The value of leaves as an additive of *Fossa alterna* pits.

Constant reference is made to the considerable benefit which can be derived by adding leaves to ***Fossa alterna*** pits. Leaves help the composting process considerably, by adding more air into the mix, and by adding a composting process undertaken largely by fungi to the already existing bacteriological process undertaken by soil micro-organisms.

During the first year of operation, the second pit of the ***Fossa alterna***, which must be built at the same time as the first pit, can be left empty and covered with a wooden lid. This will be the standard procedure. However it is possible to take advantage of the second pit during the first year of operation. One of the best methods is to make leaf compost within this pit for the first year of operation.

At one site in Epworth close to Harare, leaves were gathered and emptied into the pit interspersed with thin layers of the local topsoil. Water was added from time to time. After 12 months the leaf compost was excavated and proved to be much richer in nutrients than the original soil. In fact plants grew in this leaf mould far better than in the original soil. The second pit acted like a pit composter and was well worth the simple effort involved of adding leaves, soil and water. The following table shows the increase of nutrient levels in the leaf compost made in the second pit compared to the local topsoil

The figures below show the pH and levels of nitrogen (after incubation), phosphorus, (ppm) and also potassium, calcium and magnesium (ME/100gms.) in the leaf compost formed in the second pit of a ***Fossa alterna*** compared to the surrounding topsoil which was added together with local leaves.

Soil source	pH	N	P	K	Ca	Mg
Local topsoil (Epworth)	**4.1**	**23**	**54**	**0.07**	**1.72**	**0.50**
Leaf compost from second pit	**7.7**	**81**	**130**	**1.86**	**9.31**	**1.88**

Composted leaves clearly have a considerable nutrient value of their own and no doubt greatly enhance the final quality of ***Fossa*** humus, if added. The results of four soil analyses of leaf mould formed in wire baskets and a variety of containers is given below. A description of these leaf mould makers is given later in this book.

Analysis of leaf mould

Soil source	pH	N	P	K
Leaf compost in wire basket	**8.2**	**256**	**344**	**3.92**
Leaf compost formed in plastic bag	**7.8**	**267**	**294**	**8.50**
Leaf compost formed in steel drum	**7.6**	**239**	**255**	**0.60**
Leaf compost formed in brick moulder	**7.4**	**540**	**266**	**9.00**

Overall comparisons of soils and composts

Soil source	pH	N	P	K
Mean value (local top soils)	**5.5**	**38**	**44**	**0.49**
Mean value leaf mould	**7.75**	**325**	**290**	**8.00**
Mean value (*Fossa alterna*)	**6.86**	**273**	**278**	**4.22**

Physical properties of excreta, soil, leaf mixes.

One interesting property of excreta or mixes of excreta and soil, both in jars and pits is that the volume is considerably reduced over time. Even with abandoned full latrine pits the volume may decrease considerably over time. In urine diverting toilets the urine is channeled away and the faeces dehydrate or compost and loose their initial volume due to loss of moisture. In shallow pits the combination of urine and faeces also loose volume over time with the urine being absorbed into the soil added to the pit and also into the soil surrounding the pit. The bulk and volume of the faeces is also reduced over time with the liquid fraction of the faeces being absorbed into the soil added to the pit. It is known that the water content of the faeces is variable but always high. It is this larger water fraction of the faeces which can be absorbed into other ingredients added to the pit (soil, ash, leaves),whilst the remaining smaller solid fraction of the faeces is converted into humus, which forms part of the final total volume of the humus formed in the pit or jar.

But what are the fractions?

The following experiment was carried out to calculate the percentage water content of faeces by combining a known weight and volume of faeces with a known weight and volume of dry soil. Since the dry soil would loose neither weight of volume, any change in the final volume and weight of the mix would be caused by changes in the properties of the faeces.

A sample of faeces was collected in the ***Skyloo***. This sample weighed 357gms, had a volume of 340mls and a density 1.05 gm/ml. This was mixed with a near equal volume of dry soil with a weight of 352gms, a volume of 310mls and a density of 1.135 gm/ml. Therefore the total weight of the mix was 709gms having a volume of 650mls and an overall density of 1.084 gm/ml.

On the left, raw faeces and soil being mixed prior to composting. On the right a mix of leaves, soil and raw faeces prior to mixing and composting

This was allowed to slowly compost over a period of 24 days. Fly larvae developed in the mix, which also attacked by ants. Slowly the mix changed into soil.

Another mix was made with an approximately equal mix of faeces, dry soil and crushed dry leaves. This mix was also allowed to compost for the same period.

After the period of composting both samples were laid out in the sun to substantially dry out, but not to full dessication status. The final weight of the dried soil/faeces mix was 420gms, with a volume of 405mls and a density of 1.037gm/ml.

Thus the weight of the "new soil" formed had increased from 352 to 420g (about 19%), compared to the original soil in the mix and the volume of the "new soil" had increased from 310mls to 405mls (about 30%) compared to the original soil in the mix. Since the volume and weight of the dried original soil cannot change, the faeces weight had therefore been reduced from 357g to 68g (420 - 352g) - 19% of original. So water content was 81%. The faeces volume had therefore been reduced from 340mls to 95ml (405 - 310ml) - 28% of original). So the final density of the mix was less than the original soil. The mix was also darker in colour. The overall initial combined wt of the combo was reduced from 709g to 420g) (59.23% of original). The overall initial volume of the combo was reduced from 650 ml to 405ml. (62.3% of original).

The processed combination of "NEW SOIL" was very similar in appearance to original soil since 76.5% of its new volume and 83.8 % of its new weight consists of the original soil.

Samples of original soil (left), and "new soil" made from faeces and soil (centre) and from faeces, soil and leaves (right)

In the case of the faeces/soil/leaf mix a final weight of 270gms was measured with a volume of 405mls. This gives a density of the combination of 0.66gms/ml. This is a much lower density compared to the faece/ soil mix. Clearly the addition of leaves lowers the density, a result no doubt of the less compaction and more air in the mix due to the presence of leaves.

These properties would encourage far more efficient composting. Composting is far more effective as the air content increases.

This is a very important finding.

Density trials on *Fossa alterna* humus

The results shown above would explain why a mix of excreta, soil and leaves appears to compost much faster than a mix of soil and excreta only. To test this theory the humus taken from a ***Fossa alterna*** which had a mix of excreta, soil and leaves was compared to the humus taken from another ***Fossa alterna*** which had a mix of excreta and soil only.

The initial comparisons (for volume, weight and density) were made in crumbly (not dried) ***Fossa alterna*** humus. These samples were then dried out in the sun to obtain new parameters.

***Fossa alterna* soil (crumbly, not dried)**

Soil /humus type	Vol. ml	Wt.gm	density
FA kia (excreta,soil,leaves)	410 (jam jar)	370g	0.90g/ml
FA FF (xcreta,soil only)	410	402g	0.98g/ml
Garden soil	400	443g	1/10g/ml

***Fossa alterna* soil (sun dried)**

Soil/humus type	vol. ml	Wt.gm	density
FA kia	325	278	0.85g/ml
Fa FF	370	338	0.91g/ml
Soil	368	392	1.06g/ml

These results reveal that where leaves are added to the ***Fossa alterna*** pit the resulting density of the humus is lower. The density of the humus is related to both the moisture content and the air content. The more air (with some moisture) the better the conditions for composting. Thus a mix of excreta, soil and leaf in the Fossa alterna pit is more effective and leads to a faster and more efficient composting process than the mix of excreta and soil alone. Interestingly it was this mix of excreta, soil and leaves which was tested in the initial ***Fossa alterna*** trial in 1999.

Leaves are an important ingredient in this process because the leaves provide extra nutrients to the mix, they provide extra air and improve soil texture. They add a process of fungal decay in the mix as well as composting based on bacteria. They also provide a larger surface area for the composting process to take place and allow for better pit drainage. All these combined beneficial effects of leaves enhance the composting process considerably.

Consequently the addition of leaves to the shallow pit composting process in both the ***Arborloo*** and ***Fossa alterna*** has been greatly encouraged. Similarly leaves are now added to the buckets holding faeces, ash and soil in the ***Skyloo*** and subsequent jar composters.

Adding leaves to shallow pits

Adding dried leaves to shallow pits used in the *Arborloo* and *Fossa alterna* helps the composting process considerably.

Adding leaves to *Fossa alterna* pits. On left at Woodhall road, on right at Epworth, near Harare.

Placing leaves down a toilet pit in Maputaland, South Africa. Right: Photo of two sacks full of leaves at the base of a concrete lined pit in Maputaland,

Adding semi composted palm leaves to the base of a *Fossa alterna* pit in Mombasa, Kenya (left). Adding leaves to a *Fossa alterna* pit at Fambidzanai, the Permaculture Association of Zimbabwe.