

DLG Expert report 5/2014

Special sensory analysis of nuts and shell-fruits



In 2012 Germans consumed on average 4.3 kg shell-fruit (including peanuts). In 2013 altogether 304,459 metric tons of nuts (including peanuts) were imported to Germany, the greatest shares of which comprised peanut kernels (92,669 metric tons) and shelled almonds (75,372 metric tons), followed by hazelnut kernels (61,321 metric tons) pistachios (22,762 metric tons) and cashew kernels (22,604 metric tons). The main processor is the confectionery industry. Nuts and shell-fruits are used above all in snacks, muesli mixtures, as baking ingredients, or for obtaining oils.

A large number of influences during growth, harvesting and processing affect the quality and the sensory properties of nuts and shell-fruits. The sensory assessment and grading into quality levels presupposes extensive experience and commodity-specific knowledge concerning nuts and shell-fruits and this work is highly important for the trade, the processing industry and consumers.

This DLG Expert Knowledge Report aims to examine the sensory characteristics of the most important nut families and key factors in the value chain that can influence the sensory quality and assessment of the end product. This worksheet focuses on nut kernels and not on nuts in the shell. The quality criteria for all nuts are appearance (size, colour, form), odour and taste, as well as texture. Alongside positive quality criteria, quality defects such as e.g. the proportion of damaged and broken nuts are important for sensory evaluation.

1. Definition of nuts and shell-fruits

Nut fruits are indehiscent (not splitting open to release seeds when ripe) fruits in which all three layers of the fruit wall, i.e. the pericarp, lignify. Shell-fruit is the normal trade description for fruit with fruit kernels that are surrounded by a hard, mainly woody shell with kernels that are suitable for human consumption. According to the German regulations for oilseed, “nuts” only include hazelnuts and walnuts. Shell-fruit is the term used for instance for almonds, pistachios, hazelnuts, walnuts, macadamia nuts and cashew kernels.

For the purpose of orientation and to facilitate international merchandise trade, the “Economic Commission for Europe” of the United Nations (UN/ECE) has published standards for nuts in international trade which are commented on briefly below.

2. Types of nuts and shell-fruits: commodity-specific knowledge – cultivation/processing – sensory analysis

2.1 Hazelnut kernels (HNK)

2.1.1 Commodity-specific knowledge

The fruit of the hazelnut (*Corylus avellana*, *Corylus maxima*) consists of the seed and a seamless, lignified fruit wall. A distinction is made between two types: the roundish Zellernuss variety and the elongated cylindrical variety known as filberts. Longish varieties taste better than round varieties (subjectively). In the trade, hazelnuts are chiefly available as whole, shelled nuts or in chopped or ground form (as baking ingredients).

2.1.2 Cultivation/processing

In Turkey hazelnuts are generally picked by hand and after a few days the surrounding leaves are removed. The nuts should be dried down to a moisture content of approx. 6% (see Turkish standard, which also applies for other nuts!). They are stored in their shells until they are cracked with the help of conical stone discs. After this, post-sorting is carried out with the aid of machines and in some cases manually.

- **Turkish HNK** – the world's largest producer today is Turkey. The cultivation region extends along the entire Black Sea coast. Cultivation areas for Levantine HNK from Turkey are Trabzon, Giresun, Unye, Samsun, Akcakoca and Ordu. The Giresun products are the richest in fat and easy to blanch. Nuts of all other origins contain less fat and some are difficult to blanch.
- **Italian HNK** – Italy is the second largest producer of hazelnut kernels. The Italian hazelnut kernels are divided into the following qualities: Long Naples (large kernel with cavity, dry in taste), Mortarelle (similar to the Romana, but darker), Round Romana (large, full, light kernel), Sicilian hazelnut kernels in smaller quantities. The individual qualities also differ strongly in taste according to the nature of the soils. The kernels also differ strongly as regards structure, form and skin thickness.
- **Other Regions** – Other regions are Spain with the Tarragona (round kernels, dark seed skin), Georgia (qualities similar to those from Turkey), Azerbaijan (reddish skin colouring, excellent “nutty” aromas), and the USA Oregon kernels (very large, with cavity, very sweetish), but which are generally not of interest for the European market.

2.1.3 Sensory analysis

Hazelnut kernels have a light to medium-brown seed skin and darken over time, above all under the influence of light. They should have a maximum moisture content of 6%. The lower the fat content of the nut, the higher the water component that the kernels can tolerate without developing mould. The kernels are hygroscopic and their water content depends on the surrounding atmospheric humidity. Hazelnut kernels taste best shortly after ripening. They have a mild and aromatic flavour. If the nuts are stored for too long, their typical aromatic taste disappears gradually. Fresh nuts are white-cream coloured on the inside. Older nuts have a higher FFA value and strongly yellow-brownish kernels, clearly evident in the cross section. In general all hazelnut origins are tied to the Turkish Standard TS 3075 as regards the quality criteria (cross-section, moisture content etc.). Furthermore, the *UNECE Norm “DDP-04 Hazelnut Kernels”* applies for hazelnut kernels and is used to assess consignments correctly. This standard defines the different kernels, the outer and inner quality parameters (e.g. sizes), the process quality and the minimum requirements made of hazelnut kernels.

2.2 Almond kernels

2.2.1 Commodity-specific knowledge

The almond (*Prunus dulcis*) is a shell-fruit, the flesh of which bursts on ripening and releases the hard shell with the seed enclosed inside, the almond kernel. A distinction is made between sweet and bitter almonds. Sweet almonds come onto the market either as shelled almonds or as cracked almonds (almonds in the shell). The shelled almonds are partly also skinned and are used untreated in chopped or ground form for baking and cooking, or are roasted and salted as snacks. Bitter almonds, which contain a preliminary stage of hydrocyanic acid which is harmful to health in largish quantities, are used for producing aroma substances. They may not be consumed raw. Almonds contain many proteins and carbohydrates.

2.2.2 Cultivation/processing

The almond trees originate from the Near East and Central Asia. They only bear their full amount of fruit after eight years. After harvesting, almonds are cracked, fumigated and separated by blower from the shells, cleaned, sieved and sorted.

2.2.3 Sensory analysis

Almonds from California, Australia and Chile have a sweetish/almond taste, while almonds from the Mediterranean countries have a stronger, more aromatic almond taste. The maximum moisture content for an optimal quality is 6%. 80% of Italian almonds are used for producing spirits and within the country. The *UNECE Norm "DDP-06 Almonds"* can be used to assess the sensory quality of almond kernels. This also defines and describes minimum requirements, the classification, sizes, quality tolerances and defects. See also USDA Standard of shelled almonds (Grades, Size etc.)!

- **Californian almonds** – California is the world’s largest producer of sweet almond kernels. The Californian almond is a 100% sweet almond and has no bitter almond component. The various qualities such as California (medium brown), Nonpareil (even, light brown kernel, distinct grain pattern), Ne Plus (longish kernel, slivers, rather dark brown), Mission (strong skin, roundish, drop-shaped, rather dark brown kernel, difficult to blanch, flours), Butte/Padre (medium brown) and Carmel (medium brown kernel, asymmetrically shaped) have different sensory properties. This is attributable to the different growing regions, the skin thickness and the age of the product. Californian almond kernels are subject to a USDA Norm.
- **Spanish almonds** – In Spanish almonds a bitter almond component of 1–2% can be tolerated. They have a strong taste. Valencias (brown skin colour, typically almond-shaped kernel) and Languettas (brown skin colour, long, slim kernel) are the most frequently produced almonds. In general, Spanish almonds tend towards dust adhesion (more furry skin than Californian almonds).
- **Italian almonds** – Italian almonds have a very strong and aromatic almond taste, tend slightly towards bitterness and are darker. The main cultivation areas are the regions of Bari (typical cross-shaped notch) and Sicily.
- **Other regions** – The Australian and Chilean almond kernels are comparable with products from California, but smaller quantities are harvested.
- **Bitter almonds** – The bitter almonds are cultivated chiefly in North Africa (Morocco, Algeria). Smaller quantities are produced in the Mediterranean region. The nuts are smaller, tend more towards breakage, are dustier and have more contamination (shell residues, smaller stones).

2.3 Walnut kernels

2.3.1 Commodity-specific knowledge

The walnut (*Juglans regia*) is considered by botanists to be a stone fruit, as a fibrous green covering is to be found over the two-part hard shell. The name “walnut” is derived from “wal-hnutu”, a Germanic compound meaning “foreign nut”.

2.3.2 Cultivation/processing

Walnut kernels are cultivated worldwide, e.g. in California, China, Eastern Europe, France. The tree bears fruit after seven years and reaches its full productivity after 15 years. Around 10% of walnuts are harvested before they are fully ripened. These still very soft kernels with a bitter-tasting skin are considered to be a speciality particularly in France, Italy and Belgium.

- **Californian walnut kernels** – The cultivation region for Californian walnut kernels lies in the Sacramento and San Joaquin Valley and in a few valleys of the coastal mountain region.



- **Chinese walnut kernels** – Chinese walnut kernels differ widely in size and colour, have a distinct bitter note and tend to develop mould quickly due to the local circumstances.
- **French walnut kernels** – French walnut kernels have a strong, nutty taste with a slightly bitter aftertaste. They are available in various colour shades from light to amber. The varieties are called Marbot, Corne, Franquette.
- **Indian walnut kernels** – India is the largest producer of organic walnut kernels. The fruits have a distinct bitter component and are relatively small in size.
- **Other regions** – Only smaller quantities of walnut kernels from Chile are available and are used e.g. for coating. Their quality is similar to that of Californian products.

2.3.3 Sensory analysis

Walnut kernels are 2–3 cm large, round, light brown nuts that have an irregular shape, are white-yellowish inside and display more or less strong (Eastern Europe: strong, China: moderate, Europe: slight, California: mild) bitterness due to the tannic acid. A “colour gauge for walnut kernels” for international standardisation of fruit and vegetables can be used to assess the colour. Walnut kernels tend to become rancid very quickly under the influence of oxygen and heat, while the fat content is very high at about 70%. The maximum moisture content should be 6%. The share of broken nuts, the size, the colour etc. also influence the sensory analysis of consignments. The *UNECE Norm “DDP-02 Walnut Kernels”* can be used as an aid here. It describes the minimum requirements, the classes, sizes and forms, as well as the possible defects.

2.4 Pecan nut kernels

2.4.1 Commodity-specific knowledge

The pecan nut (*carya illinoensis*) belongs to the walnut family and is at home in Texas and Arizona. However, it is more slender (reminiscent of over-sized acorns) and has a thinner, smooth outer shell that can be cracked easily. Its edible kernel is milder, firmer and has a finer aroma than the walnut kernel and hardly any tannic acid (bitter aromas).

2.4.2 Cultivation/processing

The pecan nut has only been cultivated commercially since the end of the 19th century in the Southern States of the USA, in Mexico, Australia, South Africa, and partly in Israel. The fruits are cracked after harvesting, sorted in factories, cleaned and stored.

2.4.3 Sensory analysis

The pecan nut has a mild nutty taste and unlike walnuts is not bitter. It is differentiated by size and colour and categorized. The moisture content is 3–5 % (hygroscopic) and despite a fat content of around 70%, the pecan nut tends to become less rancid than the walnut. By way of precaution, in order to keep the taste and texture stable, pecan nut kernels should be stored under vacuum. The colour grading of the kernels is light amber to amber; the size grading is Mammoth, Junior mammoth, Jumbo, Extra Large, Large, Medium, Topper, and the processing grades are pieces, granules, meal.

2.5 Pistachio kernels

2.5.1 Commodity-specific knowledge

The pistachio (*pistacia vera*) is at home in Central Asia and the Near East. The stone fruit is related to cashew nut kernels. Unshelled pistachios of good quality can be recognised by the fact that nearly all shells have a split at the seam. Pistachios are eaten raw, roasted and salted and used for bread, bakery products, ice cream, fruit salad, vegetable dishes, muesli and sausage.

2.5.2 Cultivation/processing

Cultivation areas are above all Iran, Iraq, Turkey and California. Pistachios thrive in dry climates. The plantations are irrigated artificially. The pistachio is very often infected by aflatoxins (*Aspergillus flavus*, *Aspergillus parasitus*), which is partly attributable to the nature of the soil. Pistachios tend more than other nuts to infestation with aflatoxins! The pistachio blossoms in March. The longish nut then ripens in the year following this within a few weeks from July to September. In its ripe condition, the two halves of the shell open. The shell half is woody-hard and the kernel assumes a green-violet-grey colour. Harvesting and further processing are carried out by machine.

2.5.3 Sensory analysis

Pistachios are offered in various sizes with or without shells, partly also already roasted and salted directly from their origin. They are round, almond-shaped or oval, with a light green colour and a fine, mildly spicy nut taste. The kernels from Iran are classified by colour and form: Class 1 (dark green, full kernels, hardly any breakages), Class 2 (grass-green, full kernels, slight breakage), Class 3 (light green kernels, a few yellowish kernels, some breakage). The maximum moisture content of the nuts is 6–7% and the fat content around 50–55%. The *UNECE Norm "DDP-10 Pistachio Kernels and Peeled Pistachio Kernels"* is used for quality grading of the pistachio kernels. Here too,

minimum requirements and quality parameters such as e.g. colour and size as well as defects are described. See also: USDA Standard for grades of shelled Pistachio nuts!

2.6 Brazil nut kernels

2.6.1 Commodity-specific knowledge

The Brazil nut (*bartholletia excelsa*) grows wild. The Brazil nut tree only bears fruit after 50 years. The Brazil nuts look like a football inside which the triangular, hard-shelled Brazil nuts are located in different sizes (Large, Medium, Small, Midgets, Tiny). The triangular whole Brazil nuts may not be imported into Europe as there is a risk of elevated aflatoxin values.

2.6.2 Cultivation/processing

The nuts are gathered by Indian tribes in the source area of the Amazon in the Para Region, located in the border triangle Bolivia, Brazil and Peru, and taken to the respective cooperatives for further processing. For cracking, the nuts are soaked for approx. 24 hours, then treated for approx. 10 minutes with super-heated steam and cracked manually with levers.

2.6.3 Sensory analysis

The seed has a slightly nutty, roasted odour and taste, a light-brown skin with differing abrasion. Inside, the kernel is white to ivory in colour. The moisture content should not exceed 6% and 3–4% is preferable. The fat content is around 67%, which is why it is advisable to store Brazil nuts under vacuum conditions. One outcome of the last session of the UNECE in 2013 was (among other things) to establish a new *UNECE Norm for Brazil nut kernels!*

2.7 Macadamia kernels

2.7.1 Commodity-specific knowledge

The fruits (*macadamia integrifolia* / *macadamia tetraphylla*) of the macadamia trees originating from the Australian rain forests are similar to chestnuts with a thick, dark brown, smooth shell. This is so hard that it has to be cracked with the help of machines. The macadamia was only discovered in the middle of the 19th century.

2.7.2 Cultivation/processing

Cultivation areas are Australia, South Africa, Kenya, Malawi and Hawaii. The trees grow to an average height of 10 – 12 m. They begin to bear fruits at an age of five to eight years. Harvesting is very labour-intensive and extends over several months.

2.7.3 Sensory analysis

The spherical, cream-white-coloured nut kernel is roughly the size of a chestnut and has a very fine, mild, sweet, fatty taste. The moisture content should not exceed 2%. The fat content is the highest of all kernel fruits and up to 77%. As the macadamia nut is very difficult to crack (conical discs), there is a large proportion of breakages during processing. The qualities are specified in styles. The nuts are mainly marketed roasted, salted and vacuum-packaged. The *UNECE Norm "DDP-23 Macadamia Kernels"* provides good assistance for assessing macadamia kernels.

2.8 Coconut/Flakes

2.8.1 Commodity-specific knowledge

These almost head-sized fruits (*cocos nucifera*) from tropical regions are grown worldwide. Each ripe coconut is surrounded by a green outer shell and a thick fibre layer, which are mainly removed prior to shipping. The hard kernel is the actual coconut. It is hollow and filled with coconut water. This is the only nut fruit that is used 100%.

2.8.2 Cultivation/processing

The main supplier countries are located in all tropical regions, but mainly the Philippines, Indonesia, Sri Lanka and Vietnam. Trees grow up to a height of 30 m. The nuts are harvested by shaking the coconut palms, or people climb the palm trees to twist off the coconuts. In some regions of the Philippines this work is carried out by trained apes. The complete green coconuts are stacked in piles and dried in the sun. The ripe nuts are collected, freed from the fibre cover and cracked. After removal of the brown seed skin, the fruits are soaked in hot water, flaked, dried and sieved.

2.8.3 Sensory analysis

In order to eat the fruit flesh, it is first necessary to open the very hard shell. In addition to whole nuts, it is also possible to buy flaked coconut in various grades (medium, fine, extra fine). In appearance, the nut is white-ivory coloured and free from impurities. The strong coconut taste is characteristic and sweetish. The older the product, the more it tends to become acidic or soapy. The moisture content should not exceed 3% and the fat content is usually 60–70%.



2.9 Cashew kernels

2.9.1 Commodity-specific knowledge

The cashew kernels (*anacardium occidentale*) are at home in the Tropical Forests of Brazil. They were taken to Africa, India and South-East Asia, in particular Vietnam, by the Portuguese and Spaniards. The small, kidney-shaped nuts are part of the cashew apple and were originally surrounded by a firm, leathery shell. The nut is located at the tip of the yellow or red cashew apple, originally eaten fresh and processed to juice and jam. The core yield is around 20–25% of the whole nut weight. Cashew kernels are available untreated, or roasted and salted. They are generally peeled.

2.9.2 Cultivation/processing

The main supplier countries are India, Vietnam and Brazil, Tanzania, Mozambique and Indonesia. The trees bear fruit at an age of three to five years and grow to a height of 10–20 m. In order to obtain the kernel, it is necessary to separate the seed skin from the kernel, which is done under a strong heating process (either with hot steam or by drum roasting over an open fire). The woody shell contains a strongly caustic oil.

2.9.3 Sensory analysis

Their mild, nutty, sweet, particularly fine taste makes them so popular among consumers. The moisture content of the kernels should not exceed 5%. The odour can range from characteristically nutty to slightly fishy and still be acceptable. The quality is graded on the basis of the size of the pieces and the colour. The following designations apply, for example, for India and Vietnam, while other countries partly have different designations and meanings: White wholes (white-ivory-light grey, broken components 5 %) are practically offered solely as snack nuts for the German trade. Scorched wholes (yellowish due to overheating during roasting), dessert wholes (strongly discoloured, stained, bluish also due to overheating during roasting), white pieces (butts, splits, large white pieces, small white pieces, baby bits) are intended for industrial use. The *UNECE Norm "DDP-17 Cashew Kernels"* can be used for the sensory assessment of cashew kernels. This defines the minimum requirements, classification including colour descriptions, sizes and quality tolerances.

3. Preparations (shredded, chopped, sliced, ground)

Almond and hazelnut kernel preparations have become increasingly more important in the trade in recent years. Processing is carried out either in the countries of origin or in the domestic industry. All preparations have a shorter shelf life and are more sensitive to rancidity than whole nuts as the surface area is greatly enlarged as a result of the many small pieces.

3.1 Almond preparations

The main producers are California and Spain. The brown almond kernels are treated with super-heated steam, the seed skin swells up and is pressed away between two rubber rollers and removed by blower. These almonds blanched in this way are dried and as required passed on for further processing. The following properties (apart from the form) apply for almond preparations: light ivory colour and almost white; almond-like taste in accordance with the raw material used, but weaker than the actual raw materials; moisture content max. 7%.

- Blanched: size graded as for brown almonds (see *UNECE Norm "DP-21 Blanched Almond Kernels"*).
- Chopped: made from small pieces, irregular or screened breakage of blanched almonds; they are cut into tubes as evenly as possible with a cutter and screened via a sieve (approx. 3 mm); the smaller granulated material is processed further to ground almonds.
- Sliced: made from blanched almonds with pieces as large as possible; the almonds, laid out flat, are cut horizontally with a cutter and then screened; flakes or granules are by-products.
- Shredded: made from blanched almonds with pieces as large as possible; cut longitudinally with a cutter and then screened; granules for grinding are a by-product.
- Ground: generally gained from the by-products of the other preparations; brought into unified form by grinding.

3.2 Hazelnut kernel preparations

In order to remove the seed skin from the kernel, these are roasted (dry) in hot air and then the skin is rubbed off and removed with a blower. Kernels that are not completely blanched can be sorted out with colour filters.

- Chopped: the taste is more intensive due to roasting than in the case of natural kernels; appearance; light yellow/light brown, partly with adhesions of residual seed skin; moisture content max. 2%.
- Sliced: natural product with skin, not roasted (!), if possible 13–15 mm, whole kernels, moisture content max. 6%.
- Ground (natural): natural meal is produced from small kernels; taste is optimally characteristic of fresh hazelnut kernels (mainly less intensive); Appearance: light brown with seed skin; moisture content: max. 6%; size grading see Turkish Standard.
- Roasted grit: results when screening chopped kernels (< 2 mm); taste with distinct roasting aroma, appearance: golden yellow with seed skin residues; moisture content approx. 2%.

4. Further effects on the sensory quality of nut kernels and preparations

The sensory assessment covers all the characteristic properties of the product to be examined (appearance or colour and form, odour, taste, consistency). This makes it possible to draw conclusions regarding important factors in the overall value chain that can all influence the sensory quality.

4.1 General

Origin and cultivation area, growing and harvesting conditions, variety and production conditions exert substantial influence on the product quality, above all on the sensory quality.

4.2 Storage

Nut kernels should optimally be stored at a temperature of 4–8 °C and atmospheric humidity of 50–60%, as this offers optimal protection against pest infestation, against microbiological changes inside the goods, and keeps the sensory properties such as e.g. the product colour largely constant. Under these conditions stability of 12 months can be ensured.

4.3 Packaging

The packing of the nut kernels on import and during storage can influence the sensory quality. Packing options are e.g. Big Bags, jute bags, cartons, vacuumed or open. The trend is towards Big Bags / bins, while jute bags are being used ever less due to the strong odour and taste impairments they involved and an elevated risk of pest infestation.

4.4 Pests and insects

The most frequent pest infestation in the case of incorrect storage is due to moths (Indian meal moth = *Plodia interpunctella*), mites, beetles (*Trogoderma variabile*), and mould fungi. HNK and Cimiciato infestation: during growth in late spring, an insect can prick the young fruit in order to suck out the fruit milk. As a consequence scurfing occurs at the prick of the kernel which from a diameter and depth of 3 mm upwards is to be assessed as defect. Further defects: various damage to the seed skin, resulting in webs (from moths and beetle).

4.5 Further influence factors

In the event of incorrect handling, consignments can also take on foreign odours, for example from spices or other products such as e.g. chemicals. This can be avoided by an appropriate QM system. Contamination with foreign bodies (pieces of shell, residues of stone or skin, glass, metal or wood splinters; animal hairs, fibres, paper/plastic sheeting residues) due to inadequate sorting are thus largely avoidable.

5. Sensory testing

Sensory testing of nut kernels is as a matter of principle carried out in accordance with the generally valid methods and procedures for sensory analysis of products. For this neutral testing conditions, i.e. ideally test rooms fitted out in accordance with ISO 8589, are just as relevant for quality as a panel of testers with sound knowledge of the commodity and sensory training, who are able to provide an objective test judgement on the basis of a previously defined testing method. The samples to be examined should represent a good reference sample of the complete consignment (average samples, well homogenised). The test samples are handed out coded to all testers for tasting. It is vital to neutralise palates e.g. with neutral water between testing of different test samples.

The sensory assessment or description of the test sample is generally carried out in the form of descriptive tests. When recording all feature properties of a product or a group of products, the “simple descriptive test” (§64 LFGB L00.90-6) plays a major role. Its goal is to identify all product properties and characterise the product in words. A further possible option is to draw up a sensory profile for the various nut species with the help of a “sensory profile test” (§64 LFGB L00.90-11). Here products of a category can be assessed as regards different positive or negative property features. The following steps are to be carried out and optimally noted, in this sequence too, on the test sheet (see Fig. 1 “Test sheet – simple descriptive test”).

1. Assessment of the outer product appearance (colour, form, size) and the interior of the nut; note: colour charts for individual nut varieties simplify the categorising of the optical appearance/colour of the product.
2. Detailed description of the odour impression of the nut kernel from the outside and the inside.
3. For taste, all the impressions perceived should be noted.
4. As regards the texture impression, the bite, chewing process and swallowing should be evaluated.

Sensory Analysis Test Sheet	
Simple descriptive test of nut kernels <small>(in accordance with ASU L00.90-6)</small>	
Name:	
Sample number:	
Date:	
Test question: Please describe the attribute properties of the product before you in as much detail as possible.	
Appearance (colour, form)	
Odour	
Taste	
Texture (consistency, mouthfeel)	

Fig. 1: Test sheet - simple descriptive test

It is expedient to formulate appropriate specifications with all the positive and negative sensory characteristics for the product to be tested. The nut products can then be subjected regularly to sensory testing in accordance with the criteria defined in this way. General positive attributes for odour and/or taste for nut kernels are, for example, aromatic, nutty, fresh, sweet/sweetish, tart, crunchy. The various defects and negative descriptions of products can occur as a result of pest infestation of the product, due to inappropriate packing materials, incorrect storage, unusual carriage conditions etc. Furthermore, a microscopic test is a good aid for identifying defects, e.g. pest infestation. Given the high fat/oil component, a frequent sensory defect in nut products is the rancidness/rancidity that is caused via contact with air (oxygen) and light. Examination of the fat indices is to be recommended. Further negative attributes can be: colourless, off-colour, glassy, stale, old, mouldy, rancid, oily, dry, soft.

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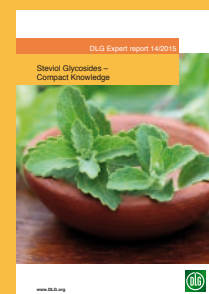
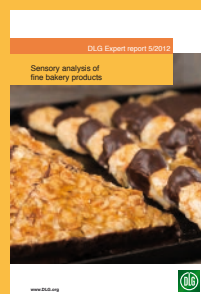
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