



## Analysis of commercial beverage products by size exclusion chromatography coupled with UV–vis absorbance detection and dynamic surface tension detection

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### ABSTRACT

Multidimensional analysis of instant coffee and barley beverage samples using size exclusion chromatography (SEC) combined with a dynamic surface tension detector (DSTD) and a UV–vis absorbance detector (UV) is reported. A unique finding of this study was the action of the tetrabutylammonium (TBA) cation as a modifying agent (with bromide as the counter anion) that substantially increased the surface pressure signal and sensitivity of many of the proteins in the chromatographically separated samples. The tetrabutylammonium bromide (TBAB) enhancement of the surface pressure signal was further investigated by studying the response of 12 commercial standard proteins ( $\alpha$ -lactalbumin,  $\beta$ -lactoglobulin, human serum albumin (HSA), albumin from chicken egg white (OVA), bovine serum albumin (BSA), hemoglobin,  $\alpha$ -chymotrypsinogen A, cytochrome C, myoglobin, RNase A, carbonic anhydrase, and lysozyme) in buffer performed using flow injection analysis (FIA) coupled with the DSTD with and without various concentrations of TBAB. The FIA-DSTD data show that 1 mM TBAB enhances sensitivity of HSA detection, by lowering the limit of detection (LOD) from 2 mg/mL to 0.1 mg/mL. Similarly, the LOD for BSA was reduced from 1 mg/mL to 0.2 mg/mL. These FIA-DSTD experiments allowed the detection conditions to be optimized for further SEC-UV/DSTD experiments. Thus, the SEC-UV/DSTD system has been optimized and successfully applied to the selective analysis of surface-active protein fractions in a commercial instant coffee sample and in a soluble barley sample. The complementary selectivity of using the DSTD relative to an absorbance detector is also demonstrated.

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### 1. Introduction

The direct measurement of surface tension is of interest in the investigation of molecular interactions at the air–liquid interface, the study of thermodynamic kinetics of protein denaturation at the air–liquid interface, and in determining foaming capabilities of foods and beverages. Proteins play a key role in the stabilization of foams, emulsions, and composite systems in food products and in cosmetics [1–7]. The creation of emulsions and foams in food products represent dynamic processes and the dynamic surface-active properties of protein solutions are considered to play an important role in the formation and stabilization of these systems [6,8,9].

Traditional methods of quantifying surface tension are based on optical observations of drop growth, optical imaging, tensiometry, and manual observations of foam performance [10–12]. Most of these techniques are restricted to static measurements and cannot assess the dynamic nature of foams and emulsions. Additionally there may be other limitations of these methods such as protein adsorption [13] or lack of compatibility with flow injection analysis (FIA) or liquid chromatographic systems [14].

The limitations of previous methods have led to the development of a versatile technique to assess the dynamic surface pressure of flowing liquids. The dynamic surface tension detector (DSTD) is a high-throughput automated chemical analyzer capable of quantifying the surface tension of a complex sample [13–17]. The surface-tension-lowering response observed by the DSTD is converted to a quantity known as the surface pressure. The DSTD provides real-time surface pressure data for surface-active sample

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