



Investigation of Physicochemical Composition of *Sceliphron caementarium* (black and yellow mud dauber) Nest

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Abstract

Nests of *Sceliphron caementarium* (black and yellow mud dauber) were collected from Sant Gadge Baba Amravati University (SGBAU), Amravati campus and analysed for their physicochemical composition. The investigation gave results for the nest as - pH 6.57, porosity 0.87mg/g, bulk density 1.02g/mL, moisture content 1.01%, total surface area 5.55g/mgI₂ and total surface charge 1.11mmolH⁺eq/g. Values obtained for the ordinary soil from the campus were pH 7.82, porosity 0.75mg/g, bulk density 1.48g/mL, moisture content 2.27%, total surface area 4.76g/mgI₂ and total surface charge 0.98mmolH⁺eq/g. Higher content of calcium and magnesium were found in nest clay samples as compared to the normal soil, whereas the iodine adsorption number and phosphorus were lower than normal soil.

Key Words: Bulk density, Calcium, Magnesium, Moisture, Mud dauber nest, pH

Introduction

Mud dauber (Insecta: Hymenoptera: Sphecidae) play important roles in the ecosystem functions like predators, herbivores, scavengers and pollinator (Chown *et al.*, 2010). One of the widely distributed sphecids, *Sceliphron caementarium* (Drury), the black and yellow mud dauber, hunts spiders and builds characteristic mud nests to develop their offspring. *S. caementarium* female typically build their nests on urban structures like roof tops and walls of houses, offices, schools, and bridges (Evans, 2007). The suitability of the nest site depends on the elements of shelter, on the quality of mud and spider prey (Coville, 1987; Shafer, 1949). Thus, mud dauber nests usually considered as aesthetic pests. Earlier researchers showed that mud wasp builds nest by blending water and a variety of constructing materials like soil clay, plant material with its' saliva (Singh *et al.*, 2017). Velede (1995), described that clay soils are hydrous phyllosilicates of aluminium, along with variable alkaline metals, magnesium, iron, alkaline earths and other cations. Mud dauber collect mud, water to wet it, and regurgitate the mixture with saliva, that serves as an adhesive. The saliva produced from the spittle overlaps and build the mud cells cylindrically over the constructions.

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S. caementarium nests can get very crowded on buildings when left undisturbed for extended periods. This species is thus considered as aesthetic pest for the architecture. Physicochemical characterization of Hymenoptera sphecidae (mud-wasp) nest was done by Adie *et al.* (2013), for their promising use as adsorbent material. For the proper application of the nest material through knowledge of their physicochemical composition is required. Therefore, in the present investigation some physicochemical properties of *S. caementarium* nests were analysed for their possible use, rather than being thrown away after removal as annoying material.

Material and Methods

Collection of nests and normal soil:

From the walls of various departmental buildings at Sant Gadge Baba Amravati University (SGBAU), Amravati Campus, twenty nest samples of *Sceliphron caementarium* (black and yellow mud dauber) were collected, using plastic troughs. The normal soil samples were collected around the nearby water bodies like taps, wells, pond. The sample collection was done during September 2018-March 2019.

Physicochemical Characteristic Investigation:

Analytical grade reagents were used for the physicochemical analysis of mud wasp nests.

Collected nests were air-dried, some part of the selected nest was removed and ground into fine powder with the help of pestle and mortar and filtered using mesh (2mm). Powdered nest material was carefully preserved in sterile tubes and properly labelled for further investigation at the Department of Zoology, Sant Gadge Baba Amravati University (SGBAU) Amravati. The investigation involved the analysis of the physicochemical composition of wasp nest clay and normal soil.

Determination of pH: In 150ml beaker, 1.0g of *S. caementarium* nest material was added to 100ml of distilled water. The mixture was stirred constantly about an hour and then filtered on a Whatman filter paper. pH of the filtrate was determined by a digital pH meter.

Determination of Porosity: In a graduated tube 1.0g nest sample was mixed with 50 ml distilled water and centrifuged in the centrifuge machine at 5000 rpm for 10 minutes. The resulting volume was recorded as V_T and the porosity was calculated by using the equation (Adie *et al.*, 2013)

$$\alpha = V_W/V_T$$

where, V_W = volume of water taken

V_T = volume resulting after the dispersion of mud-wasp nest

Determination of bulk density: The tamping method described by Ahmedna, *et al.* (1997), was used for the determination of bulk density. In a 5mL graduated measuring cylinder 2.0gm of the nest material was placed. Then tap the measuring cylinder until the minimum volume was fully occupied. Then bulk density was calculated by placing the values in the equation.

$$\rho_B(g/mL) = m/V_{min}$$

where, m = mass of mud dauber nest,

V_{min} = minimum volume of mud dauber in measuring cylinder

Determination of moisture content: It was estimated by the method established by the Association of Official Analytical Chemists (A.O.A.C., 1990).

1. Empty dish with lid is dried at 105 ° C for 3 hours in an oven and then cooled in the desiccator.
2. 3 g of the sample was spread in the dish with a spatula.
3. The dish was placed in the oven to drying, at 105 ° C for 3 hours.

4. Then, the dish was transferred to the desiccator, with a partially covered lid, to cool. Re-weigh the dish and its dried sample.

Calculation - Moisture (%) = $(W1-W2) \times 100 / W1$
 where: W1 = weight (g) of sample before drying
 W2 = weight (g) of sample after drying

Determination of iodine adsorption number (IAN): Method followed was described by Okieimen *et al.*, (2007).

1. Slur 0.5 g portion of the mud dauber nest with extra aqueous solution of 0.05 M iodine in a 250mL glass beaker.

2. Swirl the contents vigorously for 10 minutes and then filter it through glass wool impregnated in a funnel.

3. A part of the filtrate was back titrated with a standard thiosulphate solution.

The mass (mg) of iodine used or absorbed per gram of mud dauber nest as obtained in the result is the number of iodine.

Determination of surface area of nest material:

Surface area (S.A.) was calculated as the inverse of the iodine number Surface Area = 1/IAN.

Determination of titrable surface charge:

The Boehm (1994), titration was used for the determination of titrable surface functional groups.

1. 1.0 g portion of the mud dauber nest was mixed in 50 mL of aqueous 0.1 M NaOH solution with occasional stirring for 12 hrs.

2. The slurry was then filtered through a plastic funnel impregnated with glass wool.

3. 10mL of filtrate aliquots were added to 15mL of standard aqueous 0.1 M HCl solution and the then resulting solution was titrated back with standard aqueous 0.1 M NaOH solution. The amount of NaOH required to neutralize the sample was converted into a titrable negative surface charge by expressing the result as millimoles of H⁺ ions consumed by excess OH⁻ ion per gram of sample

Mineral Content Test: Nest clay and normal soil samples collected from the SGBAU campus were tested for their mineral contents such as Calcium, Magnesium and Potassium using atomic absorption spectrometer (Model: AA300, M/S Perkin Elmer, USA) in the Central Instrumentation Cell (CIC), SGBAU, Amravati.



Results and Discussion

One of the wasp species selected from the diverse group of wasp species in the SGBAU campus was the *S. caementarium* (black and yellow mud-dauber) for this study. The identification of the wasp nests was based on the available literature (Dvorak and Carpenter, 2010; Das and Gupta, 1989; Evans, 2007; Kim *et al.*, 2014).

For the present study, a total of 20 nests of *S. caementarium* (black and yellow mud-dauber), nests were collected from the walls of the department buildings of SGBAU during September 2018 to March 2019. The collected wasp nests were carefully processed and stored in the laboratory for their physicochemical analysis. The most widely used building material by the mud dauber is clay, a mixture of soil and regurgitated water. The comparative analysis between the nest sample of the mud dauber and the normal soil showed that the nest material was acidic (pH 6.75) whereas the normal soil was alkaline 7.82. The moisture content of the mud dauber nest was significantly low, 1.01 %. This means that the mud dauber nest can be stored for a long time without any microbial activity. The bulk density of the nest clay sample was lower than that of normal soil (Table 1).

Table: 1 Physicochemical characteristic of *Sceliphron caementarium* (black and yellow mud-dauber) nest-

Parameters	Nest Clay	Ordinary Soil
pH	6.57± 0.01	7.82±0.02
Porosity(mg/g)	0.87±0.01	0.75±0.02
Bulk Density (g/cm ³)	1.02±0.02	1.48±0.02
Moisture content (%)	1.01±0.01	2.27±0.05
Total Surface Area (g/mgI ₂)	5.55± 0.01	4.76±0.02
Total Surface Charge (mmol H ⁺ eq/g)	1.11±0.01	0.98±0.02
Iodine adsorption number (mmol/g)	0.18± 1.07	0.21 ±2.01
Calcium(mg/kg)	07.261	05.841
Magnesium (mg/kg)	02.254	01.832
Potassium(mg/kg)	01.094	02.053

This means that the nest of the mud dauber is lighter and less dense than the normal soil. The calcium and magnesium composition of the investigated nest sample was found to be high (07.261mg/kg and 02.254mg/kg) as compared to the normal soil (05.841 mg/kg and 01.832mg/kg).

Instead, the potassium content found to be quite low in nest sample over the normal soil (Table1). From the results it can be deduced that the chemical composition of the adhesive compound used for the construction of mud nests, makes it lighter and stronger than normal soil. The regurgitated mixture of the mud dauber contains a high quality of calcium, magnesium and low potassium content than normal clay soil in the SGBAU campus. Though the composition might vary by location. The investigated mud dauber nests were having the total surface area of 5.55g/mgI₂ and the surface charge of the nest sample was estimated to be 1.11gm/mgI₂ with porosity 0.87mg/g. The iodine adsorption number for nest was 0.18 mmol/g which was slightly greater for the normal soil 0.21 mmol/g.

Conclusion

From a physicochemical analysis, it can be concluded that the chemical compound responsible for the strength, lightness, and adhesive properties, of *S. caementarium* nest is the composition of various amounts of calcium, potassium and magnesium. The physicochemical properties observed for *S. caementarium* nest show that it is a compound material that could possibly be used, rather than being thrown away after removal as annoying material.

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