MEASURING TASTE OBJECTIVELY

The Electronic Tongue can even pinpoint the vineyard

An electronic tongue electrochemically converts ionic potential into volts when constructed according to the NERNST potential – which is based on ionic concentrations across a membrane. This easy-to-determine pattern describes the ionic state in the solution being analyzed. This information regarding a solution's ionic state can be added to the product's chemical and word descriptions.

Jena Electronic Tongue Multi-SENSORICCARD®

This technical solution uses low-cost/high-performance electronics for the detection of electrode-generated voltages within an electrolyte, using tiny, (250 micrometer) protruding pins of different materials.

This is done according to the same measuring principle according to NERNST mentioned above, similar to the principle used in dry cells and accumulators. In milliseconds, a pattern/description as a vector or "fingerprint" is available for delivery to an 8-channel measuring head.

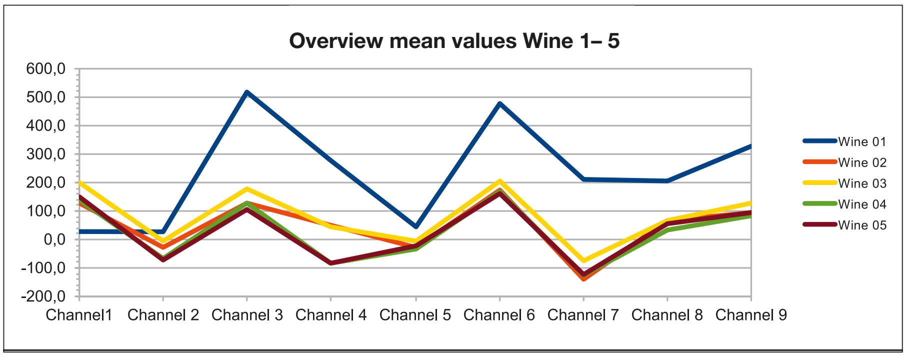

Fig. 1: Results of five wine varieties recorded with the Jena Electronic Tongue Multi-SENSORICCARD® in a 9-channel configuration

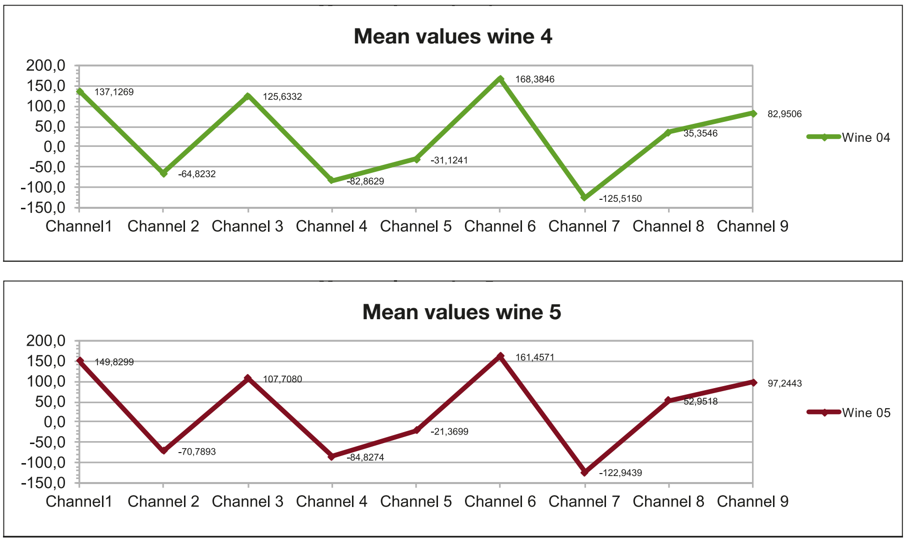

Fig. 2: The two Riesling wines show close similarities (vector components and fingerprints), but subtle differences can be found due to their origin.

With 8-bit resolution, a sufficient number of gradations is possible. This is more than enough for practical applications of this nature. Any item containing ions will reveal its structure to this instrument. Since even a hint of moisture contains ions, wine will be relatively easy to read. The electronic tongue can be used for data collection after a reasonably brief yet comprehensive self-actuation period. After a short ramp-up phase, it will be able to quickly and reliably complete various tasks during cultivation, maturation, fermentation, processing, storage, sales and consumption.

The device can be coupled with a computer to access the full potential of the Internet. This does not mean that the refractometer has been replaced, but now that traditional instrument can be partnered with this new, multitalented device to improve the objectivity and quality of each step in the production, delivery and consumption process.

Wine varieties

Each wine variety is characterized by the elements and molecules it contains. Since elements and molecules are in an aqueous solution, they are all, to a certain extent, ionized. The electronic tongue, using the NERNST transformation principle, is able to read variety-specific components in solution as a pattern of voltage values.

Figure 1 shows five wine varieties in a 9-channel configuration. Each type generates different electrode voltages, and can therefore be described and distinguished from one another. It is striking that the two Rieslings show nearly overlapping curves. The results are again shown in Fig. 2 and highlighted with several digits after the decimal (comma). In practice, three digits would also suffice. It is, however, included here in this form to make it quite clear that the vineyard, its associated cultivation conditions as well as the location have an influence on the grape variety being cultivated. This is generally known, but can now be readily detected using the electronic tongue.

Wine in the glass

A common practice among wine afficionados is decanting, which aerates the wine and allows it to reach room temperature before drinking. This method makes use of the interaction of wine with air and is acknowledged to have an effect on taste. In Fig. 3, the human tongue is now replaced by the electronic tongue. It shows individual electrode voltages K1 to K8 over half an hour's time. Some voltages undergo significant changes. This demonstrates taste-changing processes. If the sommelier, gourmet or winemaker assigns his own subjectively perceived taste to the measuring points, he can adjust his report – after training – even without tasting.

Flavor detection can be purely technical

Taste has always been a subjective factor, determined by our human sense organs – nose and tongue – allowing for the wildest speculations and assertions. Now, science is trying to shed some light on this phenomenon. Molecular/biological as well as chemical approaches have been attempted. The neural connections guiding taste information in the brain are indisputable yet subjective and still not fully understood. The technology of an electronic tongue, on the other hand, now allows a taste reference, based on known taste experiences, in order to determine the relationship between these known reference points and the sample being tested. This relationship, expressed as a ratio, can be calculated as the so-called Euclidean distance. If statistically reliable state or taste descriptions are also available, a determination according to MAHALANOBIS is recommended.

A purely technical taste result can be achieved based on the following sequence:

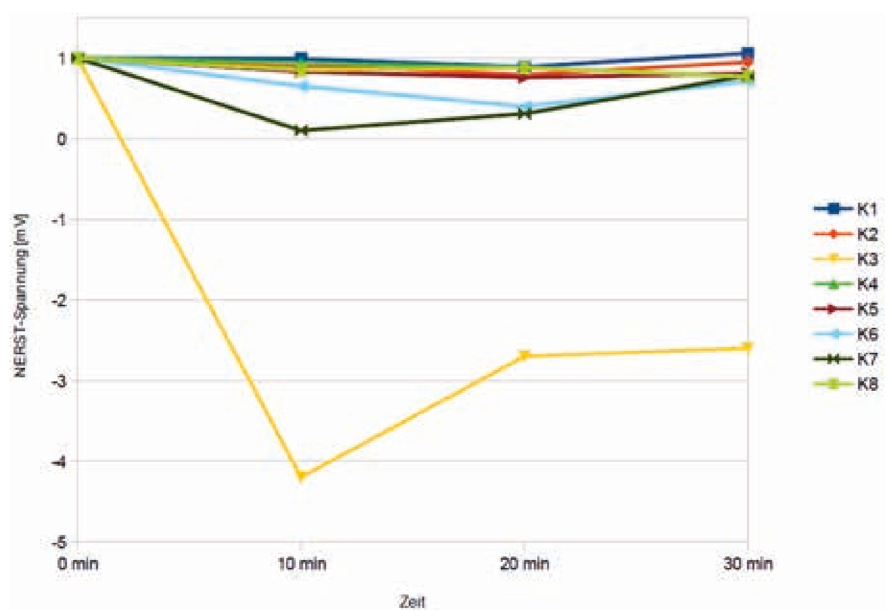

Fig. 3: Chronological sequence of voltage values of the Jena Electronic Tongue measuring a wine after opening the bottle and pouring the wine into a wine glass. Measuring device Card 270, Tongue 206, measuring head 3M1

Vector 1	Vector 2	Vector 3	Vector 4	Measuring Channels	
				(mV)	
527	505	498	365	K1	
600	561	558	480	K2	
380	317	259	323	K3	
1	2	2	3	K4	
554	317	317	201	K5	
394	128	185	2	K6	
510	489	490	377	K7	
174	177	75	172	K8	

Red Wine Francois Dulac, 12 %vol., from Pertersbach, France
Electronic MB 627, measuring head 3M4
Vector 1: dry, fruity, elegant
Vector 2: sweet, fruity aromatic
Vector 3: mixture dry to sweet, ratio 5:1
Vector 4: basic taste sweet (qualitative sugar solution)

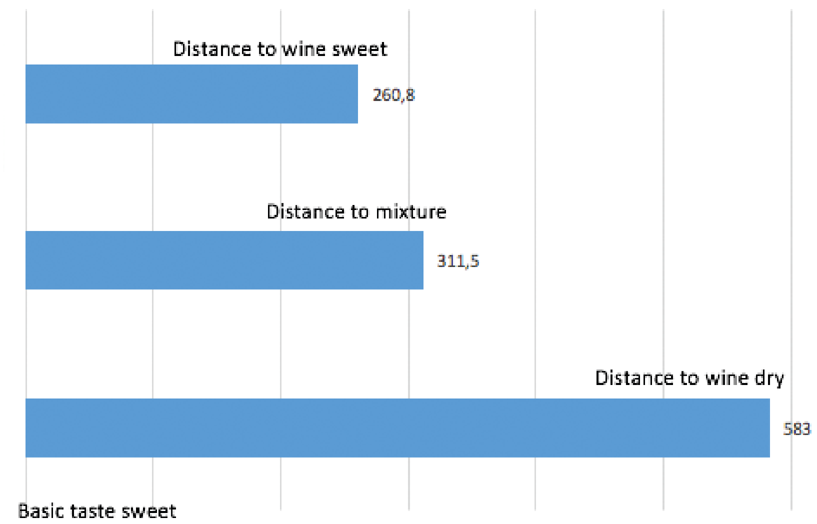

Fig. 4: Example of a solely technical taste description using the Jena Electronic Tongue Multiion-SENSORICCARD®

1. Determination of the electronically generated electrical description of a reference pattern by means of an electronic tongue, grounded in a singular experience or supported statistically
2. Determination of the description according to 1. to achieve a sample flavor attribution
3. Optional assignment of subjective assessments and descriptions
4. Storage of the descriptions/vectors in a database
5. Calculation of the Euclidean or MAHALANOBIS distance

The ionic composition of any product or object containing ions can be tested in this same way (for example concrete, earth, sewage and oceans, organisms, plants, petroleum, chemicals, DNA, diseases, etc.) generating the means to achieve a general concept of taste. Putting together a world taste database by this method would make logical sense. Anyone could access this information via a simple device and using today's modern, nearly ubiquitous information and communications technologies.

Data as shown in Fig. 4 are one example. The taste of a sweet red wine as compared to a technical reference pattern can be determined by comparison to two measurements (vector 2 to vector 4, distance from sweet wine), as well as to a mixture of both wines (vector 3 to vector 4). As a reference, the qualitative taste "swee" is simulated by a sugar solution (quantitatively influenced by different concentrations of sucrose in water). This is listed in vector 4.

The Euclidean distance is calculated from the sum of the squared differences between the measurement channel voltages of the reference pattern, and the sample and then the root is calculated. As expected, the Euclidean distance of sweet red wine from the basic pattern of "sweet" is least (260.8). The addition of dry red wine increases this distance (311.5) and the dry red wine is the furthest away from the basic flavor "sweet" (583). ☐

Horst Ahlers

University Lecturer,
Dr.-Ing. habil. et Dr. sc. techn.,
MULTISENSORIC GmbH, Jena, Germany