Pharmaceutical Residues
in human dejecta

Must we be concerned about using composted dejecta for food crops?

By Joseph Országh
(adapted and translated by André Leguerrier)

The issue

Here is an excerpt of a message from one of our correspondents:

« During a Forum on Permaculture in Hungary, we witnessed a passionate discussion opposing BioLitter Toilet (BLT) [1] dry toilet users to those who were concerned about using this type of dry toilet. The issue was: what is the better option? Using a BLT? Or collecting dejecta in a closed holding tank from which the dejecta would be periodically removed to be dispatched for treatment by specialized companies?

A person at the Forum asserted that hormone residues contained in contraceptive drugs and other pharmaceutical residues can subsist in composted humanure (human dejecta) derived from the use of a BLT. Whereas these same dejecta, collected in a closed holding tank, can be entrusted to companies that have the appropriate technology to decompose said residues. »

The Forum organizers wanted to know what stand would be taken by the EAUTARCIE group.

Joseph Országh's response

Such discussions often happen between BioLitter Toilet advocates and opponents in France and Belgium where the BLT is relatively popular (and known as the « toilette à litière biomaitrisée » or « TLB »). The BLT is subject to criticism that usually revolves around recurrent themes. An article published on the EAUTARCIE website [2] by Joseph Országh and André Leguerrier somewhat calmed the debate in France. Said article analysed the work of a Japanese scientist, which suggested that the compost derived from a BioLitter dry toilet system (or « conventional style » dry toilet as it is called in the scientist's paper) would lose almost all the nitrogen contained in human dejecta. This claim was based on experiments conducted by the scientist. Our analysis of said experiments and findings showed the complete opposite. After the publication of our article, BLT opponents (senior academics among them) hushed up – at least temporarily [3].

[1] Link: https://www.youtube.com/watch?feature=player_embedded&v=zUTaiFItH58.
[2] Link: http://www.eautarcie.org/doc/article-qualite-compost-tlb-en.pdf.
[3] Sometimes even renowned scientists come to construe their experimental findings to mean what they had initially set out to prove. During my 43-year academic career, I have often been called upon to be part of juries to evaluate doctoral work. On such occasions, I sometimes did calculations that the author had not deemed useful, and in many instances, my calculations proved the opposite of the author's conclusions. (Such situations always hurt the doctoral supervisor more than the doctoral candidate). A classic example of this type of approach is an article published in France on zinc and cadmium pollution of the Seine River from building roofs in Paris. See explanations at following link: http://www.eautarcie.org/en/03b.html#d2.

The BioLitter Toilet and the real concerns about pharmaceutical residues

The controversy around drug residues found in the effluent of BioLitter Toilets goes way beyond the field of composting human waste. Laboratories that study the effects on aquatic life of pharmaceutical residues from sewage are aware of the problem's extent. The real threat does not come from using a BLT, but from the route by which such residues travel within the biosphere. The need for alternatives to wastewater treatment is self-evident. How can we bring people to recognize that the science of sanitary engineering is in a dead end?

Unlike many environmentalists, I personally am no longer a hardcore advocate for the « all-out » use of the BioLitter Toilet [4] : better to stay realistic. Even in peri-urban and rural areas where BLTs could easily be used, the majority of the population refuses to consider them. Yet there is another practical side to ponder: already now, and even more in the future, an increasing proportion of humanity will live in cities and huge buildings where managing a BioLitter Toilet is virtually impossible. So those who criticize BLT-type dry toilets are missing the mark: BLT usage is a marginal activity that has no impact on a worldwide scale. Evidently, people do not even realize that the BioLitter Toilet *modus operandi (*that we call the *BioLitter principle)* can be transposed to cities through a system that involves placing the equivalent of a « gigantic BLT » on the outskirts of a city (that we call the « Biomass treatment and composting centre » [5]), whereat the population can keep using flush toilets. With this option, the agricultural use of human waste becomes possible, without sanitary danger and without the need for wastewater treatment/purification. Also, the spreading of sewage sludge on land is only a caricature of the SAINECO system [6] (i.e. EAUTARCIE's version of ECOSAN) and is inefficient for the regeneration of the biosphere.

In the new (SAINECO) system, black water is collected separately from greywater and conveyed to biomass treatment and composting facilities to produce good quality soil conditioner. Such facilities would replace conventional sanitation plants more efficiently and less expensively.

Mainstream thought has it that faecal matter « must be destroyed » at the molecular level through wastewater treatment/purification. However, doing so produces undesirable substances (nitrates, phosphates) instead of being used to synthesize desirable humic acids [7]. In addition, the new option mimics the natural processes of soil formation.

It is also true that wastewater purification/treatment has mobilized and still requires great financial and human resources. Conventional sanitation is an industrial activity that protects its « market share ». Yet although composting of human waste from cities may challenge the current system, it does not demand the eradication of the sanitation industry. It only requires that sanitation mutate from « conventional » to « sustainable » by changing its technological approach. Is it fear of such change that fuels the controversy about the option we propose?

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[4] And this despite the fact I was among the first to launch a BLT-type dry toilet close to 30 years ago (with Joseph Jenkins and his then-called « sawdust toilet »). Read more on this at: http://www.eautarcie.org/en/01c.html#i. For years, I also defended the idea that we must abandon the flush toilet. It took environmentalists over 20 years before accepting the idea of dry toilets. Unfortunately, dry toilets are in turn becoming irrelevant when compared to EAUTARCIE's version of ECOSAN, the « SAINECO » system. Do we need to wait another 20 years before this new concept is accepted?

[5] Link: http://www.trecofim.com/fonctionnement.html. To our knowledge (March 2016), there are 5 such (impregnation and composting) treatment centres managed by TRECOFIM, treating sewage from domestic septic tanks combined with straw or green waste from other sources. A sixth set-up we know of treats green city waste from the French city of Vannes, using pig slurry. The composting process is kindled (or activated) to reach temperatures of 90°C. See: http://www.arvor-compost.com/.

[6] Link: https://www.youtube.com/watch?v=u9er47QA_yM&feature=player_embedded.

[7] We must however emphasize that the main problem with the current system is not pollution, but rather the fact we are depriving the biosphere of an essential organic resource.

Objections to the BioLitter Toilet

You often hear objections like – « the elimination of drug residues via composting is not a scientifically proven fact » – because no such proof has been published in international scientific journals. True, yet there has at least been one scientific observation on this subject, as described on our webpage http://www.eautarcie.org/en/05f.html#e. The issue is whether you can give credit to a single unpublished scientific observation. We were fully aware of this at the time (1998)[8]. On the other hand, opponents of the BLT claim that food plants absorb drug residues from the composted humanure (derived from the use of a BioLitter Toilet). From my point of view, I would also ask: where are the scientific publications that prove the presence of such residues in plants grown on soil amended with humanure composted as recommended [9]?

For those who contend that composted humanure could introduce residues of harmful substances in the food production chain (such as hormones from birth control pills and other pharmaceuticals), conventional sanitation's preferred approach is to entrust flush toilet wastewater management to specialized companies that will assume the responsibility of « deactivating » said substances. In other words, preference will be given to wastewater treatment, believing that said substances are really disabled by this technique.

We are here faced with two assertions. First assertion: BLT dry toilet effluent contains drug residues, which is true. From this some conclude that even after composting, these residues are dangerous to public health. Such a conclusion is disputable. Under the second assertion, wastewater treatment – the only currently approved sanitation technology – is supposed to eliminate or neutralize these residues.

We will herein show that:

- Pharmaceutical residues contained in urban wastewater are not broken down by the treatment/purification process. They are present, both in treated wastewater and sewage sludge (often used in agriculture). This is not a theoretical assertion on our part: it is a proven fact that has been widely reported in specialized literature. During wastewater treatment/purification, there is indeed a form of decomposition involved, that of the protein molecules contained in human dejecta, molecules that are essential to the formation of humic acids. Meanwhile, pharmaceutical residues are better resistant to biological oxidation than all the rest.

[8] After this first experiment, we submitted a request to the European Community (EC) to pursue the program we had initiated. However, our project was not selected. The EC's experts declared that « composting is not a new technology that the EC can finance ». After that, we asked for funding from the Walloon Region Government (Belgium), presenting a project aimed at remediating seriously contaminated brownfields and treating dredging sludge. In its refusal, the administration argued that « the mixing of industrial and agricultural waste is not permitted by law ». Short of agreeing, we can acknowledge that the experts' stand followed a certain logic. In 1998, I myself had not yet realized the full extent of these experiments. That is why I did not even see fit to keep a copy of our rejected requests. It was only in 2013 that I returned to the Library at the Agricultural Institute of Ath to seek out the graduate student's work on these experiments. Even with the help of former colleagues, we have not managed to get a hold of the dissertation, which seems to have mysteriously disappeared. After that, I asked colleagues to repeat the experiment, to which they agreed. Unfortunately, experiments have not yet been undertaken (2016) because of the academic authorities' refusal to fund the research. They suggested we resort to external financing. In this regard, our efforts have so far been unsuccessful, despite the fact that it would involve very simple and really inexpensive composting experiments.

[9] Link: http://www.eautarcie.org/en/05f.html.

Asserting that the use of composted humanure on soil represents a health hazard is strictly hypothetical. There is much indirect scientific proof from other research to show the frailty of that hypothesis.

Current wastewater treatment

The treatment/purification process basically involves a form of biological oxidation that effectively decomposes the protein substances contained in faeces, releasing undesirable substances such as nitrate and phosphate ions [10]. Need we be reminded that pharmaceutical residues are practically not oxidized, nor disabled, in an aqueous medium that has a temperature of 15 to 25° C, with a residence time of 7 to 8 hours in a treatment plant? The same applies to other substances found in wastewater, namely soap and detergent molecules and trace toxic organic substances. Part of these unwanted substances end up in the treated water, the other part ends up in the sewage sludge.

Despite research efforts, no economically viable and efficient method (to our knowledge) has been proposed to eliminate these unwanted substances from wastewater. Given the vast diversity of existing chemical residues, it is unlikely a chemical method will ever be found to overcome this problem. Some have envisaged filtering wastewater using reverse osmosis (!).

What happens to pharmaceutical residues retained in sewage sludge after this sludge has been spread on farmland? The answer is simple: pharmaceuticals will infiltrate into the ground. From there, opponents to the BLT would argue that these compounds are taken up by plants and ultimately end up in our plates.

Fortunately, that is disputable. No other domain is so scrutinized and subjected to such frequent testing and analyses as is food. At this level, it is necessary to make a distinction between plant-food and meat-food. To my knowledge, plant-food is known to contain pesticide and herbicide residues, but no pharmaceutical residues. And pesticide/herbicide residues are not found in sewage sludge. On the other hand, meat and animal products tend to contain residues of veterinary pharmaceuticals and growth hormones that come from veterinary care, not from fodder.

Opponents of the BLT tend to extrapolate that composted humanure spread on soil is just as bad as the proven harmfulness of pharmaceuticals discharged by sewage treatment plants into water bodies. Such extrapolation is encouraged by legislation that does not distinguish between discharging into a river and infiltrating into the soil. The same discharge standards are applied to both situations, whereas the impacts are very different. The purifying capacity of the soil is supported by abundant literature, probably little read by legislative authorities. Pedo-purification (wastewater purification via the soil) is more efficient than current systems, and it is free. The lack of interest for that field is probably why the interactions between soil and composted humanure are disregarded.

Let's examine said interactions, assuming again that pharmaceutical residues are totally eliminated by composting.

[10] The fact that in the most modern wastewater treatment plants, about 70% of the nitrogen that enters the facility is denitrified – thus lost to the biosphere – does not diminish the fact that wastewater treatment alters the aquatic life in rivers.

Indirect proof of pharmaceutical eradication

The following findings are, in a sense, indirect evidence that pharmaceutical molecules in the soil are spontaneously eradicated by soil.

1. Reusing livestock manure and spreading septic tank sewage sludge

The chemical and biological composition of pig slurry (used in agriculture since at least 70 years) and humanure (that enters the BioLitter Toilet) are virtually identical. In both you will find residues of medicinal drugs, antibiotics and hormones. Pig slurry is applied in large quantities on farmland, without any prior composting. You can wonder why no pharmaceutical residues are found in the edible plants produced on such farmland, next to pesticide/herbicide residues? On the other hand, the presence of growth hormones and/or antibiotics is commonly reported in meat from livestock raised on farms. It would be really surprising that the meat produced could have been contaminated by fodder plants.

Given these facts, one can rightly ask why the use of human waste that has been composted for two years would lead to human pharmaceutical residues entering our food plants? Facts suggest otherwise. For example, urban green waste from the city of Vannes in France is composted after having been impregnated with pig slurry. The resulting compost is sieved, bagged and sold in supermarket gardening centres after having been subjected to various detailed analyses.

Other impregnation and composting centres operate in France, using chopped straw or other green waste that is impregnated with sewage collected from private domestic septic tanks (i.e. human waste). The resulting compost is sought out by farmers of the region and is regularly analyzed by the competent authorities.

2. Farmstead manure

Some are concerned about organic farming, where fertilization also uses non-composted animal manure that may contain residues of veterinary drugs. Proponents of the hygienist ideology (or « hygienics ») are also concerned about contamination by faecal bacteria, especially from human waste.

The fundamental question lies elsewhere. Are these bacteria absorbed by cultivated plants? For example, if a tomato that is grown in human/animal manure and externally disinfected is analysed, will it contain these same bacteria? Or human/veterinary pharmaceutical residues?

We note in passing that in Belgium, organic producers are authorized to apply septic tank sewage sludge on their land, in controlled quantities and at certain times of the year. Here also, uncomposted human waste containing drug residues and faecal bacteria is applied on land. When I reported this detail to environmentalists who only eat « organic »", they were outraged and did not want to hear about it. Meanwhile, these same people refuse to eat vegetables and fruits grown in composted humanure.

3. Pollution of our drinking water reserves

It is a known fact that a huge amount of faecal-contaminated bacteria is spread on farmland, mostly from animals but also from humans. The organic soil amendment derived from animal/human waste also contains a certain amount of animal/human pharmaceutical residues.

The question then arises: to what extent these bacteria and unwanted substances do they end up in our underground drinking water reserves [11]? In other words: will these medicinal residues leach into the ground unscathed by soil organisms and reach our water reserves?

In reality, agriculture is the greater polluter of our underground water reserves: with nitrates from nitrogen-based fertilizers & pig slurry / cow manure, and pesticides/herbicides. Have there been any reports of the presence of drug residues, antibiotics, hormones or even soap and detergent residues in our underground water reserves? To my knowledge, this has not been shown [12].

Some direct proof

In discussing with colleagues about the elimination of drug residues through composting, it was pointed out that my assertions were not based on published experiments but only on a few observations. True, when looking at removing the entirety of pharmaceutical residues. Yet the present article purposes to show that even assuming the non-removal of these unwanted substances by composting, the indirect proof that human dejecta is safe to use in a food production system is consistent with our observations.

Nevertheless, we recently came across a paper [13] that is consistent with our observations, at least with respect to an antibiotic, salinomycin, found in the faeces of a chicken farm. The paper's research project aimed to check if composting was an effective way to degrade said antibiotic. The results showed the following:

- After 38 days in a compost bin, the antibiotic level went down from 22 mg/kg to 2.10^{-5} µg/kg (equal to 2.10^{-8} mg/kg).
- After 38 days in a compost heap, it went down from 27.5 mg/kg to 24 µg/kg (equal to 24.10^{-3} mg/kg).

In both cases, it can be said that the antibiotic was almost totally eliminated (close to 100 %.)

A few words on Scandinavian dry toilets

Most environmentalists look on Scandinavian dry toilets as an example to follow, as the « pinnacle of ecological consciousness ». They repeatedly put forth the example of a small Swedish town (Tanum) where the use of flush toilets is forbidden by law in new homes and source-separating dry toilets have become mandatory.

These are source-separating toilets, separating the urine from the faeces. Urine is collected separately, diverted to an enclosed holding tank, while faeces fall into a receptacle where they

[11] We are not referring here to groundwaters that may be close to the surface, where faecal bacterial contamination can occur. Such groundwaters are not normally used to supply drinking water.

[12] At the Walloon Region Water Commission of which I was a member for 16 years, we were often asked to analyse and monitor the quality of our drinking water reserves over a period of time. From the mass of information we got, it was clear that said reserves never got polluted by pharmaceutical residues, nor by soaps and detergents for that matter. All this despite the fact that at the time (1980s), the overwhelming majority of wastewater from rural homes was discharged into absorption pits (soakaways). On the other hand, we sometimes observed the concurrent presence of nitrates (from fertilization of food crops) and atrazine (an herbicide commonly used in agriculture). This clearly indicated that pollution of our drinking water reserves came essentially from agriculture, not households.

[13] Ramaswamy J, Prasher SO, Patel RM, Hussain SA, Barrington SF., The effect of composting on the degradation of a veterinary pharmaceutical, Elsevier – Bioresource Technology, Dept. of Resource Engineering, MacDonald Campus of McGill University, Ste-Anne-de-Bellevue, Canada, November 2009, 7 pages.

are dried with an electric heater or a solar dryer. The advantage of separating urine from faeces, compared to the BioLitter Toilet, is that you can space out the intervals at which a dry toilet receptacle needs to be emptied.

In a closed container, the urine's urea content (carbamide) is spontaneously decomposed into ammonia and carbon dioxide by enzymatic hydrolysis, through the action of urease, which is ever present in urine. Afterward, the nitrogen compounds thus formed partially oxidize, generating nitrite and nitrate ions. This ultimately produces a concentrated solution of ammonium nitrate, identical to a chemical fertilizer. That is why crop yields in a garden increase when urine is used (diluted 8 times). Urine works like a fertilizer: it increases yields at the expense of soil's humus reserves. Curiously, proponents of source-separating dry toilets tend to describe dried faeces as « humus ». In fact, this is like defecating in nature, but in one's garden, without composting. In doing so, a family of 4 would need a land area of 1000 m² so as not to exceed European standards that limit the amount of nitrogen that can be spread on land, comparable to using pig slurry or cow manure on farmland for example.

Note: considering that opponents of the BLT claim that pharmaceutical residues will leach into the soil even after composting human waste, what would they have to say about Scandinavian toilets where there isn't even any composting?

To conclude…

Although direct experimental proof of the elimination of pharmaceutical residues during thermogenic composting is in its infancy, there is enough indirect proof to show that composted dejecta are safe to use on soil.

Joseph Országh

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