

Important considerations for application of wax on citrus and other fruit

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Wax treatment of fruit, in particular citrus is an important part of ensuring postharvest quality maintenance during export. The main function of such packing wax is to prevent excessive moisture loss, although it also contributes to the aesthetic value of the fruit and may even serve as a carrier for the application of protective postharvest chemicals. As with all the fungicides and sanitisers used during preparation for export, application of packing wax requires precision. In this respect, it is not only the line equipment that needs careful attention, although that is an imperative, but also the handling of the fruit and maintenance of the emulsion.

The water-based packing wax formulations used in citrus are specialised and refined, containing emulsifiers, plasticisers, drying agents, and the solid content. Importantly, the solid content is the only variable in the product that contributes to the eventual fruit quality. The percentage used by a packhouse is usually decided through consideration of the fruit kind, fruit ripeness, and export market requirements.

Everything in a packing wax emulsion is always present in carefully formulated ratios, in order for each component to function as intended, with the emulsifier being the most complex. In properly maintained and applied packing wax the emulsifiers will interact with the natural fruit wax, effectively emulsifying that into the applied packing wax, forming a homogenous film (Figure 1).

The importance of careful management of packing wax is illustrated with the following example: When a specific formulation is opted for, e.g. 18% carnauba wax, it means that in every litre of that emulsion, there is 180 g of the solid. At an average application rate of 1 L/T, this would mean that 180 g of the solid is applied to 3 125 oranges (at an average mass of 320 g) or up to 6 666 pieces of soft citrus (at an average mass of 150 g), to a total thickness varying between 2 – 5 µm. Packing wax is formulated to deliver the solid as a precise coating, and to form the previously mentioned film at this point, becoming a protective layer that minimises moisture loss while imbuing the desirable gloss. The newly formed film is also somewhat flexible due to the plasticisers in the formulation, which allow it to withstand slight deformation when the fruit is packed and shipped.

Excellent film formation is only possible with meticulous management of the packing wax formulation by the packhouse. Not only is careful attention to application required, but minimising loss of volatiles, keeping the emulsion homogenous, and not diluting the product during application is imperative. Keeping the packing wax closed once a drum is opened for use is non-negotiable to prevent loss of volatiles. Similarly, slow and continuous stirring is very important, particularly when fungicides are added to the wax.

Less conspicuous, yet exceptionally technical, is the serious issue of wax application on wet fruit. Expanding on the earlier maths on how many pieces of fruit we cover, the amount of wax on an orange of 320 g will be 0,32 mL. An average, single water drop has a volume of about 0,1 mL. Wet fruit can carry as much as 0,3 mL of water. With these volumes in mind, it now becomes easy to see how the dilution factor works against the packing wax. Although the emulsion is water-based, and therefore quite miscible in any free water present on the fruit surface, the ratio of the functional constituents in the formulation is ruined. This implies that the film formation that is needed for optimal protection during export will be impeded. Somewhat paradoxically, *slightly* damp fruit does assist in even spreading of the applied wax.

What does excessive free water on the fruit surface do to packing wax? To answer this question, the constituency of the packing wax emulsion and how it interacts with the fruit wax must be considered. Diluted packing wax cannot fulfil the requirement for emulsification of the natural fruit wax, resulting in a film that is inconsistent, often incomplete, and brittle as the ratio of the plasticisers are also disrupted by free water.

The scanning electron micrographs below clearly illustrate a perfectly formed film consisting of emulsified packing and natural wax (Figure 1), as well as an incomplete film, with the packing wax and epicuticular fruit wax clearly distinguishable (Figure 2).

Packing wax is formulated using strictly controlled components, as it is considered a food additive. This means that the options available to formulators are limited. The volatiles in the packing wax usually serve a dual purpose: they assist in the drying process, and contribute to the emulsification of the natural wax. Loss of volatiles from the packing wax before actual application is detrimental in terms of film integrity as well as the drying of the packing wax. Quite often, persistent tackiness after wax application is due to premature loss of volatiles. However, when fruit is too wet, the volatiles are lost with the water, without congealing the solid contents. The overall result is also tacky fruit that take very long to dry completely, soiling the line, clinging to each other, and breaking off where the fruit touches other surfaces. The same effect happens due to over-zealous drying processes, when volatiles are lost too rapidly. However, this is not the only issue with incorrect drying: too high temperatures also result in tackiness, because the solids are degraded without setting as an intact film.

Another important point is that negligence of the brushes used in the application of packing wax is ruinous. The bristles will become too stiff, with hardened, coarse ends. Such bristles inflict microscopic and larger wounds, which can become the focus from where

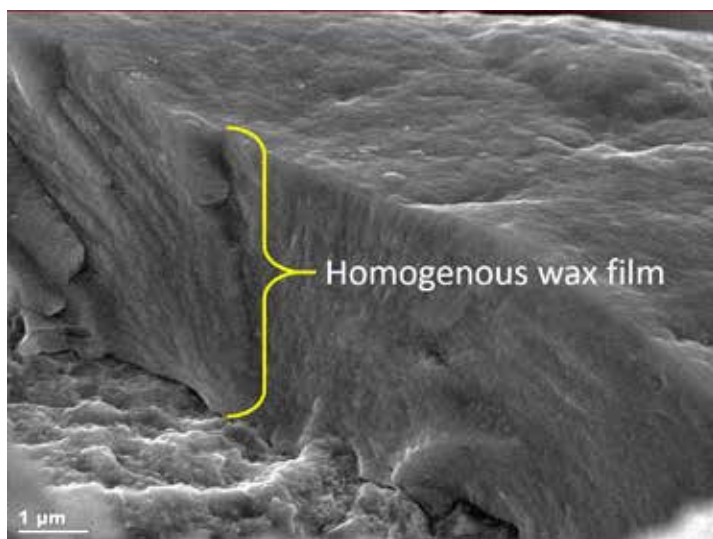


Fig. 1. Perfect wax film constituted by emulsification of the packing wax and natural wax.

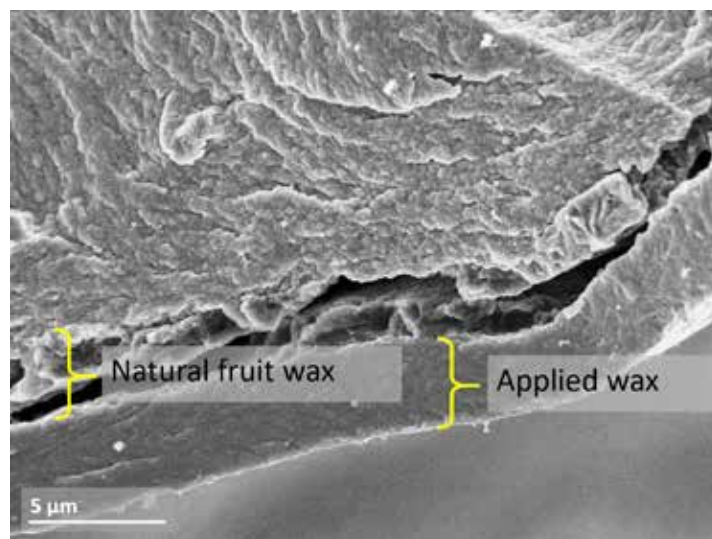


Fig. 2. Poorly formed film, with natural wax and packing wax readily distinguishable.

the film will shatter, apart from the obvious infection risk.

Lastly, wax application has a very particular role to play in the imminent cold sterilisation export protocols. A heavier wax – i.e. higher solids content – will afford some additional protection against rind damage during the export period. The addition of thiabendazole may also contribute, however, this will have to be considered against the MRL requirements of the market, specifically the number of MRLs being used. Somewhat contrary to the benefits of the denser wax, exporters need to pay careful attention to the humidity in the containers. As temperature management is already strictly controlled, this should not be an issue during export. However, once the containers reach the destination markets, the very low temperature of the fruit pulp will lead to excessive condensation on the rind. This can potentially cause disintegration of the film, and subsequent powdering may take place.

In conclusion, packing wax is an expensive remedy against moisture loss, apart from any additional benefits. The maintenance thereof should be a financial incentive, and can be summarised in the following few points:

1. Equipment maintenance

- a. Applicator, including the nozzles and counter must be clean and free of concretion.
- b. Brushes used in the unit cleaned daily – keep a second / swop-out set at the ready and wash daily using warm water and approved food grade soap

2. Formulation maintenance

- a. Correct level of application – follow label rigorously
- b. Application to dry fruit – spreading of the film improves on *slightly* damp fruit, never wet
- c. Drying process management – not too hot, or too long.

3. Humidity management

- a. Create awareness, and put preventative measures in place to curb excessive condensation on very cold fruit.

OPSOMMING

Die gebruik van na-oes verpakkingswas by sitrus is 'n belangrike deel van vrugkwaliteitsbestuur tydens uitvoer. Die hoofsaaklike funksie van hierdie was is om oormatige vogverlies te bekamp, alhoewel dit ook 'n estetiese waarde het en selfs as draer vir beskermende na-oes chemikalieë mag dien. Soos met die aanwending van al die swamdoders en saniteermiddels wat gebruik word ter voorbereiding van uitvoer, vereis die aanwending van verpakkingswas presisie. In hierdie verband is dit nie net die lyntoerusting wat noukeurige aandag verg nie (alhoewel dit ook 'n kritiese punt is), maar ook die bestuur en aanwending van die emulsie.

Opsommingsgewys moet die onderhoud en bestuur van verpakkingswas 'n finansiële standpunt wees en is hieronder opgesom:

1. Onderhoud van toerusting

- a. Aanwender, wat die spuitkoppies en die tellingseenheid insluit moet skoon en vry van aanpaksels wees.
- b. Aanwendingseenheid Borsels se borsels in die aanwendingseenheid moet daaglik skoongemaak word – hou 'n tweede / uitrail stel gereed en was daaglik met warm, goedgekeurde voedselgraad seepoplossing.

2. Onderhoud van die formulasie

- a. Korrekte aanwendingsvlakke – volg die etiket noukeurig.
- b. Aanwending op droë vrugte -filmverspeiding verbeter as die vrugte *effens* klam is, nooit nat.
- c. Bestuur van die droogproses – nie te warm of te lank nie.

3. Humiditeitsbestuur – met spesifieke verwysing na koue sterilisasie uitvoerprotokolle

- a. Skep bewustheid en tref voldoende maatreëls om kondensasie op yskoue vrugte te voorkom, aangesien dit die film sal laat disintegreer en lei tot verpoëring.