ACOUSTIC ENVELOPE DETECTOR FOR CRISPNESS ASSESSMENT OF BISCUITS

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ABSTRACT

The crispness of food materials based on the force/displacement behavior and their acoustic nature was assessed using an Acoustic Envelope Detector (AED) attached to the Texture Analyzer, wherein six kinds of biscuits were used: Carr's Table Water, Crackerbread, Digestive, Dutch Crispbakes, Rich Tea fingers and Shortbread. The force/displacement and acoustic signals were simultaneously recorded during the breakup of biscuits. For each detected acoustic signal, there was a sudden drop in the compression force. The analysis of the force/displacement curve demonstrated the links between the second derivative of force curve and the acoustic event, indicating the energy released through the air of these crack events. The acoustic behavior of the biscuits was assessed in terms of maximum sound pressure level and the number of acoustic events, which were further interpreted as the acoustic events per unit area of newly created surface area and the acoustic event per unit time. The acoustic ranking of biscuits from instrumental assessment was in very good agreement with that from sensory panel tests. The normal integration time (1.25 ms) for the AED was generally effective in detecting acoustic signals for crisp biscuits, but a shorter integration time (0.25 ms) was found advantageous in detecting acoustic signals that occur within a very short time period and gave better differentiation of crisp biscuits.

KEYWORDS

Acoustic Envelope Detector, bending-snapping, biscuits, crispness, sensory, sound

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INTRODUCTION

Crispness is an important sensory attribute in many types of foods, and "crisp" is the most frequently used English word describing a textural attribute. However, its meaning is imprecise and the perception of crispness greatly varies from individual to individual and from country to country (Bourne 2002). The large variation of crispness perception is reflected in various taste panel results and gives food scientists great difficulty in defining a parameter that is scientifically meaningful and easy to measure. Nevertheless, there are two features we all agree about crisp foods: they are mechanically brittle and acoustically noisy.

Extensive researches on food crispness have attempted to establish correlations between crispness and mechanical properties of food materials, in particular, force/displacement. Crisp foods give sequential low-degree fractures once the load exceeds a critical value (Dobraszczyk and Vincent 1999). Such mechanical brittleness was referred as the jaggedness of force/displacement curves of puffed cereal particles (Suwonsichon *et al.* 1997) and was also observed from the force deflection curves of starch-based crisp foods (Vincent 1998). It was believed that a large number of small fracture events suppressed the development of large fracture events by competing for the available energy, thus creating the sensation of crispness (Vincent 1998). Here, we recognize the ambiguity of the English language with regard to "crispness" by referring to it alternatively as crispness or crispy/crunchiness.

The acoustic nature of crispness has also been extensively investigated by two different approaches: one is to measure the perception of air-conducted sounds to establish the contribution of these sounds to the sensation of food crispness, and the other is to record the sounds produced during the application of a force to a crisp food product to obtain quantitative information regarding the crisp, crunchy or crackly sounds (Duizer 2001). The former adopts sensory tests technique (Christensen and Vickers 1981; Vickers 1985) and the latter requires the development of acoustic detection devices (Edmister and Vickers 1985; Seymour and Hamann 1988; Tesch *et al.* 1995; Duizer 2001; Srisawas and Jindal 2003). Although these reports indicated positive correlations between acoustic measurements and the sensation of crispness, the precise interpretation of acoustic data is still difficult.

Little research has been done on the combination of force/displacement measurement and acoustic detection of food materials. This combination possesses the advantages of both techniques and should be able to reveal much more information about the crispness of food than either technique alone. An Acoustic Envelope Detector (AED) has recently been developed by the manufacturer of the Texture Analyzer, Stable Micro Systems (Surrey, U.K.). The device can be easily attached to the Texture Analyzer as an additional fixture

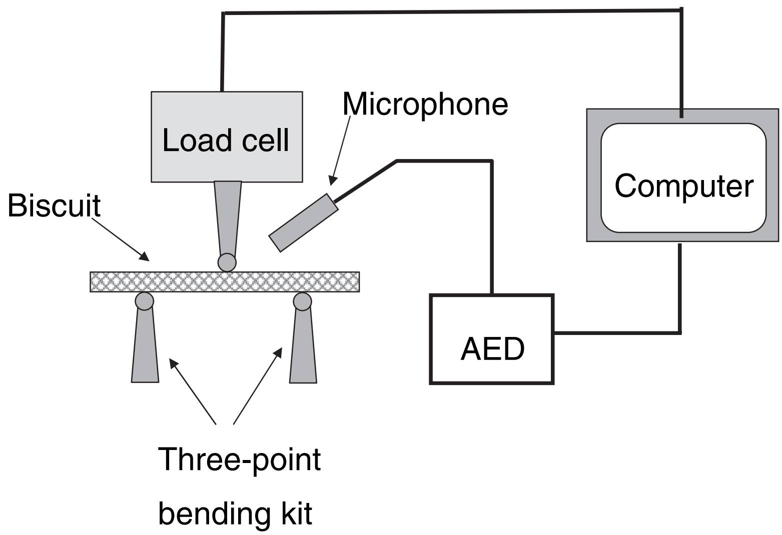

FIG. 1. A SCHEMATIC DIAGRAM OF INSTRUMENTAL SETUP OF THE TEXTURE ANALYZER CAPABLE OF DETECTING FORCE/DISPLACEMENT AND ACOUSTIC SIGNALS
AED, acoustic envelope detector.

(Fig. 1), so that both mechanical force and acoustic signals can be detected at the same time. In this work, we will assess the applicability and reliability of the device in assessing the crispness/crunchiness of food materials. A number of biscuits was assessed for their acoustic characteristics together with the force/displacement information during the breakup of these materials. The instrumental test results were further assessed by comparison with taste panel tests. It is hoped that the results from this work could enhance our understanding of the acoustic and mechanical characteristics of crisp food materials and help us to establish a reliable and simple method for discerning the crispness of food products.

MATERIALS AND METHODS

Testing Materials

Six kinds of biscuits were purchased from supermarkets: Carr's Table Water ([CTW] Carr's of Carlisle, PA), Crackerbread ([CBD] Ryvita Co., Poole, Dorset, U.K.), Digestive ([McD] McVitie's, Ashby-De-La-Zouch, Leicesteshire, U.K.), Dutch Crispbakes ([DCB], Safeway, Hayes, U.K.), Rich Tea fingers ([RTF] Safeway) and Shortbread ([SBD] Safeway). The geometric dimensions of the biscuits are given in Table 1. The samples were unpacked