Eco. Env. & Cons. 29 (May Suppl. Issue) : 2023; pp. (S114-S119)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i03s.024

Characterization of Agnihotra ash

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(Received 10 November, 2022; Accepted 20 January, 2023)

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. The ash produced after performance of Agnihotra yajnya has various applications in the agricultural sector, environmental pollution control, medical sector, etc. In the present study we have characterized the Agnihotra ash. Elemental analysis of Agnihotra ash was done with the help of Atomic Absorption Spectroscopy. Characterization of Agnihotra ash was done by using X-Ray Diffraction analysis and Fourier Transform Infrared analysis. Analysis of ash compounds was done by X-Ray Diffraction – Theta-2-Theta spectrum and Energy Dispersive X-Ray spectrum. Agnihotra ash mainly consists of silicon dioxide (SiO_2) as major compound.The Agnihotra ash was a highly porous material with a large internal specific surface area.

***Key words**: Agnihotra, Agnihotra ash, Characterization, Silicon Dioxide*

Introduction

Agnihotra is a traditional domestic solemnity, performed to maintain harmony between living beings and nature, without harming and by giving respect to the nature. 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. The Agnihotra is simplest form of fire based technique moving down from the ancient Vedic literatures. 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 (Paranjpe, 1989). The ash produced after performance of Agnihotra yajnya has various applications in the agricultural sector, environmental pollution control, medical sector, etc. (Abhang *et al.*, 2016 and 2017).

The *Agnihotra* ash has novel application in water purification process as it controls the water quality parameters (Abhang *et al.*, 2015 and Abhang, 2015). As per Pathade *et al.*, (2014), Agnihotra ash can reduce the pathogenicity of bacteria due to which diseases can be controlled. The application of Agnihotra ash along with cow urine accelerates the action against fungi by inhibiting hyphae growth and by controlling soil borne pathogens (Berde *et al.*, 2015). According to Devi *et al.*, (2004), an application of Agnihotra ash to rice seeds enhances seed germination from primary stage, which was measured in terms of bud length with respect to seed weight. Kratz *et al.*, (2007), stated that Agnihotra ash when added to soil it increases the content of soluble phosphate. It is reported by Indira *et al.*, (2010), that Agnihotra ash provides nutrition to mushroom during cultivation when supplemented with the straw substrate. The yield of maize crop (*Zea mays*) enhances due to addition of Agnihotra ash in yellow soil by regulating the growth of maize crop (Sharma *et al.*, 2012). *Agnihotra* ash as an external ointment is a new healing application towards wound healing process which was reported through *in vivo* experiments carried on human finger for physical injury, domestic cat's ear for infections (Otitis) (Pathade *et al.*, 2014). According to Richa, (2009) and Abhang *et al.*, (2015), use of dung of cow, brown rice, butter fat of cow, copper pot, specific timings and incantation of mantras during performance of Agnihotra has synergetic and significant effect on ash. In order to producing various positive effects, the ash of Agnihotra prepared by performing it at exact timings of sunrise/sunset with inchantation of mantras and with the help of proper raw materials possesses various micronutrients and macronutrients.

Taking into account the encouraging results of the ash produced after performance of Agnihotra yajnya in above reports towards agricultural applications, environmental cleaning aspects as well as medicinal importance, we have reported in this article the characterization studies of Agnihotra ash and raw material of Agnihotra yajnya.

Materials and Methods

Agnihotra procedure

Agnihotra yajnya was performed as per Paranjpe, (1989) and Potdar, (1993). In brief the 100 g of dried dung of *Gir* cow (*Bos (primigenius) indicus*) 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 as '*Suryayaswáahá*| *Suryáyaidamna mama*||*Prajápatayeswáahá*| *Prajápatayeidamna mama*||' and sunset mantra as '*Agnayeswaáhá*| *Agnayeidamna mama*|| *Prajápatayeswaáhá*| *Prajápatayeidamna mama*||'

The ash produced after performance of Agnihotra was further used for the characterization experiments.

Characterization of Agnihotra ash

The ash produced after performance of Agnihotra was characterized by following parameters. The elemental analysis of Agnihotra ash was done by using Atomic Absorption Spectroscopy (AAS) as per ASTM [American Society for Testing and Materials], 1984.

The physicochemical characterization of Agnihotra ash was done by using *X-Ray Diffraction* (XRD) and Fourier-Transform Infrared Spectroscopy (FTIR) analysis.

The analysis of compounds present in Agnihotra ash was done by XRD/ Theta 2 Theta spectrum analysis and was confirmed by using Energy Dispersive X-Ray Spectroscopy (EDX) spectrum.

Results and Discussion

Elemental Analysis of Agnihotra ash

The elemental Analysis of Agnihotra ash by using Atomic Absorption Spectroscopy (AAS) showed Calcium, Chlorides, Potassium, Silica, Sodium, To-

Table 1. Elemental Analysis of Agnihotra ash

Sr. No.	Elements	Symbol	Average conc. in ppm	Sr. No.	Elements	Symbol	Average conc. in ppm
1	Aluminum	Al	0.030	16	Manganese	Mn	0.010
2	Antimony	Sb	0.005	17	Mercury	Hg	0.001
3	Arsenic	As	0.001	18	Molybdenum	Mo	0.007
4	Calcium	Ca	0.600	19	Nickel	Ni	0.020
5	Barium	Ba	0.070	20	Potassium	K	1.100
6	Beryllium	Be	0.004	21	Selenium	Se	0.010
7	Cadmium	Cd	0.003	22	Silica	Si	0.800
8	Chlorides	Cl	0.560	23	Silver	Ag	0.010
9	Chromium	Cr	0.005	24	Sodium	Na	1.250
10	Cobalt	Co	0.050	25	Strontium	Sr	0.090
11	Copper	Cu	0.005	26	Sulphur	S	0.080
12	Fluorides	F	0.001	27	Total Nitrogen	N	1.500
13	Iron	Fe	0.030	28	Total Phosphorus	P	1.010
14	Lead	Pb	0.001				
15	Magnesium	Mg	0.300	29	Zinc	Zn	0.500

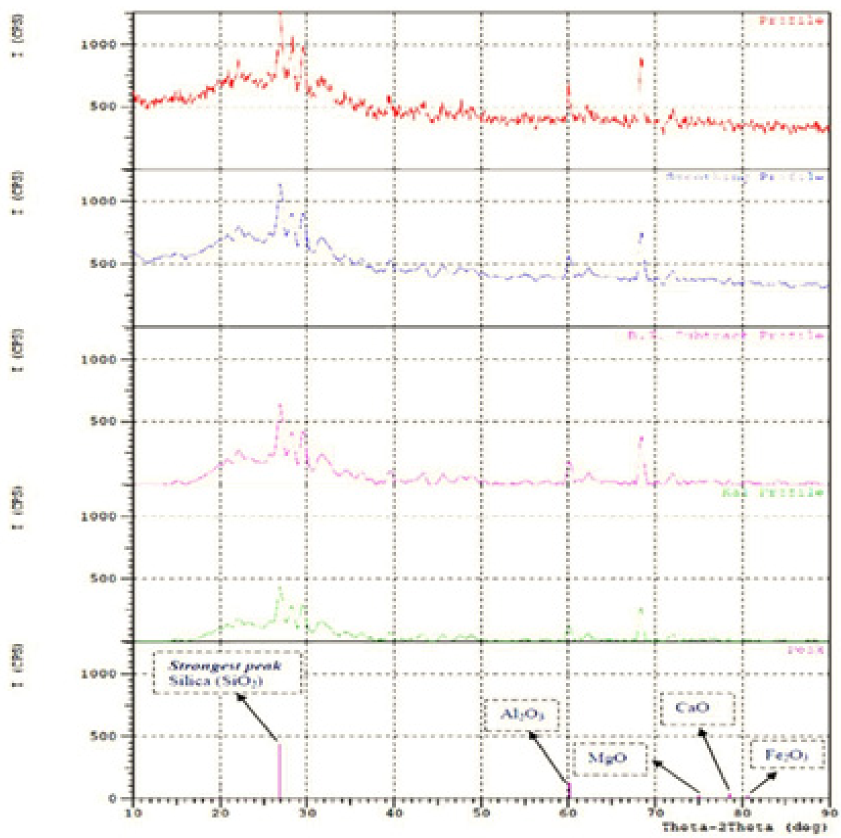
tal Nitrogen, Total Phosphorus and Zinc in higher concentration as compared to other elements (Table 1).

Physico-chemical characterization of Agnihotra ash by using XRD and FTIR analysis

The 2θ versus Intensity (I) (CPS - Counts per second) plot shows the profiles and peaks of compounds identified in XRD (Figure 1). Also, experimental XRD peaks of CDA at 500 °C were indexed with Joint Committee on Powder Diffraction Standards (JCPDS) file. It can be seen from Figure 1 that silica (SiO_2) is a major phase in Agnihotra ash followed by Al_2O_3, MgO, CaO and Fe_2O_3.

The XRD profile of the Agnihotra ash is shown in Figure 2A. The Agnihotra ash was completely amorphous, as indicated by the featureless diffract gram and the appearance of a diffuse maxima at 2θ = 22° to 27 °, which was typical for amorphous silica. The several studies have reported the formation of amorphous silica when rice husk is combusted at low temperatures (Ramezanianpour *et al.*, 2009) and combustion of cow dung (Sivakumar *et al.*, 2018).

The FTIR spectra showed the presence of a strong band at 1086/ cm, coupled with bands around 614/ cm, representing asymmetric and stretching vibrations of the siloxane bond and Si – O – Si, respectively (Figure 2B). The bands found around 748/cm to 796/cm can be attributed to the bending vibration of the Si–O–Si groups (Socrates, 2004). The infrared



Compound	% Amount
SiO_2	67.45
Al_2O_3	4.57
Fe_2O_3	3.24
CaO	13.32
MgO	2.07
SO_3	0.96
P_2O_3	2.91
Na_2O	0.52
P_2O_5	1.42
Mn_2O_3	0.61
$CaCO_3$	23.78
TiO_2	0.38

Compound	JCPDS	hkl	d-spacing (nm)		Position (2Θ)		Relative intensity (%)	
			Std.	Exp.	Std.	Exp.	Std.	Exp.
SiO_2	(46-1045)	101	0.3343	0.3315	26.63	26.86	100	100
Al_2O_3	(10-0173)	122	0.1514	0.1514	61.16	61.10	5	6
MgO	(45-0946)	311	0.1269	0.1265	74.69	75.01	5	5
CaO	(37-1497)	400	0.1202	0.1218	79.66	78.42	6	7
Fe_2O_3	(33-0664)	128	0.1190	0.1192	80.71	80.50	5	4

Fig. 1. XRD (è2è) pattern of Agnihotra ash; and comparison of d-spacing; amount of compounds present in Agnihotra ash and position and relative (strongest peak) intensities of Agnihotra ash with standard compounds

(IR) spectra had a small broad band in the region between 3,433.41/cmto 3,446.91 /cm due to the surface O–H vibration, this band was due to the SiO–H (silanol) groups and the HO–H vibration of the adsorbed water molecules bound to the silica surface (Kamath *et al.*, 1998). The small peak around 1,641.48/cmto 1,737.92 /cm corresponded to C=O stretching of aromatic groups that might be attributed to the hemicelluloses and lignin aromatic group. The C=C stretching vibrations between 1,514.17 /cm and 1,656.91 /cm were indicative of alkenes and aromatic functional groups. The peaks around 1,471.74/cmto 1,462.09 /cm indicated the presence of CH_2 and CH_3 groups. The peaks in the 1,163.11/cmto 1,315.5 /cm corresponded to vibration of CO group in lactones. The peaks around 469.32cm^{-1} to 800 cm^{-1} indicated the presence of –OCH_3 (Wong *et al*., 2000; Nadeem *et al*., 2006).

The EDX analysis (Figure 2C) confirmed the presence of silica (Si) as a significant constituent, with Al, Mg, and Fe as minor elements. The cow dung ash as well as rice husk EDX analysis showed presence of silica as a major constituent (Yadav *et al.*, 2017; Jyothi *et al.*, 2015; Vishwakarma *et al.*, 2016; Gurjar *et al.*, 2015; Hariharan *et al.*, 2013; Mor *et al.*, 2016; Liu *et al.*, 2016 and Adebayo *et al.*, 2014)

Scanning electron microscopic (SEM) analysis of Agnihotra ash

The surface morphology of the Agnihotra raw material (i.e. without burning) and Agnihotra ash (i.e. burned raw material in Agnihotra experiment) were examined under a scanning electron microscope (Figure 3). The SEM micrographs of Agnihotra ash showed that many residual pores were distributed within the ash samples, indicating that Agnihotra ash was a highly porous material with a large internal specific surface area. The small cavities on the surface indicated the presence of an interconnected porous net. The rice husk might have broken up during thermal decomposition, thus obtaining a highly porous structure (Genieva *et al.*, 2008).

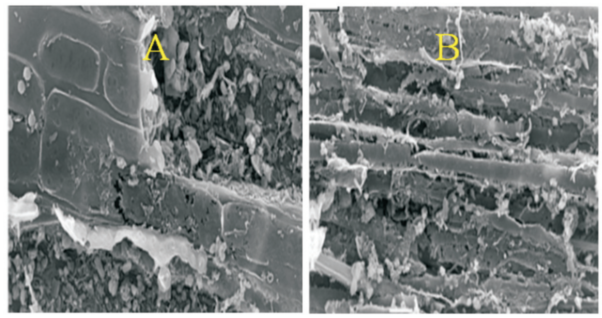
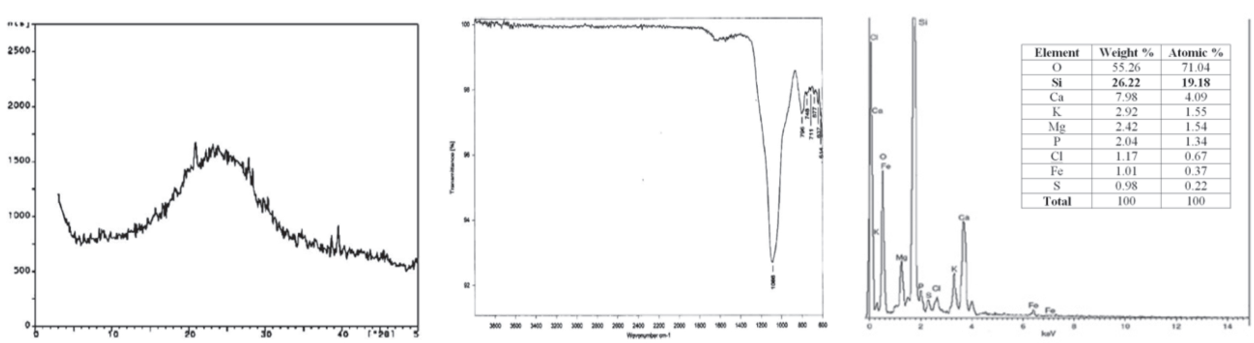


Fig. 3. SEM micrographs of (A) Agnihotra raw material and (B) Agnihotra ash

Particle size analysis of Agnihotra ash

The particle size analysis of Agnihotra ash showed maximum particle size ranges from 10 µm to 50 µm. About 60% particles of Agnihotra ash ranged from 1 µm to 50 µm. There were less particles of maximum size range 50 µm to 100 µm, i.e. only 7%. (Figure 4)

The particle size plays important role in heterogeneous chemical reactions (Muller *et al.*, 2002) and adsorption (Muller *et al.*, 1996 and 1998) mechanisms. The rate of adsorption of activated carbon (Marsh *et al.*, 2006) and zeolites (Muller *et al.*, 1996 and 1998) depends inversely on particle size. Also, the adsorption properties of activated carbon depend on internal surface area, their shape and pore size distributions (Pis *et al.*, 1996), which are proportional to the particle size. Being as ash, Agnihotra ash mainly composed of carbon and hence maximum lower particle size enhances adsorption activity.



Element	Weight %	Atomic %
O	55.26	71.04
Si	**26.22**	**19.18**
Ca	7.98	4.09
K	2.92	1.55
Mg	2.42	1.54
P	2.04	1.34
Cl	1.17	0.67
Fe	1.01	0.37
S	0.98	0.22
Total	100	100

Fig. 2. XRD profile FTIR spectra and EDX profile of Agnihotra ash

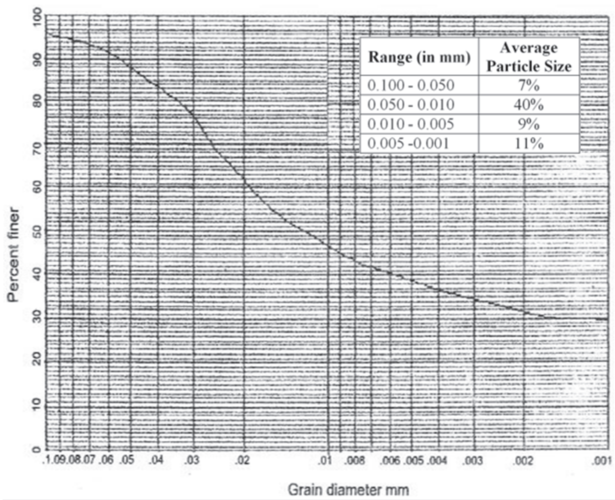


Fig. 4. Particle size distribution of Agnihotra ash with grain diameter verses percent finer

Conclusion

Agnihotra ash mainly consists of the silica, calcium, chlorides, potassium, sodium, nitrogen, phosphorus and zinc elements in higher amount as compare with other elements. Agnihotra ash mainly consists of the silica (SiO_2) as a major compound and also the compounds like $Al2O_3$, MgO, CaO, Fe_2O_3, etc were present in ash. The various bonds like siloxane, Si–O–Si, SiO–H (silanol), C=O, C=C, CH_2, CH_3, $–OCH_3$, etc. were present in Agnihotra ash. The Agnihotra ash was a highly porous material with a large internal specific surface area. Agnihotra ash had maximum particle size ranges from 10 µm to 50 µm.

Acknowledgements

Authors are thankful to the Principal, Fergusson College, Pune and Dr. Suresh Bhosale, Chancellor, Krishna Institute of Medical Sciences, Deemed to be University, Karad for giving us an opportunity to work on this topic.

Conflict of Interest

Authors do not have any conflict of interest to declare.

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