LABORATORY TESTING OF THE MICROBIOLOGICAL PRODUCT

Andriy Kiuru

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ABSTRACT

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The aim of the Thesis work was to test in laboratory microbiological product developed by the contractor Kopli Oy. For the test, two different products were prepared by the contractor Kopli Oy, applying contractor's recipe. This recipe is developed by contractor and not to be described in this work. The products are named in the study as "solid product" and "liquid product"

According to Kopli Oy, both products are developed for production of liquid fertilizer from biowaste on household level. Biowaste is treated applying the product and after several weeks rich on nutrients liquid is produced. The liquid can be diluted and used as a fertilizer for food production or for watering the garden plants.

The laboratory experiment was done in TAMK's laboratory to test product's ability to produce fertilizer in liquid form. Biowaste from TAMK's kitchen were treated with tested products in custom reactors. Duration of the treatment was five weeks, during this period, liquid samples from the reactors were taken, as well as sensory observations and temperature measurements were done. Liquid from the reactors was analysed to determine tot N, P, K concentrations, pH and conductivity. When samples were analysed, it was found that total nitrogen content of the liquid from reactor with tested solid product fluctuated over testing period and was 2.8 g/L – 3.5 g/L; total phosphorus fluctuation was 1,3 g/L - 1,7 g/L; total potassium fluctuation was 2,8 g/L - 3,8 g/L.

Key words: aerobic composting, fermentation.

CONTENTS

ABBREVIATIONS AND TERMS 4
1 INTRODUCTION 5
3 MATERIALS AND METHODS 6
3.1. Tested products 6
3.2. Set-up and implementation of the experiment 7
3.3. Building and testing of the reactors 8
3.4. Load of reactors 11
3.5. Observations and sampling 12
3.6. Laboratory analyses of liquid samples 14
4 RESULTS 17
4.1. Total nitrogen concentration of liquid samples 17
4.2. Total phosphorus concentration of liquid samples 18
4.3. Total potassium concentration of liquid samples 19
4.4. Final results from TN, TP and TK analyses. 20
4.5. Temperature changes during the test 21
4.6. pH and conductivity of the liquid samples 23
4.7. Volume of the liquid produced 24
4.8. Sensory observations 24
5 CONCLUSION AND DISCUSSION 25
REFERENCES 27
APPENDICES 29
RESULTS FROM TOTAL NITROGEN ANALYSES APPENDIX 1 29
RESULTS FROM TOTAL PHOSPHORUS ANALYSES APPENDIX 2 30
RESULTS FROM TOTAL POTASSIUM ANALYSES APPENDIX 3 31

ABBREVIATIONS AND TERMS

AAS	Atomic Absorption Spectrophotometer
Biolan Kuivike	Bulking agent, Biolan™ Komposti-ja Huussikuivike
EM™	Effective Microorganisms™
rpm	revolutions per minute
TAMK	Tampere University of Applied Sciences
TP	Total Phosphorus
TN	Total Nitrogen
TK	Total Potassium

1 INTRODUCTION

The work was commissioned by Kopli Oy - family enterprise operating since 1994. The slogan of the company is small environmental acts together with our customers (DT-keskus).[1] The company specialises on environmentally friendly waste management and provides to the customers wide range of dry toilet models, wastewater purification systems and composting equipment. Company also helps to the clients to design, implement and maintain waste treatment systems.

The work covers laboratory testing of traditional aerobic composting and anaerobic decomposition applying tested product. The aim of the laboratory experiment was to test the ability of two microbiological products to produce liquid fertilizer from biowaste. Tested products as well as most important information on experiment handling were provided by Kopli Oy (Kiukas 2012).

Both tested products are developed by Kopli Oy for production of liquid fertilizer from biowaste on household level. Since the recipes of both products are developed by Kopli Oy, there is limited description of the product content in this work (Kiukas 2012). However, experimental data is provided in details for possible replication of the experiment in the future. Further in this work, products are identified as “solid product” and “liquid product”.

[1] "Pieniä ympäristötekoja yhdessä asiakkaiden kanssa" (DT-keskus 2012).[1]

3 MATERIALS AND METHODS

3.1. Tested products

Both tested products are microbiological products containing three beneficial microorganism groups: lactic acid bacteria, phototrophic bacteria, and yeast coexisting in spare media (EMRO, Microorganisms). According to Kopli Oy, both products can be used for production of liquid fertilizer from biowaste (Kiukas 2012). Biowaste is treated with one of the product and after several weeks rich on nutrients liquid is produced.

Solid product applies anaerobic fermentation (Reiner, 2013), in which mix of microbes in anaerobic conditions used to degrade organic matter. After several weeks, liquid and fermented matter is produced as a result of fermentation process. The process is totally odour free, thus it does not attract the insects. Liquid is rich on nutrients and it can be diluted and used as a fertilizer for food production or for watering the garden plants. Fermented matter is buried into soil in a garden and after several months it would become soil. (EMRO, EM Bokashi.).

Liquid product is a mixture of same type microorganisms carried on liquid media. Microorganisms work together in air tight conditions to brake-down organic matter (EMRO, EM-1.). After several weeks, organic matter treated with liquid product produces reach on nutrients liquid and fermented matter. Thus, liquid can be diluted and used as a fertilizer for food production or for watering the garden plants.

Composting is natural, aerobic process aiming at decaying organic matter by microbes and bacteria. In this process, worms and fungi brake down organic material, aerobic bacteria converts organics into ammonium, carbon dioxide and heat is released. Further, ammonium is converted by bacteria into nitrites and nitrates, process called nitrification. Composting process requires specific moisture and temperature, as well as access of oxygen. (Gasser 1985, 27.)

3.2. Set-up and implementation of the experiment

The aim of the laboratory experiment was to test the ability of solid and liquid product to produce fertilizer from biowaste. There were three treatments of the fresh biowaste, first treatment applied liquid product, second treatment applied solid product and third treatment applied composting method. Each treatment had two replicates.

Solid product and liquid product, as well as composting, were tested in two-type custom reactors, fermentation reactor and composting reactor (figure 1). Both were designed and tested by the author of the work before the experiment set-up. There were six reactors built for the experiment, two for solid product, two for liquid product and two for composting. To ensure anaerobic conditions in the fermentation reactors they were covered by plastic bag and 2.5 kg load was placed on top of the bag. Composting was done in the same type custom reactor; the only difference is that there was constant access of air into the composting reactor, as composting is aerobic process. Both types of reactors were insulated with 5 mm thick polyethylene foam. Figure below (figure 1) shows general information on reactor’s layout and load during the experiment.

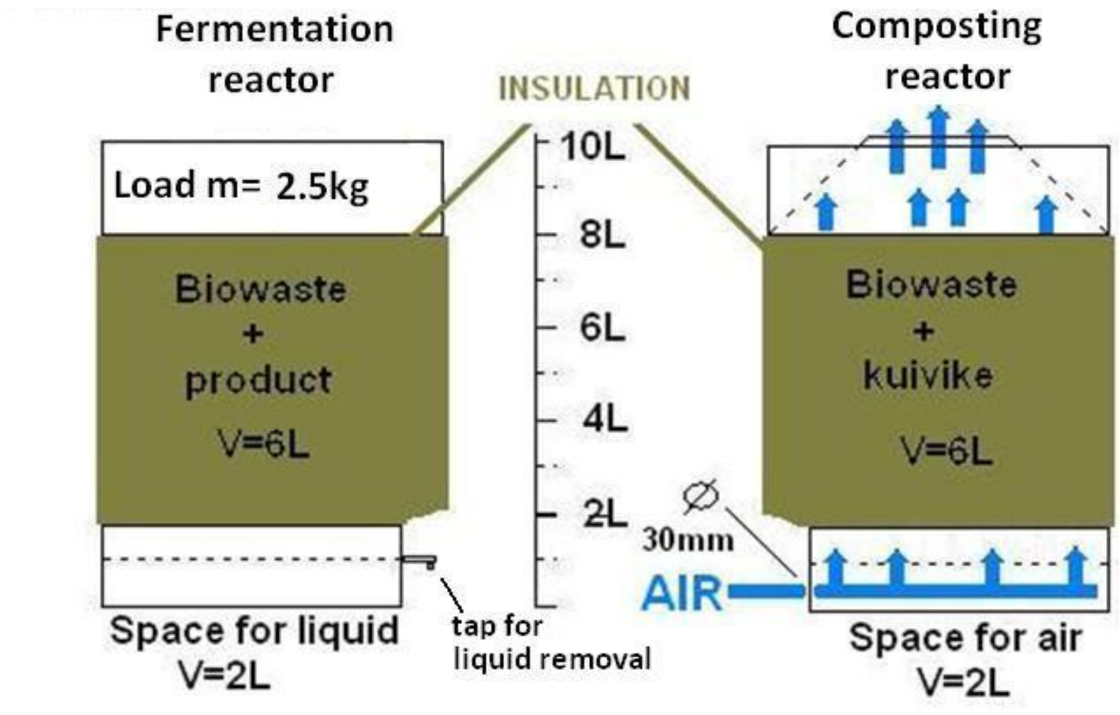


FIGURE 1. Two types of reactors

During the laboratory experiment liquid samples from three treatments were collected and several parameters were analysed. They include total nitrogen, total phosphorus, total potassium concentrations, conductivity, pH and sensory observations. Sensory observations were done to find any changes in appearance of content of the reactor and to identify odour. The mass of fresh biowaste and the mass the applied product were measured to find the amount of liquid produced per one kilogram of biowaste. The volume of the content of every reactor was measured before and after the experiment. This was done to find reduction of content by volume. These parameters were compared and presented in this Thesis.

3.3. Building and testing of the reactors

Firstly, the reactors for the experiment handling were built from 10 litre water canister (figure2). Six 10 litre canisters were cut from the top. Four plastic containers from the yogurt were placed on the bottom of the canisters and covered with plastic false bottom. False bottom was done from the plastic carving board, which were cut to fit the canister size. There were 20 holes, drilled in the bottom; each hole is 5 mm in diameter.

The holes in a false bottom were done to provide aeration for composting reactor and liquid separation for fermentation reactor. Two types of reactors are identical; the only difference is that there is a 30mm hole in composting reactor for constant access of air into the vessel. In case of fermentation reactor, there was a tap for liquid removal, installed on the same position, where 30mm hole appears on composting reactor.

After reactors were built, the physical test of one reactor was done; the aim of the test was to make sure false bottom will sustain significant amount of load. For the test, 10 kg of sand were placed in a plastic bag and the bag was put into canister, on a false bottom. The canister was left for one night and checked next day. Since there was no damage and deformation of the support of false bottom, the trial test of the canister started.

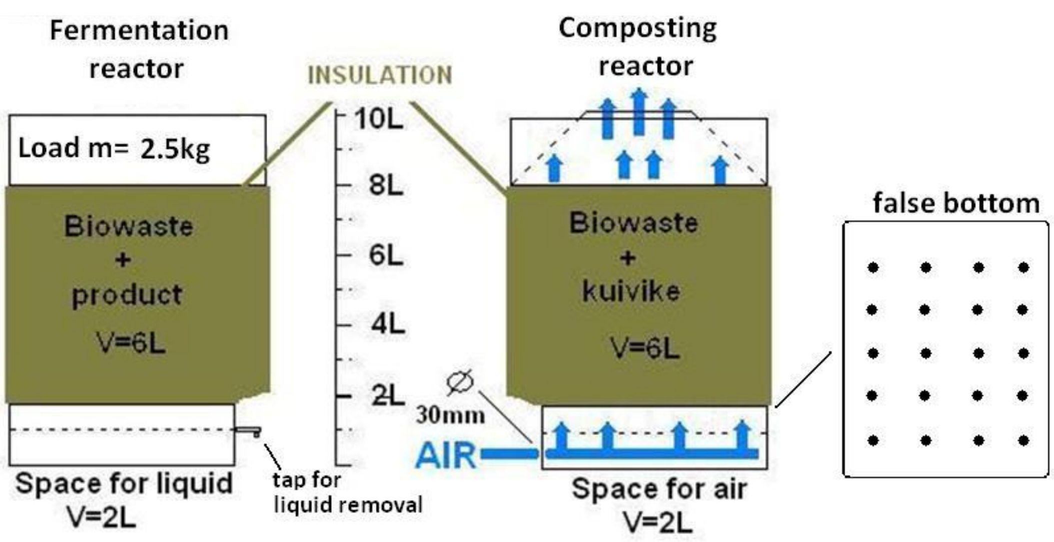


FIGURE 2. Layout of the reactors

The trial test was done at home, using available equipment and materials. The aims of the trial test were to examine reactor's functionality and to gather some information on solid product work. Testing time was one week, from 23.11.2012 to 30.11.12. Temperature changes as well as visual observations were done during the test.

For the trial test the kitchen waste was collected during 3 days. The biowaste mainly consisted of potatoes peelings, banana peelings, citrus fruit peelings, fish bones, meat bones and paper napkins. Before load, the waste was homogenised by knife cutting; there were no parts of the waste bigger in one dimension then 3 cm, measured visually. Fish bones and meat bones were left without cutting. Then, solid product was mixed with prepared kitchen biowaste in ratio: one part of solid product to three parts of biowaste by volume, obtained mixture was loaded into fermentation reactor. Mixing during the load was done as follows: 300ml of waste were placed in reactor and covered by 100ml of solid product. Total volume of mixture in reactor was 6 litres. Then, the reactor was covered by plastic bag with 2 kg of sand in it and placed in a cupboard in the kitchen under the sink.

After one week period of being in warm and anaerobic conditions, kitchen biowaste, including meat and fish residues, not produce rancid or rotten odour. Moreover, there was no evidence of insects observed in a kitchen or near the reactors. The only smell were identified is product smell, which is sweet. The amount of liquid produced was very low, this can be explained by relatively low moisture content of the load and short period of trial test.

Table below (table 1) presents the temperature changes in the reactors and volume of liquid which was determined visually. At the end of the experiment, the approximate amount of liquid was measured by 200 ml glass.

TABLE 1. Results from the trial test

Date	t°C inside	t°C outside	V of liquid (ml)
23.11.2012	20.7	24.3	None
26.11.2012	21.8	24.9	≈ 15
28.11.2012	21.1	24.5	≈ 50
30.11.2012	21.3	24.5	≈ 100

Picture below (figure 3) shows the trial test of reactor, it was taken on 30.11.2012, which was the last day of the trial experiment. As can be seen from the picture, there is small amount of liquid, produced during 7 days time period.

FIGURE 3. Last day of the trial experiment

The results from the trial experiment provided solid reference for the actual experiment handling. However, there were some minor changes done to the reactor build, for instance the polyethylene foam insulation of 0.5 mm thickness was applied to all reactors.

3.4. Load of reactors

All reactors were installed and loaded in TAMK's laboratory, the load of reactors was done on 10th of December 2012. The biowaste was collected from the TAMK's kitchen and delivered to the laboratory. Then it was chopped under the hood to make sure there were no pieces bigger then 2 cm in size. Biowaste consisted of food products and mainly included carrots, cucumbers, different bakery products, butter and napkins.

Then, necessary quantities of biowaste, both products and Biolan Kuivike, were measured and prepared for mixing. Waste was divided into 6 portions of 4 litters in volume each and the mass of each portion was identified. The mass and volume of solid product was measured to obtain 2 equal portions of 1.2 litters by volume each. Then, the mass of each portion was measured. Bulking agent - Biolan Kuivike, was prepared in same way to get 4 portions of 2.6 litters in volume. Liquid Product was diluted with tap water; dilution ratio was 1:4, one part of product to 4 parts of water.

Then, the load of reactors was done. Composting reactors were loaded as described: some amount of Biolan Kuivike was put on a false bottom of reactor and covered by biowaste after that, biowaste was covered by Biolan Kuivike and whole procedure was repeated until reactor was full.

Solid product reactors were fed in the same way as composting reactors. Some amount of solid product was applied on a false bottom of reactor and covered by biowaste. After that, biowaste was covered by solid product and whole procedure was repeated until reactor was full.

Liquid product reactors were loaded as described: some amount of Biolan Kuivike was put on a false bottom of reactor and covered by biowaste, which was sprinkled by liquid product. Sprinkling was done until liquid formed tiny droplets on a surface of the waste and then biowaste was covered by Biolan Kuivike. The whole procedure was repeated until reactor was full.

Reactors were marked as follows: two reactors with liquid product were marked as A1 and A2; reactors with solid product were marked as B1 and B2; two composting reactors were marked as C1 and C2. Reactors A1 and A2 were replicates of biowaste treatment applying liquid product. Reactors B1 and B2 were replicates of biowaste treatment applying solid product. Reactors C1 and C2 were replicates of biowaste treatment applying composting method. All reactors were placed in a cardboard box with open top and then put on the floor surface in the TAMK's greenhouse. The aim of the box was to prevent reactors from possible direct sun light.

Table 2 below shows the amount of waste and product loaded into reactors. For instance, the mass of the fresh biowaste in each reactor were close to four kilograms, at the same time the volume of biowaste was close to two litres.

TABLE 2. Load of reactors

	Liquid product (A1)	**Liquid product (A2)**	**Solid product (B1)**	**Solid product (B2)**	**Composting (C1)**	**Composting (C2)**
m Waste (g)	1941	1893	2185	2060	2040	2089
V Waste (l)	4	4	4	4	4	4
M Kuivike (g)	497	500	None	none	535	524
V Kuivike (l)	2,6	2,6	None	none	2,6	2,6
m product (g)	200	200	492	533	none	none
V product (l)	0,2	0,2	1,2	1,2	none	none
tot. m (g)	2638	2593	2677	2593	2575	2613
tot. V (l)	6,8	6,8	5,2	5,2	6,6	6,6

3.5. Observations and sampling

Observation session included collecting of the liquid samples from reactors with solid and liquid product, determination of pH, conductivity and visual observation of the reactors. Visual observation were done to find any changes in content of the reactors and to detect odour by sensory impression. Observation sessions were done five times, the dates of the observation sessions can be found in table 3 below. Green tick mark indicates that measurement were done, red cross indicates that measurement was not done. As can be seen from the table, there were 18 samples taken on 28th of December.

TABLE 3. Check-list for sampling

Date	°C	°C	Conductivity	pH	Notes	Amount of samples for		
14.12.2012	✓	✓	✗	✗	✓	✗	✗	✗
21.12.2012	✓	✓	✓	✓	✓	4	4	4
28.12.2012	✓	✓	✓	✓	✓	6	6	6
04.01.2013	✓	✓	✓	✓	✓	4	4	4
16.01.2013	✓	✓	✓	✓	✓	4	4	4

On 14th of December 2012 the samples were not taken, but the observations and temperature measurements were done. This observation session was done to check that reactors are working in normal conditions.

On 21st of December 2012 there were twelve liquid samples taken from reactors with solid and liquid product. Set of three samples was taken from A1 reactor, set of three samples was taken from A2 reactor, set from three samples was taken from B1 reactor and set of three samples was taken from B2 reactor. Each set of samples was reserved for total nitrogen, total phosphorus and total potassium analyses.

On 28th of December 2012 there were eighteen liquid samples taken. Twelve liquid samples were taken from reactors with solid and liquid product. Additional six liquid samples were taken from composting reactors. There were 3 samples from C1 reactor for TN, TP and TK analyses and 3 samples from C2 reactor for TN, TP and TK analyses.

On 4th of January 2013 and 16th of January 2013 as same samples were taken as on 21st of December 2012.

Figure (figure 4) shows 6 reactors on a table in the laboratory. Reactors from left to right stay as B1, B2, A1, A2, C1, C2. Picture shows that there is some amount of brown liquid in B1 and B2 reactors.

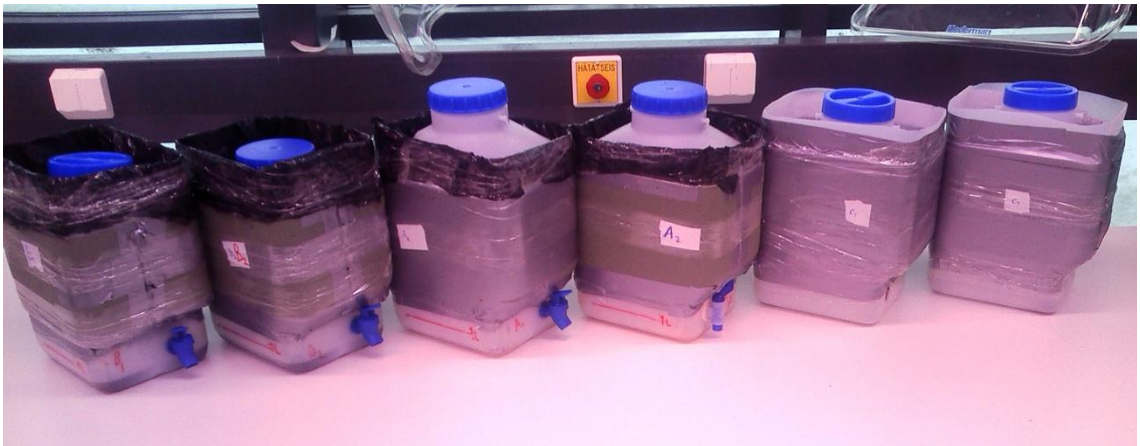


FIGURE 4. Reactors during the observation session on 14.12.2012

Collected samples were labelled and stored in the freezer until the chemical analyses. Samples were unfrozen on demand before analyses and analysed. It was discovered that all samples from A2 reactor done on 16th of January 2013 were missed. However, there were unlabeled samples in the freezer, but they were not analysed because they were unknown samples. Also, the results from samples from A2 reactor done on 16th of January 2013 are not included in this Thesis.

3.6. Laboratory analyses of liquid samples

Total potassium concentrations were determined by Atomic Absorption Spectrophotometer – PerkinElmer Instruments AAnalyst 400. Samples for total potassium analyses were prepared one day before the actual analyses. During the preparation, samples were unfrozen and centrifuged during 10 minutes at 3000 rpm in Thermo Scientific IES CL30R Centrifuge. Then, all the samples were diluted; dilution of the samples was done as follows: 5 ml of the sample were transferred into 100ml Erlenmeyer flask. One gram of 0,1M lanthanum chloride was added to each sample to overcome interferences. (Lajunen & Perämäki 2004, 75). After that, ultra high purity distilled water was added to Erlenmeyer flask to reach 100 ml mark on a flask.

After that, potassium standard solutions for calibration of the AAS were prepared. Initially, there were 5 standard solutions, the concentrations were as follows: 30 mg/L, 60 mg/L, 90 mg/L, 120 mg/L and 150mg/L (see appendix 3: 1 (15)). But during the analysis session, it was discovered that some samples are of greater concentration then that of the highest standard (see appendix 3: 8 (15)). Due to this reason, additional standard solutions of 200 mg/L and 250 mg/L were prepared. During preparation of the standard solutions, one gram of 0,1M lanthanum chloride was added to each solution. (Lajunen & Perämäki 2004, 75).

The analysis of the samples was done on 18^{th} of April 2013 under supervision of laboratory engineer Heli Knuutila (Knuutila 2013). The K 404.41 lamp was chosen for analyses. (Dean 1995, 20). Then, the calibration line was done and samples were analysed one by one. During the analyses, simplified naming for the samples was created. Samples were named as combined date and reactor code, where first number stays for the date and letter with digit 1 or 2 stays for reactor. For instance, sample taken on 21 of December 2012 from A1 reactor was named as “21A1” during the analysis. All the results can be found in appendix 3.

Samples for total nitrogen and phosphorus analyses were unfrozen and centrifuged 10 minutes at 3000 rpm using Thermo Scientific IES CL30R Centrifuge. After that, the dilution factor for each sample was found by applying different dilution ratios and analysing the samples. Then, each sample was analysed twice, this was done to increase reliability of the results.

Total phosphorus was determined by HACH using HACH LANGE LCK 349 method. The principle of the method is “phosphate ions react with molybdate and antimony ions in an acidic solution to form an antimonyl phosphomolybdate complex, which is reduced by ascorbic acid to phosphomolybdenum blue.” (LCK 349, 2012). Method LCK 349 includes preparation of the sample, digestion in thermostat and analyses. Those steps were done as described in manual instructions (LCK 349, 2012.).

Digestion of the samples at 200 °C during 15 minutes was done in DRLANGE HT 200S Thermostat, analyses of the samples was done using HACH LANGE DR 2800.

Total nitrogen was determined by HACH LANGE DR 2800, applying HACH LANGE LCK 138 method. Based on LCK 138 manual instructions, the principle of the method is “inorganically and organically bounded nitrogen is oxidized to nitrite by digestion with peroxo-disulphate. The nitrate ions react with 2.6-dimethylphenol in a solution of sulphuric and phosphoric acid to form nitrophenol.” (LCK 138, 2012). Digestion of the sample in thermostat at 200 °C during 15 minutes is required before the analyses and it was done in DRLANGE HT 200S Thermostat.

Conductivity of the liquid samples was measured by using METLER TOLEDO FE30 Conductivity meter. Acidity of the liquid samples were measured by using METLER TOLEDO FE20 pH meter.

4 RESULTS

4.1. Total nitrogen concentration of liquid samples

Complete results from the total nitrogen analyses can be found in appendix 1. Table 4 shows mean values for each reactor. Letters with number stands for reactor, dates stands for sampling date, empty fields indicate that no sample was available for analyses. The reason for that is explained this Thesis (chapter 3.5).

Table (table 4) shows that concentrations of TN of A1 and A2 samples fluctuated from 184.3 mg/L to 381.1 mg/L. Concentrations of the B1 and B2 samples varied from 2710 mg/L to 3860 mg/L. At the same time, the concentrations of B1 and B2 samples were considerably higher than concentrations of A1 and A2. The one TN measurement of the C1 and C1 samples showed concentration of 88.4 mg/L and 118 mg/L correspondingly.

TABLE 4. Mean concentrations of TN of the samples

	Mean concentrations in mg/L					
Sampling dates	A1	A2	B1	B2	C1	C2
21.12.2012	184.3	235,3	3072	3860		
28.12.2012	305	218.1	2710	2880	88.4	118
04.01.2013	371.3	278.8	2800	3280		
16.01.2013	381.3		2950	2980		

Figure 5 below provides comparison of three treatments tested. Figure (figure 5) shows TN concentrations of the samples taken on 28th of December 2012. The colour key stands for the number of the reactor. Liquid product stands for of A1 and A2 reactors, solid product stands for B1 and B2 reactors, composting stands for C1 and C2 reactors. Reactor 1 and reactor 2 are replicate treatments. Figure (figure 5) shows that TN content of the samples from solid product is considerably higher than TN content of the samples from liquid product and composting. As shown on the bar chart, TN concentrations of the solid product samples are higher than 2500 mg/L; whereas, TN content of liquid product samples and composting is lower than 500 mg/L.

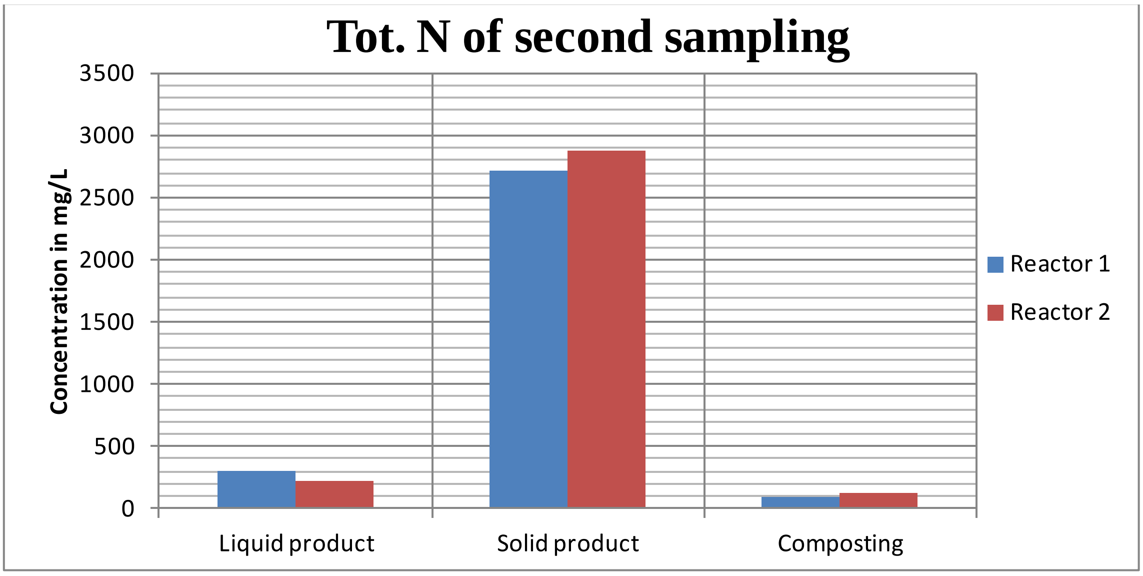


Figure 5. Total nitrogen concentrations of sampling done on 28th of December 2012

4.2. Total phosphorus concentration of liquid samples

Table below (table 5) based on results from the total phosphorus analyses (appendix 2). Table 5 shows mean concentrations of the liquid from each reactor. Letters with number stands for reactor, dates stands for sampling date, empty fields indicate that no sample was available for analyses. The reason for that is explained this Thesis (chapter 3.5). Table (table 5) shows that TP concentrations of A1 and A2 samples varied from 173,6 mg/L to 227 mg/L. At the same time, TP content of B1 and B2 samples was higher and fluctuated between 968 mg/L and 1859 mg/L. Measurement of TP of the C1 and C2 samples showed concentration of 144,5 mg/L and 125 mg/L correspondingly.

TABLE 5. Mean concentrations of TP of the samples

	Mean concentrations mg/L					
Dates	A1	A2	B1	B2	C1	C2
21.12.2012	173.6	196,8	1245	2200		
28.12.2012	207	160.2	968	1603	144.5	125
04.01.2013	224	181.5	1495	1859		
16.01.2013	227		1590.8	1612		

Figure 6 below provides comparison of the total phosphorus concentrations of the samples from three treatments. The data for the bar chart is taken from the samples done on 28th of December 2012. Liquid product indicated in a bar chart stands for of A1 and A2 reactors, solid product stands for B1 and B2 reactors, composting stands for C1 and C2 reactors. Reactor 1 and reactor 2 are replicate treatments. The colour key stands for the number of the reactor. Figure (figure 6) below shows that TP concentrations of the solid product samples are considerably higher than concentrations of liquid product and composting. For instance, concentrations of liquid product and composting were lower of 200 mg/L, while concentrations of solid product were slightly less than 1000 mg/L for reactor 1 and about 1600 mg/L for reactor 2.

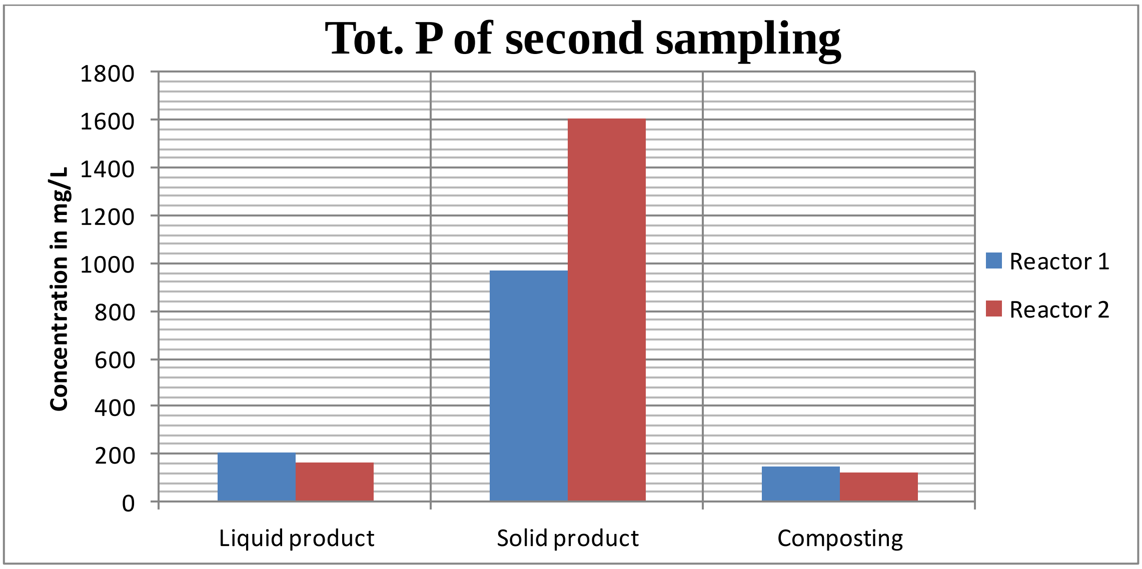


Figure 6. Total phosphorous concentrations on 28th of December 2012

4.3. Total potassium concentration of liquid samples

Complete results from the total potassium analyses can be found in appendix 3. Table 6 shows mean concentrations of the samples for each reactor. Letters with number stands for reactor, dates stands for sampling date, empty fields indicate that no sample was available for analyses. The reason for that is explained this Thesis (chapter 3.5). As shown on a table below (table 6), total potassium concentrations of A1 and A2 samples varied from 1161,6 mg/L to 2056,9 mg/L. TK content of B1 and B2 samples was higher and fluctuated between 2634,2 mg/L and 3808,3 mg/L. Measurement of TK of the C1 and C2 showed concentration of 144,5 mg/L and 125 mg/L correspondingly.

TABLE 6. Mean concentrations of TK of the samples

	Mean concentrations mg/L					
Dates	A1	A2	B1	B2	C1	C2
21.12.2012	1729,1	1858,4	3760,0	3808,3		
28.12.2012	1876,1	1743,7	3024,2	2634,2	1048,2	1253,3
04.01.2013	1880,2	2056,9	2910,8	3886,7		
16.01.2013	1161,6		3575,8	3794,2		

Figure 7 below provides comparison of the total potassium concentrations of the samples taken on 28th of December 2012. The colour key stands for the number of the reactor. Liquid product stands for A1 and A2 reactors, solid product stands for B1 and B2 reactors, composting stands for C1 and C2 reactors. Reactor 1 and reactor 2 are replicate treatments. As shown on the figure 7, solid product had the highest concentrations, liquid product had lower concentrations ant composting had the lowest concentrations.

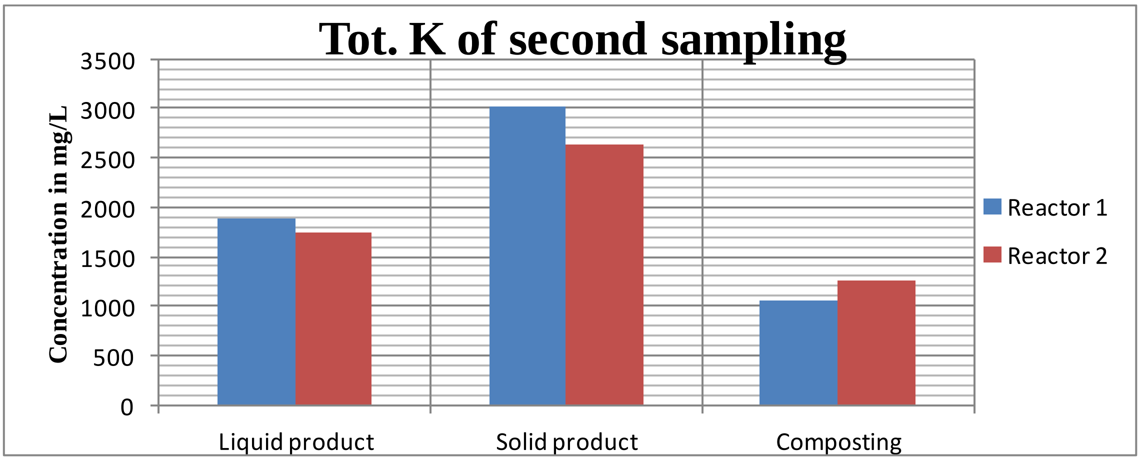


Figure 7. Total potassium concentrations of sampling done on 28th of December 2012

4.4. Final results from TN, TP and TK analyses.

Table 7 shows the overall results by date and by product. Empty fields indicate that no sample was available for analyses. The reason for that is explained this Thesis (chapter 3.5). The concentrations are given in milligrams per litre.

TABLE 7. Overall results by product

Dates	Liquid product			Solid product			Composting		
	Tot.N (mg/L)	Tot.P (mg/L)	Tot.K (mg/L)	Tot.N (mg/L)	Tot.P	Tot.K (mg/L)	Tot.N (mg/L)	Tot.P (mg/L)	Tot.K (mg/L)
21.12.2012	209,8	185,2	1793,8	3466	1722,5	3784,2			
28.12.2012	261,6	183,6	1809,9	2795	1285,5	2829,2	103,2	134,8	1150,7
04.01.2013	325	202,8	1968,5	3040	1677	3398,8			
16.01.2013	381,3*	227*	1161,6*	2965	1601,4	3685			

*Note: result of the A1 sample, not mean of A1 and A2

Figure 8 shows comparison of the total N, P, K values from the second sampling. The colour key stands for total N, P, K concentrations in milligrams per litre. As shown on the figure 11, the highest N, P, K content showed solid product. Total potassium values of both products and composting were the highest, compared to TN and TP.

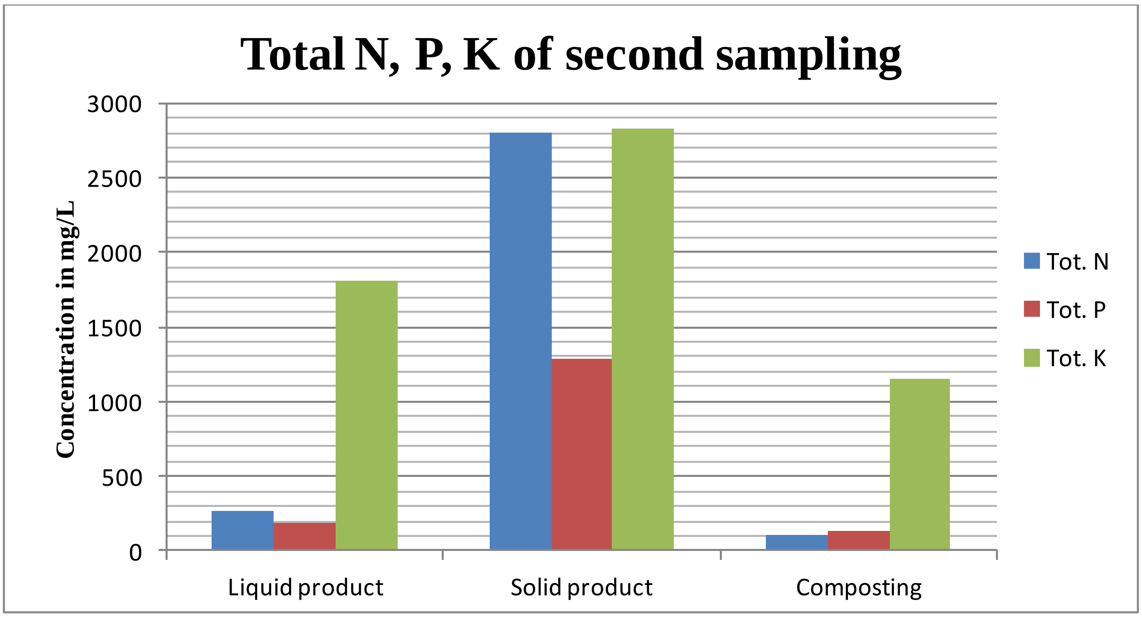


FIGURE 8. Total N, P, K of first sampling which was done on 21st of December 2012

4.5. Temperature changes during the test

Table 8 shows that temperature in the laboratory on 14th December was 15.5°C and 13.2°C on 21st of December. It was also reported that there were cold conditions in the TAMK's greenhouse at middle of December 2012 (Yrjönen 2012). On 14th of

December 2012, the highest observed temperature was measured in content of C2 reactor and it was 37.6 °C. At the same date, the temperature in content of C1 reactor was 32,1 °C. During the other dates, the temperature in all reactors was close to the temperature of ambient air.

TABLE 8. Temperature measurements

Date	14.12.2012	21.12.2012	28.12.2012	04.01.2013	16.01.2013
t (°C) in lab	15,5	16,6	22,1	21,8	23,1
t (°C) in A1	23,6	17,0	23,1	24,3	23,8
t (°C) in A2	25,6	16,3	23,5	23,7	23,9
t (°C) in B1	19,8	16,8	23,1	24,1	23,5
t (°C) in B2	19,5	16,0	23,5	23,8	22,2
t (°C) in C1	32,1	16,5	23,8	23,2	23,5
t (°C) in C2	37,1	16,0	24,1	23,5	24,1

Figure 9 shows reactor C2 on 14th of December 2012. Black thermometer stick into reactor shows temperature 37.1 °C, at the same time, round white thermometer shows temperature of the ambient air and it is 16.6 °C.

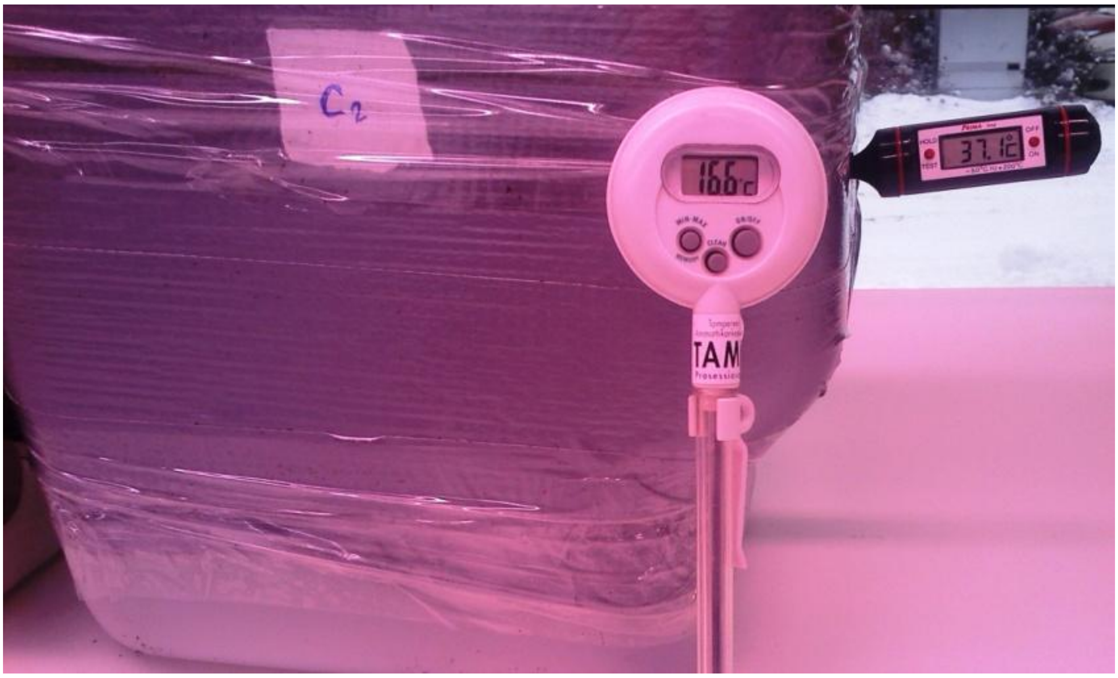


FIGURE 9. Reactor C2 on 14th of December 2012.

4.6. pH and conductivity of the liquid samples

Table 9 shows that pH values of the liquid samples. Mean values of pH in A and B reactors fluctuated between 3.48 and 3.98. Acidity of the C1 and C2 reactors was measured only on 28[th] of December 2013. The reason is explained in chapter 3.5.

TABLE 9. pH measurements of the samples

Date	21.12.2012	28.12.2012	04.01.2013	16.01.2013
pH in A1	3,48	3,51	3,64	3,69
pH in A2	3,52	3,55	3,62	3,70
pH in B1	3,95	3,92	3,90	3,95
pH in B2	3,94	3,90	3,91	3,98
pH in C1		6,32		
pH in C2		6,25		
Mean pH of A1 and A2	**3,50**	**3,53**	**3,63**	**3,70**
Mean pH of B1 and B2	**3,95**	**3,91**	**3,91**	**3,97**
Mean pH of C1 and C2		**6,28**		

Table 10 shows conductivity changes during the experiment. The highest mean conductivity values showed B reactors, the lowest – C reactors.

TABLE 10. Conductivity of the samples

	Date			
Conductivity in mS/cm	21.12.2012	28.12.2012	04.01.2013	16.01.2013
pH in A1	5,33	6,18	6,44	6,62
pH in A2	5,72	6,05	5,98	6,10
pH in B1	13,61	13,96	14,50	14,57
pH in B2	12,70	13,12	14,32	14,50
pH in C1		4,20		
pH in C2		4,11		
Mean pH of A1 and A2	**5,53**	**6,12**	**6,21**	**6,36**
Mean pH of B1 and B2	**13,16**	**13,5**	**14,41**	**14,54**
Mean pH of C1 and C2		**4,15**		

4.7. Volume of the liquid produced

Table 11 shows the volume of liquid from each reactor. Reactor A2 provided volume bigger then 500 ml, because some samples from A2 reactor was lost during the storage and thus the volume of the lost samples is not included in the table (chapter 3.5).

TABLE 11. Approximate volume of liquid from the reactors

Reactor	A1	A2	B1	B2	C1	C2
Total V (ml)	650	500	750	800	200	200
Average V (ml)	**575**		**775**		**200**	
Average V of liquid per one kilogram of fresh biowaste (ml/kg)	**300**		**360**		**96**	

4.8. Sensory observations

Both reactors with liquid product had food smell in the beginning of the experiment. Unpleasant rotten smell from both reactors with liquid product appeared when reactors were opened and unloaded. Both reactors with solid product had specific smell of the tested product. This smell was stronger during December 2012 and weaker during January 2013.

All reactors with solid and liquid product showed development of the white matter, possibly fungi, on top layer of the food in the reactor. During the experiment, a significant reduction of volume was observed. The reduction of volume in containers with solid product was about 1/3 of original volume. The reduction of volume in containers with liquid product and composting were approximately 20 % and 10% correspondingly.

5 CONCLUSION AND DISCUSSION

The study showed that tested liquid product and tested solid product are capable to produce reach on nitrogen, phosphorus and potassium liquid. However, solid product showed higher concentrations of TN, TP and TK than liquid product.

As can be seen from the table 4, during the first and second sampling, concentration of total nitrogen of the samples from reactors with solid product was more than ten times higher than concentrations of the samples from liquid product. Table 7 shows that concentration of TN of samples taken from solid product fluctuated between 2795 mg/L and 3040 mg/L. Those values correspond to range of 2.8 – 3.5 %. At the same time, the concentration of TN of samples taken from liquid product fluctuated between 209.8 mg/L and 381.3 mg/L. TN concentration of the tested media from reactors with compost treatment was not measured. But approximate nitrogen level from the composts can be found in literature. For instance, according to Koike (2012, 48) nitrogen concentrations of the composts range from 1% to 2% of dry weight. Neider and Bendi (2008, 52) state that content of nitrogen in bio compost is about 8.5 kg over one tonne of compost. This is equals to 0.85% of TN in bio compost. To conclude, I can say that TN content of the liquid produced in case of biowaste treatment with tested solid product is higher than TN content of the compost found in literature.

Total phosphorus concentration of the sampled liquid from solid and liquid product also showed significant difference in results. As can be seen from the table 7, the TP concentration of samples from solid product fluctuated between 1285.5 mg/L to 1722.5 mg/L. In percentage those concentrations equals to range from 1.3% to 1.7%. These results can be compared with results of TP content of the composts found in literature. For example, according to Epstein (2011, 295) the concentrations of the phosphorus in composts produced from biosolids usually range from 0.87% to 2.12%. In conclusion I can say that TP content of the liquid produced as a result of biowaste treatment with tested solid product is relatively same with TN content of the compost found in literature.

Table 7 shows that samples taken from reactors with solid product showed the highest concentration of total potassium, compared to samples taken from reactors with liquid product and composting. The TK concentration of the samples from solid product varied from 2829.2 mg/L to 3784.2 mg/L, this corresponds to the range of 2.8% and 3.8%. These values of TK concentrations can also be compared with TK concentrations of the composts found in literature. According to Epstein (2011, 295) the content of the potassium in composts produced from biosolids normally varies from 0.46% to 0.63%. According to Dedousis and Bartzanas (2010, 197) the concentrations of TK in biowaste composts varies from 0.64% to 0.96%. To summarise, I can say TK content of the liquid produced as a result of biowaste treatment with solid product is higher than TK content of the composts found in literature.

It would be good to test the impact of the produced liquid on growth of the plants. In this case, it might provide solid basis for calling the liquid a fertilizer. However, there were several articles found which dedicated to the biowaste treatment applying solid product. For instance, according to Sangakkara (Sangakkara, 2010) application of same type liquid enhanced tomatoes yields by 9% when compared to yields from control plot to which the liquid was not added.

REFERENCES

Dean, J. 1995. Analytical Chemistry Handbook. USA: McGraw-Hill Inc

Dedousis, A. & Bartzanas, T. 2010. Soil Engineering. Springer

DT-keskus Kuivakäymälä. Company's motto. Visited 09.08.2013 http://huussinen.wordpress.com/yritys/

EMRO. 2013. EM Bokashi. Read 16.06.2013. http://www.emrojapan.com/about-em/em-products/activated-materials/howtomakebokashi.html

EMRO. 2013. EM-1. Read 12.09.2013 http://www.emrojapan.com/about-em/em-products/em1.html

EMRO. 2013 Microorganisms in EM. Read 12.09.2013 http://www.emrojapan.com/about-em/microorganisms-in-em.html

Epstein, E. 2011. Inductrial Composting: Environmental Engineering and Facilities Management.

Gasser, J. 1985. Composting of agricultural and other wastes. 1985. Essex : Elsevier applied science publishers.

HACH LANGE LCK 349 (total phosphorus) method. Downloaded 08.08.2013 http://www.hach-lange.co.uk/view/content/facetsearch?query=lck+349&type=Product

HACH LANGE LCK 138 (total nitrogen) method. Downloaded 08.08.2013 http://www.hach-lange.co.uk/view/content/facetsearch?query=lck+138&type=Product

Kiukas, R. owner of DT-keskus Kuivakäymälä. 2012. Personal meeting, November 2012.

Knuutila, H. TAMK's laboratory engineer. Guidance and supervision of AAS analyses. 18.04.2013

Koike, S. 2012. Organic strawberry production manual. California: University of California Agriculture and Natural Resources.

Lajunen, L. & Perämäki, P. 2004. Spectrochemical analysis by atomic absorption and emission. 2^{nd} edition. Cambridge: Royal Society of Chemistry.

Neider, R. & Benbi, D. 2008. Carbon and Nitrogen in the Terrestrial Environment. Springer Science.

Reiner, K. Updated 01.04.2013. Carbohydrate fermentation protocol. American society for microbiology. Read 16.6.2013.http://www.microbelibrary.org/library/laboratory-test/3779-carbohydrate-fermentation-protocol

Sangakkara, R. Post Date 21.05.2010. Influence of Method of Application of Effective Microorganism on Growth and Yields of Selected Crops. Read 16.09.2013 http://emrojapan.com/emdb/content/202.html

Yrjönen, R. TAMK’s laboratory engineer. Discussion at the TAMK’s greenhouse. 21.12.2012.

APPENDICES

RESULTS FROM TOTAL NITROGEN ANALYSES APPENDIX 1

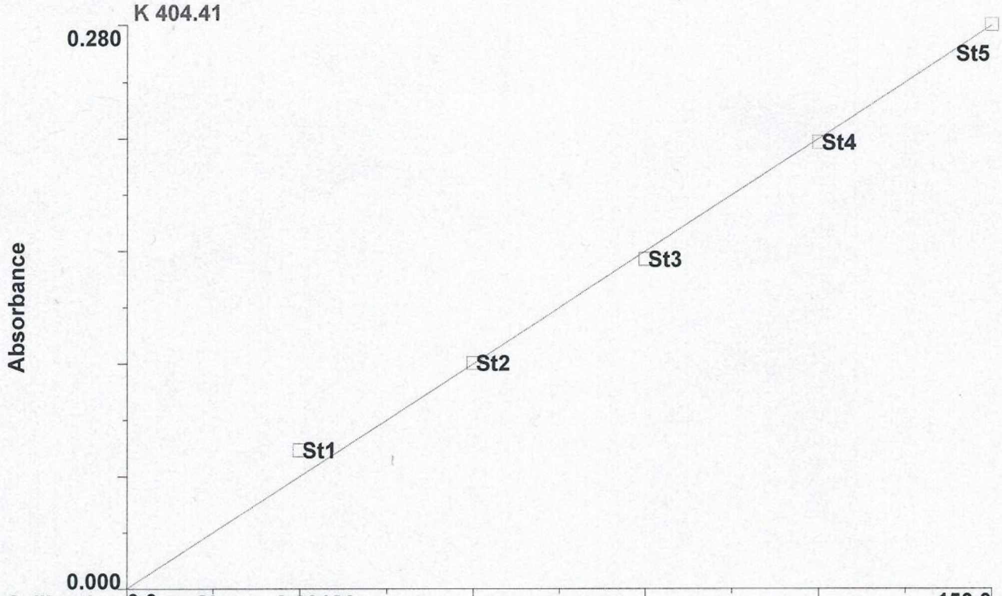
start of the experement 10.12.12							
A1= first container liquid product				B1=first container with solid product			
A2= second container liquid product				B2=second container with solid product			
reading=result from analysing equipment				C1=first container with compost			
conc. mg/L= concentration of sample				C2=second container with compost			
Total Nitrogen							
Fist sampling and results				Second sampling and results			
21.12.2012				28.12.2012			
A1	reading	conc. mg/L	dilut. factor	A1	reading	conc. mg/L	dilut. factor
	6,4	160,8	25,0		12,8	320,0	25,0
	8,3	207,8	25,0		11,6	290,0	25,0
mean	**7,4**	**184,3**		**mean**	**12,2**	**305,0**	
A2	10,4	260,0	25,0	A2	9,1	228,0	25,0
	8,4	210,5	25,0		8,3	208,3	25,0
mean	**9,4**	**235,3**		**mean**	**8,7**	**218,1**	
B1	7,7	3064,0	400,0	B1	13,2	2640,0	200,0
	7,7	3080,0	400,0		13,9	2780,0	200,0
mean	**7,7**	**3072,0**		**mean**	**13,6**	**2710,0**	
B2	9,5	3780,0	400,0	B2	14,3	2860,0	200,0
	9,9	3940,0	400,0		14,5	2900,0	200,0
mean	**9,7**	**3860,0**		**mean**	**14,4**	**2880,0**	
				C1	3,6	91,0	25,0
					3,4	85,8	25,0
				mean	**3,5**	**88,4**	
				C2	4,8	120,3	25,0
					4,6	115,8	25,0
				mean	**4,7**	**118,0**	
Third sampling and results				Fourth sampling and results			
04.01.2013				16.01.2013			
A1	reading	conc. mg/L	dilut. factor	A1	reading	conc. mg/L	dilut. factor
	15,7	392,5	25,0		15,9	397,5	25,0
	14,0	350,0	25,0		14,6	365,0	25,0
mean	**14,9**	**371,3**		**mean**	**15,3**	**381,3**	
A2	12,3	307,5	25,0	A2	sample was lost		
	10,0	250,0	25,0				
mean	**11,2**	**278,8**					
B1	14,1	2820,0	200,0	B1	15,0	3000,0	200,0
	13,9	2780,0	200,0		14,5	2900,0	200,0
mean	**14,0**	**2800,0**		**mean**	**14,8**	**2950,0**	
B2	16,5	3300,0	200,0	B2	15,5	3100,0	200,0
	16,3	3260,0	200,0		14,3	2860,0	200,0
mean	**16,4**	**3280,0**		**mean**	**14,9**	**2980,0**	

RESULTS FROM TOTAL PHOSPHORUS ANALYSES APPENDIX 2

start of the experement 10.12.12							
A1= first container liquid product				B1=first container with solid product			
A2= second container liquid product				B2=second container with solid product			
reading=result from analysing equipment				C1=first container with compost			
conc. mg/L= concentration of sample				C2=second container with compost			
total Phosphorous							
Fist sampling and results				Second sampling and results			
21.12.2012				28.12.2012			
A1	reading	conc. mg/	dilut. factor	A1	reading	conc. mg/	dilut. facto
	0,87	174,2	200		1,07	214	200
	0,87	173	200		1,00	200	200
mean	**0,87**	**173,6**		**mean**	**1,04**	**207**	
A2	1,00	200	200	A2	0,84	167,4	200
	0,97	193,6	200		0,77	153	200
mean	**0,98**	**196,8**		**mean**	**0,80**	**160,2**	
B1	1,31	1310	1000	B1	0,98	980	1000
	1,18	1180	1000		0,96	956	1000
mean	**1,25**	**1245**		**mean**	**0,97**	**968**	
B2	1,05	2100	2000	B2	0,82	1634	2000
	1,15	2300	2000		0,79	1572	2000
mean	**1,10**	**2200**		**mean**	**0,80**	**1603**	
				C1	1,49	149	100
					1,40	140	100
				mean	**1,45**	**144,5**	
				C2	1,28	128	100
					1,22	122	100
				mean	**1,25**	**125**	
Third sampling and results				Fourth sampling and results			
04.01.2013				16.01.2013			
A1	reading	conc. mg/	dilut. factor	A1	reading	conc. mg/	dilut. facto
	1,15	230	200		1,16	232	200
	1,09	218	200		1,11	222	200
mean	**1,12**	**224**		**mean**	**1,14**	**227**	
A2	0,91	182,4	200	A2	sample lost		
	0,90	180,6	200				
mean	**0,91**	**181,5**					
B1	1,53	1530	1000	B1	0,80	1602	2000
	1,46	1460	1000		0,79	1579,6	2000
mean	**1,50**	**1495**		**mean**	**0,80**	**1590,8**	
B2	0,94	1872	2000	B2	0,81	1624	2000
	0,92	1846	2000		0,80	1600	2000
mean	**0,93**	**1859**		**mean**	**0,81**	**1612**	

Edit Calibration

Result: 130418K



Calibration Curve Slope: 0.00186
Calibration Curve Intercept: 0.00000
Calibration Curve Correlation Coefficient: 0.996960
Calibration Curve Type: Linear Through Zero

Std #	Standard ID	Entered Conc.	Calculated Conc.	Action
Blank	nolla	0	0.000	Include
1	St1	30.0	37.002	Include
2	St2	60.0	60.197	Include
3	St3	90.0	87.877	Include
4	St4	120.0	118.998	Include
5	St5	150.0	150.232	Include
18.4.2013	10:27:36			

(continues)

PAGE 1 2 (15)

Method: 130418K Page 1 Date: 18.4.2013 11:23:52

Analysis Begun

Logged In Analyst: Järjestelmänvalvoja Technique: AA Flame
Spectrometer Model: AAnalyst 400, S/N 201S3071404 Autosampler Model:

Sample Information File:
Batch ID:
Results Data Set: 130418K
Results Library: C:\data-AA\Järjestelmänvalvoja\Results\Results.mdb

Method Loaded
Method Name: 130418K Method Last Saved: 18.4.2013 9:54:10
Method Description: Potassium

Sequence No.: 1 Autosampler Location:
Sample ID: nolla Date Collected: 18.4.2013 10:21:52
Analyst: Data Type: Original

Replicate Data: nolla

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1		[0.00]	0.163	10:21:52	Yes
2		[0.00]	0.163	10:21:57	Yes
3		[0.00]	0.163	10:22:02	Yes
Mean:		[0.00]	0.163		
SD:		0.00	0.0004		
%RSD:		0.00	0.22		

Auto-zero performed.

Sequence No.: 2 Autosampler Location:
Sample ID: nolla Date Collected: 18.4.2013 10:22:10
Analyst: Data Type: Original

Replicate Data: nolla

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1		[0.00]	-0.001	10:22:10	Yes
2		[0.00]	0.002	10:22:15	Yes
3		[0.00]	-0.001	10:22:20	Yes
Mean:		[0.00]	-0.000		
SD:		0.00	0.0016		
%RSD:		0.00	>999.9%		

Auto-zero performed.

Sequence No.: 3 Autosampler Location:
Sample ID: St1 Date Collected: 18.4.2013 10:22:39
Analyst: Data Type: Original

Replicate Data: St1

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1		[30]	0.071	10:22:44	Yes
2		[30]	0.067	10:22:49	Yes
3		[30]	0.069	10:22:54	Yes
Mean:		[30]	0.069		
SD:		0	0.0022		
%RSD:		0	3.20		

Standard number 1 applied. [30]
Correlation Coef.: 1.000000 Slope: 0.00230 Intercept: 0.00000

Sequence No.: 4 Autosampler Location:
Sample ID: St2 Date Collected: 18.4.2013 10:23:28

(continues)

PAGE 2 3 (15)

Method: 130418K Page 2 Date: 18.4.2013 11:23:52

Analyst: Data Type: Original

Replicate Data: St2

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1		[60]	0.112	10:23:33	Yes
2		[60]	0.112	10:23:38	Yes
3		[60]	0.112	10:23:43	Yes
Mean:		[60]	0.112		
SD:		0	0.0001		
%RSD:		0	0.08		

Standard number 2 applied. [60]
Correlation Coef.: 0.961064 Slope: 0.00197 Intercept: 0.00000

Sequence No.: 5 Autosampler Location:
Sample ID: St3 Date Collected: 18.4.2013 10:24:32
Analyst: Data Type: Original

Replicate Data: St3

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1		[90]	0.167	10:24:37	Yes
2		[90]	0.161	10:24:41	Yes
3		[90]	0.163	10:24:47	Yes
Mean:		[90]	0.164		
SD:		0	0.0031		
%RSD:		0	1.87		

Standard number 3 applied. [90]
Correlation Coef.: 0.985164 Slope: 0.00188 Intercept: 0.00000

Sequence No.: 6 Autosampler Location:
Sample ID: St4 Date Collected: 18.4.2013 10:25:33
Analyst: Data Type: Original

Replicate Data: St4

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1		[120]	-0.003	10:25:38	Yes
2		[120]	-0.007	10:25:43	Yes
3		[120]	-0.008	10:25:48	Yes
Mean:		[120]	-0.006		
SD:		0	0.0025		
%RSD:		0	41.72		

Standard number 4 not applied. [120]
No calibration curve because standard absorbance and concentration values are not in the same orc

Sequence No.: 7 Autosampler Location:
Sample ID: St4 Date Collected: 18.4.2013 10:26:14
Analyst: Data Type: Original

Replicate Data: St4

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1		[120]	0.225	10:26:18	Yes
2		[120]	0.219	10:26:23	Yes
3		[120]	0.222	10:26:28	Yes
Mean:		[120]	0.222		
SD:		0	0.0029		
%RSD:		0	1.29		

Standard number 4 applied. [120]
Correlation Coef.: 0.993923 Slope: 0.00186 Intercept: 0.00000

Sequence No.: 8 Autosampler Location:
Sample ID: St5 Date Collected: 18.4.2013 10:27:03

(continues)

PAGE 3 4 (15)

```
Method: 130418K                                     Page   3                        Date: 18.4.2013 11:23:52

Analyst:                                           Data Type: Original

-------------------------------------------------------------------------------------------------------
Replicate Data: St5
Repl   SampleConc  StndConc  BlnkCorr   Time        Signal
 #     mg/L        mg/L      Signal                 Stored
 1                 [150]     0.283      10:27:08     Yes
 2                 [150]     0.279      10:27:13     Yes
 3                 [150]     0.279      10:27:18     Yes
Mean:              [150]     0.280
SD:                0         0.0024
%RSD:              0         0.85
Standard number 5 applied. [150]
Correlation Coef.: 0.996960   Slope: 0.00186    Intercept: 0.00000
   The calibration curve may not be linear.

-------------------------------------------------------------------------------------------------------
Calibration data for K 404.41                         Equation: Linear Through Zero
                                   Entered  Calculated
                     Mean Signal    Conc.     Conc.     Standard
        ID              (Abs)       mg/L      mg/L      Deviation     %RSD
      nolla            0.0000         0       0.000       0.00       >999.9%
       St1             0.0690       30.0     37.002       0.00         3.2
       St2             0.1123       60.0     60.197       0.00         0.1
       St3             0.1639       90.0     87.877       0.00         1.9
       St4             0.2219      120.0    118.998       0.00         1.3
       St5             0.2802      150.0    150.232       0.00         0.9
Correlation Coef.: 0.996960   Slope: 0.00186    Intercept: 0.00000

=======================================================================================================
Sequence No.: 9                                    Autosampler Location:
Sample ID: 21A1                                    Date Collected: 18.4.2013 10:29:55
Analyst:                                           Data Type: Original

-------------------------------------------------------------------------------------------------------
Replicate Data: 21A1
Repl   SampleConc  StndConc  BlnkCorr   Time        Signal
 #     mg/L        mg/L      Signal                 Stored
 1     66.09       66.09     0.123      10:30:00     Yes
 2     71.48       71.48     0.133      10:30:05     Yes
 3     69.92       69.92     0.130      10:30:10     Yes
Mean:  69.16       69.16     0.129
SD:    2.774       2.774     0.0052
%RSD:  4.011       4.011     4.01

=======================================================================================================
Sequence No.: 10                                   Autosampler Location:
Sample ID: 21A2                                    Date Collected: 18.4.2013 10:31:00
Analyst:                                           Data Type: Original

-------------------------------------------------------------------------------------------------------
Replicate Data: 21A2
Repl   SampleConc  StndConc  BlnkCorr   Time        Signal
 #     mg/L        mg/L      Signal                 Stored
 1     75.85       75.85     0.141      10:31:05     Yes
 2     70.71       70.71     0.132      10:31:10     Yes
 3     76.45       76.45     0.143      10:31:15     Yes
Mean:  74.34       74.34     0.139
SD:    3.155       3.155     0.0059
%RSD:  4.243       4.243     4.24

=======================================================================================================
Sequence No.: 11                                   Autosampler Location:
Sample ID: 21B1                                    Date Collected: 18.4.2013 10:31:56
Analyst:                                           Data Type: Original

-------------------------------------------------------------------------------------------------------
Replicate Data: 21B1
Repl   SampleConc  StndConc  BlnkCorr   Time        Signal
 #     mg/L        mg/L      Signal                 Stored
 1     169.4       169.4     0.316      10:32:01     Yes
```

(continues)

PAGE 4 5 (15)

Method: 130418K Page 4 Date: 18.4.2013 11:23:52

Sample concentration is greater than that of the highest standard.

2	170.3	170.3	0.318	10:32:06	Yes

Sample concentration is greater than that of the highest standard.

3	167.5	167.5	0.312	10:32:11	Yes

Sample concentration is greater than that of the highest standard.

Mean:	169.0	169.0	0.315
SD:	1.430	1.430	0.0027
%RSD:	0.846	0.846	0.85

Sample concentration is greater than that of the highest standard.

Sequence No.: 12 **Autosampler Location:**
Sample ID: 28C1 **Date Collected: 18.4.2013 10:33:19**
Analyst: **Data Type: Original**

Replicate Data: 28C1

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	42.99	42.99	0.080	10:33:24	Yes
2	42.72	42.72	0.080	10:33:29	Yes
3	40.07	40.07	0.075	10:33:34	Yes
Mean:	41.93	41.93	0.078		
SD:	1.611	1.611	0.0030		
%RSD:	3.844	3.844	3.84		

Sequence No.: 13 **Autosampler Location:**
Sample ID: 28C2 **Date Collected: 18.4.2013 10:34:04**
Analyst: **Data Type: Original**

Replicate Data: 28C2

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	50.70	50.70	0.095	10:34:09	Yes
2	50.26	50.26	0.094	10:34:14	Yes
3	49.43	49.43	0.092	10:34:20	Yes
Mean:	50.13	50.13	0.093		
SD:	0.644	0.644	0.0012		
%RSD:	1.285	1.285	1.29		

Sequence No.: 14 **Autosampler Location:**
Sample ID: 28A1 **Date Collected: 18.4.2013 10:34:59**
Analyst: **Data Type: Original**

Replicate Data: 28A1

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	75.89	75.89	0.142	10:35:04	Yes
2	74.63	74.63	0.139	10:35:09	Yes
3	74.61	74.61	0.139	10:35:14	Yes
Mean:	75.04	75.04	0.140		
SD:	0.737	0.737	0.0014		
%RSD:	0.982	0.982	0.98		

Sequence No.: 15 **Autosampler Location:**
Sample ID: 28A2 **Date Collected: 18.4.2013 10:35:42**
Analyst: **Data Type: Original**

Replicate Data: 28A2

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	70.04	70.04	0.131	10:35:47	Yes
2	69.50	69.50	0.130	10:35:52	Yes
3	69.70	69.70	0.130	10:35:57	Yes
Mean:	69.75	69.75	0.130		
SD:	0.277	0.277	0.0005		

(continues)

PAGE 5 6 (15)

Method: 130418K Page 5 Date: 18.4.2013 11:23:52

%RSD:	0.398	0.398	0.40

Sequence No.: 16 Autosampler Location:
Sample ID: 4A1 Date Collected: 18.4.2013 10:36:52
Analyst: Data Type: Original

Replicate Data: 4A1

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	77.58	77.58	0.145	10:36:57	Yes
2	73.27	73.27	0.137	10:37:02	Yes
3	74.77	74.77	0.139	10:37:07	Yes
Mean:	75.21	75.21	0.140		
SD:	2.187	2.187	0.0041		
%RSD:	2.908	2.908	2.91		

Sequence No.: 17 Autosampler Location:
Sample ID: 4A2 Date Collected: 18.4.2013 10:37:39
Analyst: Data Type: Original

Replicate Data: 4A2

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	81.57	81.57	0.152	10:37:44	Yes
2	82.70	82.70	0.154	10:37:48	Yes
3	82.56	82.56	0.154	10:37:53	Yes
Mean:	82.28	82.28	0.153		
SD:	0.619	0.619	0.0012		
%RSD:	0.753	0.753	0.75		

Sequence No.: 18 Autosampler Location:
Sample ID: 16A1 Date Collected: 18.4.2013 10:38:48
Analyst: Data Type: Original

Replicate Data: 16A1

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	46.43	46.43	0.087	10:38:53	Yes
2	46.37	46.37	0.086	10:38:58	Yes
3	46.59	46.59	0.087	10:39:03	Yes
Mean:	46.46	46.46	0.087		
SD:	0.115	0.115	0.0002		
%RSD:	0.247	0.247	0.25		

Sequence No.: 19 Autosampler Location:
Sample ID: 28B1 Date Collected: 18.4.2013 10:40:09
Analyst: Data Type: Original

Replicate Data: 28B1

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	121.1	121.1	0.226	10:40:13	Yes
2	122.0	122.0	0.227	10:40:19	Yes
3	119.8	119.8	0.223	10:40:24	Yes
Mean:	120.9	120.9	0.226		
SD:	1.116	1.116	0.0021		
%RSD:	0.923	0.923	0.92		

Sequence No.: 20 Autosampler Location:
Sample ID: 28B2 Date Collected: 18.4.2013 10:40:54
Analyst: Data Type: Original

(continues)

Method: 130418K Page 6 Date: 18.4.2013 11:23:52

Replicate Data: 28B2

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	104.7	104.7	0.195	10:40:59	Yes
2	105.9	105.9	0.197	10:41:04	Yes
3	105.5	105.5	0.197	10:41:09	Yes
Mean:	105.4	105.4	0.197		
SD:	0.586	0.586	0.0011		
%RSD:	0.557	0.557	0.56		

Sequence No.: 21
Sample ID: 4B1
Analyst:

Autosampler Location:
Date Collected: 18.4.2013 10:41:46
Data Type: Original

Replicate Data: 4B1

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	115.6	115.6	0.216	10:41:51	Yes
2	117.9	117.9	0.220	10:41:56	Yes
3	115.8	115.8	0.216	10:42:01	Yes
Mean:	116.4	116.4	0.217		
SD:	1.251	1.251	0.0023		
%RSD:	1.075	1.075	1.07		

Sequence No.: 22
Sample ID: 4B2
Analyst:

Autosampler Location:
Date Collected: 18.4.2013 10:42:29
Data Type: Original

Replicate Data: 4B2

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	156.1	156.1	0.291	10:42:34	Yes
2	155.7	155.7	0.290	10:42:39	Yes
3	154.6	154.6	0.288	10:42:44	Yes
Mean:	155.4	155.4	0.290		
SD:	0.767	0.767	0.0014		
%RSD:	0.494	0.494	0.49		

Sequence No.: 23
Sample ID: 16B1
Analyst:

Autosampler Location:
Date Collected: 18.4.2013 10:43:20
Data Type: Original

Replicate Data: 16B1

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	142.3	142.3	0.265	10:43:24	Yes
2	142.2	142.2	0.265	10:43:30	Yes
3	144.6	144.6	0.270	10:43:35	Yes
Mean:	143.0	143.0	0.267		
SD:	1.346	1.346	0.0025		
%RSD:	0.941	0.941	0.94		

Sequence No.: 24
Sample ID: 16B2
Analyst:

Autosampler Location:
Date Collected: 18.4.2013 10:44:03
Data Type: Original

Replicate Data: 16B2

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	151.9	151.9	0.283	10:44:07	Yes
2	153.5	153.5	0.286	10:44:13	Yes
3	149.9	149.9	0.279	10:44:18	Yes
Mean:	151.7	151.7	0.283		
SD:	1.839	1.839	0.0034		

(continues)

PAGE 7 8 (15)

Method: 130418K Page 7 Date: 18.4.2013 11:23:53

%RSD: 1.212 1.212 1.21

Sequence No.: 25
Sample ID: 21B2
Analyst:

Autosampler Location:
Date Collected: 18.4.2013 10:46:10
Data Type: Original

Replicate Data: 21B2

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	168.2	168.2	0.314	10:46:15	Yes
Sample concentration is greater than that of the highest standard.					
2	165.9	165.9	0.309	10:46:20	Yes
Sample concentration is greater than that of the highest standard.					
3	168.7	168.7	0.315	10:46:25	Yes
Sample concentration is greater than that of the highest standard.					
Mean:	167.6	167.6	0.313		
SD:	1.466	1.466	0.0027		
%RSD:	0.875	0.875	0.87		

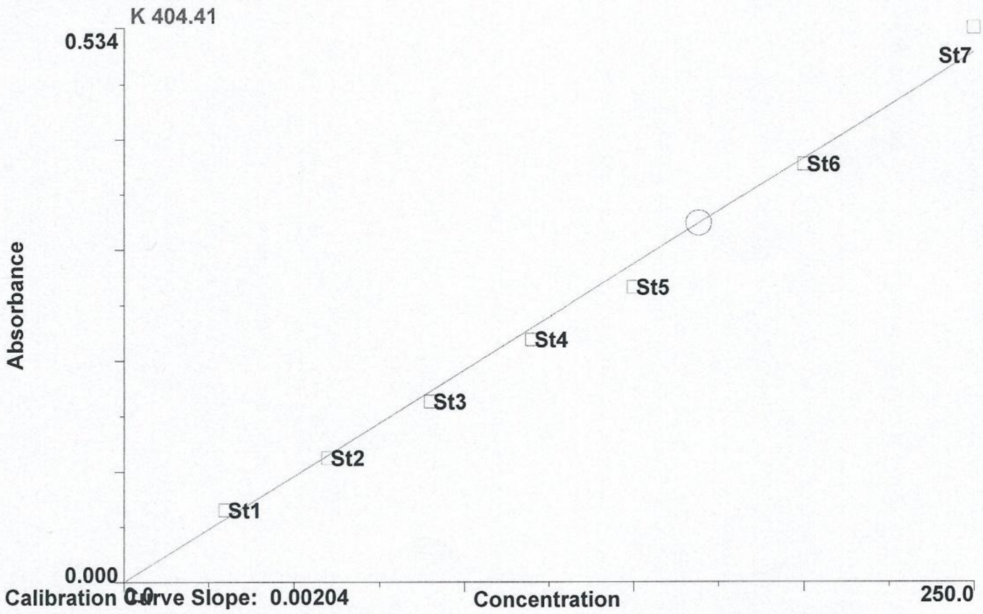
Sample concentration is greater than that of the highest standard.

(continues)

NEW CALIBRATION 9 (15)

Edit Calibration

Result: 130418K



Calibration Curve Slope: 0.00204
Calibration Curve Intercept: 0.00000
Calibration Curve Correlation Coefficient: 0.995371
Calibration Curve Type: Linear Through Zero
Current Sample Concentration: 169.189 mg/L

Std #	Standard ID	Entered Conc.	Calculated Conc.	Action
Blank	nolla	0	0.000	Include
1	St1	30.0	34.147	Include
2	St2	60.0	58.752	Include
3	St3	90.0	85.225	Include
4	St4	120.0	114.410	Include
5	St5	150.0	139.127	Include
6	St6	200.0	197.155	Include
7	St7	250.0	261.663	Include
18.4.2013	11:55:34			

(continues)

PAGE 1 (NEW CALLIBRARION) 10 (15)

```
Method: 130418K                          Page   1                Date: 18.4.2013 12:03:25

==========================================================================================
Sequence No.: 26                                  Autosampler Location:
Sample ID: nolla                                  Date Collected: 18.4.2013 11:26:14
Analyst:                                          Data Type: Original

------------------------------------------------------------------------------------------
Replicate Data: nolla
Repl   SampleConc  StndConc  BlnkCorr   Time        Signal
 #     mg/L        mg/L      Signal                 Stored
 1                 [0.00]    0.175      11:26:19      Yes
 2                 [0.00]    0.174      11:26:24      Yes
 3                 [0.00]    0.174      11:26:30      Yes
Mean:              [0.00]    0.174
SD:                0.00      0.0004
%RSD:              0.00      0.24
Auto-zero performed.

==========================================================================================
Sequence No.: 27                                  Autosampler Location:
Sample ID: nolla                                  Date Collected: 18.4.2013 11:26:38
Analyst:                                          Data Type: Original

------------------------------------------------------------------------------------------
Replicate Data: nolla
Repl   SampleConc  StndConc  BlnkCorr   Time        Signal
 #     mg/L        mg/L      Signal                 Stored
 1                 [0.00]    0.000      11:26:38      Yes
 2                 [0.00]    0.001      11:26:43      Yes
 3                 [0.00]    -0.003     11:26:48      Yes
Mean:              [0.00]    -0.001
SD:                0.00      0.0023
%RSD:              0.00      352.36
Auto-zero performed.

==========================================================================================
Method Loaded
Method Name: 130418K                              Method Last Saved: 18.4.2013 11:27:33
Method Description: Potassium

==========================================================================================
Sequence No.: 28                                  Autosampler Location:
Sample ID: St1                                    Date Collected: 18.4.2013 11:27:57
Analyst:                                          Data Type: Original

------------------------------------------------------------------------------------------
Replicate Data: St1
Repl   SampleConc  StndConc  BlnkCorr   Time        Signal
 #     mg/L        mg/L      Signal                 Stored
 1                 [30]      0.068      11:28:02      Yes
 2                 [30]      0.070      11:28:07      Yes
 3                 [30]      0.071      11:28:12      Yes
Mean:              [30]      0.070
SD:                0         0.0016
%RSD:              0         2.25
Standard number 1 applied. [30]
Correlation Coef.: 1.000000    Slope: 0.00232    Intercept: 0.00000

==========================================================================================
Sequence No.: 29                                  Autosampler Location:
Sample ID: St2                                    Date Collected: 18.4.2013 11:28:38
Analyst:                                          Data Type: Original

------------------------------------------------------------------------------------------
Replicate Data: St2
Repl   SampleConc  StndConc  BlnkCorr   Time        Signal
 #     mg/L        mg/L      Signal                 Stored
 1                 [60]      0.122      11:28:43      Yes
 2                 [60]      0.121      11:28:48      Yes
 3                 [60]      0.117      11:28:53      Yes
Mean:              [60]      0.120
SD:                0         0.0022
```

(continues)

PAGE 2 (NEW CALIBRATION) 11 (15)

```
Method: 130418K                                  Page   2                    Date: 18.4.2013 12:03:25

%RSD:              0          1.86
Standard number 2 applied. [60]
Correlation Coef.: 0.980081   Slope: 0.00207    Intercept: 0.00000

==============================================================================================
Sequence No.: 30                                   Autosampler Location:
Sample ID: St3                                     Date Collected: 18.4.2013 11:29:17
Analyst:                                           Data Type: Original

----------------------------------------------------------------------------------------------
Replicate Data: St3
Repl    SampleConc  StndConc  BlnkCorr   Time         Signal
 #      mg/L        mg/L      Signal                  Stored
 1                  [90]      0.173      11:29:22       Yes
 2                  [90]      0.176      11:29:26       Yes
 3                  [90]      0.172      11:29:32       Yes
Mean:               [90]      0.174
SD:                 0         0.0019
%RSD:               0         1.11
Standard number 3 applied. [90]
Correlation Coef.: 0.991097   Slope: 0.00198    Intercept: 0.00000

==============================================================================================
Sequence No.: 31                                   Autosampler Location:
Sample ID: St4                                     Date Collected: 18.4.2013 11:30:13
Analyst:                                           Data Type: Original

----------------------------------------------------------------------------------------------
Replicate Data: St4
Repl    SampleConc  StndConc  BlnkCorr   Time         Signal
 #      mg/L        mg/L      Signal                  Stored
 1                  [120]     0.234      11:30:17       Yes
 2                  [120]     0.231      11:30:22       Yes
 3                  [120]     0.236      11:30:27       Yes
Mean:               [120]     0.234
SD:                 0         0.0029
%RSD:               0         1.24
Standard number 4 applied. [120]
Correlation Coef.: 0.996161   Slope: 0.00196    Intercept: 0.00000

==============================================================================================
Sequence No.: 32                                   Autosampler Location:
Sample ID: St5                                     Date Collected: 18.4.2013 11:30:58
Analyst:                                           Data Type: Original

----------------------------------------------------------------------------------------------
Replicate Data: St5
Repl    SampleConc  StndConc  BlnkCorr   Time         Signal
 #      mg/L        mg/L      Signal                  Stored
 1                  [150]     0.276      11:31:03       Yes
 2                  [150]     0.290      11:31:08       Yes
 3                  [150]     0.285      11:31:13       Yes
Mean:               [150]     0.284
SD:                 0         0.0069
%RSD:               0         2.42
Standard number 5 applied. [150]
Correlation Coef.: 0.997160   Slope: 0.00193    Intercept: 0.00000

==============================================================================================
Sequence No.: 33                                   Autosampler Location:
Sample ID: St6                                     Date Collected: 18.4.2013 11:31:49
Analyst:                                           Data Type: Original

----------------------------------------------------------------------------------------------
Replicate Data: St6
Repl    SampleConc  StndConc  BlnkCorr   Time         Signal
 #      mg/L        mg/L      Signal                  Stored
 1                  [200]     0.079      11:31:54       Yes
 2                  [200]     0.081      11:31:59       Yes
 3                  [200]     0.081      11:32:04       Yes
Mean:               [200]     0.080
SD:                 0         0.0015
```

(continues)

PAGE 3 (NEW CALIBRATION) 12 (15)

Method: 130418K **Page 3** **Date: 18.4.2013 12:03:26**

%RSD: 0 1.86
Standard number 6 not applied. [200]
No calibration curve because standard absorbance and concentration values are not in the same ord

Sequence No.: 34 **Autosampler Location:**
Sample ID: St7 **Date Collected: 18.4.2013 11:34:10**
Analyst: **Data Type: Original**

Replicate Data: St7

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1		[250]	0.187	11:34:15	Yes
2		[250]	0.184	11:34:20	Yes
3		[250]	0.180	11:34:25	Yes
Mean:		[250]	0.183		
SD:		0	0.0034		
%RSD:		0	1.83		

Standard number 7 not applied. [250]
No calibration curve because standard absorbance and concentration values are not in the same ord

Sequence No.: 35 **Autosampler Location:**
Sample ID: testi **Date Collected: 18.4.2013 11:39:38**
Analyst: **Data Type: Original**

Replicate Data: testi

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1			0.347	11:39:43	Yes
2			0.350	11:39:48	Yes
3			0.100	11:39:53	Yes
Mean:			0.266		
SD:			0.1431		
%RSD:			53.86		

Sequence No.: 36 **Autosampler Location:**
Sample ID: Sample019 **Date Collected: 18.4.2013 11:40:05**
Analyst: **Data Type: Original**

Replicate Data: Sample019

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1			0.350	11:40:05	Yes
2			0.348	11:40:10	Yes
3			0.338	11:40:15	Yes
Mean:			0.345		
SD:			0.0060		
%RSD:			1.74		

Sequence No.: 37 **Autosampler Location:**
Sample ID: St6 **Date Collected: 18.4.2013 11:54:08**
Analyst: **Data Type: Original**

Replicate Data: St6

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1		[200]	0.409	11:54:13	Yes
2		[200]	0.399	11:54:18	Yes
3		[200]	0.398	11:54:23	Yes
Mean:		[200]	0.402		
SD:		0	0.0061		
%RSD:		0	1.52		

Standard number 6 not applied. [200]
No calibration curve because standard absorbance and concentration values are not in the same ord

(continues)

PAGE 4 (NEW CALIBRATION) 13 (15)

Method: 130418K Page 4 Date: 18.4.2013 12:03:26

Sequence No.: 38 Autosampler Location:
Sample ID: St7 Date Collected: 18.4.2013 11:54:53
Analyst: Data Type: Original

Replicate Data: St7

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1		[250]	0.528	11:54:58	Yes
2		[250]	0.542	11:55:03	Yes
3		[250]	0.533	11:55:08	Yes
Mean:		[250]	0.534		
SD:		0	0.0070		
%RSD:		0	1.32		

Standard number 7 applied. [250]
Correlation Coef.: 0.995371 Slope: 0.00204 Intercept: 0.00000

Calibration data for K 404.41 Equation: Linear Through Zero

ID	Mean Signal (Abs)	Entered Conc. mg/L	Calculated Conc. mg/L	Standard Deviation	%RSD
nolla	0.0000	0	0.000	0.00	352.4
St1	0.0697	30.0	34.147	0.00	2.2
St2	0.1199	60.0	58.752	0.00	1.9
St3	0.1739	90.0	85.225	0.00	1.1
St4	0.2335	120.0	114.410	0.00	1.2
St5	0.2840	150.0	139.127	0.01	2.4
St6	0.4024	200.0	197.155	0.01	1.5
St7	0.5341	250.0	261.663	0.01	1.3

Correlation Coef.: 0.995371 Slope: 0.00204 Intercept: 0.00000

Sequence No.: 39 Autosampler Location:
Sample ID: 21B1 new st Date Collected: 18.4.2013 11:56:32
Analyst: Data Type: Original

Replicate Data: 21B1 new st

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	153.0	153.0	0.312	11:56:37	Yes
2	154.2	154.2	0.315	11:56:43	Yes
3	144.0	144.0	0.294	11:56:48	Yes
Mean:	150.4	150.4	0.307		
SD:	5.600	5.600	0.0114		
%RSD:	3.723	3.723	3.72		

Sequence No.: 40 Autosampler Location:
Sample ID: Sample021 Date Collected: 18.4.2013 11:57:00
Analyst: Data Type: Original

Replicate Data: Sample021 Note: "021" is "21B2"

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	151.6	151.6	0.309	11:57:00	Yes
2	153.1	153.1	0.312	11:57:05	Yes
3	152.3	152.3	0.311	11:57:10	Yes
Mean:	152.3	152.3	0.311		
SD:	0.762	0.762	0.0016		
%RSD:	0.500	0.500	0.50		

Sequence No.: 41 Autosampler Location:
Sample ID: 21B2 new st Date Collected: 18.4.2013 11:58:03
Analyst: Data Type: Original

(continues)

PAGE 5 (NEW CALIBRATION) 14 (15)

Method: 130418K Page 5 Date: 18.4.2013 12:03:26

Replicate Data: 21B2 new st

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	151.0	151.0	0.308	11:58:08	Yes
2	153.9	153.9	0.314	11:58:13	Yes
3	152.1	152.1	0.310	11:58:18	Yes
Mean:	152.3	152.3	0.311		
SD:	1.436	1.436	0.0029		
%RSD:	0.943	0.943	0.94		

Sequence No.: 42
Sample ID: 28B1 new st
Analyst:
Autosampler Location:
Date Collected: 18.4.2013 11:58:46
Data Type: Original

Replicate Data: 28B1 new st

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	110.7	110.7	0.226	11:58:51	Yes
2	110.1	110.1	0.225	11:58:56	Yes
3	109.7	109.7	0.224	11:59:01	Yes
Mean:	110.2	110.2	0.225		
SD:	0.499	0.499	0.0010		
%RSD:	0.453	0.453	0.45		

Sequence No.: 43
Sample ID: 28B2 new st
Analyst:
Autosampler Location:
Date Collected: 18.4.2013 11:59:28
Data Type: Original

Replicate Data: 28B2 new st

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	95.25	95.25	0.194	11:59:33	Yes
2	92.72	92.72	0.189	11:59:38	Yes
3	93.61	93.61	0.191	11:59:43	Yes
Mean:	93.86	93.86	0.192		
SD:	1.282	1.282	0.0026		
%RSD:	1.366	1.366	1.37		

Sequence No.: 44
Sample ID: 4B1 new st
Analyst:
Autosampler Location:
Date Collected: 18.4.2013 12:00:20
Data Type: Original

Replicate Data: 4B1 new st

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	103.3	103.3	0.211	12:00:25	Yes
2	103.0	103.0	0.210	12:00:30	Yes
3	105.2	105.2	0.215	12:00:35	Yes
Mean:	103.8	103.8	0.212		
SD:	1.182	1.182	0.0024		
%RSD:	1.139	1.139	1.14		

Sequence No.: 45
Sample ID: 4B2 new st
Analyst:
Autosampler Location:
Date Collected: 18.4.2013 12:01:00
Data Type: Original

Replicate Data: 4B2 new st

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	140.7	140.7	0.287	12:01:05	Yes
2	135.9	135.9	0.277	12:01:10	Yes
3	138.6	138.6	0.283	12:01:15	Yes
Mean:	138.4	138.4	0.282		
SD:	2.385	2.385	0.0049		

(continues)

PAGE 6 (NEW CALIBRATION) 15 (15)

Method: 130418K Page 6 Date: 18.4.2013 12:03:26

%RSD: 1.723 1.723 1.72

Sequence No.: 46
Sample ID: 16B1 new st
Analyst:

Autosampler Location:
Date Collected: 18.4.2013 12:01:48
Data Type: Original

Replicate Data: 16B1 new st

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	129.6	129.6	0.265	12:01:53	Yes
2	130.6	130.6	0.266	12:01:58	Yes
3	132.1	132.1	0.270	12:02:03	Yes
Mean:	130.8	130.8	0.267		
SD:	1.256	1.256	0.0026		
%RSD:	0.961	0.961	0.96		

Sequence No.: 47
Sample ID: 16B2 new st
Analyst:

Autosampler Location:
Date Collected: 18.4.2013 12:02:45
Data Type: Original

Replicate Data: 16B2 new st

Repl #	SampleConc mg/L	StndConc mg/L	BlnkCorr Signal	Time	Signal Stored
1	135.3	135.3	0.276	12:02:50	Yes
2	138.3	138.3	0.282	12:02:55	Yes
3	136.5	136.5	0.279	12:03:00	Yes
Mean:	136.7	136.7	0.279		
SD:	1.488	1.488	0.0030		
%RSD:	1.088	1.088	1.09		