Navarro, S. and Donahaye, E. [Eds.](1993) Proc. Int. Conf. Controlled Atmosphere and Fumigation in Grain Storages, Winnipeg, Canada, June 1992, Caspit Press Ltd., Jerusalem, pp. 485-488.

QUALITY CHANGES IN PEANUTS SHIPPED BY RAIL UNDER CARBON DIOXIDE

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ABSTRACT

Forty-eight loads of shelled peanuts were shipped by rail from May 15 - October 5, 1991 from southern Alabama to Lexington, Kentucky. Rapid gaseous CO_2 filling stations were engineered to fill the rail cars to a concentration of 55-80% CO_2 (approximately 410 kg CO_2 per car) before sealing and shipment. Forty one loads were treated with CO_2 and seven companion loads were fumigated with PH_3. The maximum CO_2 concentration in the ambient atmosphere surrounding the cars was below 0.5% during filling and no elevated CO_2 was detected during unloading. The effectiveness of CO_2 fumigation depends on the retention of CO_2 for several days. There was complete insect control in all but two of the cars treated with CO_2, and these had to be refumigated with PH_3 in Lexington. After shipment, neither the moisture content (m.c.) nor the microflora of the peanuts shipped under CO_2 atmosphere differed from those found with the PH_3 fumigation.

EXPERIMENTAL

This field trial was designed to find out if CO_2 fumigation of rail cars to approximately 60%CO_2 could be used to control insects while not adversely affecting the peanuts during rail shipment. Forty-eight rail cars (86,000 kg/car) of US no.1 shelled peanuts (6-7% kernel m.c.) were shipped from two locations in Alabama to Lexington, Kentucky in 1991 (Table 1). The initial and final CO_2 percentages in the atmosphere and number of dead and live insects at Lexington are given in Table 2.

The incidence of fungi before and after transit is given in Tables 3 and 4. The numbers in Tables 3 and 4 represent % of 200 kernels from each location from which the fungus was isolated after incubation for 7 days at 30°C on malt salt agar containing 10% NaCl. Peanuts were sampled from the top and bottom of the rail car during loading and unloading. Fungi presence

was tested before and after fumigation with CO_2 or PH_3. The m.c. was unaffected by the treatments.

Table 1: Treatments of US no.1 shelled peanuts shipped to Lexington, KY from May 15 - October 5 1991 by 48 rail cars.

Shipping point	Treatment	Tempered[a]	Non-Tempered	Total
Sunstates	CO_2[b]	11	6	17
Dothan, AL	PH_3[c]	2	3	5
DOMCO	CO_2	0	24	24
Headland, AL	PH_3	0	2	2
		13	35	48

[a] Tempered - peanuts were tempered after removal from cold storage before unloading rail cars.
[b] Gaseous CO_2 was added during bulk loading. The entire CO_2 fumigation added about 15 minutes to the loading process.
[c] Aluminium phosphide strips were used at the recommended dosage for peanuts.

SUMMARY OF FINDINGS

1. All Sunstates peanut shipments gave complete insect control, while two of 24 DOMCO shipments required refumigation with PH_3 in Lexington, KY.
2. Costs were as follows:
   a) CO_2 tank installation ranges from $3,000-$11,000.
   b) 410 kg CO_2 were required per car, amounting to $70/car.
   c) Tank rental was $425 per month, plus an annual rental fee.
3. CO_2 filling stations were efficient. No vacuum developed in bulk cars.
4. Peanut m.c. and microflora counts were similar after shipment for CO_2 and PH_3 treatments.
5. CO_2 levels outside rail cars were less than 0.5% during loading and did not elevate during unloading.

CONCLUSION

Rail cars were fumigated successfully with CO_2. The CO_2 treatment resulted in the death of insect adults and larvae when the CO_2 did not escape too rapidly. The CO_2 fumigation had a minimal effect on m.c. and fungal microflora during shipment in this field trial.

Table 2: Selected data on CO_2 concentrations and insect control[a,b].

Fill Date	Unload Date	Ship From	Initial CO_2	Final CO_2	Dead Insects	Live Insects
15 May	27 May	DOM	74	70	5	0
16 May	30 May	SSD	64	58	0	0
28 May	6 Jun	SSD	62	8	25	0
7 Jun	18 Jun	SSD	77	60	0	0
7 Jun	20 Jun	DOM	60	24	0	0
10 Jun	25 Jun	DOM	60	10	0	0
11 Jun	26 Jun	DOM	60	7	0	0
12 Jun	18 Jun	SSD	75	5	0	0
12 Jun	22 Jun	SSD	75	49	0	0
14 Jun	25 Jun	SSD	73	23	0	0
27 Jun	3 Jul	SSD	75	35	0	0
28 Jun	5 Jul	SSD	75	48	0	0
9 Jul	15 Jul	SSD	75	0	0	0
12 Jul	20 Jul	SSD	73	30	1	0
16 Jul	24 Jul	SSD	73	40	0	0
16 Jul	24 Jul	DOM	60	20	8	5*
18 Jul	24 Jul	SSD	73	20	0	0
24 Jul	5 Aug	DOM	58	4	1	0
25 Jul	5 Aug	DOM	63	60	1	0
31 Jul	17 Aug	DOM	58	4	0	0
3 Aug	16 Aug	DOM	58	3	0	0
8 Aug	19 Aug	DOM	58	5	0	20*
10 Aug	19 Aug	DOM	60	20	1	0
14 Aug	21 Aug	DOM	58	10	1	0
14 Aug	23 Aug	DOM	58	10	0	0
10 Sep	24 Sep	DOM	60	5	8	1
14 Sep	25 Sep	DOM	60	7	0	0
27 Sep	9 Oct	DOM	60	0	3	0
2 Oct	11 Oct	DOM	70	3	0	1

[a] Shipping point: DOM = DOMCO, SSD = Sunstates. No live insects were found in the 7 cars fumigated with PH_3.

[b] Loads marked with * were refumigated with PH_3 in Lexington.

Table 3: Mean incidence (average % from 41 cars) of fungi in peanuts before CO_2 treatment and after transit.

	Top		Bottom	
	Before	After	Before	After
Aspergillus flavus	45	39	39	39
Aspergillus niger	28	25	32	26
Other *Aspergilli*	69	68	61	41
Penicillium spp.	1	1	1	3
Fusarium spp.	1	1	1	1
Other fungi	13	19	19	26

Table 4: Mean incidence (average % from 7 cars) of fungi in peanuts before PH_3 treatment and after transit.

	Top		Bottom	
	Before	After	Before	After
Aspergillus flavus	57	56	42	40
Aspergillus niger	44	10	38	18
Other *Aspergilli*	63	65	93	87
Penicillium spp.	1	0	2	1
Fusarium spp.	1	1	1	0
Other fungi	21	16	23	31