Group : Organic Chemistry
Project : On-site Alcohol Quantification in beverages with paper microfluidic & 3D-printed analytical devices
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Introduction

Craft brewing and artisan drinks are very popular nowadays. Such products are made by small companies that often lack resources for proper quality control, for example on the alcohol content. Traditionally, the alcohol concentration in alcoholic beverages is determined by gravimetric methods; density is measured using a hydrometer and correlated with the alcohol content of the beverage. Different physical properties can also be used for alcohol quantification. For instance, surface tension is used in a vinometer that works by measuring the rise of the wine in a capillary, arising from surface tension,. However, these methods require analytical skills to be executed properly. Alternatively, instrumental analyses can also be used for high performance (accurate, precise) such as gas chromatography; these are sophisticated techniques that require expertise and are not affordable for small breweries and distilleries. They also consist of several steps like sample preparation and so take time to obtain results [1]. Hence, there is still an ongoing demand for quick, cheap, user-friendly and accurate on-site analytical devices for alcohol quantification.

In this project, cellulose paper is used for the development of such an on-site device. Paper is a cheap, flexible, light weight, and sustainable material, which is produced by processing of cellulosic fibers derived from trees and plants. Paper has a porous structure formed by the complex fibril networks, which enables passive capillary fluid movement, *i.e.*, microfluidic transportation, through paper [2]. On the other hand, cellulose has a very hydrophilic nature due to abundant hydroxyl groups in its chemical structure, which makes paper easily modifiable by substituting these hydroxyl groups [3].

Covalent modification of cellulose paper alters the surface energy, and accordingly the microfluidic properties such as capillary action; the resulting fluidic movement can be directly related to properties of the sample solution, and lead to a novel device for alcohol analysis. However, the effects of reaction parameters of the modification, *i.e.*, reagent type, reaction temperature and time, on physical and chemical structure of the paper should be better understood. It is therefore essential to investigate the effects of these parameters on paper microfluidics.

Goals

The main aim of this project is to investigate the effect of reaction parameters on paper microfluidic properties in order to develop a user-friendly, paper-based microfluidic device to quantify alcohol concentration in beverages.

Techniques to be used

Modification of paper with different reagents; 3D printing to construct user-friendly devices; Wicking and flow tests; Instrumental analysis: FTIR, Contact angle measurements

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