11

Sensory quality assurance in the chilled and frozen ready meal, soup and sauce sectors

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Abstract: This chapter discusses the use of sensory evaluation in the assurance of product quality within the food production sectors of ready meals, soups and sauces. The chapter methodically reviews typical food processing stages, from recipe development through to end product supply, and considers how sensory assessment methods can be utilised to help assure the quality of the end products within these selected high-risk chilled food sectors.

Key words: sensory analysis, organoleptic assessment, key sensory points (KSPs), quality assurance, quality control, taste panel, ready meals, soups, sauces.

11.1 Introduction

Multi-component foods such as ready meals, soups and sauces by their very nature comprise a diverse range of ingredients. The final quality of the foods produced will typically be heavily influenced by the quality of these raw materials and the consistency of the production processes involved. With particular regard to these factors, sensory assessment has a key role to play in ensuring product quality at each stage of the food manufacturing operation. This chapter considers the many development and processing stages of a typical ready meal, soup or sauce manufacturing operation and provides detail upon the use of sensory assessment within each phase of the production process.

It should be noted that during the manufacture of food products there are usually many checks that have to be conducted to help ensure product safety, quality and legality. This chapter particularly seeks to focus upon the use of sensory evaluation within the quality assurance (QA) aspects of food production. A reputable food manufacturing business QA system will view

sensory evaluation as one of many useful tools to be utilised in the monitoring and control of product quality, safety and legality throughout the manufacturing operation. The reader is therefore encouraged to consider how such checks may complement the QA system of their own manufacturing operation.

11.2 Sensory quality assurance (QA) in the recipe development process

Recipe creation and development within a multi-component food production business are typically the role of a new product development (NPD) department. This department is often considered to be the lifeblood of a business as the extent of customer acceptance of its new product creations will be reflected in the total sales of the business. A very high proportion of the customer's engagement with food products is based upon organoleptic factors (e.g. appearance, aroma, taste and texture) and therefore it is vital that the NPD department utilises a wide range of sensory skills and techniques in order to create products which will satisfy the expectations of the end consumer.

It is generally accepted that consumers will have subjective reactions to food products and describe new foods in terms of their 'likes' and 'dislikes', whereas food manufacturing operations will often benefit from objectivity in identifying and defining sensory attributes. By combining consumer reactions with well-defined sensory attributes it is possible to gain an insight into those foods which have attributes that consumers will accept and those which the consumer will reject.

Such skills at the NPD stage include the ability to be able to physically create the product envisaged and this skill is greatly helped by experience. Once the required product sensory characteristics (including appearance, aroma, taste and texture) have been clearly defined, the development chef can then reflect upon how other products with similar characteristics are made. Such an approach will often help to then define the ingredient list and the likely production process for the new product.

These skills will certainly help during the following typical NPD scenarios:

- **Blue-sky creativity**: sometimes during the development process the NPD team will dream-up ideas for new products, utilising their sensory skills to then create the product which has been envisaged. This is a skill that can take years to refine, and the process is greatly supported by an ability to define and then achieve the desired product sensory attributes.
- **Customer brief**: often the business NPD team will receive a 'brief'/ description from the customer upon the type of product or product

range they are interested in procuring. Sometimes these briefs can be extremely detailed, providing the desired key sensory points (KSPs) for each individual recipe, and other times the 'customer brief' may only outline a general range of products required and just state the product names or target consumer groups, in which case the NPD team has a wide degree of artistic licence to formulate product samples designed to gain the customer's business.

- **'Me too'/'copycat' approach**: sometimes the customer or internal business drive will wish to move into a product category/market that already has the product types in it that they also wish to sell. In such cases businesses will often take product samples of the competition, carry out well-structured benchmarking sessions, decide upon suitable production methods for each product, and ideally find a way to make the products better than the competition and at a lower cost. Usually in such circumstances the NPD team will have the added benefit of being able to review the food packaging label of the product that they are seeking to copy, and therefore may benefit from knowledge of aspects such as the ingredient declarations and nutritional data of the competitors products.

During the NPD process there are a number of techniques that can be utilised to aid the selection of the best products/recipes. These techniques include the following:

- **Difference testing**: selected business sensory evaluation panel members are each in isolation (to avoid any influence) presented with a set of individually labelled product samples (typically three), all at the same time. One sample is different from the other two (i.e. the single sample may be a proposed new recipe version or the current standard recipe), and the panellists are asked to pick out which sample is different. The results of the panel will inform the business whether there is an actual consistently distinguishable difference between the current recipe and the proposed new recipe.
- **Preference testing** or 'consumer testing' has limited use in the early stages of the NPD function, but is vital once a product has been developed to guage consumer reaction to the new product. Members of the business sensory assessment panel are individually presented with samples of the current and the proposed new recipe (which are unmarked to ensure that it is unclear which is which) and are asked to select the sample which they prefer. It should be noted that when selecting such a testing method the manager should ensure that it is appropriate for the recipe being assessed. For example, the product being assessed may be for eventual sale as an accompaniment to a product (e.g. a pour-over sauce for steak), and in such circumstances the benefits of assessing the product in the context of its end use should be considered.

Whilst evaluating a proposed new recipe it is important to understand your customer and the aspects of the product that particularly matter to them (i.e. the KSPs of the product). Such an approach will help keep the NPD team focused upon delivering specifically what the customer wants.

- **Customer panels** can be used to help define the product KSPs (e.g. appearance, aroma, taste, texture) and thereby ensure a business that the products being developed are likely to meet with the approval of the end consumer once launched. Customer panels can utilise sensory evaluation techniques including acceptance/preference testing, focus groups, central location testing and product placement or can simply request the panellist to taste the product and state what they like and what they dislike about the product, and ultimately would they purchase the product at the price that it is intended to be sold for?

  Sometimes it will be of benefit to ensure that the consumer panellists selected have experience of regularly eating the product types to be tested in order to ensure that their assessment is very finely focused upon the product KSPs. As a minimum requirement consumers should be non-rejectors of the product, and ideally they should be current users of the product.
- **'Old product development'** (OPD) is a process in which the development team is tasked with making particular improvements/adjustments to existing 'live' product recipes. These 'improvements' may often be related to aspects of product quality or cost (e.g. seeking a sales margin increase) and such work is an important phase of the product life cycle in terms of protecting product sales/operating margins. OPD also is often required as businesses seek to review their product ranges to meet the increasing customer requirements for healthier foods; for example, when seeking to develop product nutritional claims such as 'reduced fat' or 'reduced salt'.

11.3 Sensory quality assurance (QA) in the post-development product scale-up

Sensory assessment plays an important role within the product scale-up phase as it is vital to ensure that the product when manufactured on a full industrial scale still achieves all of the KSPs of the approved development sample (as this is what the end customer will have agreed and therefore will be expecting to be delivered as the final product). All too often during factory trials of a new product there are problems encountered when trying to match the factory product to the development kitchen samples which have been approved by the customer.

The following are aspects of the scale-up process that can impact upon/cause variations in the organoleptic properties of the factory-produced product when compared to the development kitchen sample:

- Ingredients purchased on an industrial scale are typically not as 'quality consistent' as the development kitchen purchased and hand-prepared ingredients. Perhaps the 'industrial scale supply' meat/vegetable particulates contain more 'off-cuts' or 'fines' which affect the appearance of the end product. When preparing product samples for agreement with the customer, the development department should be encouraged to always use factory grade ingredients, as using hand-selected 'perfect' ingredients should be done only if such standards are consistently achievable by the supplier at the price point intended. The exception to this may sometimes be the use of hand-selected samples for product artwork, although care must be taken not to mislead the consumer at this stage. If such points are not controlled then the business is likely to over-promise and under-deliver in terms of product quality/consistency.
- Production factors such as mixing/blending/cooking/holding times on an industrial scale in the factory typically take far longer than when making a very small quantity of product in the development kitchen. Such conditions can lead to an increased potential for product texture breakdown, colour deterioration and flavour changes. The technologist who oversees the scale-up operation should select the best factory methods to minimise such issues, make recommendations for more appropriate pieces of equipment and limit maximum batch sizes wherever processing time has an adverse impact upon product organoleptic quality.
- The development sample may only have been cooked to a very limited extent in order to preserve texture, colour and flavour. However, in the full industrial process the product will also need to achieve certain shelf-life aspirations which often involve having to cook the product at higher temperatures or for longer periods of time in order to ensure a sufficient level of microbiological reduction. Clearly there is therefore the potential for a reduction of organoleptic quality whilst seeking to achieve product safety/shelf-life. As product safety is a non-negotiable product requirement, the scale-up technologist must ensure that the process and operating times/temperatures selected achieve the required levels of safety and shelf-life whilst avoiding unacceptable levels of product organoleptic deterioration caused by over-processing.

11.3.1 Shelf-life assessment

Shelf-life assessment will typically involve holding the new product within storage and handling conditions that reflect both the product supply chain and the holding conditions of the end consumer (most retailers/food service operations will have pre-set criteria detailing the expected times, temperatures and storage conditions of the shelf-life trials required for any products which are to be sold through their operations). Shelf-life testing usually requires both microbiological and organoleptic assessment over the course of the required shelf-life period (in some cases nutritional analysis will also

be required to ensure that the nutritional performance of the product is as required over shelf-life).

Often during the shelf-life assessment of a proposed new product, samples of the product will be despatched to a contract microbiology laboratory to be held at the required temperatures for the designated amounts of time between microbiological tests. The storage temperatures during such trials for chilled foods will usually be elevated to reflect the typically higher temperature storage conditions within the distribution chain and consumer storage (compared with the relatively low and consistent storage temperatures achievable within a closely controlled business chill store). It can sometimes be the product organoleptic performance that limits the total product shelf-life rather than the overall product microbiological performance. Therefore it is important to ensure that the organoleptic assessment of the product during shelf-life testing evaluates product samples that have been held in the same storage conditions (e.g. times and temperatures) as the microbiological test samples.

To aid process efficiencies and reduce wastage there will often be business commercial pressures to apply as long a shelf-life to products as is possible. In such circumstances it can be tempting for a business to conduct its shelf-life testing using 'best case'/optimum storage conditions. However, failure to take account of 'worst case' or even just 'real world' storage conditions/factors may well lead to a business applying a length of shelf-life to products which is based upon optimum storage control, rather than the real world storage conditions that the product is actually going to encounter within the supply chain. Application of an inappropriately long shelf-life may result in consumer complaints of product deterioration before the 'use by' date of the product has been reached and can lead to serious consumer health issues and product recalls based upon product quality or safety grounds.

Often the simplest approach is to have the microbiological laboratory hold both the microbiological and the organoleptic shelf-life test samples within their storage incubators set at the required temperatures for the required amounts of time. Each time a product is due for microbiological assessment (at set points over the length of shelf-life to be assessed) the laboratory should also return the required number of samples back to the manufacturer for organoleptic shelf-life evaluation.

It is also prudent to assess product shelf-life performance to a point which is past the length of shelf-life that will be typically applied to the product. Not only is this good practice in demonstrating due diligence that the shelf-life applied also allows for a margin of safety, but also by conducting such tests the business will gain an understanding of the product characteristics/features which are exhibited by the product as it deteriorates. In addition there may be times in the future when the business would benefit from an understanding of how long the product can actually last (e.g. perhaps helpful in circumstances when the customer has queried the poten-

tial for a shelf-life extension due to excess stock holding) and therefore having already conducted such tests will prove to be invaluable in enabling a swift response.

11.4 Sensory quality assurance (QA) in the production process

11.4.1 Definition of the required product organoleptic quality standard

The end goal of the production process is to create a product which meets the customer's expectations. Typically within the food manufacturing sector a sensory specification/standard for each product is used to aid product quality assessment. The product profile of organoleptic expectations is often written and agreed with the end customer at the time of product development or scale-up.

This sensory description for each product should clearly define the specific organoleptic characteristics required to be achieved. This information is usually defined under sections including appearance, aroma, taste and texture (Fig. 11.1). Photographs of the product can also be incorporated within such sensory descriptions to further define the visual standard required.

One issue with regard to the use of end product sensory descriptions is that at certain stages within the production process the product may require sensory assessment but will not yet be expected to meet the end product sensory description. For example, pre-fried onions may require an organoleptic assessment to confirm that they are sufficiently soft and caramelised prior to their addition to the sauce component of a chicken tikka masala ready meal. Therefore 'intermediary stage' sensory descriptions may be of benefit to the quality assurance of such product components. Often these sensory descriptions are written by the process technologist responsible for the scale-up of the product, as the technologist will know the performance criteria required of the component at this specific process stage.

11.4.2 Production process sensory evaluation techniques and useful equipment for product assessment

The following section seeks to describe the many sensory related checks that can be conducted as part of a QA programme within a food manufacturing operation. Businesses will typically select particular sensory assessments and check frequencies based upon their staff and time resources available, the potential for product variability and the scale of the financial/business consequences of failure to supply to the quality specification required.

Sensory evaluation of ingredients and end products within the production processes of ready meals, soups and sauces often relies heavily upon

Product Sensory Assessment Check-Sheet.		
Product Name: Chicken Tikka Masala Sauce. **Product Code: XYZ123**. Batch / Use-by Code: Date & Time of Assessment: Assessed By:		
Product Attribute.	Sensory Standard.	Pass / Fail & Comments:
Appearance: Colour:	A pulpy pale red/orange sauce of medium thickness with visible flecks of coriander. The sauce contains visible 20 mm diced chicken breast, 5 mm sliced onions and 3 mm sliced green chillies. Occasionally there will be pieces of 12 mm diced tomato present. There will be only slight visible oil separation. Colour chart reference: Acceptable range = ABC789 to ABC794.	
Aroma:	Aroma is of fresh coriander, mild garlic and almonds, with a background of tomato.	
Flavour: Aftertaste:	Well-balanced flavours typical of tikka masala. Tomato, chilli, onion, coriander and garlic flavours dominate. Heat from the green chillies building during continued eating. Mildly spicy aftertaste and ongoing heat from the green chillies.	
Texture: Viscosity:	A medium thickness sauce with slight oiliness. The sauce should have a pulpy consistency Chicken pieces should be firm to the bite, but not tough or chewy. The sliced onions and green chillies should be soft but still clearly defined within the end product. A medium thickness sauce. Bostwick consistometer check: Sauce sample must be sieved pre-test. Acceptable range = 10 – 12 cm / 30 s @80 °C.	
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Fig. 11.1 Example product sensory description/check-sheet.

the organoleptic assessment skills of the production operatives and supervisory staff. It is therefore vital that all staff who are to be placed within factory operation roles involving the sensory assessment of the food products must be:

- screened to ensure that they can recognise to an appropriate degree the key flavours of sweet, sour, bitter, acid and umami – British Standard methods for sensory analysis of food are available to support taste identification and threshold testing;
- screened for colour blindness – the Ishihara test technique can be used when screening for colour blindness;
- trained to adequately assess the sensory performance of a food product – such training can include understanding of the standards to be attained (and where to find such sensory descriptions within the business operating system), the importance of not allowing personal preference to influence the tests completed/test results and also reviewing corrective actions to be taken in the event of a non-conformance.

Whilst the use of a trained operator's pallet and visual assessment skills provides an excellent resource for quality assurance, such checks upon appearance, aroma, taste and texture can by their nature be quite subjective. Therefore it is also of great benefit to a manufacturer's QA programme to also incorporate equipment which can provide objective, measured tests upon the acceptability of the food products.

Test equipment typically used during the production processes of soups, sauces and ready meals include the following.

Bostwick consistometer

Products such as soups, sauces, dips and dressings are all viscous liquids. The Bostwick consistometer (Fig. 11.2) determines the food sample consistency by measuring the distance which the material flows under its own weight over a set period of time. This enables the assessment of liquid food samples against pre-set consistency/viscosity standards.

It should be noted when using such equipment that product viscosity will vary with product temperature. Typically the hotter the product, the less viscous it will be. Such checks should therefore always be conducted at a set temperature point. Usually manufacturers will choose a set temperature close to the temperature that the product is likely to be at that point of assessment. For example a pasteurised sauce to be assessed at the stage of cooked batch completion may be assessed at 80 °C, whereas a cold blend sauce to be assessed at the point of batch completion may be assessed at 4 °C. To ensure accuracy a calibrated hand probe should be used to confirm that the product is at the required temperature at the point of assessment.

Another point of potential variation in results is that when assessing soups and sauces which contain particulates, the amount of particulates in each small test sample will affect the flow rate/viscosity of the product. Therefore it is common business practice, when assessing the viscosity of particulate sauces/soups, to always conduct a 'sieved Bostwick' where the sample is sieved through a set size sieve to remove the particulates before viscosity assessment in order to eliminate the 'particulate variable'.

Fig. 11.2 Short and long Bostwick consistometers.

Brookfield viscometer

Brookfield viscometer (Fig. 11.3) are often used within the food processing sectors where accurate bench-top analysis of product viscosity is needed. Brookfield Viscometers use the principle of 'rotational viscometry', i.e. their measurement of product viscosity is based upon immersing a specifically selected spindle within a sample of the product followed by measurement of the torque required to rotate the spindle at a set speed whilst immersed within the product sample. As the torque required will be proportional to the quantity of viscous drag upon the spindle, this therefore provides an assessment of the product viscosity, reported in centipoise units (cP).

Colour reference charts

Colours can be described, but the use of colour charts enables the assessor to work back to a consistent standard, rather than having to envisage the expected colour defined by a written description. There are a number of

Fig. 11.3 Brookfield viscometer.

colour reference charts available to use within the food manufacturing sector, commonly used colour reference charts include Royal Horticultural Society (RHS) and Pantone. Many food companies now rely on photographic standards for colour assessments and often these standards will be reviewed on the computer screen at the relevant food manufacturing work-station.

In addition to supporting in-house process control, the use of specific test equipment also enables the manufacturing operation to communicate and work to a common standard with suppliers/customers, helping to ensure that quality standards for raw material supply and end product acceptance are clearly and objectively defined.

11.4.3 Ingredients

There are a number of steps that can be taken to help achieve the consistent supply of correct quality ingredients to the food manufacturing operation. The use of 'approved suppliers' (where the supplier is assessed for control of aspects such as product quality, safety and legality prior to being authorised to supply) is a good start to the assurance of consistent ingredient supply.

Purchase to a pre-agreed ingredient specification which reflects the quality performance requirements of the ingredient is an important factor. By having a clear understanding and definition of the intended end product KSPs, checks can then focus upon ensuring that the ingredient KSPs are aligned with the end product specification.

Definition of ingredient KSPs will include written description of the sensory aspects of the ingredient, including its appearance, aroma, taste and texture. These specified KSPs can then be checked to confirm conformance to requirements upon point of delivery. Consistent ingredient supply is highly reliant upon consistent processes and machinery at the supplier site; therefore, where possible supplier audits should seek to review the supplier's ability to achieve a consistently correct ingredient quality.

Sensory assessment of incoming ingredients should be conducted by a member of staff who has been trained upon such checks and confirmed to be capable of reviewing each ingredient against its specified quality criteria. These checks may include raw or cooked product tests in order to confirm that the ingredient's appearance, aroma, taste and texture meet the requirements defined within the specification/sensory description.

It is always important to ensure that a representative sample is taken from the incoming goods to be assessed. Staff can be trained upon sampling amounts and techniques to ensure that various points of the delivery are checked (including coverage of the range of supplier lot/batch/date codes present).

Where cook tests are required (for example for the organoleptic assessment of raw meats) it is important to ensure that appropriate assessment

facilities/cooking equipment are consistently available to the operator, otherwise there is a risk that checks will not be conducted. Also such tests can be time consuming and therefore it is important to ensure that operators are trained to focus upon the checks and do not rush.

Sensory related checks upon incoming ingredients include the following:

- **Vegetables** (typically assessed raw unless cook rate/texture is a critical factor to check in advance of processing): size (including dice or slice dimensions if applicable), texture, taste, aroma, colour, skin presence, extraneous matter and soil presence.
- **Meats** (typically visually assessed in a raw state, and then fully organoleptically assessed upon cooking): aroma, size (including dice, slice or mince dimensions), visual lean, texture, colour, blood, gristle and extraneous matter.
- **Dairy products**: colour, aroma, viscosity and taste.

Food manufacturers should consider the pro-active benefits of encouraging their suppliers to conduct pre-outload sensory assessment of the raw materials, in order that by the time the ingredient reaches the manufacturing site it has already received a recent confirmatory check that it meets all of the sensory criteria expected. Such a 'right first time' approach can help avoid a lot of disruption and cost to both operations.

A relevant point of note is to ensure that when agreeing a specified standard for ingredient assessment pre-despatch (at the supplier site) and upon arrival at your manufacturing site, the same design/model of testing equipment should ideally be used at both sites to help reduce the potential for variances in the testing approach taken. Also the test methods/conditions need to be stipulated to ensure consistency between the two sites; for example, product viscosity will be affected by temperature and therefore should always be measured at a pre-agreed temperature to facilitate comparison.

Over time a business may wish to vary its frequency of checks upon each ingredient, with the extent of assessment dependent upon the supplier track history of consistency of supply, the potential for major product/business impact in the event of a fault, and some ingredients may require extra focus upon particular 'at risk' times of year with regard to consistency/seasonality of supply. For example small dice/slice sizes of fresh processed carrots, because of their high surface area, can be far more susceptible to spoilage at certain times of the year. Such spoilage can result in an acidic flavour/aroma which, if the 'off' carrots were then accidentally used, would render the end product unsalable. As a consequence manufacturers may choose to reduce the operating shelf-life of such ingredients at particular 'known issue' times of year. It is often useful to build up a catalogue of these potential supply issues that can be used within a food production business for staff training and advanced warning purposes.

Often manufacturers will conduct incoming goods checks in the area in which they are going to store the product as long delays whilst conducting checks in ambient conditions can have an adverse effect upon both the organoleptic and microbiological properties of chilled/frozen ingredients.

11.4.4 Ingredient supply changes, cost improvement initiatives and ingredient substitutions

There can be many circumstances which will drive a business to replace a currently supplied ingredient with another. Perhaps the supplier is unable to achieve the consistency of supply required due to the order volumes being too small, too big or too infrequent. Perhaps there is a business initiative to improve the nutritional status of the end product (e.g. reduced salt or reduced fat projects). Another potential reason is that of 'cost control' or 'margin protection', where a cheaper supply is therefore being sought. Also there is the possibility that the usual manufacturing site unexpectedly does not have the ingredient available and therefore the business needs to use a substitute ingredient in order to avoid significant disruption in their production/delivery plan.

It is important to highlight at this stage that when seeking to make adjustments to the ingredients used a business must ensure that it is in control of key factors such as ingredient declaration changes, any food safety/allergen status changes and impacts upon end product specifications/customer approval. Changes in some ingredient characteristics which initially appear to be minor, can sometimes make the difference between the end product being safe or unsafe. For example when evaluating a new chopped tomato product for use as a base ingredient within fresh, cold-blended salsa sauces/dips, if the new chopped tomato supply is not as acidic as the previously used ingredient then there is the significant potential that the resultant end product will not be as acidic and will therefore be more susceptible to spoilage and potentially pathogen presence/growth.

When considering proposed new ingredients it is also important to ensure that the end product quality is not going to be adversely affected by any such ingredient changes and therefore, in advance of progression to factory trials of any new ingredient, sample assessment using sensory evaluation techniques can help to ensure that the proposed new ingredient is likely to be successful.

There is the temptation for suppliers to provide perfect hand-selected samples at the initial sales phases which can sometimes give an unrealistic impression of the quality and consistency of the ingredient to be supplied. It is therefore important to always request factory-produced samples from the suppliers of proposed new ingredients to ensure that the product being assessed is representative of the product to be supplied on an ongoing basis.

Organoleptic assessment of the proposed new ingredient against the required ingredient specification and against a sample drawn from the current supply is a typical approach used by businesses when evaluating the adequacy of a proposed new ingredient. Such checks are usually conducted by a company panel, consisting of staff who have confirmed their competence in sensory evaluation (often quality and development staff), and involve the review (uncooked or cooked as appropriate) of aspects such as ingredient appearance, aroma, taste and texture (and also viscosity assessment for liquid products).

In business often there can be resistance to change. Some staff will have their preferred suppliers, perhaps due to relationships that have been built over many years of supply. Other staff may be influenced by thoughts that if a proposed new ingredient is cheaper then it cannot possibly be as good as the currently supplied ingredient. Staff may be risk averse, feeling that any changes may have the potential to damage the end product/business reputation.

In order to avoid such matters from clouding the fair evaluation of an ingredient, drawing together an ingredient sensory evaluation panel and applying 'Difference testing' or 'Preference testing' methods can be used to overcome any bias and provide objective rather than subjective responses.

When conducting such evaluation panels often an ingredient may be distinguishable as different from the current supply when assessed in isolation, but when that ingredient is present within the intended multicomponent end products the difference in performance cannot be distinguished. A business that does not consider such aspects may be missing out on potential supply benefits and cost savings. Therefore sometimes the most appropriate way to evaluate a proposed ingredient change is via review of the ingredient performance in the end product and not in isolation.

Evaluation of the proposed ingredient performance within the end product may also be appropriate when the characteristics of that ingredient make it very difficult to judge objectively when in isolation. For example extra-mature blue Stilton cheese crusts may be purchased for their excellent strength of flavour when added to certain soups and sauces, but when eaten on their own some may find such ingredients overpowering. As a consequence may select the mildest sample during preference testing, which actually would not provide the same extent of flavour performance as the stronger sample once added to the end product.

Some ingredients within a business manufacturing multicomponent food products may be widely used across a large number of products. With regard to sauce and soup manufacture such ingredients may include tomatoes, milks and creams which are often used as the background for soup and sauce products, diced/sliced vegetables frequently used as a particulate or blended component, and herbs/spices which are typically used to add extra flavour.

Clearly any change to an ingredient which is used within many different products has the potential to cause widespread problems if the change is not controlled and ensured to be appropriate. For these reasons it is important when considering such ingredient changes that 'worst case' scenarios are considered, i.e. conducting kitchen or factory production trials upon the products which contain the highest quantities or are most influenced by the ingredient that is being considered for change. Sometimes the result may be that a new ingredient is approved for use only in recipes where it is used at a low level (e.g. below a threshold of noticeability/influence upon the KSPs of the end product).

During all testing and evaluation of ingredients and their subsequent performance within the end products it is important to focus upon the aspects of the end product that the consumer would miss/notice when influenced by a change in the characteristics of an ingredient. Will the end consumer notice the change? If so, will the consumer feel that the change makes the product better or worse, or will the consumer feel that the change has made no difference at all to their enjoyment of the product? It is important to bear in mind whether or not proposed changes are going to be communicated to the end consumer. If consumers are told that there is a difference then they will expect and seek to find a difference.

11.4.5 Packaging

The delivery packaging of the ingredients can serve many functions including protection from physical damage, microbiological spoilage, contamination and flavour taints over shelf-life. Alongside these key factors it is worth ensuring that the ingredient delivery format facilitates a good range of ingredient assessment, including sensory evaluation, upon arrival. Factors such as ensuring that all parts of a delivery can be accessed for inspection always need to be considered (e.g. vegetable delivery suppliers may use Dolavs or cages which can sometimes lead to certain individual ingredient packs being inaccessible until the whole load is unpacked).

In addition it may be costly to open packaging formats such as vacuum packed meats for evaluation immediately upon delivery if the ingredient is not to be used until many days after delivery (as opening will allow air into the pack which will consequently reduce the shelf-life of the amount of ingredient remaining in the pack following testing). For such reasons the manufacturing operation may decide to defer a full assessment of the ingredient quality until nearer the time of use (but not so near that there would be insufficient time to deal with any problems arising from this inspection), or perhaps arrange for a smaller 'sample pack' to be sent alongside the main larger delivery packs. Such arrangements send a clear message to the supplier that their customer is monitoring the quality of their supply upon delivery and therefore will heighten the supplier's focus upon ensuring full adherence to the specified quality standards.

With regard to the final products produced, the packaging of the end product (and in particular the direct food contact packaging) has the potential to impart flavour taints to the product if the packaging is of a sub-standard quality (i.e. not suitable for food contact) or reacts with the product under certain conditions (e.g. some acidic products can be quite chemically aggressive, leading to the increased potential for taints to occur).

If the product is to be cooked/re-heated within the food contact packaging then businesses should also be mindful of the potential for packaging impacts upon the end product during such heating phases (e.g. reactions occurring upon microwave heating the end product where very high localised temperatures can be reached, particularly when in the presence of foods with a high oil content as the heat conductance of such oils can cause particularly high temperature hot spots to occur and therefore increase the potential for chemical reaction/deterioration).

During the initial approval of packaging for product use it is vital that a full organoleptic analysis is conducted upon the food product which has been held within the packaging in a manner which reflects the worst case scenarios and timescales of the production process, storage, distribution and consumer end use.

If the nature of the product would make it difficult to ascertain whether a flavour taint was being caused by the packaging (e.g. perhaps the product is a very spicy, aromatic dish which would mask any flavour taints if present) then consideration should be given to also running trials upon more sensitive products within the packaging. Such test products would ideally have quite bland flavours and therefore could include water, mild food oil or mashed potato. The manufacturer should select the most appropriate type of test product for the packaging and intended end use.

Such packaging/product tests could be conducted by a food manufacturer on a routine basis in order to form part of a packaging quality monitoring programme, and should certainly be conducted upon any proposed change of packaging specification or packaging supplier.

11.4.6 Storage

It is vital to product quality consistency and safety that all product ingredients are stored in a manner which reflects the supplier's recommendations and good manufacturing practice upon aspects such as temperature control, relative humidity and the avoidance of physical damage (e.g. stacking/compression of goods). Whilst some ingredients (including chilled cut vegetables) will typically be used within a few days of arrival on site, many longer shelf-life ingredients may be stored for weeks or months before being required for use. It is therefore advisable for a business to monitor these ingredients during their storage phase for factors including organoleptic performance, as such checks will provide advanced notice of any developing

quality deterioration issue and therefore ensure sufficient time to rectify the matter without disruption to the business production plan.

Routine checks during storage can also include review of the condition of the ingredient packaging, as damage and poor seals can allow air ingress which may accelerate spoilage, drying or oxidative reactions. An ever-increasing amount of foods are now reliant upon vacuum packaging or modified atmosphere packaging (MAP) for the achievement of their shelf-lives and therefore a small seal failure across a batch if unnoticed can soon lead to a major failure in organoleptic performance and possibly food safety issues.

Ensuring that all ingredients are held within appropriate storage conditions is a key factor in assuring their consistent organoleptic performance over the course of their shelf-life. Optimal storage conditions will benefit each ingredient and typically a multicomponent ready meal, soup or sauce manufacturing business will have chilled product stores running at below +4 °C and frozen goods stores running at below –18 °C. With regard to chilled and frozen products, high air flow conditions can significantly dry any exposed product (in frozen products this is known as 'freezer burn' and can be protected against through thorough containment within the primary packaging). Higher than ideal storage temperatures can encourage microbiological growth which, in addition to the associated food safety issues, can also cause flavour taints and deterioration in product texture.

Further assurance of organoleptic performance can be gained by installation of recording and alarm systems upon chills and freezers to confirm that the optimum running conditions are being consistently achieved. Relative humidity could also be monitored and controlled in dry goods stores, as too much moisture within the air can lead to clumping of powders and the potential for elevated levels of microbial spoilage.

11.4.7 Ingredient shelf-life extension

Occasionally in food manufacturing operations there will be circumstances where the business has a surplus of a particular ingredient which when assessed against predicted usage rates would be at risk of exceeding its site process use by/best before date before being scheduled for use. Such circumstances can occur due to over-ordering (perhaps resulting from a mistake or due to planning to predicted orders which have turned out to be unrealistically high) or perhaps due to delays in the production plan caused by line breakdowns.

If it is not possible to pull forward the next production date, in an attempt to save the cost of ingredient stock losses food production businesses will sometimes seek to extend the shelf-life of the ingredients at risk of going out of date through factors such as formal review and agreement of shelf-life extensions with the particular ingredient supplier, or sometimes will consider the freezing of the particular 'at risk' ingredient stocks which

would otherwise have perished before the date of the next scheduled use if continued to be stored in chilled conditions. In such circumstances the use of sensory evaluation plays an important role in confirming that the decision to extend the shelf-life of the ingredient does not adversely affect to an unacceptable extent the ingredient organoleptic properties, and as a consequence does not pose a threat to the quality of the end product.

It should be noted that when considering the potential for ingredient shelf-life extensions that the primary concern must always be that of product safety. (For example, during the additional shelf-life required is there a risk of the safety of the ingredient being compromised?) If through a combination of detailed product/process knowledge and liaison with the ingredient supplier it can be ascertained that the application of additional shelf-life would not pose a threat to food safety, then it would be appropriate to conduct a thorough sensory assessment in order to also confirm that the extended shelf life ingredient will still deliver (and not threaten to damage) the required KSPs within the final product.

Shelf-life extension checks should be conducted by experienced members of the technical, quality and development teams, who have first-hand experience of the usual organoleptic properties of the specific ingredient, and are well aware of the likely signs of deterioration or spoilage. Such signs can include off-aromas and off-flavours, colour deterioration and texture changes (e.g. perhaps a change to become slimy or dry).

Points for consideration during such organoleptic assessments to underpin shelf-life extensions include ensuring that a representative sample size is being assessed from the ingredient stock in question, as the early signs of ingredient deterioration may be localised and not yet widespread across an ingredient batch. Businesses should also consider the balance of 'risk to reward'. If by applying an ingredient shelf-life extension the business is saving only a small amount of ingredient or money and has plenty of 'within standard shelf life' material in stock, is it worth the time, trouble and end product quality performance risk to extend the shelf-life of the ingredient stock?

It should also be noted that the end customer, be it a supermarket or food service business, may have a supplier policy upon whether they authorise (or need to be advised of) the procedure of controlled extensions to ingredient shelf-lives. Therefore with regard to ingredient shelf-life extensions it is always wise for the manufacturer to check their customer policies before considering how to proceed with the best interests of all parties in mind.

11.4.8 Recipe preparation phase

This processing stage typically involves the removal of the ingredients from their primary packaging and measurement into their required recipe weights to await further processing. This is therefore usually the first point

in the production process at which 100% of each ingredient can be handled and closely reviewed. Such circumstances therefore provide a key control point for ensuring that each ingredient meets the organoleptic quality required.

Some intake checks may have been deferred until the preparation phase to avoid the potential for ingredient deterioration caused by opening the packaging at an earlier stage, or perhaps a supplier ingredient delivery comprising of numerous separate batches which for further assurance of product quality all require an individual check at this stage. Quality checks at this stage could be classed as 'vigilance' by the factory preparation staff who should be trained to ensure that each ingredient being prepared consistently appears to meet the quality standards required.

Preparation staff should be made aware that each ingredient may have been stored on site for a significant amount of time and therefore could have deteriorated since delivery. Staff should also understand that whilst ingredients may have passed an inspection upon intake, the checker at that stage is only likely to have viewed a small percentage sample of that ingredient, whereas at the preparation stage all of the batch of that ingredient can be inspected to at least some extent. It is important therefore that staff see themselves far more as a key operators who are providing a vital QA role in monitoring product quality and questioning any issues, rather than as team members who have a relatively narrow remit of only weighing ingredients.

In a manufacturing business where many product recipes are being processed on a daily basis it is unlikely that production staff will be able to remember the key attributes of each specific ingredient, and it is also unlikely that production staff would have the time to cross-reference every ingredient being processed against a written specification/description. However, the relevant production staff could be trained upon an appropriate 'top five organoleptic quality points' or 'key quality criteria' for each ingredient group (e.g. meats, dairy, vegetables, herbs, spices) to enable them to be particularly vigilant during the handling of every ingredient. Such quality check points could include: Does the ingredient match its name given upon the recipe sheet? (For example, Does the ingredient look like 10 mm Diced Streaky Smoked Rindless Bacon?) Are the appearance, colour and aroma as expected?

Most companies prefer their operators not to taste test the ingredients during the processing operation as such practices can be linked to poor hygienic practice and can set a poor example to other staff. However, in some circumstances a taste check will provide a vital point of quality assurance and therefore each business should decide upon the appropriate amount of taste testing for their particular operation and the location at which the taste testing should take place. Potentially such testing could take place within a designated area of the factory, perhaps a tasting table/booth could be set up in order to further highlight to staff that the tasting of

ingredients forms a key part of QA and should only be conducted in the designated area and at the appropriate stages of the process.

11.4.9 Work in progress (WIP) storage

Manufacturing operations need to ensure that the selected prepared ingredient storage methods do not have an adverse impact upon the organoleptic performance of the ingredient. Often manufacturers of multicomponent foods will ensure that the ingredient (or ingredient mix) is stored in lidded food grade plastic containers. The term 'food grade' expects that the supplier of the container has selected/tested the material to ensure that it does not impart any flavours, taints or chemical compounds detrimental to the safety or quality of the ingredients to be contained.

Clear labelling is important at this stage as the primary packaging is often no longer present and the ingredient will therefore usually have a reduced 'prepared shelf-life' which should be recorded upon the containers together with identification of the ingredient and the destination product/batch. Usually the prepared shelf-life of each ingredient is kept as short as possible to help ensure the ingredient's quality at point of use.

Whilst the quality monitoring of work in progress (WIP) is often confined to routine checks upon the prepared ingredient storage areas to ensure that the required holding conditions are being maintained and that none of the ingredients has exceeded is 'prepared shelf-life', sensory assessment will be required typically in the event of an ingredient quality query, or in the circumstances where the standard 'prepared shelf-life' has been exceeded (perhaps due to production delays or breakdowns) and the factory therefore requires a decision upon whether the prepared ingredient is still acceptable for use. Where shelf-life extension is to be considered the primary consideration must always be that of product safety. The points documented within Section 11.4.7 are equally as relevant in these circumstances at the WIP production stage.

11.4.10 Processing: mixing and cooking operations

As with the preparation stage, the mixing/cooking stage is also a phase in the operation at which staff will have the opportunity to review and inspect all of the ingredients to be used within the production batch. This processing stage therefore provides another key QA point via monitoring that each ingredient meets the organoleptic standards required.

Staff who are trained in the sensory review of ingredients at this stage will be of great advantage to the food manufacturing operation. Ensuring that each ingredient to be added to the batch is of the quality standards required is a key element of a food manufacturer's QA system.

During their training the processing staff should be briefed upon the need for ingredient quality awareness at all times, and the importance of

not assuming that the ingredient quality is bound to be correct just on the basis that the ingredient has passed other check points to reach this particular stage of the process. Often it is beneficial to highlight to processing staff that if they do not spot an ingredient problem prior to use, that ingredient issue could then lead to an end product quality fault which may not be traceable back to that particular raw material fault, and consequently may leave the process operator open to suspicion that they may have incorrectly processed the product. Such an approach can help ensure that operators remain vigilant and always question any ingredient quality issues that they are not entirely sure upon.

At the cooking/mixing stage there are a lot of ingredient physical and chemical interactions occurring (e.g. Maillard reactions, blending or softening of particulates, formation of oil-in-water emulsions). In an ideal world applying the same cooking/mixing process (times, temperatures, mixing/blending speeds, etc.) would result in exactly the same end product on every occasion. However, as most food production operations are dealing with natural ingredients which can vary in variety, source and season, and also vary in factors such as their temperature and age upon addition to the product mix, such variations in the ingredients will often lead to variations in the processing performance of the end product.

It is also not uncommon for manufacturing sites to possess a variety of processing equipment which can be used to produce the end products (e.g. dicers, slicers, mixers, blenders, homogenisers, cookers, packing machinery, chillers), and yet depending upon which equipment is available/selected, there can be variability in terms of the end results achieved (for example, mixers, agitators and pumps will vary in their degree of damage caused to the food product).

As a result of the variables detailed above, in order to ensure that the end product meets the required sensory standards (e.g. appearance, aroma, taste, texture, viscosity), ideally the product sensory description will have been written and agreed in a form which allows for an acceptable range of product variability from one batch to the next. For example with regard to soups and sauces the colour reference may allow a shade either side of the ideal colour, and the product viscosity may allow for a set amount of deviation from the standard target. As variation is a fact of life for most processing operations handling natural ingredients, the processing team often have to assess the product at key stages within the production flow, and make adjustments to the processing parameters in order to ensure that the desired end result is achieved.

Such checks and corrective actions typically involve sensory assessment of the product/batch at the point of phase completion, and before progression to the next stage of the operation (typically a cooling or packing stage). A sufficiently sized sample should be drawn from the most appropriate points in the batch (if the production batch is known to vary at certain points then all such points should be assessed) and the product should then

be evaluated by the production operator or nominated quality assurance operative against the appropriate product sensory description (see Fig. 11.1 for an example sensory description for chicken tikka masala). The selected assessor should have been trained and screened in advance to confirm that they are capable of end product sensory analysis. Such staff training would typically take the form of the measures outlined earlier in this chapter.

Upon sensory assessment, if the product meets all of the defined requirements then it can be allowed to progress to the next process stage. However, if a non-conformance is raised at this stage then corrective action will typically be required. Corrective actions in soups and sauces may include:

- addition of water if the batch is too thick;
- extra cooking if the batch particulates are too firm;
- extra homogenisation if the batch texture is too coarse;
- addition of more thickening agent (e.g. starch) if the batch requires greater viscosity;
- addition of extra particulates if the product texture has broken down.

Many such corrective actions have an impact upon the product recipe and consequently the ingredient declaration. It is therefore prudent to have agreed the appropriate and acceptable corrective actions with the relevant authorities and customers in advance. Any product adjustments should also be logged upon the process records to ensure full traceability.

A similar approach can also be taken when assessing the results of intermediate stage processes (e.g. pre-frying minced beef before addition to a bolognaise sauce, or perhaps pre-blending a starch/powder slurry mix before addition to a batch of soup). As previously mentioned, such assessments will require specific sensory standards to be written. At their simplest these standards could be one-line reminders placed upon the process sheets (for example 'Check that the slurry mix is lump free before addition to the batch'), or could be a more complex full sensory description (e.g. appearance, aroma, taste, and texture guidance for a batch of par-cooked pilau rice which will then complete its cook at a later processing stage).

As such product assessments and adjustments can be quite time consuming, and are typically conducted by production staff whose Key Performance Indicators often include 'speed of operation'/'throughput rates', it is therefore important that these production operatives are encouraged not to rush their work related to QA. Production staff are often time pressured to complete the current product and move on to the next product in the plan. However, it must be stressed to the operators that the primary concerns of their role are the safety and quality of the food products and that therefore it is far more cost effective to take a little extra time to get the product 'right first time'.

Any batch recipe or process corrections/adjustments should be formally fed back to the team member responsible for setting the production process/

production sheets (typically a 'process technologist') as the requirement to routinely have to adjust a particular product may suggest that the standard production process requires a permanent adjustment or re-trialling in order to increase the chances of first time success, and avoid the requirement for time-consuming corrective action every time that particular product is made. It is very important that where an operator has highlighted that there has been an issue which required 'in-process correction', the person responsible for adjusting future productions to avoid a recurrence of the issue should always feed-back to the operator what corrective measures have been taken. The production operator will then feel that their feedback has been valued and will be focused upon highlighting other opportunities for improvement in the future. In circumstances where operators feel that their feedback is not listened to or that 'we always have problems on this product' there is a danger of acceptance of less than ideal quality standards and a loss of quality focus over time.

With regard to the physical provision of sensory descriptions to the factory operators for reference against when conducting their product sensory checks, processing operations take different approaches, each of which can be effective providing that they are managed and monitored carefully with close focus upon document control and issue of updates as and when required. Common approaches include:

- printing a summary of the product sensory description upon the relevant production process instruction sheets (e.g. the mixing/cooking sheet);
- holding copies of all product sensory descriptions in files within the relevant processing areas;
- maintaining an electronic database of sensory descriptions which can be accessed at a computer terminal or printed out when required.

All batch assessment checks should be recorded to maintain full traceability within the operation and help prove in the event of an issue/complaint that the batch was correct at that particular point in the operation. In addition the recording of such results and any further corrective actions can also be used to trend analyse the product over time for any routine problems or seasonal variances. (For example, perhaps variation with regard to colour, flavour or texture which could be linked to seasonally varying produce. If the extent of such seasonal variability is unacceptable then a solution may be to opt to use a frozen version of the variable ingredients, which has been harvested and frozen at one set point in the year, and is then available to be used consistently all year round.)

In batch production processes, where a number of separate batches of the same product are to be produced sequentially, a technique that is often also used during sensory assessment is that of maintaining a reference sample of each of the previous batches for review against as each new batch is made. Such comparison enables a check to ensure that the product performance is not gradually drifting away from the required standard.

11.4.11 Delays/holding times upon completion of the batch (or at key stages of the batch/product process)

In many production processes, following operations such as cooking/mixing, and prior to packing there is the potential for a delay/holding time between such process stages. Sometimes this amount of time needs to be closely controlled to help ensure that the final end product quality will not be adversely affected. For example in ready meal manufacture, rice which has been cooked and chilled will ideally be used immediately but may be stored in a refrigerated area for approximately 24 hours before packing as a component into the final ready meal packs (e.g. 'Sweet and sour chicken with egg fried rice'). In such a scenario there is the potential during this holding time for the rice to become dry/hard, especially if it has been stored uncovered and placed in a chill store area which has a high air flow.

It is therefore important not only to set an optimised storage method and maximum amount of time before the component can no longer be used (in ready meal production such limiting of holding times can be as much related to product microbiological control as to product organoleptic control), but also to ensure that there is a confirmatory organoleptic assessment upon the component appearance, aroma, taste and texture before further processing/packing. At this stage if the component quality is found to have deteriorated beyond an acceptable point, the business would incur further significant product, time and packaging cost losses by continuing to process the product, only to realise later at final product analysis stage that a specific component has caused the entire product to be organoleptically unacceptable. Well-timed sensory checks serve to ensure product quality and help avoid incurring unnecessary costs by highlighting faults as early as possible.

11.4.12 Product packing

The process of packing the product following the recipe mix/cooking operation can have significant impacts upon the product's organoleptic performance. For example, when manufacturing soups and sauces the products will typically have been transferred from the recipe mix/cooking operation via a series of vessels, pipework and pumps (which may or may not have been designed to handle the product as gently as possible) and will often then be held in an agitated vessel during the packing process in order to ensure a consistent mix/blend. In addition, if the products are being hot-filled into the packaging then the products will be hot and therefore continuing to cook whilst awaiting being packed into the final product packaging.

Heat and agitation factors will lead to organoleptic effects such as the softening of particulates, deterioration of starches/gels, colour and viscosity changes and therefore often the process technologist who has scaled-up the product will have set a maximum batch size related to the rate at which the

product can be packed. (This packing rate is usually dictated by the speed of the packing machines, and sometimes by the cooling/freezing capacity of the operation post-packing.) The technologist may calculate and set such maximum holding times by organoleptically assessing trial batches during the course of the batch packing operation until the point is reached where the product has deteriorated past a point of acceptability.

Any delays in the packing operation (perhaps due to machinery breakdown) may incur further deterioration of the food. In order to reduce the adverse impacts of such delays upon the end product in soup and sauce operations, factories will often choose to turn off the agitation of the batch during the delay to reduce the physical impacts upon the product, and where batches are held hot, a factory may also choose to reduce the holding temperature during the time of the delay (whilst ensuring that the temperature reduction does not fall below a point where microbiological growth may become an issue).

In the event of delays, food businesses will benefit from use of a 'delay procedure' (a summary of all of the actions required to be taken in the event of a process delay) which not only seeks to minimise the organoleptic impacts upon the product, but also ensures that the product quality is monitored closely during the delay (typically via the requirement for routine product assessments conducted by key staff) in order that the factory is quickly aware of when the delayed batch has gone past the point of being acceptable to pack. Where particulate deterioration in soups and sauces is a key concern, samples of the product may be routinely sieved to enable closer visual examination of the particulates. Sometimes colour change may be the main concern, requiring routine comparison against colour charts during the course of the delay.

The physical packing process through vessels, agitators, pumps, pistons and pipework can also have product quality impacts, which will be further magnified if a significant proportion of the product is being recycled within the process, perhaps due to product being reworked back into the batch pre-packing/holding system (e.g. if the packing of the batch is encountering machine problems causing a high level of pack weight or seal integrity rejects which are then being reworked to save wastage).

The significant scope for product organoleptic variation at the packing phase usually leads to businesses placing a great deal of organoleptic scrutiny upon samples drawn from the final product at the start, middle and end of the batch. Sometimes such checks are conducted even more frequently/throughout the packing operation if particular problems are being encountered; for example, excessive variability in particulate distribution which therefore requires further analysis to monitor and ascertain the root cause of the issue.

In soup/sauce batch production, focus upon a 'distribution issue' may necessitate routine 'washouts' of packs to ascertain the consistency of distribution of particulates across the packed batch (i.e. whether all of the

product components are evenly present throughout the batch). Some particulates may sink or float when the batch is being packed which can lead to their being present mostly at the start or end of the batch. Also if certain larger size particulates are becoming blocked in the feed pipes/dosing pistons this may lead to their sporadic distribution as every so often the pressure may build up until a burst of those stuck particulates are finally dosed into the packaging.

11.4.13 Pre- or post-packing 'cooling/chilling' phases and the sensory evaluation of the end product

Organoleptic deterioration is also a consideration in the product cooling/chilling phases. For example, if the product is cooled in an open state, the chilled air flow that it is exposed to may cause some drying of the product, whereas if a product is cooled in its packaging, although this may protect the product from the drying effect of chilled air flows, the product can sometimes be found to take longer to cool due to the insulating effect of the packaging, which can also cause organoleptic changes. In addition, some cooling/chilling operations may require the product to be agitated, or may require the outer edges of the product to be crust frozen. Such aspects of cooling processes will also impact upon the organoleptic performance of the end product.

Only after the product has been packed and cooled can a business start to be confident that its organoleptic quality tests are assessing the product in a form that the end consumer is likely to experience. Therefore the final product sensory evaluation of aspects including appearance, aroma, taste and texture is a very important stage of the business QA system. At this stage businesses will often evaluate a number of samples drawn from the start, middle and end areas of the production batch, the number of which should reflect the potential for variability within the production process. Food manufacturers will typically ensure that these checks are conducted immediately upon the completed end product by an experienced member of the cooling/packing teams or by a QA technician.

11.4.14 Taste panel

Most food manufacturers will also place all recently completed products upon a routine (often daily) business taste panel which is attended by a multidisciplinary cross section of the business staff and management. It is usually beneficial for the end product taste panel to include members of the NPD department, process development and sales teams, as these team members will often be able to closely remember the customer's expectations of the particular products and how these expectations should be reflected within the KSPs of each particular product. Also having members of the factory production and QA teams present at the formal end product

taste panel will help ensure a good transfer of product sensory knowledge and provide the opportunity to discuss any particular processing issues/problems being encountered.

Most end product taste panels will assess a representative sample of each production batch against the sensory description (Fig. 11.1) set either internally or with the end customer. Some businesses choose to score the attendee's assessment of each batch, while others choose a simple 'pass/fail' approach. The more data that can be captured at this stage, the greater the potential for trend analysis of results over time. Such results can be used to drive business focus upon product quality (e.g. trend analysis of end product taste panel results may show a gradual deterioration in a product's colour or texture over time which, owing to the gradual drift in standard, may not have been picked up by the individuals regularly attending each taste panel).

There is also a good case for insisting that during the taste panel product assessment phase, every panellist should evaluate each sample in silence or isolation from other panellists to ensure that their judgement cannot be influenced in any way by more dominant, opinionated or senior members of the panel. Potentially some panel members may be biased in their opinions upon the acceptability of products due to pressures such as production throughputs, financial impacts or customer demands.

As the end product taste panel will typically be the most thorough organoleptic evaluation that the product is going to receive on site, businesses should seek to ensure that the taste panels take place before the particular batches of products are due to be despatched to the customer. This will ensure that if a product is found at the business taste panel to be unacceptable (or in need of further scrutiny), then the product will still be within the control of the business, rather than incurring the difficult situation of having to consider a withdrawal/recall from the distribution chain or customer.

11.4.15 Freezing

If the end product is intended to be sold in a frozen format then there are often extra organoleptic factors to be considered and monitored via the use of sensory assessment during the product/process design phase and the subsequent production quality assurance phase. These considerations include the fact that the freezing of food products will form ice crystals within the food. Typically, the slower the freezing process, the larger the ice crystals formed and therefore the greater the potential to damage the food product structure (including deterioration of the physical texture of particulates and damage to product starch/gel suspensions, which can lead to excessive product syneresis upon defrost).

Other organoleptic quality issues that can arise at the product freezing phase are the potential for 'freezer burn' (quality deterioration typically

caused by product dehydration and oxidation, often linked to the product not being sufficiently wrapped in protective packaging) and also the potential for product quality loss during storage, which is especially a concern for products which are particularly susceptible to deterioration (for example, high-fat meat products can be particularly prone to rancidity during frozen storage). Poorly maintained freezer stores can also increase the potential for product deterioration due to significant fluctuations in air temperature.

11.4.16 Storage (Including monitoring over shelf-life)

Business efficiency pressures to produce larger product batch runs less frequently can lead to end products being held in storage for a significant amount of time pre-despatch to the customer. During this holding time most products organoleptic performance will typically be deteriorating. This is especially so if the product bears a 'use-by' code rather than a 'best before' code (e.g. usually chilled products).

Most chilled foods will deteriorate during storage due to a combination of microbiological, physical and chemical factors. Frozen foods may deteriorate due to ice crystal formation and aspects such as oxidative reactions and freezer burn. Ambient products could be susceptible to the absorbance of moisture from the environment over time (especially if not packaged in robust gas and moisture barrier packaging materials). External factors can increase the potential for such deterioration to occur, including higher than ideal chill store/frozen store temperatures.

As a result of the potential for product deterioration during storage some businesses choose to conduct a sensory evaluation of the stored (stock holding) batches on a routine basis and at a frequency which reflects the potential for deterioration to occur. Such checks are important as it is better to be aware of the deterioration of a product batch early in order that a fresh batch run can be planned in time, rather than awaiting receipt of a customer order, only to then find during final quality checks at point of despatch that the product does not meet the quality criteria required due to deterioration which has occurred during storage.

11.4.17 Despatch

Some food companies tend to focus their taste panels on the final product just before despatch to the customer. At this stage there is little that can be done to rectify any product problems which may have occurred earlier in the production process; however, such checks serve as a useful quality control check point and provide the major control of avoiding any sub-standard products from being despatched to the end customer.

For these reasons the final assessment of product organoleptic performance (compared against the requirements defined in the agreed customer

specification) is typically seen as the final 'quality safety-net' prior to despatch.

11.5 Sensory quality assurance (QA) after product despatch

11.5.1 Distribution depot and in-store inspection

Sensory checks upon the product are likely to continue even after it has been despatched, usually in the form of 'depot checks' (typically conducted upon delivery as part of the customer acceptance checks) or in-store/stock inspections conducted by the customer. By having a clearly defined and agreed sensory description/specification for each food product, quality queries and problems at depot and in-store can be reduced. Without agreed product standards the manufacturer risks the potential for their foods to be judged and possibly rejected purely on subjective assessments.

11.5.2 End-of-life assessment/review

On a routine basis many businesses review the organoleptic performance of their products at the very end of the product shelf-life as part of their QA program. These tests can involve comparison against newer stock of the products and focus upon comparison against the agreed/specified sensory profile (which should define the target and limits of acceptability upon aspects including product appearance, aroma, taste and texture). Typically such assessments will involve the use of a multidisciplinary panel including members of the quality, NPD, process development, production and sales teams.

To best reflect the actual conditions that the product batches will encounter during distribution and consumer storage, businesses should seek to hold their end-of-life samples in temperature conditions which reflect the end customer shelf-life testing criteria, and this is most easily achieved through the use of storage incubators. However, many businesses choose to simplify this approach by purchasing samples of their products from the relevant retail/food service outlets, storing them in domestic fridges (set to temperatures recognised by industry research to reflect typical consumer fridge conditions) for the remaining days of their shelf-life, followed by taste panel evaluation on the last day of the shelf-life to confirm that the organoleptic shelf-life appears to be set correctly (i.e. the product quality has not yet deteriorated to a point of being unacceptable to the end consumer).

As with the routine daily site taste panels the businesses may choose to score the attendee's assessment of each 'end-of-life' sample whereas others choose a simple 'pass/fail' approach. The results can then be trend analysed over time and reacted to in the event of a problem issue being noted.

11.5.3 Conflicts of interest

Whilst organoleptic performance is very important to the commercial success of the product, the vital issue of ensuring product safety can sometimes lead to compromises being necessary with regard to the achievement of an optimum organoleptic quality. For example many food products require cooking for a 'longer than organoleptically ideal' length of time to achieve the required levels of microbiological reduction, thereby achieving product safety and shelf-life, and in doing so the process may adversely affect the texture, consistency or colour of the product.

Another example is that product acidification to help achieve microbiological control and increased shelf-life can consequently impact upon the flavour profile of the product and make product consistency (e.g. some soup/sauce starch suspensions) more prone to deterioration. As the customer and business consequences of a food safety issue can be catastrophic, it is vitally important that all departments work to the same site priorities, always ensuring product safety first whilst striving to attain the required product quality/consistency.

11.6 Conclusions

As can be seen by the numerous examples given in this chapter, the manufacture of multicomponent food products such as soups, sauces and ready meals presents a wide range of potential for faults to occur with regard to the quality of the products being manufactured. It may be useful for the reader to reflect upon the use of sensory evaluation as a tool in assuring quality at each stage of the food production process. Such sensory evaluation in support of quality assurance could be categorised in distinct phases which include:

- **avoid:** sensory techniques to help avoid product faults (e.g. checks to confirm the correctness of incoming ingredients);
- **detect:** sensory techniques designed to detect product faults (e.g. checks upon the organoleptic quality correctness of intermediary and end product recipes);
- **decide:** sensory techniques to help decision make and resolve issues (e.g. sensory assessments and panels can be utilised to help decide whether a product quality fault contravenes the product specification and/or renders the product unacceptable to the end consumer. Sensory panels can also help a business decide whether the reprocessing/reworking of excess or sub-standard product batches is a possible salvage/cost saving option, or whether such actions will merely result in creating further non-saleable stock).

The key themes of benefit to businesses seeking to develop sensory control include:

- focus upon ensuring the correct and consistent quality of all ingredient supplies;
- ensure that all manufacturing processes are well maintained, robust and consistent;
- continually seek to make sensory checks objective rather than subjective wherever possible;
- always ensure that the sensory criteria required of the product are realistic and consistently achievable before being formally agreed/committed to with the end customer;
- ensure that the product sensory criteria are clearly defined within the agreed customer product specification, together with all acceptable tolerance limits;
- constantly monitor (via supervisory checks and audits) that the required sensory standard checks are diligently and consistently applied at each key stage of the manufacturing process.

The application of sensory-related quality assurance techniques within the ready meal, soup and sauce sectors can be viewed as a vast and complex area, yet the reader should be assured that the majority of the systems and checks applied are low cost, relatively straightforward in their design and application, and are best administered by trained staff who have sound experience of the products and good clear knowledge of the customer expectations.

11.7 Acknowledgements

BOSTWICK CONSISTOMETERS. Christison Particle Technologies Ltd, Albany Road, Gateshead NE8 3AT, UK http://www.christison.com/ http://www.consistometer.com/

BROOKFIELD VISCOMETERS. Brookfield Engineering Laboratories, Inc. 11 Commerce Boulevard, Middleboro, MA 02346-1031, USA http://www.brookfieldengineering.com

11.8 Sources of further information

BETTS, G.D., BROWN, H.M. and EVERIS, L.K., 2004. *Evaluation of Product Shelf-life for Chilled Foods*. Chipping Campden: CCFRA.

BRITISH STANDARDS INSTITUTION, 1989. British Standard methods for sensory analysis of food BS 5929. London: BSI.

BROWN, M., 2008. *Chilled Foods, A Comprehensive Guide*. Combridge: Woodhead.

CAMPDEN & CHORLEYWOOD FOOD RESEARCH ASSOCIATION, 1996. *Product Development Guide for the Food Industry*. Chipping Campden: CCFRA.

FELLOWS, P., 1990; 1988. *Food Processing Technology Principles and Practice*. New York, London: Ellis Horwood.

HUTTON, T., 2001. *Food Manufacturing: An Overview*. Chipping Campden: CCFRA.

ISHIHARA, S., 2004. *Ishihara's Tests for Colour Deficiency*. Tokyo: Kanehara Trading Inc.

KEMP, S., HOLLOWOOD, T. and HORT, J., 2009. *Sensory Evaluation: A Practical Handbook*. Chichester: Wiley Blackwell.

KNIGHT, C., STANLEY, R., JONES, L., CAMPDEN & CHORLEYWOOD FOOD RESEARCH ASSOCIATION and ROYAL AGRICULTURAL SOCIETY OF ENGLAND, 2002. *Agriculture in the Food Supply Chain: An Overview*. Chipping Campden: CCFRA.

SAXBY, M.J., 1993. *Food Taints and Off-flavours*, 1st edn. London, New York: Blackie Academic & Professional; Chapman & Hall.