



# Packaging of organic products in PLA – and other films

Confidential

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Report 934

22509413



## Colophon

Title	Packaging of organic products in PLA- and other films
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AFSG number	Report 934
ISBN-number	
Date of publication	June 2008
Confidentiality	Yes
OPD code	
Approved by	Herman Peppelenbos

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## **Abstract**

Bell peppers were flowpacked in different films and tomatoes on the vine were packed in different combinations of bowls and films. The effects of the type of packaging on a number of quality parameters were tested.

No type of package was found having a positive effect on all quality parameters. Films that showed firmer fruits sometimes showed more stemrot (bell peppers) or more fungal infection and fruit fall (tomatoes on the vine). The results do not indicate that bell peppers or tomatoes on the vine, packed in PLA film, have a longer shelf life than when packed in other types of packaging tested.

The sugarcane bowl for tomatoes on the vine has an attractive appearance and is easy to handle.

# Content

<b>Abstract</b>	<b>3</b>
<b>1 Introduction</b>	<b>5</b>
<b>2 Methods</b>	<b>6</b>
2.1 Types of packaging	6
2.2 Distribution chain	6
2.3 Quality inspection	6
<b>3 Results</b>	<b>7</b>
3.1 Bell peppers	7
3.1.1 Colour	7
3.1.2 Firmness	7
3.1.3 Shrivelling of the skin	8
3.1.4 Stemrot and fungal infection on calyx	9
3.2 Tomatoes on the vine	9
3.2.1 Colour	9
3.2.2 Firmness	10
3.2.3 Green parts	11
3.2.4 Fruit fall	11
3.2.5 Handling and appearance of the packaging	11
<b>4 Conclusions</b>	<b>12</b>
4.1 Bell peppers	12
4.2 Tomatoes on the vine	12
<b>Appendices</b>	<b>13</b>
Appendix 1. Packaging types for bell peppers	13
Appendix 2. Packaging types for tomatoes on the vine	15
Appendix 3. Quality parameters and scaling of bell peppers	17
Appendix 4. Quality parameters and scaling of tomatoes on the vine	18

## **1 Introduction**

Eosta B.V. in Waddinxveen (The Netherlands) has the impression that bell peppers and tomatoes on the vine, packed in PLA film have a longer shelf life than when packed in OPP film.

If this statement can be founded by a neutral research institute like A&F, this is an important sales argument and it will be a tool, when engaged in negotiations with customers.

This report describes the experimental design and the results of an experiment, carried out by A&F in cooperation with Eosta B.V.

Eosta B.V. has selected producers of bell peppers and tomatoes on the vine and the film types and bowl types for the experiment.

## 2 Methods

### 2.1 Types of packaging

For bell peppers as well as tomatoes on the vine different types of packaging were tested. The types of packaging for bell peppers were OPP, PLA, Natureflex, Sidaplex and A&F film. As a reference bell peppers were kept unpacked in the same conditions. Each package contained 3 bell peppers (so called “traffic light”: a green-, yellow- and red bell pepper in a package). Bell peppers were obtained from two growers. Each grower delivered green-, yellow- and red bell peppers. Per type of packaging 10 “traffic lights” were flowpacked per grower; in the A&F film 20 “traffic lights” per grower were flowpacked.

Tomatoes on the vine were packed in a PET bowl in OPP film, a PLA bowl in PLA film, a sugarcane bowl in Natureflex film and a sugarcane bowl in A&F film. As a reference tomatoes on the vine were packed in a PET bowl without film. Each package contained 500 grams of tomatoes on the vine. Tomatoes on the vine were obtained from two growers. Per type of packaging 10 units of 500 grams were flowpacked per grower. Pictures of all types of packaging are presented in Appendices 1 and 2.

The products were flowpacked by Eosta B.V. The flow packed products were placed in open plastic trays. Extra products for immediate quality inspection and for packaging in the A&F film were packed in cardboard boxes. Trays and boxes were transported by van from Eosta B.V. to A&F in about 1 hour after packaging. A&F flowpacked the products in the A&F film and these packages were also placed in open trays.

### 2.2 Distribution chain

The bell peppers and the tomatoes on the vine were exposed to a transport simulation based on an Edeka distribution chain. This chain was:

From Eosta to DC:	24 hours at 13°C / 70% RH
From DC to store:	24 hours at 13°C / 70% RH
48 hours on the shelf:	48 hours at 17°C / 70% RH

### 2.3 Quality inspection

The quality of the products was inspected three times:

- At arrival at AFSG: inspection of unpacked products from two growers
- After transport simulation; all products were unpacked and inspected; after inspection the products were stored in open trays in a shelf life room (18°C / 75% RH)
- After 4 days in the shelf life room

The quality parameters for bell peppers were colour, firmness, shrivelling, stemrot and fruitrot and for tomatoes on the vine colour, firmness, condition and colour of the stem and calices, fungi on fruits, fungi on stem and calices and fruit fall. The quality parameters and the scalings are presented in Appendices 3 and 4.

### 3 Results

#### 3.1 Bell peppers

##### 3.1.1 Colour

All green bell peppers were completely green at the start and after 4 days of distribution simulation. After 4 more days at 18°C a few green bell peppers showed some red colouration.

All red bell peppers were completely red during the whole experiment.

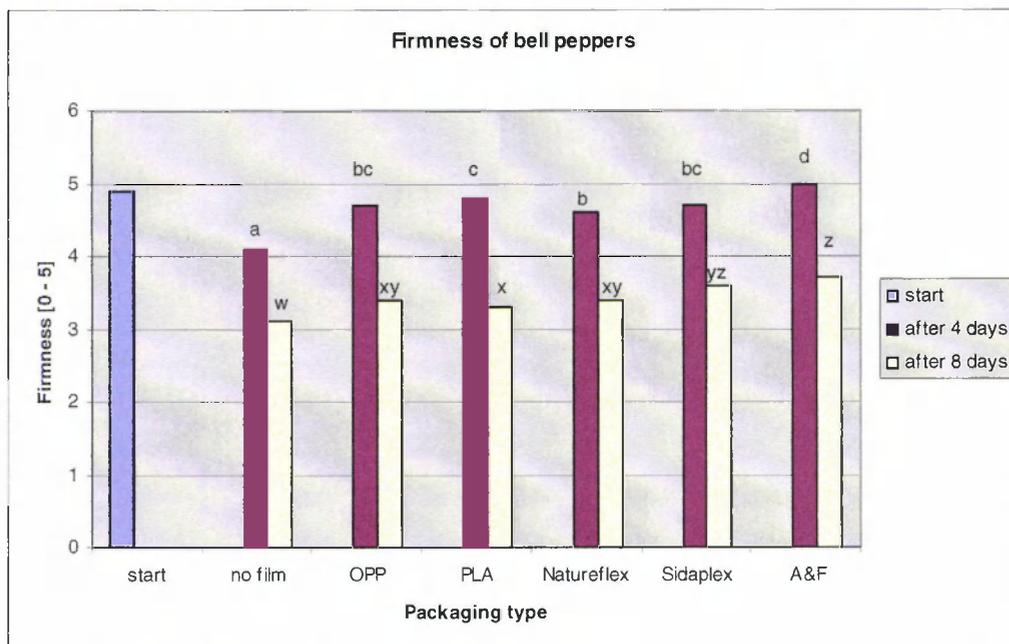
The yellow bell peppers were partly green at the start and the yellow part turned to orange here and there (table 1). At the start of the experiment the yellow bell peppers from grower A were greener than the ones from grower B. After 8 days no difference between the growers was found anymore. Colouring was not influenced by the type of packaging.

**Table 1. Colouring of yellow bell peppers (percentage of surface)**

Grower	start			After 4 days			After 8 days		
	green	yellow	orange	green	yellow	orange	green	yellow	orange
A	21	74	5	9	88	3	1	96	3
B	8	88	4	4	94	2	1	96	3

##### 3.1.2 Firmness

Figure 1 shows the firmness of the bell peppers at the start of the experiment, after the simulation (4 days) and after 4 more days at 18°C (after 8 days).



**Figure 1. Average firmness of green -, yellow – and red bell peppers at the start of the experiment and after 4 and 8 days. There is no statistical difference when data have one or more the same characters.**

Firmness after 4 days:

- All films had a positive effect on firmness of green, red and yellow bell peppers
- The firmest red and yellow bell peppers had been packed in A&F film
- PLA film showed firmer red and yellow bell peppers than Natureflex, there was no difference between PLA, OPP and Sidaplex.

Firmness after 8 days:

- All films had a positive effect on firmness
- A&F film gave better results than the other films, except Sidaplex
- No difference was found between OPP, PLA and Natureflex
- There were some small differences between the colours

Green bell peppers were firmer than the yellow and red ones after 4 and 8 days.

### 3.1.3 Shrivelling of the skin

After 4 days only a few bell peppers showed skin shrivelling. After 8 days the shrivelling was more clear. Figure 2 shows skin shrivelling after 8 days.

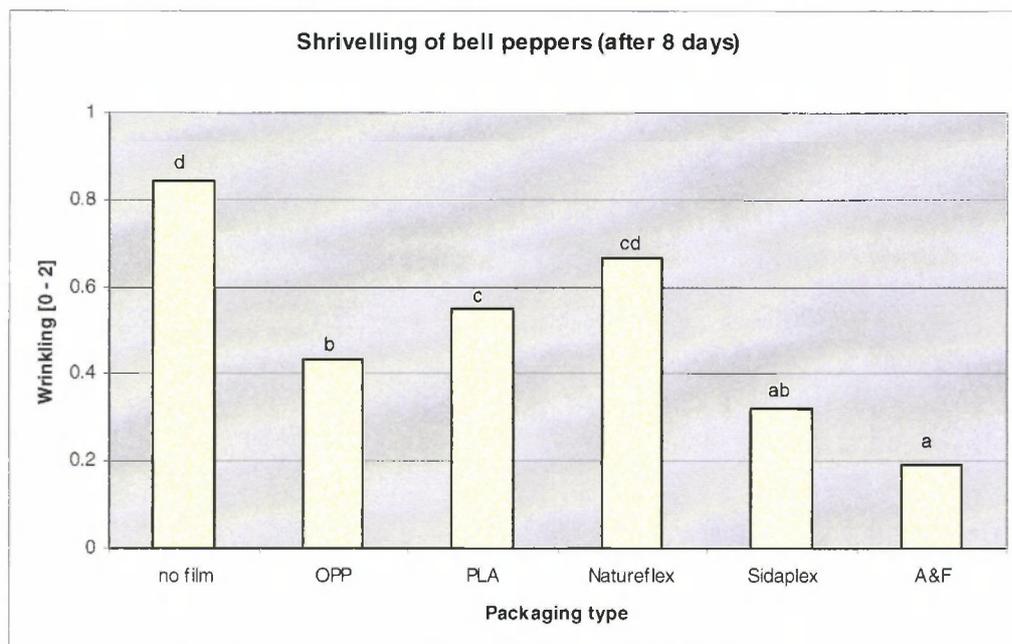


Figure 2. Average shrivelling of green -, yellow - and red bell peppers at the start of the experiment and after 4 and 8 days. There is no statistical difference when data have one or more the same characters.

Figure 2 shows that:

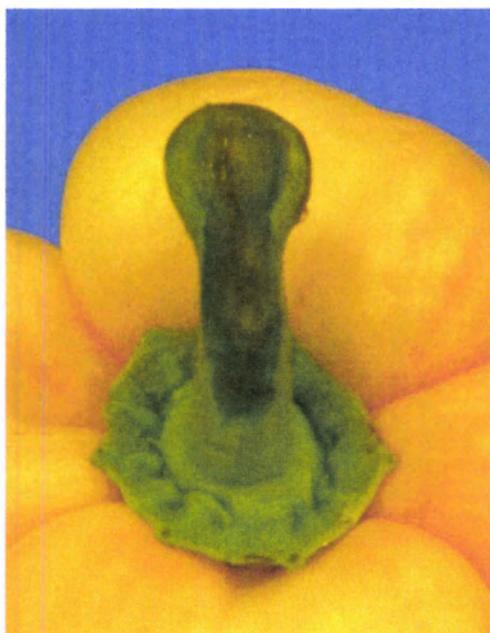
- Bell peppers from all films except Natureflex showed less shrivelling than the unpacked bell peppers.
- A&F film gave better results than all other films, except Sidaplex

- Bell peppers from PLA film showed more skin shrivelling than bell peppers from all films except Natureflex

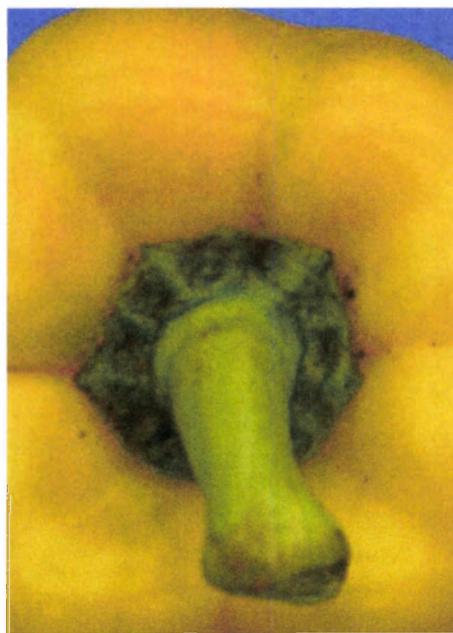
Green bell peppers showed very little skin shrivelling, and no differences between the types of packaging.

#### 3.1.4 *Stemrot and fungal infection on calyx*

After 4 days some bell peppers showed “wet” stem rot (picture 1), after 8 days in most cases this stemrot had become dry. Bell peppers packed in A&F film showed more stemrot than the bell peppers from the other types of packaging. The packed bell peppers had no more stem rot than the unpacked reference (except the ones packed in A&F film). Some yellow and red bell peppers showed a fungal infection on the calyx (picture 2). This was not due to the type of film.



Picture 1 Stemrot (wet)



Picture 2 Fungal infection on calyx

## 3.2 Tomatoes on the vine

### 3.2.1 *Colour*

Table 2 shows the percentage of tomatoes with an orange red or dark red colour, without green or greenish parts. There was only a little difference between growers A and B. Some statistically differences between packages were found, but because macro – or micro perforations in the films could not affect the atmospheric composition, it is assumed that the colour differences were caused by differences in ripeness at the start of the experiment.

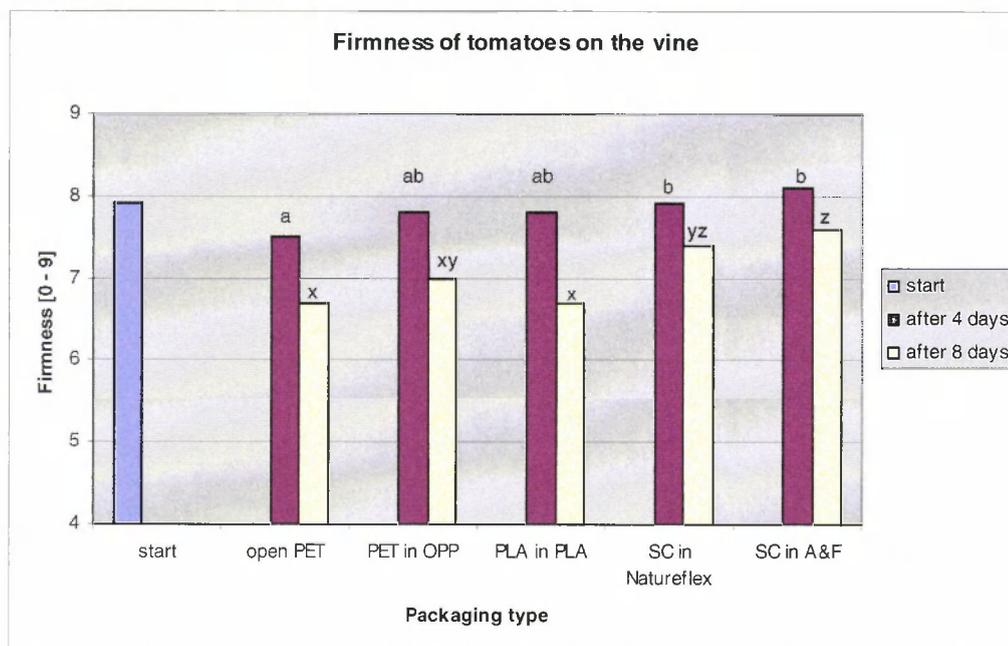
**Table 2. Percentage of orange-red, red and dark red tomatoes on the vine**

Grower	start	After 4 days	After 8 days
A	54	82	96
B	60	86	98

Table 2 shows that after 8 days almost all tomatoes were at least orange red.

### 3.2.2 Firmness

Figure 3 shows the firmness of the tomatoes on the vine at the start of the experiment, after the simulation (4 days) and after 4 more days at 18°C (after 8 days).



**Figure 3. Average firmness of tomatoes on the vine at the start of the experiment and after 4 and 8 days. There is no statistical difference when data have one or more the same characters.**

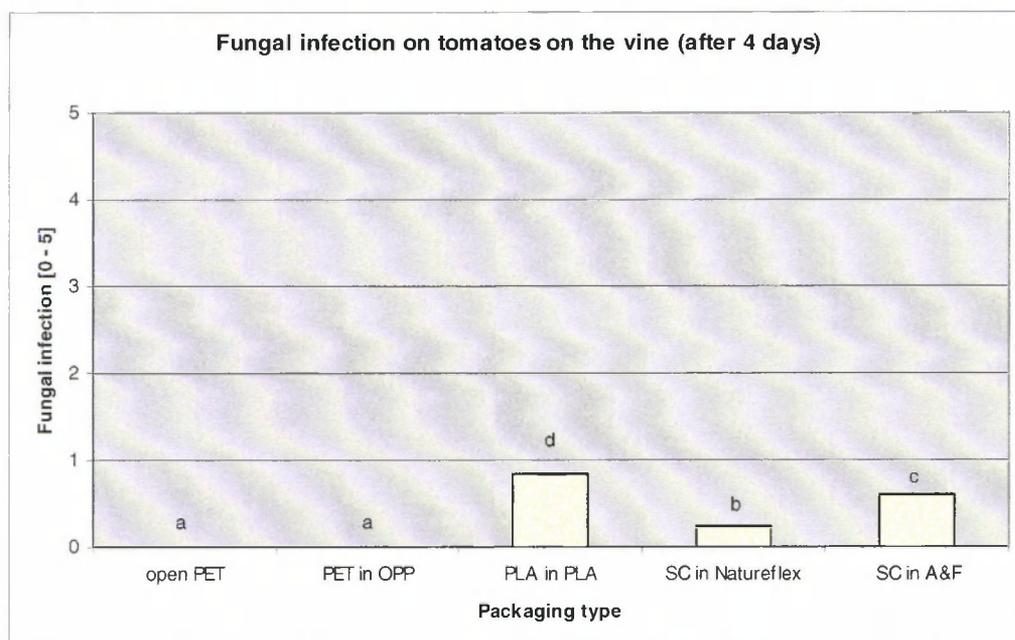
Figure 3 shows that:

- After 4 days:
  - The differences between the types of packaging were very small
  - The fruits in sugarcane bowls in Natureflex or A&F film were “statistically” firmer than the fruits in the PET bowl without film
- After 8 days:
  - The fruits in sugarcane bowls in Natureflex or A&F film were firmer than the fruits in the PET bowl without film and the fruits in the PLA bowl in PLA film

After 4 as well as 8 days the differences between PLA and the other films were only noticed in the fruits of grower A.

### 3.2.3 Green parts

The condition of the green parts (stem and calices) did not show differences due to the type of packaging. The condition of the green parts was not very good. The fungal infection on the green parts is shown in figure 4. Fungal infection is most clear after unpacking. Therefore figure 4 shows the fungal infection after 4 days.



**Figure 4. Fungal infection on the green parts of tomatoes on the vine after 4 days. There is no statistical difference when data have one or more the same characters.**

The green parts from the reference and the PET bowl in OPP film showed no fungal infection at all. Although the fungal infection was not serious (< 1 on a 0 – 5 scale), the other types of packaging, “PLA in PLA” in particular” and “SC in A&F” showed some fungal infection.

### 3.2.4 Fruit fall

Most fruit fall occurred in the sugarcane bowl in A&F film.

### 3.2.5 Handling and appearance of the packaging

The tomatoes in the PET – and PLA bowls are more or less jammed in the bowls; at removal from the bowls the tomatoes have to be forced, which is a disadvantage of this type of packaging. The green sugarcane bowls have two advantages: removal of the tomatoes from the bowls is possible without forcing and the appearance of the bowls is very attractive.

## 4 Conclusions

### 4.1 Bell peppers

- All types of film had a positive effect on firmness and shrivelling, even if the bell peppers were unpacked during shelf life, which was the case in this experiment
- A&F film was better than PLA, OPP and Natureflex concerning firmness and shrivelling, but bell peppers from the A&F film showed more stemrot than the ones from the other films
- Sidaplex had a better – or at least an equal effect on the quality parameters compared with OPP, PLA and Natureflex.

### 4.2 Tomatoes on the vine

- The A&F film has an advantage (firm fruits) and two disadvantages (fungal infection and fruit fall). Therefore the A&F film is not recommended for packaging of tomatoes on the vine.
- The differences between the other types of packaging are too small to base a recommendation on for one or more type of packaging.
- The sugarcane bowl has an attractive appearance and is easy to handle.

## Appendices

### Appendix 1. Packaging types for bell peppers



OPP film



PLA film



Natureflex



Sidaplex



A&F film

## Appendix 2. Packaging types for tomatoes on the vine



PET bowl (Reference)



PET bowl in OPP film



PLA bowl in PLA film



Sugarcane bowl in Natureflex film



Sugarcane bowl in A&F film

### Appendix 3. Quality parameters and scaling of bell peppers

Colour: Colour in % of surface

Firmness:

- 5 = very firm
- 4 = firm
- 3 = rather soft
- 2 = soft
- 1 = very soft

Shrivelling

- 0 = no shrivelling
- 1 = some shrivelling
- 2 = clear shrivelling

Stem rot:

- 0 = no stem rot
- 1 = up to 25% of stem length rotten
- 2 = 25 – 50% of stem length rotten
- 3 = 50 – 75% of stem length rotten
- 4 = 75 – 100% of stem length rotten
- 5 = 75 – 100% of stem length + (part of) calyx rotten

Fruit rot: Rotten surface in %

#### Appendix 4. Quality parameters and scaling of tomatoes on the vine

Colour: Pictures 1 – 11:

9 = orange red

10 = red

11 = dark red

Firmness:

9 = very firm (like a stone)

8 = very firm

7 = firm

6 = rather soft (sufficient)

5 = rather soft (insufficient)

4 = soft

3 = very soft

Condition of green parts (stem + calyx):

5 = very green and turgescient

4 = green and turgescient

3 = moderate green and turgescient

2 = rather dry (sufficient)

1 = dry, insufficient

0 = totally dry

Fungal infection of green parts (stem + calyx):

0 = no fungal infection]

1 = minimal fungal infection

2 = some fungal infection

3 = clear fungal infection

4 = severe fungal infection

5 = totally covered with fungi