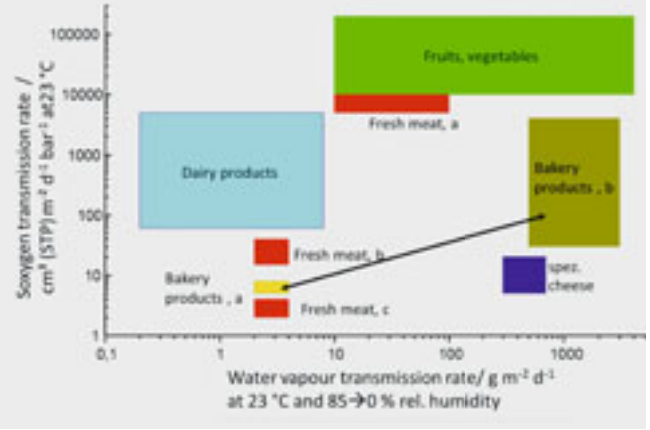
Packing under protective gas

SPECIAL PACKAGING DESIGNS ARE NEEDED FOR CAKES, BREAD AND OTHER BAKED GOODS THAT ARE PARTICULARLY SENSITIVE TO MICROBIAL SPOILAGE, OXYGEN AND LIGHT. IN THIS ARTICLE THE FRAUNHOFER IVV PRESENTS THE USE OF PROTECTIVE GAS AND OTHER OPTIONS

++ figure 1



Source: Fraunhofer IVV

++ figure 1
Oxygen and water vapour permeability requirements of packaging materials

+ Packing under a protective gas atmosphere (Modified Atmosphere Packaging, abbr. MAP) enables greater product security and a longer shelf life. However, this concept cannot fulfil the requirements regarding product protection unless other factors in the supply chain are correct: maximum product quality and manufacturing hygiene, consistent compliance with the cooling chain, and packagings whose interaction with the contents is optimally matched to the food being packed and thus provide the preconditions for a high-quality product with the longest possible minimum shelf life.

Product protection as the packaging's main task

For baked goods, product protection as the packaging's main task comprises various different aspects: moist baked goods such as fruit flan, for example, must be protected against drying out. Dry baked goods such as biscuits/cookies must be protected against moisture absorption. A corresponding water vapour barrier is needed in both cases. In addition to moisture, oxygen plays a decisive role in the case of baked goods containing fat or susceptible to microbial spoilage.

The shelf life of baked goods can be increased significantly by using MAP packagings. The minimum shelf lives achievable by MAP for various products are shown in table 1. The standard gases used as protective gases are nitrogen (N_2) and carbon dioxide (CO_2) mixed in various ratios. Reducing the headspace oxygen, i.e. the oxygen which is in the headspace of the packaging after the closure, suppresses the growth of mould fungi and the oxidation of fats. In addition carbon dioxide decreases the activity of microorganisms. The required mixing ratio depends on the food being packed: the higher the pH and water activity of the food, the greater the risk of microbial spoilage. This is why the CO_2 content is adjusted to a higher value of up to 100% for sensitive foods such as cakes, baked goods or bread, as CO_2 has a inhibitory effect on the growth of many microorganisms. However, it must be noted that an excessively high CO_2 content can also impair the sensory properties.

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Barrier requirement for packaging

The packaging must display appropriate barrier properties towards oxygen, carbon dioxide and water vapour to ensure that the protective gas atmosphere is retained. Figure 1 can be used as a guideline for an initial rough estimate to design the packaging.

The requirements regarding the permeability of packagings for baked goods shown in figure 1 can differ greatly, and can be divided into various categories:

+ Materials with high barrier requirements (= low permeability): baked goods and cakes containing fat require high barrier properties, especially to oxygen and carbon dioxide. For baked goods, high barrier requirements means O_2 permeability values of ≤ 10 $cm^3/(m^2\ d\ bar)$. Polypropylene laminates with an ethylene-vinyl alcohol copolymer (EVOH) barrier, polyamide-polyethylene laminated films or polyethylene terephthalate (PET) films with inorganic barrier layers are used to achieve these permeability values. A thin inorganic film of vacuum-evaporated aluminium around 50 nm thick provides good additional protection from light.
+ Materials with a small but nonetheless defined barrier (= defined high permeability): dry baked goods require packagings with a defined high gas permeability so as to avoid firstly mould growth and secondly drying out. Therefore Cellophane, waxed paper or polyethylene films with perforations are used as packaging materials for this product group.

Active packaging functions

Active packaging functions have come into increasing use in recent years in order to achieve an even longer shelf life and/or greater product safety/security. Promising active functions include the absorption of oxygen by so-called oxygen scavengers, the adjustment of a defined humidity by packaging

Table 1: Gas mixtures recommended for dry foods and baked goods

Product	Gas mixture	Gas volume for 100 g	Shelf life (4–6 °C) Air/MAP
Pre-baked bread	100% CO_2	50–100 cm^3	5 days/20 days
Cakes	50% CO_2 / 50% N_2	50–100 cm^3	15 days /60 days
Milk powder	100% N_2	50–100 cm^3	12 weeks/52 weeks
Peanuts	100% N_2	50–100 cm^3	12 weeks /52 weeks

Source: Linde AG, Linde Gas Division, www.linde-gas.de

materials with moisture-regulating properties, and the integration of antimicrobial substances into the packaging.

Oxygen scavengers: The first active packaging components were introduced in Japan in the nineteen seventies and were added to the packaging in the form of small sachets. These sachets consist of a permeable membrane containing an oxygen absorbent. In the simplest case the oxygen absorbent is iron powder, which rusts in the presence of oxygen and moisture. However, sachets have the disadvantage that they are unsuitable for direct contact with liquids, and are not accepted in Europe. Therefore the active material is preferably integrated into the polymer matrix of the packaging material. Up to now the main areas of application in Europe have been oxygen-sensitive beverages together with snack products, meat products or convenience foods that need heat treatment to preserve them. However, oxygen scavengers have also already been used successfully in Asia and North America for cakes or small baked goods.

Moisture-regulating packaging materials: Moisture-absorbing films containing salts as absorbers are being manufactured in an ongoing development. Many salts have the property of absorbing large amounts of water vapour spontaneously when substance-specific relative air humidity is exceeded. The water is released again when the relative air humidity falls below a substance-specific value. One possible area of application for these films is as packaging materials for baked goods with the aim of establishing a defined humidity.

Packagings with antimicrobial activity are used to prevent or suppress microbial growth on foodstuffs. In this way they prolong the shelf life and the quality of packed foods. Antimicrobial packagings have been used in Asia for around 30 years, mostly as a silver coating. However, there are increasing concerns regarding the use of nano-silver in packaging materials. An alternative to silver is ethanol, which is used as an antimicrobially active volatile vapour. Research in the area of antimicrobial packaging films is currently focusing on the development of films that have a targeted property of releasing either permitted preservatives such as sorbic acid or natural active substances, e.g. from wasabi (Japanese horseradish).

Summary

The shelf life of baked goods can be increased significantly by using protective gas. In this respect the decisive parameters are the correct gas mixture and the use of packaging materials with adequate passive barrier properties towards oxygen, carbon dioxide and water vapour. If the passive barrier properties are insufficient, active packaging functions such as oxygen scavengers, moisture-regulating packaging materials and antimicrobially active packagings offer additional product safety/security. +++