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Variability of faecal sludge characteristics and its implication for dewaterability across different on-site sanitation containments in unplanned settlements in Dar es Salaam, Tanzania

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ABSTRACT

This article evaluates the physical-chemical parameters of Faecal Sludge (FS) as possible predictors of dewatering performances. Also, the variability of FS dewatering characteristics was assessed from different containments and in different seasons in relationship with dewatering performance. A total of 120 samples were collected and analyzed during the rainy and dry seasons in April and July 2019, respectively, to capture seasonal variability. FS from pit latrines (PT) took longer to dewater followed by mixer containments, while soak-away sludge (SO) took a relatively short time to dewater. Also, FS from PT was found to have a high amount of settled solids, hence high % of TS in dry cakes. Slow dewatering and turbid supernatant corresponded to high pH, electrical conductivity and total solids, but cake solids after dewatering were correlated with total solids of FS. The FS dewaterability was higher for SO (DI = 0.9) and least for PT (DI = 0.3). Seasonal variability of FS dewaterability within the containments was higher for PT (DI = 0.74) and least for SO (DI = 0.5). Planning of FS treatment plants including sizing and design for effective dewatering performance, variation of physical-chemical dewatering predictors in sources and season could provide a relatively low-cost way to predict dewatering performance.

Key words: dewaterability, dewatering time, faecal sludge, physical-chemical predictors

HIGHLIGHTS

- Variability of FS characteristics from different containments.
- Seasonal variability of FS within the containment.
- Dewaterability potential of FS.
- Variation of dewaterability potential of FS among and within containments.
- The containment type and seasonal variation influenced the treatment of FS.

INTRODUCTION

Ensuring availability and sustainable management of water and sanitation for all is the 6th Sustainable Development Goal among the 17 Sustainable Development Goals (SDGs) adopted by the UN (United Nations 2016). Unlike the Millennium Development Goals (MDGs), SDGs emphasize the application of creativity and innovation to solve development challenges that face the world and to ensure no one is left behind (Index 2016). Faecal Sludge Management (FSM) has become a global sanitation management challenge (Strauss *et al.* 2003) especially in urban and low-income areas where a majority of the population depends on Onsite Sanitation Systems (OSS). According to Muzaki (2011), about 90% of the Dar es Salaam inhabitants use OSS facilities; where 60% of the inhabitants use pit latrines and 30% use septic tanks. The main problem that OSS facility users face is poor management services and where the management is proper, the services are rather expensive (Jenkins *et al.* 2015).

To achieve an effective and well-performing FSM system, one has to incorporate all important components of FSM planning (Strauss *et al.* 2003). The main components of FSM planning, which have been receiving a lot of attention currently, include having appropriate toilet facilities, establishing an effective collection and transportation system of FS, developing strategies for treatment, disposal, and re-use, and operational and maintenance requirements, as well as the associated costs (Strauss 2002).

Despite ensuring all the above-listed components are in place, little attention is focused on the characterization and estimation of FS quantities produced in various OSS systems. Faecal sludge (FS) treatment has presented a huge urban sanitation management challenge mainly due to the high variability of FS characteristics and high water content. Normally, dewatering is considered to be the first line of defense for FS treatment. Proper design and thus the optimal operation of FS treatment facilities, to a great extent, rely on accurate knowledge of FS characteristics. However, for accurate designing of FS treatment systems, knowledge of FS quantities generated and their characteristics are inevitable (Anh & Nguyen 2013). The design of a treatment system should be based on the results of the analysis of parameters established from samples of sludge collected from the site instead of the adoption of standard characteristics found in the literature (AECOM *et al.* 2010).

Physical-chemical characteristics of FS, however, are very variable, complicating the designing of FS treatment plants. Knowing FS physical-chemical characteristics while still in containment can contribute towards a better understanding of the future design criteria and appropriate selection of FS treatment technologies. Despite numerous studies on FS characteristics (Niwagaba *et al.* 2014; Ahmed *et al.* 2019; Awere *et al.* 2020), the variability of physical-chemical characteristics of FS affected by the type of OSS containments and season has not been documented based on type. Moreover, the physical-chemical predictor of FS also varies with season. This huge variation in physical-chemical characteristics of FS may be affecting the wide use of dewatering facilities. The second challenge is posed by the age of FS in a pit (Strande 2014a). The age of FS also affects the ability to dewater the sludge, fresh or raw FS is difficult to dewater because it is more stabilized (Strande 2014b). In this study, FS was characterized to ascertain its potential of being dewatered, taking care of variation of physical-chemical predictors of FS between different seasons. The study took place in Dar es Salaam city, where FSM is a persistent problem and residents have adopted various types of containments.

METHODOLOGY

Description of study area

This study was conducted in Ubungo district of Dar es Salaam city (Figure 1), which is one of the fastest-growing cities in Africa. It is estimated that 70% of the city population lives in an unplanned area and therefore FS treatment is a problem (Mrimi *et al.* 2020; Seleman *et al.* 2020). According to Brandes *et al.* (2015), only about 43% of the generated FS in Dar es Salaam is safely managed, the remaining amount is disposed of in the surrounding

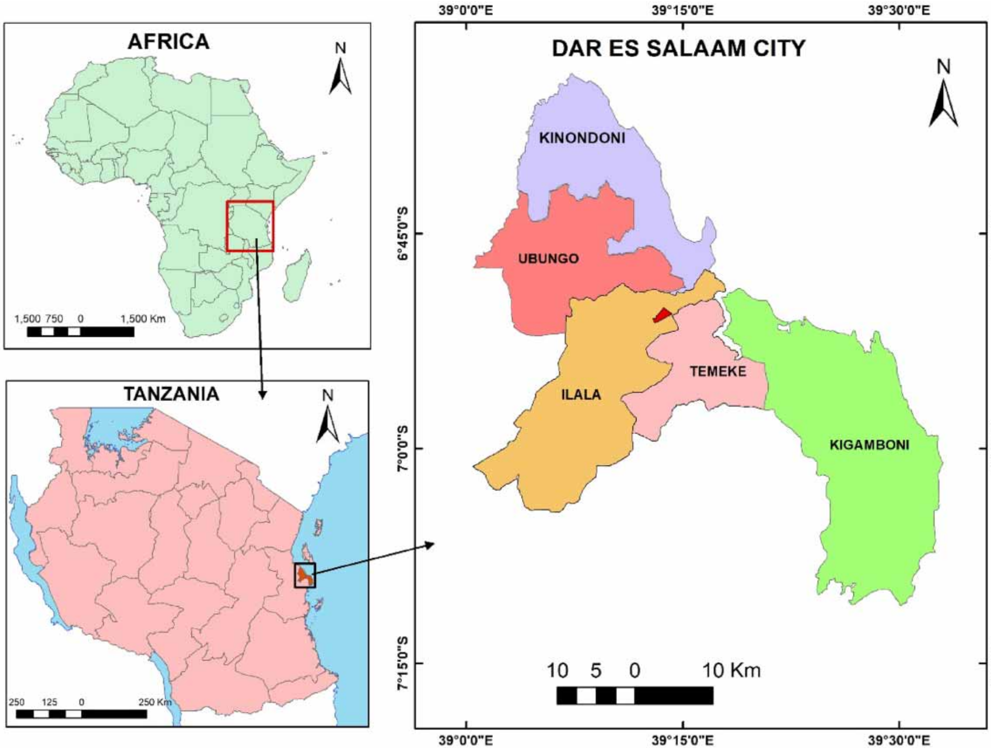

Figure 1 | Location of a case study (modified from Ramani-Huria shape files, 2012).

environment (Mwambete & Tairo 2018; Mkude *et al.* 2019). The study area is characterized by having two main seasons. The dry season starts from June to August and the rainy season starts from March to May (Ngailo *et al.* 2018). The city comprises an estimated population of 6.4 million with a growth rate of 5.29% (NBS 2017).

Study approach

The study was designed to capture the seasonality and variation of weather that was argued to influence FS characteristics. Samples were collected in two sets, one set during the rainy season in April 2019 and another set in the dry season, July 2019.

Faecal sludge sampling

A composite sampling technique was used to collect FS samples from emptier trucks that were discharging FS at the disposal site of Vingunguti Waste Stabilization Ponds (WSPs). The FS samples from trucks were collected at three intervals; a one liter grab sample was collected at the beginning of the discharge when the truck tank volume was full, and two-litre samples were collected at the middle of discharge when the truck tank volume was half, as observed on the gauge, as suggested by Strande *et al.* (2018). Lastly, a one-liter sample was collected at the end of discharge when the volume was about a quarter full. The grab samples from each truck were mixed in a 10-liter container to obtain a composite sample from which one-liter FS was taken for laboratory analysis. A total of 120 FS samples were collected, 60 samples during the dry season and 60 samples during the rainy season.

FS source

The information about the source and nature of FS was obtained from the emptier truck operators and drivers through interviews just before the sampling process began. Four groups of samples were clustered based on their containment sources as pit latrines (PL), septic tanks (ST), soak-away pits (SO), and a mixture of soak-away pits and septic tanks (MX). To get the minimum number of 30 samples from one containment, 15 samples were collected per season from each containment. The FS samples were collected until the desired sample numbers were reached. The collected samples were stored at 4 °C, and transported to a laboratory for analysis on the same day.

Sample analysis

Physical-chemical characteristics

FS samples were analysed for physical-chemicals as possible predictors of FS dewatering performance. Samples were characterized for total and volatile solids (TS and TVS), total suspended solids (TSS), electrical conductivity (EC), temperature, and pH according to the standard methods (APHA *et al.* 2017).

Dewatering performance

Settling of particles. The volume of settled particles after extended settling (12 hours) was evaluated to compare performance amongst the different sludges from different containments during the dry and rainy season. Compressibility of the settled sludge was monitored by volume of particles settles (sludge volume index (ml/g)) after 60 min of settling in Imhoff cones following standard method (APHA *et al.* 2017).

Dewatering time. Dewatering time, the time it takes for free water to filter through the sludge and filter paper, was measured using the capillary suction time (CST (s)) according to standard methods (APHA *et al.* 2017). A Triton 319 Multi-CST apparatus with an 18 mm funnel was used. CST values were normalized based on TS in the sample (sL/gTS), to compare results across samples with different solids concentrations (Peng *et al.* 2011; APHA *et al.* 2017).

Dewatering extent. Dewatered cake solids (dewatering extent) were defined as the total dry solids in the dewatered sludge cake after centrifugation. 40 mL faecal sludge samples were centrifuged in 50 mL centrifuge tubes at 400 × g for 5 minutes. After centrifugation, the supernatant was decanted, and dry solids (% of TS) in the cake measured in accordance with standard methods (APHA *et al.* 2017). Dry cake solids after centrifugation were measured in the laboratory to determine dewatering performance at scale (Kopp and Dichtl 1998; Gold *et al.* 2018).

Dewaterability potential of FS. It has been reported that several FS sources show physical-chemical parameters prospects for dewatering, though at laboratory scale. Therefore, it is important to evaluate the comparative suitability of a particular source before choosing it for dewatering. Given the various requirements for successful FS dewaterability, a 'Dewaterbility Index' (DI) is defined to provide a quantitative assessment indicating the suitability of an FS dewaterability based on its physical-chemical parameters specifically pH, EC, TS, TSS, TVS. The index formula was adopted and modified from Kataki *et al.* (2016) as the density of water applied in the FS field by Tayler (2018). A higher DI will indicate better suitability of the FS from containments for dewaterability. To determine the DI, it was assumed that high concentrations of pH, EC, TS, TSS, and TVS were beneficial for FS dewaterability. DI is determined for each group of the four FS streams. The maximum values for favorable physical-chemical parameters, here pH, EC, TS, TSS, and TVS values of the group of predictors, were used for estimation of DI as given in Equation (1). The DI calculated as the median of the normalized values was considered to rank the FS sources for their suitability as a dewaterability source. For FS with variable composition, a DI range was calculated.

$$DI = \frac{1}{(m+n)} \sum_{i=1}^{i=n} \left(\frac{(x_i)}{x_{i,max}} \right) \tag{1}$$

Let $A = 1/(m)$ then modified equation used in this study is shown by Equation (2)

$$DI = A \sum_{i=1}^{i=n} \left(\frac{(x_i)}{x_{i,max}} \right) \tag{2}$$

where $DI =$ dewaterability index; $x_i =$ sample value corresponding to the i^{th} favorable FS physical-chemical dewatering parameter; $x_{i,max} =$ maximum of the sample values corresponding to the i^{th} favorable FS physical-chemical dewatering parameter; and $m =$ total number of favorable parameters, which for this case was 5.

The value of $\mathrm{A} = 0.2$ was used throughout and it was obtained from $1/(m)$.

Measurement replicates for parameters were performed according to recommended quality assurance and quality control (QA/QC) measures stipulated in standard methods (APHA *et al.* 2017). Reported values are averages of measurement replicates, and error bars in figures represent the standard deviation of the replicates. Descriptive statistics (min, max, means, median and standard deviations) were used to describe characteristics of FS from different containments. Statistical analysis was performed using the RX 64 4.0.2. Plots were produced using R-studio 4.0.2. For boxplots, the middle line represents the median, and the boundaries of the box represent the first and third quartiles (Q1 and Q3). The upper whisker extends to the last data point less than Q3 + 1.5 * (Q3 – Q1), and the lower whisker extends to the first data point greater than Q1 – 1.5 * (Q3 – Q1). Outside of the whiskers, data are considered outliers and plotted individually as open circles.

Normality distribution of parameters data within the containments was tested using the Shapiro-Wilk test ($\alpha \leq 0.05$), together with Q-Q normal graphs. Descriptive statistic was used to describe a variation of predictors of FS dewaterability in terms of minimum, maximum, mean, median, and standard deviation of the results. Statistical significant difference among the containments was analyzed using a non-parametric test (Kruskal-Wallis test). To ascertain the seasonal variation of FS characteristics within the containments, the Wilcoxon test for mean at 95% significance level was used. All the analysis was run using R software (version 4.0.2).

RESULTS AND DISCUSSION

Normality of data

The results of the normality test of FS data for all predictors from all containments with their corresponding Shapiro-Wilk numbers show that some of the predictors in some containments especially that of soak-away containments were normally distributed. However, all TS, TSS, EC data from all containments lack normality distribution. These results line with results found in some literature (Gold *et al.* 2018; Semiyaga *et al.* 2017; Ward *et al.* 2019). Therefore, all the data of the predictors which lack normality were analyzed with the non-parametric test (Kruskal-Wallis test and Wilcoxon-test) while normally distributed were analyzed using the parametric test (ANOVA and t-test). Therefore, based on these results in this study, non-parametric tests and parametric tests were used interchangeably.

Variation of FS characterization among four containments

Table 1 present the results of faecal sludge characterization variation as grouped by source and compared with existing literature values of FS. The results of FS physical-chemical characteristics in the current study are within the range of the FS reported values from other literature studies. Generally, the results of the Kruskal-Wallis test show that the mean values of measured physical-chemical predictors were significantly higher in FS from pit latrines than other sources ($\alpha \leq 0.005$). However, values of pH in FS from pit latrines were not significantly different from those of other containments (Table 1). Also, the results indicate that the mean EC values in the pit latrine are 1.2–2 times higher than the other containments. The low TVS proportions in FS from pit latrines could be a reflection of reduced organic matter through microbial degradation into carbon dioxide and ammonia. Likewise, the higher TS pit latrine FS (15,776 ± 10,837) compared to that of other containments could be due to infiltration of liquid through pit sides as opposed to all retained sludge in other containments.

Table 1 | Descriptive statistics for faecal sludge predictors organized by source

			Physical-chemical predictors of FS				
Source	**Descriptive analysis**	**N**	**pH**	**EC (μS/cm)**	**TS (mg/l)**	**TSS (mg/l)**	**TVS (mg/l)**
PT	Min	30	6.5	823	4,587	478	567
	Max	30	8.2	11,970	47,228	9,643	8,987
	Mean	30	7.3	4,603	15,776	2,883	4,095
	Median	30	7.4	3,865	13,475	1,602	4,222
	Std	30	0.5	2,825	10,837	2,669	2,212
ST	Min	30	6.5	1,107	3,568	236	321
	Max	30	8.8	5,950	22,572	6,239	4,012
	Mean	30	7.4	2,567	8,794	1,385	1,745
	Median	30	7.4	2,025	7,141	1,234	1,498
	Std	30	0.6	1,426	4,602	1,082	1,081
SO	Min	30	0.4	596	1,370	214	204
	Max	30	7.4	6,510	11,884	3,919	4,008
	Mean	30	7.4	2,797	4,301	840	1,568
	Median	30	6.4	2,565	2,711	539	1,262
	Std	30	8.0	1,551	3,131	767	909
MX	Min	30	6.5	53.8	8,097	225	817
	Max	30	8.3	5,400	18,999	19,682	11,034
	Mean	30	7.3	1,934	19,682	1,434	3,737
	Median	30	7.4	1,581	2,272	1,145	3,002
	Std	30	0.5	0.27	1,509	1,490	1,434
Literature FS			6.9–8.5[a,c]	2,000–18,000[d]	1,000–52,000[b,d]	200–30,000[b,d]	430–38,480[c]
P-values			0.234	0.0045**	0.0002**	0.0035**	0.0013**

Literature values shown are a range of mean values from the published characterization of faecal sludge.

**Significant values.

[a] US EPA (1984).

[b] Lowe *et al*. (2009).

[c] Henze *et al*. (2008).

[d] Gold *et al.* (2018).

There is a significant difference for all FS dewatering predictors' characteristics among the containments. The design and thus the operation aspects of the containments could have contributed to these differences. This variability might have been caused by different factors such as storage duration, climate, type of onsite system, and pump capacity of the emptying truck. Besides, the lack of consistent sampling methods could have a significant impact on the results (Niwagaba *et al.* 2014; Strande 2014a). These results are supported by previous studies found elsewhere (Gudda *et al.* 2017), Cameroon (Maffo *et al.* 2019), and Ghana (Awere *et al.* 2020). A similar trend was detected in FS parameters affecting the dewaterability of FS among and within the OSS containments.

Seasonal variation of FS characteristics within the containments

The seasonal variation in the FS characteristics within the pit latrine is shown in Table 2. The results have shown that all predictors of FS measured in pit latrines generally decreased significantly during the rainy season, except that of pH and TVs with $p = 0.65$ and 0.191, respectively. Due to this high variability, a statistically significant difference of other EC, TS, and TSS observed in pit latrines between the dry and rainy seasons was detected. However, total solids (TS) increased significantly during the dry season ($p = 0.001$). The change in the trend of the total solids was expected since water was lost from the wall of the pit latrine during the dry season.

Table 2 | Descriptive statistics for faecal sludge predictors from pit latrines

FS predictors in seasonal	N	Mean	Std.	Min	Max	*P*-values $\alpha \leq 0.005$
pH-dry	15	7.4	0.6	6.5	8.24	0.65
pH-rain	15	7.3	0.5	6.49	7.98	
EC-dry (µS/cm)	15	5,658	3,135	823	11,970	0.047**
EC-rain (µS/cm)	15	3,548	2,077	1,207	8,940	
TS –dry (mg/l)	15	22,844	10,849	11,884	47,228	0.001**
TS–rain (mg/l)	15	8,709	4,308	3,568	18,960	
TSS-dry (mg/l)	15	4,572	2,885	1,138	9,643	0.001**
TSS-rain mg/l)	15	1,194	567	478	2,561	
TVS-dry(mg/l)	15	4,543	1,809	1,268	7,388	0.191
TVS-rain (mg/l)	15	3,647	2,536	567	8,987	

**Significant values.

Table 3 present the results of the Wilcoxon signed-rank test for FS from septic tanks, soak-away, and mixture. The results indicated that all other predictors in septic tanks FS except for pH significantly varied during the dry and rainy season. Further, the pH of FS from the soak-away pit show statistically significant difference during the dry and rainy season ($p = 0.008$). On the other hand, only EC of the FS from the mixture varied significantly during the dry and rain season ($p = 0.035$). Generally, most FS predictors in soak-away pits and mixtures have no statistical significance during the rainy and dry seasons. The seasonal variability of FS dewatering potential within the containments could have been attributed to the availability of FS dewatering predictors during the dry and rainy seasons. Similar results were reported in Ouagadougou, Burkina Faso (Bassan *et al.* 2013).

Table 3 | *P*-values of seasonal variability of FS from the septic tank, soak-away and mixed sludge

	P-values ($\alpha \leq 0.005$) of FS-predictors with the containments during dry and rain season				
Sources at different seasons	pH	EC (µS/cm)	TS (mg/l)	TSS (mg/l)	TVS (mg/l)
Sep-Dry Sept-Rain	0.008	0.003**	0.004**	0.0045**	0.004**
SO-Dry SO-rain	0.019**	0.778	0.730	0.551	0.551
MX-Dry MX-Rain	0.006	0.035**	0.096	0.006	0.006

**Significant values.

FS dewatering performance

The results of FS dewatering performance by the source of FS are presented in Figure 2. Third-quarter of the FS from pit latrines settled after prolonged settling for 24 hours compared with other sources (Figure 2(a)). Besides, FS from pit latrines took longer to dewater (indicated by higher CST values) compared to other sources (Figure 2(b)). Moreover, the difference in dewatered cake solids between sources was notable, where large %

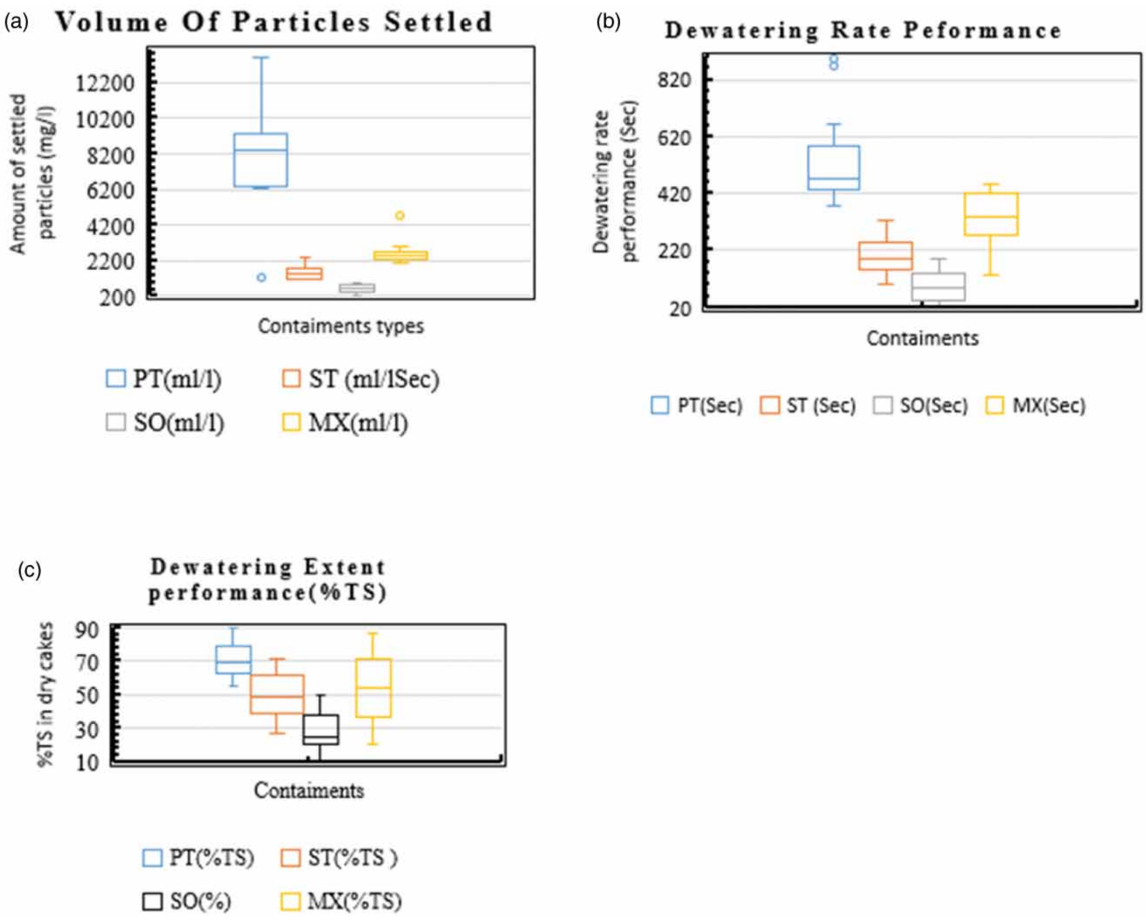

Figure 2 | Box plots showing the relationship between containments and the FS dewatering performances.

TS in cakes were noted in the PT source (Figure 2(c)). While faecal sludge coming from PT toilets was a predictor of a high amount of settled particles, long dewatering times, and final cake solids after dewatering. In comparison to the research detailed in Strande *et al.* (2018), PT and other sites had the same type of containment. The difference in dewatering performance between PT and other sources is likely related to physical-chemical parameter that can affect FS qualities.

Dewatering time

The influence of physical-chemical parameters on dewatering time performance for FS from different containments is presented in Figure 3(a), 3(c), 3(e), 3(g), 3(i). Slower dewatering (i.e. higher CST) corresponded to the higher concentrations of TS, TSS, pH, EC, and TVS in pit latrines compare to other sources (Figure 3(a), 3(c), 3(e), 3(g), 3(i)). High concentrations of TS contribute to clogging of filters and pores within the sludge cake, resulting in slower dewatering. This was the main contributor to poor filtration performance for FS sludge from pit latrines (Gold *et al.* 2018; Ward *et al.* 2019). As depicted in Figure 3, dewatering time (CST) increased with increasing EC, TS, TSS, and TVS of FS and was unpredictable with decreasing pH of FS. For example, samples with high EC concentrations took longer to dewater.

Additionally, it has been observed that physical-chemical predictors also affect FS dewatering by either increasing or decreasing FS dewaterability performance parameters (decreasing and increasing dewatering rates). Therefore, high pH, EC, TS, TSS, and TVS slow dewatering rate of FS through increase of dewatering extent (high %TS in dry cakes). The same observation has been reported by Ward *et al.* (2019). Therefore, it was hypothesized that faecal sludge samples with high pH, EC, TS, and TSS affected the coagulation properties of FS, hence the dewatering performance parameters such as CST.

Percent TS of dry cake performance

The influence of physical-chemical parameters on % TS of dry cakes performance for FS from different containments is presented in Figure 3(b), 3(d), 3(f), 3(h), 3(j). As illustrated in Figure 3, dewatered cake solids were

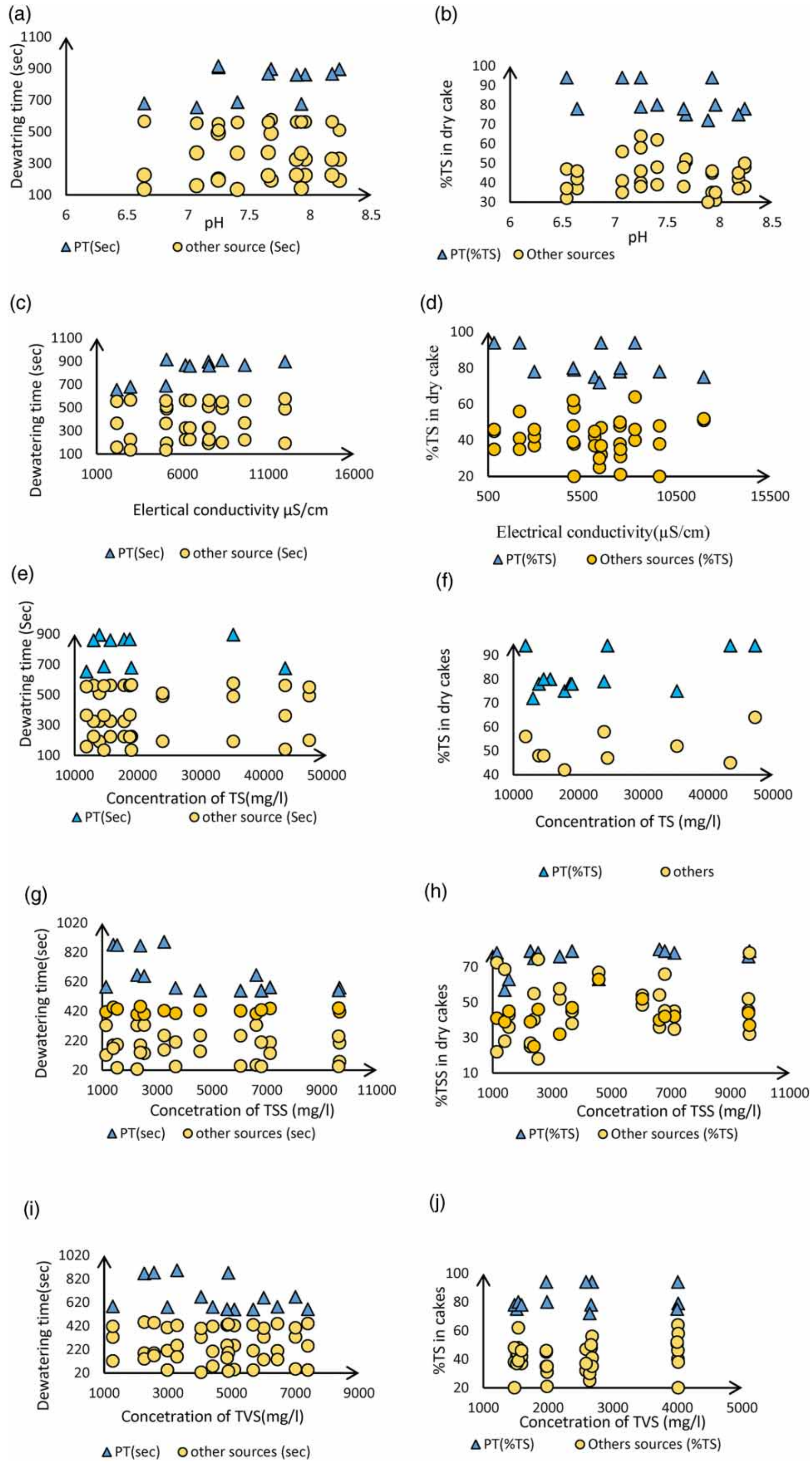

Figure 3 | Scatter plots illustrating the relationship between dewatering time (CST (sL/gTS)) and the concentration of pH, EC, TS and TVS. Samples from the pit latrine are represented by filled triangles, and samples from all other sources (ST, SO, and MX) are represented by filled circles.

generally higher in FS with lower TSS both in a pit latrine than other sources. It was indicated by pit latrine having high amount of % of TS in dry cake solids compared to other sources. In Figure 3(f), dewatered cake solids were generally higher in faecal sludge with lower TVS, especially for PT. We hypothesize that TVS was not a strong predictor of dewatering due to the influence of large inorganic particles that may be present in faecal sludge. Dewatered cake solids do not increase with decreasing TVS, although observations do fit within the existing behavior of faecal sludge from septic tanks and lined pit latrines (Gold *et al.* 2018).

Seasonal variation of FS dewatering performances

Figure 4 present the seasonal variation of FS dewatering performances, which include dewatering time and extent. The results indicated that dewatering time performance in all containments is higher than during the rainy season, especially that of PT (Figure 4(a)). This might be due to loss of water through the wall of PT leading to high concentrations of TS in the PT, contributing to clogging of filters and pores within the sludge cake, resulting in slower dewatering. Moreover, the results indicated that there is a variation of % TS in dry cakes during the rainy season especially for PT and ST (Figure 4(b)). However, results indicate a significant percentage of TS in the dry season compared with the rainy season, $p = 0.003$.

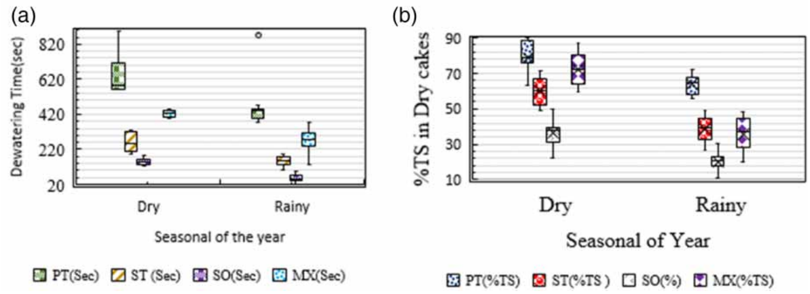

Figure 4 | Box plots illustrating the seasonal variability of dewatering time performance (CST (sL/gTS)) and dewatering extent (%TS in dry cakes) performance in different containments. (a) Dewatering rate performance for FS dewatering, (b) dewatering extent performance for FS dewatering.

Dewaterbility potential of FS

Figure 5 presents the dewaterability potential as represented by the dewaterability index (DI) of FS among the containment. The DI results obtained indicate that SO has a higher dewaterability potential as depicted by DI (0.9) than other containments. Probably, this could be due to filtrate water allowing more water to come in the SO after solid particles settled on ST containment. The order of the dewaterability potential was found to be high on SO and least on PT. There is a decreasing trend in dewaterable FS among different containments. The highly dewaterable FS is the one produced by SO while the least is that produced by PT. This might be because in SO a large number of solids have been settled, leaving more free water (Strande *et al.* 2018). In PT, it could be probably due to a large amount of free water in FS percolating through the wall of the pit and leaving a large portion of interstitial and surface water bonded on solid particles (Gold *et al.* 2018).

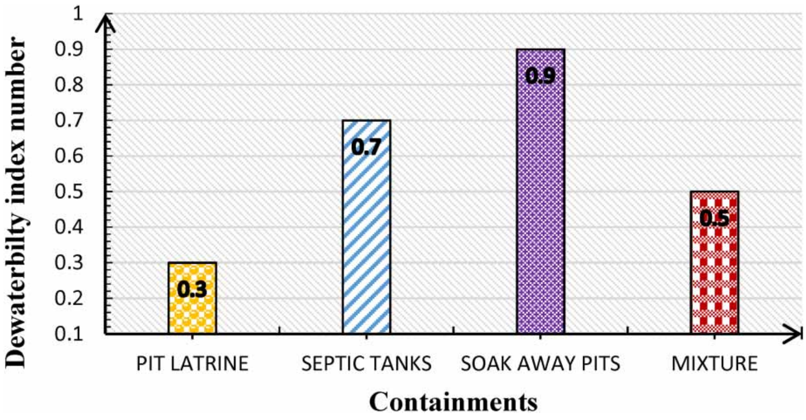

Figure 5 | Dewaterability potential among the containments.

Seasonal dewaterability potential of FS

It is valuable to compare the dewaterability potential of faecal from different containments both in dry and rainy seasons to determine what knowledge can be transferred to faecal sludge and what cannot. Figure 6 presents the seasonal dewaterability potential of FS. The results indicate that the dewaterability indexes for all containers were higher in the rainy season than in the dry season. This might be due to rain water infiltrating into the containments, especially for unlined pit latrines. Also, there was an increase in microbial activity in breaking down the biodegradable component of the FS in the rainy season, resulting in leaving a larger portion of water in FS than solids. The seasonal dewaterability potential was higher in PT and least in SO.

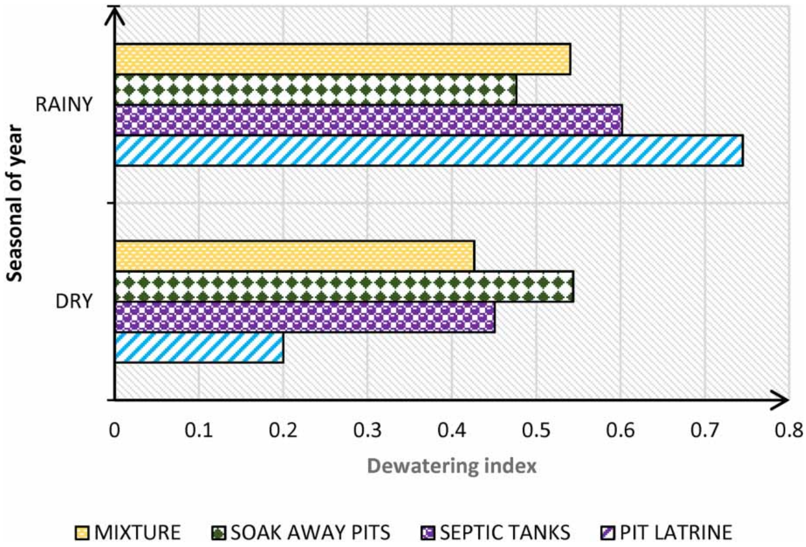

Figure 6 | Seasonal Dewaterbility index of FS dewatering characteristics.

For the planning of community- to city-wide faecal sludge treatment, including planning, sizing, and design of treatment plants, relationships between containments (sources of FS) and seasonal and physical-chemical characteristics of faecal sludge could provide a relatively low-cost way to help predict dewatering performance.

CONCLUSION AND RECOMMENDATION

This study was conducted to understand the variability in FS characteristics and its implication for the dewaterability potential across different OSS containments. It was concluded that there are various FS characteristics in different OSS containments. There was a huge intrinsic variation between all the FS samples, with statistically significant differences during the rainy and dry seasons, and among the different OSS containments. Types of onsite systems need to be considered when designing FS treatment plants, as they have a direct impact on the variability of FS dewatering performance parameters. The same should be considered during the dry and rainy seasons.

Physical-chemical parameters of FS are important for faecal sludge dewatering performance, as observed in this study. Higher concentrations of EC, TS, and TSS are likely to contribute to clogging dewatering technologies like sand dry beds, therefore increasing the dewatering rate. It was observed that there are relationships between EC, pH, TSS, and dewatering time. This could be quick and cheap to implement and predict dewaterability at treatment plants or be used for dosing of conditioners for enhanced dewatering.

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DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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