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CONTRACT RESEAPCH PROJECT REPORT

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Georgia Experiment Station
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Title of Contract:--Study of the Storage Stability
of Containers and Food Procured for the Civil
Defense Shelter Program.

Summary

Annual Report #III includes results of examinations of
stored shelter rations as follows:

<u>Codes</u>	<u>Products</u>	<u>Storage Periods</u>
CD1, 3, 5, & 8	survival cracker	18 and 24 months
CD2, 4, 6, & 7	survival biscuits	18 and 24 months
CD9 & 10	wafers, bulgur wheat	18 and 24 months
CD11, 12, & 13	carbohydrate supplements	6 and 12 months

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Data for rations CD1-5 from the 18-months examination were given in Report No. II; they are repeated here in order to fit crackers CD1, 3, 5 and biscuits CD2, 4 into the overall pattern of second year storage.

I. Fiberboard Cases.

- I.1. Bursting strength decreased by a mean of 40 psig at 100°F and increased by a mean of 26 psig at 40° and 0°, with no significant trend at 70°. Cases having bursting strength below 400 psig increased from the initial 3.5% to mean levels of 44.6% at 100° and 10.3% at lower temperatures.
- I.2. Moisture content ranged with temperature and humidity conditions from a mean of 7.1% at 100°/57% to 12.4% at 0°/amb., the only significant change from first-year equilibria being a mean reduction from 10.6% at 6 months at 6.8% at 18 and 24 months in the 100°/80% condition. This change apparently resulted from alterations in load and stacking pattern in the storage room.
- I.3. General condition of cases was satisfactory for continued storage at all conditions, with no significant amounts of mold, delamination or loosening of flaps. Cases containing the heavier wafer and supplement cans were moderately wrinkled and bulged in the stacks, however, and there were moderate amounts of moisture staining of cases and cans from the 80% r.h. conditions.
- I.4. Case markings remained almost entirely as received, with no serious fading or blurring of print at any storage condition.

II. Metal Cans

- II.1-3. External corrosion & pitted rust near seams and in a few instances on panels and bottoms increased slightly (but erratically during the second year, particularly at the 80% r.h. conditions) in proportion to storage temperatures.

Internal corrosion as surface discoloration where packages or products touched the cans also increased somewhat at 100° and 70°F. There was practically no pitting of internal surfaces.

- II.4. Defects in coatings of cans were essentially rusting near seams, with no evidence of further erosion except in a few areas of speckled rust where coating was apparently thin on panels.
- II.5. Leaking cans averaged about 5% of all cans examined through 18 months, increasing to 20% at 24 months. Questionable leakers ranged ca 5 ±2% from initial through 24 months. There were no

leakers among wafer cans, practically none in one lot of crackers, two of biscuits, one of carbohydrate supplement. About 75% of cans leaked in one lot of biscuits, 35% in one of supplement, 25% in one of crackers. No leaks were attributed to corrosion or associated with storage conditions.

III. Rations.

III.A. Bakery Items.

III.A.1.a. Package seals and materials increased in mean breakage during the second year by about 8% for crackers, 22% for biscuits, only 0.4% for wafers. Broken seals predominated in crackers, torn packages in biscuits; one lot of biscuits had no broken packages, one had no broken seals, and one lot of wafers had no torn wrappers. Influence of temperature on percentages of broken packages was indefinite.

III.A.1.b. Breakage of products increased by about 2% for crackers, 4% for biscuits and 30% for wafers, the latter almost entirely in crumbling of edges. Crackers and biscuits were damaged about equally by breaking apart of units in layers and breaking of individual units. Variance among cans, samples and products was extreme; no definite temperature effect was observed.

III.A.2.a. Sensory scores for appearance-color varied with degree of browning of products in baking, with no consistent effect of storage temperature or time. The lightest two lots of biscuits and the darker lot of wafers varied without pattern, the lighter wafer scored highest at 40° and 0°F, two fairly light crackers and one biscuit were judged better at 70° or below, while the darkest two lots of crackers and one of biscuits scored best at 100°, where some of the dark color was bleached out.

III.A.2.b. Hunter color readings indicated that color changes included both fading and darkening in various items, fading being less during the second year but darkening being greater. Crackers tended to fade at 100° and 70°F, were variable at 40° and 0°F. Biscuits generally faded at 100°, were variable at 70°, darkened at 40° and 0°. Wafers were variable at 100° and 70°, darkened at 40° and 0°.

III.A.3. Fracture strength averaged slight increases with time and with reduction of storage temperatures below 70°F, but these were insignificant when compared to the variances of items, cans and replicate units.

III.A.4.a. Residual oxygen averaged around 5% at 100° and 70°, 13% at 40°, and 15% at 0°F in wafers after 24 months in storage. Mean retention was ca 7% for crackers and near 11% for biscuits at 100°.

although one lot of biscuits was comparable to the crackers. Oxygen in crackers and biscuits from 70° to 0° averaged 16 to 20%.

III.A.4.b. Moisture contents exhibited no consistent trends with either temperature or time of storage; item means were 2.6 ±0.5 for crackers and biscuits, 3.8 ±0.2 for wafers. There were statistically significant correlations of moisture with decreased fracture strength in crackers, but increased fracture strength in biscuits and wafers.

III.A.4.c. Peroxide values of the fat were low during the second year, ranging from ca 1.7 and 1.0 for crackers and biscuits at 100°F to 0.1 at 0°; wafers ranged 0.7 at 70° to 0.3 at 0°, but 0.1 at 100°.

Free fatty acids varied with items rather than products, item group means ranging from .16 to .64% at 100°F and .10 to .53% at 70° and below.

III.A.5.a. Sensory scores for texture were slightly lower at 100°F for crackers and biscuits, but about the same at all temperatures for wafers.

Aroma scores at 24 months ranged 4.36 for crackers to 5.35 for wafers at 100°, 5.75 for wafers to 6.26 for crackers at 70°, 6.58 for wafers to 7.03 for biscuits at 40° and 0°F.

Flavor scores were similar to those for aroma, averaging slightly higher for crackers at 100°, lower for wafers at 70°, and lower for biscuits at both 70° and the lower temperatures.

III.A.5.b. Hedonic ratings for aroma at 24 months ranged 4.64 for crackers to 5.28 for biscuits at 100°, 5.07 and 5.41 for wafers to 6.02 and 6.17 for biscuits at 70° and 40°-0°F, respectively.

Flavor ratings were very similar to aroma, averaging higher by 0.12 at 100°, 0.15 at 70°, and 0.33 (for wafers and biscuits) at 40°-0°F.

Palatability ratings had the same product relationships as aroma and flavor, but averaged 0.39 higher than flavor at 100°, 0.13 higher at 70°, but 0.17 lower (for wafers only) at 40°-0°F. Wafers rated higher than initial at all temperatures.

III.A.5.c. Correlations of palatability with other measurements were sufficiently consistent to indicate definite trends (or lack of trends) associated with storage temperatures during the second year.

III.B. Carbohydrate Supplements.

III.B.1.a. Condition of bags packed in the cans of candy was unchanged by one year of storage, with the exception of a 3% increase in total separations or 0.65 inch increase per 40 seams on seam test of one lot of supplement.

III.B.1.b. Condition of candies remained essentially the same as when received for storage, excepting a lighter surface on pieces of one cherry sample from 100°F/60% r.h.

III.B.2.a. Sensory scores for appearance-color were only slightly reduced by storage at 100°F, the decrease being due to slight fading of the red of cherry-type samples after 12 months.

III.B.2.b. Hunter color values were quite variable; the only trend indicated was slight increase in "L" and decrease in "a" for the sample noted in 1.b.

III.B.4.b. Moisture content did not vary significantly with storage time or temperature.

III.B.4.d. pH values of the candies did not vary consistently with any other factor.

III.B.4.e. Sugar contents exhibited no definite storage influence or relationship to any other variable.

III.B.5.a. Sensory scores for texture were not significantly changed after one year, excepting a mean 0.5-point reduction in score for the cherry-type sample referred to in 1.b.

Aroma and flavor scores averaged 0.4 lower at 70° than at 40°-0°F at 12 months; differences between 40°-0° and 100°F averaged 0.6 at 6 months and 1.1 at 12 months. Reduced scores were attributed to "terpene" aroma and flavor at the higher temperatures.

III.B.5.b. Hedonic ratings for aroma, flavor and palatability exhibited a maximum difference between 40°-0° and 100°F samples of less than 0.5 point after 12 months in storage; mean values for this difference were less than 0.3.

III.B.5.c. Correlations of palatability with other measurements indicated no definite association of palatability with any other factor during the first year of storage of the carbohydrate supplements.

STUDY OF THE STORAGE STABILITY OF CONTAINERS AND FOOD
PROCURED FOR THE CIVIL DEFENSE SHELTER PROGRAM

During the third year of the study, all items remained in continuous storage. Due to variations in periodic examination dates for the 13 products, the total period of storage covered by the present report is 13 January 1964 to 5 April 1965. Storage conditions for this period (as averages and standard deviations) were as follows:

<u>Code</u>	<u>Temperature</u> °F	<u>Relative Humidity</u> percent
100/80	100.2 +2.0, -1.6	80.8 +4.2, -4.2
100/57	99.9 +2.2, -2.5	56.8 +3.6, -3.8
70/80	70.1 +0.6, -1.1	80.1 +2.1, -3.0
70/57	69.9 +1.1, -1.3	56.9 +2.9, -4.1
40/57	40.0 +2.2, -2.3	58.0 +3.5, -3.4
0/amb	-0.5 +3.8, -1.9	ambient

Deviations in storage conditions were those in exposed air spaces where recorders were installed, resulting largely from repeated opening of room doors for maintenance of equipment and removal of samples. Fluctuations inside cases and cans may be assumed to have been considerably smaller.

Products and examinations included in the report are as follows:

<u>Code</u>	<u>Product</u>	<u>Product Pack Code</u>	<u>Contract</u>	<u>Storage Periods</u>
CD1	Cracker	8920-823-7666	2692-62	24 months*
CD3	Cracker	8920-823-7666	2689-62	24 months
CD5	Cracker	8920-823-7667	2687-62	24 months
CD8	Cracker	8920-823-7667	2691-62	18 and 24 months
CD4	Biscuit	8920-823-7367	2694-62	24 months*
CD2	Biscuit	8920-823-7665	2686-62	24 months
CD6	Biscuit	8920-323-7665	2688-62	18 and 24 months
CD7	Biscuit	8920-823-7665	2687-62	18 and 24 months
CD9	Bulgur wafer, white	8920-823-7399	2254-62	18 and 24 months
CD10	Bulgur wafer, red	8920-823-7399	2254-62	18 and 24 months
CD11	Carbohydrate supplement	8925-082-5575	24018-63	6 and 12 months
CD12	Carbohydrate supplement	8925-082-5575	24016-63	6 and 12 months
CD13	Carbohydrate supplement	8925-082-5575	24023-63	6 and 12 months

*Results for 18 months, repeated from Annual Report No. II, are also included in data tables, and discussed as part of the overall pattern of second-year storage.

Statistical treatment of data.

The bases for expression of results of physical, chemical and sensory evaluations of cases, cans and products as means, standard deviations and standard differences are indicated for each set of data presented in the report. Arrangement of data follows the order set up in the initial statements of work, Neg. Rec. AE-266-L and RDT & E-164-P.

All statements of significance of differences are based on analyses of variance, or simple regression analyses for correlation coefficients, by customary procedures. The "significant differences, 5%" were usually derived by multiplying Duncan's Multiple-Range *t* values at the 5% level of probability by standard errors calculated from data error variances. The *t* value for the lowest sub-range (*p*) which would apply to the entire range was used in each instance, in order to obtain a single value for significant difference. For a few sets of data in which group means differed significantly (100° and 70° vs 40° and 0°, for example) but individual treatment means did not, the group mean difference was used as a significant difference, with the restriction that it must lie between the value derived from Duncan's *t* and that found by reversing an "individual-degree-of-freedom" calculation from the starting point of the significant *F* value.

For data on cases, which were single-unit samples, standard errors were calculated from the variance of replicate determinations. For cans and products, based on two-can samples, all standard errors of storage condition means were calculated from can variance, but pooled can and rep variances (or can and judge variances for sensory and hedonic panel scores) were used for estimating standard errors of product means.

I. Fiberboard (V3c) Cases

Periodic examinations included one case of each product from each storage condition. This one case, containing two 5-gallon cans, was the complete sampling unit for all items except CD1, CD3, and CD4. These are packed in 2½-gallon cans, six cans per case, and the sampling unit is 1/3 of a case, the remainder being resealed and returned to storage until each case has been used for three examinations. For CD1, the six storage samples at 24 months were each the first 1/3 of a new case, the first set of six cases having been finished at 18 months. For CD3 and CD4, the first sets were used at 0, 6, and 12 months, the second sets at 18, 24, and (1/3 of each remains for) 36 months.

Data for cases from bakery items (A) and carbohydrate supplements (B) are reported together in this section.

I.A.B.1. Bursting Strength. (Table 1)

General trends for bursting strength over two years of storage were decreases at 100°F, approximate stability at 70°, and increases at 40° and 0°. While most of the changes occurred during the first year, bursting strength of cases at 100° continued to decrease at reduced rates during the second year.

From an initial average of 474 psig, mean values for cases of the 10 bakery items ranged as follows:

<u>Condition</u>	<u>6 to 24 months</u>
100/80	424 to 390
100/57	453 to 407
70/80	452 ± 11
70/57	481 ± 11
40/57	499 ± 6
0/amb	505 ± 17

The cases of carbohydrate supplement were somewhat less definite in trends for the first year. From an initial average of 448 psig, mean values at 6 and 12 months were 412 and 379 at 100°F, 431 ± 6 at 70°, and 418 ± 35 at 40° and 0°.

Among the 13 ration items, percentages of cases having bursting strength below 400 psig were 13.8 initially (10.3 from CD12), 15.4 at 6 months, (9.0 from CD11-13), 28.2 at 12 months (12.8 from CD11-13) 21.7 at 18 and 24 months (CD1-10 only). These average 21.0% of all cases examined, of which 9.2% came from CD12 and CD5, 4.6% from CD9 and CD10; items CD4 and CD8 had no cases below 400 psig. By storage conditions, in the order listed above, percentages of cases below 400 psig were 52.2, 37.0, 15.2, 6.5, 6.5, and 13.0, respectively. Hence the data show definite differences associated with storage time, storage temperature, and (initial averages, ranging from 365 to 558 psig) with point of origin.

I.A.B.2. Moisture Content. (Table 2)

Variations of moisture content of the fiberboard with relative humidity and inversely with temperature are shown in Table 2. The only notable changes from previous periods were in moisture from the 100°/80% condition. As mean values from this room decreased from 10.6% at 6 months to 9.3% at 12 and

8.8% at 18 months, it was suggested that the warm, humid atmosphere might be reducing the moisture-holding properties of the board. Results for 18 and 24 months in bakery items and 6 and 12 months in carbohydrate supplement cases gave a mean of $8.66 \pm .12\%$, however, so it seems probable that the decreases during the first three 6-months periods resulted from alterations in the loading and circulation patterns in the room, which was adjusted from a recorder remaining in a constant position.

There were moderate, but significant, correlations of moisture content with bursting strength in many of the items, though of course the relatively greater variations of bursting strength among items and of moisture content among storage conditions tended to reduce the value of overall or combined correlation coefficients. Examples of this variability are as follows:

<u>ten bakery items</u>	<u>18 months</u>	<u>24 months</u>
	r	r
mean of 9 item coefficients (10th was -)	$+.269 \pm .186$	$+.591^a \pm .135$
mean of "wet" and "dry" condition coefficients	$+.548^a \pm .037$	$+.412 \pm .180$
combined coefficient	$+.188$	$+.452^a$
<u>three supplement items</u>	<u>6 and 12 months</u>	
	r	
mean of 6 "item" coefficients	$+.274 \pm .397$	
mean of 5 coefficients, rooms above freezing (0° was -)	$+.788^a \pm .131$	
combined coefficient	$+.254$	

^aSignificant correlation coefficient.

While there seems little doubt that high storage temperature reduced the bursting strength of the fiberboard (Table 1), the correlations listed above suggest an erratic but nevertheless significant trend toward increased strength with increases in moisture in the range below 12%, particularly at moderate temperatures. Even if the relationship is merely fortuitous (i.e., bursting strength and moisture independently associated with temperature), it still indicates no significant reduction in strength of the board with uptake of moisture from "damp" storage.

I.A.B.3. General Condition of Cases.

All cases examined up to 24 months for bakery items and 12 months for carbohydrate supplements remained in satisfactory condition for continued storage of the cans. As compared to general condition when received, however, certain relatively minor changes were noted and rated on a 7-point scale for "defects".

Loose seals. None of the cases was actually sealed, being closed merely by folding the non-overlapping flaps and stapling at the bottom, gluing at the top. Small center open spaces where flaps failed to meet were left in several cases. These "seals" remained in good condition through 24 months with no pulled-out staples and no loosening of glue. The adhesive was inadequately spread between the flaps of certain cases, leaving loose edges or corners; the maximum defect rating for this condition was 2.0 in one case of supplement CD11, average ratings for all cases examined being .25 for cracker CD5, .17 for biscuit CD7, .09 for wafer CD10, and .29 and .13 for supplements CD11 and CD13.

Delamination. With the exception of a few "frayed" corners of slightly damaged cases or of loose flaps, only three cases had significant amounts of delamination. This was caused by ice in the bottom of one case of CD4 (rating 1.5) at 24 months and one of CD11 (rating 1.0) at 12 months, and by either inadequate fabrication or softening of adhesive in a 5-inch section of panel in one case of CD6 (rating 4.0) at 24 months.

Collapse. As the stacked cases were actually supported by the cans, which showed no evidence of collapse, the only indications of case collapse were pressure wrinkles and bulged panels. These varied considerably with case weights and depth of stacking (most of the 24-month cases were originally third or fourth case down in the stacks, the 12-month cases second down). Illustrative mean values were:

case wt. av. lbs.	items CD	collapse 24 months	Storage °F/% r.h.	collapse	
				24 months	12 months
34	2,7,8	.63 ± .46	100/80	1.12 ± .90	1.67 ± .48
40	5,6	.87 ± .66	100/57	.54 ± .33	1.67 ± .24
55 ^a	1,3,4	.65 ± .40	70/80	1.41 ± .79	1.63 ± .62
71	9,10	1.64 ± .90	70/57	.88 ± .77	1.63 ± .27
		12 months	40/57	.65 ± .37	1.17 ± .24
78	11,12,13	1.49 ± .47	0/amb	.72 ± .51	1.17 ± .48

^aLarger cases containing six 2½-gal. cans, sampled at three periods each.

Values for the bakery item cases at 24 months averaged 0.30 ± .77 above the 18-months values, 12-months values for the supplements were 0.65 ± .70 above 6 months. Greater changes were observed in the lighter cases from 18 to 24 months, indicating a more gradual collapse than with the heavier wafer and supplement stacks, which were generally sitting "flat on the cans" by the end of the first year.

Mold. Small areas of very light mold were observed on the outside of ten of the total number of cases examined through the second year of storage. These occurred on CD7, 11 and 13 from 100°/80% at 12 months (rating $.87 \pm .50$); the other seven cases came from 70°/80%, being CD6, 7 and 13 at 12 months ($1.47 \pm .76$), CD6 and 7 at 18 months ($.60 \pm .20$), and CD6 and 8 at 24 months ($.75 \pm .25$).

Only two areas of mold have been found on the inside of cases, both from 100°/80% at 24 months. A spot inside the case of CD9 received a defect rating of .2 (very slight), while a somewhat larger area, rated 1.0, was noted inside the CD10 case.

Sweating of cases. Sweating of the outside of cases of the ten bakery items, as indicated by moisture stains, was rated $.19 \pm .63$, $-.19$ at 6 months and $.44 \pm .39$ at 24 months (both higher than the .01 and .14 averages at 6 and 12 months). Supplement cases were rated $.12 \pm .82$, $-.12$ at 6 months and $1.62 \pm .85$ at 12 months. Averages by rooms at the latest examination periods were:

<u>Storage</u> °F/% r.h.	<u>Bakery Items</u> 24 months	<u>Carbohydrate Supplements</u> 12 months
100/80	$.61 \pm .33$	$2.43 \pm .81$
100/57	$.31 \pm .57$, $-.27$	$2.17 \pm .85$
70/80	$.67 \pm .45$	$1.90 \pm .54$
70/57	$.18 \pm .36$, $-.18$	$1.37 \pm .58$
40/57	$.34 \pm .27$	$.87 \pm .34$
0/amb	$.54 \pm .34$	$.97 \pm .21$

The increased sweating of the supplement cases, particular during the second period, was attributed to their being located nearest the room doors, and the humidifiers over the doors in the 100° and 70°F rooms. The second period included the winter months, resulting in increased amounts of "dew" being deposited on cases in these locations.

Sweating of cans in cases. Sweating inside cases and evidences of moisture on cans were rated separately, but as both were based largely on rust staining, of cases and cans respectively, the two ratings averaged almost the same values and are considered together. Average ratings were $.37 \pm .90$, $-.29$ at 18 months and $.67 \pm .99$, $-.47$ at 24 months (as compared to .07 and .31 at 6 and 12 months) for the bakery items, $.32 \pm .31$ at 6 months and $.99 \pm .45$ at 12 months for the supplements. Averages for storage conditions at the latest periods were:

<u>storage</u> °F/% r.h.	<u>bakery items</u> 24 months	<u>carbohydrate supplements</u> 12 months
100/80	1.27 ± .94	1.28 ± .37
100/57	.35 ± .35	1.02 ± .25
70/80	1.42 ± .59	1.33 ± .34
70/57	.29 + .35, -.26	.93 ± .28
40/57	.35 ± .29	.72 ± .44
0/amb	.36 ± .30	.65 ± .23

It is apparent that moisture staining was more pronounced inside the cases of bakery items at high humidities (except at 0°F, where ice-damage was somewhat greater on the outside). Staining on the inside of supplement cases was less pronounced than that resulting from outside condensate as noted above.

I.A,B.4. Condition of Markings.

There were no significant storage changes in legibility or general condition of printing on the outside of any of the cases. The print on the case of CD10 from 100°/80% at 24 months appeared slightly faded, and the board color was moderately darker for CD6 and CD8 from this room. These were apparently unit variations, however, as remaining cases of the three products at 100°/80% were unchanged.

II. Metal Cans

II.A,B.1-3. Location, Severity and Type of Corrosion. (Tables 3 & 5)

External rusting of the 2½-gallon cans (Table 3) occurred mostly on the bottoms, with moderate to slight amounts on the panels and along the seams. Practically all of the corrosion apparently started on spots from which the protective coating had been abraded or chipped off.

The 5-gallon cans (Tables 3 & 5) rusted more extensively near the soldered seams, where the coating had been burned or eroded and there was considerable evidence of flux burning. Rusted areas were also found on panels and bottoms where coatings had apparently been scraped thin or removed entirely by abrasion. Although mean values for the 5-gallon cans (including supplement cans at 12 months) were greater than those for the 2½-gallon type, external rusting of the larger cans of CD2, 8, 11 and 12 was comparable to that of the smaller containers.

Internal corrosion of both 2½-gallon and 5-gallon cans was limited almost entirely to areas of direct contact between can surface and package (in the ten bakery items) or piece of candy (in the unpackaged supplements). Hence inner top surfaces were generally free of corrosion except in a few instances of tightly packed cans. As with external rusting, the greater mean values for the larger-can group did not apply to all of the larger cans, several product groups also being comparable to the smaller cans in extent of internal corrosion (Tables 3 & 5).

All external rusting resulted in pitting, some surface corrosion also remaining at 12 and 18 months. Most internal corrosion was surface type only, with slight pitting in certain cans as indicated in the tables. External damage was associated with temperature and storage humidity, internal damage with temperature, and both of course were influenced by time. The time factor remains somewhat uncertain, however, as most of the cans examined at 6 and 18 months were rated higher on corrosion than those at 12 and 24 months. The influence of product type on internal corrosion also remains uncertain - no consistent trends were associated with type of packaging, and while cracker CD8 had more moisture and more internal corrosion than other crackers or biscuits, and wafer CD9 more of both than wafer CD10, there was no generally significant relationship of product moisture with internal corrosion. The possible relationship of corrosion to product humidity equilibrium was not evaluated.

II.A,B.4. Defects of Can Coatings. (Tables 4 & 5)

No softening, or other structural change which could be associated with storage, was noted in any of the can coatings. Hence the rating of coating defects was based almost entirely on lack of coating near seams or in spots where it had been scraped off by some type of abrasion. As such areas were also those which rusted, ratings for coating defects closely paralleled those for corrosion. Even after 24 months, there was relatively little evidence of further erosion of coating by rust, but a few cans were beginning to develop spreading areas of "speckled" rust in places where coating was apparently thin or "pinholed" in application.

II.A,B.5. Leaking Cans. (Table 6)

Data in Table 6, showing percentages of leaking cans and cans noted as "questionable leakers" by product and can type, examination dates and storage conditions, include the following numbers of cans:

examination leakers questionable total cans opened

initial	5	3	62
6-12 mo.	28	19	312
18 mo.	11	8	120
24 mo.	<u>24</u>	<u>4</u>	<u>120</u>
Total	68	34	614

As seen from Table 6, mean percentage of unquestionably sealed cans was lowest in the 2½-gallon type (average 64%, CD4 only 24%) followed by averages of 79% at 12 months for the supplement cans (CD11 only 62%) and 92% at 24 months for the 5-gallon bakery item cans (CD6 only 72%). All questionable leaks (slow succession of bubbles from cans showing no other evidence of leaking) were in top or upper side seams, as were the definite leaks in 56 of the 68 unquestionable leakers. These apparently resulted from defective seam closures. Of the other 12 cans, 3 leaked at apparently defective bottom seams (CD1, 6, 13), 5 at seams opened by dents in the can (CD1, 1, 3, 12, 13), 1 at a closing-chuck pinhole (CD4), and 3 cans of CD11 from lids which were crimped so loosely as to be removable by hand.

No can leaked from corrosion, and there was no significant influence of storage conditions on the number of leaks.

III. The Rations

A. Bakery Items

III.A.1.a. Breakage of Package Seals and Wrapping Materials. (Tables 7 - 9)

Seals broken. Percentages of package seals broken sufficiently to allow ration units to escape increased from 12 to 18 months in all products except CD2 and 6 (no seal breaks) and CD9 (remained .2%). Average increases in the other products were 4.4% for crackers, 5.4% for biscuits CD4 and 7, and .3% for wafer CD10. Further increases in all items except CD1 and 2 at 24 months are shown in Table 7, increases averaging 3.8% in crackers CD3, 5 and 8, 4.8% in biscuits CD4, 6 and 7, and .2% in the wafers. Differences associated with storage conditions were essentially meaningless when compared to the variances of products and duplicate cans.

Packages Torn. There were no torn packages in biscuit CD2 or wafer CD10 at either 18 or 24 months, and cracker CD3 and wafer CD9 had fewer at 18 months than at 12 months. Increases from 12 to 18 months in other products averaged 1.4% in crackers

and 1.5% in biscuits. As seen in Table 8, no packages were torn in cracker CD1 at 24 months, and wafer CD9 had less than .5%. The other three crackers and three biscuits averaged increases of 2.7% and 13.5%, respectively, during the fourth 6-month period. Although torn packages averaged significantly higher from the 0°/amb. condition, the increase came mostly from two products (CD6 and 7), so any real temperature effect seems open to question.

Total Packages Broken. Most of total package breakage was the sum of broken seals and torn wrappers, the mean "overlap" (i.e., torn packages with broken seals) being only .17% at 18 months and .71% at 24 months. Average increases in total packages broken (Table 9) from 12 to 18 months and from 18 to 24 months were, respectively 5.1% and 2.9% for crackers (including .5% decrease for CD3 at 18 months and 6.7% for CD1 at 24 months) 4.7% and 17.2% for biscuits, and a mean of .2% for wafers. Again, any real temperature effect seems doubtful.

III.A.1.b. Breakage of Products. (Tables 10-13)

Separation of Units at Score Lines. While crackers and biscuits CD1-8 showed practically no mean increase in units broken apart in layers at 18 months as compared to 12 months, a large increase occurred in biscuit CD7 (6.3 to 11.9%). Biscuits CD4 and 6 averaged only .41% increase, CD2 decreased 2.3%. Similarly, crackers CD1, 5 and 8 varied less than .5% from the 12-months values, CD3 decreased 2.8%. Changes from 18 to 24 months exhibited the same general pattern (mean increase .23%), the large increase being in cracker CD1 (10.0%) as seen in Table 10. Other crackers increased .43 ± .75%, biscuits CD2 and 6 increased 1.82 ± .21%, CD4 and 7 remained essentially unchanged in mean separation. Differences associated with storage conditions were non-significant, large fluctuations occurring among products and cans.

Chipped edges of wafers decreased 18.4 ± .3% from 12 to 18 months, but were up 29.4 ± 7.8% from 18 to 24 months; CD10 averaged 20.6 ± 7.5% higher than CD9 in chipped edges over the three periods. Temperature differences were quite inconsistent. Chipping of edges was not serious with respect to decrease in total weight of the wafers, but did leave crumbs in the packages. Rounding the edges in forming the wafers would probably have eliminated most of these crumbs.

Moderate breakage of units. Mean increases in moderate breakage of individual units from 12 to 18 months and 18 to 24 months (Table 11) were .04 ± 2.24% and .10 ± 3.26%, respectively; i.e., there was considerable variation in changes among the ten products, but relatively little average increase. Changes for the second year

averaged $4.8 \pm 4.7\%$ increase for crackers CD3 and 5, but $1.3 \pm 3.5\%$ decrease for crackers CD1 and 8; $2.6 \pm 1.9\%$ increase for biscuits CD2, 4 and 6, but $.9 \pm 1.8\%$ decrease for biscuit CD7; and $.3 \pm .3\%$ increase for wafer CD9 but $.2 \pm .4\%$ decrease for wafer CD10. Again, differences associated with storage conditions were apparently meaningless when compared to the inconsistencies among products and duplicate cans.

Crushed units. Percentages of units badly crushed also varied widely and with no apparent relationship to storage conditions. Mean values were .65% at 12 months, .31% at 18 months, .73% at 24 months. During the second year, cracker CD8 increased $.04 \pm 1.00\%$ while crackers CD1, 3 and 5 decreased $.60 \pm 1.06\%$; biscuits increased $.28 \pm .35\%$, wafer CD9 had no crushed units, wafer CD10 had 1.51% at 24 months (Table 12).

Total product breakage. Total breakage was the sum of the types discussed above for wafers and for products packaged in four-unit layers (which have as many score-lines as units). For products packaged in two-unit layers, however, (with only half as many score-lines as units) total was less by 13.6% for cracker CD1, 2.9% for biscuit CD4, and 4.4% for cracker CD8. From 12 to 18 months, changes in total breakage averaged 5.3% decrease for crackers CD3 and 8, 3.0% increase for CD1 and 5; 2.4% decrease for CD2 and 2.9% increase for the other biscuits; and 18.1% decrease, most of which was in crumbling of edges, for the wafers. Changes from 18 to 24 months, as seen in Table 13, averaged .7% decrease for CD1 and 4.7% increase for other crackers; 1.6% decrease for CD7 and 3.5% increase for other biscuits; wafers were up $30.1 \pm 8.2\%$. Total increases during the second year averaged $2.1 \pm 2.1\%$ for crackers, $3.8 \pm 2.4\%$ for biscuits, $11.9 \pm 8.7\%$ for wafers. Significant differences noted in values for various storage conditions among the different products were apparently associated with sample variations, as no generally consistent temperature effect could be demonstrated.

III.A.2.a. Sensory Scores for Appearance and Color. (Table 14)

Appearance and color were scored as separate qualities by the five-member sensory difference panel, but mean scores have remained so nearly the same that a composite appearance-color score has been used for reporting results after the first storage period. Mean scores for the 18 and 24 months examinations are given in Table 14.

Only two changes have been noted in the ten bakery products. Slight increases in surface "glaze" began to appear at the 6th to 12th month in practically all samples, being somewhat more

pronounced at higher temperatures, and color has faded slightly in samples stored at 100°F and many of these at 70°. Neither of these changes caused much reduction in quality scores, as the glaze was not considered objectionable, and the slight fading was frequently deemed an advantage in at least half of the products which were initially described as too brown from baking.

Mean scores for the ten items were 7.33 for initial and 6-months examinations, $7.21 \pm .16$ for 12, 18 and 24 months. General product means, derived from the 24 samples of each which were removed from storage during the first two years, range $7.72 \pm .35$ to $7.02 \pm .36$ for biscuits, $7.45 \pm .32$ to $6.73 \pm .34$ for crackers, and $7.07 \pm .46$ to $6.53 \pm .29$ for wafers. Both ranges and deviations are great enough for statistical significance, but were apparently associated almost entirely with variations in degree of browning of the products in baking. General preference has been for lighter shades of browning among products and samples within products.

Temperature differences, while noted in the slight fading at 100°F, were inconsistent and non-significant in comparison to differences in degree of browning. The standard deviation of the six storage-condition means over the two-year period was only $\pm .03$, the largest periodic deviation being $\pm .10$ at 6 months and the pooled condition-by-period deviation being $.18 \pm .06$. Among products, however, the darker crackers CD1 and 5 and biscuit CD6 scored higher with fading at 100°F, lighter crackers CD3 and 5 and biscuit CD4 scored higher at 70° and below, the lighter wafer CD9 was more attractive at 40° and 0°, while the lighter biscuits CD2 and 7 and the darker wafer CD10 were variable in relation to temperature.

III.A.2.b. Hunter Color Values. (Tables 15-17)

As noted above, there was a general correlation (not calculated statistically) between sensory scores for appearance-color and Hunter color values for the various products and storage samples; lighter products tended to receive higher scores. Hunter values for color at 18 months and 24 months, in relation to trends over the two-year storage period, are discussed below.

Hunter L Values. In accord with the general tendency for slight surface glazing, and some fading of color at higher temperatures, there was a small but relatively uniform time increase in mean values for "lightness", or surface reflectance on the Hunter L scale. Values for the ten products at the five periodic examinations from initial through 24 months averaged 64.13, 64.35, 65.95, 67.25, and 67.81, respectively. The increases were not entirely due to effects of higher temperatures, as variable degrees of glazing apparently influenced readings of samples from 40° and 0°F also, even though all were ground up to eliminate the extreme browning variable before the readings were made. As an estimate of temperature effect, mean differences between 100°F readings and

readings at 0°F (or 40°-0°) at 6, 12, 18 and 24 months were 1.97, 2.07, 2.34 and 2.54, respectively, indicating that most of the temperature effect was established during the first 6-month period.

Mean increases in L readings at the end of the first two years were 4.11 for crackers, 3.71 for biscuits, and 2.77 for wafers. During the second year, product mean increases and temperature differences (Table 15) were as follows:

	<u>periodic increases</u>		<u>difference between 100°F and 0° (or 0°-40°)</u>	
	<u>12 to 18</u>	<u>18 to 24</u>	<u>18 months</u>	<u>24 months</u>
	<u>months</u>	<u>months</u>		
crackers	1.53 ± .38	.68 ± .33	3.33 ± .88	3.23 ± .40
biscuits	1.49 ± .67	.17 ± .24	2.43 ± .81	2.01 ± .83
wafers	.70 ± .31	.93 ± .23	1.60 ± .55	1.95 ± .05

Thus the wafers, which were darker than most other ration items, had both the smallest total gain in lightness and the least change associated with temperature. This relationship of degree of darkness to amount of change in color did not hold for crackers and biscuits, however.

Hunter "a" values. Readings for Hunter "a" or redness value changed with storage, following the same general time pattern, but not the storage temperature pattern shown by the L values. Samples at 100°F decreased in redness during the first 6 months, with further but smaller decreases in the second period to an average which was .69 below the initial mean value of 3.41. Redness decreased more slowly and less uniformly at 70°F, the 12-month value being .34 below initial. Products at 40°F remained fairly stable in red color during the first year, while those at 0° increased from 3.41 to 3.72 in mean value. The general but relatively erratic trend after the first year was slight increases at all storage conditions, resulting in mean values for 18 and 24 months around .4 below initial in samples from 100°F, but .1, .4 and .6 above initial in products from 70°, 40° and 0°, respectively.

Product and storage values for "a" at 18 and 24 months are given in Table 16. Average temperature differences and total changes calculated from the combined second-year data were as follows:

<u>Products</u> (18 & 24 mo.)	<u>Changes from initial values of "a"</u>			<u>difference between 0° (or 40°-0°) and 100°F</u>
	<u>100°F</u>	<u>70°F</u>	<u>40° and 0°F</u>	
crackers	-.81 ± .37	-.10 ± .44	.44 ± .50	1.38 ± .33
biscuits	-.31 ± .38	.09 ± .53	.43 ± .44	.94 ± .29
wafers	.40 ± .33	.55 ± .43	.76 ± .33	.53 ± .18

Thus the actual temperature effect, or difference between the redder samples at 40° and 0°F and the lighter samples at 70° and 100°, involved no fading of red color in the wafers and fading of only part of the biscuits and crackers at 70°. Apparently the frequently-stated preference for the appearance of the 70° or even 100° samples was for samples which had changed less in color than those stored at lower temperatures.

Hunter "b" values. Values for yellow component of color, or Hunter "b", changed less than those for L or "a" as a results of storage. The same general time pattern was observed, with maximum temperature differences being established at 6 months, maximum total changes at 12 months, and relative stability during the second year. Trends differed from those for L and "a" values, however, as "b" values tended to increase slightly at both temperature extremes, beginning within 6 months at 100°F and 12 months at 0°. Also, there was a general slight decrease in second-year values, leaving 100° and 0° mean values near or slightly above initial, 70° and 40° values slightly below.

Overall variations in yellowness were so small, when compared to L and "a" changes, that "b" values were not reported after the first period, and 18 and 24 months tabulations of "b" are omitted from this report. Brief summaries of product levels and changes from product initial values were calculated from the second-year data as follows:

Items CD	mean "b" values (item X sample)	Products (18 & 24 mo)	changes from initial values of "b"		
			100°F	70° and 40°F	0°F
1,5,6	24.69 ± .70	crackers	.07 ± .66	.07 ± .38	.38 ± .42
3,7,8,9	21.63 ± .30	biscuits	.03 ± .32	-.20 ± .29	-.08 ± .20
2,4,10	19.46 ± .49	wafers	-.10 ± .41	-.23 ± .40	-.20 ± .51

As reduction of "a" with stable or increasing "b" usually denotes fading, particularly with increases in L, whereas increases in "a" and reduction of "b" usually occurs in browning, the general trends of color changes were indicated by changes noted in the three color components. In brief, crackers exhibited a tendency to fade at higher temperatures, wafers to brown at lower temperatures, while biscuits were intermediate; as indicated, there was a considerable amount of overlapping in these general trends.

Hunter a/b ratios. For products whose dominant color wavelengths lie in the red to yellow regions, where fading or browning result in shifts of "a" or "b" in opposite directions, the ratio of a/b provides a good index of color changes. The ratios for the ten

bakery items after 18 and 24 months in storage are given in Table 17. As fading changes tended to be maximal at 12 months, while tendencies to brown developed somewhat more slowly, mean values for the ratio were somewhat lower at 12 months than during the second year; ratios at 12 months averaged .122 at 100°F, .138 at 70°, .151 at 40°, and .166 at 0°.

The initial mean a/b ratio for the bakery items was .155; it is seen from the data that ratios after storage range both above and below this mean, the differences between 0° and 100° ratios averaging .044, .050 and .040 at 12, 18 and 24 months, respectively. Product differences between initial ratios and those at 24 months averaged as follows:

products (24 mo.)	changes from initial ratios of a/b			
	100°F	70°F	40°F	0°F
crackers	-.042 ± .016	-.017 ± .015	+.005 ± .032	+.009 ± .014
biscuits	-.013 ± .014	+.002 ± .020	+.021 ± .005	+.025 ± .008
wafers	+.020 ± .018	+.003 ± .039	+.045 ± .008	+.044 ± .004

These differences indicate characteristic changes in color—fading of crackers and biscuits at 100°F and crackers at 70°, darkening of biscuits and wafers at 40° and 0°F, with variable changes in crackers at 40° and 0°, biscuits at 70°, and wafers at 100° and 70°.

III.A.3. Fracture Strength. (Table 18).

Mean fracture strengths for the ten bakery items, by examination periods, were 1417 ± 2 g for initial and 6 months, 1431 g at 12 months, and (Table 18) 1458 ± 4 g for 18 and 24 months. By storage temperatures, these averaged 1423 ± 15 g at 100° and 70°F and 1476 ± 15 g at 40° and 0°F for the first year, 1457 ± 8 g at 100° and 70° and 1491 ± 3 g at 40° and 0° for the second year. While overall temperature and time changes were statistically significant, their practical significance seems questionable when compared to item variations, which were calculated from initial values and combined second-year data as follows:

items CD	18 and 24 months mean values			mean changes from initial values		
	100°F	70°F	40° and 0°F	100°F	70°F	40° and 0°F
4,5,7	1193	1197	1218	-138 ± 87	-134 ± 79	-113 ± 98
1,2,3,8	1272	1332	1353	-14 ± 57	+46 ± 55	+67 ± 80
6,9,10	1863	1875	1954	+312 ± 123	+204 ± 199	+283 ± 140

Considering that the above classification by magnitude of change is a mixed-product arrangement, that item means ranged from 1017 (CD3) to 2324 (CD9), standard differences of cans from 30 (CD4) to 196 (CD10), and standard deviations of replicate units from 33 (CD7) to 227 (CD9) the product, time and temperature differences in fracture strength seem relatively meaningless.

III.A.4.a. Residual Oxygen in Cans. (Table 19)

Decreases in residual oxygen were fairly uniform during the second, third and fourth storage periods, amounts of decrease being roughly proportional to storage temperature. By estimating the samples with two leaking cans (Table 19) at the nearest available value for sealed cans, mean decreases from the ten-item average of 15.68% at 12 months were 1.34% at 18 months and 2.46% (or an additional 1.12%) at 24 months. All items decreased at each period except CD4 at 18 months (probably no can of this item was actually sealed, though some passed the leak test) and CD9 at 24 months. Decreases from initial item values at 24 months were as follows:

products	initial %	decreases from initial values at 24 months			
		100°F	70°F	40°F	0°F
crackers	19.88 ± .42	12.69 ± 2.60	4.00 ± 1.42	2.15 ± .36	1.23 ± .52
biscuits	19.65 ± 1.03 ^a	8.91 ± 2.29 ^b	3.20 ± 1.64 ^b	1.53 ± 1.13 ^b	-0.10 ± .63 ^b
wafers	16.80 ± .20	11.08 ± .78	12.85 ± .96	3.70 ± .20	2.00 ± .70

^aCD6 averaged 17.8%, other biscuits 20.3%.

^bCD4, with generally questionable seals, decreased less than other biscuits.

Biscuits CD2 and CD7 absorbed less oxygen at all temperatures than did other items except cracker CD3 at 70° and 40°F, and of course CD4 which could not be reliably evaluated. Biscuit CD6 was comparable to other high-absorption items at 100° and 40°F, but absorbed less oxygen than did wafers at 70° and 0°F.

III.A.4.b. Moisture Content. (Table 20)

Moisture contents varied mostly among items, with general means at 12 and 24 months being almost identical (2.87 and 2.84). Product-by-item means and deviations for these two periods were 2.73 ± .44% for crackers, 2.52 ± .26% for biscuits, and 3.79 ± .20% for wafers. As all ten items averaged lower at 18 months than at any other storage period (except CD8, which was the same as at 6 months), the 18 months values must be assumed incorrect—

the reason for the (ca 0.6%) low results was not determined.

Although statistically significant differences were noted in the ranges among storage conditions, no consistent trends were associated with either temperature or time of storage.

Correlations with fracture strength. As both loss of moisture and degree of firmness are associated with degree of baking, some correlation between moisture content and fracture strength might reasonably be expected. The correlations at 24 months averaged $-.459 \pm .175$ for CD1, 4, 7, 8 and $-.406 \pm .211$ for other items, the discrepancy being explainable by the limiting of both moisture and fracture variables within individual items. Product correlations exhibited an apparent storage trend, however, as shown by the following:

	<u>crackers</u> r	<u>biscuits</u> r	<u>wafers</u> r
6-12 months	-.087	+.423*	+.318
18 months	-.356*	+.609**	+.794**
24 months	-.503**	+.545**	+.633**

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

These coefficients suggest the development of at least a statistically significant degree of correlation of higher fracture strengths with lower moisture levels in crackers and higher moisture levels in biscuits and wafers. They also suggest that the apparent error in 18-months moisture determinations was absolute rather than relative.

III.A.4.c. Rancidity Values of Fat from Rations. (Tables 21 & 22).

Peroxide values. Mean levels of peroxides for the various storage periods were:

<u>months</u>	<u>100°F</u>	<u>70°F</u>	<u>40°F</u>	<u>0°F</u>
6	3.84	1.73	1.05	.78
12	13.26	3.84	1.68	1.41
18	1.33	.52	.18	.10
24	.83	.47	.21	.12
<u>products</u>				
18 & 24 months				
crackers	1.66 ± .88	.63 ± .57	.11 ± .13	.05 ± .08
biscuits	.98 ± .47	.24 ± .17	.11 ± .10	.09 ± .08
wafers	.13 ± .07	.74 ± .39	.50 ± .22	.30 ± .30

These patterns, the 18 and 24 months values being shown in Table 21, were typical for oxidation of "dry" bakery products in sealed cans. Peak values occurred sometime near the end of the first year, and relatively stable levels were achieved by the end of 18 months. The wafers were considerably oxidized when received (residual oxygen 16.8%, aroma and flavor score 6.0), with the result that peroxides in 100°F samples were lower than those in the (more slowly oxidizing) samples from lower temperatures throughout the two years of storage.

Free fatty acids. Hydrolysis values, as free fatty acids, remained much more closely associated with individual items and much less influenced by time and temperature of storage than did peroxide values. Item and temperature means at 24 months, from Table 22, were as follows:

<u>temperature</u>	<u>CD1,2,5,6</u>	<u>CD3,7,8</u>	<u>CD9,10</u>	<u>CD4</u>
100°F	.157 ± .035	.392 ± .029	.427 ± .048	.639 ± .007
70°, 40°, 0°F	.140 ± .022	.236 ± .038	.316 ± .033	.530 ± .017

These values were fairly typical of free fatty acids throughout the two years of storage, with the exception that there was an increasing difference between 100°F and the lower temperatures. This difference, for ten-item means, was .301 to .275 ± .009 at 6 months, .318 to .272 ± .010 at 12 months, .330 to .273 ± .002 at 18 months, and .330 to .229 ± .007 at the end of two years.

III.A.5.a. Sensory Scores for Texture, Aroma and Flavor. (Tables 23-25).

Texture. Mean texture scores were lowest at 12 months, averaging 6.47; the 6-months average, 6.90, and the second-year averages given in Table 23 were nearer the initial mean, which was 7.06. Values by products and temperatures for 18 and 24 months, fairly representative of the variability of texture scoring, were as follows:

<u>products</u>	<u>second-year mean scores for texture</u>		
	<u>100°F</u>	<u>70°F</u>	<u>40° & 0°F</u>
crackers	6.53 ± .31	6.89 ± .23	6.99 ± .30
biscuits	6.73 ± .32	7.04 ± .39	7.06 ± .34
wafers	6.39 ± .33	6.30 ± .32	6.39 ± .26

Most of the variance resulted from generally lower scores for cracker CD5 and wafer CD10 at 24 months, and for biscuit CD6 at 18 and 24 months. Reasons given for reduction in scores of samples from 100°F frequently included "too brittle," while failure to score

the other samples any higher was generally attributed to slightly too much hardness or toughness. Wafers were usually considered too "grainy" or crumbly."

Aroma. Scores for aroma generally decreased with both time and temperature; the only "break" in the periodic reduction of mean scores from initial 6.67 to 24-months 5.92 was a 12-18 months increase from 6.03 to 6.49. As seen in Table 24, all items decreased from 18 to 24 months except biscuit CD6. Product and temperature values at 24 months were as follows:

<u>products</u>	<u>24-months mean scores for aroma</u>		
	<u>100°F</u>	<u>70°F</u>	<u>40 & 0°F</u>
crackers	4.38 ± .60	6.26 ± .30	6.70 ± .51
biscuits	4.99 ± .56	6.23 ± .33	7.03 ± .23
wafers	5.35 ± .21	5.75 ± .15	6.58 ± .21

The larger variations were caused by low scores for cracker CD3 and biscuit CD7 from 100°F, and cracker CD5 at 40° and 0°F. Typical comments were "rancid" for crackers and biscuits from 100°, "very stale" for wafers from 100° and 70°, "stale" for crackers and biscuits from 70°. Wafers, which were almost 4% low in oxygen and were considered stale when received, apparently withstood 100° storage better than did the crackers, or biscuit CD7. After two years at 40° and 0°, only cracker CD5 was low on aroma score, and wafer CD9 was higher than initial.

Flavor. Flavor scores closely paralleled those for aroma, general averages being slightly lower at initial 6.74 to 24-months 5.81, with the exception of 6.15 (aroma was 6.03) at 12 months. All items decreased from 18 to 24 months as seen in Table 25. Product and temperature means at two years were:

<u>products</u>	<u>24-months mean scores for flavor</u>		
	<u>100°F</u>	<u>70°F</u>	<u>40 & 0°F</u>
crackers	4.65 ± .41	6.31 ± .27	6.60 ± .39
biscuits	5.03 ± .55	5.95 ± .31	6.45 ± .21
wafers	5.38 ± .48	5.35 ± .18	6.55 ± .31

Cracker CD1, biscuit CD7, and wafer CD10 scored lower than other items. As seen above, general means were slightly higher for flavor than for aroma of crackers at 100°F, while biscuits at 70° and below and wafers at 70° scored lower on flavor. Wafer CD9 was apparently more stable than other products at 100°, and both wafers were scored higher than initial after two years at 40° and 0°.

III.A.5.b. Hedonic Ratings for Aroma, Flavor and Palatability.
(Tables 26-28)

Mean ratings by the 25-member hedonic panel were somewhat lower, more nearly graduated with time, and exhibited considerably less "spread" from initial to 24-months levels than did the mean scores of the 5-member sensory difference panel.

Aroma. The general mean ratings for aroma of the ten bakery items were 6.01 for initial and 6 months, 5.65 at 12 and 18 months, 5.52 after two years. Initial and 24-months ratings by products and temperatures were:

products	initial aroma	aroma after 24 months		
		100°F	70°F	40° & 0°F
crackers	5.85 ± .30	4.64 ± .29	5.72 ± .28	5.76 ± .20
biscuits	6.42 ± .27	5.28 ± .39	6.02 ± .27	6.17 ± .23
wafers	5.45 ± .15	5.16 ± .12	5.07 ± .41	5.41 ± .14

Cracker CD8, biscuits CD6 and 7, and wafer CD10 were rated higher than other items in the respective product groups of Table 26. Apparently the main temperature "breaks" were at 100°F for crackers and biscuits, 70° for wafers. Time "breaks" occurred within the first year for cracker CD8, biscuits CD6 and 7, and the wafers (with some "recovery" for wafers during the second year); and at 24 months for crackers CD1 and 3 and biscuit CD4. Ratings for aroma of cracker CD5 and biscuit CD2 decreased gradually over the two years of storage.

Flavor. Mean flavor ratings were 6.17 initial, 5.95 at 6 months, and 5.78 to 5.66 at 12 to 24 months. Major trends were as follows:

products	initial flavor	flavor after 24 months		
		100°F	70°F	40° & 0°F
crackers	5.90 ± .23	4.71 ± .26	5.79 ± .19	5.75 ± .24
biscuits	6.72 ± .54	5.35 ± .34	6.19 ± .30	6.43 ± .34
wafers	5.60 ± .08	5.37 ± .12	5.29 ± .24	5.81 ± .16

Biscuits CD2, 6 and 7 were rated higher than the other seven items at 24 months. Temperature breaks for flavor were approximately the same as those for aroma; i.e., 100°F for crackers and biscuits, 70° for wafers. Time effects were more indefinite; biscuit CD6 varied but actually decreased relatively little, biscuit CD7 and the wafers "drifted" to 12-months lows and then increased some during the second year, while crackers CD8 and CD1 "drifted" to 12 months

and from 12 months, respectively. Cracker CD5 and biscuit CD2 decreased gradually over the two years. Biscuit CD4 decreased gradually to 18 months and cracker CD3 remained relatively stable for 18 months, then both "broke" to lower levels at 24 months. As seen from Table 27, the "break" in CD4 was the only change which placed the flavor level of any item out of the range of other items in the same product group.

Palatability. The initial mean rating of palatability was 6.21, the average rating for the first 18 months of storage was 5.93, and mean rating at 24 months was 5.82. Product and temperature means were as follows:

products	initial palatability	palatability after 24 months		
		100°F	70°F	40° & 0°F
crackers	6.11 ± .27	5.25 ± .22	5.89 ± .20	5.79 ± .20
biscuits	6.66 ± .57	5.68 ± .32	6.24 ± .38	6.41 ± .40
wafers	5.50 ± .34	5.56 ± .22	5.54 ± .22	5.64 ± .07

As with flavor, biscuits CD2, 6 and 7 were rated higher than the other seven items, and the temperature "break" for crackers and biscuits was at 100°F. Wafers exhibited no significant temperature effect as a group, but the low-temperature samples of CD9 averaged .23 higher than samples from 70° and 100° at 24 months (Table 25). Time effects varied with items; biscuit CD6 changed very little for 18 months, then increased slightly at 24 months; wafers had slight drops at 12 and 6 months, respectively, then increased slightly over the remaining periods; cracker CD1 increased to 12 months, then returned to just below initial during the second year. Crackers CD5 and 8 and biscuit CD7 decreased somewhat to 12 months, then "leveled off" for the second year, while cracker CD3 and biscuit CD4 remained near initial level for 18 months, then dropped at 24 months. Again, CD4 was the only item which was significantly outside (below) the range of its product group at the end of two years.

III.A.5.c. Correlations of Palatability Ratings with Objective Measurements. (Table 29)

Many of the correlations with palatability were changed or considerably influenced by the relatively sharp increase in staleness or rancidity of the higher-temperature samples from 12 to 24 months. These shifts may be observed in the correlation coefficients given in Table 29. As examples some preference for lighter-color items is indicated at 18 months, while increased staleness of higher-temperature samples

(also lighter in color) apparently overbalanced this preference at 24 months. The same trend is shown in relation to rancidity values--all correlations except a few with wafers had "switched" to negative (lower ratings for higher-temperature, more rancid samples) by 24 months. Correlations with moisture content were relatively variable--moisture levels apparently varied mostly with items and cans--but items and samples having lower fracture strength, regardless of moisture, were rated somewhat higher in palatability. Correlations with residual oxygen were generally positive, as samples at lower temperatures retained more oxygen than did the staler high-temperature rations. Finally, correlations between sensory quality scores (5-member panel) and palatability ratings (25-member hedonic panel) have generally increased, as most of the differences which were detected at earlier periods by the sensory judges were exerting a definite influence on preference ratings by the second year.

The second year data in general suggests that the bulgur wafers, although initially rated lower than crackers and much lower than biscuits, may prove to be as stable or more stable than either for prolonged storage at normal or elevated temperatures.

B. Carbohydrate Supplements

As the "survival candies" have been stored only one year, with two additional 6-months examinations scheduled for the second year, results were somewhat less definite and are discussed with somewhat less detail than were those for the two-year bakery items under section A.

III.B.1.a. Condition of Packages.

The following data are for bags from all cans examined at 0, 6 and 12 months.

Number per can. The small candy bags were specified at 20 bags per can, and ca 93% of the cans of CD11 and CD13 have contained 20 or 21 usable bags, the other 7% containing 19 bags. Item CD12 had 20 or more usable bags in less than 66% of the cans, with 19 bags in another 14%; the other 20% or six cans contained 18 and 11 usable bags in two cans each, 15 in one can, and one had no bags at all. The low-count cans usually had 20 bags, but 2 to 9 of them were torn or had only one side seam, hence were not usable.

Internal size. All bags of CD11 had 3 inches x 5 inches (300 x 500) of internal capacity; 83% of bags in CD13 were 300 x 500 and 14% were 300 x 506 (3 inches x 5½ inches), with ca 3% undersize at 208 x 500. CD12 had 85% normal 300 x 500 bags, ca 5% undersize at 300 x 413, and ca 6% undersize at 213 x 500. The other 4% of the CD12 bags were not sealed on one of the side seams.

Length of top lip. Bags from CD13 had ca 96.5% normal 04 (4/16 inch) top lips, the other 3.5% of the lips being 05. CD11 had 83% normal lips, 17% slightly short at 03. Lips of CD12 bags were 07 in 5%, 05 in 3.5%, normal 04 in 86.5%, 03 in 4.5%, and 02 in 0.5%.

Width of side seams. Bags from CD11 had ca 79.5% normal 04 (½ inch) side seams, with 14.5% extra wide at 06 and 6% slightly narrow at 03. Seams of bags from CD12 and CD13 were 72% normal 04; wider seams included 7.2% at 06, 11.8% at 07 or 08, 2.4% at 09 or 10, 1.1% at 11 or 12 (12 = ¾ inch); under-width seams included 2.5% at 03, 0.8% at 02, 1.2% at 01, and 1.0% (2% of CD12 seams) at 00 or no seam on one side.

Results of seam test. None of the seams of bags from CD11 or CD12 were completely pulled apart by the seam test (a steady 1-lb pull for 5 minutes at 73°F/50% r.h.), but complete separations of seams from CD13 were 5.6%, 7.5% and 8.5% at 0, 6 and 12 months respectively. There was no evidence of tearing of bag fabrics in any of the tests.

Some of the seams were slightly "peeled back" by the test, without complete separation. In terms of inches of total separation per can (20 bags or 40 seams), mean separation for all cans of CD11 and CD12 was $.06 \pm .07$. Total and partial separations in seams of CD13 averaged .72 inch per can on initial tests, $.85 \pm .65$ inch at 6 months, and $1.37 \pm 3.13-1.21$ inches at 12 months. Mean temperature values at 6 and 12 months were $.62 \pm .30$ at 100°F, $.32 \pm .30$ at 70°, 3.47 ± 1.94 at 40°, and $.94 \pm .53$ at 0°.

III.3.1.5. Condition of Candies.

There was no apparent effect of storage on any physical characteristic of the candies except color. The following data therefore include all cans examined through the first year.

<u>Condition</u>	<u>CD11</u>	<u>CD12</u>	<u>CD13</u>	<u>CD11-13</u>	
				<u>mean</u>	<u>std.dev.</u> 86 cans
<u>count percent:</u>					
lemon type	46.2	48.5	49.7	48.1	6.5
cherry type	53.6	51.5	50.3	51.9	6.5
normal shape	89.4	81.7	88.4	86.3	6.9
chipped pieces	2.9	17.4	5.8	8.7	8.3
off shape pieces	4.3	0.9	4.2	3.1	2.6
broken bits ^a	1.5	.0	1.3	1.0	1.1
clumped pieces	1.9	.1	.4	.8	+2.6,-.8
unsanded or off color	.1	.1	.1	.1	+.4,-.1
<u>weight percent:</u>					
loose sugar ^b	3.1	.6	.9	1.5	+1.7,-1.4
<u>clumped pieces:</u>					
number per clump	2.3	2.1	2.1	2.2	+2.6,-.2

^aCalculated as excess count of pieces over the amounts of broken bits necessary to make chipped pieces up to full weight; count was below zero in several samples, indicating chips lost before candy was placed in cans.

^bIncludes all material of particle size less than 8-mesh.

III.3.2.a. Sensory Quality Scores, Appearance and Color. (Table 30).

Although the two quality factors were scored separately, appearance scores were largely determined by color and the two scores were very nearly the same. The data given in Table 30 are, therefore, combined appearance-color scores, initial values for which were 8.36, 8.24, and 8.20 for CD11, 12, and 13, respectively, or a mean of 8.27.

As seen, color of CD12 and 13 was not seriously affected by one year of storage even at 100°F. The higher temperatures caused some fading of CD11, however, with formation of a bleached or

"whitish" surface ring on some of the red pieces from non-tightly-sealed cans stored 12 months at 100°F/80% r.h.

III.B.2.b. Hunter Color Values. (Tables 31 and 32)

Actual "shades" of color were quite variable among cans and pieces in cans, as evidenced by the relatively large can differences shown in Tables 31 and 32. Also, sanding sugar was scraped from candy used for initial examination (sugar removed before chopping and sieving) but this was found impractical for the larger number of cans from storage. This change in technique apparently resulted in higher readings for Hunter L, the estimated increase being 5.5 ± 0.8 for yellow and 3.3 ± 2.2 for red candies of the three procurement lots. Changes in "a" and "b" were less than the variability of samples, so could not be determined with any degree of reliability.

L values. The only indication of a temperature effect on L values ("lightness by reflectance") was a mean increase of 2.9 ± 1.2 for 100°F samples of CD11 red. The sample from 100°/80% at 12 months (Table 32) averaged 5.7 units higher than the other five CD11 red samples—this was the sample having the whitish surface ring. The decreases of ca 1.5 in CD11 and 12 yellow and 3.3 in CD12 red at 12 months were apparently "case lot" differences.

"a" values. There was no consistent pattern of changes in "a" values, which were in the green range for yellow candies of CD11 and 13, the slightly pink area for yellow of CD12, and of course the red for red candies. The general average was slightly lower for red candies from 100°F, however—13.13 for 100° vs 14.65 for lower temperatures, indicating a possible tendency for fading at 100°. Reference to Table 32 will show that the 100°/80% sample with lighter surface ring averaged 3.3 units below the other CD11 red samples.

"b" values. There was also no consistent pattern in "b" values, which were well up in the yellow range (average 35.6 or ca 1.7 above initial) for yellow candies and low in the yellow (average 4.7 or ca same as initial) for red candies. The lighter 12-month, 100°/80% sample of CD11 red was ca 0.9 unit under item mean, as compared to the can difference of 0.64 shown in Table 32.

a/b ratios. The ratios are included in Tables 31 and 32 for future reference if needed—they indicate no definite trends at this period of storage.

III.3.3. Fracture Strength. -- not applicable to candies.

III.3.4.a. Residual Oxygen in Cans.--Not determined in candies.

III.3.4.b. Moisture Content. (Table 33)

There were no significant differences in moisture content as related to storage time or temperature, except an apparently slight tendency for increase with decreasing temperature in CD12. Item CD11 had considerably greater ranges (1.46% to 2.32 and 2.16%) than the other candies (range $.23 \pm .10\%$) and CD12 averaged $.30 \pm .08\%$ lower than CD11 or 13. Yellow and red candies averaged about the same moisture content in CD11 and 12; CD13 yellow averaged 0.20 above CD13 red, but red candies were higher in 5 of the 28 cans examined.

III.3.4.c. Rancidity Values.--Not applicable to candies.

III.3.4.d. pH Values. (Table 33)

The only significant differences in time-temperature relationships for pH values were a general increase over initial values, averaging ca .25 higher at 6 months and .30 higher at 12 months, and slightly lower values from 100°F than from lower temperatures for CD12, means being 6.86 vs 6.93 and 6.96 vs 7.09 at 6 and 12 months, respectively. Note: The general increase may have resulted from a meter error, as a partial recheck of the three candy items after complete factory overhaul of the meter gave results averaging ca .30 lower than the 12-months values of Table 33.

Values for CD11 had greater ranges (.60 and .26) than those for CD12 and 13 ($.17 \pm .04$), and mean values for CD11 were slightly lower (6.84 vs $6.99 \pm .06$). There was no significant difference between yellow and red candies in any item. Significant correlations of pH and moisture contents were -.628 for CD11 red and -.634 and -.724 for CD12 and 13 yellow at 6 months, but +.600 for CD12 yellow and red at 12 months. Other correlations were non-significant and all except one were positive, so there was apparently no consistent relationship of pH to moisture; association of higher moisture with lower pH could influence stability of sugars.

III.3.4.e. Sugar Contents. (Table 34)

There was no definite influence of storage on sugars during the first year. As seen from the data on Table 34, item CD12 was lower in dextrose (16.09 vs $17.71 \pm .38$) but higher in sucrose

(64.90 vs 63.44 $\pm$.76) than items CD11 and 13; dextrose/sucrose ratios were .248 vs .279 $\pm$.009, but total sugars were about the same, being 80.55% for CD12 and 81.15 $\pm$.64% for CD11 and 13. CD12 was less variable, sample ranges averaging .63 $\pm$.42%, whereas ranges for CD11 and 13 averaged 1.51 $\pm$.63%. Mean differences between cherry and lemon types were -.16% dextrose, .35% sucrose, or .19% total sugar, with item differences ranging up to .27% total sugar for CD12, .67% total sugar for CD11, and .75% sucrose for CD13.

With no definite trends in the sugars, it was not surprising that correlations of sugars with pH and moisture values were also indefinite. Using candies as lemon, cherry and total sample, times as 6 and 12 months, products as CD11, 12, 13 and total, and sugar values as dextrose, sucrose, total sugar and dextrose/sucrose ratio, gave a total of 96 possible correlations with pH and 96 with moisture. Assuming that higher temperatures, lower pH and higher moisture might tend to stimulate inversion of sucrose, with the possibility that some of the lower-poly-saccharides might also be split to disaccharides by this combination of influences, an expected sign (positive or negative) could be predicted for each correlation. Only 65% of the pH correlations had the predicted sign, and only 15% were significant, one of these with the "wrong" sign. Of the moisture correlations, only 53% had the predicted sign and only 22% were significant, including 9% with unpredicted sign. Hence it seems apparent that possible definition of such storage trends must await further storage.

III.B.5.a. Sensory Scores for Texture, Aroma and Flavor. (Tables 30 and 35).

Texture. Scores for texture at 12 months indicated no definite temperature effect except a reduction of ca 0.5 point for the change in surface crystal structure of the "white ring" red candy of CD11 from the 100°/80% condition. Mean scores were higher than at 6 months (Table 30) each item averaging ca 0.2 less than initial (initials averaged 8.56 for CD12 and 8.22 $\pm$.02 for CD11 and 13). These were probably more nearly representative of the product, as comments indicated that even the more persistent judges had learned, by the conclusion of the 6-months examinations, that the carbohydrate supplement was not designed to be eaten like peanuts.

Aroma. Initial aroma scores for CD11, 12 and 13 averaged 7.36, 7.60, and 7.80, respectively. As shown in Table 35, item

CD11 was scored higher at 6 months, CD12 and 13 somewhat lower because of "lack of aroma." Scores at 12 months were nearer initial (judges having learned that CD12 and 13 had to be cracked open to evaluate aroma). Temperature effects were fairly definite; with 40° and 0°F samples averaging 7.66 at 6 months and 8.08 at 12 months, 70° samples averaged $.33 \pm .41$ and $.23 \pm .25$ lower, but 100° samples were $.61 \pm .33$ and $1.04 \pm .25$ lower, for the two storage periods. Typical comments were "lacking" for 70° storage, "terpene" or "artificial" for 100°, with CD12 changing less than the other two items.

Flavor. With initial averages of 7.92, 7.32 and 7.85, respectively, changes in flavor scores may be estimated by reference to Table 35. From 40° and 0°F scores averaging 7.62 at 6 months and 8.07 at 12 months, reductions averaging .75 for CD11 at 6 months and $.52 \pm .13$ for all items at 12 months resulted from storage at 70°. Mean scores from 100° storage were $.53 \pm .23$ and $1.08 \pm .13$ lower than 40° - 0° levels at the two periods. "Strong" "terpene," and "artificial" were variously noted as descriptive of flavor in the 100° samples.

III.B.5.b. Hedonic Ratings for Aroma, Flavor and Palatability. (Table 36)

With the exception that initial mean hedonic rating for flavor and palatability was 7.57, the hedonic ratings were generally lower than were the sensory quality scores discussed above (general average 6.89 hedonic, 7.50 sensory). Hedonic means also exhibited less "spread" for temperature effect, maximum and average item ranges between 100° and 40° - 0°F being 0.46 and 0.13 for hedonic ratings, 1.30 and 0.81 for sensory scores.

Aroma. Initial aroma ratings for CD11, 12, 13 were 6.88, 6.76, 7.04, respectively. As seen in Table 36, mean ratings for CD11 and 13 were somewhat lower at 6 months, but 12-months ratings averaged near the initial 6.89. Temperature reductions from 40° - 0° ratings averaged $.07 \pm .06$ and $.03 \pm .06$ at 6 and 12 months for 70°, $.11 \pm .11$ and $.23 \pm .14$ for these periods at 100°. Mean 100° reductions were greater in CD12 (0.30), maximum reduction (0.34) was in CD11 at 12 months.

Flavor. Initial flavor ratings for the three items were 7.76, 7.24, 7.76, average 7.59. Item means for 6 and 12 months, from Table 36, were 6.94, 6.97, 6.94, average 6.95, eliminating the initially-lower rating of CD12. The difference between 40° - 0° and 70° for the first year averaged $.01 \pm .10$, or no temperature effect at 70°. At 100°, CD12 averaged $.27 \pm .02$ below the 40° - 0° level, but CD11 and 13 were lower, by .46 and .11, only after 12 months.

Palatability. Initial ratings were 7.48, 7.40 and 7.76, average 7.55, for the three supplements. Storage means, from Table 36, were 6.94, 7.03, 6.91, average 6.96, eliminating the initially-higher rating of CD13. Differences between 40°-0° and 70°F were negligible (.01 $\pm$.10); 100°F samples were rated lower only for CD12 (-.20 $\pm$.03) and, after 12 months, for CD11 by 0.40.

III.B.5.c. Correlations of Palatability Ratings with Other Measurements.

There was not enough indication of a trend in correlations of candy palatability with any other measurement to merit tabulation. Of the 208 coefficients determined with Hunter color, moisture, pH, sugars, and the sensory scores by the five-member panel, 54% had a positive sign, 46% were negative. Only 11% were large enough for statistical significance, and these were also divided into positive (6%) and negative (5%) coefficients. Among individual measurement groups such as color, sugars, etc., no group had more than 62% of the same sign, either positive or negative, so no conclusions as to "expected" or predicted signs were warranted. In brief, palatability ratings of the carbohydrate supplements, exhibiting practically no significant trends, could not be related to other measurements which also exhibited little or no trends after one year of storage.

TABLE 1
BURSTING STRENGTH OF V3c FIBERBOARD
(pounds per square inch)

Condition °F/% r.h.	A. Bakery Products									
	CD1	CD3	CD4	CD2	CD5	CD6	CD7	CD8	CD9	Mean
<u>18 months:</u>										
100/80	405	377	478	421	388	393	387	443	342	398
100/57	345	391	459	445	366	419	448	521	368	413
70/80	418	405	489	431	395	395	443	543	398	435
70/57	477	461	490	486	436	497	482	475	449	472
40/57	496	486	513	536	410	491	531	574	478	500
0/amb	507	472	567	484	410	482	541	563	451	498
std.dev., 10 reps	30	29	34	36	31	38	33	32	35	34
sign.dif., 5%	27	26	31	33	28	35	30	29	31	12
Mean ^a	441	432	494	467	401	446	472	520	414	452
<u>24 months:</u>										
100/80	405	358	412	385	383	385	405	487	340	390
100/57	358	392	436	430	379	424	422	488	380	407
70/80	408	452	519	478	403	493	472	503	441	457
70/57	518	466	469	472	430	494	490	518	440	472
40/57	489	475	514	515	415	503	509	530	536	497
0/amb	528	498	549	556	389	568	540	625	481	525
std.dev., 10 reps	38	24	46	34	26	41	40	42	43	38
sign.dif., 5%	34	22	42	30	24	37	36	38	39	13
Mean ^a	451	440	483	473	399	478	473	525	436	458

(contd)

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at 18 and 24 months.

at 6 and 12 months.

^Different case manufacturers code.

TABLE 2
MOISTURE CONTENT OF V3c FIBERBOARD
(percent)

Condition °F/% r.h.	A. Bakery Products										
	<u>CD1</u>	<u>CD3</u>	<u>CD4</u>	<u>CD2</u>	<u>CD5</u>	<u>CD6</u>	<u>CD7</u>	<u>CD8</u>	<u>CD9</u>	<u>CD10</u>	<u>Mean</u>
<u>18 months:</u>											
100/80	8.9	9.0	8.9	8.7	9.1	8.5	8.8	8.8	8.7	8.4	8.77
100/57	7.1	7.2	7.3	7.0	7.2	6.9	7.0	6.8	7.0	6.9	7.02
70/80	12.2	12.6	12.4	12.2	12.4	12.0	12.2	12.1	11.8	11.8	12.15
70/57	7.3	7.5	7.3	7.5	7.0	8.2	8.5	7.9	8.3	8.3	7.77
40/57	8.3	8.9	8.3	8.5	8.4	8.1	8.5	7.8	8.4	8.7	8.38
0/amb	11.9	12.0	11.5	11.8	12.6	13.2	13.2	13.2	12.8	12.6	12.47
std.dev., 2 reps	.04	.07	.07	.06	.05	.05	.05	.05	.11	.06	.06
sign.diff., 5%	.09	.16	.17	.15	.11	.11	.12	.10	.26	.14	.24
Mean ^a	9.28	9.54	9.27	9.28	9.41	9.47	9.68	9.42	9.51	9.43	9.43
<u>24 months:</u>											
100/80	8.5	8.7	8.6	8.3	8.8	8.6	8.7	8.6	8.8	8.5	8.62
100/57	7.0	7.0	7.2	6.8	7.2	7.0	7.3	7.2	7.6	7.3	7.15
70/80	11.8	11.7	11.7	12.0	11.8	11.6	11.9	11.5	11.4	11.6	11.69
70/57	8.3	8.5	8.1	7.7	8.1	8.0	8.5	3.3	8.5	8.5	8.25
40/57	8.8	9.1	8.5	8.3	8.6	8.5	8.5	8.5	8.8	8.8	8.63
0/amb	12.2	11.7	11.9	12.5	12.1	12.0	13.1	13.5	12.4	12.4	12.36
std.dev., 2 reps	.04	.03	.04	.03	.05	.03	.03	.04	.06	.06	.04
sign.diff., 5%	.09	.08	.10	.07	.11	.06	.07	.09	.13	.15	.18
Mean ^a	9.43	9.47	9.29	9.27	9.43	9.28	9.66	9.58	9.58	9.53	9.45

(contd)

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^aSignificant differences were 0.29 and 0.26 for product means, 0.14 and 0.09 for products in rooms, at 18 and 24 months.

Significant differences were 0.22 and 0.25 for product means, 0.17 and 0.09 for products in rooms, at 6 and 12 months.

TABLE 3
CORROSION OF BAKERY ITEM CANS
(0-9 scale, 0 = none)

Condition •F/° r.h.	2½-gallon cans				5-gallon cans										Std.dif. cans
	CD1	CD3	CD4	Mean	CD2	CD5	CD6	CD7	CD8	CD9	CD10	Mean			
External, pitted (P) or surface (S):															
18 months:	P	P	P		P	P	P	P	P	P	P	PS			
100/80	1.3	1.1	1.5S	1.30	1.8	2.5	3.0	5.0	3.5	6.5	3.8	3.73	.92		
100/57	.0	.55	1.3S	.62	.7	.9	1.0	4.0	.15	.15	.7	1.09	1.27		
70/80	.75	.55	1.25S	.85	1.2	1.55	3.5	4.0	.3	2.5	1.2	2.04	.92		
70/57	.2	.35	.5S	.35	.75	.9	1.5	.85S	.6S	.8S	.7	.87	.67		
40/57	.2	.3	.9S	.47	.4	.45	2.1S	.55S	.1S	.4	.7	.67	1.26		
0/amb	.0	.2	.7S	.30	.25	.3	1.7S	1.0	.2S	1.1S	1.0	.79	.92		
std.dif., cans	.10	.18	.58	.36	.27	.98	2.13	1.98	.54	.43	.26	1.20	1.02		
sign.dif., 5%	.16	.31	.68	.33	.46	1.14	NS	3.37	.93	.75	.45	.80	-		
Mean ^a	.41	.51	1.03	.65	.85	1.10	2.13	2.57	.81	1.91	1.35	1.53	-		
24 months:	P	P	P		P	P	P	P	P	P	P				
100/80	1.4	1.3	.9	1.18	1.3	2.2	2.0	2.1	1.6	4.2	2.4	2.26	.48		
100/57	.2	.7	.5	.45	.6	1.3	.9	1.9	.6	.7	.6	.94	.24		
70/80	1.0	.8	.6	.78	1.1	1.9	2.4	1.45	.5	2.3	1.3	1.56	.73		
70/57	.2	.5	.4	.37	.3	.5	1.0	.6	.6	.6	.4	.57	.33		
40/57	.2	.3	.6	.37	.2	.2	1.0	.3	.5	.5	.4	.44	.37		
0/amb	.3	.2	.4	.30	.2	.9	.4	.25	.35	.5	.8	.49	.21		
std.dif., cans	.18	.25	.40	.29	.19	.34	.75	.78	.36	.43	.28	.50	.44		
sign.dif., 5%	.31	.43	NS	.29	.31	.58	1.27	1.35	.63	.74	.48	.40	-		
Mean ^b	.53	.63	.57	.58	.62	1.17	1.28	1.10	.69	1.47	.98	1.04	-		

(contd)

Table 3 (contd)

Condition •P/• r.h.	2½-gallon cans				5-gallon cans								Std.dif. cans
	CD1	CD3	CD4	Mean	CD2	CD5	CD6	CD7	CD8	CD9	CD10	Mean	
Internal, pitted (P) or surface (S):													
13 months:	S	S	S		S	S	S	S	S	S	S		
100/80	.7P	.7P	.9P	.77	.3	.7	.5	2.5P	2.0	1.75P	.7	1.21	.56
100/57	.8P	.95	1.3P	1.02	.6P	.95P	.25P	1.25	2.5P	.75	.4	.96	.71
70/80	.65	.35	.4	.47	.3	.75	.25	.75	2.1	1.9P	.9	.99	.94
70/57	.5	.6P	.55	.55	.2	.7	.35P	1.5	2.0	.6	.8	.88	.68
40/57	.7P	.6	.5P	.60	.4	.8	1.25	1.25P	1.05P	.7	.6	.86	.57
O/amb	.6P	.65	.4P	.55	.35	.8P	.75	1.5	1.4	.3	.4	.79	.57
std.dif., cans	.28	.11	.37	.28	.21	.56	.83	.89	1.28	.96	.20	.80	.68
sign.dif., 5%	NS	.19	.50	.25	.30	NS	NS	1.51	NS	1.15	.34	NS	-
Mean ^c	.66	.64	.68	.66	.36	.78	.56	1.46	1.84	1.00	.63	.95	-
24 months:	S	S	S		S	S	S	S	S	S	S		
100/80	1.05P	.5P	.3	.62	.4	1.0P	.3	.7P	.7	1.3P	1.0	.77	.28
100/57	.7P	.3	.3	.43	.4	.9P	.2	.5	1.0	1.3P	.8	.73	.36
70/80	.8P	.5P	.3	.53	.5	.9	.2	.65P	1.1	1.3P	.8	.78	.28
70/57	.9P	.5	.7	.70	.2	.6	.3	1.1P	1.3	1.0	.6	.73	.28
40/57	.5	.4	.8	.57	.3	1.0P	.3	1.0	1.2	.7	.6	.73	.15
O/amb	.6P	.3	.8	.57	.3	1.3P	.6	.85P	1.2	1.0	.7	.86	.19
std.dif., cans	.42	.12	.32	.31	.24	.33	.20	.18	.22	.30	.17	.24	.26
sign.dif., 5%	1.3	.19	.48	.22	NS	NS	.29	.32	.78	.51	.29	NS	-
Mean ^c	.76	.42	.53	.57	.35	.95	.32	.80	1.10	1.10	.75	.77	-

^aSignificant differences for products were 0.23 and 0.86; for products in rooms, NS and 1.90; for 2½-gal. and 5-gal. cans, respectively.

^bSignificant differences for products were NS and 0.43; for products in rooms, NS and 0.78; for 2½-gal. and 5-gal. cans, respectively.

^cSignificant differences for products were NS and 0.48; for products in rooms, NS and NS; for 2½-gal. and 5-gal. cans, respectively.

^dSignificant differences for products were 0.22 and 0.19; for products in rooms, NS and 0.38; for 2½-gal. and 5-gal. cans, respectively.

TABLE 4
DEFECTS IN COATINGS OF BAKERY ITEM CANS
(0-9 scale, 0 = none)

Condition •F/g r.h.	2½-gallon cans				5-gallon cans								Std.dif. cans
	CD1	CD3	CD4	Mean	CD2	CD5	CD6	CD7	CD8	CD9	CD10	Mean	
18 months:													
100/80	.4	.8	1.55	.92	1.25	.8	3.0	1.25	1.2	4.0	1.1	1.80	.55
100/57	.3	.95	1.6	.95	.8	.9	2.0	2.0	.7	.75	.5	1.09	.77
70/80	.5	1.0	1.3	.93	1.0	.85	1.5	2.25	.25	.6	.8	1.04	.44
70/57	.3	.45	.9	.55	.55	1.5	1.5	1.75	1.15	.8	.6	1.12	.58
40/57	.3	.6	1.05	.65	.65	.3	1.5	1.1	.35	.4	.6	.70	.71
O/amb	.5	.55	.65	.57	.45	.45	2.0	.75	.2	1.3	1.0	.88	.39
std.dif., cans	.17	.22	.53	.34	.20	.52	.82	1.31	.44	.43	.20	.67	.65
sign.dif., 5%	.20	.38	.70	.32	.36	.70	1.16	NS	.75	.75	.35	.50	-
Mean ^a	.38	.73	1.18	.76	.78	.80	1.92	1.52	.64	1.31	.77	1.10	-
24 months:													
100/80	.45	.8	1.5	.92	1.0	1.7	1.2	1.3	.7	2.1	1.3	1.33	.21
100/57	.05	.4	1.4	.62	1.1	1.7	1.2	1.1	.6	.7	.7	1.01	.36
70/80	.35	1.2	1.4	.98	.7	1.4	1.2	1.05	.35	.9	1.1	.96	.41
70/57	.6	.7	1.3	.87	.7	1.0	.7	1.0	.65	.6	.4	.72	.22
40/57	.4	.3	1.4	.70	1.1	1.3	.9	1.0	.35	.4	.3	.76	.51
O/amb	.6	.2	1.7	.83	1.2	1.9	.8	.75	.3	.4	.4	.82	.26
std.dif., cans	.28	.22	.61	.41	.33	.51	.44	.32	.18	.17	.17	.33	.35
sign.dif., 5%	.40	.38	NS	.28	.40	.69	NS	NS	.30	.29	.29	.26	-
Mean ^b	.41	.60	1.45	.82	.97	1.50	1.00	1.03	.49	.85	.70	.93	-

^a Significant differences for products were 0.23 and 0.54; for products in rooms, NS and 1.06; for 2½-gal. and 5-gal. cans, respectively.

^b Significant differences for products were 0.26 and 0.28; for products in rooms, NS and 0.84; for 2½-gal. and 5-gal. cans, respectively.

TABLE 5

CORROSION AND COATING DEFECTS OF CARBOHYDRATE SUPPLEMENT (5-GAL.) CANS
(0-9 scale, 0 = none)

Condition *F/g r.h.	6 months					12 months				
	CD11	CD12	CD13	Mean	Std.dif. cans	CD11	CD12	CD13	Mean	Std.dif. cans
External, pitted (P) or surface (S):										
	P	P	P			P	P	P		
100/80	1.0	.5	1.2	.90	.35	.8	.9	1.5S	1.07	.20
100/57	.65	.3	2.6	1.18	.32	.6	.5	1.3S	.80	.49
70/80	1.0	.3	1.7	1.00	.58	.9	.5	.9	.77	.49
70/57	.8	.4	1.4	.87	.57	.4	.3	.5	.40	.26
40/57	.9	.5	2.5	1.30	.60	.55	.6	.7	.62	.13
O/amb	.3	.6	2.6S	1.17	.29	.6	.5	1.1	.73	.29
std.dif., cans	.41	.28	.65	.47	-	.32	.33	.37	.34	-
sign.dif., 5%	.54	NS	.80	.35	-	NS	NS	.59	.31	-
Mean ^a	.78	.43	2.00	1.07	-	.64	.55	1.00	.73	-
Internal, pitted (P) or surface (S):										
	S	S	S			S	S	S		
100/80	.4	1.0P	.6P	.67	.35	.4	.9	1.4P	.90	.29
100/57	.6	.3	.7P	.53	.29	.5	1.0	.8	.77	.33
70/80	.2	.7P	.6P	.50	.26	.5	.7	.7P	.63	.20
70/57	1.0	.9P	.4	.77	.29	.5	.6	.8P	.63	.26
40/57	.8	.9P	.7P	.80	.37	.55	.7	1.0P	.75	.24
O/amb	.5	1.1P	.7P	.77	.29	.4	1.0	.6	.67	.26
std.dif., cans	.30	.29	.34	.31	-	.21	.22	.35	.27	-
sign.dif., 5%	.40	.39	NS	.20	-	NS	.29	.47	.24	-
Mean ^b	.58	.82	.62	.67	-	.48	.82	.88	.73	-

(contd)

2210.6 JCI

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Significant differences for products were 0.20 and 0.20; for products in rooms 0.51 and 0.51, respectively.

significant differences for products were 0.32 and 0.18; for products in rooms 0.62 and \$US, at 6 and 12 months, respectively.

significant differences for products were 0.32 and 0.18; for products in rooms 0.62 and \$US, at 6 and 12 months, respectively.

TABLE 6

LEAKING CANS
(as percentages of cans examined)

Products CL	Definite Leakers				Questionable Leakers			
	0-12 mo.	18 mo.	24 mo.	total	0-12 mo.	18 mo.	24 mo.	total
(2½-gal.)								
1	3.4	8.3	25.0	9.4	3.4	0	16.7	5.7
3	6.9	8.3	33.3	13.2	3.4	8.3	0	3.8
4	48.3	25.0	83.3	50.9	27.6	41.7	0	24.5
(5-gal.)								
2	0	0	0	0	0	8.3	0	1.9
5	13.8	8.3	8.3	11.3	3.4	0	8.3	3.8
6	11.1	41.7	41.7	25.5	3.7	0	0	2.0
7	0	0	8.3	1.9	3.4	8.3	0	3.8
8	0	0	0	0	0	0	8.3	1.9
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
(5-gal.)								
11	20.0	25.0	16.7	20.7	20.0	33.3	0	17.2
12	0	8.3	0	3.4	0	8.3	0	3.4
13	20.0	0	16.7	10.3	20.0	8.3	0	6.9
Conditions °F/° r.h.	6-12 mo. ^a	18 mo.	24 mo.	total ^a	6-12 mo. ^a	18 mo.	24 mo.	total ^a
100/80	1.9	10.0	15.0	6.5	11.5	10.0	5.0	9.8
100/57	11.5	0	15.0	9.8	5.8	0	5.0	4.3
70/80	11.5	10.0	30.0	15.2	5.8	0	0	3.3
70/57	11.5	5.0	25.0	13.0	3.8	10.0	5.0	5.4
40/57	7.7	20.0	10.0	10.9	5.8	5.0	5.0	5.4
0/amb	9.6	10.0	25.0	13.0	3.8	15.0	0	5.4
Total ^b	9.0	9.2	20.0	11.1 ^c	6.1	6.7	3.3	5.5 ^c

^aIncludes CD11-CD13.^bInitials included 8.1% leakers, 4.8% questionable leakers.^cIncludes initials.

TABLE 7
SEAL BREAKS IN PACKAGES
(as percent of packages)

Condition °F/° r.h.	Crackers			Biscuits			Bulgur Wafers		Mean	Std. dif. cans	
	CD1	CD3	CL5	CD2	CD4	CD6	CD7	CD9			CD10
18 months:											
100/80	6.7	3.3	4.2	4.2	0	6.7	0	0	.8	2.58	4.31
100/57	10.0	0	2.1	0	0	0	6.3	.4	.4	1.91	6.61
70/80	13.4	0	0	4.2	0	13.4	0	6.3	2.0	3.91	9.33
70/57	13.3	0	12.4	2.1	0	6.7	0	0	.4	3.50	9.99
40/57	16.7	0	10.4	0	0	3.3	0	0	0	3.16	6.81
O/amb	6.7	0	0	0	0	20.0	0	2.1	.8	3.07	13.43
std.dif., cans	13.87	2.74	11.03	3.80	-	20.56	-	5.64	.73	8.91	-
sign.dif., 5%	NS	NS	NS	NS	-	NS	-	NS	NS	NS	-
Mean ^a	11.12	.56	4.80	1.74	0	8.34	0	2.43	.20	3.02	-
24 months:											
100/80	13.3	0	2.1	2.1	0	13.3	0	0	1.6	3.28	12.09
100/57	10.0	0	6.3	12.5	0	16.7	0	2.1	1.6	4.91	12.48
70/80	6.7	3.3	23.0	6.3	0	43.3	0	2.1	.8	8.62	14.39
70/57	0	0	12.5	6.3	0	13.3	0	10.4	.4	4.29	4.18
40/57	0	6.7	8.3	10.4	0	13.3	1.8	4.2	.8	4.55	6.99
O/amb	6.7	0	4.2	8.3	0	20.0	0	10.4	1.6	5.32	9.28
std.dif., cans	15.64	6.09	17.27	5.90	-	20.01	1.47	9.00	1.86	10.50	-
sign.dif., 5%	NS	NS	NS	NS	-	NS	NS	NS	1.38	5.31	-
Mean ^b	6.11	1.67	9.40	7.63	0	20.00	.30	4.87	1.12	5.16	-

^aSignificant differences were 4.87 for products, NS for products in rooms, at 18 months.

^bSignificant differences were 6.23 for products, NS for products in rooms, at 24 months.

TABLE 8
TORN WRAPPERS (PACKAGES)
(as percent of packages)

Condition °F/% r.h.	Crackers				Biscuits				Bulgur Wafers		Mean dif. cans
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7	CD9	CD10	
18 months:											
100/80	0	0	0	0	0	3.3	0	2.1	0	.55	2.51
100/57	10.0	0	2.1	2.1	0	0	0	22.9	.4	3.75	9.66
70/80	3.3	0	4.2	0	0	3.3	5.4	0	0	1.62	5.23
70/57	0	3.3	4.2	4.2	0	0	1.8	0	0	1.35	4.43
40/57	0	0	0	2.1	0	0	21.4	2.1	0	2.56	9.24
0/amb	0	0	0	0	0	0	17.9	0	.4	1.82	4.53
std.dif., cans	3.84	2.74	5.09	4.17	-	3.87	13.85	12.17	.46	6.49	-
sign.dif., 5%	6.65	NS	NS	NS	-	NS	16.00	16.31	NS	NS	-
Mean ^a	2.23	.56	1.73	1.39	0	1.12	7.73	4.52	.13	1.94	-
24 months:											
100/80	0	0	2.1	12.5	0	0	14.3	8.3	0	3.72	10.87
100/57	0	0	0	8.3	0	6.7	28.6	0	.4	4.40	19.30
70/80	0	10.0	2.1	0	0	16.7	25.0	6.3	.4	6.04	15.23
70/57	0	10.0	10.4	2.1	0	3.3	55.4	2.1	0	8.33	13.96
40/57	0	0	0	2.1	0	0	3.6	25.0	.8	3.15	2.67
0/amb	0	3.3	2.1	6.3	0	16.7	83.9	27.1	1.2	14.06	11.47
std.dif., cans	-	11.87	9.00	9.50	-	7.20	36.57	7.43	.86	13.26	-
sign.dif., 5%	-	NS	NS	NS	-	12.47	62.90	12.86	NS	7.50	-
Mean ^b	0	3.89	2.78	5.22	0	7.22	35.12	11.47	.46	6.62	-

^a Significant differences were 4.53 for products, 10.37 for products in rooms, at 18 months.

^b Significant differences were 7.67 for products, 21.19 for products in rooms, at 24 months.

TABLE 9
TOTAL PACKAGES BROKEN
(as percent of packages)

Condition •F/% r.h.	Crackers				Biscuits				Bulgur Wafers		Std. dif. cans
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7	CD9	CD10	
18 months:											
100/80	6.7	3.3	4.2	4.2	0	10.0	0	2.1	0	.8	3.12
100/57	16.7	0	4.2	2.1	0	0	0	25.0	.8	.4	4.92
70/80	16.7	0	4.2	4.2	0	16.7	5.4	6.3	0	2.0	5.53
70/57	13.3	3.3	14.6	6.3	0	6.7	1.8	0	0	.4	4.64
40/57	16.7	0	10.4	2.1	0	3.3	21.4	2.1	0	1.2	5.72
0/amb	6.7	0	0	0	0	20.0	17.9	2.1	1.2	1.2	4.90
std.dif., cans	14.14	3.87	12.97	6.59	-	19.44	13.85	11.80	.73	1.34	10.67
sign.dif., 5%	NS	NS	NS	NS	-	NS	16.00	15.81	.80	NS	-
Mean ^a	12.79	1.12	6.25	3.13	0	9.46	7.73	6.26	.33	1.00	4.81
24 months:											
100/80	13.3	0	4.2	12.5	0	13.3	14.3	8.3	.4	1.6	6.79
100/57	10.0	0	6.3	18.8	0	16.7	28.6	2.1	.4	1.6	8.43
70/80	6.7	10.0	25.0	6.3	0	56.7	25.0	8.3	1.2	.8	13.99
70/57	0	10.0	22.9	6.3	0	16.7	55.4	10.4	0	.4	12.20
40/57	0	6.7	8.3	12.5	0	13.3	5.4	29.2	.8	.8	7.69
0/amb	6.7	3.3	6.3	12.5	0	26.7	83.9	33.3	3.2	1.6	17.75
std.dif., cans	15.64	13.06	21.18	8.86	-	22.28	36.71	10.48	1.42	1.86	17.02
sign.dif., 5%	NS	NS	NS	NS	-	38.54	63.14	18.14	2.44	NS	9.84
Mean ^b	6.11	5.00	12.15	11.46	0	23.89	35.42	15.28	.99	1.12	11.14

^aSignificant differences were 6.75 for products, NS for products in rooms, at 18 months.
^bSignificant differences were 12.62 for products, 27.24 for products in rooms, at 24 months.

TABLE 10
UNITS SEPARATED IN LAYERS
(as percent of "score-lines" broken apart)^a

Condition °F/% r.h.	Crackers			Biscuits			Mean	Std. dif. cans	Bulgur Wafers	
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7	CD9	CD10
18 months:										
100/80	11.9	12.8	19.9	6.7	4.3	6.3	1.8	12.2	13.8	36.2
100/57	5.1	16.3	16.4	4.8	1.2	7.0	1.5	5.0	39.1	57.6
70/80	12.2	13.8	14.5	13.6	2.8	5.6	2.0	15.4	12.5	41.7
70/57	12.6	17.6	22.2	7.7	4.4	4.9	1.6	10.8	17.3	11.4
40/57	40.3	12.6	9.4	7.3	2.6	6.7	4.0	6.0	13.34	32.1
O/amb	21.5	9.9	21.2	7.5	6.7	2.9	2.6	22.0	11.1	40.0
std.dif., cans	17.17	6.10	7.63	3.28	3.41	3.81	1.83	4.07	11.51	20.51
sign.dif., 5%	29.19	NS	11.80	5.58	4.70	NS	NS	7.19	17.57	28.50
Mean ^b	17.25	13.83	17.28	7.92	3.65	5.57	2.25	11.91	20.93	36.49
24 months:										
100/80	24.1	19.9	17.0	5.0	3.4	7.0	.4	8.4	60.5	87.0
100/57	30.8	12.7	9.1	5.0	8.8	6.5	3.7	6.6	31.6	63.4
70/80	20.1	12.9	21.9	8.3	5.8	7.8	5.3	9.7	37.1	92.7
70/57	25.9	15.2	26.9	8.1	2.0	6.3	7.6	10.5	69.6	70.2
40/57	26.5	15.0	10.6	9.0	5.0	4.3	1.4	10.5	16.93	76.6
O/amb	35.8	13.0	14.3	17.9	6.6	2.0	7.4	24.2	31.8	51.8
std.dif., cans	23.71	4.72	4.73	5.08	3.90	4.13	4.46	7.42	8.59	8.94
sign.dif., 5%	NS	NS	8.19	8.74	NS	NS	6.00	12.76	14.86	15.47
Mean ^c	27.22	14.79	16.65	8.88	5.26	5.66	4.28	11.65	42.54	73.59

^a Data for bulgur wafers are chipped edges, as wafers are packed in individual units.
^b Significant differences were 5.54 for products (CD1-CD8), 11.84 for products in rooms, at 18 months.
^c Significant differences were 8.16 for products (CD1-CD8), 15.38 for products in rooms, at 24 months.

TABLE 11
MODERATE BREAKAGE OF INDIVIDUAL UNITS OF PRODUCTS
(as percent of units)

Condition °F/% r.h.	Crackers				Biscuits				Bulgur Wafers		Std. dif. cans	
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7	CD9	CD10		Mean
<u>18 months:</u>												
100/80	18.3	10.6	16.6	18.4	1.2	14.5	2.5	7.3	.3	.6	9.01	4.51
100/57	7.9	7.0	21.6	11.4	1.5	9.1	2.5	4.9	0	.3	6.62	2.43
70/80	16.1	13.6	20.0	15.5	1.4	16.9	3.4	9.2	.1	.7	9.68	2.92
70/57	18.0	12.7	20.3	16.5	2.1	14.3	2.7	5.5	0	1.1	9.33	9.96
40/57	14.2	6.4	21.6	12.4	.6	12.1	3.4	4.6	0	1.0	7.62	3.92
O/amb	11.4	6.5	20.9	11.7	3.0	11.8	3.5	8.5	.3	0	7.76	2.42
std.dif.,cans	5.84	2.76	4.26	5.52	.75	3.54	1.44	2.09	.17	.56	3.31	-
sign.dif., 5%	10.10	4.78	NS	NS	1.30	6.11	NS	3.55	.25	.83	1.72	-
Mean ^a	14.31	9.48	20.17	14.32	1.64	13.12	2.98	6.64	.10	.61	8.34	-
<u>24 months:</u>												
100/80	9.5	18.5	15.9	16.2	2.5	17.2	3.0	4.6	.1	.1	8.75	4.51
100/57	9.9	9.2	23.4	14.9	2.8	12.4	4.3	3.6	.3	.1	8.08	4.23
70/80	5.7	26.4	18.9	13.2	2.6	20.6	3.2	5.1	.3	.7	9.66	5.47
70/57	9.3	27.9	23.5	14.6	1.1	13.6	3.5	5.8	.1	.1	10.94	4.55
40/57	14.8	13.2	21.2	15.5	3.0	13.6	3.2	3.4	.5	.3	8.88	3.65
O/amb	8.4	9.1	28.5	17.4	2.1	12.8	11.4	6.8	1.2	.2	9.78	4.76
std.dif.,cans	3.57	7.85	3.70	7.06	1.11	5.69	5.76	1.63	.79	.13	4.56	-
sign.dif., 5%	4.79	13.58	6.40	NS	1.49	NS	NS	2.77	NS	.22	NS	-
Mean ^b	9.61	17.36	21.89	15.30	2.36	15.03	6.43	4.87	.40	.25	9.35	-

^a Significant differences were 2.10 for products, NS for products in rooms, at 18 months.
^b Significant differences were 3.43 for products, 7.29 for products in rooms, at 24 months.

TABLE 12

UNITS SEVERELY CRUSHED
(as percent of units)

Condition °F/% r.h.	Crackers			Biscuits			Bulgur Wafers		Mean	Std. dif. cans	
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7			CD9
18 months:											
100/80	0	0	.5	0	0	.9	0	.2	0	0	.58
100/57	0	0	1.6	0	0	0	0	0	0	0	.99
70/80	5.8	.6	1.0	0	0	.9	0	0	0	0	3.82
70/57	1.8	.9	.3	0	0	1.8	0	.3	0	0	1.62
40/57	0	0	.7	0	0	0	1.1	0	0	0	.48
0/amb	0	0	0	0	0	0	0	0	0	0	.00
std.dif., cans	4.99	.47	1.67	-	-	1.80	.03	.26	-	-	1.77
sign.dif., 5%	NS	.80	NS	-	-	NS	.05	NS	-	-	NS
Mean ^a	1.27	.25	.69	0	0	.60	.19	.07	0	0	.31
24 months:											
100/80	.6	.7	1.8	1.3	0	0	2.0	.2	0	0	1.55
100/57	.1	.4	2.0	.3	.1	1.2	.3	.5	0	0	.95
70/80	0	.3	2.5	1.9	0	.6	.3	.3	0	0	.49
70/57	0	1.4	1.8	.8	0	1.4	1.6	.3	0	2.3	1.92
40/57	.2	.3	1.5	1.1	.1	0	.1	0	0	6.7	2.94
0/amb	.8	0	2.0	.9	0	.2	1.8	1.5	0	0	1.18
std.dif., cans	.67	1.00	1.32	1.60	.08	1.58	1.83	.89	-	4.05	1.70
sign.dif., 5%	NS	NS	NS	NS	NS	NS	NS	1.20	-	4.40	NS
Mean ^b	.28	.55	1.93	1.04	.02	.56	1.00	.47	0	1.51	.73

^aNeither products nor products in rooms differed significantly at 18 months.

^bSignificant difference for products was 1.31; product in rooms did not differ significantly at 24 months.

TABLE 13

TOTAL PRODUCT BREAKAGE
(as percent of product)

Condition °F/% r.h.	Crackers			Biscuits			Bulgur Wafers ^a		Std. dif. cans			
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7		CD9	CD10	Mean
<u>18 months:</u>												
100/80	24.2	23.4	37.0	21.7	5.5	18.5	4.3	19.6	14.1	36.8	20.51	7.55
100/57	10.5	23.3	39.5	13.8	2.7	12.6	4.0	10.0	39.1	57.9	21.32	9.00
70/80	28.0	28.0	35.5	22.3	4.2	20.6	5.3	24.6	12.6	42.4	22.35	15.20
70/57	26.0	31.3	42.9	20.4	6.5	18.7	4.3	16.6	17.3	12.4	19.63	7.50
40/57	34.2	19.0	31.7	16.1	3.2	15.5	8.6	10.6	31.8	33.1	20.37	7.90
O/amb	22.1	16.4	42.1	15.4	9.7	13.3	6.0	30.5	11.4	40.0	20.68	5.45
std.dif., cans	7.42	6.63	9.64	6.72	3.43	2.37	2.83	5.44	11.51	20.65	9.23	-
sign.dif., 5%	12.84	9.10	NS	NS	4.70	4.10	NS	9.68	19.57	35.10	NS	-
Mean ^b	24.18	23.56	38.14	18.29	5.29	16.53	5.41	18.63	21.03	37.09	20.81	-
<u>24 months:</u>												
100/80	22.1	39.1	34.7	20.0	5.9	20.7	5.4	13.3	60.5	87.1	30.87	9.33
100/57	25.4	22.4	34.5	17.7	11.7	16.9	8.3	10.7	31.9	63.4	24.27	7.92
70/80	15.8	39.6	43.4	19.2	8.4	25.1	8.7	15.0	37.4	93.4	30.59	8.51
70/57	22.2	44.5	52.2	19.5	3.1	18.1	22.6	16.6	69.7	72.6	34.12	8.95
40/57	28.3	28.6	33.3	21.1	8.1	15.7	4.7	13.9	25.2	83.6	26.23	11.67
O/amb	27.0	16.5	44.8	27.2	8.7	14.0	20.5	32.4	32.9	52.0	28.16	10.41
std.dif., cans	15.18	11.83	8.25	9.86	3.51	7.42	10.14	9.35	8.28	6.98	9.55	-
sign.dif., 5%	NS	20.46	14.27	NS	6.07	NS	15.74	15.78	14.33	12.07	6.81	-
Mean ^c	23.47	32.70	40.48	20.78	7.63	18.40	11.70	16.99	42.93	75.34	29.04	-

^a Most of the breakage of wafers was crumbled edges, as seen in Table 10.^b Significant differences were 7.66 for products, 14.75 for products in rooms, at 18 months.^c Significant differences were 8.09 for products, 15.26 for products in rooms, at 24 months.

TABLE 14

COMBINED SENSORY SCORES FOR APPEARANCE AND COLOR
(scale from 10 = excellent to 1 = poor)

Condition °F/% r.h.	Crackers			Biscuits			Pulgar Wafers		Mean	Std. d.f. cans		
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7			CD9	CD10
<u>18 months:</u>												
100/80	7.05	7.0	7.2	6.6	7.95	6.85	7.2	6.95	7.3	6.8	7.09	.35
100/57	6.85	7.4	7.8	6.2	7.8	7.15	7.7	6.9	7.25	6.6	7.17	.37
70/80	7.15	7.5	7.5	6.7	7.6	7.45	7.3	7.45	7.55	6.6	7.28	.43
70/57	7.2	7.15	7.6	6.4	7.95	7.6	7.2	7.45	7.5	6.6	7.27	.49
40/57	6.55	7.45	7.8	6.7	7.8	7.15	7.1	7.0	7.45	6.6	7.16	.69
O/amb	7.65	7.4	8.05	6.2	7.65	7.55	7.1	7.2	7.6	6.65	7.31	.37
std.dif., cans	.82	.30	.47	.32	.23	.72	.31	.46	.25	.37	.47	-
sign.dif., 5%	NS	.47	.73	NS	NS	NS	.53	NS	NS	NS	NS	-
Mean ^a	7.08	7.32	7.66	6.47	7.79	7.29	7.27	7.16	7.44	6.64	7.21	-
<u>24 months:</u>												
100/80	7.65	7.4	6.9	6.9	7.95	6.95	6.95	6.6	6.95	6.3	7.06	.50
100/57	6.95	7.5	6.95	6.75	7.9	6.8	6.8	7.05	7.15	6.3	7.02	.36
70/80	7.35	7.65	6.3	7.0	7.35	7.05	6.85	7.05	7.23	6.28	7.01	.31
70/57	6.9	7.45	6.85	6.95	7.6	7.25	6.85	7.25	7.13	6.5	7.07	.38
40/57	6.75	7.55	6.5	7.45	7.5	7.5	6.7	7.15	7.55	6.65	7.13	.36
O/amb	7.0	7.35	6.5	6.7	7.2	7.2	6.7	7.25	7.53	6.6	7.00	.24
std.dif., cans	.58	.24	.33	.11	.16	.34	.23	.53	.49	.32	.37	-
sign.dif., 5%	NS	NS	.56	.19	.27	.59	NS	NS	NS	NS	NS	-
Mean ^b	7.10	7.48	6.67	6.96	7.58	7.13	6.81	7.06	7.25	6.44	7.05	-

^a Significant differences were .36 for products, .74 for products in rooms, at 18 months.

^b Significant differences were .42 for products, .58 for products in rooms, at 24 months.

TABLE 15

HUNTER "L" COLOR VALUES

Condition °F/% r.h.	Crackers				Biscuits			Bulgur Wafers		Mean	Std. dif. cans
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7	CD9		
18 months:											
100/80	65.3	74.0	63.3	74.6	72.6	77.4	63.9	74.1	62.4	57.4	68.49
100/57	64.2	73.8	64.7	74.3	72.5	76.8	64.1	74.8	63.9	56.7	68.56
70/80	64.0	72.2	60.6	72.5	72.5	76.1	60.5	73.7	62.8	56.8	67.15
70/57	63.7	71.9	60.6	70.4	71.4	77.8	62.6	71.7	63.2	55.9	66.92
40/57	62.5	71.1	59.5	71.2	71.0	75.3	62.4	73.8	63.7	56.1	66.65
O/amb	63.1	70.7	60.1	70.5	71.1	75.4	60.7	71.3	62.1	54.9	65.99
std.dif., cans	2.28	.82	.70	1.36	.73	.61	.46	1.43	.84	1.38	1.18
sign.dif., 5%	NS	1.43	1.21	2.34	1.25	1.06	.79	2.57	1.51	NS	.65
Mean ^a	63.80	72.26	61.45	72.23	71.84	76.44	62.36	73.25	63.00	56.29	67.29
24 months:											
100/80	67.8	74.0	63.6	74.7	73.1	77.3	63.1	74.0	64.9	57.3	68.97
100/57	65.1	74.0	64.7	74.3	74.1	78.4	63.0	73.9	63.9	59.5	69.08
70/80	65.5	72.5	62.2	72.6	72.3	75.8	61.0	74.1	63.1	59.1	67.82
70/57	63.6	72.3	62.3	72.2	72.4	78.0	62.0	73.4	64.5	55.9	67.65
40/57	61.8	70.6	60.9	72.7	70.9	76.0	62.1	72.4	63.2	56.1	66.66
O/amb	64.2	71.0	60.5	71.9	70.3	75.7	61.9	72.6	62.5	56.7	66.72
std.dif., cans	2.39	.72	.39	1.02	.69	.79	.79	.75	.71	.44	1.02
sign.dif., 5%	4.07	1.25	.67	1.76	1.19	1.37	1.05	1.13	1.22	.76	.61
Mean ^b	64.65	72.38	62.38	73.04	72.18	76.84	62.16	73.38	63.70	57.45	67.81

^aSignificant differences were .84 for products, 1.97 for products in rooms, at 18 months.

^bSignificant differences were .79 for products, 1.63 for products in rooms, at 24 months.

TABLE 16
HUNTER "a" COLOR VALUES

Condition *F/2 r.h.	Crackers			Biscuits			Bulgur Wafers		Mean	Std. dif. cans		
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7			CD9	CD10
18 months:												
100/80	4.5	.8	5.7	1.5	1.6	.3	5.2	1.8	4.4	5.0	3.07	.52
100/57	4.9	.6	5.5	1.9	1.7	.8	5.0	1.2	3.7	4.9	3.01	.49
70/80	4.9	1.4	7.2	2.3	1.7	.9	6.5	1.9	3.9	4.9	3.54	.61
70/57	5.1	1.5	7.0	3.2	2.2	.0	5.7	2.9	4.1	5.6	3.73	.62
40/57	5.6	1.8	7.6	2.7	2.3	1.3	5.8	1.6	3.5	5.4	3.75	.43
O/amb	5.6	2.1	7.3	3.5	2.4	1.4	6.4	3.0	4.3	5.7	4.15	.68
std.dif., cans	.67	.23	.44	.63	.21	.46	.59	.81	.54	.73	.56	-
sign.dif., 5%	1.09	.40	.76	1.09	.37	.80	1.01	1.46	NS	NS	.31	-
Mean ^a	5.07	1.33	6.71	2.52	1.98	.75	5.75	2.06	3.98	5.24	3.54	-
24 months:												
100/80	3.7	.5	6.2	1.4	1.5	.5	5.2	2.7	3.7	5.3	3.05	.47
100/57	4.5	.7	5.6	1.2	1.5	-.1	5.3	2.2	4.4	4.6	2.99	.58
70/80	4.1	1.2	6.2	2.0	2.3	.9	5.8	2.1	4.7	4.4	3.37	.69
70/57	5.0	1.2	6.3	2.0	2.2	-.2	5.5	2.3	4.0	5.6	3.36	.65
40/57	5.8	1.8	7.1	1.6	2.3	1.0	5.9	3.1	4.4	5.5	3.83	.84
O/amb	5.3	1.7	7.4	2.3	2.4	1.0	6.1	3.0	4.6	5.5	3.92	.70
std.dif., cans	1.11	.36	.39	.66	.34	.79	.76	.74	.32	.42	.66	-
sign.dif., 5%	1.89	.62	.69	.90	.58	NS	NS	NS	.55	.72	.37	-
Mean ^b	4.73	1.16	6.46	1.74	2.01	.54	5.63	2.54	4.30	5.12	3.42	-

^aSignificant differences were .40 for products, .94 for products in rooms, at 18 months.

^bSignificant differences were .39 for products, 1.02 for products in rooms, at 24 months.

TABLE 17

HUNTER a/b COLOR VALUE RATIOS

Condition °F/° C r.h.	Crackers			Biscuits			Bulgur Wafers		Mean	Std. dif. cans	
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7			CD9
18 months:											
100/80	.180	.036	.222	.068	.078	.015	.215	.083	.200	.259	.136
100/57	.197	.026	.211	.087	.084	.038	.209	.057	.171	.259	.134
70/80	.194	.063	.279	.104	.085	.044	.271	.085	.184	.259	.157
70/57	.203	.067	.280	.147	.111	-.001	.238	.131	.193	.286	.166
40/57	.221	.084	.297	.124	.118	.067	.243	.075	.162	.286	.168
O/amb	.219	.074	.282	.156	.120	.069	.269	.137	.201	.306	.185
std.dif., cans	.031	.012	.017	.026	.010	.024	.024	.037	.026	.038	.026
sign.dif., 5%	NS	.020	.030	.044	.016	.041	.042	.056	NS	NS	.014
Mean ^a	.202	.062	.262	.115	.099	.039	.241	.095	.185	.276	.157
24 months:											
100/80	.146	.022	.241	.062	.073	.027	.213	.121	.172	.276	.135
100/57	.179	.033	.220	.057	.073	-.004	.216	.102	.203	.236	.132
70/80	.162	.057	.246	.092	.116	.048	.241	.096	.219	.233	.151
70/57	.199	.055	.251	.092	.109	-.008	.230	.107	.184	.292	.151
40/57	.233	.082	.278	.072	.113	.050	.243	.139	.203	.291	.170
O/amb	.208	.076	.289	.106	.119	.053	.257	.134	.214	.278	.173
std.dif., cans	.047	.017	.017	.030	.016	.041	.029	.034	.015	.020	.029
sign.dif., 5%	.071	.028	.028	.044	.027	.056	NS	NS	.025	.035	.014
Mean ^b	.188	.054	.254	.080	.100	.028	.234	.117	.199	.268	.152

^aSignificant differences are .018 for products, .043 for products in rooms, at 18 months.^bSignificant differences are .018 for products, .046 for products in rooms, at 24 months.

TABLE 18

FRACTURE STRENGTH OF RATION UNITS
(grams)

Condition, °F/°C and time	Crackers				Biscuits				Bulkier Wafers		Mean	Std. dif. cans
	CD1	CL1	CL5	CL8	CD2	CL4	CL6	CD7	C 9	CD10		
18 months:												
100/80	1429	1006	1434	1137	1625	1044	2078	1157	2288	1683	1488	57
100/57	1440	961	1167	1123	1583	1057	1940	1238	2269	1730	1451	67
70/80	1501	1036	1233	1203	1604	1005	1936	1219	2197	1367	1430	154
70/57	1382	1034	1346	1215	1632	1083	2001	1226	2172	1729	1483	134
40/57	1499	1089	1559	1233	1616	1040	2028	1198	2349	1278	1489	78
0/amb.	1441	976	1229	1196	1674	1048	1943	1172	2570	1677	1493	93
std. dif., cans	55	53	191	79	68	43	81	35	72	196	103	-
sign. dif., 5%	95	92	330	NS	5	74	NS	NS	124	NS	46	-
Mean ^a	1445	1017	1328	1184	1622	1046	1988	1202	2367	1577	1472	-
24 months:												
100/80	1382	1030	1366	1044	1519	1106	1939	1082	2386	1646	1450	66
100/57	1479	979	1417	1127	1453	1044	1821	1195	2339	1670	1452	91
70/80	1507	1143	1520	1156	1498	1002	1957	1098	2219	1274	1437	94
70/57	1553	1120	1498	1126	1596	999	1785	1132	2086	1773	1467	98
40/57	1695	1182	1550	1113	1619	1076	1804	1054	2335	1591	1493	52
0/amb.	1427	1169	1522	1137	1583	1098	1786	1071	2641	1442	1487	68
std. dif., cans	89	91	74	47	55	30	60	49	75	148	80	-
sign. dif., 5%	53	156	127	73	94	51	118	84	129	255	38	-
Mean ^b	1493	1103	1479	1117	1544	1054	1849	1105	2324	1566	1464	-

^a Significant differences were 87 for products, 165 for products in rooms, at 18 months.

^b Significant differences were 90 for products, 178 for products in rooms, at 24 months.

TABLE 19

RESIDUAL OXYGEN IN CAN ATMOSPHERES
(percent oxygen by volume)

Condition •F/% r.h.	Crackers			Biscuits			Bulgur Wafers		Mean	Std. dif. cans		
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7			CD9	CD10
<u>18 months:</u>												
100/80	9.0	8.6	6.0	12.3	12.7	18.2 ^a	8.4	16.2	2.9	6.7	10.10	2.95
100/57	9.4	8.6	4.4	12.7	14.4	17.5	12.6	16.0	3.2	6.9	10.58	2.17
70/80	13.2	17.7	15.3	17.1	18.4	19.8	15.6	18.0	3.6	7.6	14.63	.91
70/57	14.3	16.6	16.0	17.4	18.3	20.5 ^a	15.8	18.3	4.6	8.3	15.03	.81
40/57	16.5	19.0	18.1	19.1	19.8	20.8 ^a	20.9 ^a	19.6	13.8	11.6	17.92	.51
O/amb	17.7	20.0	18.8	19.3	20.3	20.9 ^a	17.5	20.3	15.8	14.1	18.45	.45
std.dif., cans	2.61	2.00	1.83	.49	1.47	1.46	.96	.17	.89	2.27	1.60	-
sign.dif., 5%	4.52	3.46	3.17	.85	2.55	2.53	1.67	.29	1.54	4.06	.72	-
Mean ^b	13.35	15.09	13.09	16.32	17.32	19.62	15.14	18.07	7.32	9.20	14.45	-
<u>24 months:</u>												
100/80	9.4	7.6	2.8	12.0	11.6	17.1 ^a	6.3	12.0	6.5	5.2	9.06	1.84
100/57	6.1	4.7	6.0	8.9	9.9	14.4	4.9	12.2	6.0	5.1	7.82	1.28
70/80	14.4	20.2 ^a	15.9	15.0	17.7	19.6 ^a	11.8	16.1	3.7	5.5	14.00	1.41
70/57	14.4	18.4	14.4	16.1	18.1	19.0	18.6 ^a	18.1	2.4	4.2	14.36	1.45
40/57	16.9	18.7	17.4	17.9	18.4	20.2 ^a	14.6	19.3	13.1	13.1	16.95	.58
O/amb	17.2	19.2	18.9	19.3	20.0	20.8 ^a	18.9	19.8	15.3	14.3	18.37	.69
std.dif., cans	.34	1.51	2.26	.37	1.14	.67	1.56	.26	1.03	1.90	1.29	-
sign.dif., 5%	.59	2.62	3.91	.64	1.97	1.16	2.70	.45	1.78	3.29	.58	-
Mean ^c	13.07	14.80	12.58	14.87	15.95	18.53	12.52	16.24	7.84	7.90	13.43	-

^a Both cans leaked; single leakers, omitted here, averaged 4.6 ± 3.1 higher than duplicate non-leakers at 18 months, 4.7 ± 3.7 higher at 24 months.

^b Significant differences were 1.76 for products, 2.56 for products in rooms, at 18 months.

^c Significant differences were 1.98 for products, 2.06 for products in rooms, at 24 months.

TABLE 20

MOISTURE CONTENT OF RATION UNITS
(percent)

Condition -F/% r.h.	Crackers				Biscuits			Bulgar Wafers		Mean	Std. dif. cans	
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7	CD9			CD10
18 months:												
100/80	2.29	2.16	1.25	2.70	2.00	1.56 ^a	2.03	1.55	3.48	2.99	2.20	.18
100/57	1.71	2.29	1.85	2.53	1.94	1.57	2.23	1.53	3.44	2.82	2.19	.23
70/80	2.18	2.19	1.31	3.19	2.17	1.60	1.57	1.75	3.53	3.01	2.25	.41
70/57	2.35	2.09	1.09	2.51	2.12	2.27 ^a	2.17	1.52	3.47	3.43	2.30	.30
40/57	2.49	2.28	1.38	3.05	2.22	1.95 ^a	2.49 ^a	1.99	3.49	3.05	2.44	.26
O/amb	2.05	2.09	1.79	1.96	2.22	1.77 ^a	2.24	1.37	3.67	2.97	2.21	.23
std.dif., cans	.65	.21	.10	.18	.20	.16	.24	.12	.31	.19	.28	-
sign.dif., 5%	NS	NS	.18	.31	NS	.28	.42	.21	NS	.32	.13	-
Mean ^b	2.18	2.18	1.45	2.65	2.11	1.78	2.12	1.62	3.51	3.05	2.27	-
24 months:												
100/80	3.07	2.52	1.97	3.80	2.32	2.36 ^a	2.80	2.02	3.93	3.65	2.84	.23
100/57	1.90	2.55	2.30	3.59	2.28	2.46	2.69	1.99	4.00	3.88	2.76	.24
70/80	2.88	2.61 ^a	2.11	2.89	2.20	2.19 ^a	2.96 ^a	2.12	4.02	3.45	2.74	.52
70/57	2.27	2.69	2.04	3.34	2.31	2.96	2.54 ^a	2.15	3.93	3.65	2.79	.25
40/57	2.34	2.70	2.21	3.83	2.34	2.29 ^a	2.91	2.20	4.11	3.63	2.86	.42
O/amb	3.26	3.00	2.37	3.98	2.33	2.40 ^a	2.79	2.11	4.15	4.18	3.06	.13
std.dif., cans	.83	.35	.14	.23	.07	.13	.36	.12	.06	.05	.33	-
sign.dif., 5%	NS	NS	.26	.42	.11	.23	NS	NS	.10	.09	.15	-
Mean ^c	2.62	2.68	2.17	3.57	2.30	2.44	2.78	2.10	4.02	3.74	2.84	-

^aBoth cans leaked; single leakers, omitted here, averaged .06 ± .53 higher than duplicate non-leakers at 18 months, .16 ± .42 higher at 24 months.

^bSignificant differences were .23 for products, .44 for products in rooms, at 18 months.

^cSignificant differences were .23 for products, .52 for products in rooms, at 24 months.

TABLE 21
PEROXIDE VALUES OF FATS FROM SHELTER RATIONS
(milli-equivalents per kilogram)

Condition °F/% r.h.	Crackers			Biscuits			Bulgur Wafers		Mean	Std. dif. cans		
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7			CD9	CD10
<u>18 months:</u>												
100/80	2.8	2.9	2.5	.7	1.3	1.5 ^a	.8	.8	0	.1	1.33	.34
100/57	1.2	3.0	2.1	1.6	2.0	1.7	.3	1.0	.1	.2	1.32	.47
70/80	.4	1.7	.5	.3	.1	.4	.2	0	1.1	.6	.52	.36
70/57	.4	2.0	0	.2	0	0 ^a	.1	.1	1.5	.9	.52	.28
40/57	0	.4	0	.1	0	0 ^a	0 ^a	.2	.8	.3	.18	.24
0/amb	0	0	0	0	0	0 ^a	0	.1	.8	.1	.10	.15
std.dif., cans	.21	.40	.22	.42	.25	.34	.11	.29	.46	.36	.32	-
sign.dif., 5%	.37	.70	.38	.75	.43	.59	.18	.50	.80	.65	.15	-
Mean ^b	.79	1.67	.85	.53	.55	.59	.24	.37	.70	.36	.66	-
<u>24 months:</u>												
100/80	.6	1.0	2.0	.7	1.2	.7 ^a	.4	.8	.2	.1	.76	.64
100/57	.9	.9	2.8	.9	.7	.5	.6	1.3	.2	.1	.89	.48
70/80	.4	1.3 ^a	.4	.2	.3	.3 ^a	.5	.4	.5	.6	.50	.33
70/57	.4	1.1	.6	.2	.3	.3	.5 ^a	.3	.5	.2	.43	.20
40/57	0	.2	.1	.1	.2	.1 ^a	.2	.2	.6	.3	.21	.20
0/amb	0	.1	.2	.1	.1	.2 ^a	.1	.2	.2	.1	.12	.15
std.dif., cans	.36	.43	.64	.23	.63	.19	.36	.13	.18	.06	.38	-
sign.dif., 5%	.62	.74	1.11	.40	1.09	.32	NS	.22	.32	.11	.17	-
Mean ^c	.38	.77	1.00	.35	.46	.36	.38	.55	.35	.23	.49	-

^aBoth cans leaked; single leakers, omitted here, averaged .10 ± .44 higher than duplicate non-leakers at 18 months, .52 ± .63 higher at 24 months.

^bSignificant differences were .51 for products, .52 for products in rooms, at 18 months.

^cSignificant differences were .44 for products, .60 for products in rooms, at 24 months.

TABLE 22
FREE FATTY ACIDS OF FATS FROM SHELTER RATIIONS
(percent as oleic acid)

Condition °F/% r.h.	Crackers				Biscuits				Bulgur Wafers		Mean	Std. dif. cans
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7	CD9	CD10		
16 months:												
100/80	.190	.367	.188	.317	.215	.660 ^a	.150	.320	.507	.275	.329	.050
100/57	.189	.356	.207	.379	.202	.653	.148	.202	.541	.437	.331	.074
70/80	.142	.247	.170	.331	.156	.564	.123	.274	.391	.321	.273	.033
70/57	.142	.236	.163	.299	.159	.624 ^a	.114	.220	.406	.387	.275	.048
40/57	.127	.243	.146	.300	.167	.588 ^a	.111 ^a	.281	.416	.329	.271	.039
O/amb	.146	.229	.145	.279	.162	.596 ^a	.168	.305	.393	.321	.274	.050
std.dif., cans	.013	.015	.011	.102	.027	.010	.014	.093	.037	.059	.051	-
sign.dif., 5%	.022	.026	.019	NS	.047	.018	.024	NS	.064	NS	.023	-
Mean ^b	.156	.280	.170	.317	.178	.614	.136	.267	.442	.362	.292	-
24 months:												
100/80	.150	.418	.200	.374	.167	.632 ^a	.123	.355	.481	.363	.326	.024
100/57	.117	.437	.186	.392	.201	.645	.112	.373	.465	.398	.333	.021
70/80	.088	.223 ^a	.134	.232	.133	.512 ^a	.083	.260	.347	.299	.231	.016
70/57	.077	.203	.133	.270	.137	.557 ^a	.083 ^a	.268	.362	.272	.236	.025
40/57	.078	.183	.102	.262	.118	.522 ^a	.098	.238	.310	.269	.218	.017
G/amb	.073	.169	.109	.302	.113	.529 ^a	.101	.223	.338	.330	.229	.016
std.dif., cans	.016	.021	.017	.019	.011	.015	.015	.013	.020	.039	.020	-
sign.dif., 5%	.028	.036	.028	.033	.018	.025	.026	.021	.034	.069	.009	-
Mean ^c	.097	.271	.144	.305	.145	.566	.100	.286	.384	.322	.262	-

^aBoth cans leaked; single leakers, omitted here, averaged .045 ± .144 higher than duplicate non-leakers at 18 months, .012 ± .012 higher at 24 months.

^bSignificant differences were .033 for products, .081 for products in rooms, at 18 months.

^cSignificant differences were .027 for products, .032 for products in rooms, at 24 months.

TABLE 23

SENSORY SCORES FOR TEXTURE
(scale from 10 = excellent to 1 = poor)

Condition F/% r.h.	Crackers			Biscuits			Bulgar Wafers		Mean	Std. dif. cans	
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7			CD9
18 months:											
100/80	6.4	6.8	6.7	6.3	7.2	6.9	6.2	6.4	6.7	6.6	.38
100/57	6.7	7.0	6.8	6.2	7.0	7.2	6.5	7.0	6.4	6.6	.58
70/80	6.8	7.1	6.9	6.9	7.5	7.3	6.3	7.1	6.5	6.6	.31
70/57	7.0	6.8	6.9	6.7	7.7	7.2	6.7	6.9	6.7	6.5	.54
40/57	6.9	7.1	7.1	6.9	7.4	7.3	6.5	7.1	6.5	6.4	.67
O/amb	7.1	7.3	7.1	6.7	7.6	7.3	7.0	7.0	6.7	6.7	.65
std.dif., cans	.36	.46	.52	.41	.34	.52	.48	.63	1.08	.35	.54
sign.dif., 5%	NS	NS	NS	.55	.45	NS	NS	NS	NS	NS	.25
Mean ^a	6.82	7.02	7.20	6.62	7.40	7.23	6.53	6.92	6.58	6.57	6.86
24 months:											
100/80	6.4	6.8	5.9	6.7	6.5	6.7	6.2	6.8	6.6	6.0	.29
100/57	6.7	6.6	6.0	6.4	6.8	6.6	6.6	7.1	6.5	5.7	.30
70/80	6.8	7.3	6.4	6.7	7.0	7.1	6.4	7.3	6.1	5.8	.42
70/57	6.9	7.4	6.8	6.9	7.4	7.0	6.5	7.3	6.3	5.9	.48
40/57	7.0	7.2	6.7	6.9	7.4	7.2	6.4	7.3	6.6	6.2	.39
O/amb	6.9	7.6	6.2	7.2	7.2	7.4	6.6	7.3	6.4	5.9	.42
std.dif., cans	.36	.27	.34	.37	.30	.26	.46	.34	.56	.50	.39
sign.dif., 5%	NS	.47	.59	.60	.52	.45	NS	NS	NS	NS	.19
Mean ^b	6.78	7.15	6.33	6.80	7.05	7.00	6.45	7.18	6.41	5.91	6.71

^aSignificant differences were .46 for products, NS for products in rooms, at 18 months.

^bSignificant differences were .53 for products, .62 for products in rooms, at 24 months.

TABLE 24

SENSORY SCORES FOR AROMA
(scale from 10 = excellent to 1 = poor)

Condition F/F r.h.	Crackers			Biscuits			Bulgur Wafers		Mean	Std. dif. cans		
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7			CD9	CD10
18 months:												
100/80	6.2	5.6	5.6	5.7	6.0	6.2 ^a	5.6	6.2	5.7	6.0	5.88	.50
100/57	5.9	5.5	5.5	5.1	6.0	6.7	5.6	5.6	5.8	6.1	5.78	.64
70/80	6.8	6.6	6.4	6.6	6.9	6.9	6.0	6.5	6.0	6.3	6.50	.49
70/57	6.8	6.8	7.0	6.7	7.0	7.1 ^a	6.0	6.6	6.8	5.8	6.66	.52
40/57	7.4	7.1	7.2	7.1	7.7	7.0 ^a	6.5 ^a	6.7	6.9	6.7	7.03	.39
O/amb	7.0	7.2	7.6	6.8	7.6	7.2 ^a	7.0	6.6	6.8	6.8	7.06	.48
std.dif.,cans	.49	.58	.20	.82	.53	.46	.30	.56	.53	.32	.51	-
sign.dif., 5%	.85	1.01	.35	1.40	.92	.78	.52	.70	.67	.56	.23	-
Mean ^b	6.83	6.47	6.55	6.33	6.87	6.85	6.12	6.37	6.27	6.28	6.49	-
24 months:												
100/80	4.4	3.5	5.0	4.8	5.2	5.2 ^a	5.2	4.6	5.5	5.1	4.85	.52
100/57	4.5	3.3	4.9	4.6	5.0	5.6	5.4	3.7	5.6	5.2	4.78	.74
70/80	5.9	6.1 ^a	6.0	6.6	6.4	6.4 ^a	6.0	5.5	5.6	5.7	6.02	.50
70/57	6.1 ^a	6.4	6.2	6.8	6.4	6.6	6.4 ^a	6.1	5.7	6.0	6.26	.36
40/57	6.5	7.1	6.0	7.1	7.0	7.1 ^a	7.0	6.5	6.6	6.4	6.73	.45
O/amb	6.9	7.2	5.8	7.0	7.0	7.3 ^a	7.2	7.1	6.9	6.4	6.88	.49
std.dif.,cans	.30	.37	.30	.44	.37	.76	.45	.80	.51	.71	.52	-
sign.dif., 5%	.51	.63	.52	.75	.63	1.31	.78	1.39	.88	1.07	.24	-
Mean ^c	5.72	5.60	5.65	6.14	6.17	6.37	6.20	5.58	5.98	5.80	5.92	-

^aBoth cans leaked; single leakers, omitted when widely divergent, averaged .42 ± .48 lower than duplicate non-leakers at 18 months, .25 ± .57 lower at 24 months.

^bSignificant differences were .44 for products, NS for products in rooms, at 18 months.

^cSignificant differences were .51 for products, .83 for products in rooms, at 24 months.

TABLE 25

SENSORY SCORES FOR FLAVOR
(scale from 10 = excellent to 1 = poor)

Condition •F/ % r.h.	Crackers				Biscuits			Bulgur Wafers		Mean	Std. dif. cans
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7	CD9		
18 months:											
100/80	6.2	6.0	5.7	5.7	5.6	5.7 ^a	5.8	5.7	5.8	5.8	.33
100/57	6.2	6.3	5.4	5.2	5.7	6.1	5.6	5.9	5.7	6.0	.47
70/80	6.6	6.7	6.6	6.5	6.8	6.5	6.0	6.7	6.0	6.2	.36
70/57	6.7	6.8	6.8	6.5	7.4	6.6 ^a	6.4	6.7	6.2	6.1	.48
40/57	7.2	7.2	7.1	7.0	7.5	6.8 ^a	6.5 ^a	6.8	6.3	6.3	.49
O/amb	6.9	7.3	7.6	6.8	7.8	7.0 ^a	6.8	6.9	6.7	6.4	.40
std.dif., cans	.34	.22	.26	.46	.61	.32	.53	.60	.36	.35	-
sign.dif., 5%	.59	.38	.45	.79	1.06	.56	.92	.97	.55	.60	-
Mean ^b	6.63	6.72	6.53	6.30	6.80	6.45	6.18	6.45	6.12	6.13	-
24 months:											
100/80	4.0	4.6	5.0	4.6	4.7	5.1 ^a	5.6	4.5	5.8	4.9	.52
100/57	4.2	4.5	5.3	5.0	4.6	5.6	5.8	4.3	5.9	4.9	.52
70/80	6.0	6.1 ^a	5.9	6.6	5.9	5.9 ^a	6.0	5.2	5.4	5.1	.53
70/57	6.3 ^a	6.6	6.4	6.6	6.2	6.2	6.2 ^a	6.0	5.6	5.3	.38
40/57	6.3	6.8	6.3	6.6	6.5	6.1 ^a	6.5	6.2	6.8	6.3	.37
O/amb	6.5	7.4	6.1	6.8	6.8	6.6 ^a	6.5	6.4	6.9	6.2	.46
std.dif., cans	.32	.38	.62	.57	.43	.48	.53	.42	.47	.33	-
sign.dif., 5%	.55	.66	1.08	.98	.74	.83	NS	.73	.83	.58	-
Mean ^c	5.55	6.00	5.83	6.03	5.78	5.92	6.10	5.43	6.06	5.44	-

^a Both cans leaked; single leakers, omitted when widely divergent, averaged .16 ± .53 lower than duplicate non-leakers at 18 months, .16 ± .52 lower at 24 months.

^b Significant differences were .44 for products, NS for products in rooms, at 18 months.

^c Significant differences were .48 for products, .74 for products in rooms, at 24 months.

TABLE 26

HEDONIC RATINGS FOR AROMA

Condition F/A r.h.	Crackers			Biscuits			Bulgur Wafers		Mean	Std. dif. cans		
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7			CD9	CD10
18 months:												
100/80	5.30	5.14	5.16	4.98	5.50	5.76 ^a	6.12	5.52	4.86	4.72	5.31	.36
100/57	5.64	5.00	5.04	4.82	5.48	5.74	5.84	5.54	4.90	5.08	5.31	.28
70/80	5.78	6.12	5.16	5.86	6.28	6.22	6.28	5.94	4.78	5.22	5.76	.24
70/57	5.94	5.94	5.64	5.76	6.12	6.24 ^a	6.30	6.10	4.98	5.06	5.81	.25
40/57	5.82	5.94	5.36	5.92	6.38	6.22 ^a	6.08 ^a	5.96	5.20	5.34	5.82	.28
O/amb	6.02	6.26	5.50	5.78	6.30	6.36 ^a	6.00	6.34	5.24	5.24	5.90	.22
std.dif., cans	.39	.20	.19	.26	.32	.29	.26	.26	.31	.22	.28	-
sign.dif., 5%	.42	.34	.33	.44	.54	.51	NS	.45	.34	.31	.13	-
Mean	5.75	5.73	5.31	5.52	6.01	6.09	6.10	5.90	4.99	5.11	5.65	-
24 months:												
100/80	4.38	4.34	4.92	4.88	5.14	4.94 ^a	5.64	5.40	5.00	5.18	4.98	.33
100/57	4.42	4.36	4.76	5.08	4.98	4.72	5.96	5.46	5.14	5.32	5.02	.52
70/80	5.70	5.48 ^a	5.30	6.04	5.94	5.60 ^a	6.12	6.34	4.60	5.60	5.67	.35
70/57	5.92 ^a	5.66	5.52	6.14	6.00	5.64	6.20 ^a	6.30	4.76	5.30	5.74	.26
40/57	5.80	5.84	5.36	6.10	5.90	5.92 ^a	6.36	6.36	5.20	5.40	5.83	.29
O/amb	5.72	5.84	5.38	6.06	6.08	5.88 ^a	6.40	6.40	5.46	5.56	5.88	.20
std.dif., cans	.51	.40	.49	.32	.34	.26	.10	.22	.22	.34	.34	-
sign.dif., 5%	.88	.67	.55	.56	.58	.44	.17	.37	.39	NS	.16	-
Mean ^c	5.52	5.25	5.21	5.72	5.67	5.45	6.11	6.05	5.03	5.39	5.52	-

^aBoth cans leaked; single leakers, omitted when widely divergent, averaged .07 ± .40 lower than duplicate non-leakers at 18 months, .07 ± .49 higher at 24 months.

^bSignificant differences were .24 for products, .44 for products in rooms, at 18 months.

^cSignificant differences were .24 for products, .55 for products in rooms, at 24 months.

TABLE 27

HEDONIC RATINGS FOR FLAVOR

Condition P/S r.h.	Crackers			Biscuits			Bulgar Wafers		Mean	Std. dif. cans		
	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7			CD9	CD10
18 months:												
100/80	5.26	5.32	5.30	5.14	5.68	5.68 ^a	6.00	5.34	5.10	4.94	5.38	.32
100/57	5.62	5.50	5.16	4.88	5.82	5.64	5.70	5.52	4.94	5.24	5.40	.23
70/80	5.30	6.44	5.42	5.46	6.56	6.18	6.36	6.22	4.96	5.52	5.84	.17
70/57	5.76	6.32	5.56	5.42	6.52	6.02 ^a	6.08	6.24	5.20	5.12	5.32	.22
40/57	5.56	6.18	5.36	5.84	6.58	6.22 ^a	6.16 ^a	6.40	5.48	5.48	5.93	.29
O/amb	5.70	6.44	5.70	5.72	6.62	6.48 ^a	6.16	6.46	5.24	5.60	6.01	.24
std.dif., cans	.38	.21	.18	.30	.29	.19	.07	.16	.26	.30	.25	-
sign.dif., 5%	NS	.36	.32	.51	.50	.32	.13	.27	.31	.43	.12	-
Mean ^b	5.53	6.03	5.42	5.41	6.30	6.04	6.08	6.03	5.15	5.32	5.73	-
24 months:												
100/80	4.38	4.52	5.00	4.92	5.28	5.02 ^a	5.58	5.50	5.18	5.48	5.09	.35
100/57	4.38	4.62	4.82	5.06	4.96	4.94	5.92	5.62	5.36	5.46	5.11	.46
70/80	5.76	5.64 ^a	5.50	6.04	6.38	5.58 ^a	6.30	6.24	5.12	5.62	5.82	.32
70/57	6.00 ^a	5.80	5.62	5.96	6.48	5.84	6.32 ^a	6.40	5.02	5.40	5.88	.38
40/57	.92	5.94	5.40	5.68	6.58	5.96 ^a	6.24	6.62	5.94	5.72	6.00	.38
O/amb	5.64	6.12	5.46	5.82	6.68	5.86 ^a	6.64	6.84	5.96	5.60	6.06	.35
std.dif., cans	.54	.41	.45	.39	.34	.19	.32	.23	.48	.23	.37	-
sign.dif., 5%	.93	.71	.59	.67	.58	.32	.55	.39	.78	NS	.17	-
Mean ^c	5.35	5.44	5.30	5.58	6.06	5.53	6.17	6.20	5.43	5.55	5.66	-

^aBoth cans leaked; single leakers, omitted when widely divergent, averaged .12 ± .38 lower than duplicate non-leakers at 18 months, .00 ± .47 at 24 months.

^bSignificant differences were .25 for products, .40 for products in rooms, at 18 months.

^cSignificant differences were .27 for products, .60 for products in rooms, at 24 months.

TABLE 28

HEDONIC RATINGS FOR PALATABILITY

Condition P/P F.H.	Crackers			Biscuits			Bulgur Wafers		Mean	Std. dif. cans	
	CD1	CD3	CD5	CD2	CD4	CD6	CD7	CD9			CD10
18 months:											
100/80	5.88	5.96	5.56	6.18	6.10 ^a	5.96	6.14	5.58	5.36	5.84	.35
100/57	5.80	5.92	5.44	6.14	6.02	5.86	6.22	5.30	5.10	5.78	.27
70/90	5.74	6.56	5.48	6.90	6.38	6.32	6.40	5.52	5.70	6.10	.19
70/57	6.10	6.38	5.56	6.64	6.50 ^a	5.94 ^a	6.48	5.56	5.44	6.01	.26
40/57	5.76	6.24	5.44	6.58	6.38 ^a	5.80 ^a	6.52	5.74	5.56	5.99	.23
O/amb	5.88	6.44	5.66	6.58	6.48 ^a	6.04	6.76	5.62	5.68	6.09	.16
std.dif., cans	.32	.18	.10	.23	.24	.38	.25	.22	.20	.25	-
sign.dif., 5%	NS	.31	.16	.40	.32	NS	.36	.30	.24	.12	-
Mean ^b	5.86	6.25	5.52	6.50	6.28	5.99	6.42	5.55	5.52	5.97	-
24 months:											
100/80	5.08	5.12	5.44	5.74	5.26 ^a	5.82	5.80	5.28	5.80	5.49	.43
100/57	5.02	5.06	5.16	5.50	5.18	6.20	5.90	5.42	5.72	5.47	.60
70/80	5.78	5.88 ^a	5.54	6.44	5.60 ^a	6.26	6.52	5.26	5.82	5.94	.37
70/57	5.90 ^a	5.94	5.80	6.52	5.62	6.36 ^a	6.58	5.44	5.64	5.98	.36
40/57	5.96	5.92	5.44	6.56	5.74 ^a	6.38	6.80	5.60	5.72	6.00	.37
O/amb	5.74	5.98	5.52	6.74	5.82 ^a	6.44	6.80	5.56	5.68	6.02	.33
std.dif., cans	.72	.42	.58	.47	.33	.19	.20	.39	.25	.42	-
sign.dif., 5%	.79	.73	NS	.79	.47	.32	.35	NS	NS	.19	-
Mean ^c	5.58	5.65	5.48	6.25	5.54	6.24	6.40	5.43	5.73	5.82	-

^a Both cans leaked; single leakers, omitted when widely divergent, averaged .10 ± .25 lower than duplicate non-leakers at 18 months, .13 ± .60 higher at 24 months.

^b Significant differences were .26 for products, .40 for products in rooms, at 18 months.

^c Significant differences were .27 for products, .67 for products in rooms, at 24 months.

TABLE 29

CORRELATIONS OF PALATABILITY RATINGS WITH OTHER MEASUREMENTS
(r, simple correlation coefficients)

Palatability with:

<u>Products</u>	<u>Hunter Color Values</u>			<u>Fracture Strength</u>	<u>Moisture Content</u>	<u>Residual Oxygen</u>	<u>Rancidity Values</u>		<u>Total Quality score</u>				
	<u>L</u>	<u>"a"</u>	<u>"b"</u>				<u>P.V.</u>	<u>FFA</u>					
<u>18 months:</u>													
<u>Crackers:</u>													
CD1	-.058	+ .205	+ .061	+ .189 ^b	-.505	+ .041	+.014 ^b	-.338	-.407	+ .297			
CD3	-.789 ^b	+ .767 ^b	+ .584 ^a	+ .776 ^b	+ .303	-.215	+ .807 ^b	-.649 ^a	-.900 ^b	+ .680 ^a			
CD5	-.148	+ .007	-.246	+ .084	-.320	+ .326	+ .282	-.164	-.343	+ .366			
CD8	-.236 ^b	+ .182	-.019 ^b	+ .135 ^b	+ .552	+ .414	+ .418	-.204	+ .257	+ .492			
ALL	+ .393 ^b	-.476 ^b	-.464 ^b	-.471 ^b	-.401 ^b	+ .271	+ .243	+ .018	+ .173	+ .178			
<u>Biscuits:</u>													
CD2	-.478	+ .413	+ .566	+ .453	+ .116	+ .409	+ .729 ^b	-.828 ^b	-.690 ^a	+ .567 ^b			
CD4	-.636 ^a	+ .527	+ .183	+ .535	-.447	+ .345	+ .550	-.763 ^b	-.650 ^a	+ .822			
CD6	-.525	+ .305	+ .025	+ .298	-.467	-.264	+ .425 ^b	-.416 ^b	-.526	+ .262			
CD7	-.605 ^a	+ .549	+ .090	+ .556	+ .003 ^b	+ .059	+ .800	-.723 ^b	+ .209	+ .612 ^a			
ALL	+ .439 ^b	-.444 ^b	-.545 ^b	-.397 ^b	-.412 ^b	-.121	+ .632 ^b	-.411 ^b	+ .006	+ .659 ^b			
<u>Muffins:</u>													
CD9	+ .001	-.160	-.350	-.129	+ .236	-.003	+ .514	+ .299	-.559	+ .752 ^b			
CD10	-.327	+ .153	-.396	+ .252	-.444	-.160	+ .464	-.017	-.454	+ .301			
Both	+ .038	-.068	-.006	-.041	+ .010	+ .015	+ .449 ^a	+ .201	-.365	+ .453 ^a			

(contd)

Table 29 (contd)

Palatability with:

<u>Products</u>	<u>Hunter Color Values</u>			<u>Fracture Strength</u>	<u>Moisture Content</u>	<u>Residual Oxygen</u>	<u>Rancidity Values</u>		<u>Total Quality score</u>
	<u>L</u>	<u>"a"</u>	<u>"b"</u>				<u>P.V.</u>	<u>FFA</u>	
<u>24 months:</u>									
<u>Crackers:</u>									
CD1	-0.218	+0.068	-0.162	+0.093	+1.100	+0.916 ^b	-0.311	-0.443 ^b	+0.754 ^b
CD3	-0.751 ^b	+0.695 ^a	+0.657 ^a	+0.890 ^b	+0.462	+0.833 ^b	-0.218	-0.883 ^b	+0.831 ^b
CD5	-0.449	+0.414 ^b	-0.701 ^a	+0.328	+0.273	+0.447	-0.462	-0.399 ^b	+0.513
CD6	-0.524	+0.923 ^b	+0.432	+0.561	-0.591 ^a	+0.511	-0.583 ^a	-0.825 ^b	+0.533 ^b
ALL	+0.182	-0.189	-0.292 ^a	-0.713	+0.290 ^a	+0.621 ^b	-0.393 ^b	-0.131	+0.672 ^b
<u>Biscuits:</u>									
CD2	-0.802 ^b	+0.793 ^b	+0.548	+0.529	+0.069	+0.871 ^b	-0.654 ^a	-0.892 ^b	+0.754 ^b
CD4	-0.634 ^a	+0.246	+0.048	-0.058	+0.010	+0.745 ^b	-0.050	-0.732 ^b	+0.768 ^b
CD6	-0.654 ^a	+0.178	-0.391	-0.442	+0.247 ^b	+0.486 ^b	-0.530	-0.811 ^b	+0.823 ^b
CD7	-0.597 ^a	+0.271 ^b	+0.076	-0.439	+0.742 ^b	+0.920 ^b	-0.865 ^b	-0.926 ^b	+0.862 ^b
ALL	-0.346 ^a	+0.383 ^b	+0.183	+0.220	-0.098	+0.401 ^b	-0.379 ^b	-0.636 ^b	+0.461 ^b
<u>Wafers:</u>									
CD9	-0.079	+0.195	+0.796 ^b	+0.214	+0.266	+0.420	+0.043	-0.353	+0.801 ^b
CD10	+0.166 ^b	-0.115	+0.001	+0.018	-0.279	-0.186	+0.157	+0.198	+0.027
Both	-0.574 ^b	+0.454 ^a	-0.098	-0.523 ^b	-0.424 ^a	+0.167	-0.127	-0.413 ^a	-0.064

^aSignificant at the 5% level of probability.^bSignificant at the 1% level of probability.

TABLE 30

SENSORY SCORES FOR APPEARANCE-COLOR AND TEXTURE OF CARBOHYDRATE SUPPLEMENT
(scale from 10 = excellent to 1 = poor)

Condition F/2 r.h.	6 months					12 months				
	CDL1	CDL2	CDL3	Mean	Std.dif. cans	CDL1	CDL2	CDL3	Mean	Std.dif. cans
<u>Appearance-Color:</u>										
100/80	7.5	7.1	7.65	7.42	.50	6.8	8.05	7.7	7.52	.32
100/57	7.45	7.5	7.75	7.50	.40	7.25	8.05	7.8	7.70	.54
70/80	7.75	7.1	7.85	7.57	.38	7.35	8.1	8.1	7.85	.32
70/57	7.6	7.35	7.8	7.58	.13	7.7	8.15	8.0	7.95	.27
40/57	8.15	7.55	7.85	7.85	.45	7.85	8.2	8.2	8.08	.22
O/amb	7.95	7.3	8.1	7.78	.21	8.0	8.05	8.05	8.03	.34
std.dif., cans	.48	.37	.20	.37	-	.46	.31	.22	.35	-
sign.dif., 5%	.60	NS	.25	.32	-	.57	NS	.28	.30	-
Mean ^a	7.73	7.28	7.83	7.62	-	7.49	8.10	7.98	7.86	-
<u>Texture:</u>										
100/80	8.0	7.2	7.5	7.57	.26	7.6	8.5	7.9	8.00	.17
100/57	7.9	7.0	7.5	7.47	.17	8.0	8.4	7.8	8.07	.33
70/80	7.4	7.5	7.7	7.53	.37	8.1	8.4	8.0	8.17	.26
70/57	7.2	7.3	7.7	7.40	.29	8.3	8.4	8.2	8.30	.26
40/57	7.8	7.3	7.8	7.63	.35	8.0	8.2	8.3	8.17	.26
O/amb	7.6	7.3	7.6	7.50	.35	8.2	8.3	8.0	8.17	.12
std.dif., cans	.34	.20	.37	.31	-	.12	.31	.26	.25	-
sign.dif., 5%	.58	.34	NS	NS	-	.21	NS	.44	.22	-
Mean ^b	7.65	7.27	7.63	7.52	-	8.03	8.37	8.03	8.14	-

^aSignificant differences were .42 and .32 for products, .82 and .62 for products in rooms, at 6 and 12 months.

^bSignificant differences were .32 and .30 for products, .88 and .84 for products in rooms, at 6 and 12 months.

HUNTER COLOR VALUES OF CARBOHYDRATE SUPPLEMENTS, LEMON TYPE

Hunter "a" Value:

(contd)

Table 31 (contd)

Condition •F/r.h.	6 months				12 months			
	CD11	CD12	CD13	Mean	CD11	CD12	CD13	Mean
Hunter "b" Value:								
100/80	37.5	35.2	31.1	34.59	41.3	35.7	31.1	36.04
100/57	42.0	35.8	31.2	36.32	41.5	35.4	31.2	36.05
70/80	38.5	35.6	32.0	35.37	41.5	34.7	31.4	35.87
70/57	40.3	34.7	31.5	35.52	42.6	35.5	30.7	36.26
40/57	41.0	35.1	30.6	35.56	39.1	33.9	30.4	34.44
O/amb	38.2	34.8	31.6	34.89	31.9	35.6	30.8	36.12
std.dif., cans	1.18	1.40	1.22	1.27	1.31	.85	1.19	1.14
sign.dif., 5%	2.11	NS	NS	1.11	2.23	1.45	NS	.98
Mean ^c	39.59	35.20	31.34	35.38	41.33	35.13	30.93	35.80
Hunter a/b Ratio:								
100/80	-.181	-.006	-.307	-.159	-.174	.027	-.331	-.153
100/57	-.187	.002	-.296	-.156	-.184	.081	-.304	-.132
70/80	-.157	.123	-.298	-.105	-.171	.089	-.335	-.135
70/57	-.224	.111	-.283	-.133	-.212	-.015	-.369	-.192
40/57	-.164	.012	-.327	-.153	-.217	.100	-.327	-.145
O/amb	-.218	.003	-.314	-.173	-.167	.025	-.337	-.152
std.dif., cans	.044	.009	.019	.028	.051	.027	.017	.035
sign.dif., 5%	NS	.015	.033	.024	NS	.047	.029	.030
Mean ^d	-.188	.041	-.304	-.146	-.187	.051	-.334	-.152

^aSignificant L differences were .70 and .75 for products, 1.96 and 2.20 for products in rooms, at 6 and 12 months.

^bSignificant "a" differences were .59 and .64 for products, .92 and 1.51 for products in rooms, at 6 and 12 months.

^cSignificant "b" differences were .56 and .52 for products, 1.11 and 1.32 for products in rooms, at 6 and 12 months.

^dSignificant a/b differences were .016 and .018 for products, .025 and .038 for products in rooms, at 6 and 12 months.

TABLE 32
HUNTER COLOR VALUES OF CARBOHYDRATE SUPPLEMENTS, CHERRY TYPE

Condition •P/Z r.h.	6 months				12 months			
	CDL1	CDL2	CDL3	Mean	CDL1	CDL2	CDL3	Mean
	Std.dif. cans				Std.dif. cans			
Hunter L Value:								
100/80	47.9	62.8	50.2	53.59	50.4	58.3	47.8	52.16
100/57	46.7	61.2	51.8	53.22	44.0	60.0	47.1	50.36
70/80	44.1	61.6	49.4	51.68	45.9	59.7	48.3	51.28
70/57	42.2	62.1	48.2	50.81	44.1	57.0	52.0	51.06
40/57	44.6	61.7	51.4	52.56	43.7	58.1	49.3	50.38
O/amb	44.4	62.2	48.5	51.69	45.8	58.4	50.8	51.67
std.dif., cans	3.62	1.48	1.87	2.50	2.67	2.27	1.74	2.26
sign.dif., 5%	NS	NS	3.18	2.23	4.54	NS	3.01	NS
Mean ^a	44.96	61.92	49.91	52.26	45.65	58.60	49.20	51.15
Hunter "a" Value:								
100/80	11.5	16.8	12.4	13.57	9.5	19.2	10.3	13.00
100/57	14.2	19.6	8.4	14.06	11.4	14.4	9.8	11.88
70/80	16.1	20.2	13.8	16.70	12.6	18.7	9.2	13.48
70/57	14.8	17.4	14.7	15.60	13.2	20.9	7.8	13.94
40/57	18.0	18.3	10.2	15.51	11.3	19.9	7.7	12.98
O/amb	15.4	19.2	14.5	16.35	11.7	18.6	7.7	12.65
std.dif., cans	1.28	1.33	3.26	2.18	5.43	3.31	2.10	3.87
sign.dif., 5%	2.21	2.26	5.54	1.95	NS	5.63	NS	NS
Mean ^b	14.99	18.58	12.33	15.30	11.63	18.60	8.73	12.99

(contd)

Table 32 (contd)

Condition F/F R.h.	6 months				12 months			
	CD11	CD12	CD13	Mean	CD11	CD12	CD13	Mean
Hunter "b" Value:								
100/80	4.1	5.3	2.8	4.03	3.8	7.3	3.5	4.87
100/57	4.5	6.1	3.1	4.57	5.2	7.2	3.5	5.32
70/80	5.1	6.0	3.1	4.69	4.2	6.9	3.2	4.76
70/57	4.1	6.2	3.5	4.60	5.1	7.5	3.0	5.20
40/57	3.1	6.0	3.2	4.29	4.2	7.8	3.5	5.15
O/emb	3.0	6.7	2.7	4.11	4.6	7.9	3.6	5.35
std.dif., cans	1.09	1.17	.54	.97	.64	1.03	.88	.87
sign.dif., 5%	1.85	NS	NS	NS	1.09	NS	NS	NS
Mean ^c	4.05	6.04	3.06	4.38	4.52	7.43	3.37	5.11
Hunter a/b ratio:								
100/80	2.83	3.17	4.52	3.36	2.52	2.63	2.92	2.76
100/57	3.12	3.20	2.75	3.07	2.17	2.00	2.81	2.37
70/80	3.19	3.39	4.51	3.56	3.01	2.71	2.87	2.88
70/57	3.59	2.81	4.19	3.39	2.58	2.78	2.61	2.68
40/57	5.01	3.03	3.17	3.62	2.70	2.55	2.23	2.56
O/emb	5.20	2.89	5.30	3.98	2.56	2.35	2.14	2.34
std.dif., cans	1.18	.48	1.31	1.06	1.28	.53	1.11	1.01
sign.dif., 5%	2.04	NS	2.27	.83	NS	NS	NS	NS
Mean ^d	3.70	3.08	4.04	3.49	2.57	2.50	2.59	2.54

^aSignificant L differences were .83 and 1.33 for products, 1.83 and 2.65 for products in rooms, at 6 and 12 months.

^bSignificant "a" differences were .98 and 1.65 for products, 1.65 and 4.32 for products in rooms, at 6 and 12 months.

^cSignificant "b" differences were .34 and .40 for products, .78 and 1.06 for products in rooms, at 6 and 12 months.

^dSignificant a/b differences were .47 and NS for products, .87 and NS for products in rooms, at 6 and 12 months.

TABLE 33

MOISTURE CONTENT AND pH VALUES OF CARBOHYDRATE SUPPLEMENTS

Condition F/F ₂ r.h.	6 months				12 months			
	CD11	CD12	CD13	Mean	CD11	CD12	CD13	Mean
Moisture: percent	Std.dif. cans				Std.dif. cans			
100/80	1.46	1.58	1.96	1.67	2.02	1.46	1.78	1.75
100/57	2.11	1.58	1.92	1.87	1.46	1.43	1.84	1.58
70/80	1.48	1.54	2.04	1.69	2.09	1.49	1.79	1.79
70/57	1.73	1.64	1.65	1.68	2.01	1.51	1.90	1.81
40/57	2.32	1.68	1.84	1.95	1.88	1.58	1.72	1.72
O/amb	1.88	1.67	1.88	1.81	2.16	1.63	1.85	1.88
std.dif., cans	.37	.03	.04	.21	.13	.05	.07	.09
sign.dif., 5%	.63	.05	.06	.20	.23	.09	.12	.08
Mean ^a	1.83	1.62	1.88	1.78	1.94	1.52	1.81	1.76
pH Values: (1 + 3 dilution)								
100/80	6.99	6.88	7.03	6.96	6.81	6.94	7.06	6.94
100/57	6.39	6.84	6.96	6.73	6.84	6.98	6.93	6.92
70/80	6.85	6.98	6.89	6.91	7.01	7.10	7.03	7.05
70/57	6.99	6.90	7.15	7.01	6.79	7.06	7.01	6.96
40/57	6.74	6.89	6.95	6.86	6.75	7.07	7.09	6.97
O/amb	6.91	6.93	7.11	6.99	7.01	7.12	6.94	7.02
std.dif., cans	.10	.04	.09	.08	.10	.05	.06	.08
sign.dif., 5%	.18	.07	.17	.07	.18	.08	.11	.07
Mean ^b	6.81	6.90	7.02	6.91	6.87	7.04	7.01	6.98

^aSignificant differences were .15 and .09 for products, .29 and .15 for products in rooms, at 6 and 12 months.

^bSignificant difference, were .07 and .05 for products, .12 and .09 for products in rooms, at 6 and 12 months.

TABLE 34

SUGAR CONTENTS OF CARBOHYDRATE SUPPLEMENTS

Condition T/X r.h.	6 months				12 months			
	CDL1	CDL2	CDL3	Mean	CDL1	CDL2	CDL3	Mean
Dextrose: percent	cans				cans			
				Std.dif.				Std.dif.
100/80	18.7	15.8	17.6	17.36	16.9	16.1	17.6	16.87
100/57	19.4	16.1	16.8	17.44	18.2	16.1	18.2	17.50
70/80	18.1	16.2	17.6	17.30	17.3	16.2	17.1	16.87
70/57	18.1	16.1	18.2	17.49	18.1	16.1	17.2	17.15
40/57	17.7	16.1	16.8	16.88	17.5	16.1	17.9	17.12
Q/amb	18.3	16.0	17.6	17.28	16.7	16.1	17.5	16.78
std.dif., cans	.61	.23	.19	.39	.34	.12	.31	.27
sign.dif., %	1.04	.40	.33	.34	.59	NS	.53	.24
Mean ^a	18.39	16.05	17.43	17.29	17.45	16.13	17.58	17.05
Sucrose: percent								
100/80	64.6	64.7	63.1	64.14	64.0	64.4	64.7	64.33
100/57	63.7	65.9	63.0	64.20	63.5	64.6	64.1	64.05
70/80	62.4	64.9	62.1	63.14	63.9	65.0	64.3	64.39
70/57	63.9	64.8	60.3	62.98	63.7	64.7	65.1	64.49
40/57	64.1	65.1	62.8	63.98	63.2	64.9	63.6	63.95
Q/amb	63.2	64.7	61.8	63.23	63.6	65.2	64.0	64.25
std.dif., cans	1.10	1.04	.99	1.05	1.17	.68	.66	.87
sign.dif., %	1.87	NS	1.17	.90	NS	NS	1.13	NS
Mean ^b	63.64	65.01	62.19	63.61	63.63	64.78	64.31	64.24

(contd)

Table 34 (cont'd)

Condition 7/7 r.h.	6 months				12 months			
	CD11	CD12	CD13	Mean	CD11	CD12	CD13	Mean
Total Sugar: percent								
100/80	83.3	80.5	80.7	81.50	80.9	80.5	82.3	81.20
100/57	83.1	82.0	79.8	81.64	81.7	80.7	82.3	81.55
70/80	80.5	81.1	79.7	80.44	81.2	81.2	81.4	81.26
70/57	82.0	80.9	78.5	80.47	81.8	80.8	82.3	81.64
40/57	81.8	81.2	79.6	80.86	80.7	81.0	81.5	81.07
O/amb	81.5	80.7	79.4	80.51	80.3	81.3	81.5	81.03
std. dif., cans	1.10	1.12	.84	1.03	1.10	.66	.69	NS
sign. dif., 5%	1.87	NS	1.43	.88	NS	NS	NS	NS
Mean	82.03	81.06	79.62	80.90	81.08	80.91	81.89	81.29
Dextrose/Sucrose ratio:								
100/80	.290	.244	.279	.271	.264	.251	.272	.262
100/57	.305	.244	.267	.272	.286	.250	.284	.273
70/80	.291	.249	.284	.274	.270	.249	.267	.262
70/57	.284	.249	.302	.278	.285	.249	.264	.266
40/57	.276	.248	.268	.264	.276	.247	.280	.268
O/amb	.290	.248	.284	.273	.263	.247	.274	.261
std. dif., cans	.012	.006	.008	.009	.009	.004	.006	.007
sign. dif., 5%	.021	NS	.014	.008	.015	NS	.011	.006
Mean	.289	.247	.280	.272	.274	.249	.273	.265

^a Significant differences were .38 and .31 for products, .71 and .48 for products in rooms, at 6 and 12 months.

^b Significant differences were .71 and .51 for products, 1.83 and 1.50 for products in rooms, at 6 and 12 months.

^c Significant differences were .66 and .51 for products, 1.65 and 1.34 for products in rooms, at 6 and 12 months.

^d Significant differences were .009 and .007 for products, .017 and .013 for products in rooms, at 6 and 12 months.

TABLE 35

SENSORY SCORES FOR AROMA AND FLAVOR OF CARBOHYDRATE SUPPLEMENT
(scale from 10 = excellent to 1 = poor)

Condition T/T r.h.	6 months				Std.dif. cans	12 months				Std.dif. cans
	CD11	CD12	CD13	Mean		CD11	CD12	CD13	Mean	
Aroma:										
100/80	7.1	7.0	6.8	6.97	.26	6.65	7.5	6.9	7.02	.18
100/57	7.5	7.0	6.9	7.13	.37	6.9	7.3	7.0	7.07	.49
70/80	7.65	7.3	7.4	7.54	.13	7.6	8.0	7.8	7.80	.74
70/57	7.4	6.9	7.3	7.20	.39	7.4	8.0	8.3	7.90	.74
40/57	8.25	7.5	7.4	7.72	.59	8.1	8.0	8.2	8.10	.35
0/amb	8.4	7.1	7.3	7.60	.29	7.6	8.3	8.3	8.07	.59
std.dif., cans	.23	.49	.32	.37	-	.40	.77	.43	.56	-
sign.dif., 5%	.41	NS	.55	.32	-	.72	NS	.74	.48	-
Mean ^a	7.72	7.17	7.18	7.36	-	7.38	7.85	7.75	7.66	-
Flavor:										
100/80	7.5	6.55	7.3	7.12	.34	6.75	7.1	7.1	6.98	.24
100/57	7.5	6.65	7.0	7.05	.59	6.8	7.1	7.1	7.00	.68
70/80	7.25	7.6	7.6	7.48	.72	7.05	7.6	7.8	7.48	.47
70/57	7.25	7.55	7.5	7.43	.65	7.25	7.6	8.0	7.62	.34
40/57	7.8	7.5	7.3	7.53	.29	7.8	8.0	8.2	8.00	.40
0/amb	8.2	7.3	7.6	7.70	.53	7.8	8.1	8.5	8.13	.44
std.dif., cans	.75	.47	.32	.54	-	.27	.63	.36	.45	-
sign.dif., 5%	NS	.80	.55	.48	-	.47	1.00	.62	.39	-
Mean ^b	7.58	7.19	7.38	7.39	-	7.24	7.58	7.78	7.54	-

^a Significant differences were .44 and .34 for products, 1.22 and .94 for products in rooms, at 6 and 12 months.

^b Significant differences were .39 and .27 for products, .95 and .76 for products in rooms, at 6 and 12 months.

TABLE 36
HELOMIC RATINGS FOR AROMA, FLAVOR AND PALATABILITY OF CARBOHYDRATE SUPPLEMENTS

Condition T/F F.H.	6 months					12 months				
	CD11	CD12	CD13	Mean	Std.dif. cans	CD11	CD12	CD13	Mean	Std.dif. cans
Aroma:										
100/80	6.32	6.54	6.84	6.57	.55	6.24	6.96	6.84	6.68	.41
100/57	6.34	6.66	6.78	6.59	.45	6.64	6.74	7.04	6.81	.25
70/80	6.38	6.74	6.74	6.62	.40	6.80	7.16	6.90	6.95	.28
70/57	6.32	6.86	6.64	6.61	.42	6.94	7.06	6.88	6.96	.26
40/57	6.46	6.84	6.82	6.71	.47	6.92	7.16	7.04	7.04	.44
O/amb	6.24	6.94	6.82	6.67	.57	6.68	7.16	6.94	6.93	.40
std.dif., cans	.74	.33	.20	.48	-	.34	.31	.38	.35	-
sign.dif., %	NS	NS	NS	NS	-	.58	NS	NS	.32	-
Mean ^a	6.34	6.76	6.77	6.63	-	6.70	7.04	6.91	6.88	-
Flavor:										
100/80	6.98	6.72	6.94	6.88	.49	6.52	6.70	7.16	6.79	.29
100/57	7.02	6.92	6.82	6.92	.31	6.88	6.86	6.94	6.89	.24
70/80	6.86	6.98	6.78	6.87	.31	7.12	7.16	7.12	7.13	.14
70/57	6.98	7.08	6.78	6.95	.35	7.20	6.96	7.08	7.08	.16
40/57	6.74	7.00	6.84	6.86	.40	7.34	7.22	7.16	7.24	.12
O/amb	6.68	7.14	6.78	6.87	.37	6.98	6.92	7.16	7.02	.25
std.dif., cans	.36	.52	.17	.38	-	.22	.22	.23	.21	-
sign.dif., %	NS	NS	NS	NS	-	.38	.38	NS	.20	-
Mean ^b	6.88	6.97	6.82	6.89	-	7.01	6.97	7.07	7.02	-

(contd)

Table 36 (contd)

Condition •F/% r.h.	6 months					12 months				
	CD11	CD12	CD13	Mean	Std.dif. cans	CD11	CD12	CD13	Mean	Std.dif. cans
<u>Palatability:</u>										
100/80	7.12	6.96	6.98	7.02	.28	6.44	6.98	6.98	6.80	.33
100/57	7.06	6.82	6.86	6.91	.36	6.82	6.90	6.96	6.89	.36
70/80	7.02	6.92	6.80	6.91	.28	7.04	7.12	7.02	7.06	.36
70/57	7.00	7.06	6.70	6.92	.20	7.04	7.08	7.00	7.04	.47
40/57	6.88	6.98	6.78	6.88	.29	7.10	7.18	7.04	7.11	.21
0/amb	6.74	7.16	6.74	6.88	.13	6.96	7.16	7.00	7.04	.34
std.dif., cans	.23	.34	.20	.27	-	.47	.24	.31	.36	-
sign.dif., %	.37	NS	NS	NS	-	NS	NS	NS	NS	-
Mean ^c	6.97	6.98	6.81	6.92	-	6.90	7.07	7.00	6.99	-

^a Significant differences were .24 and .21 for product means, .66 and .54 for products in rooms, at 6 and 12 months.

^b Significant differences were NS and NS for product means, NS and .58 for products in rooms, at 6 and 12 months.

^c Neither products nor products in rooms differed significantly.