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17. Aug. 2016

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Bio-basierte Ökonomie  
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August 15, 2016

## Certification

I confirm that I follow the issue of the medical use of cannabis and cannabinoids since 1994 and am aware of all relevant publications concerning vaporization of cannabis and cannabinoids since this time. Since the preparation of my review for Storz & Bickel and my last certification of September 11, 2015 two relevant new studies on this issue came to my attention. The objective of my literature review was to detect new data on the use of the Volcano Medic, the Mighty Medic or other vaporizers for the administration of cannabinoids in humans. The primary focus was studies on safety issues. One study compared to the efficiency and possible risks of five vaporizers, which are available on the market. A second study issued a warning concerning the use of vaporizers because of missing possible long-term health effects.

### 1. Investigation of five vaporizers with regard to recovery of cannabinoids, efficiency of decarboxylation and possible production of combustion products

Researchers of the University of Bern, Switzerland, investigated recoveries of THC and CBD, decarboxylation efficiency and possible combustion of cannabis by five vaporizers, among them the Volcano Medic® (Lanz et al. 2016). Recoveries of total THC and total CBD in the vapor of 4 electrically-driven vaporizers and one gas-powdered vaporizer were 58.4 and 51.4%, 66.8 and 56.1%, 82.7 and 70.0%, 54.6 and 56.7% and 55.9 and 45.9% for Volcano Medic®, Plenty Vaporizer®, Arizer Solo®, DaVinci Vaporizer® and Vape-or-Smoke™ respectively. Decarboxylation efficiency was excellent for THC ( $\geq 97.3\%$ ) and CBD ( $\geq 94.6\%$ ) for the 4 electrically-driven vaporizers and  $\geq 87.7$  for both cannabinoids with the Vape-or-Smoke™. However, combustion of cannabis was observed with this device. Authors concluded that "temperature-controlled, electrically-driven vaporizers efficiently decarboxylate inactive acidic cannabinoids and reliably release their corresponding neutral, active cannabinoids. Thus, they offer a promising application mode for the safe and efficient administration of medicinal cannabis."

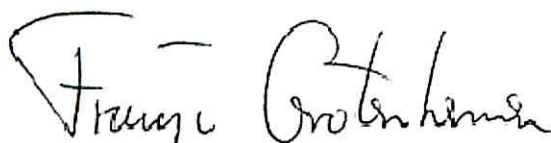
### 2. Discussion of possible long-term health effects of cannabis inhalation by vaporizers

Scientists of the Geisel School of Medicine at Dartmouth in Hanover, New Hampshire, USA, described the trend towards approval of the medicinal and recreational use of cannabis in many societies and point out that the use of vaporizers "is perceived and being sold as a safer way to use cannabis, despite the lack of data on the health effects of chronic vaping" (Budney et al. 2015) Authors speculate that this perceived safety could prompt an increased likelihood of trying cannabis, earlier age of onset, more positive initial experiences and more frequent use, "thereby increasing the probability of problematic use or addiction." However, none of these assumptions is based on any data and they remain pure speculations. This theory is based on the assumption that a safe way of intake may have an influence on the perception of dangers associated with cannabis use itself.

#### **Summary:**

The Volcano Medic continues to be used for research with cannabinoids, and scientists are interested in vaporization as a way of administration. The first study shows that the Volcano Medic is very efficient when it comes to decarboxylation of both THC and CBD without producing possible combustion products. The second study presents assumptions and speculations that because of the safety of vaporization people may be attracted to use more cannabis and at an earlier age.

I declare that literature quoted in this review reflects current state-of-the-art, that references in this review are taken from recognized scientific publications, and that this review is outcome of a study according to scientific principles.



Dr. F. Grotenhermen

#### **Literature**

Budney AJ, Sargent JD, Lee DC. Vaping cannabis (marijuana): parallel concerns to e-cigs? *Addiction* 2015;110(11):1699-704.

Lanz C, Mattsson J, Soydaner U, Brenneisen R. Medicinal Cannabis: In Vitro Validation of Vaporizers for the Smoke-Free Inhalation of Cannabis. *PLoS One* 2016;11(1):e0147286.

#### **Abstracts of the cited literature, which are all available in the database PubMed**

*PLoS One*. 2016 Jan 19;11(1):e0147286. doi: 10.1371/journal.pone.0147286. eCollection 2016.

Medicinal Cannabis: In Vitro Validation of Vaporizers for the Smoke-Free Inhalation of Cannabis.

Lanz C(1), Mattsson J(2), Soydaner U(1), Brenneisen R(1).

Author information: (1)Department of Clinical Research, Laboratory of Phytopharmacology, Bioanalytics and Pharmacokinetics, University of Bern, Bern, Switzerland. (2)Center of Laboratory Medicine, University Institute of Clinical Chemistry, Inselspital, University Hospital Bern, Bern, Switzerland.

Inhalation by vaporization is a promising application mode for cannabis in medicine. An in vitro validation of 5 commercial vaporizers was performed with THC-type and CBD-type cannabis. Gas chromatography/mass spectrometry was used to determine recoveries of total THC (THC<sub>tot</sub>) and total CBD (CBD<sub>tot</sub>) in the vapor. High-performance liquid chromatography with photodiode array detection was used for the quantitation of acidic cannabinoids in the residue and to calculate decarboxylation efficiencies. Recoveries of THC<sub>tot</sub> and CBD<sub>tot</sub> in the vapor of 4 electrically-driven vaporizers were 58.4 and 51.4%, 66.8 and 56.1%, 82.7 and 70.0% and 54.6 and 56.7% for Volcano Medic<sup>®</sup>, Plenty Vaporizer<sup>®</sup>, Arizer Solo<sup>®</sup> and DaVinci Vaporizer<sup>®</sup>, respectively. Decarboxylation efficiency was excellent for THC ( $\geq 97.3\%$ ) and CBD ( $\geq 94.6\%$ ). The gas-powered Vape-or-Smoke<sup>™</sup> showed recoveries of THC<sub>tot</sub> and CBD<sub>tot</sub> in the vapor of 55.9 and 45.9%, respectively, and a decarboxylation efficiency of  $\geq 87.7$  for both cannabinoids. However, combustion of cannabis was observed with this device. Temperature-controlled, electrically-driven vaporizers efficiently decarboxylate inactive acidic cannabinoids and reliably release their corresponding neutral, active cannabinoids. Thus, they offer a promising application mode for the safe and efficient administration of medicinal cannabis.

DOI: 10.1371/journal.pone.0147286 PMCID: PMC4718604 PMID: 26784441 [PubMed - indexed for MEDLINE]

Addiction. 2015 Nov;110(11):1699-704. doi: 10.1111/add.13036. Epub 2015 Aug 12.

Vaping cannabis (marijuana): parallel concerns to e-cigs?

Budney AJ(1), Sargent JD(1), Lee DC(1).

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The proliferation of vaporization ('vaping') as a method for administering cannabis raises many of the same public health issues being debated and investigated in relation to e-cigarettes (e-cigs). Good epidemiological data on the prevalence of vaping cannabis are not yet available, but with current trends towards societal approval of medicinal and recreational use of cannabis, the pros and cons of vaping cannabis warrant study. As with e-cigs, vaping cannabis portends putative health benefits by reducing harm from ingesting toxic smoke. Indeed, vaping is perceived and being sold as a safer way to use cannabis, despite the lack of data on the health effects of chronic vaping. Other perceived benefits include better taste, more efficient and intense effects and greater discretion which allows for use in more places. Unfortunately, these aspects of vaping could prompt an increased likelihood of trying cannabis, earlier age of onset, more positive initial experiences, and more frequent use, thereby increasing the probability of problematic use or addiction. Sales and marketing of vaping devices with no regulatory guidelines, especially related to advertising or product development targeting youth, parallels concerns under debate related to e-cigs and youth. Thus, the quandary of whether or not to promote vaping as a safer method of cannabis administration for those wishing to use cannabis, and how to regulate vaping and vaping devices, necessitates substantial investigation and discussion. Addressing these issues in concert with efforts directed towards e-cigs may save time and energy and result in a more comprehensive and effective public health policy on vaping.

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DOI: 10.1111/add.13036 PMCID: PMC4860523 [Available on 2016-11-01] PMID: 26264448 [PubMed - in process]