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Properties, Characterization and Effect of Stilbite Zeolite on Growth and Yield of Mushroom

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ABSTRACT

Zeolites are crystalline hydrated aluminosilicates of alkali and earth metals. Properties of the aluminosilicates, framework and presence of well defined channel systems make it possible a variety of application such as agricultural, industrial, and medicinal etc. Zeolites have many more useful properties with high ion exchange and retention capacity. Due to such fascinating properties of zeolites the plant growth, yield of crop have been increased by the application of zeolites and the work has been reported in many national and international journals. Taking this fact in to consideration, we have planned to focus on the characterization, properties of natural zeolite Stilbite and to study their application on the growth and yield of Mushroom.
Natural zeolite Stilbite crystals were collected from Fardapur, near Ajanata cave, District Aurangabad from the Marathwada region of Maharashtra state, India. Characterization XRD and IR of Stilbite were carried out. The powdered form of Stilbite were applied in various proportions to study the germination period, growth and yield of Mushroom. We found the growth and yield of Mushroom increased relevantly on the application of natural zeolite Stilbite.

Keywords: Stilbite, Zeolites, Fardapur, Ajanta caves, Mushroom.

I. INTRODUCTION

Zeolites are crystalline hydrated aluminosilicates of alkali and earth metals that possess infinite, three dimensional structures. These crystals are further characterized by an ability to lose and gain water reversibly and to exchange some of their constituent elements without major change of structure[1]. Now a days soilless culture is the modern cultivation system of plants is used for organic or inorganic substrate through nutrient solution nourishment[2]. Soilless growing media are easier to handle with compared to soil culture and it may provide better growing environment.
Zeolites are having potentiality as soilless media for its unique properties. Zeolite crystals alumina-silicates have negative charges, which is balanced by one or two valence of positively charged cations[3]. It has high water absorption, retention and releasing capacity. It has high cation exchange capacity with high buffering ability of

ph change[4]. Zeolites are microporous crystalline materials having high internal surface area[5]. It has been reported that due to its higher cation exchange capacity, nutrient and water holding capacity yield of wheat, tomato, carrot with another grains increased greatly. Tomato plants grown in perlite and zeolite mixture substrate increases yield. Taking this fact of the references in to consideration, we have focused on application of the zeolite Stilbite in different proportions, a platy variety of the VIIth group of zeolite crystals to check growth and yield of eatable mushroom.

II. METHODS AND MATERIAL

A platy variety of natural zeolite crystal Stilbite was collected from naturally occurring zeolite queries around Fardapur village near Ajanta caves Dist. Aurangabad of Maharashtra state, India. The sample was manually transformed into powder form using agate - mortar to a final grain size and sieved to 334 micron size mesh. A washing treatment was given to the material by magnetic stirring for a period of 1 hour. Subsequently, the material was dried at a temperature of 80°C for 24 hrs

Collected sample were characterized by XRD and IR techniques. The identification of the crystalline phases of the sample was conducted by XRD using a JEOL X-ray Diffractometer TIFR, Mumbai between the scan range 50^{o} to 60^{o}. IR spectra was recorded on Perkin IR instrument, Mumbai to confirm the phase structure and zeolitic nature of the collected sample Stilbite. The culture(seeds) of oyster mushroom variety P. Sajor Caju ware obtained from Vasantrao Naike Agriculture Marathwada University Parbhani (MS). For the purpose of cultivation, soybean straw was used as substrate and which is collected from village Gour Tq. Purna(Jn.) Dist. Parbhani (MS).

Dry Soybean straw was soaked in a cold water for 12 hours and separated from water. The soybean straw was pasteurized in a autoclave under 15Ibs pressure for 20 minutes and discharged from autoclave and cooled down to room temperature. After suitable cooling, 1kg quantity of straw per bag filled into the polythene bags with addition of powdered form of a platy variety of zeolite crystal Stilbite, in different proportions i.e 1, 3, 5,7 and 10gms. After this process polythene bags tightly packed and transferred to the Mushroom house for soil less cultivation of mushroom. Temperature and humidity conditions are maintained at 16-25^{0}C and 70-80 % respectively. Time period recorded for the formation of fruiting bodies in addition of different proportions of Stilbite. The data of experiment were recorded for the germination period and yield of the mushroom.

IR and XRD Characterization:

Sample of Zeolite characterized by IR spectroscopy shown in fig.-2, in which the band near region of 3520-3540 cm^{-1} shows –OH starching for symmetrical as well as asymmetrical region. As the metal zeolite showing property of hydrophilic in nature and it is confirmed by presence of H-O-H overtone in plane bending vibration at 2940 cm^{-1}. Not only that the strong band bending vibration observed in the region of 1644 cm^{-1} which confirmed the presence of hydrogen bonding with –OH functional group present in the zeolite. The another vibrations for Al-O and Si-O observed at the region 1090-1027 cm^{-1} for respectively asymmetric as well as symmetric stretching of Al/Si-O.

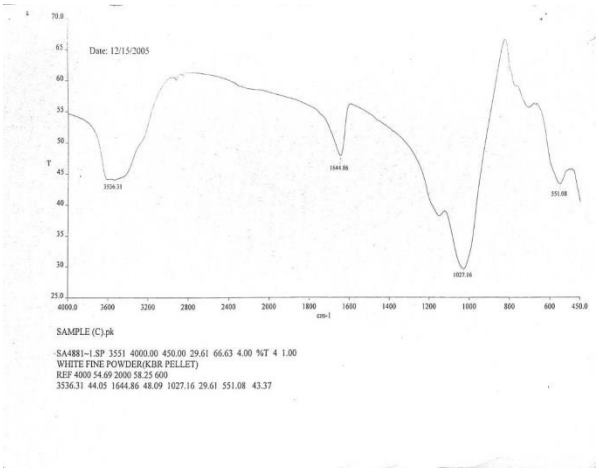

Figure 1: IR Spectrum of Stilbite zeolite

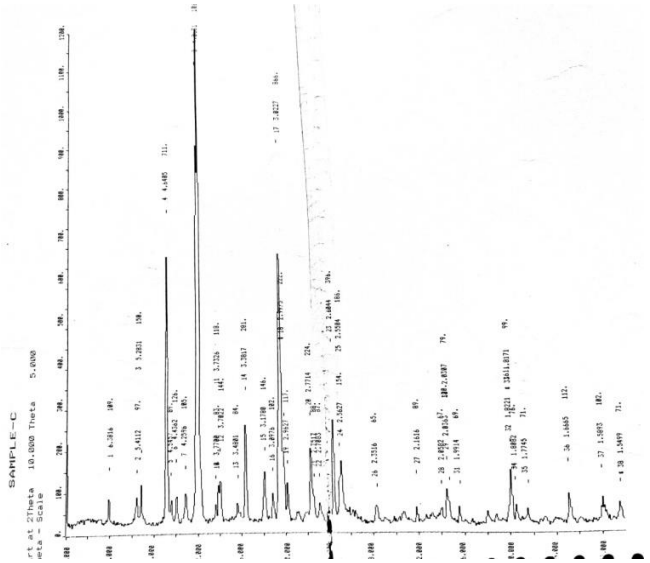

Figure 2: X-RD Pattern of Stilbite zeolite

TABLE I IR WAVENUMBER VALUES

OH stretch symmetric and asymmetric	Overtone in plane bending H-O-H	Bending H-O-H	External Al/Si-O	Asymmetric stretching Al/Si-O	Symmetric stretching Al/Si-O
3536 (s)	2940 (w)	1644 (s)	1190 (w)	1027 (s)	650 (s)

S= Strong band; W= Weak band

The XRD pattern of sample stilbite zeolite is as shown in fig.-2. which shows 2θ values 13.86°, 16.36°, 21.85°, 22.02°, 26.33°, 29.52°, 29.78° as major peak values. The scattering of X-rays from atoms produces a diffraction pattern, which contains information about the atomic arrangement within the crystal. Depending upon 2θ values miller indices are shown in spectra 109, 711, 1866, 281, 866, 224, 396 etc. Miller indices (hkl) are used to identify different planes of atoms. Observed diffraction peaks can be related to planes of atoms to assist in analyzing the atomic structure and microstructure of a sample.

III. RESULTS AND DISCUSSION

Experimental data presented in table-II, from the analysis of the data it is clear that, on the addition of zeolite Stilbite in different proportions, the yield of the P.sajor caju mushroom have been increased considerably. The fruiting bodies (mushroom) were harvested in three slots. The germination period of mushroom culture(seeds) have been reduced by 2 hours and time period required for formation of fruiting bodies of the mushroom were reduced by 1 to 2 days on the application of zeolite crystal Stilbite.

TABLE III

EFFECT OF STILBITE ZEOLITE ON MUSHROOM GROWTH

Substrate	Days for formation of fruiting bodies	Fresh wt. of Mushroom (gm/kgm of straw)	Dry wt. of Mushroom (gm/kgm of straw)
Soybean straw (Control)	17	122.10	11.91
Soybean straw + 1gm Zeolite	17	161.43	12.64
Soybean straw + 3gm Zeolite	16	171.51	13.80
Soybean straw + 5gm Zeolite	15	234.38	14.23
Soybean straw + 7gm Zeolite	15	239.3	17.25
Soybean straw + 10gm Zeolite	15	258	18.45

IV. CONCLUSION

The identification of the crystalline phases of the sample was conducted by XRD and IR spectra confirm the zeolitic nature of the applied sample. From experimental data presented in table-II, the yield (Fresh and dry wt.) of mushroom increased relevantly with the addition of different proportions of zeolite Stilbite. We found that the maximum yield of mushroom obtained 258.00 gm/kgm of straw with the addition of 10 gm of Stilbite and the ratio of the increase in the yield is 1: 2.11 as compared to control. From the above result, it can be concluded that, the productivity increases with decrease in germination period of mushroom on the application of zeolites.

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