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Short Communication

Pure human urine is a good fertiliser for cucumbers

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Abstract

Human urine obtained from separating toilets was tested as a fertiliser for cultivation of outdoor cucumber (*Cucumis sativus* L.) in a Nordic climate. The urine used contained high amounts of nitrogen with some phosphorus and potassium, but numbers of enteric microorganisms were low even though urine had not been preserved before sampling. The cucumber yield after urine fertilisation was similar or slightly better than the yield obtained from control rows fertilised with commercial mineral fertiliser. None of the cucumbers contained any enteric microorganisms (coliforms, enterococci, coliphages and clostridia). In the taste assessment, 11 out of 20 persons could recognise which cucumber of three cucumbers was different but they did not prefer one over the other cucumber samples, since all of them were assessed as equally good.

Keywords: Edible plants; Home garden; Nitrogen; Soil organic matter; Phosphorus; Tropical climate; Vegetable production; Water saving

1. Introduction

Human urine is a natural resource, which is available in all human societies—even in the poorest ones. Urine is rich in plant nutrients, since the human kidney is the main excretion organ and thus urine contains most of the nutrients present in human food which have not been utilised for new cell growth or energy consumption. The chemical composition of human urine depends on time of day, diet, climate, physical activity and body size (Sullivan and Grantham, 1982). Urea is the main nitrogen component present in human urine. Urea fertiliser production has developed during the last decades so that urea is one of the most important industrial nitrogen fertilisers (Granelli, 1995) and new urea–ammonia fertiliser plants have been built recently, for instance in India (Bhatt, 1998).

When urine becomes mixed with faeces, this mixture is much more difficult to handle hygienically outside of wastewater treatment plants. To overcome this problem, urine separating toilets have been introduced. They are an interesting alternative for houses on islands in the Baltic archipelagos, which are rather isolated and environmentally fragile, with cold climate and shortage of fresh water; also, the valuable shoreline is not suitable for construction of wastewater treatment plants due to many sailing harbours. The shortage of fresh water increases the incentive to select a separating toilet, which typically uses no or 100–200 ml water per toilet visit. The separating toilets in private homes and public sites have led to a new problem: how to utilise human urine for plant cultivation.

Urine which has been collected in urine and faeces separating toilets has been used successfully for cultivating barley (Richert Stintzing et al., 2002). If the amounts of nutrients are correct, urine could totally replace commercial fertiliser, as equal cereal yields are obtained with urine as with 'normal' fertiliser methods. Since barley and other cereals are not cultivated in home plots there should be more knowledge about the use of urine in cultivation plants in home gardens. Cucumbers were selected for this work since they and related plant species are very common and

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cultivated in home gardens throughout the world. The other reason to select cucumbers was the fact that these plants might be sensitive to microbial contamination, i.e. cucumbers have been found to be contaminated with faecal microorganisms when fertilised with composted cattle manure in a greenhouse experiment on organic farming (Holopainen et al., 2002), and cucumbers are often eaten raw without cooking.

2. Methods

The urine formed in a kindergarten, in a cafe and in private houses for a period of several months prior to the collection time was taken for microbiological hygiene and chemical nutrient analyses. Coliphages were determined by using hosts *Escherichia coli* ATCC 13706 for somatic phages and *E. coli* ATCC 15597 for RNA-phages according to the ISO (1998) method, faecal coliforms on mFC-agar (SFS 4088, 1984) at 44 °C, enterococci on Slanetz-Bartley agar confirmed on bile-esculine agar and catalase (SFS-EN ISO 7899-2, 2000) and clostridia on sulphite-iron agar after heat treatment and anaerobic incubation (ISO 6461-2, 1986). Dry matter was determined according to SFS 3008 (1990), total phosphorus with Lachat QuickChem method 10-115-01, total nitrogen with SFS 5505 (1988) and potassium with SFS 3044 (1980).

The cultivation test was done in a cowork with a private farmer in Kimito (60°10′N 22°24′E). The study soil was clay loam but no soil analysis data is available. Cucumbers (*Cucumis sativus* L.) variety Adam (Bejo zaden) were seeded in a greenhouse and the young seedlings were planted outdoors on 3rd June as is common practice in the Nordic countries in order to get a longer growth period avoiding night frosts. The seedlings were planted into banks so that seedlings were in two rows in zig-form with distances of 40 cm between each seedling. The banks were 1 m wide and 72 m long and situated side by side. Both rows of one bank were fertilised with urine (urine D, Tables 1 and 2) provided as three doses 10, 30 and 40 days after planting, giving a total of 9.7 l/m^2. Both rows of the next bank were used as control and fertilised with commercial mineral liquid fertiliser (NPK 6-5-26) provided as two doses 10 and 30 days after planting, total 57.1 g/m^2, as recommended by the manufacturer. Both fertilisers were given via underground irrigation pipes. Due to the different nutrient balances of the two fertilisers, the nitrogen fertilisations varied such that the urine rows received 23.3 g N/m^2 and the control rows 3.4 g N/m^2. The phosphorus and potassium fertilisations were 1.5 and 2.9 g P/m^2 and 5.7 and 14.8 g K/m^2 for urine and control mineral rows, respectively. Both cucumber row types were irrigated when needed.

Cucumbers reaching a length of 10 cm were harvested separately in each row from 3rd August to 1st September two or three times a week and the yields were weighed. The main yield was analysed for its microbiological hygiene by running the same tests as for urine. The taste of the cucumbers was assessed by a panel of 20 persons, whose ability to separate basic tastes (sour, sweet, salty and bitter) had been tested previously. The panel persons sitting in a test kitchen were given three fresh cucumber samples marked with blind code numbers, with one or two cucumber samples fertilised with urine and the other one or two with mineral fertiliser. The tasters had to determine which sample was different. They could also write their evaluation, especially if they wished to state a preference for one particular or two similar cucumbers. The tasters could drink water between tests and taste again without any time limitations. They could also utilise the possible differences in form or colour of cucumbers as the evaluation was done in full daylight. The test and the analysis of results have been described ivn detail by Holopainen et al. (2002).

Table 2
Main nutrients in two urine samples

Nutrient	Amount (g/l)	
	Private household D	Private household E
Dry matter	4.7	10.4
Total phosphorus	0.15	0.23
Total nitrogen	2.4	3.1
Ammonium nitrogen	2.3	2.9
Potassium	0.59	1.7

Urine D was used in cultivation trials.

Table 1
The numbers of some faecal microorganisms in separated urine samples (only one combined sample from each) as plaque forming unit/ml or colony forming units/ml, for coliphages and bacteria, respectively

Origin of urine	Coliphages host *Escherichia coli* ATCC 13706	Coliphages host *Escherichia coli* ATCC 15597	Faecal coliforms	Enterococci	Sulphite reducing clostridia
Kindergarten	13	3	170	70	33
Cafe	630	Ldl	Ldl	Ldl	Ldl
Private household A	Ldl	Ldl	Ldl	16,000	Ldl
Private household B	Ldl	Ldl	Ldl	40	14
Private household C	Ldl	Ldl	Ldl	Ldl	Ldl
Mixture of A, B and C	420	2	1	2700	20
Private household D	Nd	Nd	Ldl	>850	Nd
Private household E	Nd	Nd	2	>1000	Nd

Ldl = less than detection limit (1/ml). Nd = not determined. Samples D and E were taken in early summer, the others in early spring.