CHEM 3100 Scientific Paper

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Question:

What is the quantity and abundance of chlorine by-products within the respiratory system of competitive swimmers?

Problem:

The prevalence of respiratory problems within competitive swimming is among the highest of elite sports. The development of airway disfunctions could be due to the repeated inhalation of chlorines noxious by-products. Chlorine by-products, such as chloramines or chloroform, are formed through the reaction between the chemical substance used to disinfect indoor swimming pools and organic matter pre-existing in the water.

Solution:

Brief Summary:

An analysis of the quantity of chlorine by-products found within competitive swimmer's breath samples before, during and after a workout. Gas chromatography coupled with mass spectrometry is the most effective method of preforming breath analysis for unknown volatile organic compounds. A group of 16 male competitive swimmers provided breath samples before training, immediately after training and 2 hours after training. The respiratory phase was captured with a sorbent material after each participant breathed into it for 2 min. These samples were then analysed using GC-MS headspace where the following was determined: signal intensity of compounds with respect to retention time in the form of acquired graphs as well as the individual identification of the unknown compounds within the samples utilizing the GC-MS software.

Limitations:

Limitations of the method included the participants being male only as well as a relatively small sample size. Further, of the subjects included they must be greater than 18 years old, with the following exclusions: any kind of active or previous history of smoking, chronic respiratory diseases, history of tuberculosis or sarcoidosis and period of 3 months since last acute airway disease. Throughout the experiment participants refrained from alcohol, caffeine, and strenuous exercises 48 hours before training.

Precision and Range:

The detector response to the absolute intensity of the volatile organic compounds had the range of 10,000 to 80,000 mV. However, the final analysis included a parameter range of prominence of peaks being between 3000 to 10,000 mV with a peak width greater than 7. As well, the overall results represented excluded results with low signal-to-noise ratios. The physical characteristics of the participants included within the method demonstrated ranges of age: 19-23 years, mass: 68.5-98.0 kg and maximum O_2 uptake: 54.9-72 ml x min^{-1} x kg^{-1} to name a few.

Instruments and Techniques

The breathing samples were taken through a patented device PL230578 which contained a sorbent material being porous carbonated polyurethane. Once the samples from the participants were taken, the sorbent material was stored in a gas tight container below 0 ℃ and then prepared for analysis by agitation of 40 min at 40 ℃.

The gas chromatography-mass spectrometry instrument that preformed the analysis was the Shimadzu GCMS QP2010 Plus. The capillary column used was a ZB5 MSi with a 30 m length, 0.25 mm diameter and a film thickness of 0.25$\boldsymbol{\mu}$ and an installed precolumn of 5 m length. The chosen carrier gas was helium and the injector temperature was set to 250 ℃. The temperature program was unique with a column temperature being initially 36 ℃ isothermal for 1 min then a ramp of 8 ℃/min to a final temperature of 250 ℃ with an overall run time of 45 min. The identification of compounds was aided through the library of mass spectra JWS (John Wiley and Sons).

Practical Significance:

By analyzing the quantity of chlorine by-products in the breath samples of competitive swimmers it can provide insight to the negative impacts of training in a chlorinated environment. The method used determine the volatile organic compounds is relatively expansive due to the instrument and materials utilized. However, gas chromatography-mass spectrometry is one of the few analytical techniques used to determine unknown compounds as well as quantity of those compounds within breath samples. In lieu of the sorbent material, Tedlar bags have been used in other experiments for the collection of breath samples which would be arguably less expensive as the Tedlar Bags can be reused. Altogether the analysis of chlorine by-products within competitive swimmer's breath samples could offer an explanation for the increased airway disfunction and demonstrate the necessity to develop new methods for training swimmers.

Search Techniques Used:

Google scholar as well as the TRU online library was consulted with the search headings including, Analysis of Breath Samples, Breath Samples and GC-MS, Swimming and Breath Samples as well as Chlorine By-Products in Breath Samples.

References:

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4. Lomax, Mitch. Open Access Journal of Sports Medicine. **2016,** 7, 55-63