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Shelf Life Testing Cauliflower

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SHELF LIFE TESTING OF CAULIFLOWERS

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Abstract

Cauliflowers are delicate vegetables which need careful handling to minimise damage to the curd surface. Breakdown of the curd post harvest can be particularly rapid at certain times of the year and can lead to rejection of cauliflowers by the multiples.

Trials during 1987 and 1988 have investigated the effect of different harvest/cooling regimes, together with different film overwraps, on curd breakdown.

In 1988, trials were carried out on three occasions during August and September. Treatments applied were:

a) Harvest/cooling regime

   a. Harvest early in the morning, pre-pack on arrival at the packhouse, cool to 3°C.

   b. Harvest late in the day, cool to 3°C on arrival at the packhouse and overwrap the following day.

b) Film types

   PVC, perforated PVC, Grace SM60, SM250, polythene bags, no wrap.

The cauliflower were grown and packed under commercial conditions and assessed over four days shelf life at Luddington EHS.

Deterioration of curd was manifest in two ways. Drying out of the surface led to a browning and later blackening of the florets. Although unattractive, damage did not penetrate further than the curd surface. In contrast the development of wet rots penetrated deeper into the curd tissues.

Trials in 1988 confirmed results from the previous year that film type strongly influenced the type of curd breakdown. Films with low vapour permeability, resulted in a high proportion of wet rots, whilst treatments with a high weight loss developed very dry areas on the curd surface.

Similarly the difference between the harvest/cooling regimes was confirmed. Cauliflowers harvested later in the day and overwrapped the following morning developed less wet rots. In addition butt quality was also enhanced.

The harvesting system and film type can be chosen to minimise the deleterous effects of curd breakdown post harvest. The root of the problem remains that of physical damage to the curd during harvesting and packing operations. Further work is required to still further improve systems for handling cauliflowers.

Objective

To investigate the effect of various harvest/cooling regimes, together with different film wraps, on curd breakdown and to gain a better understanding of the causes.

Introduction

The cauliflower curd is a delicate structure which damages easily if subjected to rough handling. The use of field rigs has reduced damage during the harvesting operation but it still occurs during pre-packing.

The bacteria Erwinia carotovora and Pseudomonas spp. are commonly found in association with the crop and invade plant tissue through wounds on the cauliflower curds. Infection begins as small, yellow/black water-soaked specks in the florets, and as decay progresses the florets become increasingly discoloured and water-soaked. Infection probably follows bruising in handling and packing.

At certain times during July, August and September, curd breakdown in the post harvest period is particularly rapid and can lead to rejection of the cauliflowers by the multiples.

In 1987 results indicated that any damage caused during the harvesting, handling and pre-packing operations increased the incidence of curd breakdown. Where the film overwrap exerted pressure on the curd surface, these areas were also prone to breakdown.

In addition, the type of film overwrap and the relative permeability to water vapour influenced the type of breakdown which developed. Wet rots were more prevalent under less permeable films.

Finally curd breakdown appeared highest in cauliflowers harvested early in the day and pre-packed immediately, whilst those harvested later in the day and pre-packed after 24 hours delay showed least decay.

In 1988 therefore work was undertaken to confirm these observations and to further study a typical commercial handling system to highlight the stages which potentially cause the greatest problems.

Materials and methods

The cauliflowers were grown, harvested and packed under commercial conditions in Lincolnshire. After packing, the cauliflowers were kept in a holding store and then transported overnight to Birmingham market. They were then collected and transported to Luddington EHS and assessed over a four day shelf life at 20°C and 50 per cent RH.

Treatments

Harvest/cooling regimes

1. Harvest early in the morning, pre-pack on arrival at the packhouse then cool to 3°C.
2. Harvest late in the day, cool to 3°C on arrival at the packhouse and overwrap the following day.

Overwraps

1. PVC
2. Perforated PVC
3. SM60
4. SM250
5. Polythene bag (Maxivent)

On the 3rd trial (harvested 30 August) the SM60 wrap was replaced by an unwrapped treatment.

Harvest dates

Trial 1 : 9 August

Trial 2 : 16 August

Trial 3 : 30 August

Assessments

The cauliflowers were assessed upon entry into the shelf life room and subsequently after 24, 48, 72 and 96 hours. Quality characteristics of disease (including wet rots and dry blackened areas), butt condition and yellowing of the curd were assessed on a 9-0 score, where 9 = excellent and 6 = just unmarketable. To provide an indication of the types of disease symptoms present, these were also categorised into the percentage of wet rots and the percentage of dry symptoms. These percentages do not give any indication of amount of disease present but indicate simply the types of rots which were developing. A summary of weather conditions preceding harvest is given in Appendix I.

Statistical analysis

Three replicates of each treatment (eight heads per plot) were laid out in a randomised block design in the shelf life room. Statistical analysis has been undertaken by Mr A Mead at IHR Wellesbourne, using analysis of variance for quality scores. The percentage figures for disease were angularly transformed for improved accuracy. Transformed figures are presented in brackets. Weights during shelf life were subjected to analysis of co-variance using weight at 0 hours as the co-variate. Weight losses have been calculated from these adjusted weights.

Results and Discussion

Commercially grown cauliflowers, harvested during August, were used for the trials since this marketing period can produce the worse post harvest problems.

The first trial was harvested after a very wet, warm but overcast spell (Appendix I). Differences between the overwrap materials were very evident. SM250 and the Maxivent polythene bags lost more moisture than the other treatments, whilst SM60 lost significantly less (Table 1).

After 24, 48 and 96 hours the early harvested regime suffered significantly higher weight loss than the late harvested treatments. This difference was not significant after 72 hours although the trend was apparent.

Table 1 Percentage weight loss after 72 hours shelf life. 1st trial

Overwrap	Harvest early prepack immed.	Harvest late prepack next day	Mean
PVC	2.18	2.00	2.09
Perf. PVC	2.19	1.90	2.05
SM60	1.76	1.73	1.74
SM250	4.20	3.65	3.93
Polythene bag	2.62	3.32	3.47
Mean	2.79	2.52	

SED (between overwrap means)	0.126*** (17 df)
SED (between harvest/cooling regimes)	0.146 ns
SED (other comparisons)	0.201 ns

Weight loss did not appear to significantly affect the total amount of disease which developed (Table 2).

Table 2 Disease score (9-0 scale) after 72 hours shelf life. 1st trial

Overwrap	Harvest early prepack immed.	Harvest late prepack next day	Mean
PVC	7.43	7.07	7.25
Perf. PVC	7.27	7.20	7.23
SM60	7.37	7.53	7.45
SM250	7.33	7.07	7.20
Polythene bag	7.60	7.37	7.48
Mean	7.40	7.25	

SED (between overwrap means)	0.152 ns
SED (between harvest/cooling regimes)	0.096 ns
SED (other comparisons)	0.215 ns

However if the type of disease expression is analysed it would appear that in general the early harvested and immediately pre-packed heads developed more of the wet rots and fungal decay whilst later, harvested heads with the delay in overwrapping, developed more 'dry' symptoms (Tables 3 and 4). This may prove relevant since areas of 'dryness' are probably less detrimental to quality than equal sized areas of wet rot.

The delay between harvest and overwrapping permits surface drying of the cauliflower curd and seems to reduce the risk of fungal and bacterial breakdown.

Table 3 Percentage of 'wet' rots after 72 hours shelf life. 1st trial

Overwrap	Harvest early prepack immed.	Harvest late prepack next day	Mean
PVC	83 (65.9)	52 (46.0)	68 (55.9)
Perf. PVC	45 (42.1)	47 (43.1)	46 (42.6)
SM60	78 (62.2)	22 (27.6)	50 (44.9)
SM250	47 (42.9)	38 (38.10	43 (40.5)
Polythene bag	85 (67.2)	22 (27.9)	54 (47.6)
Mean	68 (56.1)	36 (36.5)	

SED (between overwrap means)	3.91** (18 df)
SED (between harvest/cooling regimes)	2.48*** (18 df)
SED (other comparisons)	5.53*** (18 df)

Table 4 Percentage of 'dry' symptoms after 72 hours shelf life. 1st trial

Overwrap	Harvest early prepack immed.	Harvest late prepack next day	Mean
PVC	13 (20.8)	48 (44.0)	31 (32.4)
Perf. PVC	47 (43.1)	46 (42.7)	47 (42.9)
SM60	14 (22.0)	78 (62.4)	46 (42.2)
SM250	49 (44.8)	54 (47.3)	52 (46.0)
Polythene bag	15 (22.8)	70 (56.8)	43 (39.8)
Mean	28 (30.7)	59 (50.6)	

SED (between overwrap means)	4.84 ns
SED (between harvest/cooling regime)	3.08 *** (18 df)
SED (other comparisons)	6.85 ** (18 df)

There were several significant interactions between the overwrap material and harvest regime and the type of disease symptoms present. Early harvested perforated PVC and SM250 appear to show significantly less 'wet' rots and significantly more 'dry' symptoms than other early harvested treatments. In contrast, PVC, SM60 and polythene bag treatments showed more 'wet' rots and less 'dry' symptoms. When harvested late interactions were different.

In general PVC produced a higher proportion of wet rots than the other treatments.

Other shelf life characteristics indicated that PVC and perforated PVC overwrapped cauliflowers were yellower (Table 5). This verifies findings in other trials.

Table 5 Yellowing score (9-0 scale) after 72 hours shelf life. 1st trial

Overwrap	Harvest early prepack immed.	Harvest late prepack next day	Mean
PVC	6.23	6.23	6.23
Perf. PVC	6.37	6.77	6.57
SM60	7.30	7.17	7.23
SM250	7.03	6.87	6.95
Polythene bag	7.00	7.27	7.13
Mean	6.79	6.86	

SED (between overwrap means)	0.231 ** (18 df)
SED (between harvest/cooling regimes)	0.146 ns
SED (other comparisons)	0.327 ns

Assessments on butt condition also revealed differences between treatments. The late harvested and delayed packing regime consistently fared better throughout shelf life than the early harvested heads, whilst the PVC and perforated PVC treatments resulted in low scores (Table 6).

Table 6 Butt condition scores after 72 hours shelf life. 1st trial

Overwrap	Harvest early prepack immed.	Harvest late prepack next day	Mean
PVC	6.57	7.17	6.87
Perf. PVC	6.67	7.23	6.95
SM60	7.03	7.63	7.33
SM250	7.27	7.53	7.40
Polythene bag	7.20	7.37	7.28
Mean	6.95	7.39	

SED (between overwrap means)	0.168 * (18 df)
SED (between harvest/cooling regimes)	0.106 *** (18 df)
SED (other comparisons)	0.237 ns

The second trial was harvested after a period of similar wet and warm weather conditions. Weight losses during shelf life were similar to those in the early trial where SM250 and polythene bag treatments lost significantly more weight than other overwraps. Differences between harvesting regimes were not apparent.

Disease in this trial was worst on cauliflowers overwrapped with the gussetted polythene bags (Table 7). The problem was predominantly that of drying out and blackening of the curd surface. The polythene bag overwrap had the lowest percentage of 'wet' rots and highest proportion of 'dry' symptoms at the end of shelf life, especially from the late harvest regime (Tables 8 and 9).

Table 7 Disease (9-0 score) after 72 hours shelf life. 2nd trial

Overwrap	Harvest early prepack immed.	Harvest late prepack next day	Mean
PVC	7.70	7.37	7.53
Perf. PVC	7.60	7.70	7.65
SM60	6.80	7.47	7.13
SM250	6.93	7.23	7.08
Polythene bag	6.97	6.73	6.85
Mean	7.20	7.30	

SED (between overwrap means)	0.218 ** (18 df)
SED (between harvest/cooling regime)	0.138 ns
SED (other comparisons)	0.308 ns

Table 8 Percentage of 'wet' rots after 72 hours shelf life. 2nd trial

Overwrap	Harvest early prepack immed.	Harvest late prepack next day	Mean
PVC	60 (50.6)	70 (56.6)	65 (53.6)
Perf. PVC	64 (53.0)	20 (26.2)	42 (39.6)
SM60	66 (54.8)	29 (31.6)	48 (43.2)
SM250	70 (57.1)	13 (21.1)	47 (39.1)
Polythene bag	76 (60.6)	9 (17.4)	43 (39.0)
Mean	67 (55.2)	28 (30.6)	

SED (between overwrap means)	3.12 *** (18 df)
SED (between harvest/cooling regimes)	1.97 *** (18 df)
SED (other comparisons)	4.41 *** (18 df)

Table 9 Percentage of 'dry' symptoms after 72 hours shelf life. 2nd trial

Overwrap	Harvest early prepack immed.	Harvest late prepack next day	Mean
PVC	32 (34.4)	26 (30.4)	29 (32.4)
Perf. PVC	28 (31.8)	76 (61.1)	52 (46.5)
SM60	25 (30.1)	71 (58.4)	48 (44.3)
SM250	21 (26.9)	83 (65.8)	52 (46.3)
Polythene bag	24 (29.4)	91 (72.6)	58 (51.0)
Mean	26 (30.5)	69 (57.7)	

SED (between overwrap means)	3.51 *** (18 df)
SED (between harvest/cooling regimes)	2.22 *** (18 df)
SED (other comparisons)	4.96 *** (18 df)

Least disease overall was found on those cauliflowers with PVC or perforated PVC wraps. However on late harvested treatments PVC gave the highest proportion of 'wet' rots and lowest proportion of 'dry' symptoms during shelf life (Tables 8 and 9).

In general, as in the previous trial, the early harvest regime produced more wet rots whilst problems with the late harvested regime were more associated with drying out of the curd surface.

The late harvesting regime not only reduced the development of wet rots but also reduced the deterioration of the butt. Assessments produced very similar results to those from the earlier trial.

The final trial was harvested in late August after a period of drier, sunnier weather. The SM60 overwrap treatment was dropped in this trial and was replaced with an unwrapped comparison.

Differences in weight loss between treatments were again very marked. The unwrapped cauliflower lost considerably more moisture at all times throughout shelf life than any other treatment. Even after only 24 hours shelf life weight loss was 6 per cent (Table 10). Weight loss from other treatments showed a similar ranking to that measured in previous trials (Tables 10 and 11).

Table 10 Percentage weight loss after 24 hours shelf life. 3rd trial

Overwrap	Harvest early prepack immed.	Harvest late prepack next day	Mean
PVC	0.99	0.99	0.99
Perf. PVC	1.43	1.19	1.31
No overwrap	6.77	5.75	6.26
SM250	2.16	1.92	2.04
Polythene bag	3.33	2.90	3.11
Mean	2.94	2.55	

SED between overwrap means)	0.652 *** (17 df)
SED (between harvest/cooling regimes)	0.607 ns
SED (other comparisons)	0.987 ns

Table 11 Percentage weight loss after 72 hours shelf life. 3rd trial

Overwrap	Harvest early prepack immed.	Harvest late prepack next day	Mean
PVC	2.66	2.51	2.55
Perf. PVC	3.77	2.96	3.36
No overwrap	15.34	13.38	14.36
SM250	5.75	5.14	5.44
Polythene bag	7.87	7.27	7.57
Mean	7.06	6.25	6.65

SED (between overwrap means)	1.161 *** (17 df)
SED (between harvest/cooling regimes)	1.079 ns
SED (other comparisons)	1.756 ns

The high loss of moisture from the unwrapped heads led to a rapid drying and darkening of the cauliflower curd surface, this was reflected in low disease scores (Table 12). Similarly by the end of the shelf life period the polythene bag treatment had lower disease scores than PVC, perforated PVC or SM250 film.

Table 12 Disease score (9-0 scale) after 72 hours shelf life. 3rd trial

Overwrap	Harvest early prepack immed.	Harvest late prepack next day	Mean
PVC	7.37	7.37	7.37
Perf. PVC	6.97	7.43	7.20
No overwrap	6.30	6.07	6.18
SM250	7.10	7.63	7.37
Polythene bag	6.87	7.17	7.02
Mean	6.92	7.13	

SED (between overwrap means)	0.192 *** (18 df)
SED (between harvest/cooling regimes)	0.122 ns
SED (other comparisons)	0.272 ns

Assessments on the proportion of wet and dry type symptoms were less variable than in previous trials and so could not be statistically analysed. Results do however clearly suggest that the polythene bag, SM250 and unwrapped treatments were developing mainly 'dry' type rots whilst the PVC and perforated PVC were developing 'wet' type rots.

Conclusions

1. The major cause of post harvest deterioration in cauliflowers is damage to the curd. Curd tissues which have been damaged are more vulnerable to fungal and bacterial soft rots (wet rots).

2. Overwrap treatments with low water vapour permeability resulted in the development of mostly 'wet' type diseases. High weight loss was associated with drying out of the cauliflower curd surface and the development of 'dry' types of disease symptoms.

3. PVC, perforated PVC and SM60 overwraps resulted in very small weight loss during shelf life (2 per cent approximately). In contrast SM250 and perforated polythene bags resulted in high weight loss (6 per cent approximately). Weight loss from unwrapped heads was very high (14 per cent).

4. If the rapid development of 'wet' rots is a problem, switching to a more perforated overwrap film, e.g. SM250, may prove advantageous. The cauliflowers will suffer more drying out of the curd surface but this is likely to be more acceptable than bacterial and fungal rots.

5. Harvesting cauliflowers later in the day and delaying overwrapping until the following morning appears to reduce weight loss during shelf life and to reduce the development of 'wet' rots.

Recommendations for future action

Damage appears to be the main factor enhancing curd deterioration and the development of soft rots. Future work should be directed towards the improvement of systems for handling cauliflowers. Good post harvest techniques, cooling, handling and correct choice of overwrap should be exploited to minimise curd deterioration.

Weather conditions during 7 days prior to harvest

Harvest	Mean max. temp ^{o}C	Mean min. temp ^{o}C	Total rainfall mm	Total sunshine hours
1. 9/8/88	22.4	9.6	59.9	0.2
2. 16/8/88	21.0	10.3	44.9	5.6
3. 30/8/88	19.2	11.2	33.2	19.2