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Perchlorate and chlorate in food of plant origin

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Abstract

Due to findings of perchlorate and chlorate in food of plant origin the Center for Agricultural Technology Augustenberg started two research projects in 2013 and 2014 on finding the sources for the contamination. Fertilizers and chlorination of water seem to be the main sources.

Keywords: Chlorate, Perchlorate, Plant, Food, Fertilizer, Water, Growing media, Residues, LC-MS/MS

1. Introduction

Due to reports of French and US institutions the food monitoring authority of the state of Baden-Wuerttemberg (Germany) started a survey on residues of perchlorate in food of plant origin in 2013. 30 % of the samples showed residues of perchlorate (anion) above the limit of determination. One year later the food monitoring authority extended its monitoring for the chemically similar chlorate (anion). In 25 % of all samples residues of chlorate were found. Immediately after both findings the Ministry of Rural Regions and Consumer Protection of the state of Baden-Wuerttemberg ordered the Center for Agricultural Technology Augustenberg to start a research project on finding the reasons for the contamination of plant material with perchlorate and chlorate.

In the thyroid of humans and rodents, perchlorate and chlorate competitively inhibit the uptake of iodine via the sodium iodide symporter. Iodine uptake in the thyroid is a key step in the synthesis of thyroid hormones, and its inhibition may result in the disruption of thyroid hormone synthesis and consequently disruption of the homeostasis of the hypothalamic-pituitary-thyroid axis, leading eventually to the development of hypothyroid symptoms.

2. Biological Material and Method

The research project regarding perchlorate was carried out in 2013, the one for chlorate one year later. Both projects were divided into two sections: a local monitoring and a cultivation test.

The QuPPe-Method was used for the analysis of perchlorate and chlorate in plant material and growing media. In fertilizers the content of both analytes was determined after solving and dilution in water. Water samples were directly injected into the LC-MS/MS.

For the local monitoring in the year 2013 samples of all potentially contaminated resources (growing media, water, fertilizer) from farms whose products were found to be contaminated during the food monitoring were collected and determined for perchlorate.

The cultivation test for perchlorate was carried out inside a green house. Basil seed was sowed into flower pots containing two different types of growing media. The flower pots were watered with solutions of perchlorate free water and two different fertilizers.

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Plant and growing media samples were collected at common time of harvest (day 0) and 14 days after (day +14). The samples were determined for perchlorate as well as all resources (seed, growing media, water). The chosen growing media and fertilizers were obtained from a farm whose products were found to be contaminated.

Fig. 1 and 2 are showing the analytical results of the cultivation test.

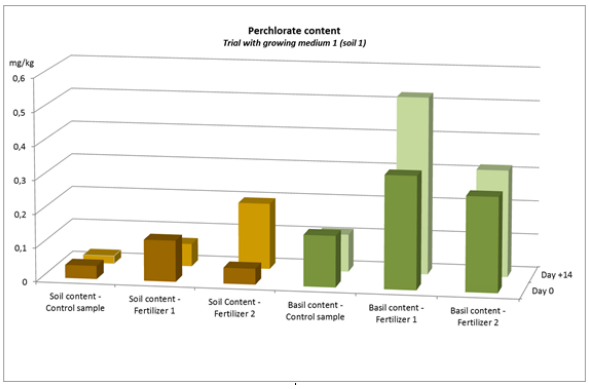

Figure 1. Perchlorate contents in trial with growing medium 1

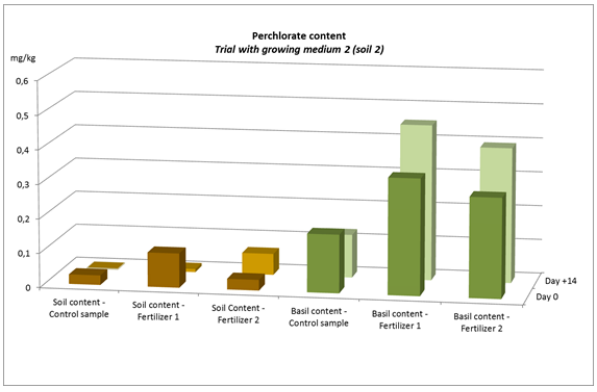

Figure 2. Perchlorate contents in trial with growing medium 2

For the local monitoring in the year 2014 samples of all potentially contaminated resources (growing media, water, fertilizer) and plant material from farms whose products were found to be contaminated during the food monitoring were collected and determined for chlorate.

The cultivation test for chlorate was carried out inside a green house. Basil and butterhead lettuce seedlings were planted into flower pots containing chlorate free growing media. The flower pots were watered with solutions of water and potassium chlorate in different concentrations. Plant and growing media samples were collected at time of planting and harvest. The samples were determined for chlorate as well as all resources (growing media, water).

Fig. 3 is showing the analytical results of the cultivation test.

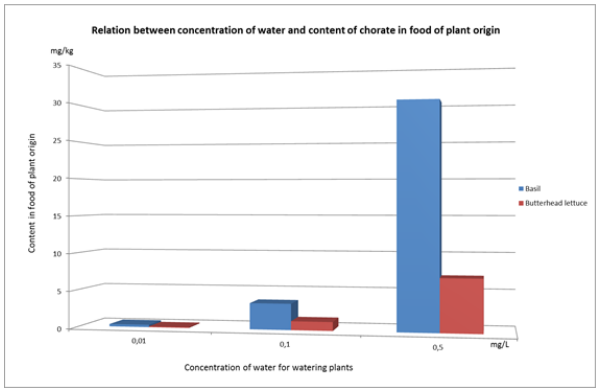

Figure 3. Content of chlorate in food of plant origin

3.Results and Discussions

The ready-to-use growing media of the cultivation test for perchlorate already contained contents of perchlorate between 0.028 and 0.036 mg/kg. Our assumption is that the ready-to-use growing media have already been fertilized (with contaminated fertilizers) by the producer. The contents of the used fertilizers in the cultivation test were 17.5 respectively 22.7 mg/kg. Seed and water were free of perchlorate. The control sample was only watered not fertilized. Fig. 1 and 2 are showing the analytical results. For both growing media and both fertilizers the tendency looks similar. Both basil control samples showed clear amounts of perchlorate. These can only result from an intake of residues of the growing medium through the water. The fertilized basil showed significantly higher contents up to 0.5 mg/kg. The additional contents result from intake of contamination of the fertilizer and the growing medium. 14 days after common time of harvest the contents of perchlorate are higher because of additional time of growing and intake.

During the local monitoring 2013 in all farms at least one fertilizer containing perchlorate was found. The highest content in fertilizers was 65.2 mg/kg. Furthermore some growing media showed also residues of perchlorate (up to 0.048 mg/kg). The

highest content in food of plant origin was 0.880 mg/kg in lettuce.

In the cultivation test for chlorate the content of chlorate in basil and butterhead lettuce could be monitored as a function of the concentration in the water used for watering the plants (see Fig. 3). For the highest concentration in the test (0.5 mg/L) contents up to 30 mg/kg were measured. The chosen growing medium was free of chlorate. No fertilizers were used. Except chlorate and potassium no other ions were present in the water used for watering. In the cultivation test the leaves of the basil and butterhead lettuce plants showed chlorosis a few days after the start at concentrations of 0.1 mg/L and above. In all food of the local monitoring no signs of chlorosis could be seen. We assume that the lack of nutritive substances and other ions e.g. nitrate which compete in plant metabolism e.g nitrate reduction process led to these chlorosis in the cultivation test.

During the local monitoring 2014 in all farms process water (for watering plants or cleaning of food, working surfaces and/or seedlings) containing chlorate was found (0.002 – 0.560 mg/L). Furthermore a few fertilizers showed also residues of chlorate. Highest content in fertilizer was 32.2 mg/kg, in food of plant origin 3.48 mg/kg in lamb's lettuce. In one seedling producing company which uses chlorinated process water seedlings with high content of chlorate were found. In all farms no plant protection products containing chlorate were used.

4. Conclusions

The cultivation test showed the intake from water and soil as possible pathway for the contamination of food of plant origin with perchlorate and chlorate. Contaminated fertilizers and fertilized growing media seem to be the main contamination sources for perchlorate. Chlorate residues in water as byproduct of chlorination seem to be mostly responsible for chlorate residues in food of plant origin. But also a few fertilizers are containing residues of chlorate.

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Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

References

1. European Food Safety Authority (EFSA), Scientific Opinion on the risks to public health related to the presence of perchlorate in food, in particular fruits and vegetables, *EFSA Journal*, **2014**, *12*(10), 3869 *http://www.efsa.europa.eu/de/efsajournal/doc/3869.pdf*
2. European Commission, Health and Consumers Directorate, *Statement as regards the presence of perchlorate in food agreed by the Standing Committee of the Food Chain and Animal Health on 16 July 2013* *http://ec.europa.eu/food/food/chemicalsafety/contaminants/statement-perchlorate_en.pdf*
3. German Federal Institute for Risk Assessment (BfR), *Proposal of the BfR for the health evaluation of chlorate residues in food, Statement No. 028/2014 on 12. May 2014* *http://www.bfr.bund.de/cm/343/vorschlaege-des-bfr-zur-gesundheitlichen-bewertung-von-chloratrueckstaenden-in-lebensmitteln.pdf*
4. EU Reference Laboratories for Residues of Pesticides, *Quick method for the analysis of numerous, highly polar pesticides in foods of plant origin via LC-MS/MS involving simultaneous extraction with methanol (QuPPe-Method)*http://www.eurl-pesticides.eu/library/docs/srm/meth_QuPPe.pdf