



QUALITY STUDIES ON POLE AND BUSH BEANS - 1958

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The quality of snap beans is influenced by size of pods, stage of maturity, condition of storage, defects, varietal characteristics and various weather factors. In the varietal evaluation program at the Oregon Agricultural Experiment Station, quality of selections and varieties of beans is based on color, percent of seed, per cent of fiber and taste panel evaluations. Other factors such as smoothness, straightness, shape and tips of pods are also considered.

Fiber content of bean pods is largely determined by variety and size of beans although it may be influenced by weather factors. Varieties with more fleshy-type pods slowly increase in fiber content with the increase in size and maturity. Other types of pods show a rapid increase in fiber content above a sieve size 3 bean.

Size of a bean pod at a certain stage of maturity usually depends on variety, yet size development may be greatly retarded by dry weather conditions. Size grading is used by industry to determine maturity of beans. However, size grade is affected by shape of the pods. Varieties grown commercially in Oregon for processing are round or semi-round podded types.

Development of seed in bean pods is much more rapid in some varieties and selections than in others. This has not been a limiting factor for meeting minimum standards for grades among varieties grown commercially in Oregon.

Defects in processed beans result from disease, adverse weather conditions, insect damage and varietal differences. Varieties with pods 5 to 6 inches in length, smooth and straight-tipped, are easily handled in high-speed processing equipment. Consequently, few defects result from unsnipped stems, misshapen pods and small pieces.

In the bean breeding program at Oregon State College many new selections decrease very little in color as size of the bean increases. Others markedly decrease in color intensity with an increase in size of beans. Since development of large sizes is a variety characteristic affecting yield, much emphasis is placed on size of bean pods. Selections which are reasonably high in yield, low in fiber, and which do not develop above a sieve size 5 bean, may have an advantage for processing. This type of selection has been observed quite frequently in the past two years in the bean program in both pole and bush bean breeding lines.

Standards of quality of the Food and Drug Administration require a maximum limit of 25 percent seed on snap beans for standard quality. Any beans having a higher percent seed than this must be labeled substandard.

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Twigg (4) has shown that percent seed in raw beans correlates with percent seed in the canned product. The Food and Drug Administration established the following ranges in percent seed for grades of canned beans: 0 to 10%, Grade A; 10.1 to 18%, Grade B; and 18.1 to 25%, Grade C. These grades are used only when fiber is not a limiting factor.

From the results of several years of research on determination of percent seed and fiber it appears that seed percent has not been a limiting factor for grading Oregon green beans. Fiber content has not been high enough to be alarming under normal conditions, but in 1958 research results indicated that fiber content in many varieties and selections in experimental plots was extremely high. This increase was probably caused by especially low humidity conditions and high temperatures which occurred during the processing season of bush and pole beans. The Food and Drug Administration established a maximum limit of 0.15% fiber content for green and wax beans. Lots higher than this in fiber content must be labeled substandard. This indicates processors should conduct fiber determinations on the finished product as a part of their quality control program.

EXPERIMENTAL METHODS

A. Methods of Preparation

Bush beans were mechanically harvested by replication in the field but replications were mixed together for processing studies. After harvesting, beans were brought to the food processing pilot plant and cleaned by removing the large pieces of vine, clinging soil and other debris. Clusters of pods were separated, but practically all remaining extraneous material was removed in the mechanical grader in the sieve 1 reel. Only a small number of usable sieve size 1 beans was obtained from most selections. Usable sieve 1 beans were sorted by hand from the debris and placed with the sieve size 2 beans. Sieve sizes 1 through 6 were combined into 3 groups (1 & 2, 3 & 4, 5 & 6) for processing. After snipping the beans, groups 2 and 3 were cut to $1\frac{1}{2}$ inch lengths. Group 1 (1 & 2 sieve mixed) was processed as whole pack beans.

Beans were packed for freezing and canning. Beans for canning were blanched $1\frac{1}{2}$ minutes at 178°F., cooled, and packed in 303 x 406 plain cans. When sufficient samples were accumulated to fill a retort, the cans were filled with boiling water, closed by a steam-flow automatic machine, and processed 20 minutes at 240°F. Each can of beans was salted with 60 grains of salt.

Beans for freezing were blanched $1\frac{1}{2}$ minutes in a steam box, cooled, and packed in metal-end cartons. These cartons were sealed by a semi-automatic metal-end carton closer and placed immediately in the blast freezer at -10°F.

Bush beans from the preliminary trial plots were hand-picked and handled in the same way except beans were not graded for size. Beans were cut to $1\frac{1}{2}$ inch lengths after snipping.

Pole beans for processing were separated into sizes but fixed percentages of sieve sizes 3, 4 and 5 were mixed together in all selections. Again, length of cut was $1\frac{1}{2}$ inches. All other procedures were same as those described for mechanically harvested bush beans.

B. Quality Measurement

1. Color -- The color of each lot of canned beans was measured by using the Hunter Color and Color Difference Meter. The instrument was standardized to the values for the SKC-15 "kitchen green" color plaque supplied by the National Bureau of Standards.

2. Crude Fiber and Percent Seed -- Crude fiber percentages were obtained on canned and frozen beans and were made approximately 3 months after processing. The FDA method was used for these determinations (2).

3. Shear Press Determinations -- Shear press readings were obtained from a 150 gram sample of canned beans after draining on an 8 mesh screen. Maryland Shear Press was used to measure shear resistance by employing the gauge that recorded in Kgs. pressure. Measurement was made by pouring a 150 gram sample of beans into a cup and arranging them uniformly in the cup. Values were obtained immediately after opening the cans.

4. Panel Evaluations -- Evaluations were conducted in part by three types of taste panels. A representative number of better selections of Blue Lake type bush beans together with samples of FM-1 pole beans were presented to a 20-member panel from the bean processing industry. For preliminary screening tests a small staff panel rated all canned and frozen bean samples at least once. Later tests were conducted with the larger expert panel of the Department of Food and Dairy Technology. In all instances bean samples were rated in coded dishes or individual cups.

Frozen beans for evaluation were cooked for 10 minutes in boiling water salted at the rate of 60 grains per 250 ml. of water for a 1-pound package of beans.

In all evaluation studies beans were rated on a 9-point hedonic scale for 6 quality factors: smoothness of pods; shape; intensity of color; color acceptance; tenderness; and flavor. Only mean scores are shown in this presentation.

RESULTS

Discussion of experimental results on bush and pole beans will be separate although experimental methods were essentially the same on both types.

A. Bush Beans

Processing and evaluation studies of bush beans in 1958 were largely made on varieties and OSC selections of beans from mechanically harvested plots. On basis of preliminary data obtained from the 1958 study, quality

of bush beans is not affected noticeably by mechanical harvesting of pods provided the beans are processed the day of harvest. Delaying processing was found to lower quality of processed beans when fresh beans were stored at 35° - 40° F storage temperatures.

Percent seed in the selections and varieties increased markedly with an increase in size of beans (Table 1). Size group 1 (1 & 2 sieve) was not included in this determination because seeds were too small to be of any importance. Most stored samples appeared to be higher in seed percentage than fresh processed beans (Table 1). Variation in seed percentage was small in most varieties and selections. However, Tenderwhite variety was quite low in percent seed. Processor and selection 410 were quite high compared to other bean varieties and selections.

Shrinkage losses occurred after storing beans for 5 days at 35° - 40° F. Losses were not prohibitive though shriveling was noticeable in the canned beans (Table 2). Samples of beans stored at 80°F., (common storage temperature) for 5 days were too badly damaged to justify processing. Frozen beans processed from stored beans showed shriveling and darkening in the pods. Browning occurred in beans mechanically damaged. This damage showed up on bean pods which were crushed, torn or broken. In addition, there was a slight darkening of bean color because of accumulation of sugars in cold storage.

Fiber content of most Blue Lake type bush beans was extremely low and fiber did not increase as rapidly with an increase in size as the commercial varieties (Table 3). All selections in Table 3 are Blue Lake type. Beans stored for 5 days at 35° to 40° F. before canning showed some differences in fiber compared to those canned immediately after harvest, but there was no increase in fiber content during the storage period (Table 4).

Fiber content appears to be lower in frozen beans than in canned beans in many instances, as shown in Table 5 and 6. Results are similar to those reported by Gould (1). The reason for this occurrence is that temperature for blanching canned beans is different from that of frozen beans. Recent data in this laboratory indicate that lower temperatures of blanch used for canned beans actually increase percentage of cell-wall substances that are indigestible by alkali when using the FDA method for fiber determination. This action probably is due to binding of bivalent ions with pectins at 178°F., the temperature used for blanching canned beans in these studies.

Resistance to shear of canned beans varied between sizes of beans and varieties. As this physical test measures firmness of beans, it appears that build-up of fiber content in large sizes increased shear resistance in a few varieties and selections (Table 7). Also, it is assumed that bean selections varied in their sensitivity to the 178°F., blanching treatment since all differences in shear resistance cannot be attributed to fiber and size. It was shown in this laboratory (3) that varieties of pole beans differ in heat resistance to different blanching temperatures which preceded the canning process.

Taste panel scores of canned and frozen beans are shown in Table 8 for those beans processed immediately after harvest. Blue Lake type bush beans received highest scores in both canned and frozen packs. Results were confirmed by an industry panel which rated a representative sample of these varieties and selections in size 3 bean only.

Lower scores were obtained on beans stored before processing (Table 9). These beans were not completely objectionable after storage but in most instances a decided decrease in quality was readily detected when these samples were compared to beans processed immediately after harvest. This was especially noticeable in frozen beans.

A comparison of mechanically harvested and hand-picked bush beans of the Processor variety did not reveal any differences due to harvesting methods. Differences existed because the beans were grown under different culture conditions.

Data obtained by the Hunter Color Meter for canned bean color showed that color becomes lighter with an increase in size of bean pods (Table 10). This increase in "Rd" (lightness) and $\sqrt{a^2 + b^2}$ (chroma) with an increase in size of bean pods was greater in the varieties than in Blue Lake type selections. Selections 530, 410, 836, 777, and 949 showed less change in color with an increase in size than the other selections. This color differential in size of beans was not as great in stored beans (Table 11). The reason for the small difference was probably due to the general darkening of beans during storage at 35-40°F.

Preliminary trials on a large number of small plots of bush beans revealed many of them have desirable canning quality. The outstanding selections among those canned were: 1374, 1454, 1259, 1222, and 1340. Beans from small plots showed a wide variation in fiber content as well as color and shear press values. Since these selections did not mature at the same time, and samples of beans for canning consisted of mixed sizes, fiber content among the selections may or may not be comparable. No definite conclusions were drawn from these objective data on fiber contents. Due to straightness of pods and uniformness of color within selections, this quality should be indicative of that expected under expanded acreage in the field. Further testing of better selections with commercial growers will be the objective in 1959. Additional data on specific selections is available upon request.

Table 1. Percentage of Seed in Canned Bush Beans

Selection	Fresh Processed		Stored Before Processing	
	Sizes 3 & 4	Sizes 5 & 6	Sizes 3 & 4	Sizes 5 & 6
415	5.67	7.47	--	--
777	5.96	7.20	--	--
836	5.86	9.33	--	--
416	4.84	6.78	--	--
410	6.83	10.01	10.40	--
816	5.40	9.51	5.69	--
530	5.04	9.08	6.38	--
412	5.84	8.41	6.30	9.10
949	5.76	9.10		
Tenderwhite	1.47	5.38	2.20	--
Processor	7.60	10.68	7.31	9.98
Harvester	3.57	10.01	--	--
Processor (Hand picked)	4.03	10.90	4.43	16.59

Table 2. Per Cent Weight Loss of Fresh Bush Beans During Storage After Mechanically Harvesting Pods

Selections and Varieties	Common Storage (Approx. 80° F.)			35 - 40° F. Storage		
	Sizes 1 & 2	3 & 4	5 & 6	Sizes 1 & 2	3 & 4	5 & 6
410	16.8	18.6	-	2.4	3.6	-
412	16.7	16.3	14.8	2.6	2.8	3.0
816	20.0	15.5	-	2.7	2.5	-
530	14.1	15.9	-	2.6	2.5	-
Processor	19.6	18.0	20.5	2.9	2.8	3.2
Processor (Hand picked)	20.0	19.4	21.7	4.8	3.5	3.6

Table 3. Fiber Content of Mechanically Harvested Bush Beans by Sizes (Canned Beans, Fresh Processed)

Selection	Percentage by Size Groups		
	1 & 2	3 & 4	5 & 6
415	.0211	.0419	.1105
777	.0060	.0266	.0308
836	.0294	.0442	.0720
416	.0235	.0411	.0816
410	.0420	.0532	.0587
816	.0330	.0447	.0692
530	.0416	.0381	.0801
412	.0294	.0329	.1036
949	.0333	.0531	.1043
Tenderwhite	.0325	.0421	.1375
Processor	.0413	.1001	.1750
Harvester	.0595	.0895	.1725
Processor (Hand Picked)	.0162	.0269	.3725

Table 4. Fiber Content of Mechanically Harvested Bush Beans by Sizes (Canned Beans, Stored Before Processing)

Selection	Percentage by Size Groups		
	1 & 2	3 & 4	5 & 6
412	.0237	.0476	.0916
410	.0720	.1286	--
530	.0378	.0571	--
816	.0388	.0419	--
Tenderwhite	.0192	.0365	--
Processor	.0730	.0943	.1497
Processor (Hand Picked)	.0278	.0708	.4150

Table 5. Fiber Content of Mechanically Harvested Bush Beans by Size Groups (Frozen Beans, Processed Fresh)

Percentage by Size Groups			
Selections or Varieties	1 & 2	3 & 4	5 & 6
415	.0488	.0287	.0724
777	.0388	.0469	.0570
836	.0237	.0258	.0478
416	.0108	.0404	.0558
410	.0229	.0130	
816	.0226	.0165	.0298
530	.0257	.0265	.0869
412	.0233	.0328	.0536
949	.0185	.0287	.0423
Tenderwhite	.0231	.0158	.1065
Processor	.0245	.0759	.1172
Harvester	.0173	.0403	
Processor (Hand Picked)	.0325	.0535	.1269

Table 6. Fiber Content of Mechanically Harvested Bush Beans by Sizes (Frozen Beans, Stored Before Processing)

Percentage by Size Groups			
Selections or Varieties	1 & 2	3 & 4	5 & 6
412	.0458	.0554	.0989
410	.0426	.0544	--
530	.0560	.0411	--
816	.0379	.0555	--
Processor	.0367	.0586	.3230
Processor (Hand Picked)	.0278	.0459	.4269

Table 7. Resistance to Shear (kgs) of Mechanically Harvested Bush Beans

Selections or Varieties	Canned Immediately			Canned After Storage		
	1 & 2	Sizes 3 & 4	5 & 6	1 & 2	Sizes 3 & 4	5 & 6
415	21.5	23.0	26.0	--	--	--
777	25.5	24.0	25.0	--	--	--
836	26.0	26.5	30.0	--	--	--
416	24.0	26.0	26.0	--	--	--
410	26.0	26.5	29.5	29.5	32.5	--
816	28.0	23.5	27.5	25.0	25.5	--
530	23.0	22.5	26.5	23.5	23.5	--
412	28.0	29.0	32.0	26.5	26.5	31.5
949	28.0	26.0	27.5	--	--	--
Tenderwhite	19.0	23.0	29.0	23.0	27.5	--
Processor	25.5	26.0	27.0	28.0	27.5	35.0
Harvester	18.5	23.5	27.5	--	--	--

Table 8. Taste Panel Scores* of Mechanically Harvested Bush Beans (Processed Immediately)

Selections or Varieties	Canned			Frozen		
	1 & 2	Sizes 3 & 4	5 & 6	1 & 2	Sizes 3 & 4	5 & 6
415	7.05	6.64	6.18	7.10	6.86	6.80
777	7.24	6.97	7.17	7.90	7.74	7.00
836	7.71	7.17	6.80	8.00	7.40	7.10
416	7.56	7.02	6.80	7.80	7.23	7.50
410	7.64	7.28	6.09	7.42	7.17	6.10
816	7.93	7.40	7.10	7.80	7.06	6.80
530	7.38	5.64	6.79	7.90	7.30	--
412	8.40	7.32	6.22	7.50	7.24	7.00
949	6.91	6.39	6.84	7.90	7.34	6.84
Tenderwhite	6.50	5.76	4.66	5.26	4.92	4.70
Processor	5.21	4.62	4.00	4.71	4.84	5.20
Harvester	6.43	5.79	6.32	6.10	6.55	4.22
Processor (Hand Picked)	5.38	3.98	4.99	6.10	5.36	3.78

* Mean Scores for six quality factors: 9 = highest; 1 = lowest quality

Table 9. Taste Panel Scores* of Mechanically Harvested Bush Beans (Stored Before Processing)

Selections or Varieties	Canned			Frozen		
	1 & 2	Sizes 3 & 4	5 & 6	1 & 2	Sizes 3 & 4	5 & 6
410	6.90	7.10	6.91	7.90	6.90	--
412	7.84	7.31	7.15	7.16	7.40	6.70
816	7.30	7.60	7.88	6.40	5.84	--
530	6.26	7.02	7.40	5.87	6.04	--
Processor	6.00	5.50	5.78	5.80	4.80	4.26
Processor (Hand Picked)	6.10	5.78	6.04	6.30	5.60	4.30

* Mean Scores for six quality factors: 9 = highest; 1 = lowest quality.

Table 10. Hunter Color Measurements of Mechanically Harvested Bush Beans, Canned Immediately

Selection or Variety	Hunter Color Data					
	Sizes 1 & 2		Sizes 3 & 4		Sizes 5 & 6	
	Rd	$\sqrt{a^2 + b^2}$	Rd	$\sqrt{a^2 + b^2}$	Rd	$\sqrt{a^2 + b^2}$
415	7.4	9.82	9.5	12.38	10.2	13.34
777	6.3	6.12	7.4	8.62	7.7	10.57
836	7.1	9.73	7.3	9.83	8.6	10.24
416	7.5	10.32	8.1	10.32	8.2	9.82
410	8.9	12.85	7.8	10.85	9.6	13.20
816	7.1	9.52	7.7	11.33	9.5	12.85
530	7.3	9.52	8.3	10.55	8.2	10.53
412	7.0	7.95	8.0	11.02	8.5	11.11
949	8.4	11.07	8.5	10.85	9.8	11.75
Tenderwhite	8.4	10.88	9.7	12.85	12.2	14.62
Processor	9.0	11.19	10.5	12.95	10.6	14.22
Harvester	8.4	10.58	9.0	10.62	10.7	12.97

Table 11. Hunter Color Measurements of Mechanically Harvested Bush Beans, Canned After Storage

Selection or Variety	Hunter Color Data					
	Sizes 1 & 2		Sizes 3 & 4		Sizes 5 & 6	
	Rd	$\sqrt{a^2 + b^2}$	Rd	$\sqrt{a^2 + b^2}$	Rd	$\sqrt{a^2 + b^2}$
412	7.8	10.46	8.1	10.65	9.3	11.93
410	7.3	9.72	7.8	9.92	--	--
530	7.3	9.62	7.4	9.63	--	--
816	7.9	10.55	8.4	10.97	--	--
Tenderwhite	8.1	10.36	8.9	11.38	--	--
Processor	8.2	9.58	9.7	12.18	9.6	11.96

B. Pole Beans

Distinctive quality among Blue Lake pole bean varieties has been recorded for many years. Characteristics which have made this quality are: flavor; color uniformity and intensity; straightness of pods; and yield per acre.

Recently, new selections of bush beans, developed by Dr. W. A. Frazier by backcrossing bush bean lines to Blue Lake pole beans, have bridged the gap of quality between bush and pole green beans. An industry panel representative of the bean processing industry rated many new selections of bush beans equal to or better than FM-1 pole beans in a replicated test.

Need exists to develop pole beans with higher yields as well as to improve efficiency of harvesting, handling and processing. Primary consideration in any step toward improvement should be placed on quality. These factors were considered in choosing selections of pole beans for processing studies.

Selections of pole beans chosen for evaluation in the variety testing program in 1958 are shown in Table 12. No large differences existed in Hunter Color Values on canned beans as these selections were screened for desirable features before processing. The low "Rd" indicates a darker bean color. Any of the selections would be quite satisfactory for commercial varieties on basis of quality alone.

Fiber content of several of the selections was rather high compared to FM-1 and other selections. Low fiber content is a desirable variety characteristic but it appears part of these selections develop fiber rapidly with an increase in size of bean pods. Processing studies were conducted on a mixture of sieve sizes 3, 4 and 5 beans which contained the same percentages of sizes for each selection. Seed percentage did not necessarily increase with an increase in fiber content.

The taste panel scores for quality of canned and frozen pole beans are tabulated in Table 13. Uniformity of quality among selections is demonstrated by mean scores of canned and frozen beans. Due to quality uniformity of this group of pole bean selections, choosing bean selections for further trial will necessarily be based largely on yield, earliness, growth or vining habit, and pod characteristics. Nevertheless, selections such as 637, 1167, 284 and 571 were high in quality as well as yielding ability. The FM-1 variety ranked higher in taste panel scores than in the previous two years. The reason for this high rating may be because of a major improvement in strain or because of more favorable weather conditions in 1958.

Table 12. Results of the Objective Tests on Canned Pole Beans

Selection or Variety	Hunter Color		Shear-press (kgs pressure)	% seed	% fiber
	Rd	Data $\sqrt{a^2 + b^2}$			
FM-1	7.7	10.91	25.5	2.60	.0272
571	8.3	11.79	25.0	3.47	.0593
624	7.3	10.33	27.0	3.53	.0847
464	8.4	10.82	28.5	3.73	.0289
996	7.4	10.75	25.0	4.77	.0522
276	8.1	11.50	24.0	3.41	.0756
637	7.8	10.21	30.0	2.80	.0350
1167	7.2	11.18	27.9	4.35	.0487
913	8.0	9.58	28.5	6.53	.0594
284	7.3	9.92	27.0	2.79	.0612
928	8.1	10.58	23.5	5.51	.0774
1188	7.0	10.24	27.5	3.16	.0368
918	8.4	10.43	28.0	5.18	.0582
1185 (Wax)	-	-	26.0	4.14	.0604
Golden Lake (Wax)	-	-	20.5	6.18	.0574

Table 13. Results of the Taste Panel Evaluations of Canned and Frozen Pole Beans

Variety or Selection	*Mean Rating	
	Canned Beans	Frozen Beans
FM-1	8.06	7.90
571	8.19	8.20
624	6.84	8.30
464	6.94	8.00
996	7.14	7.80
276	7.66	7.90
637	7.69	8.70
1167	8.03	8.40
913	6.83	8.30
284	7.75	8.50
928	7.59	8.30
1188	7.74	8.10
918	7.95	7.90
1185 (Wax)	6.06	7.60
Golden Lake (Wax)	7.09	8.15

* Mean rating from six quality factors rated on a 9 point hedonic scale where 9 was highest quality, and 1 was lowest quality.

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