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Detection of Valuable Material-Protein, in Faecal Sludge

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ABSTRACT

This work focuses on detection of protein, as a valuable resource or material recovery, from faecal sludge. This would open up business prospects for recovering valuable materials from scrap, paving the door for cost-effective and long-term sanitation. Proteins from faecal sludge have been attempted to be detected using sludge samples obtained from the Faecal Sludge Treatment Plant. The presence of protein was confirmed by Scanning Electron Microscopy (SEM) and Energy Dispersive X-Ray Analysis (EDX).

Key words: *Faecal sludge, Protein detection, Resource recovery*

Introduction

A total of 290 billion Kilograms of faecal matter is produced yearly by humans around the globe, most of which remains untreated. More than half of this untreated faecal matter is directly dumped into water bodies (lakes, rivers and oceans). Even though there have been significant attempts at improving the management of generated faecal matter, very few have been successful. The fault has often been found to lie within the feasibility and sustainability of faecal matter management systems. The only possible approach to rectify these faults is to construct faecal matter management systems in the guise of profitable business opportunities. These management systems would incorporate business models intertwined with innovative technology, modern infrastructure and an expanded expenditure bracket around resource recovery. This would in turn pave way for advancements in the sector by providing feasible and sustainable sanitation (Diener *et al.,* 2014).

Till date, the ultimate fate of faecal sludge has been either fuel for combustion and soil applications without proper treatment or illegal dumping. This is due to lack of proper technology and disposal sites. This has also increased the total costs (monetary / non-monetary) of treatment with the environmental protection laws adding to the burden (Hwang *et al.,* 2008). The current practices focus only on the elimination of faecal matter. Alternately, it can be used as a valuable resource that can facilitate material recovery.

Faecal matter, which is composed of water, proteins, undigested lipids, polysaccharides, bacterial biomass, ash, and undigested food particles, is a major and underutilised source for material recovery (Rose *et al.,* 2015).

Mimouni *et al.* (2010) studied the microstructure of milk protein and the scanning electron micrographs of the milk protein was seen to have a smooth surface. Gorinstein *et al.* (2004) investigated the similarities and differences in structures of cereal and pseudocereal proteins using scanning electron

microscopy (SEM). The Scanning electron micrographs revealed that the maize proteins are regular and spherical in shape and consist of smooth surface. Yuh-Fun Maa *et al*. (1997) investigated the effect of various conditions on the morphology of spray dried proteins and scanning electron microscopy revealed that at lower temperature a greater number of spherical shaped particles were detected. It is well recognised that using heat, acid, and pressure to isolate proteins is a frequent method, and that they alter the structure of the proteins (Horstmann *et al.,* 2017).

Materials and Methods

Collection of samples

Faecal sludge sample was obtained from Faecal Sludge Treatment Plant (FSTP) Devanahalli, Karnataka. The sample is a mixture of the faecal and organic waste from multiple residential localities covered under the constituency of Devanahalli Village and Devanahalli Town. On account of the location and nature of stool sample collected there is a good probability that the faecal sludge sample may contain traces of Covid-19 causing pathogen SARS-CoV-2.

Sludge sample handling

The sludge sample was handled with extreme precaution in light of the pandemic along with the possible presence of the pathogenic coronavirus in addition to the standard precautions and guidelines that are adhered to whilst handling samples that possibly are of infectious nature.

Sludge sample preparation

The sludge was dried at temperatures of 50 °C and 90 °C in an oven. The faecal sludge sample dried at 50 °C and 90 °C were labelled as FS-50 and FS-90 respectively. Once the samples had dried completely, it was subjected to grinding using a mortar and pestle. The resulting fine powdered sludge samples were stored under inert conditions in a refrigerator to prevent protein denaturation.

Protein detection

The prepared samples of FS-50 and FS-90 were analysed for the protein present in the Faecal sludge by SEM (TESCAN-VEGA3 LMU) for morphology and EDX for quantity of constituents present in the sludge.

Results and Discussion

Figure 1. shows the SEM image of the dried sludge at temperatures of 50 °C and 90 °C. The sample contains structures having spherical shape with smooth surface (Figure 1. (A), (B)) (Costa *et al.,* 2020; Horstmann *et al.,* 2017).

The EDX analysis gave the elemental composition of the sludge sample. The carbon content in the sludge gives an estimate of the protein present in the

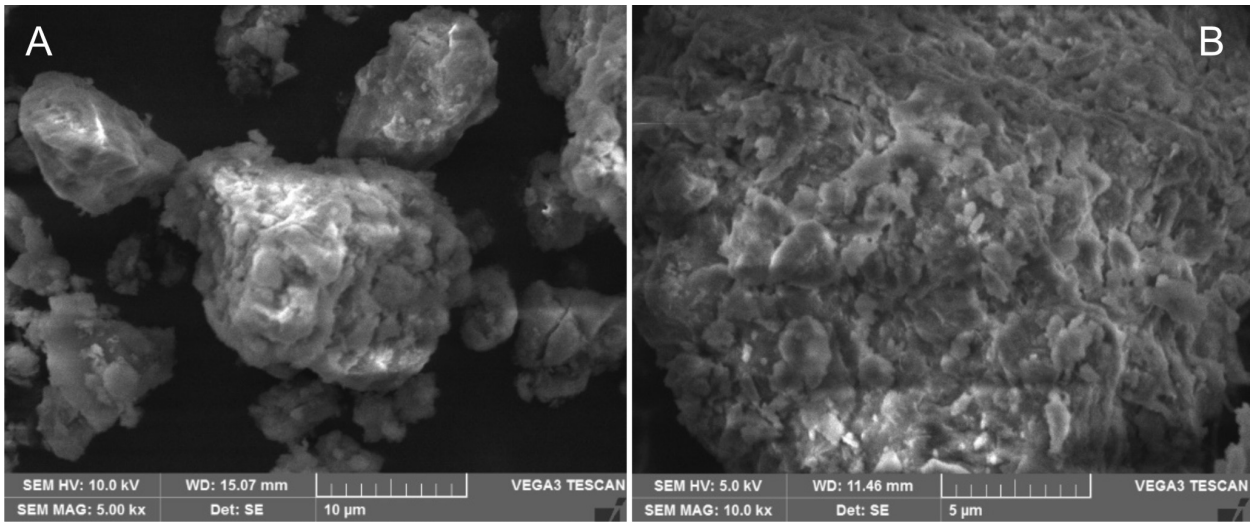

Fig. 1. Scanning Electron Micrograph of dried sludge samples.
(A) SEM image at temperature 50 °C, (B) SEM image at temperature 90 °C.

sample. Analysis of the 50 °C and 90 °C sludge sample showed around 53% carbon content (Table 1 and 2). The samples at different temperatures showed no significant difference in the carbon content.

Table 1. Energy Dispersive X-Ray Analysis of dried sludge sample at temperature 50 °C

S. No.	Element	Weight%	Atomic%
1.	CK	53.08	62.14
2.	OK	38.88	34.18
3.	AlK	1.40	0.73
4.	SiK	4.30	2.02
5.	SK	0.41	0.18
6.	CaK	1.48	0.52
7.	FeK	0.40	0.10

Table 2. Energy Dispersive X-Ray Analysis of dried sludge sample at temperature 90 °C

S. No.	Element	Weight%	Atomic%
1.	CK	53.60	62.39
2.	OK	39.45	34.48
3.	AlK	1.79	0.93
4.	SiK	2.52	1.25
5.	SK	0.52	0.23
6.	CaK	1.56	0.54
7.	FeK	0.38	0.09

Conclusion

The presence of protein was confirmed by Scanning Electron Microscopy (SEM) and Energy Dispersive X-Ray Analysis (EDX). This detected protein can be quantified and identified for the further scope of the faecal sludge management.

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