PÔSTER - RESUMO - SENSORES E BIOSSENSORES

PORTABLE MULTI CHANNEL ELECTRIC IMPEDANCE ANALYZER FOR DETECTION OF OFF-FLAVOR SUBSTANCES IN THE BREWING PROCESS

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Brazil is among the world's largest beer consumers and has experienced strong expansion in the sector, driven mainly by craft microbreweries, reflecting a changing consumer profile that is now more demanding and interested in differentiated products [1]. In parallel, technological advances have allowed for greater control over production stages. Large breweries prioritize rigorously standardized processes to ensure uniformity, while quality is collectively assessed by experts. Craft breweries, on the other hand, face greater difficulty in maintaining standardization due to the complexity of production control and lower investment. Among the factors impacting quality are so-called off-flavors. Although many do not pose a health risk, some compounds, such as higher-order alcohol (fusel), can intensify hangovers. They can result from inadequate fermentation conditions, including temperature and inoculum. Examples include n-propanol, 2-methylpropanol, 3-methylbutanol, ß-phenylethanol, and benzyl alcohol. Other undesirable compounds include dimethyl sulfide, acetaldehyde, 2,3-butanedione, ethyl acetate, and methanol. A certification process for the

absence of off-flavor substances above human detection limits that is fast, inexpensive, and does not require the intervention of a qualified professional is highly desirable for the popularization of high-quality beers. To this end, it is necessary to implement a fully automated methodology that yields objective results, unlike certification through sensory analysis or sommelier assessments. This work presents the development of a portable electrical impedance analysis system integrated with a multiplexer that accesses a matrix of electronic sensory units, enabling an automated, fast, and objective quality certification system that reduces the subjectivity of traditional sensory analyses. We have designed a circuit board for electric impedance measurements based on the AD5933 integrated circuit [2], which is an impedance converter that integrates an internal frequency generator and an analog-to-digital converter (ADC), enabling AC excitation signal generation and response acquisition for impedance calculation using a Discrete Fourier Transform (DFT). Despite its versatility, the device has limitations regarding the frequency range, the number of discrete excitation voltage levels, and the presence of an undesired DC component in the generated signal. The development of an enhanced system aims to expand the operational flexibility and measurement accuracy of the default commercial configuration. The designed circuit allows impedance measurements from 10 Hz to 100 kHz, a higher impedance dynamic range (100 Ohm to 1 MOhm), and dc offset compensation, all controlled by an onboard firmware based on an Arduino Mega platform. A Python-based software application was developed to1 provide enhanced flexibility in system configuration and operation, communicate with the device firmware, and support a wide variety of experimental combinations, tailored to user needs. The developed software allows users to select measurement channels, configure measurement intervals, and define repetitive acquisition routines. The system was validated using a four-sensor matrix comprising zinc oxide (ZnO), poly(3-hexylthiophene) (P3HT), multi-walled carbon nanotubes (MWCNTs), and zinc tin oxide (ZTO) modified electrodes to detect off-flavor in beer samples. The system detected toxic substances such as ethylene glycol and diethylene glycol at levels well below the human toxicity threshold.

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References

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Palavras-chave: sensors; off-flavor; impedance.