THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

RESIDUE OF BIPHENYL CONTAINED IN ORANGES SHIPPED IN BIPHENYL TREATED FIBERBOARD BOXES

Project 1108-7-4 – Reports for the Registration of Biphenyl with the U.S. Dept. Agriculture

A Report Prepared For

THE FOURDRINIER KRAFT BOARD INSTITUTE

by

E. E. Dickey, J. W. Green, Willis M. Van Horn

March 15, 1955

RESIDUES OF BIPHENYL CONTAINED IN ORANGES SHIPPED IN BIPHENYL TREATED FIBERBOARD CONTAINERS

This was a co-operative study between Sunkist Growers in California; Waverly Growers Cooperative, Waverly, Florida; The Central Research Laboratory of Monsanto Chemical Company, Dayton, Ohio; The Fruit and Vegetable Laboratory, U.S. Department of Agriculture, Pasadena, California; The Lake Alfred Citrus Experiment Station of the University of Florida; and The Institute of Paper Chemistry, Appleton, Wisconsin. The Sunkist and Waverly organizations supplied large amounts of fruit to each of the four laboratories mentioned.

The work was divided into two phases as follows. The Florida and Pasadena laboratories took fruit and held it in biphenyl treated boxes under simulated shipping conditions in their own laboratories. After various periods of storage, under varying conditions of temperature the fruit was taken from the boxes and its biphenyl residue evaluated. On the other hand the Sunkist and Waverly organizations packed the oranges in biphenyl treated boxes and shipped them, through regular commercial channels to the Monsanto and Institute of Paper Chemistry laboratories. In these places the oranges were analyzed for biphenyl residues, sometimes as received, at other times under conditions simulating sequence of events transpiring in an ordinary grocery store or food market.

The boxes of oranges were prepared as follows: In a separate operation fiberboard was treated with biphenyl applied at the rate of four pounds per thousand square feet (12.6 mg. per square inch). This board was then processed to form "collars" which were then placed in the box in such a way as to fit snugly against the side and end panels.

It has been calculated that the total amount of biphenyl on each collar was approximately 5.3 grams at the time of application. After the collar was in place the box was filled with fruit and then shipped or held as the case may be.

The methods used in the analyses were those developed at each laboratory, copies of which are attached.

Data Obtained at The Institute of Paper Chemistry
on Florida Oranges Shipped in Biphenyl Treated
Fiberboard Boxes

The first shipment of Florida oranges, consisting of eleven boxes, were sampled and analyzed on receipt, and data are contained in Table I.

TABLE I

FIRST SHIPMENT FROM FLORIDA

Biphenyl Content of Florida Oranges Shipped in Biphenyl Treated Fiberboard Boxes

Each sample, from each box, was 2 oranges which had been in contact with treated surface (T) or 2 oranges which had not (U).

	Biphenyl Content		
Sample No.	Pulp mg./Orange	Whole Fruit, p.p.m.	Peel, p.p.m.
1 T	0.34	50	283
U	0.32	43	268
2 T	0.41	59	321
U	0.30	53	276
3 T	0.23	67	307
U	0.23	64	332
4 T	0.26	62	336
U	0.29	54	291
5 T	0.25	62	327
U	0.20	50	252
6 T	0.27	63	328
U		51	276
7 T	0.26	82	477
U		75	413
8 T		86	506
U			
9 T	0.27	48	252
U	0.13	52	252
10 T	0.50	90	463
U	0.35	91	499
11 T	0.33	74	439
U	0.32	104	562

The remaining fruit from Shipment 1 was stored at room temperature in pyramidal stacks on shelves, to simulate what would happen in a food market. Samples were taken from these stacks periodically and their biphenyl content determined. There were approximately 100 oranges in each stack. The composition of the stacks and their designation were as follows:

Sample Number Assigned to Fruit Stacked in Air at Room Temperature	
PT-1	From boxes 1 and 2--fruit which had been in contact with biphenyl treated surface.
PU-1	From boxes 1 and 2--fruit which had not been in contact with biphenyl treated surface.
PT-3	From boxes 3 and 4--fruit which had been in contact with biphenyl treated surface.
PU-3	From boxes 3 and 4--fruit which had not been in contact with biphenyl treated surface.
PT-5	From boxes 5 and 6--fruit which had been in contact with biphenyl treated surface.
PU-5	From boxes 5 and 6--fruit which had not been in contact with biphenyl treated surface.
PT-7	From boxes 7 and 8--fruit which had been in contact with biphenyl treated surface.
PU-7	From boxes 7 and 8--fruit which had not been in contact with biphenyl treated surface.
PT-9	From boxes 9 and 10--fruit which had been in contact with biphenyl treated surface.
PU-9	From boxes 9 and 10--fruit which had not been in contact with biphenyl treated surface.

The data from these holding "shelf life" tests are contained in Table II.

TABLE II

BIPHENYL CONTENT OF FLORIDA ORANGES (SHIPMENT NUMBER I)
HELD UNDER CONDITIONS SIMULATING
THOSE FOUND IN FOOD MARKETS

	Biphenyl Content (p.p.m.)					
	Whole Fruit	Peel	Pulp	Whole Fruit	Peel	Pulp
		PT-1			PU-1	
Shelf-life, days						
0	47	295	1.4	44	251	1.2
1	52	315	--	46	301	--
2	36	236	1.6	37	213	1.1
4-5	39	262	1.2	33	209	1.0
9	39	242	0.8	47	291	0.7
		PT-3			PU-3	
Shelf-life, days						
0	64	282		58	347	
1	58	312		55	286	
2	47	274		46	250	
4-5	65	364		50	291	
9	54	318		58	332	
		PT-5			PU-5	
Shelf-life, days						
0	38	253		41	228	
1	44	236		35	228	
2	28	165		29	183	
4-5	38	237		30	203	
9	31	210		36	211	
		PT-7			PU-7	
Shelf life, days,						
0	82	420	1.5	65	375	1.5
1	64	394	--	69	406	--
2	59	330	1.3	56	303	1.0
4-5	71	414	1.3	49	318	1.5
9	64	376	1.0	54	302	1.2
		PT-9			PU-9	
Shelf life, days						
0	55	313	1.3	65	374	1.6
1	69	367	--	67	349	--
2	53	318	1.5	31	157	0.8
4-5	58	328	1.0	43	240	1.0
9	59	325	0.3	83	546	1.2

While there is considerable variation in the biphenyl values shown in Table II, by and large the data do not indicate a significant decrease in the biphenyl residue over a nine-day exposure to ordinary room conditions.

Shipment Number Two of Florida oranges consisted of eleven boxes of fruit. These were analyzed as received and the data are shown in Table III. Collars were recovered from several of the boxes and their biphenyl content also reported. The symbols "T" and "U" have the same reference as in Table I.

TABLE III

SECOND SHIPMENT FROM FLORIDA

Biphenyl Content of Florida Oranges Shipped in Biphenyl Treated Fiberboard Boxes

	Biphenyl Content of Fruit (p.p.m.)			Biphenyl Content of Collar	
Sample No.	Pulp	Whole Fruit	Peel	mg./sq. inch	lb./1000 sq. ft.
1 T	0.65	42	223	0.72	0.23
U	0.39	39	185		
2 T	1.37	43	238	0.96	0.31
U	1.61	42	238		
3 T	4.01	33	188	0.74	0.23
U	2.88	37	198		
4 T	1.92	60	312	0.72	0.23
U	4.76	49	260		
5 T	0.54	39	195	0.76	0.24
U	0.80	42	222		
6 T	0.79	56	290	--	--
U	0.67	39	218		
7 T	0.80	54	272	--	--
U	0.65	48	240		
8 T	0.90	52	257	--	--
U	1.16	45	223		

TABLE III
(Continued)

SECOND SHIPMENT FROM FLORIDA

Sample No.	Biphenyl Content of Fruit (p.p.m.) Pulp	Whole Fruit	Peel	Biphenyl Content of Collar mg./sq. inch	lb./1000 sq. ft.
9 T	2.18	45	213	0.95	0.30
U	0.56	38	191		
10 T	0.64	40	233	0.61	0.19
U	--	--	--		
11 T	0.97	53	252	0.81	0.26
U	0.57	31	153		

As in the case of Shipment Number One, the oranges remaining after the initial sampling (Table III) were placed on shelves for a period, in this case, of twelve days. Then composite samples obtained by selecting every tenth orange were prepared and their biphenyl content measured. Data are shown in Table IV.

TABLE IV

SECOND SHIPMENT FROM FLORIDA

Biphenyl Content of Florida Oranges Held Twelve Days
Under Conditions Simulating Those
Found in a Food Market

Composite Sample	Biphenyl Content (p.p.m.) Pulp	Whole Fruit	Peel
1(T)	0.45	30	196
2(T)	0.46	33	210
3(T)	0.47	42	293
4(T)	0.27	29	175
5(U)	0.40	31	206
6(U)	0.28	35	179

Table V contains residue data for the third shipment of ten boxes Florida oranges. The symbols "T" and "U" have the same meaning as in Table I.

TABLE V

THIRD SHIPMENT FROM FLORIDA

Biphenyl Content of Florida Oranges Shipped in Biphenyl Treated Fiberboard Boxes

Sample No.	Biphenyl Content (p.p.m.) Pulp	Whole Fruit	Peel
1 T	1.08	36	200
U	0.70	32	165
2 T	0.45	24	129
U	0.57		
3 T	0.56		
U	0.39	23	120
4 T	1.10		
U	0.96	34	182
5 T	0.81		
U	0.56		
6 T	2.94	40	196
U	0.64	30	163
7 T	1.12	43	210
U	0.64	36	192
8 T		43	250
U	0.71		
9 T	1.54	47	260
U	2.55	38	202
10 T	1.13		
U	1.44		
Chip 31 T	0.77	36	172
U	0.91	35	184
Chip PhX T	0.58	35	184
U	0.83	29	166

Shipment Number Three was made at the conclusion of the Florida season, and accordingly shipments were started from California at the start of Valencia season. The California results are discussed later in this report. In January 1954 shipments from Florida were resumed. By that time it was apparent that enough data were available to provide an adequate idea of the biphenyl content of single fruits and for that reason the last three Florida shipments (shipment four--4 boxes, shipments five and six--3 boxes each.) were sampled at random for each box, each random sample composited and an analysis made of each composite. In other words only one analysis per box was made.

The data for shipments 4, 5, and 6 from Florida are shown in Table VI.

TABLE VI

SHIPMENTS 4, 5 AND 6 FROM FLORIDA

Biphenyl Content of Florida Oranges Shipped
in Biphenyl Treated Fiberboard Boxes

	Biphenyl Content of Fruit (p.p.m.)			Biphenyl Content of Collars	
Sample No.	Peel	Whole Fruit	Juice	mg./sq. in.	lb./1000 sq. ft.
Shipment No. 4					
1	88	21	0.62	6.7	2.2
2	122	26	0.75	8.1	2.6
3	132	34	0.78	6.7	2.2
4	106	25	0.48	3.9	1.2
Shipment No. 5					
1	115	29	0.20	1.47	0.47
2	85	22	0.42	2.76	0.88
3	73	16	0.41	2.16	0.69
Shipment No. 6					
1	128	23	0.56	0.932	0.30
2	85	21	0.89	0.866	0.28
3	97	21	0.82	0.999	0.32

Data Obtained at The Institute of Paper Chemistry on California Oranges Shipped in Biphenyl Treated Fiberboard Boxes

The first shipment received from California consisted of six "Lemonoil" boxes and six "Phenodor" boxes. The term "Lemonoil" means that the boxes were treated with a 50-50 mixture of biphenyl and petrolatum wax to which lemon oil had been added in amounts sufficient to mask the odor of biphenyl. It should be noted that this was an experimental preparation and it is not now being used. The term "Phenodor" means that a different masking agent was used. In both cases, however, the amount of biphenyl applied to the board was the usual amount--4 pounds per thousand square feet.

The data for this shipment are shown in Table VII.

After the fruit for the initial analyses were removed from the boxes, the remaining fruit was placed on shelves at room temperature and held for seven days. Composite samples were then taken and their biphenyl content determined. These data are contained in Table VIII.

TABLE VII

FIRST SHIPMENT FROM CALIFORNIA

Biphenyl Content of California Valencia Oranges Shipped in Biphenyl Treated Fiberboard Boxes

Sample No.	No. of Fruit Analyzed	Biphenyl Content of Fruit (p.p.m.)			Biphenyl Content of Collar	
		Pulp	Whole Fruit	Peel	mg./sq. in.	lb./1000 sq. ft.
1 L	1	2.3	88	352	0.54	0.17
	2	3.3	--	--		
2 L	1	2.2	106	424	1.04	0.33
	2	3.4	131	524		
3 L	1	1.8	109	432	0.75	0.24
	2	1.5	74	272		
4 L	1	2.4	120	423	1.45	0.46
	2	--	99	377		
5 L	1	1.4	70	284	0.80	0.25
	2	1.7	102	352		
6 L	1	1.4	95	310	1.81	0.58
	2	2.3	100	425		
7 P	1	--	15	58	0.059	0.018
	2	0.51	16	61		
8 P	1	0.67	13	58	0.066	0.021
	2	0.45	15	52		
9 P	1	0.22	40	138	0.044	0.014
	2	0.13	21	78		
10 P	1	0.20	22	86	0.053	0.017
	2	0.17	--	--		
11 P	1	0.57	34	142	0.031	0.010
	2	0.52	23	92		
12 P	1	0.06	21	80	0.038	0.012
	2	0.38	24	100		

L - Lemon Oil Collar
P - Phenodor Collar

TABLE VIII

Biphenyl Content of California Valencia Oranges (Shipment 1) Held Seven Days Under Conditions Simulating Those Found in Food Markets

Sample No.	Type	No. of Fruit Analyzed From Each Box	Biphenyl Content (p.p.m.) Pulp	Whole Fruit	Peel
1	Composite from boxes 7 and 8	1	0.59	18	69
		2	0.30	28	108
		4	0.34	15	58
2	Composite from box 9	1	0.44	14	62
		2	1.06	22	92
		4	0.16	40	173
3	Composite from box 10	1	0.41	21	100
		2	0.45	12	55
		4	0.54	8	29
4	Composite from boxes 11 and 12	1	0.34	13	52
		2	0.39	6	25
		4	0.31	11	50

In shipment number two of California oranges (six boxes) all fruit analyzed had been in contact with a biphenyl treated surface. Two samples of one orange each were analyzed from each box. Data from this shipment are contained in Table IX.

In analyzing the oranges from the third shipment (eleven boxes) from California each sample consisted of eight oranges which were composited together and an aliquot portion of the whole analyzed. Two such 8 orange samples were taken from each box. All oranges had been in contact with a biphenyl treated surface. Data are shown in Table X.

TABLE IX

SECOND SHIPMENT FROM CALIFORNIA

Biphenyl Content of California Valencia Oranges
Shipped in Biphenyl Treated Fiberboard Boxes
(All Boxes With Phenodor Collars)

Sample No.	Biphenyl Content (p.p.m.) Pulp	Whole Fruit	Peel
1 A	0.34	8	34
B	0.83	9	37
2 A	0.33	18	64
B	0.42	17	46
3 A	0.96	6	24
B	0.42	16	57
4 A	0.09	12	45
B	--	12	45
5 A	0.32	10	44
B	2.0	19	81
6 A	0.64	13	57
B	0.96	10	38

Biphenyl content after one weeks shelf-life; oranges taken from same boxes as above.

1 A	0.24	27	97
B	0.55	16	67
2 A	0.51	18	69
B	0.60	17	68
3 A	0.78	22	85
B	0.25	15	69
4 A	0.23	20	75
B	0.54	20	77
5 A	0.60	18	68
B	0.35	21	75
6 A	0.42	18	76
B	0.40	16	69

TABLE X

THIRD SHIPMENT FROM CALIFORNIA

Biphenyl Content of California Valencia Oranges
Shipped in Biphenyl Treated Fiberboard Boxes
(All Boxes with Phenodor Collars)

Sample No.	Biphenyl Content of Fruit (p.p.m.) Pulp	Whole Fruit	Peel	Biphenyl Content of Collar mg./sq. in.	lb./1000 sq. ft.
1 A	1.56	61	260	2.22	0.71
B	1.46	52	236		
2 A	0.34	10	39	0.34	0.11
B	0.32	10	40		
3 A	--	63	239	2.22	0.71
B	1.40	52	243		
4 A	1.43	59	241	2.27	0.72
B	1.95	60	246		
5 A	0.30	12	48	0.28	0.090
B	0.33	14	63		
6 A	0.33	11	49	0.27	0.087
B	0.34	12	55		
7 A	1.34	63	239	2.68	0.85
B	1.25	57	214		
8 A	1.23	54	218	1.00	0.32
B	1.50	48	191		
9 A	1.38	63	259	6.51	2.07
B	1.24	61	232		
10 A	0.35	12	52	0.27	0.087
B	0.33	12	52		
11 A	0.20	11	42	0.27	0.085
B	0.23	12	45		

TABLE XI

THIRD SHIPMENT OF CALIFORNIA ORANGES

Biphenyl Content of California Valencia Oranges
Held Twelve Days Under Conditions Simulating
Those Found in Food Markets

Sample No.	Biphenyl Content (p.p.m.) Pulp	Whole Fruit	Peel
1	0.57	55	266
2	0.15	10	40
3	0.61	43	190
4	0.61	53	234
5	0.13	12	48
6	0.20	13	59
7	0.72	53	226
8	0.48	42	221
9	0.79	51	50
10	0.23	10	50
11	0.13	11	46

The fourth shipment of California Valencia oranges consisted of eleven boxes. In this shipment each sample consisted of two oranges, and two such samples were taken from each box. All oranges taken had been in contact with biphenyl treated surface. Data for biphenyl analyses are shown in Table XII.

TABLE XII

FOURTH SHIPMENT OF CALIFORNIA ORANGES

Biphenyl Content of California Valencia Oranges
Shipped in Biphenyl Treated Fiberboard Boxes
All Boxes With Phenodor Collars

	Biphenyl Content of Fruit (p.p.m.)			Biphenyl Content of Collar	
Sample No.	Pulp	Whole Fruit	Peel	mg./sq. in	lb./1000 sq. ft.
1 A	1.45	73	336	3.22	1.02
B	1.67	84	352		
2 A	2.06	50	278	0.55	0.17
B	0.85	47	204		
3 A	0.45	40	172	0.59	0.19
B	1.71	60	286		
4 A	1.56	76	327	3.38	1.07
B	0.87	77	233		
5 A	2.23	98	388	3.73	1.18
B	1.88	97	439		
6 A	0.66	38	166	0.43	0.14
B	0.71	48	189		
7 A	0.62	41	148	0.56	0.18
B	0.55	40	132		
8 A	0.69	78	265	4.38	1.39
B	1.44	76	266		
9 A	0.39	33	131	0.64	0.20
B	0.57	32	123		
10 A	0.86	65	244	4.98	1.58
B	1.60	71	300		
11 A	0.79	47	169	0.74	0.23
B	0.81	39	157		
12 A	2.17	89	329	4.65	1.48
B	2.71	100	414		

After the initial samples were taken from Shipment Four, the remaining oranges were placed on shelves in piles, one pile for each box and allowed to stand at room temperature for nine days. Then two samples of two oranges each were removed from each pile and their biphenyl content determined. These data are contained in Table XIII.

TABLE III

FOURTH SHIPMENT OF CALIFORNIA ORANGES

Biphenyl Content of California Valencia Oranges
Held Nine Days Under Conditions Simulating
Those Found in a Food Market

Sample No.	Biphenyl Content (p.p.m.) Pulp	Whole Fruit	Peel
1 A		83	429
B	1.08	131	485
2 A	0.56	55	216
B	0.46	74	284
3 A	0.55	35	166
B	0.53	30	203
4 A	0.35	67	226
B	0.78	62	269
5 A	1.60	89	352
B	1.07	99	374
6 A	0.31	34	141
B	0.43	44	216
7 A	0.49	33	143
B	0.78	48	230
8 A	1.09	70	315
B	1.09	58	282
9 A	0.25	34	132
B	0.34	42	166
10 A	0.89	64	305
B	1.23	102	516
11 A	0.56	32	137
B	0.46	29	183
12 A	1.42	97	398
B	0.93	100	395

The fifth shipment of California oranges consisted of six boxes containing Lemonoil (L) collars and six boxes having Phenodor (P) collars. Each sample consisted of six to eight oranges, chosen at random, but all having been in contact with a biphenyl treated surface. These oranges were analyzed as whole fruits only. However, composite samples were made of all the Phenodor and all the Lemonoil boxes and these were analyzed on a pulp, whole fruit and peel basis.

The oranges remaining after the initial sampling were placed on shelves and left for 12 days. Composite samples were then taken of both the Phenodor and Lemonoil piles and reported on the basis of whole fruit biphenyl content.

The data from these analyses are shown in Table XIV.

TABLE XIV

FIFTH SHIPMENT OF CALIFORNIA ORANGES

Biphenyl Content of California Valencia Oranges
Shipped in Biphenyl Treated Fiberboard Boxes
Six Boxes Each With Phenodor and
Lemonoil Collars

	Biphenyl Content of Fruit (p.p.m.)			Biphenyl Content of Collars	
Sample No.	Pulp	Whole Fruit	Peel	mg./sq. in	lb./1000 sq. ft.
1 P		19		0.17	0.054
2 P		33		0.25	0.079
3 P		32		0.34	0.108
4 P		42		0.30	0.095
5 P		35		0.37	0.118
6 P		34		0.39	0.124
Composite					
P	0.52	26	25		
1 L		25		1.34	0.43
2 L		57		1.38	0.44
3 L		60		2.38	0.76
4 L		52		1.79	0.57
5 L		32		2.27	0.72
6 L		57		1.90	0.60
Composite					
L	1.3	51	50		
Composite After twelve days shelf life					
P		34			
L		51			

P = Phenodor collars
L = Lemonoil collars

Shipments six, seven, and eight were the same as number five and were analyzed in the same way except for varying lengths of "shelf-life" periods. Data for Shipment Number Six are contained in Table XV.

TABLE XV

SIXTH SHIPMENT OF CALIFORNIA ORANGES

Biphenyl Content of California Valencia Oranges
Shipped in Biphenyl Treated Fiberboard Boxes
Six Boxes Each With Phenodor and
Lemonoil Collars

Sample No.	Biphenyl Content of Fruit (p.p.m.) Pulp	Whole Fruit	Peel	Biphenyl Content of Collars mg./sq. in.	lb./1000 sq. ft.
1 P		71		1.60	0.51
2 P		52		1.75	0.56
3 P		67		1.58	0.50
4 P		38		1.90	0.60
5 P		52		1.50	0.48
6 P		51		1.66	0.53
Composite					
P	0.69	33	32		
1 L		21		1.18	0.37
2 L		18		0.96	0.31
3 L		19		1.21	0.38
4 L		20		0.95	0.30
5 L		18		1.25	0.40
6 L		22		1.15	0.37
Composite					
L	0.52	21	20		
Composite After twelve days shelf life					
P		48			
L		21			

P = Phenodor collar
L = Biphenyl in lemon oil collar

Data from Shipment Number Seven are contained in Table XVI.

TABLE XVI

SEVENTH SHIPMENT OF CALIFORNIA ORANGES

Biphenyl Content of California Valencia Oranges
Shipped in Biphenyl Treated Fiberboard Boxes
Six Boxes Each With Phenodor and
Lemonoil Collars

	Biphenyl Content of Fruit (p.p.m.)			Biphenyl Content of Collars	
Sample No.	Pulp	Whole Fruit	Peel	mg./sq. in.	lb./1000 sq. ft.
1 P		23		2.55	0.81
2 P		38		1.85	0.59
3 P		38		2.38	0.76
4 P		37		1.80	0.57
5 P		55		2.15	0.68
6 P		69		2.38	0.76
Composite P	0.43	36.2	35.9		
1 L		39		4.30	1.36
2 L		40		3.68	1.17
3 L		35		3.00	0.95
4 L		51		4.65	1.48
5 L		37		2.60	0.83
6 L		41		4.50	1.43
Composite L	0.27	27.4	27.2		
2 weeks at room temperature					
P		29.3			
L		31.3			

P = Phenodor collar
L = Biphenyl in lemon oil collar

Data from analyses of Shipment Number Eight are shown in Table XVII.

TABLE XVII

EIGHTH SHIPMENT OF CALIFORNIA ORANGES

Biphenyl Content of California Valencia Oranges
Shipped in Biphenyl Treated Fiberboard Boxes
Six Boxes Each With Phenodor and
Lemonoil Collars

	Biphenyl Content of Fruit (p.p.m.)			Biphenyl Content of Collars	
Sample No.	Pulp	Whole Fruit	Peel	mg./sq. in.	lb./1000 sq. ft.
1 P		41		4.30	1.36
2 P		45		3.95	1.25
3 P		49		5.62	1.78
4 P		55		6.05	1.92
5 P		46		7.75	2.46
6 P		48		6.23	1.98
Composite P	0.58	43.4	42.7		
1 L		56		3.90	1.24
2 L		60		3.90	1.24
3 L		55		3.28	1.04
4 L		23		1.28	0.41
5 L		50		4.50	1.43
6 L		44		4.93	1.57
Composite L	0.36	37.5	37.1		
Stored for 2 weeks at room temperature					
P		46			
L		44			

P = Phenodor collar
L = Biphenyl in lemon oil collar

Five shipments of one box each of California Navel oranges were received. From each box two samples of thirty oranges each were taken. In one sample the fruits were halved transversely and reamed on a mechanical juicer--an ordinary type marketed by Sunkist Growers Inc. The other sample was macerated for a whole fruit analysis.

The data for these analyses are shown in Table XVIII.

TABLE XVIII

Biphenyl Content of Five Shipments of California Navel Oranges
Shipped in Biphenyl Treated Fiberboard Boxes.
All Boxes With Phenodor Collars

	Biphenyl Content of Fruit (p.p.m.)		Biphenyl Content of Collar	
Shipment No.	Juice	Whole Fruit	mg./sq. in.	lb./1000 sq. ft.
1	1.04	39	4.88	1.55
2	1.54	43	4.48	1.42
3	0.48	36	5.43	1.73
4	0.86	36	3.58	1.14
5	0.88	47	4.03	1.28