14. Sensory Measurement of Meat Quality

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Learning objectives

At the end of this lecture you will be able to:

- describe how meat quality traits are assessed by human senses
- describe the major frameworks within which this assessment is done
- discuss the benefits and disadvantages of these methods

14.1 Introduction

The assessment of meat quality can be done subjectively by humans using their senses (sensory measurement) or by machines. There are advantages and disadvantages of both approaches. This lecture presents the various methods used for sensory assessment of meat quality, and how they are applied.

Sensory evaluation
Sensory means "of the senses" – and applies to any assessment in which a sensory organ or part of the human body (nose, eyes, taste buds, teeth) is used. It therefore follows that sensory assessment must be made by humans, not by laboratory equipment.

The advantage of sensory evaluation is that you get a direct quantification of a human's perception of meat attributes. You can also get preferences. The disadvantages are that it is time consuming, expensive, and there is huge variation, both between and within individuals, in assessment. Humans can also be influenced by irrelevant factors. There are three major attributes of meat which contributes to the sensory perception of eating quality: tenderness (or texture), juiciness and flavour.

14.2 Tenderness evaluation

Tenderness is primarily determined by the myofibrillar and connective tissue components of muscle. This may interact with the physiological aspects of mastication (chewing). A simplistic definition of tenderness is the psychological response to physical-chemical stimuli caused by chewing (Bailey 1964). Assessment of how tender/tough a piece of meat is starts as soon as the piece of meat is first bitten. In fact, if the sample has to be cut by the assessor, then assessment may start with the knife cut.

The components of tenderness which may be considered in its evaluation during chewing include:

- the initial ease of penetration by the teeth on the first bite
- the ease with which the meat breaks into fibres
- the amount of resistance to chewing
- the force and time required until the meat is ready for swallowing.

Many evaluations using untrained consumers do not define tenderness, but simply allow it to be interpreted by individuals, and evaluated as a single attribute. More complex evaluations may separate the evaluation into categories such as myofibrillar toughness, ease of fragmentation, connective tissue tenderness and overall tenderness. This is only possible when using people trained to recognise and separate the various components.

14.3 Juiciness evaluation

Juiciness is comprised of the amount of water retained in the cooked meat, the amount of melted lipids in the sample, and the degree of salivation occurring during chewing. The latter is not an intrinsic factor of the sample, but may be related to intrinsic factors. Judge et al (1989) said that the principal sources of detected juiciness are the intramuscular lipids and water. In combination with water, melted lipids constitute a broth that, when retained in meat, is released upon chewing and this broth may stimulate saliva flow and thus improve "apparent" juiciness. As with tenderness the evaluation of juiciness starts with the first bite of the sample.

The components of juiciness to evaluate include:

- the initial burst of juice or wetness when the meat is first bitten into
- the degree of moistness that remains as the meat is chewed well ready for swallowing.

14.4 Flavour evaluation

For the purpose of practical sensory analysis, flavour can be defined as the impressions perceived via the chemical senses from a product in the mouth (Caul 1957). This includes the aromatics (olfactory perceptions), the tastes caused by soluble substances in the mouth (sweet, bitter, sour, salty), and the chemical feeling factors which stimulate nerve ends (eg astringency, metallic flavour, umami).

The flavour component of meat is two-fold. The "meat" flavour resides in the water-soluble fraction of meat and is essentially the same for all meat species. The species specific component which enables us to distinguish one species from the other eg. pork from beef, resides in the fat fraction. Added to the perception of flavour are those flavours imparted by the process of cooking – for instance the browning or caramelisation of grilled meat.

Flavour is a very complex trait and the relationship between specific flavours and the underlying biochemistry is, as yet, poorly understood. Although some people can learn to distinguish and describe specific tastes that make up an overall flavour, and assess it on this basis, other studies just quantify the degree of "liking" of flavour in the various samples.

14.5 Methods of recording sensory responses

There are various methods used to record the sensory perceptions of people when they are tasting meat. The method used will depend on what is being tested.

Some methods are:

- Classification: Subjects mark a term (or classification) which they think best describes the sample – eg. very tender, tender, tough.
- Grading: Graded into categories such as "choice", "regular", "reject". There is no information recorded about actual traits of the sample.

- Ranking: Subjects receive 3 or more samples which are to be arranged in order of intensity or degree of some specified attribute – eg. tenderness.
- Scaling: This involves the use of numbers or words to express the intensity of a perceived attribute (tenderness, juiciness) or reaction to an attribute (liking, intent to purchase).

Scaling in more detail

Scaling is the more informative and therefore the more useful form of recording the intensity of perception. A problem with scales is that subjects tend to use only the middle section.

Three types of scales are commonly used:

Category scaling: the subject is asked to "rate" the intensity of a particular stimulus by assigning it a value (category) on a limited, usually numerical scale. They do not generally provide values which measure the degree (how much) one sample is more than another. On a 7-point scale for tenderness, a sample rated a 6 is not necessarily twice as tender as a sample with a rating of 3.

Line scales: With a linear or line scale the panellist "rates" the intensity of a given stimulus by making a mark on a horizontal line which corresponds to the range of the perceived stimulus. These lines have "anchors" at the ends which describe the extremes of the attribute being assessed. Normally the left end of the scale corresponds to "none" or zero amount of the stimulus while the right end of the scale represents a large amount or a very strong level of the stimulus. Panellists use the line scale by placing a mark on the scale to represent the perceived intensity of the attribute in question. The marks from line scales are converted to numbers by manually measuring the position of each mark on each scale using a ruler or other measure.

MSA uses line scales in its consumer testing. An example is shown in Figure 14.1. The lines are 100mm long, anchored on the left by descriptions at the negative end of perception (eg very tough, dislike intensely). When converted to numerical values, the scale is from 0 to 100, with 0 being very tough, very dry etc, and 100 being very tender, like intensely etc.

Figure 14.1 An example of a line scale, as used by MSA to record consumers' perceptions of the meat quality attributes they are testing. Source: M.S.A.
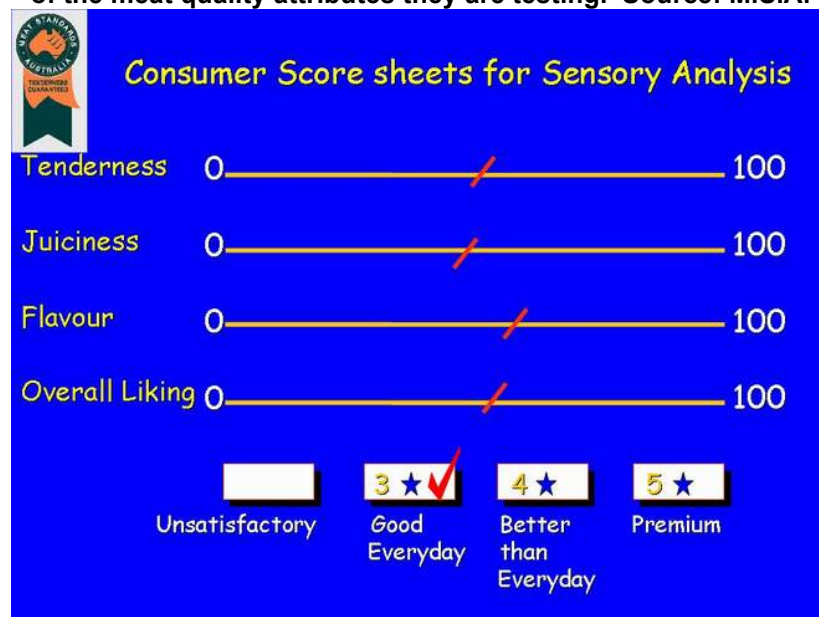
Magnitude estimation scaling: this is also called free number matching. The first sample a panellist receives is assigned a freely chosen number. The panellist is then asked to assign all subsequent ratings of subsequent samples in proportion to the first sample rating. Panellists are instructed to keep the number ratings in proportion to the ratios between sensations.

14.6 Types of sensory analysis

Sensory tests can be discriminatory, descriptive, or about preferences (affective tests).

Discriminatory tests: or overall difference tests, indicate whether there is a difference between samples that humans can detect. Does a sensory difference exist between these samples? An example is the triangle test, which is used in situations where treatment effects may have produced product changes, which can not be characterised simply by one or two attributes. Three samples are presented to the panellist, and they are told that two are the same, one is different. They have to select the "odd man out". Obviously if there is no detectable difference, there will still be a number of panellists who get it "right" randomly. The statistical analysis deals with this. There are numerous other tests which can be set up, which may test whether something is similar or different to other samples, or to a control. These include "attribute" difference tests, which measure a single attribute, eg tenderness, comparing one sample with one or more others. The question asked is usually "which sample is eg . more tender or more tough.

Descriptive analysis tests: these involve the detection and description of both the qualitative and quantitative aspects of a product. Panellists need to be trained to detect and describe the perceived sensory attributes of a sample. The qualitative aspects of a product combine to define the product, and include all of the appearance, aroma, flavour and texture properties of the product which differentiate it from others. Panellists also differentiate and rate the quantitative or intensity aspects of a sample. Two products may contain the same qualitative descriptors, but they may differ in the intensity of each, which will result in different sensory profiles.

Descriptive tests are used to obtain detailed description of the aroma, flavour and oral texture of food and beverages.

Affective tests: these assess the personal response (preference and/or acceptance) to a product by consumers. Do consumers like or dislike a product. It is based solely on preferences, and does not measure attributes of the product per se. They are used by companies when developing new products, maintaining market share of current products, assessment of market potential.

14.7 Taste panels

Sensory evaluation of eating quality can be done by either:

* untrained consumers
* a trained taste panel

Consumer panels: Untrained consumer taste panels are very useful tools to determine consumer preferences, and assessment of texture and juiciness. They have the disadvantage of being time consuming, expensive, and subject to the influence of external (irrelevant) factors. These include things such as degree of doneness, visible blood, smell, mood, and lighting. There can also be a large variation in response both between and within consumers. Firstly, meat is not an homogenous product, so that even adjacent samples may be genuinely different. Secondly, people come to the taste panel with different prior
experience. Those used to eating fillet steak will judge as tough a sample that another consumer (used to grilled chuck!) would rate as tender. Thirdly, the same person will not necessarily give the same assessment to the same piece of meat if given several samples. Because of this variation, it is necessary to do large numbers of tastings to determine palatability, or to detect differences between treatments.

There are various levels of consumer tests.

In home surveys: The researcher has little or no control over cooking or environment.

In restaurant surveys: There can be some control over cooking, but still affected by surroundings and other external factors.

Consumer panels: Consist of untrained people. The researcher can control cooking and presentation, as well as many external factors. There is no standardisation beforehand (ie no one tells them what is tough, what is tender). For this reason assessment is unbiased by training, but can be affected by an individual's prior experience. Because of the large variation in the perceptions/preference/acceptance of untrained consumers, large numbers are needed to detect differences (eg between treatments) or to obtain a valid overall score for an attribute. When untrained consumers are used, they need to be selected at random and to be representative of all consumers in the population under study. It is important to use untrained consumers when consumer preferences or desirability ratings are required. For untrained consumer tastings, either line scoring or category preference ratings with relatively simple scales can be used for evaluations.

Figure 14.2 Consumer panel (MSA). Photo JM Thompson.

Trained taste panels: the use of trained taste panels avoids the disadvantages associated with untrained consumers, whilst still providing a sensory evaluation. They provide an intermediate between untrained consumers and objective measurement.

Trained panels are used in research situations. These are made up of people who have been trained and have a high level of discrimination for the attribute in question. Advantages of trained panels are:

- Allows meat to be evaluated quickly, accurately, and reliably
- Panellists have above average ability for detecting differences in the relevant attributes
- More discriminatory and sensitive than consumers
- Not influenced by irrelevant factors

The success and accuracy of trained panels is dependent on the selection and training processes. A trained taste panel usually consists of a group of people who have undergone a selection and training process to improve their ability to evaluate the relevant sensory attributes with greater precision and repeatability. The selection process is conducted to identify those individuals who have above average ability to detect differences in the attribute/s being assessed. This group of people then undergo a period of training. The panel is theoretically trained to ignore irrelevant external factors and essentially to provide a more objective evaluation of eating quality attributes, as interpreted by humans.

The aims of the training phase have been described as two fold: first to minimise the variability of the individual's judgement and align it with standards, and secondly, to enhance the individual's memory and sensitivity. The latter is important because it produces results that are more uniform from one tasting session to another. During training it is important for panellists to learn to ignore personal preferences.

Figure 14.3 Trained taste panellist. Photo JM Thompson

The benefits of using a trained taste panel (compared to untrained consumers) include reduced costs and time, minimisation of irrelevant influences and subjectivity and less variability within and between individual scores. Trained taste panels, however, cannot provide any information on preferences. This can only be done by untrained consumer panels.

14.8 Experimental methods

For both trained and consumer panels, it is important to standardise techniques and methods as much as possible.   For meat tasting this means that the following things must be as similar as possible within one experiment:

- pre-tasting treatment (eg thawing time)
- thickness or size of sample
- cooking method
- degree of doneness
- sample presentation (eg hot or cold).

In general, the meat should be tasted in a realistic manner (hot v cold), in physical surroundings that are non-distracting and where factors such as lighting can be controlled. Panellists should be isolated from each other. Special taste panel rooms may be available for use by trained panels, and these will usually be divided into carrels for individual use. With untrained consumers it may be sufficient to space them around tables so that they are not influenced by their neighbours.

Experimental design of taste panels session can be complex, depending on the number of samples to be tested. Things that need to be decided are:

- number of samples per session
- number of panellists
- presentation order of samples
- whether or not link product is used if more than one tasting session is used
- coding of samples
- recording of panellists scores

Number of samples to be tested per session is important. Humans' ability to discriminate sensory attributes gets fatigued if tasting more than 6 or 7 samples. It is therefore necessary to run several tasting sessions within any one experiment. In this case link products may be used to help standardise results from each session (ie one sample will be common between 2 sessions). It can also be useful to include a "starter" sample, the results of which won't be used (though this is not known to the panellist), but will help the taster get used to what he is doing. Order of presentation is also important. One reason is tasting fatigue may bias scores given to samples tasted later. Another is that if sample B is always tasted after sample A, then the score given to sample A may influence that given to sample B. For this reason samples are presented to different tasters in a different order.

14.9 What happens with meat standards Australia?

MSA uses untrained consumer panels. Panellists chosen must fit within certain demographics – age, liking of meat, health. Panellists are used only once for any cooking method. Given that MSA tested thousands of samples, it follows that a very large number of panellists were used. These were usually recruited through community organisations such as sporting clubs, P&C groups, Rotary. In return for organising 20 of their members to turn up for a designated tasting session, they received a donation to their club.

Each panel comprised 20 tasters. Each taster received 7 samples to taste. The first of these was a dummy (ie the results were not used). Each sample of meat was assessed by 10 consumers. This was possible because, in the case of grilled samples, the original piece of meat was divided into 5 sub-samples before testing. Only one of these samples was included in any one tasting session. So – each sample was tasted in 5 separate sessions, by 2 people in each session. This eliminated bias that may have been caused by demographics, or external factors peculiar to any one session. Samples were presented to tasters in a complicated latin square design, with every sample being tasted in a different presentation order in each session.

The tasters scores were recorded on a linear scale, as shown in Fig 1. They were asked to assess tenderness, juiciness, liking of flavour, and overall liking of the meat. This is an example of using a linear scale. They were then asked to tick a category box which they thought described the sample. This is an example of grading, as discussed earlier. Pre-cooking treatment of samples, thickness and weight were standardised. All cooking methods were standardised as to equipment used, temperature and time of cooking and resultant degree of doneness.

Readings

The following readings are available on CD:
1. Meilgaard, M.C., Civille, G.V. and Carr, B.T. Sensory evaluation techniques, 2nd edition. 1991. CRC Press, Inc.
2. Perry, D. Rymill, S.R., Hearnshaw, H., Ferguson, D.M. and Thompson, J.M. The Relationship between Consumer Scores and Objective Measurements of Tenderness. Presented at the 44th Internatonal Congress of Meat Science and Technology, Barcelona, Spain, vol 44 pp 814-815.

Activities

ⓤ Available on WebCT

Multi-Choice Questions

ⓤ Submit answers via WebCT

Useful Web Links

ⓤ Available on WebCT

Assignment Questions

Ⓤ Choose ONE question from ONE of the topics as your assignment. Short answer questions appear on WebCT. Submit your answer via WebCT

Summary

Summary Slides are available on CD

- sensory evaluation can only be done by humans
- taste panellists can be either untrained consumers or trained tasters
- only untrained consumers can give preferences
- sensory testing is expensive
- large numbers of panellists are needed for consumer panels
- there is large variation around sensory assessment, especially by untrained panels
- the main meat quality attributes assessed are tenderness and juiciness, sometimes flavour
- there are different ways of recording sensory assessment. The method used will depend on the experiment
- Linear scales are probably the most useful
- MSA uses both linear scales and a grading category
- Experimental design is important
- Sensory evaluation has the advantage of quantifying human perceptions

References

Bailey, M.E., 1964. Meat tenderness. Agricultural Scientific Review, vol 2 p 29.

Caul, J.F., 1957. The profile method of flavour analysis. Advanced Food Research, vol 7 p 1.

Judge, M.D., Aberle, E.D. Forrest, J.C. Hedrick, H.B. and Merkel, R.A., 1989. Principles of Meat Science, 2nd edition. Kendall/Hunt Publishing Company, Iowa.

Meat Standards Australia (MSA). Consumer score sheets for sensory Analysis of meat quality - Meat and Livestock Australia, Ltd.

Glossary of terms

Sensory	of the senses. Sensory assessment involves using the senses to make an assessment of some attribute, eg. using smell and taste to evaluate flavour.
Subjective assessment	using human judgement to assess and attribute. Usually involves the senses, and includes biases due to prior experience, preferences, emotions, changing perceptions.
Objective assessment	usually done by machines or humans assisted by tools to get a repeatable measure. Eg using a set of scales to weigh something, a laboratory machine to measure tenderness. Eliminates human perception and preferences.