOx and NOx levels in ambient air from Yajnya performed at Beed, Pune and Ratnagiri. **E** = Air sampling in the evening time, **M** = Air sampling in the morning time.

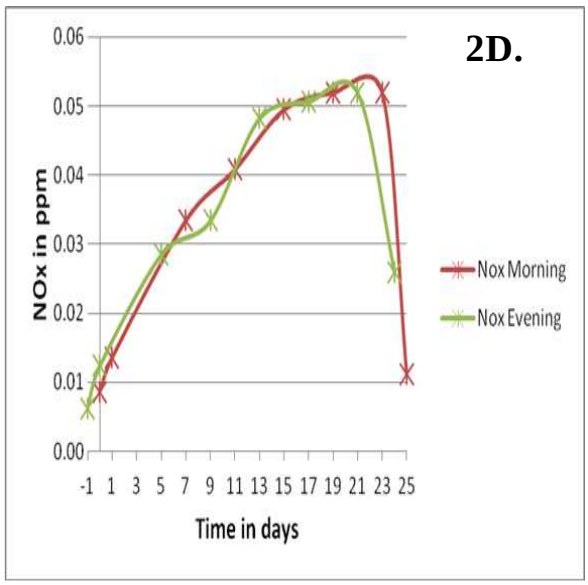
Date and time	Day	Temp. near Yajnya	Temp. 50 feet apart from Yajnya	SO_X in ppm	NO_X in ppm
Somyag Yajnya Performed at Beed					
26/1/2013(Before)	-2	28°C	27°C	0.1747	0.00173
10/2/2013(After)	13	26.5°C	24°C	0.0175	0.00094
Somyag Yajnya Performed at Pune					
06/2/2014 E	-1	22.5 °C	23 °C	0.4304	0.0062
07/2/2014 M	0	13 °C	12.5 °C	0.4357	0.0087
07/2/2014 E	0	23 °C	23 °C	0.3826	0.0124
08/2/2014 M	1	12 °C	12 °C	0.4144	0.0136
12/2/2014 E	5	27 °C	26 °C	0.3241	0.0284
14/2/2014 M	7	12 °C	12.5 °C	0.2444	0.0334
16/2/2014 E	9	28 °C	27 °C	0.0691	0.0334
18/2/2014 M	11	8.5 °C	8.5 °C	0.0478	0.0408
20/2/2014 E	13	30 °C	29 °C	0.0478	0.0482
22/2/2014 M	15	14 °C	13.5 °C	0.0425	0.0495
24/2/2014 E	17	30 °C	29 °C	0.0425	0.0507
26/2/2014 M	19	16 °C	16 °C	0.0425	0.0519
28/2/2014 E	21	30 °C	29 °C	0.0425	0.0519
02/3/2014 M	23	14 °C	14 °C	0.0425	0.0519
03/3/2014 E	24	32 °C	32 °C	0.0478	0.0260
04/3/2014 M	25	18°C	18.5 °C	0.0478	0.0111
Somyag Yajnya Performed at Ratnagiri					
16/1/2015 M	-1	19.5°C	19°C	0.000625	0.0052
16/1/2015 E	0	23°C	23°C	0.000604	0.0048
17/1/2015 M	1	19°C	18.5°C	0.000527	0.0055
17/1/2015 E	1	24°C	24.5°C	0.000591	0.0051
18/1/2015 M	2	20°C	19°C	0.000476	0.0052
18/1/2015 E	2	27°C	26.5°C	0.000519	0.0054
19/1/2015 M	3	20.5°C	19.5°C	0.000472	0.0060
19/1/2015 E	3	28°C	27°C	0.000493	0.0050
20/1/2015 M	4	17°C	18°C	0.000451	0.0058

20/1/2015 E	4	20°C	21.5°C	0.000404	0.0066
21/1/2015 M	5	18°C	19°C	0.000387	0.0062
21/1/2015 E	5	21°C	20.5°C	0.000378	0.0063





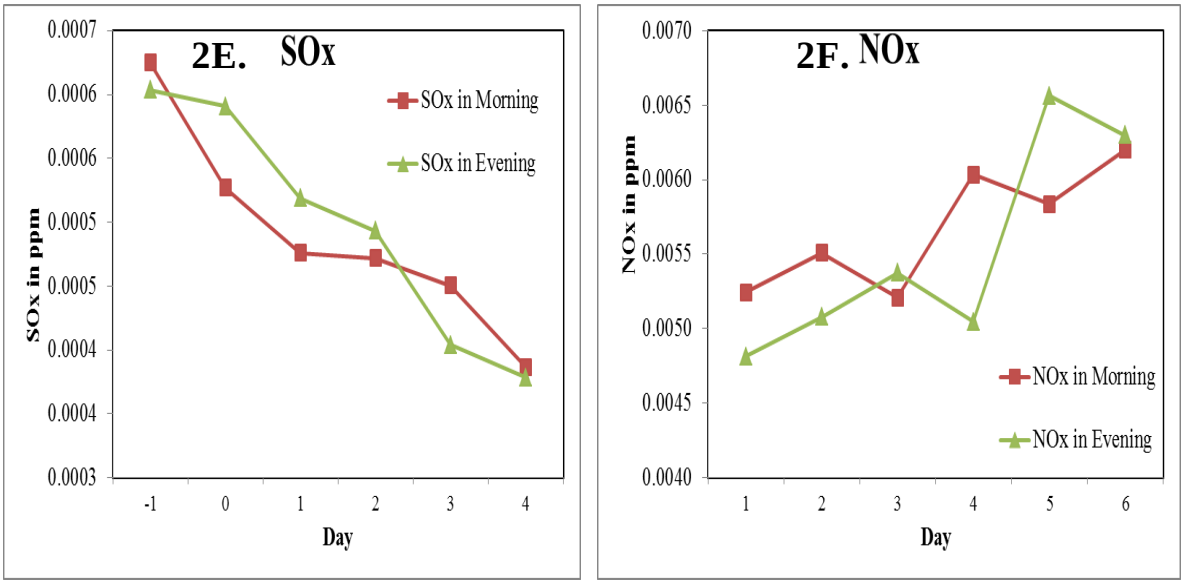




Estimation of air samples collected from Beed reveals that SOx and NOx levels reduces up to 90% and 45% respectively after Somyag Yajnya due to fumes (Graph 2A and 2B).

As per our results of estimated air samples collected from Pune, SO_x level decreases during and after Yajnya up to 10 times that of initial (Reduces from 0.43 ppm to 0.048 ppm). This effect is long lasting as SO_x level remains decreased even after the Yajnya (at least up to 2 days) was finished. SO_x pollution in the air can be reduce up to 90% by performing Somyag Yajnya (Graph 2C). NOx level increases during Yajnya up to 0.05 ppm (increases up to 20% as compare to initial levels), but also decrease to normal level (0.01 ppm) after Yajnya (Graph 2D). Standard NO_x (mostly NO_2) level (annual average per hour) provided by 'Maharashtra Pollution Control Board' as well as 'National Ambient Air Quality Standards'

(NAAQS) is 0.053 ppm. Maximum value recorded was 0.052 ppm (during day 19 to 23) which is less as compare to standard levels.



Graph 2 – SOx and NOx levels monitored during Somyag Yajnya performed in Beed, Pune and Ratnagiri. Graph 2A, 2C and 2E are graphical representation for effect of fumes on SOx levels in Beed, Pune and Ratnagiri while Graph 2B, 2D and 2F are graphical representation for effect of fumes on NOx levels in Beed, Pune and Ratnagiri respectively.

4. Conclusions

Fumes generated by burning woody plant materials in Somyag Yajnya ceremony shows antimicrobial properties and reduces bacterial load in ambient air. Bacterial count in the ambient air can be reduces up to 95% from the source of Yajnya to 30 feet apart. Effect is not long lasting; at the end of Yajnya bacterial count started increasing. SOx levels reduces up to 40-90% that of initial levels due to the Somyag Yajnya, also effect is long lasting. NOx levels initially increases up to 10-20% during Yajnya but at the end of Somyag, NOx level become normal that of initial. Also results suggest that NOx levels not exceeds beyond limit to pollute air. Hence we can purify ambient air, in terms of controlling pollution due to oxides of Sulphur and nitrogen as well as microbial pollutants, by performing Somyag Yajnya. One needs to identify active principals of plants used during Somyag Yajnya, as they are the only source for the creation fumes. Chemical as well as physical changes in an ambient air need to study in details to find out mechanism of action for purification of air by fumes or Somyag ceremony.

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