ATO-DLO

Expertise-Report for ESIS International, Inc. at Rotterdam

Assessment of damage on white asparagus in a Reefer container from ms "SA Helderberg-Rohlig" at Rotterdam, December 1998

CONFIDENTIAL

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Introduction

Reefer containers loaded with white asparagus from South Africa arrived at Rotterdam with ms SA Helderberg-Rohlig on 2nd December 1998. The spears showed a severe pitting along the stems, whereas the butts were soft and showed cavities. The produce of the containers were severely reduced in commercial value or even worthless as a fresh crop. ESIS International, Inc. and Dutch Marine Consultants B.V. took samples of the containers, which arrived at Rotterdam on 2nd December 1998 and asked ATO-DLO at Wageningen to assess these samples in comparison with air-transported asparagus also from South Africa and arrived at Rotterdam in the same period as the produce in the sea containers. ATO-DLO was also asked to correlate, if possible, the assessment of the asparagus spears with the transport conditions during sailing from South Africa to the Netherlands.

ATO-DLO performed assessments of the asparagus spears, determined CO_2 and O_2 contents in the packages and alcohol contents in the tissues of the spears. We present here the results of our investigations.

1 Transport asparagus

Mr L. Moret from ESIS International, Inc. and Mr H.F.J Oomens from Dutch Marine Consultants B.V. delivered information about the transport of the asparagus. The spears were packed in MA packages on 31st October 1998 in South Africa. The packages were put into cardboard boxes, which were put into the containers (CRLU 3112047 and CRLU 3112690). The containers were equipped with the CA system of Transfresh and the conditions were set to 2°C, 10.5% CO_2 and 10.5% O_2. The ship arrived in Rotterdam on 2nd December 1998. The container was inspected and the asparagus spears showed soft butts with cavities and also pitting along the stems was observed. In some cases some white fungus mycelium on the butts could be detected.

Samples of the load of the containers were taken by Mr Moret from ESIS International, Inc. and Mr Oomens from Dutch Marine Consultants B.V. Description on the boxes: 2 boxes Fyffes Asparagus: ANACO International B.V. P.O. Box 1086, Ficksburg 9730, R.S.A., tel. +27.5193.33881, fax +27.5193.33801, Class I Asparagus, Nett weight 8x500g, White, 16-22 mm, 160-220 mm, L6 44, (indicated as **Box I**) and White 22-28 mm, 160-220 mm, L6 44 (indicated as **Box II**); 2 boxes Wagener Farming Owanty Asparagus, P.O. Box 722, Ficksburg 9730, R.S.A., tel. +27.5192.3833, fax. +27.192.2924, 4kg = 8x500g, Diameter 16+, violet/long (indicated as **Box III**) and white/short (indicated as **Box IV**). 2 boxes of asparagus, transported by air were delivered as a reference. Description on the boxes: Free State Gold, P.O. Box 52, Ficksburg, R.S.A., tel. +27.5192.3692, fax. +27.5192.4658, Class I, violet, 10x500 g, 16-22 mm, 160-220 mm (indicated as **Box V**) and white, 16-22 mm, 120-160 mm (indicated as **Box VI**). The Free State Gold spears were MA-wrapped while the other 4 samples were all MA-packed on trays. Pictures were taken from the boxes and spears and these are added to this report as annex 1.

Subsamples of these asparagus were taken for determination of alcohol in the tissues by CONEX BV (Advise Bureau and Laboratory for Food and Environment) in Ede, The Netherlands. Other subsamples were used for determination of CO_2 and O_2 contents within the packages.

2 Assessments of the asparagus spears

The 4 samples of the involved container and the two airfreight samples were assessed on 3rd December and again on 7th December after storage in a cold room at 2°C.

The spears of the boxes I and II showed the following quality problems on 3rd December. The butts were soft and showed cavities in it. This part of the spears could be compressed easily. In some cases some white fungus mycelium could be detected on the butts. The tips were white, sometimes some tips showing darkening. The tips showed sometimes a very diffuse white mycelium. Severe pitting was observed along the spears: spots of some millimeters to several centimeters, elliptical and sunken in the tissue. These spots were white whereas liquid could easily be extracted from these spots by rubbing a fingernail along it. The contents of the spots were very soft and in some cases almost whole spears were soft. The unaffected parts of the spears were mostly still crispy.

The asparagus in the boxes III and IV showed on 3rd December the same quality problems as boxes I and II but the problems were less serious. The violet spears showed some darkening tips without mycelium. The butts and stems showed similar problems as mentioned for boxes I and II.

Asparagus from the boxes V and VI did not show the described quality problems. However, these spears showed some kind of pitting. Many very small (<1-2 mm) brownish lesions were observed along the spears. These lesions seemed different from the ones observed in the boxes I to IV.

The assessments were repeated after 4 days of storage at 2°C. The observations are summarized in table 1.

Table 1: Observations on asparagus spears in samples from a South African container on 3rd and 7th December 1998

Sample	Box	Butt Myc.	Tip Myc.	Stem Myc.	Pitting	Dark Tips	Soft Butts	Soft stems
	02-12-98,							
Anaco white 16-22, 160-220	Box I	-	-	-	+	-	+	+
Anaco white 22-28, 160-220	Box II	-	±	-	+	-	+	+
Wagener, violet/long	Box III	-	-	-	+	+	+	±
Wagener, white/short	Box IV	-	-	-	+	-	+	±
Free State G., violet 16-22, 160-220	Box V	-	-	-	+*	-	-	-
Free State G. white 16-22, 120-160	Box VI	-	-	-	+*	+	-	-
	07-12-98							
Anaco white 16-22, 160-220	Box I	+	+	+	+	±	+	+
Anaco white 22-28, 160-220	Box II	+	+	+	+	-	+	+
Wagener, violet/long	Box III	+	-	-	+	+	+	-
Wagener, white/short	Box IV	+	±	±	+	-	+	±
Free State G., violet 16-22, 160-220	Box V	-	-	-	+*	+	-	-
Free State G. white 16-22, 120-160	Box VI	-	-	±**	+*	-	-	-

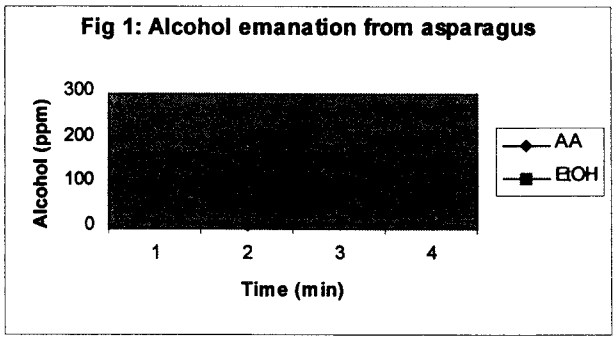
+ = present; - = absent; ± sometimes
* = different from pitting in boxes I to IV
** = only in wounds

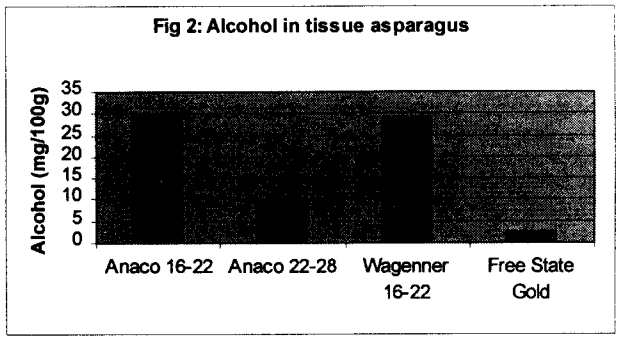
Hardly any visual mycelium was present at arrival in ATO-DLO on 3rd December. However abundant mycelium was present on any part of the spears after a couple of days at 2°C. A serious pitting was found in all samples, although pitting of the boxes V and VI was different from the other samples.

The phenomenon of dark tips did not increase from 3rd to 7th December. It seems that this phenomenon is a characteristic of the consignment. The soft butts and stems were found in all samples, which were transported in the sea-containers. Airfreight samples did not show this problem. The soft parts of the spears represent a serious quality lack of the asparagus.

3 Determination of alcohol

Asparagus spears from samples from earlier containers from South Africa than the containers in this research were used for ethanol determinations. The spears were put into gastight glass vessels, which were closed. The air in the vessels was analyzed on ethanol content within some minutes after closing. The analyses were repeated 4 times and the result is presented in figure 1 (AA= acetaldehyde and EtOH = alcohol). The analyses in the tissues of the asparagus are presented in figure 2.The original data of both determinations are presented in annexes 2 and 3.





Acetaldehyde concentration does not increase in time, whereas alcohol content rises quickly (Fig. 1). This is not very surprising since AA is a precursor of EtOH. Determination of alcohol in the asparagus tissues: the airfreight sample (Free State Gold) is much lower than the other 3 samples.

4 Carbon dioxide and Oxygen in the packages

CO_2, O_2 and N_2 concentrations were measured by ATO-DLO in 9 packages some hours after arrival of the samples at ATO-DLO. The results of these measurements are presented in table 2.

Table 2: Carbon dioxide, oxygen and nitrogen concentrations in packages with asparagus.

Samples		Oxygen (%)	Carbon Dioxide (%)	Nitrogen (%)
Anaco	1	15.97	5.08	78.95
	2	12.32	7.22	80.45
	3	11.86	8.08	80.06
Wagener Farming	1	3.58	7.13	89.29
	2	16.62	3.14	80.24
	3	6.07	6.66	87.28
Free State Gold	1	16.01	3.72	80.26
	2	18.88	3.11	78.01
	3	2.98	4.85	92.17
Average Anaco		13.04	6.8	79.8
Wagener Farming		8.8	5.6	85.6
Free State Gold		12.6	3.9	83.5

The films, which are used to pack the spears, allow an accumulation of carbon dioxide and a decrease in the oxygen content in the packages.

The following air composition was found in an air sample taken from the container by ESIS and Dutch Marine Consultants in Rotterdam before opening: 20-22% carbon dioxide, 1.4% oxygen, 71% nitrogen, 0.6% argon, 100 ppm other compounds and a surprisingly high ethanol content.

5 Discussion

According recommendations for storage, asparagus (Anon, 1984; Lutz & Hardenburg, 1977; Lidster et al, 1988; Saltveit, 1997) can be stored about 2-3 weeks at 0°C in normal air. CA conditions (5-10% CO_2 and 10-20% O_2) favour storability (Anon 1980, Saltveit 1997), although according to other research less than 3 weeks may be too long, if the storage period is followed by a shelf period of 3 days at 15°C (Schouten 1991).

The spears had been stored in MA-packages in the containers from 31st October 1998 (L6 44) to 2nd December 1998. This is more than 4 weeks and this must be considered as a very long storage period even in MA packages.

The most serious quality problems of the investigated asparagus at arrival were pitting and softness of butts. The spears were covered with white fungus mycelium within 4 days at 2°C indicating that the asparagus tissue was already seriously damaged on 2nd December. The appearance of mycelium growth must be considered as a secondary phenomenon made possible by damage of asparagus tissue. The observation of white mycelium after a couple of days clearly indicates that there was no shelf life left at arrival in Rotterdam. The airfreight samples did not show the observed problems of the asparagus transported by sea-containers (table 1).

Pitting as a result of CO_2 is described in the literature by Lipton (1964) as "sunken areas of various sizes: small, round pits, large pits elongated parallel to the spear, corrugated areas and discolorations" and "with increasing severity: small pits graded into deep long pits below the tip and in severe cases the entire spear became pitted and discolored". We did not see discolorations, but the rest of the description fits very well into the observed symptoms of the spears of the sea-containers. A warning for pitting by high CO_2 contents is given in recommendations (Saltveit 1997): 5-9% CO_2 at 3-6°C and 10-14% CO_2 at 0-3°C. It remains obscure if the very small lesions in airfreight samples must also be considered as CO_2 damage in a beginning phase. The soft butts could be considered as a consequence of severe water loss. This is however not true since all spears were normally crispy at breaking.

It seems to us, that the asparagus is damaged mostly by too high carbon dioxide contents. The atmosphere in the packages contained between 3.14 and 8.08% CO_2 (tabel 2) which meets recommendations. However the carbon dioxide content in the containers was 10.5% (annex 4) during 4 weeks. MA packages in this atmosphere will show very high CO_2 contents of much more than 10% and then pitting is possible according Saltveit (1997) even if the temperature is only 2.5°C. The measurement after arrival at Rotterdam of a CO_2 content of 20-22% fits very well for this situation. The effects of a too high carbon dioxide content in the packages will be enhanced by a long exposure period, because the injurious effects of CO_2 are time dependent.

Further support for the idea of too high CO_2 contents in the packages is found in the observation of a high ethanol content in the container-air sample taken at arrival of the container in Rotterdam and in the ethanol content of the spears (fig 2). The ethanol content in the airfreight asparagus was minimal. Ethanol accumulation is generally possible if the oxygen content becomes too low or the carbon dioxide content becomes too high or both (Ke & Kader 1993) because of a shift from normal respiration to fermentation.

6 Summary and Conclusion

Asparagus spears were transported in the CA-container CRLU 3112047 and CRLU 3112690 from South Africa to Holland in the period 31st October and 2nd December 1998. The asparagus spears were packed in MA packages, the air composition in the containers was 10.5% CO_2 + 10.5% O_2. Severe pitting and soft butts were observed on arrival whereas an increase in the alcohol content of the asparagus tissues could be established. Storage of packages at 20°C during 4 days resulted in the development of white fungus mycelium on the spears indicating that there was no shelf life left for these asparagus spears. The airfreight samples did not show the observed quality problems of the asparagus transported by the sea-containers. Measurements of CO_2 and O_2 contents in the packages showed that the atmosphere within the packages contained 3.14-8.08% CO_2.

The observed quality problems of the asparagus transported by the sea-containers must be attributed to the very high CO_2 content in the packages as a consequence of storage in a CA-container with an elevated carbon dioxide content till 1`0.5% during a possibly too long storage duration of more than 4 weeks. This conclusion is based on the information given by ESIS International, Inc. and Dutch Marine Consultants B.V. in Rotterdam and on ATO-DLO observations of the asparagus in the samples delivered by ESIS International, Inc. and Dutch Marine Consultants B.V.

Literature

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Lutz J.M. & R.E Hardenburg (1977): The Commercial Storage of Fruits, Vegetables, and Florist Nursery Stocks, USDA Agriculture Handbook No 66.

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Schouten S.P. (1991): CA Bewaring Asperges 1991. ATO-DLO Rapport 395/November 1993.

Annex 1


ASPARAGUS
ASPERGES
Class 1
Klasse 1
ASPARAGUS
ASPERGES
Ffes
PRODUCE OF SOUTH AFRICA


ASPARAGUS
ASPARAGUS
WAGENER FARMING
OWANTY
P.O.BOX 722, FICKSBURG 9730
REPUBLIC OF SOUTH AFRICA
TEL: +275192 - 3833, FAX: + 275192 - 2924
ASPARAGUS


ASPARAGUS
Class 1
SPARGEL
Klasse 1
FREE STATE

Bijlage 2

Respiration Metabolites

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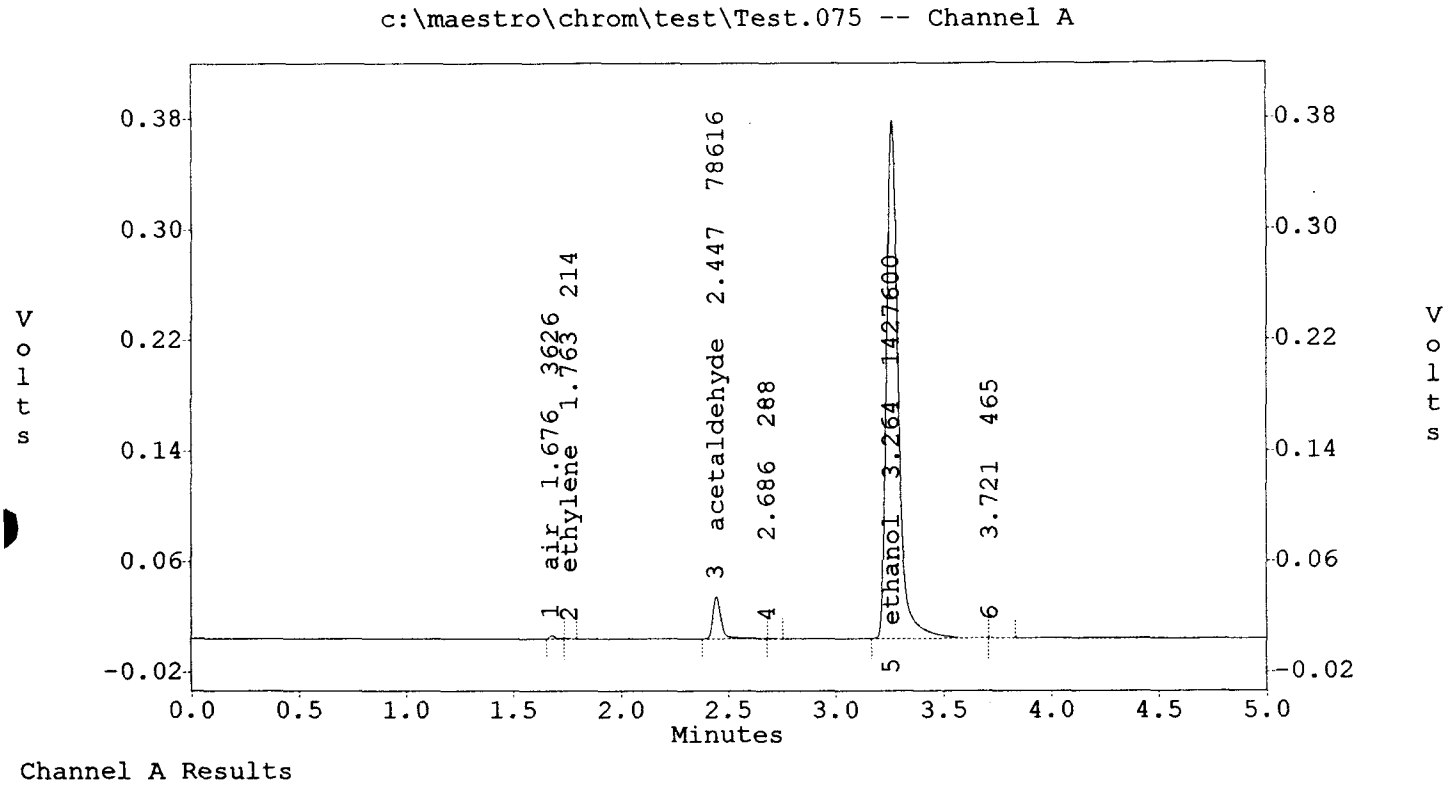

Channel A Results

Peak ntration	Peak Name	Time	Area	ESTD Conce
1	air	1.676	3626	9.171
2	ethylene	1.763	214	0.000
3	acetaldehyde	2.447	78616	12.708
4		2.686	288	0.000
5	ethanol	3.264	1427600	250.769
6		3.721	465	0.000

Respiration Metabolites

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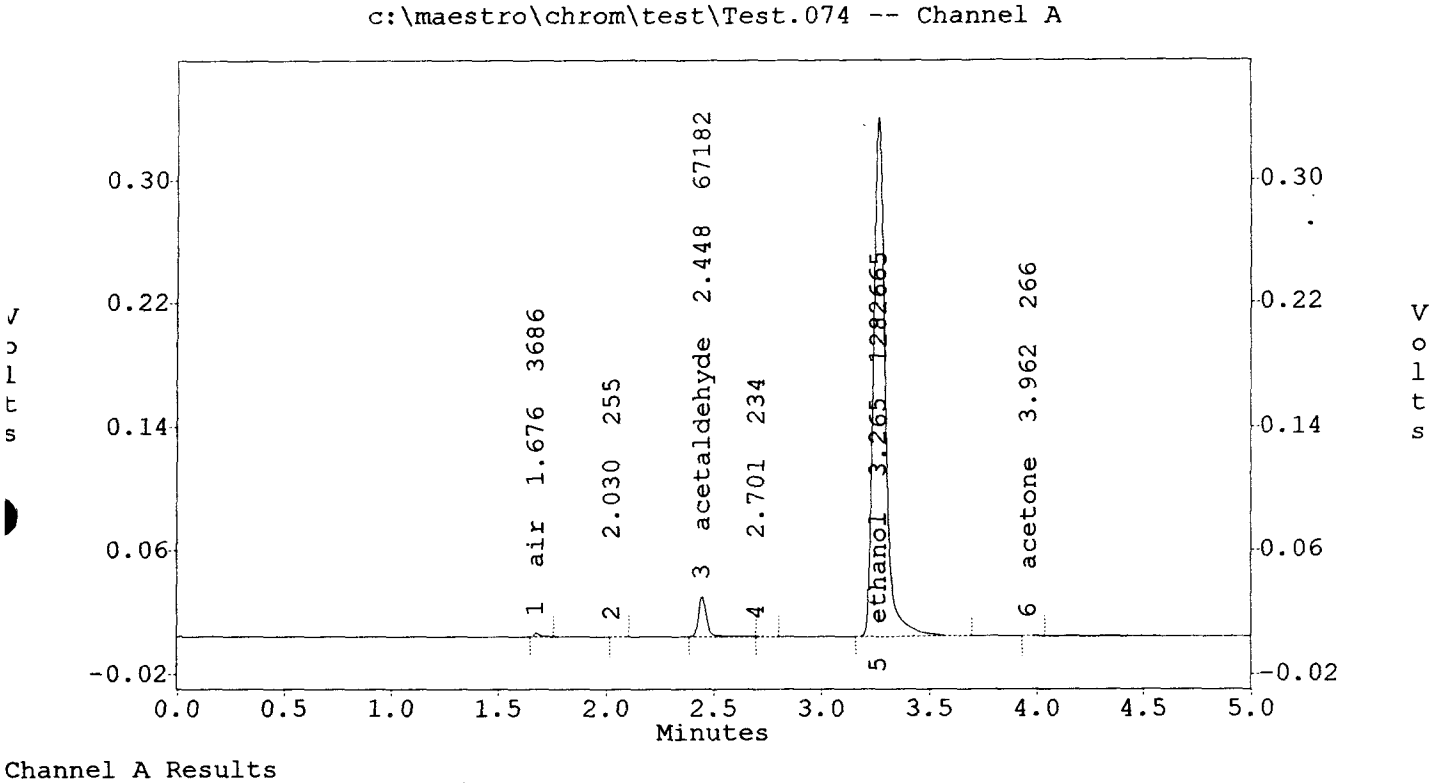

Channel A Results

Peak ntration	Peak Name	Time	Area	ESTD Conce
1	air	1.676	3686	9.323
2		2.030	255	0.000
3	acetaldehyde	2.448	67182	10.865
4		2.701	234	0.000
5	ethanol	3.265	1282665	225.312
6	acetone	3.962	266	0.000

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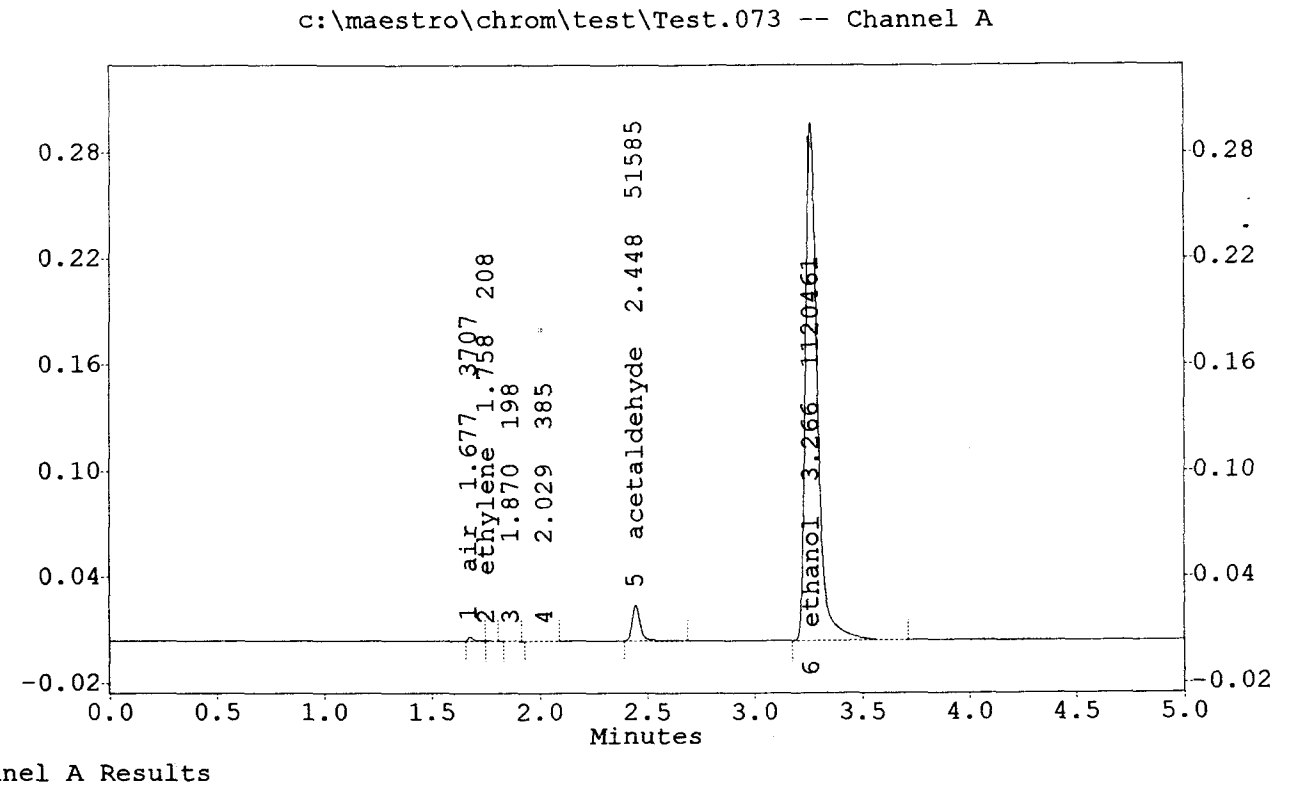

Channel A Results

Peak	Peak Name	Time	Area	ESTD Conce ntration
1	air	1.677	3707	9.376
2	ethylene	1.758	208	0.000
3		1.870	198	0.000
4		2.029	385	0.000
5	acetaldehyde	2.448	51585	8.353
6	ethanol	3.266	1120461	196.823

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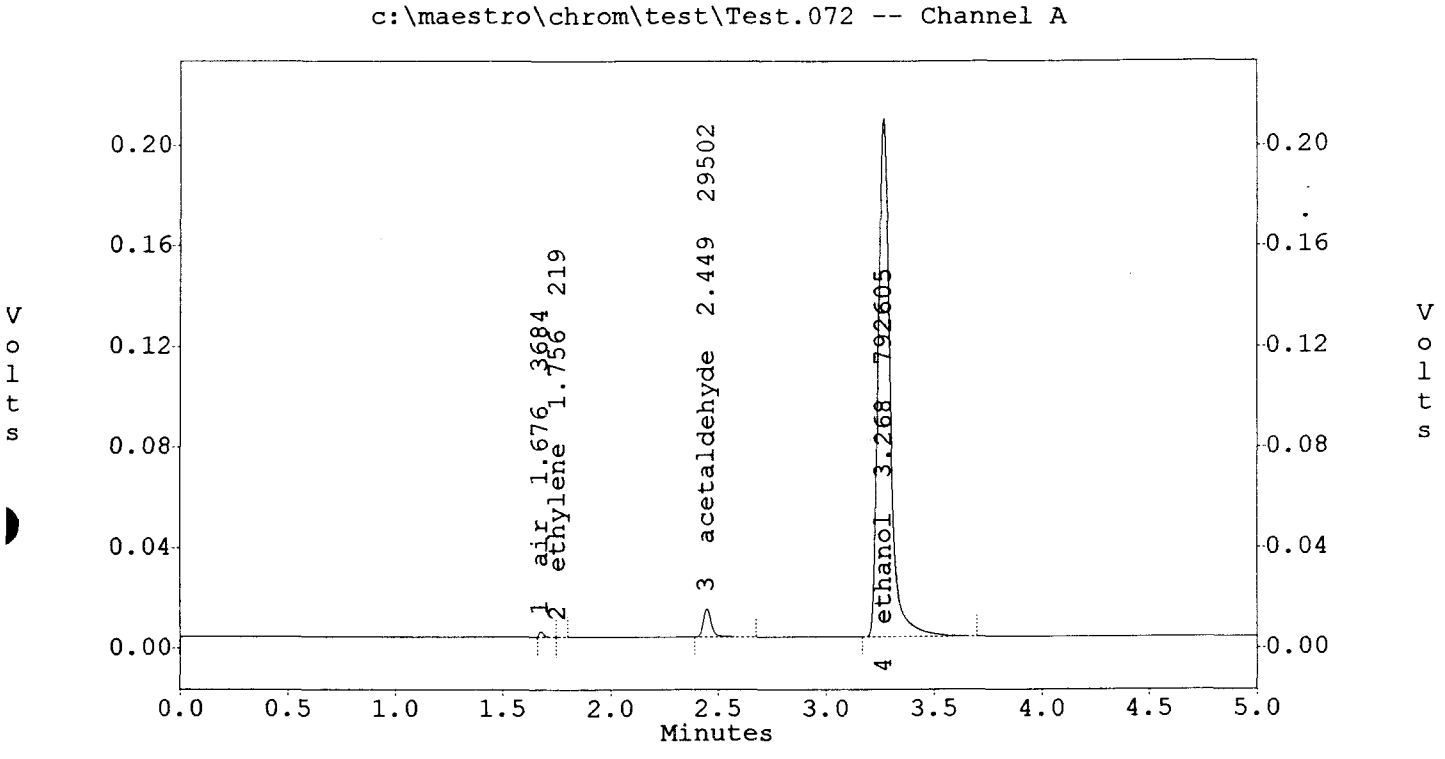


Channel A Results

Peak	Peak Name	Time	Area	ESTD Conce ntration
1	air	1.676	3684	9.318
2	ethylene	1.756	219	0.000
3	acetaldehyde	2.449	29502	4.795
4	ethanol	3.268	792605	139.240

Bijlage 3

CONEX
adviesbureau en laboratorium
voor voedingsmiddelen en milieu

ANALYSERAPPORT Blad A/B-1

Opdrachtgever : ATO-DLO
Plaats : Wageningen
Nummer : 94

Kenmerk : FS/js-77023
Datum ontvangst : 04-12-1998
Datum onderzoek : 07-12-1998 tot 09-12-1998

Monsternummer Conex		301317	301318
Omschrijving monster		: asperges	asperges
Monsterinformatie		: diepvries	diepvries
Sortering		: 16-22	22-28
Merknaam		: Anaco	Anaco
Code		: 1 L 644	2 L 644
Analyse	**Q Dimensie**	**301317**	**301318**
Ethanol	mg/100 g	: 30	10

Ede, 10 december 1998

CONEX

Een met "Q" gemerkte analyse valt onder de STERLAB-erkenning

CONEX
adviesbureau en laboratorium
voor voedingsmiddelen en milieu

ANALYSERAPPORT Blad B/B-1

Opdrachtgever : ATO-DLO
Plaats : Wageningen
Nummer : 94

Kenmerk : FS/js-77023
Datum ontvangst : 04-12-1998
Datum onderzoek : 07-12-1998 tot 09-12-1998

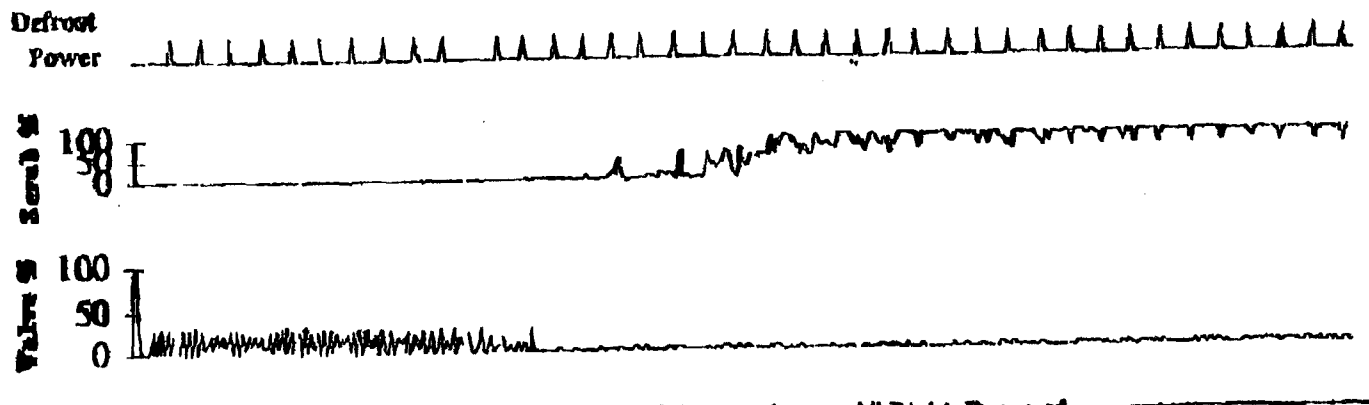
Monsternummer Conex		301319	301320
Omschrijving monster		: asperges	asperges
Monsterinformatie		: diepvries	diepvries
Sortering		: 16-22	16-22 + 16+22
Merknaam		: Wagener	Free State Gold
Code		: 3	4
Analyse	**Q Dimensie**	**301319**	**301320**
Ethanol	mg/100 g	: 29	2,6

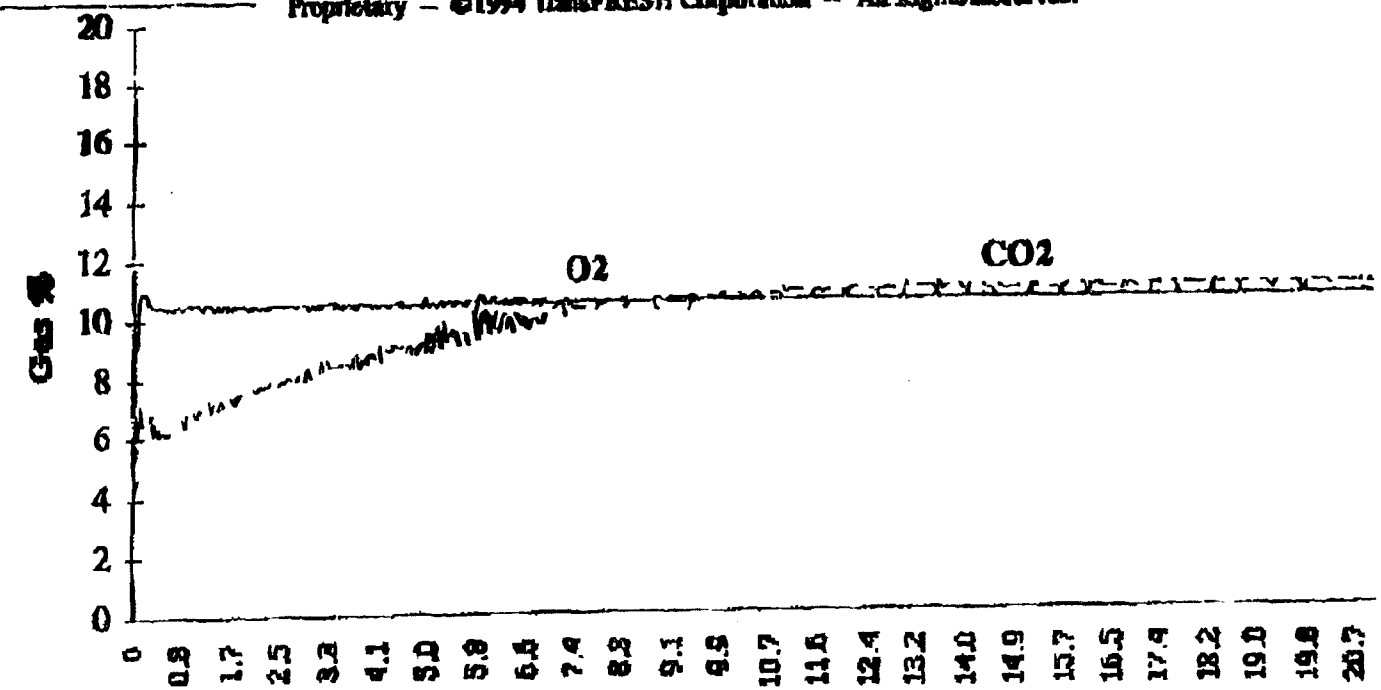
Ede, 10 december 1998

CONEX

Een met "Q" gemerkte analyse valt onder de STERLAB-erkenning

TECTROL® Controlled Atmosphere Trip: KB428244





Cargo	ASPARAGUS
Pulp Temp	2C
Reefer Set Point	2C
Leak Test Rate	9MIN
O2 VSP	10.5
CO2 VSP	13
CO2 SSP	10.5
Scrubber Line	0
Free Line	0
Purge	2

Shipment ID	KB428244
Shipment Date	11/3/98
Customer	AGRIMAX
From	CPT
To	TBY
Shipping Line	SAFMARINE
Vessel Name	HELDERBERG
Voyage Number	A041

Container ID	CRLU 3112047
Security Enclosure	SE389548
Leak Test Location	CPT
Leak Test Date	10/29/98
Serviced By	W EYBERS

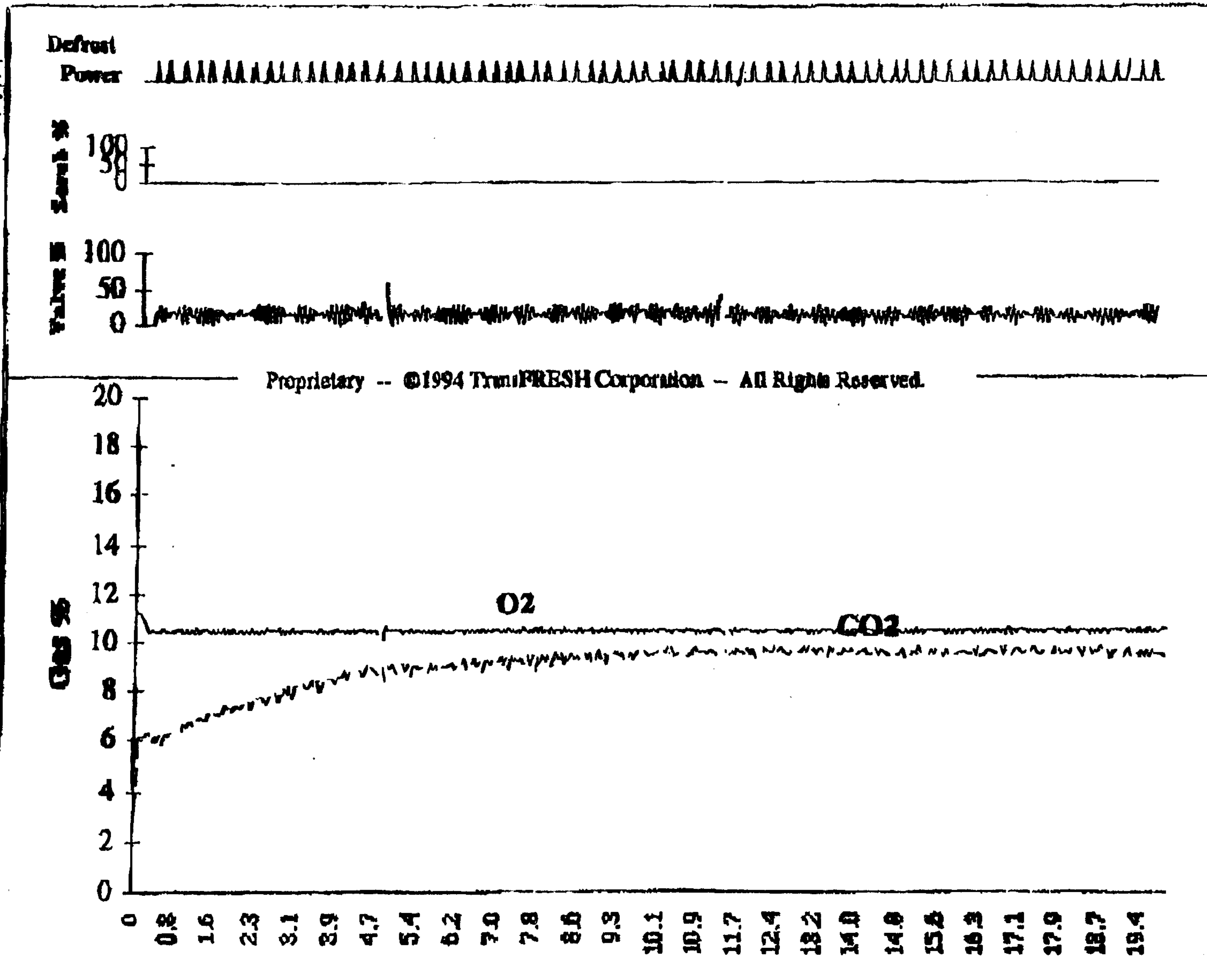
Controller ID	CA301918
Sensor Board ID	7291
ROM Revision	0.6
Patch Revision	9
Log Period	70
Power Down Period	30
No Power Mv Open	720

Notes: SR131459

Original File Name	KB428244
Date Processed	12/29/98

Comments: Chart truncated to 21.6 days due power failure greater than 4 days. Status Event Log ends at 57 days.

TECTROL® Controlled Atmosphere Trip: KB429247



Cargo	ASPARAGUS
Pulp Temp	2C
Reefer Set Point	2C
Leak Test Rate	8MIN
O2 VSP	10.5
CO2 VSP	13
CO2 SSP	10.5
Scrubber Lime	0
Free Lime	0
Pallets	2
Shipment ID	KB429247
Shipment Date	11/4/98
Customer	AGRIMAX
From	CPT
To	TBY
Shipping Line	SAF MARINE
Vessel Name	HELDERBERG
Voyage Number	A641
Container ID	CRLU 3112690
Security Enclosure	SE323711
Leak Test Location	CPT
Leak Test Date	10/29/98
Serviced By	J DU PLESSIS
Controller ID	CA300471
Sensor Board ID	1148
ROM Revision	0.8
Patch Revision	9
Log Period	70
Power Down Period	30
No Power Vlv Open	720
Notes:	BR131482
Original File Name	KB429247
Date Processed	12/29/98

Comments: Status Event Log ends at 37.8 days.