



# QUALITY EVALUATION of FROZEN VEGETABLES

I  
BUSH  
GREEN  
BEANS

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## QUALITY EVALUATION OF FROZEN VEGETABLES

### I. Bush Green Beans

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Bush green beans are found in virtually every home garden in Kentucky. Commercial production of green beans has been increasing for several years. The soil and climate in most sections of Kentucky are suitable for growing beans, indicating the possibility for larger commercial acreage to meet increasing consumer demand.

This study was designed to determine the suitability for freezing of certain Kentucky-grown green bean varieties and selections. The experiments were carried out as part of a cooperative project between the University of Kentucky Department of Horticulture and the School of Home Economics.

### EXPERIMENTAL METHODS

Ten varieties and selections from Experiment Station variety trials were evaluated in 1960: Wade, Wadex, Tenderlong-15, Corneli-14, Extender, B-3370, Improved Tendergreen, Tenderwhite, "Sconce," and White Half-runner.

"Sconce" is locally grown in a small area of Indiana and is not a recognized horticultural variety. White Half-runner is a popular home garden variety in Kentucky. Both beans are being used as parents in the Kentucky bean breeding program which seeks to combine their favorable characteristics into a round, smooth, straight-pod bush green bean.

Four of the 1960 varieties -- Wade, Wadex, Tenderlong-15, and Corneli-14 -- were again evaluated in 1961, together with B-3125-X-5-2, Processor, Tendercrop, Harris Shipper, Harvester, and Slenderwhite. All test plantings were field-replicated three times, and the field replications were carried through all quality tests.

Beans used in the studies were harvested at optimum stages of maturity. Damaged and malformed beans were removed by sorting. The beans were then washed, cut into 1-inch lengths, blanched in boiling water for  $2\frac{1}{2}$  minutes, cooled, and packed in 1-pint waxed containers. Samples were quick-frozen at  $-30^{\circ}\text{F}$  and stored at or below  $0^{\circ}\text{F}$  until used.

A 12-member taste panel evaluated the beans for flavor, color, and texture soon after processing and after 3, 6, and 9 months' frozen storage. Samples were prepared for the panel by cooking in  $\frac{1}{2}$  cup boiling water for 10 minutes. No more than eight samples were evaluated by the panel at one sitting. Panel evaluations were based on a 10-point scale (10 = excellent and 1 = very poor).

All samples were analyzed for ascorbic acid by a modification of the 2,4-dinitrophenylhydrazine procedure.<sup>1</sup> In 1960, total ascorbic acid values were obtained for all 10 varieties and selections included in the experiment. In 1961, seven varieties were analyzed for total ascorbic acid and its components: reduced ascorbic acid,

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<sup>1</sup> Association of Vitamin Chemists. 1951. Methods of Vitamin Assay. Second Edition, p. 93. Interscience Publ. Inc., New York.

dehydroascorbic acid, and diketogulonic acid. Only four of these varieties, however, were included in the taste panel and other evaluations.

A Bausch and Lomb Spectronic 20 colorimeter with reflectance attachment was used to measure color of the thawed, uncooked beans at each of the four time periods previously described. From the reflectance measurements, dominant wavelength, percent purity, and Y (brightness) of the samples were calculated.

Color measurements were also made, in 1961, using a Gardner Color Difference Meter. A Gardner Reference Standard (CMG0061) having values of  $R_d = +26.2$ , "a" = -28.5, "b" = +8.2 was used. Reflectance readings were taken in duplicate.

Fiber content of all varieties was determined by a procedure based on the Kramer<sup>2</sup> method for bean fiber and the Showalter<sup>3</sup> method for sweet corn pericarp.

Shear press measurements were made on beans studied in 1961. One hundred grams of thawed, uncooked beans were placed in the standard cell of the Shear-Press and the pounds of force required to shear through this sample was recorded.

Data from all experiments were subjected to analysis of variance, and simple correlation coefficients were calculated for all possible pairs of measurements. Electronic data-processing equipment at the University Computing Center was used for all calculations.

## RESULTS AND DISCUSSION

Results of 1960 taste panel evaluations are shown in Table 1. There was considerable variability among time periods, probably because of difference in composition of the panel rather than storage changes in the varieties. White Half-runner had a mean score significantly lower than that of the other nine varieties tested. White Half-runner is a relatively small, light-colored bean with less well-developed flavor than was desired by the panelists. All of the other varieties tested in 1960 were very closely ranked by the panelists, and there were no other significant taste panel differences among them.

Table 2 summarizes results of 1961 taste panel evaluations. All 10 of the varieties and selections tested were very similar and were closely ranked by the panelists. There were no significant flavor or texture differences among samples, and the observed color differences were slight. Tendercrop and B-3125-X-5-2 received the highest color scores. Slenderwhite had the lowest overall color score, supporting the 1960 observation that light-colored beans are generally scored lower by panelists. Mean scores for the 10 varieties were separated by 0.5 or less at all four time periods, indicating that all were about equally acceptable to the taste panel.

Total ascorbic acid content of varieties analyzed in 1960 is shown in Table 3. Initial ascorbic acid content of the fresh beans ranged from 21.5 mg/100 gm for "Sconce" to 12.5 mg/100 gm for B-3370. When analyzed immediately after freezing, the varieties contained from 10.1 to 14.4 mg/100 gm total ascorbic acid. The loss during preparation

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<sup>2</sup> Amihud Kramer, Faster quality check for snap beans. Food Packer, June 1951.

<sup>3</sup> Robert K. Showalter, Measuring the pericarp content of sweet corn. Proceedings of the Association of Southern Agricultural Workers. Vol. 57. 1960.

TABLE 1. - RESULTS OF TASTE PANEL EVALUATION OF GREEN BEANS, 1960

Variety	PERIOD OF FROZEN STORAGE															Over-all Mean
	0 Months			3 Months			6 Months			9 Months			Time Periods Combined			
	Flavor	Color	Texture	Flavor	Color	Texture	Flavor	Color	Texture	Flavor	Color	Texture	Flavor	Color	Texture	
Wade	7.7	8.4	7.6	7.8	8.0	7.4	7.9	8.2	7.9	8.1	8.4	8.3	7.9	8.3	7.8	8.0
Wadex	7.8	7.9	7.8	7.9	8.2	7.7	8.0	8.5	7.8	8.3	8.6	8.3	8.0	8.3	7.9	8.1
Tenderlong-15	7.9	8.4	8.2	7.9	8.3	8.0	8.0	8.0	7.8	8.1	8.1	8.3	8.0	8.3	8.0	8.1
Corneli-14	7.9	8.1	7.8	8.1	8.0	7.9	7.9	8.3	7.8	9.0	8.7	8.3	8.2	8.3	8.0	8.2
Extender	7.9	8.2	7.9	8.1	8.2	7.7	7.7	8.1	7.8	8.1	8.2	8.1	7.9	8.2	7.9	8.0
B-3370	7.6	8.4	7.7	7.8	8.2	7.8	8.0	8.4	7.9	7.8	8.7	8.7	7.8	8.4	7.9	8.0
Improved Tendergreen	7.7	8.1	7.5	8.1	8.4	7.9	7.9	8.6	7.9	8.0	8.6	8.6	7.9	8.4	8.0	8.1
Tenderwhite	8.0	8.4	8.1	7.9	7.7	7.6	8.3	8.0	8.2	8.5	8.1	8.3	8.2	8.0	8.1	8.1
"Sconce"	8.4	8.4	7.1	7.9	7.4	7.5	7.9	8.0	7.8	8.3	8.6	8.6	8.1	8.1	7.6	7.9
White Half-runner	6.2	6.6	7.0	7.0	6.7	7.4	7.3	7.2	7.5	7.4	7.6	7.6	7.0	7.0	7.4	7.2

TABLE 2. - RESULTS OF TASTE PANEL EVALUATION OF GREEN BEANS, 1961

Variety	PERIOD OF FROZEN STORAGE															Over- all Mean
	0 Months			3 Months			6 Months			9 Months			Time Periods Combined			
	Flavor	Color	Texture	Flavor	Color	Texture	Flavor	Color	Texture	Flavor	Color	Texture	Flavor	Color	Texture	
Wade	8.0	8.3	7.9	7.7	7.8	7.7	7.4	7.9	7.9	8.2	7.8	8.2	7.8	8.1	7.8	7.9
Wadex	7.6	8.3	7.5	7.9	7.7	7.6	7.8	8.5	7.8	8.3	7.6	8.3	7.7	8.2	7.6	7.9
Tenderlong-15	7.3	8.1	7.8	7.7	8.1	8.1	7.3	8.3	7.9	8.2	7.9	8.2	7.6	8.2	7.9	7.9
Cornell-14	7.5	8.0	8.0	7.3	7.8	7.4	7.5	8.2	7.6	8.2	7.4	8.2	7.5	8.1	7.6	7.7
B-3125-X-5-2	8.2	8.1	7.4	7.5	8.4	7.9	7.5	8.7	7.9	8.2	7.7	8.2	7.9	8.4	7.8	8.0
Processor	7.9	7.8	7.7	7.8	8.1	7.7	7.8	8.0	7.4	7.8	7.4	7.6	7.6	7.9	7.6	7.8
Tendercrop	7.9	8.7	7.6	7.4	7.9	7.8	7.6	8.6	7.4	8.5	7.5	8.5	7.6	8.4	7.6	7.9
Harris Shipper	7.4	7.9	7.7	7.6	7.4	7.8	7.8	8.2	7.8	8.0	7.6	8.0	7.8	7.9	7.8	7.8
Harvester	8.0	8.4	7.5	7.2	7.9	7.6	7.2	8.1	7.5	7.8	7.7	7.8	7.8	8.0	7.6	7.7
Slenderwhite	7.9	7.7	7.8	7.7	7.8	7.6	7.7	8.0	7.3	7.6	7.8	7.6	7.5	7.8	7.5	7.7

TABLE 3. - TOTAL ASCORBIC ACID CONTENT OF GREEN BEANS, 1960

Variety or Selection	TOTAL ASCORBIC ACID (mg/100 gm)					Mean for Processed Beans
	Fresh Beans	Period of Frozen Storage, Months				
		0	3	6	9	
Wade	15.0	10.7	11.0	8.3	9.0	9.8
Wadex	15.2	10.4	7.7	5.5	5.4	7.2
Tenderlong-15	13.4	12.2	11.0	7.7	7.2	9.5
Corneli-14	14.7	11.4	12.2	10.6	10.0	11.0
Extender	16.1	10.5	9.0	6.8	6.6	8.2
B-3370	12.5	10.1	9.4	6.4	5.7	7.9
Improved Tendergreen	18.3	14.4	12.4	8.8	8.1	10.9
Tenderwhite	14.7	10.1	8.7	8.3	6.6	8.4
"Sconce"	21.5	13.0	13.2	10.0	9.1	11.3
White Half-runner	17.5	13.3	12.0	10.9	9.9	11.5

and freezing was greatest for "Sconce" (40 percent) and smallest for Tenderlong-15 (9 percent). After 9 months' frozen storage, Corneli-14, White Half-runner, and "Sconce" had the highest total ascorbic acid content.

When green beans from the 1961 harvest were analyzed immediately after freezing, the total ascorbic acid content ranged from 19.8 mg/100 gm to 11.3 mg/100 gm (Table 4). During 9 months' storage at 0°F or below, the total ascorbic acid in all varieties remained relatively constant, and there were no significant differences among time periods. Reduced ascorbic acid (ASA) followed much the same distribution pattern as did total ascorbic acid, with Tenderlong-15, Extender, and "Sconce" having the highest ASA levels each time the samples were analyzed. Dehydroascorbic acid of the samples varied from 5.0 mg/100 gm (Extender) to 1.7 mg/100 gm ("Sconce") when analyzed immediately after freezing, but the differences among varieties were not significant after 3, 6, and 9 months' storage. All samples contained small amounts of biologically inactive diketogulonic acid.

Reflectance measurements on green beans in the 1960 study showed that the instrument was measuring the same color attributes as were the panelists but somewhat less acutely (Tables 5 and 6). Dominant wavelengths of all the uncooked samples were very similar, ranging from 560.0 to 564.8 millimicrons. Dominant wavelengths of the

TABLE 4. - TOTAL ASCORBIC ACID AND ITS COMPONENTS IN GREEN BEANS, 1961

	TOTAL ASCORBIC ACID	REDUCED ASCORBIC ACID	DEHYDRO- ASCORBIC ACID	DIKETO- GULONIC ACID
Immediately After Processing				
	<u>mg/100gm</u>	<u>mg/100gm</u>	<u>mg/100gm</u>	<u>mg/100gm</u>
Wade	11.3	8.1	2.2	1.0
Wadex	11.8	8.3	2.5	1.0
Tenderlong-15	19.8	15.8	2.8	1.2
Harvester	15.3	10.9	3.1	1.3
Extender	17.6	11.3	5.0	1.3
B-3370	14.8	10.7	3.0	1.1
"Sconce"	17.4	14.5	1.7	1.2
After 3 Months' Frozen Storage				
Wade	12.1	8.7	2.0	1.4
Wadex	11.6	8.2	2.0	1.4
Tenderlong-15	19.5	15.2	2.7	1.6
Harvester	15.4	11.7	2.3	1.4
Extender	18.0	14.0	2.7	1.3
B-3370	14.5	10.4	2.6	1.5
"Sconce"	16.7	13.2	2.2	1.3
After 6 Months' Frozen Storage				
Wade	12.2	8.7	2.2	1.3
Wadex	12.1	8.4	2.6	1.1
Tenderlong-15	20.6	16.2	2.6	1.8
Harvester	15.9	11.3	3.0	1.6
Extender	18.7	13.4	3.9	1.4
B-3370	15.0	11.2	2.2	1.6
"Sconce"	18.1	14.0	2.8	1.3
After 9 Months' Frozen Storage				
Wade	12.2	8.8	1.7	1.7
Wadex	12.0	8.9	1.9	1.2
Tenderlong-15	20.1	16.0	2.5	1.6
Harvester	16.1	11.4	3.2	1.5
Extender	18.8	15.1	2.1	1.6
B-3370	14.7	11.2	1.9	1.6
"Sconce"	17.1	14.3	1.5	1.3

TABLE 5. - DOMINANT WAVELENGTH, PERCENT PURITY, AND BRIGHTNESS OF UNCOOKED GREEN BEANS, 1960

Variety	IMMEDIATELY AFTER PROCESSING				AFTER 3 MONTHS' FROZEN STORAGE							
	Dominant Wavelength	Percent Purity	Brightness (Y) in %	Dominant Wavelength	Percent Purity	Brightness (Y) in %	Dominant Wavelength	Percent Purity	Brightness (Y) in %			
Wade	561.2	16.4	20.6	561.7	37.3	14.2						
Wadex	560.9	15.9	20.0	560.6	33.8	12.2						
Tenderlong-15	560.9	16.3	20.9	560.0	37.2	13.6						
Corneli-14	560.6	18.3	21.7	560.5	34.8	13.5						
Extender	560.7	15.6	20.0	560.4	30.2	13.7						
B-3370	561.7	21.4	21.9	561.1	39.7	14.2						
Improved												
Tendergreen	560.9	17.1	20.4	563.7	36.2	13.4						
Tenderwhite	561.2	20.8	22.2	563.4	42.9	15.1						
"Sconce"	560.9	17.1	20.2	562.1	36.0	12.3						
White Half-runner	562.3	25.4	25.6	560.9	47.0	18.3						
TIME PERIODS COMBINED												
	AFTER 6 MONTHS' FROZEN STORAGE				AFTER 9 MONTHS' FROZEN STORAGE				TIME PERIODS COMBINED			
	Dominant Wavelength	Percent Purity	Brightness (Y) in %	Dominant Wavelength	Percent Purity	Brightness (Y) in %	Dominant Wavelength	Percent Purity	Brightness (Y) in %	Dominant Wavelength	Percent Purity	Brightness (Y) in %
Wade	561.4	33.9	12.6	563.4	34.6	14.8	561.9	30.5	15.6	561.9	30.5	15.6
Wadex	560.7	33.4	12.8	562.2	31.8	13.7	561.1	28.7	14.7	561.1	28.7	14.7
Tenderlong-15	561.8	39.1	14.1	564.8	33.4	14.5	561.9	31.5	15.8	561.9	31.5	15.8
Corneli-14	561.4	29.6	13.8	562.7	32.6	15.2	561.3	28.8	16.0	561.3	28.8	16.0
Extender	562.0	31.2	12.9	561.9	28.7	13.5	561.2	26.4	15.0	561.2	26.4	15.0
B-3370	563.6	44.3	13.9	561.7	32.3	14.1	562.0	34.4	16.0	562.0	34.4	16.0
Improved												
Tendergreen	562.9	31.9	12.8	563.0	34.2	14.6	562.6	29.8	15.3	562.6	29.8	15.3
Tenderwhite	563.1	44.1	15.9	563.4	37.6	15.6	562.8	36.3	17.2	562.8	36.3	17.2
"Sconce"	561.6	31.1	11.4	562.8	37.3	13.9	561.8	30.4	14.5	561.8	30.4	14.5
White Half-runner	563.0	47.5	18.3	562.7	39.5	18.9	562.2	39.9	20.3	562.2	39.9	20.3





cooked beans were slightly higher, from 568.2 to 571.5 millimicrons, indicating a shift on cooking toward the yellow area of the spectrum. White Half-runner had the highest percentage of purity of all samples measured, both cooked and uncooked, at all time periods. Purities varied somewhat among time periods, but the relationships among samples remained fairly constant. White Half-runner also had the highest brightness, supporting the visual observation that this variety was characterized by a lighter color than the others.

In 1961, reflectance measurements followed the same patterns as those of 1960, but the range of values was shorter because of the greater color similarity of all the samples (Tables 7 and 8). There were no significant differences in dominant wavelengths of the varieties tested. Slenderwhite had the highest average brightness and one of the lowest taste panel color scores. In both 1960 and 1961, brightness seemed to be a more accurate indicator of panel preference for green beans than dominant wavelength or purity.

Color of all beans in the 1961 studies was measured with a Gardner Color Difference Meter, yielding values for  $R_d$ , "a", and "b" (Table 9).  $R_d$  represents the amount of light reflected by the sample and is equivalent to brightness (Y) expressed in percent. Negative "a" values indicate relative greenness, and positive "b" values indicate relative yellowness of the sample. Color scores assigned by the panel were significantly correlated with  $R_d$  measurements on the cooked beans ( $r = -0.643^*$ ) and with the a/b ratio in both cooked and uncooked beans ( $r = 0.701^*$  and  $0.656^*$ , respectively). There was good correlation between Y, as measured by the Spectronic 20, and  $R_d$ , as measured by the Gardner Color Difference Meter.

Fiber contents of all green beans analyzed in 1960 (Table 10) were less than 0.1 percent, when time periods were combined. Tenderlong-15 and Wade had the highest average fiber content of the varieties tested, and Extender had the lowest. All beans used in the experiments were harvested at optimum stages of maturity, and none were judged tough or stringy by the panel.

Of the beans analyzed for fiber in 1961, Slenderwhite and Wade had the highest average fiber content (0.232 and 0.177 percent, respectively) (Table 11). Tendercrop was lowest in fiber. Fiber content was not significantly correlated with texture scores in 1960 or 1961, probably because the fiber in all varieties was within acceptable limits and the taste panel texture scores were very closely ranked for all varieties.

Shear values for bean varieties in the 1961 studies are reported in Table 12. Force required to shear a 100-gram sample was greatest for Wade, smallest for Tendercrop. These values were generally in agreement with the results of fiber determinations.

## SUMMARY

Tables 13 and 14 summarize results of quality measurements on green bean varieties and selections included in the 1960 and 1961 studies.

All of the green beans evaluated in 1960 were acceptable to the taste panel, but White Half-runner was scored significantly lower than the others. The panel found only slight flavor, color, and texture differences among all the beans evaluated in 1961.

"Sconce," White Half-runner, Improved Tendergreen, and Corneli-14 had the highest ascorbic acid content of the processed beans analyzed in 1960. Nine to forty

\*Significant at the 5% level of probability

TABLE 7. -DOMINANT WAVELENGTH, PERCENT PURITY, AND BRIGHTNESS OF UNCOOKED GREEN BEANS, 1961

Variety	IMMEDIATELY AFTER PROCESSING			AFTER 3 MONTHS' FROZEN STORAGE		
	Dominant Wavelength	Percent Purity	Brightness (Y) in %	Dominant Wavelength	Percent Purity	Brightness (Y) in %
Wade	560.2	28.1	17.5	562.0	25.2	19.4
Wadex	559.7	27.4	18.4	562.7	28.7	20.0
Tenderlong-15	561.8	28.0	17.3	561.8	27.7	19.9
Corneli-14	559.5	26.4	18.5	561.2	24.0	17.7
B-3125-X-5-2	559.7	28.7	18.8	559.9	31.9	20.5
Processor	561.0	32.3	20.2	563.1	29.3	20.5
Tendercrop	559.4	28.0	18.1	561.2	26.3	19.4
Harris Shipper	559.2	25.0	18.5	561.3	24.3	18.0
Harvester	560.4	27.3	18.4	561.5	30.2	19.9
Slenderwhite	560.4	29.0	19.9	560.2	27.9	21.0

  

Variety	AFTER 6 MONTHS' FROZEN STORAGE			TIME PERIODS COMBINED		
	Dominant Wavelength	Percent Purity	Brightness (Y) in %	Dominant Wavelength	Percent Purity	Brightness (Y) in %
Wade	561.5	24.0	19.8	561.2	25.8	18.9
Wadex	562.4	23.6	20.0	561.6	26.6	19.4
Tenderlong-15	562.1	25.2	19.9	561.9	26.9	19.0
Corneli-14	562.6	25.0	20.4	561.1	25.2	18.8
B-3125-X-5-2	561.7	27.7	20.3	560.4	29.4	19.9
Processor	562.0	26.0	20.8	562.0	29.2	20.5
Tendercrop	561.2	23.1	18.8	560.6	25.8	18.8
Harris Shipper	563.2	27.8	20.2	561.2	25.7	18.9
Harvester	562.1	28.1	21.6	561.3	28.6	20.0
Slenderwhite	562.4	25.2	21.9	561.0	27.4	20.9

TABLE 8. - DOMINANT WAVELENGTH, PERCENT PURITY, AND BRIGHTNESS OF COOKED GREEN BEANS, 1961

Variety	IMMEDIATELY AFTER PROCESSING				AFTER 3 MONTHS' FROZEN STORAGE			
	Dominant Wavelength	Percent Purity	Brightness (Y) in %	Taste Panel Color Score	Dominant Wavelength	Percent Purity	Brightness (Y) in %	Taste Panel Color Score
Wade	567.8	26.0	17.7	8.3	569.4	24.7	20.2	7.8
Wadex	568.1	26.9	17.6	8.3	569.5	29.1	19.4	7.7
Tenderlong-15	569.0	24.0	17.0	8.1	570.0	26.7	19.7	8.1
Corneli-14	567.8	27.3	17.9	8.0	565.8	23.9	18.7	7.8
B-3125-X-5-2	568.8	28.9	18.8	8.1	569.4	28.9	20.1	8.4
Processor	569.3	32.8	20.0	7.8	566.5	24.6	20.8	8.1
Tendercrop	567.7	27.3	17.8	8.7	568.9	28.5	18.2	7.9
Harris Shipper	568.5	27.0	18.4	7.9	570.6	27.4	19.0	7.4
Harvester	568.0	31.3	19.4	8.4	570.7	30.2	19.5	7.9
Slenderwhite	568.9	29.2	19.5	7.7	570.0	28.3	21.4	7.8

  

Variety	AFTER 6 MONTHS' FROZEN STORAGE				TIME PERIODS COMBINED			
	Dominant Wavelength	Percent Purity	Brightness (Y) in %	Taste Panel Color Score	Dominant Wavelength	Percent Purity	Brightness (Y) in %	Taste Panel Color Score
Wade	570.8	25.0	19.1	7.9	569.3	25.3	19.0	8.0
Wadex	570.2	26.8	19.9	8.5	569.3	27.6	19.0	8.2
Tenderlong-15	569.2	24.9	19.1	8.3	569.4	25.2	18.6	8.2
Corneli-14	569.9	23.6	20.0	8.2	567.8	24.9	18.9	8.0
B-3125-X-5-2	570.4	29.8	20.3	8.7	569.4	29.2	19.7	8.4
Processor	570.2	25.7	20.8	8.0	568.7	27.7	20.5	8.0
Tendercrop	569.5	26.8	19.7	8.6	568.7	27.5	18.6	8.4
Harris Shipper	571.1	25.5	20.1	8.2	570.1	26.7	19.2	7.8
Harvester	570.1	26.7	21.8	8.1	569.6	29.4	20.3	8.1
Slenderwhite	571.0	25.4	21.1	8.0	569.9	27.6	20.7	7.8

TABLE 9. - GARDNER COLOR DIFFERENCE METER MEASUREMENTS ON GREEN BEANS, 1961

Variety	PERIOD OF FROZEN STORAGE												TIME PERIODS COMBINED			
	3 Months				6 Months				9 Months				R <sub>d</sub>	"a"	"b"	a/b
	R <sub>d</sub>	"a"	"b"	R <sub>d</sub>	"a"	"b"	R <sub>d</sub>	"a"	"b"	R <sub>d</sub>	"a"	"b"				
Wade	10.9	-16.7	14.1	10.0	-16.2	16.3	10.5	-17.4	17.4	10.4	-16.8	15.9	1.053			
Wadex	10.8	-16.1	14.2	10.5	-16.5	16.8	11.0	-17.7	17.5	10.8	-16.8	16.2	1.036			
Tenderlong-15	10.5	-16.6	13.6	10.0	-16.8	16.5	10.1	-17.1	16.4	10.2	-16.8	15.5	1.084			
Corneli-14	9.9	-15.6	12.8	9.8	-15.5	15.4	9.8	-16.6	16.2	9.8	-15.9	14.8	1.076			
B-3125-X-5-2	10.9	-17.3	14.8	10.3	-18.1	18.0	10.3	-18.1	17.8	10.5	-17.8	16.9	1.056			
Processor	11.4	-16.9	15.2	10.7	-17.1	17.5	11.0	-18.3	18.6	11.0	-17.4	17.1	1.018			
Tendercrop	9.7	-16.1	13.4	9.9	-16.6	16.5	9.5	-17.8	16.8	9.7	-16.8	15.5	1.083			
Harris Shipper	10.9	-16.0	13.7	10.0	-16.2	16.4	10.8	-17.5	17.4	10.6	-16.6	15.8	1.047			
Harvester	11.5	-17.5	15.6	10.1	-17.4	17.8	10.6	-17.8	18.1	10.7	-17.6	17.1	1.026			
Slenderwhite	11.6	-16.3	15.1	10.1	-15.8	16.5	10.6	-16.7	17.2	10.8	-16.3	16.3	1.000			
Wade	10.7	- 8.2	14.1	10.1	- 7.5	16.3	9.7	- 9.5	16.1	10.2	- 8.4	15.5	.542			
Wadex	10.7	- 7.8	14.3	10.2	- 7.4	16.1	9.7	- 8.7	15.8	10.2	- 8.0	15.4	.518			
Tenderlong-15	10.6	- 8.1	13.8	10.1	- 7.7	16.4	9.4	- 8.5	15.0	10.0	- 8.1	15.1	.537			
Corneli-14	10.3	- 8.5	13.3	10.1	- 7.9	15.4	10.7	- 9.4	16.5	10.3	- 8.6	15.1	.571			
B-3125-X-5-2	11.0	- 8.8	15.0	10.1	- 8.4	17.5	10.5	- 9.8	17.6	10.5	- 9.0	16.7	.538			
Processor	11.3	- 8.4	15.4	11.4	- 8.2	17.6	11.3	- 9.4	18.2	11.3	- 8.7	17.1	.508			
Tendercrop	10.1	- 8.4	13.4	9.8	- 7.7	15.6	9.3	- 9.6	15.3	9.7	- 8.6	14.8	.580			
Harris Shipper	10.7	- 8.0	14.0	10.3	- 7.3	16.0	10.0	- 8.5	15.8	10.3	- 7.9	15.3	.519			
Harvester	11.3	- 9.3	15.0	11.2	- 8.3	18.2	11.3	-10.1	18.4	11.3	- 9.2	17.2	.537			
Slenderwhite	11.0	- 8.4	14.7	10.9	- 7.5	16.8	11.0	- 8.8	17.2	11.0	- 8.2	16.2	.507			

UNCOOKED

COOKED

TABLE 10. - FIBER CONTENT (PERCENT FRESH WEIGHT) OF GREEN BEANS, 1960

Variety	PERIOD OF FROZEN STORAGE				Average
	0 months	3 months	6 months	9 months	
Wade	0.102	0.060	0.101	0.107	0.092
Wadex	.076	.108	.076	.093	.088
Tenderlong-15	.046	.084	.092	.161	.096
Corneli-14	.073	.097	.061	.108	.085
Extender	.023	.038	.035	.033	.032
B-3370	.039	.070	.063	.132	.076
Improved Tendergreen	.047	.081	.065	.109	.076
Tenderwhite	.021	.045	.069	.111	.062
"Sconce"	.043	.052	.078	.177	.087
White Half-runner	.045	.086	.112	.116	.090

TABLE 11. - FIBER CONTENT (PERCENT FRESH WEIGHT) OF GREEN BEANS, 1961

Variety	PERIOD OF FROZEN STORAGE				Average
	0 months	3 months	6 months	9 months	
Wade	0.222	0.178	0.210	0.099	0.177
Wadex	.160	.172	.092	.076	.125
Tenderlong-15	.057	.058	.087	.031	.058
Corneli-14	.068	.071	.063	.016	.054
B-3125-X-5-2	.074	.066	.110	.052	.076
Processor	.119	.119	.098	.045	.095
Tendercrop	.019	.051	.039	.012	.030
Harris Shipper	.080	.154	.100	.057	.098
Harvester	.137	.137	.122	.076	.118
Slenderwhite	.191	.417	.205	.113	.232

TABLE 12. - SHEAR PRESS MEASUREMENTS ON GREEN BEANS, 1961

Variety	Pounds force	Rank
Wade	345	10
Wadex	278	4
Tenderlong-15	307	9
Corneli-14	207	2
B-3125-X-5-2	275	3
Processor	288	7
Tendercrop	183	1
Harris Shipper	303	8
Harvester	282	5
Slenderwhite	283	6

TABLE 13. - VARIETIES AND SELECTIONS RANKED, IN DESCENDING ORDER, ACCORDING TO FACTORS MEASURED, 1960

Taste Panel Scores <sup>1</sup>	Ascorbic Acid Content <sup>2</sup>	Objective Color Measurements <sup>3</sup>	Objective Texture Measurements <sup>4</sup>
Corneli-14	"Sconce"	Extender	Extender
Improved Tendergreen	White Half-runner	Wadex	Tenderwhite
Tenderlong-15	Improved Tendergreen	Corneli-14	B-3370
Tenderwhite	Corneli-14	"Sconce"	Improved Tendergreen
Wadex	Wade	Wade	Corneli-14
B-3370	Extender	B-3370	"Sconce"
Wade	Tenderwhite	Improved Tendergreen	Wadex
Extender	Tenderlong-15	Tenderlong-15	White Half-runner
"Sconce"	Wadex	White Half-runner	Wade
White Half-runner	B-3370	Tenderwhite	Tenderlong-15

<sup>1</sup>Taste panel scores include flavor, color, and texture. Times of evaluation were combined to obtain all rankings in this table.

<sup>2</sup>Ascorbic acid content includes the total ascorbic acid in fresh beans, and the average in frozen beans.

<sup>3</sup>Objective color measurements include dominant wavelength, purity, and brightness of cooked and uncooked beans.

<sup>4</sup>Objective texture measurement was a mechanical separation of bean fiber.

TABLE 14. - VARIETIES AND SELECTIONS RANKED, IN DESCENDING ORDER, ACCORDING TO FACTORS MEASURED, 1961

Taste Panel Scores <sup>1</sup>	Ascorbic Acid Content <sup>2</sup>	Objective Color Measurements <sup>3</sup>	Objective Texture Measurements <sup>4</sup>
B-3125-X-5-2	Tenderlong-15	Corneli-14	Tendercrop
Wade	Extender	Tendercrop	Corneli-14
Tenderlong-15	"Sconce"	Tenderlong-15	B-3125-X-5-2
Tendercrop	Harvester	Wade	Harvester
Wadex	B-3370	Harris Shipper	Processor
Processor	Wade	Wadex	Tenderlong-15
Harris Shipper	Wadex	Slenderwhite	Wadex
Slenderwhite		B-3125-X-5-2	Harris Shipper
Corneli-14		Processor	Slenderwhite
Harvester		Harvester	Wade

percent of the total ascorbic acid of fresh beans was lost during handling, blanching, and freezing.

Of the seven varieties analyzed in 1961, Tenderlong-15, Extender, and "Sconce" contained the most total ascorbic acid after all storage periods. These three varieties also had the highest amount of the nutritionally active forms (reduced ascorbic acid and dehydroascorbic acid). The distribution of reduced and dehydroascorbic acid and deketogulonic acid in all samples remained practically constant throughout 9 months' frozen storage.

Objective color measurements failed to reveal one "best" variety in respect to retention of bright green color, but the two varieties ranked lowest by this means in 1960 were also those the taste panel judged as having the least desirable color. Several objective color measurements were significantly correlated with taste panel ratings for color. In 1960 these were the brightness of uncooked beans and the purity of both cooked and uncooked beans. In 1961 the taste panel color ratings were significantly correlated with the  $R_d$  of cooked beans and with the a/b ratio for both cooked and uncooked beans.

All varieties tested had an acceptably low fiber content. In 1960 Extender, Tenderwhite, B-3370 and Improved Tendergreen had the lowest fiber; while in 1961 Tendercrop, Corneli-14, Tenderlong-15, and B-3125-X-5-2 were lowest in fiber. The overall rating for objective texture measurement was better for Corneli-14 than for the other three varieties which were evaluated both years.

<sup>1</sup> Taste panel scores include flavor, color, and texture. Times of evaluation were combined to obtain all the rankings in this table.

<sup>2</sup> Ascorbic acid content includes total ascorbic acid and reduced ascorbic acid in processed beans.

<sup>3</sup> Objective color measurements include (a) dominant wavelength, purity and brightness, and (b) Gardner Color Difference Meter measurements of  $R_d$ , "a", and "b" of cooked and uncooked beans.

<sup>4</sup> Objective texture measurements include mechanical separation of fiber and shear press readings.



All varieties tested during the two years' work were found suitable for freezing when harvested at optimum stages of maturity and processed according to recommended procedures.

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