Micro-perforations for major improvements in shelf-life

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Food waste in the western world is high, with up to 40% of all fresh produce discarded. This is of concern for everybody. For companies in the value chain it is a significant cost factor, for consumers who are effectively throwing money away are effectively reducing their purchasing power and for governments it raises concerns as to how we will continue to feed the world’s population.

There is now a new system of packaging that has been developed to combat food waste that cites impressive results, maintaining optimal product quality whilst attaining longer shelf-life.

Fruit and vegetables need oxygen to stay fresh, but the respiration rate of produce varies by season, region and variety making the design of packaging material a challenge. To overcome this problem PerfoTec, a Dutch company, have designed a system whereby the respiration rate of produce is measured and used to program a laser designed to adapt packaging film permeability to precise product requirements.

The PerfoTec system of packaging that has been reported to extend shelf-life of some products up to 100% and has been reported to reduce waste by on average 50%.

Extending shelf-life is not only an attractive benefit for consumers, but it also encourages repeat purchases as more consumers have a positive experience with the product. Increases in shelf-life also improve value chain efficiency, making distribution more simply, flexible and efficient.

How it works

Respiration

Respiration is a complicated sequence of chemical reactions involving conversion of starches to sugars, and the transformation of sugars into energy. The normal respiration reaction results in the produce consuming oxygen to release carbon dioxide, water and heat. The higher the ambient temperature surrounding the product, the greater the temperature of the product and consequently the faster the rate of respiration.

This also displays the importance of the cold chain in ensuring maximum shelf-life is attained.

Different products have different rates of respiration; some respire at a faster rate (thus are more perishable), while some have a relatively slow respiration rate (less perishable). Not only that, but the respiration rate also varies seasonally and by region, even for the same product.
Fresh produce needs oxygen to stay alive. By controlling the supply of oxygen to the product, the respiration rate and thus the aging process are reduced. This extends the shelf life and slows product degradation. The oxygen concentration in the package must remain high enough to ensure that some aerobic respiration can occur, as if there is no oxygen present, anaerobic respiration will quickly spoil the produce.

**EMAP**

Equilibrium Modified Atmosphere Packaging (EMAP) is a method for prolonging the shelf life of fresh produce by optimizing the in-packging equilibrium atmosphere. This is achieved by optimally controlling the equilibrium concentration of O₂ and CO₂. In general, a relatively low concentration of O₂ and a relatively high concentration of CO₂ slow or prevent the oxidation process, which is responsible for the deterioration of the taste and flavour.

EMAP exploits the natural respiration of fresh produce for regulating the in-package atmosphere. The targeted Modified Atmosphere is an equilibrium steady state composition controlled by the modified permeability of the packaging film. The required transfer rate through the packaging film is obtained by modifying the micro-perforation pattern.

The difference between MAP and EMAP is that MAP uses inert gases to create a static atmosphere whereas EMAP merely adapts the permeability of the packaging in order to achieve the appropriate equilibrium atmosphere (see Figure 1).

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**Micro-perforation**

Produce is typically packaged in perforated materials so the product can continue to breathe postharvest. But this is not an optimal process as the type of produce packed and the permeability of the packaging material have to be attuned to each other. Three years of product development led to a machine that measures the respiration rate of produce being paired to laser that cuts the precise amount of micro-perforations in the plastic film to achieve the correct exchange of air.

Micro-perforations are tiny holes in the packaging that are invisible to the human eye. Film permeability is the critical control point for the quality and shelf life. One perforation more or less can make the difference between 1–3 days extra shelf life.

Further complicating matters is that film thickness is often variable, which can lead to variation in hole sizes. It is therefore important for the laser to automatically adjust itself to balance out any variation in film thickness. The PerfoTec laser is the only laser in the world with the ability to adjust micro-perforation with relation to film thickness with its patented closed-loop feedback camera system.

**The process**

The PerfoTec system operates as a four step process (see Figure 2).

**The products**

Fast respiration meter

Fast respiration meter is designed to measure the respiration rate of fresh produce in just four hours. This enables growers to effectively respond to seasonal variations. It measures oxygen consumption and carbon dioxide production, from this calculating the respiration rate. This information is uploaded and used to calculate required packaging transmission rate per package.
Laser perforation system
The patented laser system adapts the film permeability during packing. It is specially developed for integration with vertical or horizontal packing machines as well as film converting machines.

The laser makes consistent and precise holes and has been developed to work reliably in wet, cold and dusty conditions.

The laser can make very small holes down to 55–60 microns in diameter. Through automatic control system the laser has an integrated camera to inspect each hole. The hole is analysed for diameter and shape. For quality control purposes it is able to check the Oxygen Transmission Rate (OTR) of each pack, and automatically adjust its operation to ensure consistent micro-perforation of packaging.

Benefits of the PerfoTec system
As a producer or packer, the PerfoTec system aims to assist in better satisfying the needs of existing customers, and attract new ones. Whilst there may be apprehension that reducing waste may result in fewer sales, the reverse has been found to be true with sales increasing due to the improved quality of the products. An improved reputation for the supply of quality produce can attract new customers and gain you access to new markets. PerfoTec can also offer great benefits to exporters as greater shelf-life allows product to travel further, or give importers greater shelf-life in country, making Australian product a more feasible option in some markets.

Summary of potential benefits:
- Increase sales revenue
- Wider market reach
- Attracts new customers
- Extends the freshness of fruit and vegetables
- Improves fresh product image, increasing demand
- Reduces transportation and distribution costs
- Increases production flexibility
- Reduces waste and costs significantly.

Product performance
Table 1 displays the reported shelf-life extension possible with the PerfoTec system.

<table>
<thead>
<tr>
<th>Product</th>
<th>Extra shelf-life [days]</th>
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<tbody>
<tr>
<td>Asparagus</td>
<td>3–5</td>
</tr>
<tr>
<td>Beans</td>
<td>1–2</td>
</tr>
<tr>
<td>Broccoli</td>
<td>3–7</td>
</tr>
<tr>
<td>Carrots</td>
<td>2–4</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>2–4</td>
</tr>
<tr>
<td>Chinese cabbage</td>
<td>2–4</td>
</tr>
<tr>
<td>Herbs</td>
<td>2–4</td>
</tr>
<tr>
<td>Leek</td>
<td>2–4</td>
</tr>
<tr>
<td>Lettuce</td>
<td>1–3</td>
</tr>
<tr>
<td>Capsicum</td>
<td>2–5</td>
</tr>
<tr>
<td>Radish</td>
<td>1–2</td>
</tr>
</tbody>
</table>

Source: perfotec.com

CASE STUDY 1:
MARKS & SPENCER, UK

Marks & Spencer conducted several commercial trials with fresh grapes, raspberries and strawberries, and managed to extend the shelf life by:
- 5–7 days for grapes;
- 5–10 days for raspberries; and
- 4–8 days for strawberries.

Due to the longer shelf life, in store waste was reduced by 50%, creating major cost savings. In addition the increase in product quality resulted in significant sales growth (double digit). This has lead the company to mandate the use of the PerfoTec system for all UK suppliers of soft fruits.

MORE INFORMATION

More information can be found at perfotec.com or by contacting the Australian supply representative, Raymax Lasers:
Phone: (02) 9979 7646
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