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EFFECTS OF CHANGES IN ATMOSPHERIC
PRESSURE ON FRUITS & VEGETABLES

(Tests conducted under
simulated flight conditions)

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Effects of Changes in Atmospheric Pressure on Fruits & Vegetables
(Tests conducted under simulated flight conditions)

The effect of altitude on fruits and vegetables is an important consideration in determining the need for pressurizing the cargo compartments of planes. This subject was of sufficient interest to the Prototype Working Group of the Civil Transport Aircraft Evaluation and Development Board to warrant study and a request was made to the Department of Agriculture in late October to develop information on the effect of altitude on perishable foods. The work on fruits and vegetables was done in California where freshly harvested produce of wide variety was still available. Of all of the fruits and vegetables tested, which included 34 separate items, only 2 showed injury that could be attributed to altitude. These were several specimens of large ripe tomatoes and one ripe persimmon out of several lugs of both that were tested during the simulated flights. The conditions under which the injury occurred were extremely severe, namely during ascent to 50,000 feet at a rate of 5,000 ft. per minute. The type of injury was splitting of the persimmon and tomato occurring between 45,000 and 50,000 ft. elevation (Fig. 1). Strawberries, grapes, peaches, figs, sweet corn, bell peppers, summer squash and limes exposed to the same elevations showed no injury.

These tests indicated that many fruits and vegetables became dull and unattractive during simulated flights, not because of altitude but because of warm temperatures and low humidities during the flight. Mold on berries made considerable growth during warm "flights". These observations point to the need of cool temperature and a moist atmosphere for the air transportation of many fruits and vegetables. Plane design should take into consideration these requirements for fruits and vegetables.

Test Procedure

Under the auspices of the Air Cargo Institute of California a meeting with air cargo specialists and aircraft manufacturers was held in Burbank on November 4 to outline the altitudes, rates of climb and descent that would represent transcontinental flights in planes of the near future. It was agreed that practical altitude tests should be at elevations not exceeding 20,000 ft. and that the chamber should be brought to sea level at 3 intervals during the test thus subjecting the perishables to 4 ascents and descents. The rates of climb and descent were to be at 1,000 ft. per minute. If any commodities showed injury, lower elevations were to be tried and if none showed damage more extreme conditions of altitude and rates of altitude change were to be employed. Non-precooled and precooled flights were to be made. Whenever practicable, commercial containers were to be used. Duplicate control lots of each commodity were to be held at temperatures and humidities similar to those in the altitude chamber so that any altitude effect could be evaluated by close comparison with the checks. Inspections were to be made at the end of the flight and a day or two later to determine differences in market life.

The facilities for conducting the tests were provided by the Lockheed Aircraft Corp. and the work was done cooperatively between this agency and the U. S. Department of Agriculture. The decompression chamber used to simulate flights permitted the control of altitude, rate of climb and descent, temperature and humidity. Fruits and vegetables for the tests were purchased by the U. S. Department of Agriculture from the Los Angeles wholesale market early in the morning, and if they were not to be precooled they were trucked to Burbank in less than an hour, inspected, weighed and placed in the altitude chamber. When precooling was desired the produce was held 24 hours at 40° in a precooling room at the market and the test was made the following day.

Eight tests were made, (table 1), two of which were at altitudes of 20,000 ft., 4 at 30,000 ft., one at 10,000 ft., and a final one at 50,000 ft. Temperatures of the produce and the air of the chamber were read during the test period with thermocouples and humidity records were obtained with a hygrothermograph placed in the chamber. Similar records were made in the rooms in which the control lots were held. Dial indicators were installed on tomatoes, peppers and avocados to show changes in diameter during the altitude test. Photographs of the decompression chamber and instruments used are shown in figures 2 to 4. The fruits and vegetables used in test A are shown in figure 5. Thirty-four different fruits and vegetables were tested as indicated below:

Asparagus	Cauliflower	Onions	Salad mix
Avocados	Celery	Parsley	Spinach
Beans, string	Cucumbers	Peaches	Strawberries
Beans, lima	Eggplants	Peas	Sweet corn
Beets	Figs	Pears	Squash, summer
Bell peppers	Grapes	Persimmons	Tomatoes
Broccoli	Limes	Radishes	Water cress
Brussel sprouts	Mushrooms	Raspberries	
Carrots	Mustard greens	Romaine lettuce	

Results

The results of the individual tests are presented in chronological order. Test A consisted of a "flight" to 20,000 ft. with rates of ascent and descent of 1,000 ft. per minute. Three descents were made during a 12 hour "flight", 8 hours of which was spent at 20,000 ft. (fig. 6). The produce was not precooled and air temperatures were about 80°F. the first 2 hours and then were 60° to 75° for the remainder of the test. Commodity temperatures were about 65°. Humidities were low, ranging from 25 to 30 percent. This was considered a warm dry flight and the condition of some of the commodities after the first 2 hours in the chamber showed the effects of it in dullness and wilting. Weight loss recorded during the 24 hour period encompassing the flight was high and some commodities, such as asparagus, broccoli and green onions, red raspberries and strawberries (table 2) showed losses ranging from 6 to 15 percent. Of the 31 commodities used in this test, only tomatoes showed any indication of altitude injury, and its cause was doubtful for the leaking and bruising may have been due to mechanical damage. The indicator gauges used on 3 specimens of tomatoes during the test showed expansion and contraction in 2 samples amounting to

15 to 30 thousandths of an inch which was quite small for a 3 to 3 1/2 inch tomato (fig. 6). Tomato A was punctured after the third "flight" but it still expanded on the next ascent. Peppers and avocados did not show expansion.

Test B was a duplication of test A in respect to altitude but commodity and air temperatures were maintained at about 42°F. and humidity at 55 to 70 percent (fig. 7). The fruits and vegetables were precooled to about 40° for this test. It was thought that produce if cold would be more turgid than if warm and would split more easily. No splitting was observed in any of the lots (table 3). The most noticeable result was the fresher appearance of the fruits and vegetables as compared with those in the previous test. The weight losses of several commodities during the 24 hours period including the "flight" in these two tests are compared below and the advantage of a cool, moist flight in retaining weight is evident.

	Weight Loss	
	Test A - non-precooled	Test B - precooled
	<u>Pct.</u>	<u>Pct.</u>
Asparagus	14.6	0
Red raspberries	5.8	0
Strawberries	6.9	1.5
Squash, summer	4.1	1.9

Tests C-1 and C-2 were exploratory, made to find whether elevations of 30,000 ft. would be damaging to fruits and vegetables. The first flight was made at a rate of 3,000 ft. per minute ascent and descent and the second at 2,000 ft. per minute. Both were cool flights of 35 to 45°F. Duration at 30,000 ft. was 20 minutes in C-1 and 30 minutes in flight C-2. Red raspberries, strawberries, pears (Comice), tomatoes, cucumbers, figs (Brown Turkey), grapes (Muscat and Tokay), string beans, Zucchini squash and sweet corn (husked) were used and they were exposed to both flights. None of these fruits or vegetables showed injury.

Tests D and E were flights to 30,000 ft. with ascent and descent rates of 2,000 and 1,000 ft. per minute, respectively. The fruits and vegetables were held at 30,000 ft. for 2 hours in both tests. Temperatures were 38° to 43°F. and humidities 80 to 88 percent in test D and 35 to 50 percent in E. The following day another sample of the same lots of fruit was "flown" at 10,000 ft. (i.e. in a pressurized cabin "flight") for 5-1/4 hours with rates of ascent and descent of 500 ft. per minute. It was a cool flight at 44° to 57°F. but fairly dry, 32 to 53 percent humidity. The condition of the produce from this test and tests D and E is compared with that of the check lots in table 4. With only one exception none of the commodities showed injury that could be attributed to altitude. Some large specimens of ripe tomatoes showed cracking of the skin in tests E and F. It is strange that the lot exposed to only 10,000 ft. should show injury (test F) whereas one lot, exposed to 30,000 ft. (test D) did not. Weight losses were moderate in all three tests.

Test G was a final one made on November 24 with the check fruit from the previous test. The produce was brought to an elevation of about 49,500 ft. and held there for 30 minutes. Ascent rates were 5,000 ft. per minute up to 40,000 ft., diminishing as higher elevations were reached. Descent was at the rate of 5,000 ft. per minute. The air temperature was close to 50°F. and humidity 40 to 70 percent. One tomato and a persimmon showed splitting when 48,000 ft. was reached. The split of the persimmon closed appreciably during descent. Dial gauges placed on a tomato showed expansion of about .023 inches at an elevation of 48,500 ft. Small tomatoes and other commodities used in the test were not injured.

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Table 1 - Test conditions used during simulated flights.

Lockheed decompression chamber, Burbank, California, Nov. 10-24, 1948.

Test	Test alti- tude	Total time at alt.	Total test time	Climb and descent rate	Temperature and Humidity				
					In decompression chamber			During subsequent storage	
					Temperature Commod.	Air	Rel. hum.	Air temp.	Rel. hum.
	Ft.			Ft. per min.	°F	°F	Pct.	°F	Pct.
A	20,000	8 hrs. (4, 2-hr. periods)	12 hrs.	1,000	62	57	24	75	35
					to	to	to		
					72	83	31		
B	20,000	8 hrs. (4, 2-hr. periods)	11 hrs. 45 min.	1,000	40	41	54	70	40
					to	to	to	to	to
					44	45	70	73	48
C-1	30,000	20 min.	42 min.	3,000	50	35	60	70	40
					to	to	to	to	to
					60	41	98	73	45
C-2	30,000	30 min.	1 hr.	2,000	40	37	50	70	40
					to	to	to	to	to
					60	47	70	73	45
D	30,000	2 hrs.	2 hrs. 31 min.	2,000	42	38	80	40	50
					to	to	to	to	to
					64	43	88	48	80
E	30,000	2 hrs.	2 hrs. 53 min.	1,000	44	38	35	40	50
					to	to	to	to	to
					61	43	70	48	80
F	10,000	5 hrs. 15 min.	6 hrs.	500	46	44	32	40	50
					to	to	to	to	to
					55	57	53	48	80
G	50,000	30 min.	1 hr.	5,000	47	46	40	(not held)	
					to	to	to		
					53	57	70		

Table 2. Effect of altitude on fruits and vegetables in test A, Lockheed decompression chamber, Burbank, Calif., November 10, 1948. ("Flight" conditions: climb 1,000 ft. per min. to 20,000 ft. hold for 2 hrs. descend same rate to sea level, hold 20 min. repeat 4 times. Air temp. of chamber 70-80° F., humidity approx. 30%, check samples held 75° F., 35% r.h.).

Commodity	Container	Weight loss $\frac{1}{2}$			Condition of produce after exposure to altitude test.
		Weight lbs. Oz.	1st day; Pct.	1st & 2nd day Pct.	
Asparagus, Imperial Valley, 1/2 crate		18 0	14.6	16.6	No injury, slightly more wilting in altitude test lot first day, both wilted and shrivelled second day.
Mary Washington					
Check lot	do.	15 6	3.3	6.6	
Avocado,					No injury to either variety, same appearances as check. Puerte firm, bright; Puebla slightly soft by 2nd day.
Fuerte and Puebla	Flat	13 13	3.2	4.5	
Check lot	do.	13 1	2.4	4.3	
Beans,					No injury, same as check on first day, both dull second day, slightly more wilting in altitude test lot.
Lima and Green	Lug	22 5	3.4	5.6	
Check lot	do.	23 14	1.8	4.2	
Broccoli and					No injury to either broccoli or onions, slightly more wilting of tops of onions in altitude test lot, broccoli shows wilting, yellowing both lots.
Bunched Onions	do.	14 0	6.7	10.0	
Check lot	do.	15 6	3.2	6.4	
Brussel sprouts, spinach,					No injury, spinach shows slight wilting in altitude test lot; sprouts, salad mix fresh first day, slight yellowing of sprouts, wilting of salad mix 2nd day.
salad mix, 6 transparent bags of each	do.	16 5	2.7	4.6	
Check lot	do.	15 5	1.6	4.1	
Cauliflower (trimmed);					No injury, cauliflower, white, fresh first day, slightly yellowed 2nd day both lots; egg plant bright, fresh, slightly soft 2nd day both lots.
egg plant	do.	-- --	--	--	
Check lot	do.	-- --	--	--	
Cucumbers (waxed, prepackaged)do.					No injury, cucumbers dull, greasy from waxing (?) both lots; celery white and crisp both lots for 2 days.
celery in plicofilm bags.	do.	-- --	--	--	
Check lot	do.	-- --	--	--	

Table 2. - Continued

Commodity	Container	Weight		Weight Loss ^{1/}		Condition of produce after exposure to altitude test.
		Lbs.	Oz.	1st day; 1st & 2nd day	Pct.	
Figs, Brown Turkey Check lot.	Flat do.	15 14	3 15	2.9 1.7	4.1 3.8	No injury, slightly soft first day; 10 per-cent decay in check lot 2nd day, altitude test lot shows no decay but more shrivel.
Grapes, Muscat of Alexandria Check lot	Lug do.	37 36	7 3	0.6 0.5	0.8 0.5	No injury, both lots fresh, sound.
Grapes, Flame Tokay Check lot	do. do.	34 32	11 6	0.7 0.8	1.1 1.2	No injury, both lots fresh, sound.
Mushrooms, Button Check lot	Six 8 oz. boxes Four 8 oz. boxes	-- --	-- --	-- --	-- --	No injury, both lots fairly white on first day but slightly browned by 2nd day.
Peaches, Cucamonga Freestones Check lot	Lug do.	25 26	12 0	1.0 1.0	1.9 1.9	No injury, both lots fairly firm, no pitting on first day, on second day altitude lot softer than check lots.
Peas, Telephone Check lot	Lug do.	14 15	15 7	3.3 2.8	5.4 4.9	No injury, altitude test lot slightly more wilted than check lot at both inspections.
Peppers, Bell Check lot	Lug do.	19 19	3 8	1.0 1.0	2.3 1.3	No injury, both lots fresh, bright on first day, on 2nd day slightly more shrivel on shoulder of altitude test lot.
Persimmons, ripe Hachiya Check lot	Lug do.	24 24	3 4	1.0 0.5	1.5 1.3	No injury, both lots bright, slightly soft, no pitting, by 2nd day both lots soft ripe.

Commodity	Container	Weight loss ^{1/}				Condition of produce after exposure to altitude test.
		Weight lbs.	Oz.	1st day; Pct.	1st & 2nd day Pct.	
Radishes, carrots, beets, endive, watercress, parsley, mustard (6 bunches each lot)	Mixed crate	--	--	--	--	No injury, but all of these vegetables show serious wilting from the low humidities at which they were held.
Check lot	do.	--	--	--	--	
Red raspberries (San Martin) (Casperberry)	12 basket crate	9	11	5.8	9.7	No injury, berries soft with some mold starting in both lots, slight leaking in check first day, by 2nd day no leaking in altitude lot, 10-20% mold in both.
Check lot	do.	9	0	3.5	7.6	
Squash, zucchini and white button or Cymalings	Lug	29	4	4.1	5.8	No injury, Zucchini squash shows more wilting in altitude test lot by 2nd day, button squash bright fresh both lots first day, wilted, pitted both lots 2nd day.
Check lot	do.	28	15	1.7	3.7	
Strawberries, (Sunol)	12 basket crate	13	8	6.9	12.0	No injury, no leaking, altitude test lot slightly duller than check, by 2nd day both lots unsalable, about 50% decay.
Check lot	do.	12	13	2.4	10.2	
Strawberries (Santa Maria) Klondike (soft berry)	do.	13	15	5.8	10.7	No injury, slight leaking in both lots, altitude test lot less bright than check, by 2nd day both lots unsalable 50-80% mold.
Check lot (Watsonville)	do.	13	6	3.3	6.6	
Sweet corn (Borego Springs)	Lug	20	12	1.8	4.8	No injury, both lots fairly fresh, some yellowing of kernels noted on husked ears in altitude lot, by 2nd day same as check, some drying.
Check lot	do.	21	8	5.2	8.1	
Golden Bantam Cross						
Tomatoes (El Segundo)	Lug	28	12	0.7	1.1	Possible slight injury, bottom layer of tomatoes in altitude lot show leaking from pressure bruises 2nd day's inspection.
Check lot	do.	24	13	0.3	1.0	
Large, firm ripe to ripe, stem attached						

^{1/} Fruits and vegetables weighed just prior to test started at noon November 10 and re-weighed the following morning after test "flight". Second weighing made November 12 after holding a day at 75°, 35% r.h. Losses expressed as percent of original gross weight.

Table 3.

Effect of altitude on fruits and vegetables in test B, Lockheed decompression chamber, Burbank, California, November 16, 1948. ("Flight" conditions: climb 1,000 ft. per min. to 20,000 ft. hold for approx. 2 hrs., descend same rate to sea level and hold 20 minutes, repeat 4 times. Produce precooled 20 hours in cold storage to 42° F. before "flight." Air temperature in chamber approx. 45° F., humidity 60 to 70%. Check lots held in cold storage during "flight" period.)

Commodity	Container	Weight lbs. Oz.	Weight loss $\frac{1}{2}$		Condition of produce after exposure to altitude test.
			1st period Pct.	1st & 2nd periods Pct.	
Asparagus, Imperial Valley, 1/2 crate		17	0	1.1	) <u>No injury.</u> Both lots fresh, green 1st day; wilted and flowering 2nd day.
Mary Washington					
Check lot	do.	16	4	0	) <u>No injury.</u> Both lots fresh, green 1st day; fairly fresh, no shrivel 2nd day.
Beans-String, Coachella Valley, lug		20	12	1.2	
Blue Lake					) <u>No injury.</u> Both lots fresh, green 1st day; fairly fresh, no shrivel 2nd day.
Check lot	do.	20	6	1.5	
Beans-Lima, Ventura,		21	3	1.8	) <u>No injury.</u> Both lots fresh, green 1st day; fairly fresh, no shrivel 2nd day.
Fordhook					
Check lot	do.	22	3	.3	) <u>No injury.</u> Both lots fresh, bright 2nd day.
Cucumbers, Delano		39	11	.3	
Large 8"					) <u>No injury.</u> Both lots fresh, bright 2nd day.
Check lot	do.	33	12	.2	
Figs, So. California	1/2 flat	10	4	1.2	) <u>No splitting or leaking.</u> Both lots soft ripe, altitude test lot slightly more shrivelled than check on 1st and 2nd days.
Brown Turkey					
Check lot	do.	10	1	.6	) <u>No splitting or leaking.</u> Both lots fairly firm, stems slightly dry; stems of altitude test lot slightly browner than check on 2nd day.
Grapes, Fresno,		40	11	.2	
Muscat of Alexandria	lug				) <u>No splitting or leaking.</u> Both lots fairly firm, stems slightly dry; stems of altitude test lot slightly browner than check on 2nd day.
Check lot	do.	40	13	0	
Grapes, Lodi,		32	4	.6	) <u>No splitting or leaking.</u> Both lots bright firm; stems fairly fresh on 2nd day.
Flame Tokay					
Check lot	do.	32	2	.2	) <u>No splitting or leaking.</u> Both lots bright firm; stems fairly fresh on 2nd day.
				.8	

Table 3 (Continued)

Commodity	Container	Weight		Weight loss 1st & 2nd periods Pct.	1/ Condition of produce after exposure to altitude test.
		Lbs.	Oz.	1st period Pct.	
Pears, Placerville, Bartlett (firm ripe) Check lot	Lug do.	25	12	.2 0 .2	))) No injury. Both lots yellow, ripe, with many dark brown spots on skin following unavoidable jolting during handling.
Pears, San Jose, Comice (firm ripe) Check lot	do. do.	26	3	0 0 0	))) No injury. Both lots straw-russet, ripe, with very few bruised spots.
Peas, Hayward Telephone Check lot	do. do. do.	16	2	2.3 4.7 3.0	))) No injury. Both lots fresh, green 1st day; fairly fresh, no shrivel 2nd day.
Peppers, San Jose Large Bell Check lot	do. do. do.	18	10	0 1.0 .4	))) No injury. Both lots fresh, bright on 2nd day.
Red raspberries, San Martin 1/2 crate Cacherry	8 do.	12	0	2.1 .7	))) No splitting or leaking. Both lots soft, dull with a few flattened "sacs" or drupelets. Both lots salable on 2nd day.
Squash, Calipatria. Button or Cwmling Check lot	Lug do.	33	2	1.5 .6 2.5	))) No injury. Both lots fresh, bright 1st day; altitude test lot slightly more browned than check on 2nd day.
Squash, Dinuba Zucchini Check lot	do. do. do.	30	3	1.9 2.9 2.4	))) No injury. Both lots fresh, bright, slightly pitted. Altitude test lot slightly more wilted than check on 2nd day.
Strawberries, Sunol 20th Cent. (drv, firm) Check lot	12 basket crate do.	12	10	1.5 4.5 7.9	)))) No splitting or leaking. Both lots firm, slightly dull, with some water spots on surface. Unsalable 2nd day, moldy. Altitude test lot slightly more shrivelled than check.

Table 3 (Continued)

Commodity	Container	Weight Lbs. Oz.	<u>1/</u> Weight loss		Condition of produce after exposure to altitude test.
			1st period Pct.	1st & 2nd periods Pct.	
Strawberries, Santa Clara University (Semi-dry) Check lot	12 basket crate do.	13 14 4	4.5 2.6	7.2 4.8	No splitting or leaking. Both lots firm, dark, dull; many with water spots. Unsal- able 2nd day due to mold and water spots.
Strawberries, Santa Maria Klondike (soft) Check lot	do. do	13 10 3	5.0 4.4	7.3 6.6	No splitting or leaking. Both lots fairly firm, bright; most with water spots. Un- salable 2nd day due to mold and water spots. Altitude test lot slightly more shrivelled and duller than check.
Sweet Corn, Arvin Golden Cross Check lot	Crate do.	43 11 47 0	4.9 2.9	7.6 6.6	No injury. Both lots fairly fresh, kernels plump, no shrivel 2nd day.
Tomatoes, El Segundo Large, firm ripe, stems attached. Check lot	lug do.	26 4 26 6 0	.2 .5	1.0	No splitting or leaking. Both lots firm ripe 1st day; fairly firm, no shrivel 2nd day.

1/ Fruits and vegetables weighed prior to precooling Nov. 15, re-weighed Nov. 17 after altitude test and holding overnight in cool chamber. Final weighing Nov. 18 after holding 24 hours in a warm room. Check lots held in cold room until Nov. 17. Losses expressed as percentage of original gross weight.

Table 4 - Effect of altitude on fruits and vegetables in tests D and E (high altitude) and test F (low altitude simulating pressurization). Lockheed decompression chamber, Burbank, California, November 22-23, 1948. 1/

Commodity	Test and altitude Ft.	2/ Weight		3/ Weight loss		Condition of produce after exposure to altitude test.
		Lbs.	Oz.	1st Period Pct.	1st & 2nd Periods Pct.	
Figs	D-30,000	7	11	.8	.8)	<u>No injury</u> , all lots soft-ripe, slightly shriveled.
	E-30,000	7	6	.8	2.5)	
	F-10,000	7	9	.8	.8)	
Check lot		12	1	.5	1.0)	
Grapes (Muscat)	D-30,000	15	4	0	0)	<u>No injury</u> . All lots incl. check showing some raisining also wetness from loose berries.
	E-30,000	15	6	0	0)	
	F-10,000	16	1	.4	.4)	
Check lot		14	15	0	0)	
Grapes (Tokay)	D-30,000	16	12	0	.4)	<u>No injury</u> . All lots dull, no wetness.
	E-30,000	19	12	.3	1.0)	
	F-10,000	18	3	1.0	1.4)	
Check lot		13	7	0	0)	
Limes	D-30,000	10	10	0	0)	<u>No injury</u> . All lots firm and bright.
	E-30,000	10	8	0	.6)	
	F-10,000	7	10	0	.8)	
Check lot		9	5	0	0)	
Peaches (Freestone)	D-30,000	12	15	0	0)	<u>No injury</u> . All lots incl. check ripe to soft ripe, few slightly shriveled.
	E-30,000	13	1	0	.5)	
	F-10,000	12	12	1.5	1.5)	
Check lot		12	11	.5	1.0)	
Pears (Comice)	D-30,000	15	8	0	0)	<u>No injury</u> . All lots firm ripe.
	E-30,000	15	10	0	0)	
	F-10,000	15	3	0	.4)	
Check lot		16	6	0	0)	
Peppers (Bell)	D-30,000	20	10	0	.3)	<u>No injury</u> . All lots fresh, bright.
	E-30,000	15	9	0	0)	
	F-10,000	18	2	.3	.7)	
Check lot		19	8	.3	.3)	
Persimmons (soft ripe)	D-30,000	14	11	0	0)	<u>No injury</u> . All lots incl. check, soft, no splitting.
	E-30,000	13	3	0	1.0)	
	F-10,000	14	5	0	0)	
Check lot		13	5	0	0)	
Spinach (Packaged)	D-30,000	5	11	2.2	2.2)	<u>No injury</u> . All lots incl. check slightly wilted.
	E-30,000	5	12	1.1	1.1)	
	F-10,000	5	8	2.3	2.3)	
Check lot		5	15	1.1	2.1)	

Table 4 (Continued)

Commodity	Test and altitude Ft.	2/ Weight		3/ Weight loss		Condition of produce after exposure to altitude test.
		Lbs.	Oz.	1st Period Pct.	1st & 2nd Periods Pct.	
Squash (Button)	D-30,000	15	11	1.2	1.6)	<u>No injury.</u> All lots incl. check fresh but somewhat pitted.
	E-30,000	13	15	2.7	3.6)	
	F-10,000	13	4	3.3	3.8)	
Check lot		16	9	1.1	1.5)	
Squash (Zucchini)	D-30,000	19	4	1.0	1.6)	<u>No injury.</u> All lots fresh, bright.
	E-30,000	15	14	1.2	1.6)	
	F-10,000	15	11	2.0	2.4)	
Check lot		19	0	1.0	1.6)	
Strawberries (Firm, 90% color)	D-30,000	6	1	2.1	3.1)	<u>No injury.</u> Lots E & F somewhat dull.
	E-30,000	5	11	2.2	4.4)	
	F-10,000	5	4	4.8	4.8)	
Check lot		5	11	3.3	3.3)	
Strawberries (Firm, full, color)	D-30,000	5	9	1.1	1.1)	<u>No injury.</u> Lots D & E somewhat dull.
	E-30,000	5	8	2.3	3.4)	
	F-10,000	5	7	2.3	2.3)	
Check lot		5	14	1.1	2.1)	
Sweet Corn (trimmed)	D-30,000	11	12	1.6	2.6)	<u>No injury.</u> All lots fairly fresh, kernels plump.
	E-30,000	12	5	1.0	2.5)	
	F-10,000	12	3	1.5	2.1)	
Check lot		11	7	1.1	1.6)	
Tomatoes (Large, ripe stems off)	D-30,000	19	1	0	.3)	<u>Possible injury.</u> Skins cracked on several soft-ripe tomatoes in Lots E & F.
	E-30,000	19	8	0	.6)	
	F-10,000	19	12	0	0)	
Check lot		19	1	0	0)	
Tomatoes (Small, ripe stems off)	D-30,000	14	1	.9	.9)	<u>No injury.</u> All lots ripe, few soft ripe; no cracking of skin on soft ripe tomatoes.
	E-30,000	12	4	0	0)	
	F-10,000	12	1	.5	.5)	
Check lot		14	0	0	0)	

1/ See Table 1 for differences in rate of climb, temperature, humidity, and duration of "flight." Low humidity for 6 hours in "pressurized" test F increased weight loss but other differences in "flight" conditions had little or no effect upon the produce.

2/ Lug boxes approximately half full.

3/ Fruits and vegetables weighed Nov. 22 just prior to altitude tests, re-weighed following "flight". Final weighing Nov. 24. All lots held in laboratory cold chamber at approx. 45° F., 65% r.h. following altitude tests.

Figure 1. Ripe tomato and ripe persimmon split by swelling at about 48,000 foot altitude during simulated ascent of 5,000 feet per minute to 50,000 foot altitude (Test G).

Figure 2. Loading decompression chamber with fruits and vegetables. Hygrothermograph and instrument for reading temperatures with thermocouples on table at left of photograph.

H-936

Figure 3. Interior view of decompression chamber showing dial gauges on tomatoes in foreground and produce on shelf of chamber. Test A.

W-9404

Figure 4. Close-up of dial gauges installed to show expansion and contraction of tomato, Test B.

H-9318

Figure 5. Display of fruits and vegetables used in Test A photographed the day following the test.

Figure 6. Test A in decompression chamber. Altitudes, temperatures and humidities fruits and vegetables were subjected to, and the expansion of tomatoes during the test, November 10, 1948.

Figure 7. Test B in decompression chamber. Altitudes, temperatures and humidities fruits and vegetables were subjected to, November 16, 1948.