

INTERPRETATION OF AVOCADO QUALITY AND CONDITION IN THE MARKETING CONTEXT

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OPSOMMING

Die Suid-Afrikaanse Avokado bedryf is afhanklik van Europese markte wat 10 000 km ver is. Lugvrug is duur en die meeste vrugte word dus per spoor en houerbote vervoer. Hierdie reis is lank en baie faktore kan die kwaliteit en kondisie benadeel.

Die volgende 5 groepe speel elk 'n kritieke rol wat die kwaliteit en kondisie van ons avokados op die markte bepaal: Die produsent, plukker, verpakker, vervoerkontraakteur en die agent. Dit is belangrik dat slegs droë, volwasse vrugte gepluk en verpak word en dat verkoeling so gou moontlik sal begin en dat hierdie verkoelingsketting tot op die bemarkingsstadium tydens elke fase volgehou word. Behoorlike beplanning is nodig om vrugte so vars as moontlik te bemark en tydsbewustheid deur alle stadiums is uiters belangrik. Die tydltemperatuur verhouding is die belangrikste faktore wat bemarkingskwaliteit en kondisie bepaal en verlenging van opbergingsperiode verhoog die persentasie bederf. Sagte vrugte word as die grootste enkele bemarkings probleem beskou.

Sellofaan en Tag waks kan die raklewe van avokados verleng met die voorbehoud dat toediening en beheer van 'n hoe gehalte is.

SUMMARY

The South African Avocado industry is dependent on the European markets which are 10 000 km away. Airfreight is expensive and the bulk of the fruit is transported by rail and container vessels. The journey is long and many factors can influence fruit quality and condition adversely. The following 5 groups each play a vital role in avocado quality and condition namely: The producer, picker, packer, transporter and the agent. It is important to pick and pack dry mature fruit and initiate the cold chain as soon as possible and maintain temperature control through all stages to the market. Proper planning to get fruit as fresh as possible to the markets and a time consciousness through all stages is necessary. The time/temperature relationship is the most important factor determining fruit quality and condition and lengthening of storage period increases the percentage decay. Soft arrivals are the most serious factor which leads to low prices on overseas markets.

Cellophane and Tag wax can extend shelf life on condition that application is up to standard and properly supervised.

1. INTRODUCTION

South Africa is unique in the world in the sense that we produce avocados more than 10 000 km from our main markets of the UK and Europe.

This distance from the markets forces us to handle fruit differently from any other avocado industry in the world. Our fruits are subjected to an abnormally long storage period which has been responsible for many disappointments and financial losses due to poor quality or condition of avocados on arrival.

Soft avocados on arrival constitutes the major problem to the industry and a soft avocado is regarded as a second-grade fruit in France.

With the expected future increase of Israeli avocado production from 1982 onwards, the marketing of California Hass in Europe, the development of Spain as an avocado export country, the first exports of avocados from Mexico to Europe and also exports from Florida, South African avocados will have to be sold in a competitive market contrary to traditional marketing in which our fruits were the only fruits available. To meet this challenge we will have to market fruit of good quality and condition.

2. INTERPRETATION OF POST HARVEST RESULTS

To evaluate the importance of a single factor on the condition and quality of avocados, one has to see it against the background of the long storage period and the existing transport systems of which airfreight is not considered, for obvious reasons. Fruit quality will deteriorate with longer storage time. Any factor that lengthens storage or ripening time will thus have a negative effect on fruit quality. The quality and condition of the avocado at greengrocer or supermarket level will be dependent on 5 groups namely:-

1. The producer
2. The picker
3. The packer
4. The transporter
5. The agent

2.1 The Producer

2.1.1 *Stress Conditions*

The avocado fruit acts as a reservoir for moisture and when the rate of transpiration exceeds the tempo of water uptake, water is withdrawn from the fruit. Fruit under moisture stress ripens faster than turgid fruit and this factor was over emphasized during the dry winter of 1979 during which period more than 1 000 000 cartons of avocados (A. Betts personal communication) arrived soft in the UK and France. Proper controlled irrigation is very important to the avocado which regains its turgor within 3 days (Lahav personal communication) after irrigation and regains its normal storage potential.

Stress conditions are also caused by *Phytophthora cinnamomi* which kills the feeder roots. There are various ways to combat *Phytophthora* and by minimizing the cause of root rot, fruit of potentially higher quality will be produced.

2.1.2 Pre-harvest control of fruit disease

By effectively controlling *Cercospora* fruit spot, a measure of postharvest disease control is achieved as shown in the following table. (Westfalia unpublished results.)

	DISEASE RATING 0–10	
	Anthracnose	Stem end Browning
Unsprayed control	0,85	0,32
Benomyl	0,30	0,18

The producer can thus at least contribute to minimizing his post-harvest disease problems (which he normally never sees) by controlling *Cercospora* fruit spot prior to harvest.

2.2 The Picker

2.2.1 Limit the time between picking and pre-cooling.

2.2.1.1 Lead Discolouration

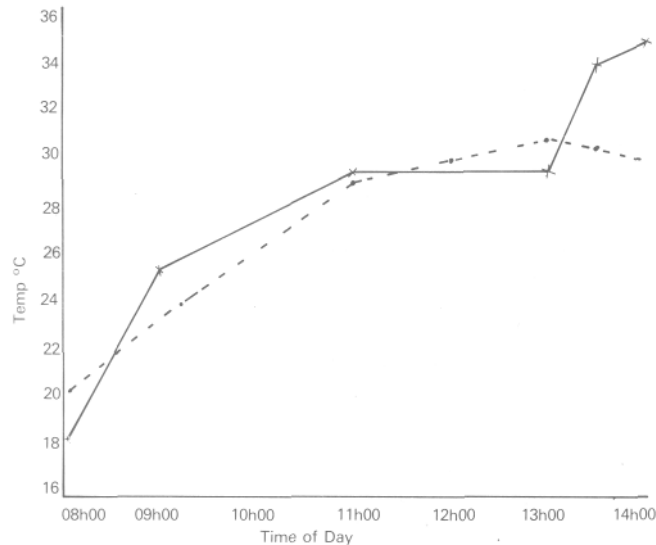
Delayed cooling of avocados leads to an increase in lead discolouration. This is shown in results by DH Swarts (1979)

Time between — Picking and Cooling	% Lead Discolouration
25 Minutes	10
19 Hours	13,4
24 Hours	25,0
37 Hours	35,9

2.2.1.2 Effect of delayed cooling on ripening

The avocado does not ripen on the tree and the ripening process starts only after the fruit is picked. Ripening or softening of the fruit is the result of an enzymatic breakdown of the cell walls (E. Pesis, Y. Fuchs, and Zauberman 1978). This process can be slowed down but is irreversible.

2.2.1.3 *The Fruit temperature in response to day temperatures (Slabbert and Toerien 1979)*



GRAPH 1: Fruit Temperature

2.2.1.4 The effect of fruit temperature on fruit activity

The avocado is a very active fruit which generates much energy during respiration. This is illustrated by the following graph drawn from data of Lutz and Harden burg (1968).

It is thus important that the picker should be temperature conscious and aware of the importance of temperature control.

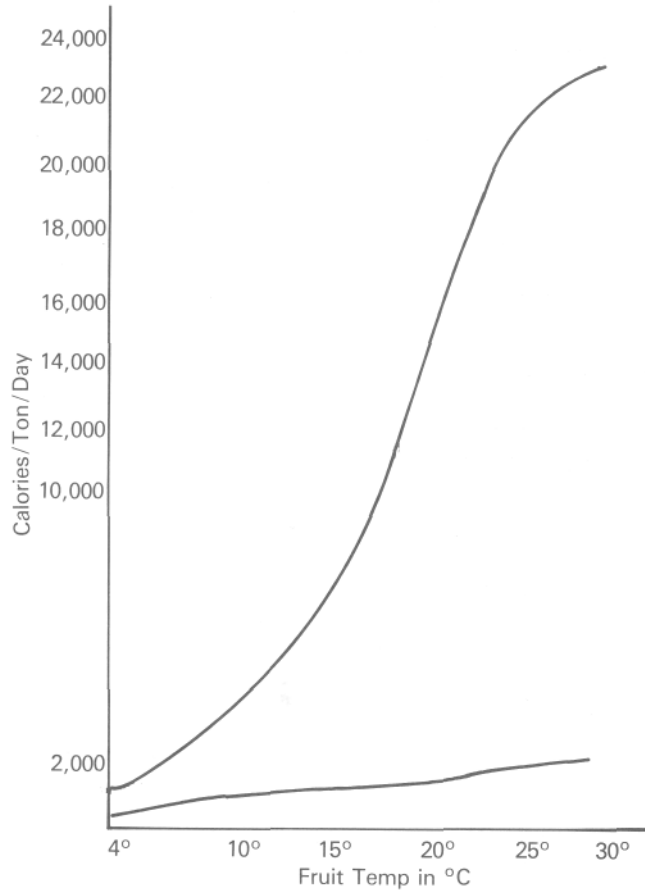
At Westfalia we have adopted a system of getting fruit to precooling within 2 hours after picking.

2.2.2 Selective Picking

By determining stage of maturity at regular intervals picking can be planned so as to pick mature fruit selectively. Considerations are fruit size, cultivar, aspect and position on the tree. By picking selectively, mature fruit is taken off continuously by which method the picking season can be lengthened and the risk of over-matured fruit minimized. This is a basic integral part of exporting avocados with the minimum risk.

2.2.3 Avoiding Wet Fruit

Wet avocados leads to an increased post-harvest decay problem. Much more *Anthraco*, stem end rot, vascular browning and *Dothiorella* develops on fruit that was picked with dew or rain. The following results illustrate the effect of packing wet fruit (Darvas unpublished).



GRAPH 2: Respiration Energy

0 to 10 Rating Scale (No disease symptoms = 0)

	March	June
Dry Fruit	2,11	0,14
Wet Fruit	6,47	1,15

2.2.4 Summary of Picking

The picker can contribute to better fruit quality and condition by selective picking of dry avocados which should be delivered to the pre-cooling store as soon as possible after picking.

Contrarily, by unselective picking and picking of wet fruit and delayed deliveries to the pre-cooling store, the picker contributes to poor quality fruit in poor condition on our export markets and by doing so affects the market adversely for himself and other exporters.

3. THE PACKER

Packing of avocados has become specialized and capital intensive. Poor quality fruit in poor condition on the overseas markets has done the South African avocado industry much harm over many years. If the packhouse receives fresh well-grown and picked avocados, effective packing must be done to ensure good quality and condition on the markets.

The method of effective packing include the following very important aspects.

3.1 Limited time from tree to market.

3.2 Controlled pre-cooling.

3.3 Cellophane) and/or combinations

3.4 Waxing)

3.5 Efficient, rapid cooling and maintenance of travelling temperature.

3.6 Controlled Atmosphere (for future research).

3.1 Limited Time from Tree to Market

The avocado has a limited shell life and by increasing the storage period too much, post-harvest problems increase.

The physiological deterioration can be illustrated by results from Mr D.H. Swarts (1979).

Storage Period	% Lead Discolouration
2 Weeks	0
3	0
4	3,3
5	4,5
6	26,1
7	22,7
8	45,2

Our results confirm these findings and in many cases are even more dramatic, particularly when fruit is stored for more than 30 days.

Longer storage time also increases the disease factor dramatically especially Anthracnose, Dothiorella and stem-end rot and vascular browning.

Proper planning of picking, packing, rail age and sailing schedules can reduce unnecessary storage time provided that the packhouse has sufficient capacity to ensure fast efficient handling of the fruit.

3.2 Effective Pre-cooling

Avocado fruits are very active and generate much heat — see graph 2. This heat

generation starts within 48 hours after picking. It is thus essential that avocados must be at 5,5°C within 48 hours after picking.

Fruit temperatures of up to 36°C can be measured on hot days in avocado orchards.

Pre-cooling can be done very effectively as there are no restricting layers of packing material. Fruit should be in the precooling store within 2 hours after picking. Avoid condensation by proper temperature control and by taking ambient temperature and relative humidity into account.

3.3 Cellophane Wrapping

In local trials I regard the untreated fruit as a basis but keeping in mind that under commercial consignments it would result in poor condition fruit.

Specification Cellophane qms 345 grade 1 is selectively permeable to CO₂ and O₂ and as result of respiration there is a build-up of CO₂ and a lowering of O₂ concentration which therefore slows down the tempo of respiration.

The advantages of cellophane

- 1). The fruit looks attractive and makes the pack firm and therefore decreases the degree of mechanical injury.
- 2). The shelf-life of the avocado is extended by up to 1 day in local trials. Commercial shipments of nude fruit tended to arrive soft compared to harder fruit when cellophane is used.
- 3). Cellophane isolates individual fruits from one another. It therefore effectively reduces the fruit-to-fruit spread of pathogenic fungi like *Rhizopus*, *Colletotrichum* and *Botryodiplodia* fruit rot within the carton.
- 4). Cellophane reduces the incidence and degree of cold damage. The local experimental results have been confirmed by experience of commercial shipments to the UK and France over a number of years.

Disadvantages of cellophane

- 1). Under local experimental conditions, cellophane increases post-harvest diseases such as anthracnose, *Dothiorella* fruit rot and stem end rot.
- 2). Cellophane is expensive.
- 3). Packing tempo is reduced with cellophane which means a higher capital investment to pack a given volume of fruit per day.
- 4). Cellophane is a restricting factor in ventilation of avocados during storage. Up to 7°C difference of fruit temperature can be found in a pallet.

3.4 Waxing of Avocados

Tag wax has been tested and used commercially for 7 years. All references to wax means Tag wax and no opinion is expressed with regard to the effect of any other type of wax on avocados in general.

All the results of waxing on avocados are from mechanical brush-roller application and not dipping.

Commercially wax is applied at 0,6ℓ/Ton of avocados in the early season and increased to 1ℓ/Ton towards the middle and end of the season.

Advantage of waxed avocados

3.4.1) Waxed avocados look superior to unwaxed fruit.

3.4.2) Waxed avocados have an extended shelf-life of up to 2Vi days over unwaxed fruit.

Commercially wax enables fruit to arrive firm on oversease markets compared to the tendency of unwaxed avocados to arrive in a soft condition.

3.4.3) Waxing of avocados is cheap — less than 2c/Cartron. *Disadvantages*

- 1). Waxing of avocados needs proper equipment and proper supervision which may be a problem for inadequately equipped packhouses where supervision is not of a high standard.
- 2). Extension of shelf life leads to more post-harvest decay. Improper application such as dipping of avocados will lead to a commercial loss to the grower.

Combination of wax and cellophane

Westfalia have been using Tag Wax and cellophane in combination commercially for 5 years and have exported more than 2 million cartons during this period. Many trials have been done and we feel that it is to our advantage to use the combination. Experiments under commercial conditions show that in waxed fruit with cellophane:-

- 1). Avocados normally reach the market in a hard condition.
- 2). The avocados ripen within a week.
- 3). The wax + cellophane fruit shows less cold damage than nude fruit.
- 4). Our agents prefer the combination of wax plus cellophane and this opinion has been built up over many years with many experimental cartons and commercial consignments.
- 5). We are convinced that we get a financial advantage by using wax + cellophane.

Experimental Results (Darvas, J.M. Unpublished)

Waxing:- of wet vs. dry avocados and a comparison of dipping vs. roller-brush application.

Dipping Application of Wax

<i>Wet Fruit</i>	<i>Total Decay</i>	<i>Ripening time in days after 28 days storage</i>
Wax-dipped	6,86	8,0
Control	2,71	6,9
<i>Dry Fruit</i>		
Wax-dipped	3,10	—
Control	2,49	—

Mechanical Roller-Brush Application of Wax

<i>Wet Fruit</i>	<i>Total Decay</i>	<i>Ripening time in days after 28 days storage</i>
Waxed by Roller-Brush	3,11	8,0
Control	1,33	4,7
<i>Dry Fruit</i>		
Roller-Brush waxed + Cellophane	0,86	10,7
No Wax + Cellophane	0,80	8,1
Roller-Brush waxed — Nude	0,47	10,1
Untreated — Nude	0,31	7,5

Wrapping of Wet Fruit in Cellophane vs. Dry Fruit

Wet fruit Cellophane	3,38	—
Wet fruit Nude	2,43	—
Dry fruit Cellophane	1,20	7,0
Dry fruit Nude	0,77	6,4

Summary

Discussion of Experimental Results vs. Commercial Reality

Nude Control

Looking at the untreated Control in local experiments it could be reasoned that these fruits have the least post-harvest problems at ripening and have 5 to 6 days before ripening which is ideal for our export requirements.

The heavy losses of commercial consignments over many years by most producers and exporters have shown that untreated nude avocados do not reach our markets in a satisfactory condition.

Cellophane

Unwaxed avocados wrapped in cellophane also have a poor commercial record over many years. Many consignments arrived soft.

Waxed Nude

Waxed nude avocados do not ripen as fast as the untreated nude avocados under commercial conditions but have the disadvantage of being subjected to cold damage. Large trials confirmed this during the 1980 season.

Combination

Commercial results over many years by a number of producers and exporters show that this combination of wax and cellophane at least has the potential of permitting fruit to reach the markets in a hard condition with ripening in 5 to 6 days which is ideal, and equivalent to the untreated control under local ideal conditions.

3.5 Effective Cooling

3.5.1 Fruit temperature during packing

During the packing process individual avocados are exposed to ambient temperatures and fruit temperatures rise fast. During this phase the pre-cooling initiative can be lost. There are two alternatives.

A) Faster packing

The following table gives an indication of time needed to fill a pallet of 200 cartons with a packing tempo of 6 000 cartons per day. (Slabbert & Toerien 1979).

Count	Hours to fill a pallet					
	10	12	14	16	18	20
Average time	9,8	6,3	9,1	6,2	9,3	7,9
Minimum time	1,7	1,1	2,0	2,0	3,0	3,0
Maximum time	37,5	21,8	27,0	17,0	21,5	19,0

These differences in packing time cause delayed cooling and can explain why certain counts can arrive soft on the markets. Faster packing will further decrease exposure time.

B) Temperature controlled packing area

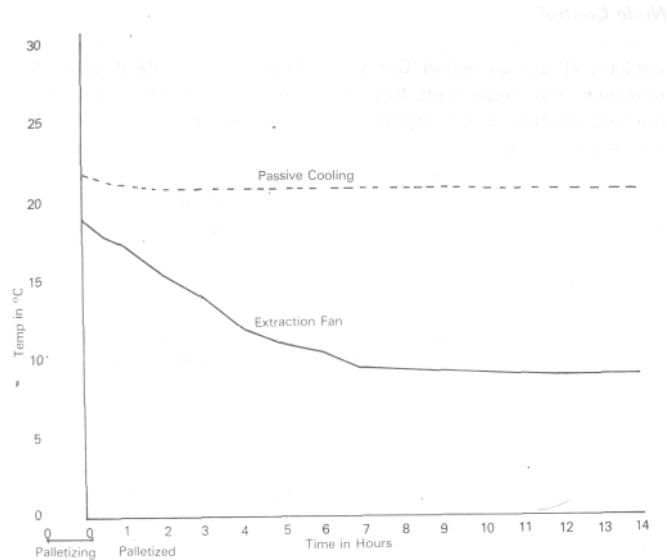
This is more practical than a faster packing tempo and the following should be considered.

3.5.1 (B.1) Use bulk bins which can be kept under refrigeration after sizing.

(B.2) Packing in a temperature controlled area.

3.5.2 *Temperature control during Palletisation*

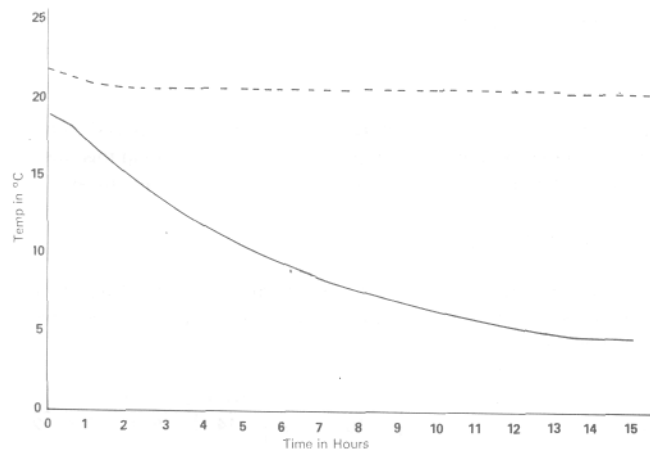
With reference to the time that it takes to stack a pallet, forced draught cooling should be used. Passive cooling is relatively ineffective as shown in graph 3 whereas the FORCED DRAUGHT is very effective. (Slabbert & Toerien 1979.)



GRAPH 3: Extraction Fan

3.5.3 *Temperature control of stacked pallets*

In a pallet, air movement is restricted and cooling takes place at a very ' slow tempo under passive cooling. A system like the extraction fan speeds up the cooling process as shown in graph 4 (Slabbert & Toerien 1979).



GRAPH 4: Forced Draught

3.5.4 Correct storage temperature

Early season Fuerte avocados are more sensitive than more mature, mid or late-season fruit.

The following table gives an indication of fruit sensitivity to low temperatures.

Cold damage at different storage temperatures (DH Swarts 1979).

	15 Days	28 Days	34 Days
3,3°C	12,5	66,0	82,0
4,4°C	3,6	16,0	43,3
5,6°C	0,0	10,2	20,0
6,7°C	0,0	1,9	1,9
7,6°C	0,0	0,0	0,0

Selecting the optimal temperature at a given time should be based on fruit maturity.

4. THE TRANSPORTER

The avocado is in the hands of a transporting agent for 21 out of the 28 days taken from tree to the market. Their role in the condition and quality of avocados is therefore vital. Maintaining the cold chain as close to optimum and attaining it in the minimum time have improved over the past years.

4.1 Packhouse to Harbour

Although some road transport is used, the bulk of the avocados are transported by rail and will continue to do so in the future.

After initial poor temperature control and a very slow journey to Cape Town up to the year 1976, the SAR & H speeded up their service by 6 or even 8 days down to a very satisfactory 3 days. Ryan recorders showed unfavorable high and low temperatures up to 1976 as well, and this has been improved by more control and better cooling equipment on control systems since then.

Today we have an excellent service for avocado transport to the harbor apart from a period during 1980 where there was confusion about delivery and return air temperatures.

4.2 Storage, Containerization and Loading

At present this period represents 2 days prior to arrival of container vessels plus the day of loading. Although there are real practical problems in shortening this period, it is still our ideal to shorten the time involved.

Containerization at the packhouse could be an alternative. This possibility should continuously be investigated and discussed with PPECB, SAR & H and container companies as well as Safmarine.

4.3 Cape Town to UK and Europe

Containerization with the new container-vessels has improved loading and offloading and temperature control much beyond the potential of the old mail boat service. The present 14 days sailing time could be reduced to 12 days, for which they are designed. This will only be achieved when the total demand exceeds the present carrying capacity which we hope will happen soon (and also depending on the price of oil).

4.4 Other Commodities

With Ethylene gas build-up by many other commodities, it is essential that avocados are not brought into contact with these fruits or vegetables. Many of the avocados from the old mail boats showed similar symptoms as avocados that have been exposed to ethylene.

Fortunately this situation has been favourable for a number of years now which indicates that the transport system is relatively free from ethylene contamination risks.

5. AGENT

As link to the end user, the agent has a vital role to play. An understanding of the avocado and its behavior can help him to make the correct commercial decisions. By the time the ship docks in South Hampton, the avocado could be 23 to 28 days old. Off-loading and transport could take up to 2 to 3 days and to France another day can be added.

5.1 Ageing of Avocados

One must accept that the South African avocado has a limited storage life and time consciousness is essential. The off-loading procedures have improved over the years and much effort goes into this operation.

Market conditions and fruit condition determine how fast, at what price and where avocados are sold. Depressed markets could lead to larger storage periods which will definitely result in poor quality and condition fruit being sold eventually.

5.2 Storage of Avocados

Avocados should be stored on their own without any accompanying crops and prolonged storage with example Golden Delicious apples can result in up to 70% internal discolouration.

It could be that fruit that was in good condition and quality on arrival be ruined unintentionally by the agent during storage. Temperatures during the European summer is high and it is important that the cold chain is maintained.

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