Can the quality of apples be gauged automatically?

Crunching Machine

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Those fantastically juicy apples sitting on supermarket shelves are not just simply nature's gift to us – they are also the result of numerous tests and ongoing scientific research

As the old saying goes, an apple a day keeps the doctor away. Fruit and vegetables, especially apples, are a good source of health-promoting substances, such as phenols and cholesterol-reducing fiber. According to some sources, eating a single apple a day can actually lower cholesterol levels by as much as 8-10%. The flavonoids in apples, in turn, have powerful antioxidant and anti-inflammatory properties, and they also strengthen the blood vessels. It hardly comes as a surprise, then, that many research groups are working on improving apple quality to make sure consumers have access to attractive, organoleptic, tasty, and healthy fruit.

Food and the senses

The four key factors of food quality are appearance, smell, texture, and nutritional value. The first three are known as sensory acceptability factors, since they are perceived by the human senses and can be assessed directly by the consumers. Sensory acceptability of food products is incredibly important, since people want to enjoy eating their favorite products. It can also be difficult to convince consumers to eat healthy products that are unappealing in terms of appearance and texture. Food gives us pleasure not just through its flavor or fragrance; we also want to be aware that what we are eating is fresh. In case of fruit, we associate the latter with mechanical qualities; apples are desirable when their texture is crunchy, crisp and juicy, and less so when they are mealy.

Crispy, juicy, mealy

From a mechanical perspective, crispness, juiciness, and mealiness are all associated with how the cellular structure is broken down. If biting into an apple causes the cell walls to rupture releasing intracellular juices, it makes the apple feel juicy and crispy. This is because of the acoustic signal generated as part of the process, which is perceived positively by our auditory system. Recent research shows that crispness can be perceived as a combination of acoustic impressions and the strength required to break down the product, while the acoustic signal is largely perceived as vibrations by the jaw bone (bone-conducted sound). Once the cellular walls rupture, the fruit takes on a mealy quality and the apple is generally perceived to be overripe.

Texture is a sensory characteristic; assessing it objectively is extremely difficult since consumers' personal and cultural predispositions vary greatly, and percep-

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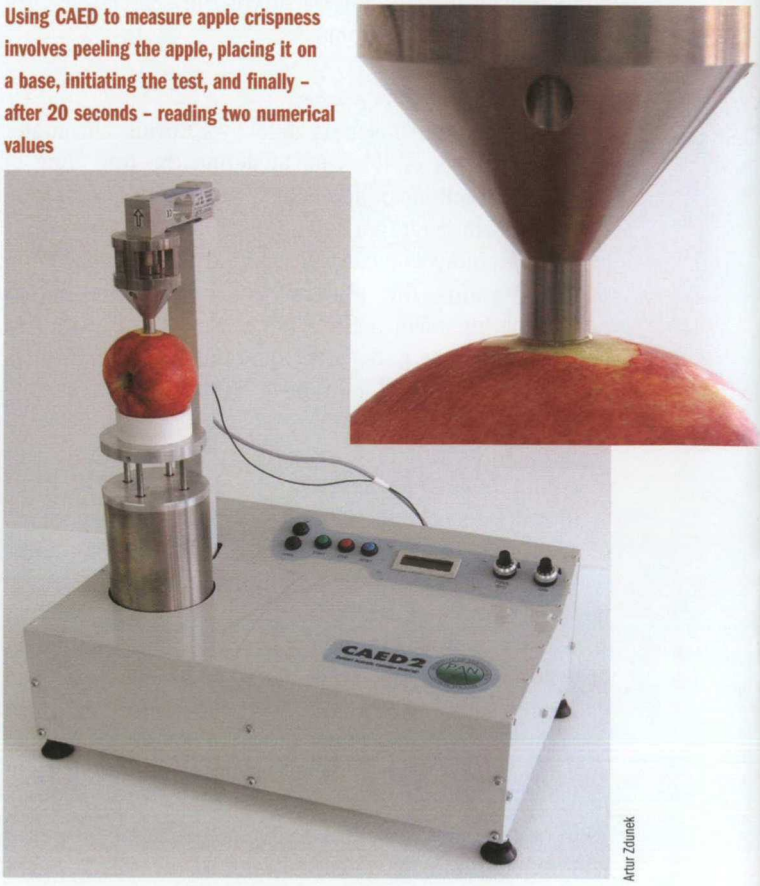

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CAED – a Lublin-designed device for measuring apple crispness – could replace trained human testers

tions can even depend on the person's mood or frame of mind at the time. Texture is also not a constant feature, and is affected by many factors, such as treatment prior to picking, time of picking, and method and duration of storage. This is why it should be monitored on an ongoing basis, while at the same time the measurements should be simple, repeatable, and low-cost. Unfortunately sensory assessment conducted by a professional panel or representative group of consumers does not meet these criteria.

CAED

The Department of Microstructure and Mechanics of Biomaterials of the PAS Institute of Agrophysics in Lublin has designed a device meant to fill this gap, to be used for assessing apple texture objectively: the Contact Acoustic Emission Detector (CAED), created by a team led by the present author with funding from the Polish National Center for Research and Development. The project has been completed and the device is ready for commercialization.

It takes advantage of the acoustic emissions generated during a typical puncture test used to assess apple crispness. The measurement method simulates the process of biting into an apple being tested, and the sensory perception of the attendant auditory and mechanical stimuli. CAED was calibrated by comparing it against two specialist sensory panels on 19 popular apple varieties. The calibration proved to be very successful, and opened the way for the development of an automatic measuring procedure. Using the device is simple: one peels an apple, places the fruit on a base, initiates the testing, and finally – after 20 seconds – reads two numerical values which are then used in the calibration equations. Using measurements taken on 10 fruits from a test batch, the values of several sensory attributes are calculated (the same process as is used by professional sensory panels of human testers). The tests show that CAED is effective at assessing whether apples are crisp, hard, and juicy, and provides a precise general assessment of texture. The time required to assess the texture of one batch of apples is just 10 minutes – significantly less than preparing and conducting sensory analysis. Using sensory analysis on a 1-10 scale as a reference point, the precision of the device makes it possible to classify fruit into one of five texture categories. This means that CAED could replace sensory panels as it is faster, and – as is usually the case with technology – it is objective and does not suffer from fatigue. It is also small and easy to use, which makes it possible for producers and processors to take on-site measurements. ■

Further reading:

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