Compensating for congested transport routes

World wide developments and trends are expected to increase the demand for high standards of transportation for perishable goods at reduced cost. Although this is a challenging task, this should be possible based on our current knowledge of food products, climate control technology and market developments.

By Helen Armstrong

Quality loss of perishable products is largely dependent on the climatic conditions during transportation. Temperature, relative humidity and gas composition are important parameters which influence the products. In addition, the products themselves influence the climatic conditions by breathing and evaporation.

At the present time, developments in climate control technology are mainly focused on hardware, with the aim of improving reliability and reducing energy consumption, and on refrigerants. Far less attention has been paid to the product and what it requires in order to maintain its optimum quality. Yet energy can be saved and quality can be maintained by adjusting climate control and by assuring that the stacking and packaging of the product are adequate.

It is also necessary to consider the relationship between transportation time and investment in expensive climatic manipulation. Sometimes it is more economically beneficial to ensure that there are no delays and to optimise speed of transportation.

"Our post-harvest research confirms that each link in the chain must function at its optimal but in practise this is rarely achieved, " said Henry Boerrigter, programme coordinator packaging agro-products at ATO, Wageningen, the Netherlands.

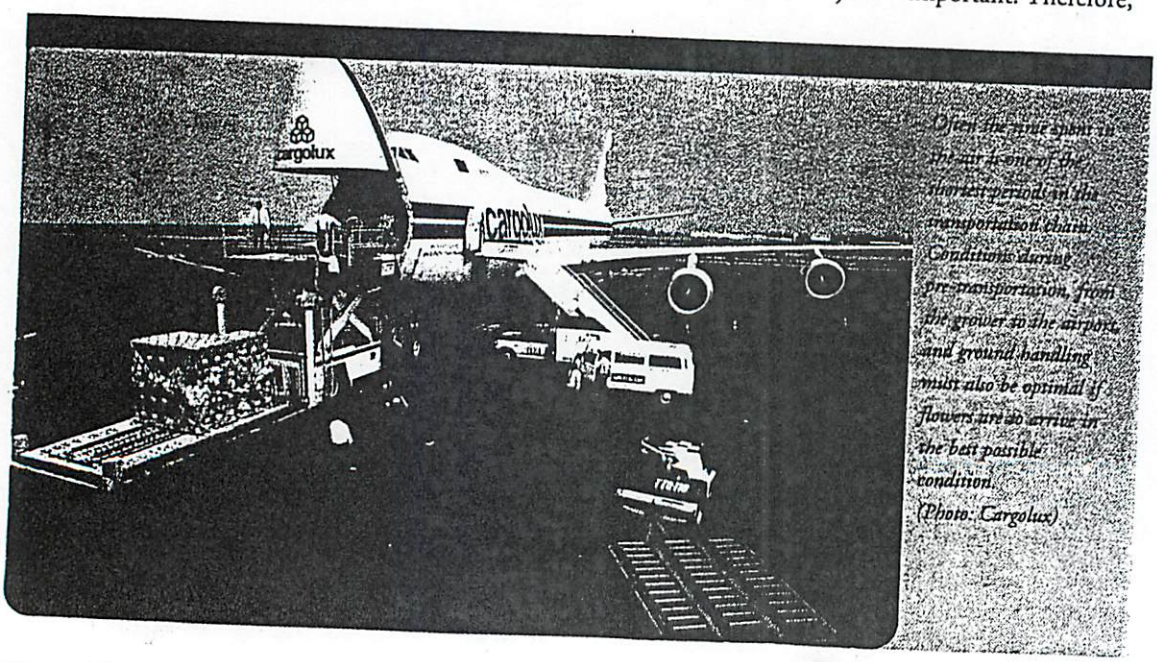
Yet, as air travel and roads become ever more congested it becomes more and more difficult to cut down on transportation time.

"Growers want to know that when their flowers arrive in another part of the world they are in the same condition as when they left," says Rebecca Mok of Cargolux, the largest European all-freight air carrier.

Often the time spent in the air is one of the shortest periods in the transportation chain. Therefore conditions during pre-transportation, from the grower to the airport, and ground handling are just as important. Therefore, the relationship between an exporter (which sometimes is the grower) and a forwarder (the agency which finds the best logistical solution for transportation) needs to be good, she says.

Good communication is very important and it is best to have as few people involved in the chain as possible.

"If flowers arrive at our air carrier at 20°C we refuse to transport them," said Ms. Mok. "Not only can they then affect other products being transported it is all too easy for growers to blame us for not transporting them correctly."

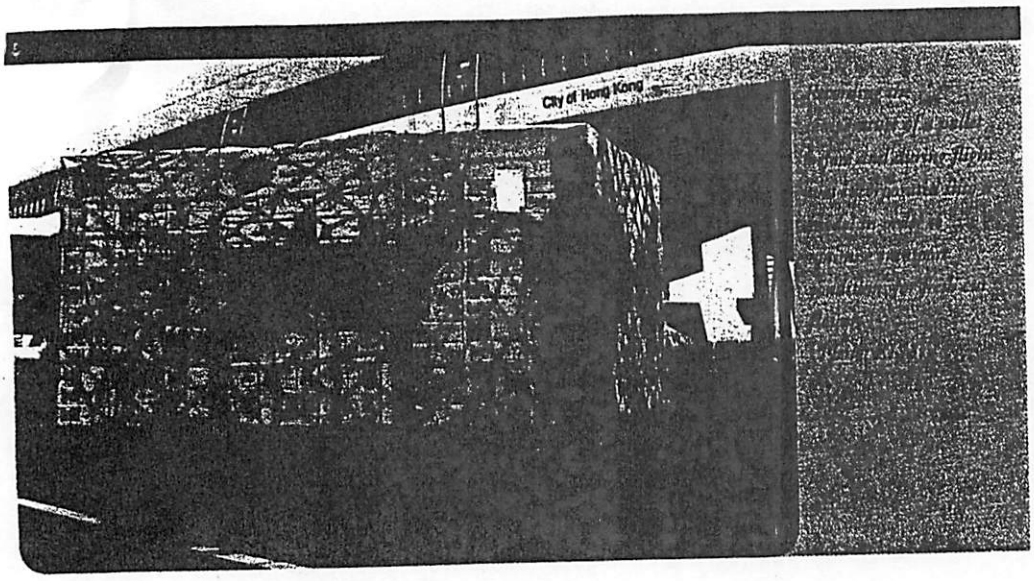


Often the time spent in the air is one of the shortest periods in the transportation chain. Conditions during pre-transportation, from the grower to the airport, and ground handling must also be optimal if flowers are to arrive in the best possible condition.
(Photo: Cargolux)

Importance of packaging

The boxes in which the flowers are shipped also play a major role in the maintenance of quality. Many growers and shippers will try and cut costs by cutting the cost of the packaging but this is a false economy, she says. If boxes aren't of a good quality and they happen to be stacked at the bottom of the pallet there is a good chance that they will be squashed and broken boxes often invite stealing, she says. "But many growers aren't aware of how a shipment is built up."

Currently the numerous types of boxes used by growers does not facilitate the stacking of a pallet or conservation of the flowers within. Yet each grower is independent and chooses a box to suit his own circumstances. With such a mixture of boxes on one pallet a vacuum chilling system is an ideal method of reducing the overall



temperature of flowers on the pallet, says Boerrigter. However, it is a sophisticated, expensive system and can cause a bottleneck because usually only one pallet can be treated at a time. Only a handful are in operation around the world.

"This is a practical way of getting the heat out of the flower but it is necessary to consider if the costs involved make it worthwhile," he said.

In the future, pressure by retailers could bring more uniformity into packaging ultimately resulting in a modular system which could facilitate other methods of cooling. But the most optimum and practical method should be considered.

"If the distribution area is not too great, just a few hundred kilometres, time can be kept short so providing that the temperature is under control other factors such as relative humidity and condensation are then less important," said Boerrigter.

Product response

Controlled Atmosphere technology has been around for many years but there has been limited knowledge on how this should be applied to various products and cultivars. Usually the product environment is set at a pre-determined level. However, it is expected that in future climate control will be directly related to the direct needs of the product. There are several ways of doing so.

At ATO, in Wageningen, the Netherlands, which has extensive, sophisticated laboratory testing facilities, there have been two research projects in this area.

The first is referred to as DCS: Dynamic Control System. The idea is to control the climatic conditions within the packaging based on the response of the product. For example the system measures the amount of heat, water, ethylene or alcohol produced and then alters climatic conditions accordingly.

The second area is MPC: Model-based Predictive Control. The idea is to translate knowledge of how a product reacts and how a climate control system operates into mathematical models so that it is possible to predict the quality development of the product under certain controlled circumstances.

Based on the DCS research, a product specific box has been developed for the transportation of flowers or fruit and vegetables, which is dependent on the product inside. The box is fairly airtight such that the initial gas concentrations are modified by the respiration of the flowers. Oxygen decreases while carbon dioxide, water vapour and ethylene levels increase. It was discovered that the level of these gases subsequently stabilised at values which preserve the condition of the flower. This is optimum when the temperature is about 4°C but the principle still works at higher temperatures. The quality of the product will be less but this is still better than if the product was in a conventional box (see *Figure 1*). The conditions which build up in the box preserve the flowers.

"On opening the box the flowers are effectively "woken-up". They then opened well and there were no negative aspects," said Boerrigter.

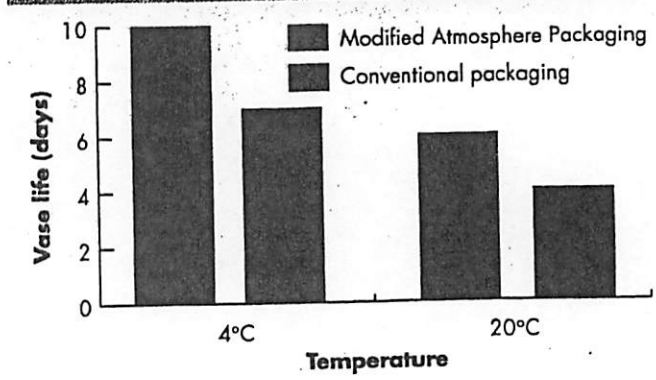
"In fact the incidence of botrytis was less than normal which was very surprising because the relative humidity in this packaging was higher because the water was unable to escape."

This system is most applicable when the situation is sub-optimal or if the transportation period needs to be extended, he said. It could provide an option of sending flowers by boat which is a much cheaper means of transportation.

However, more trials need to be made on different flowers because not only could growing conditions affect the response, biological variation between cultivars is also expected to play a role.

This type of packaging could also be applicable to individual bunches of flowers since the system can delay the onset of aging and therefore can extend vase–life. It can also be used on pot plants where it has been shown to decrease bud drop.

Figure 1. Modified Atmosphere Packaging allows an improvement in vase life. Its relative contribution to quality is greater when climatic conditions are poor but this can never the exceed the effect of controlled temperature conditions.



The boxes are now being marketed by Kappa Packaging of the Netherlands.

Model for in-flight climate control

The Model-Based Predictive Control (MPC) research has been incorporated into a model currently used by the air carrier KLM-cargo. The model was devised based on measurements of temperature and humidity throughout the transportation period. It can now be used to predict the temperature-time relationship from acceptance to delivery and how this will affect quality.

Initial research was focused on the thermodynamic behaviour of the cut flowers which was then coupled to a model based on the thermodynamic properties of the packaging.

Transport is divided into several phases the most important of which are the platform phase, during which the flowers stand at the airport, often for about one hour waiting to be loaded, and the flight phase.

The model was tested by measuring the temperature development within a pallet during transportation from the Flower Auction Aalsmeer, the Netherlands to New York on a day in May. It took about 30 minutes to stack the pallet and another 30 minutes to deliver the flowers to Schipol airport. It took about two hours 30 minutes before the pallet was loaded and flight time was approximately eight hours.

Actual measurements closely followed the prediction made by the model:

There was a rise in temperature at the top and sides of the pallet during the platform phase when often a plastic cover is thrown over the pallet to protect it from the elements, followed by a decrease in temperature during flight although the temperature at the centre of the pallet remained relatively constant.

At Aalsmeer the temperature of the box was about 21°C although the box had to be opened to position the sensors so the air temperature was equal to surrounding air temperature. The temperature of the chilled cut flowers was expected to be lower although the flowers had been transported to the airport in a truck without cooling facilities.

During the first two hours the air temperature fell as it was cooled by the cut flowers although there was a noticeable difference between the locations in the pallet: the heat decrease was substantially less at the top of the pallet compared to the bottom due to heat penetrating from the top and sides.

During flight the temperature at the top and sides of the pallet decreased as the temperature of the air in the hold ranged from about 2 to 13°C, being particularly cool close to the walls of the plane. Thus at the top and sides of the pallet there is a decrease in temperature while in the middle the temperature rises due to respiration by the flowers. Thus cooling at the sides of the pallet is not enough to prevent a temperature rise in the middle. Therefore it is important to ensure that the temperature in the middle of the pallet is sufficiently low before flight. If the temperature of the centre of the pallet is already low, the respiration rate will also be lower. Then the temperature rise will be less so only a small cooling effect is necessary to prevent any temperature increase.

The advantage of the model is that it can be coupled to time tables and it can be used to judge the merits of investment in such items as cold storage facilities. ■

Controlled Atmosphere 2001

For the first time, the international Controlled Atmosphere conference, held every four years, will be held in Europe. Until now, since its inauguration in 1968, it has been held in the USA.

The program is being organised by ATO, Wageningen, the Netherlands and the conference will be held in Rotterdam, one of Europe's Cultural Cities for 2001, from 8 to 13 July.

ATO has long been involved in post harvest research of perishable products from the point of harvest to the consumer.

While much of the conference is devoted to fruit and vegetables, papers concerning flowers will also be presented.

"This is an ideal chance for the flower industry to see the newest controlled atmosphere technologies available because these are already much further advanced in the fruit and vegetable industry," said conference chairman, Koos Oosterhaven.

Controlled atmosphere techniques can maintain a given quality during transportation ensuring that consumers all over the world receive the desired product.

"Today, flowers are mostly transported long distances by plane but this is very expensive and costs a lot of energy. In the future this may not be environmentally acceptable. This conference will give an insight into the alternatives available," said Oosterhaven.

Also, as the use of crop protection agents around the world diminishes CA technology can be used to replace these chemicals, helping to prevent wastage: It is estimated that post harvest losses of fresh fruit and vegetables amounts to 30% which is a tremendous waste of time, labour and money.

In addition to the main oral presentations, over 200 posters have been accepted and alongside the conference will be a small trade show.

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