

THE ACCEPTABILITY OF FOUR EDIBLE VARIETIES OF  
GUAR--CYAMPOSIIS TETRAGONOLOBA (L.) TAUB--BY A  
TASTE PANEL IN RELATION TO MATURITY, METHODS  
OF PREPARATION, AND PROTEIN CONTENT

By

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## CHAPTER I

### INTRODUCTION AND REVIEW OF LITERATURE

Will people in the United States eat guar? In the department of Agronomy at Oklahoma State University long-term genetic studies are being conducted by Mr. Theodore Hymowitz (22). One site was the Agronomy Research Station near Stillwater, Oklahoma, from which beans were made available for use in a culinary study. A taste panel was chosen to investigate the flavor acceptance and to determine methods of preparation for guar.

Guar gum has been used commercially in this country for the last fifteen years, but the green pod with the bean has not been used at all (7,8, and 18). In both India and Pakistan the green pod is eaten as a vegetable. The long flat pods provide an inexpensive table food which is a source of protein, ascorbic acid, and energy (7,9,17,19,20, 23 and 28).

#### Problems Expected

Guar has been described as having a bitter taste (23) which will need to be overcome. The recipes used for preparing guar in India and Pakistan utilize a great number of spices. The present study was undertaken to see if the guar

pod and bean would be accepted as a green vegetable similar to snap beans (17,21, and 29). It was not known if any special cooking methods other than those used in snap bean preparation would be necessary, nor was it known at what stage of maturity the guar could best be used. What, if any, were the differences in varieties? Could guar be frozen or canned? These basic questions were approached through the use of a ten-member panel tasting for acceptability. These panel members described and gave suggestions which revealed the nature of guar and indicated ways to prepare it with equipment and cooking methods familiarly used in the United States.

#### What is Guar?

Guar is an annual summer-growing legume. It grows on a wide range of soils and is found in the United States in areas where cotton is cultivated. Guar has been found to be an excellent rotation crop of high economic importance (6, 7, and 21). Some of the more prominent uses of guar in the food industry utilize its properties as a viscosity modifier and emulsion stabilizer (3,36).

#### World Need For A Protein Source

The use of legumes has been suggested by Dr. Charles Glen King (14) as one of the best and most economical means of solving the world's need for more protein. Presuming the world divided in half, two levels of nutrition would be obvious: those countries with abundant nutrient supplies, and

those which lack for some reason the nutrients required by their populations. The United States is one of the well-supplied nations but the emphasis on low calorie and fat diets often curtails the normal protein intake or alters the quality of protein. This situation presents a problem to be faced in the United States (14). Economically speaking, based on conditions in 1957, the most feasible method of increasing proteins is to supplement protein from animal sources with vegetable sources (14,27, and 31). Neilson (21) goes so far as to predict and suggest the necessity for new products. The use of pure synthetic amino acids as supplements has begun, but long-term studies in man have not been completed.

Progress is going to be slow and difficult but improved nutrition promotes improved relations among neighbors (14). Each development, large or small, has its contribution. Sharing knowledge obtained in the United States will help make us better neighbors. In his food product suggestions, Dr. King (14) lists beans in general; certainly guar can be included.

### History

The search for proteins may lead to production of completely new products. On first inspection guar may seem to be "new", but it has been traced to early Egyptian days in the tombs of the Pharaohs. It is native to Central Africa, India and Pakistan. The predominant uses in these countries



are three: (a) as a table vegetable, the pod picked while green; (b) as a shade plant to protect growing ginger and other delicate plants; and (c) most extensively as fodder and forage for horses and cattle (7).

Guar was introduced to the United States in 1903 by the United States Department of Agriculture as a possible green manure or cover crop. During the second world war a great need arose for domestic products containing mannogalactum polysaccharide for the paper industry which, until this time, had been obtained from imported locust bean flour. Thus guar, a legume with the mannogalactum structure, was firmly established as a domestic crop. Through the years, and more particularly the last 15, guar has become a valuable crop (6, 7, and 9).

#### Description of Guar

There are many types and varieties of guar. Esser (6,7) and Goldfrank (9) have characterized guar in the following manner. Generally the leaves are large, described as similar to but smaller than those of blackeye pea and others and with waxy margins. Tiny flowers in clusters at axils of the leaves are followed by clusters of pods ranging from one and one-half to three and one-quarter inches in length. It is a deep-rooted, drought-tolerant plant which grows well in country where cotton is cultivated; this area includes the southwest United States. It grows in irrigation areas and on a range of soils, from black lands to deep sands, the best being medium textured sandy soils.

As a crop its value as a soil conditioner is important. Tests have proven guar to be an excellent rotation crop whether turned under or simply grown and cut off the land. Beans are produced for protein feed for cattle; the whole plant is used as bundle feed and ensilage. Standard harvesting equipment already familiar to farmers makes guar readily acceptable.

#### Comparison With Sunflower and Soybean

In the world search for proteins, soybeans and sunflower seeds have proven to be very important plant sources. They are dry foods which can be added to any basic diet. Each one presents problems also found in guar: the soybean has a bitter flavor to be overcome and the sunflower has a husk (4). Wheeler, et al. (37) determined the thiamine retention and palatability of soybeans when they were canned, frozen and stored by different methods. The guar seed bean has an outer husk which is difficult to remove. In India one method used for removing the husks has been to soak the seeds in water, coat them with mud and allow to germinate for 48 hours. When the mud is removed the outer coat of the bean comes off. The amino acid content of the treated seed was as follows:

Amino Acid	%
lysine	12.3
aspartic	12.2
glutamic	24.2
leucine	13.2
isoleucine	10.8
valine	7.5
methionine	5.6
arginine	2.4

The nitrogen content was 6.6 per cent (23).

Dean (4) has described in detail how soybeans are processed in areas where electricity and equipment are difficult to obtain. Soya is prepared by the following method: the beans are soaked in water up to 48 hours, the swollen beans are rubbed with the hands under water to remove the husks and to separate the beans from them. The dehusked beans are minced and packed in jars (of the kind used for preserving fruit), the jars are filled with water and tops are put on loosely. These jars are placed in water in large boiling vessels, the water is brought to a boil and boiled ten hours. At this time the beans should have lost their bitter flavor. A soft mash results, tasting slightly beany but not objectionable. This mash is a good addition to a diet for treatment of Kwashiorkor and is used extensively in East Africa. Though soya is rich in phosphorus it is lacking in calcium and vitamin B<sub>12</sub>.

The sunflower seeds are subjected to a cold processing which removes a fine oil, useful for other purposes, and yields 35 per cent protein that keeps well. This protein is rich in methionine (4).

Wheeler et al. (37) found that freezing soybeans resulted in retention of approximately 90 per cent of thiamine originally present while canning yielded 24 per cent thiamine retention. The palatability of the frozen soybeans rated "good" while canned ones rated only "fair" when tasted by a panel. When two methods of canning

soybeans were used, the pressure saucepan showed a higher thiamine retention but much lower palatability than the tightly covered saucepan.

#### Comparative Nutrient Content

Protein analyses have been made on guar beans (23) and guar flour (24). Attention is called to the fact that tryptophan has been reported by Block and Weiss (2) but not by Sirny (24). Esser (7) reported the protein content of field-run guar beans to be 28 per cent to 31 per cent, while the nitrogen content of dehulled guar bean was reported as 6.6 per cent by Ramakrishnan (23). This author supports Sirny in his report of the absence of tryptophan in guar.

Such varied reports indicated the practicality of running Kjeldahl analyses for total nitrogen in order to determine the amount of protein present when guar was grown near Stillwater, Oklahoma. Investigation of the amino acid composition and quality of protein content would merit further study. Moisture content was determined by oven drying.

#### Taste Panels Reveal Acceptability By Man

A taste panel is valuable but human judgment versus the statistical test needs to be weighed; where can one be more valuable than the other when man is the one who is going to eat the food prepared (11,16,26, and 39)?

Several kinds of taste panels are possible depending on the purpose of the study and expected results (13,16,25 and 26). The number of people on the panel may vary. Paulk

(26) lists ten members to be necessary to give statistical significance. Trained panel members have actually received instructions whereas experienced members need not necessarily be trained (11). An understanding of what is expected and knowledge of the project has been shown to have a positive psychological effect on the taster (11,26).

Meticulous testing is characterized by diminishing ability to recognize small differences. The common procedure in tasting to eliminate or compensate for this factor is to limit the number of samples to be tasted at one time. Lane et al. (15) suggests that the stronger the taste and odor, the fewer samples should be tasted. In this study syrup caused fatigue while coffee did not. Thus only general rules can be made and more work is needed for better understanding of taste fatigue (5,15). It is proper to avoid extremes, yet Harper (11) warns not to stay too much in the middle thus giving no sense of change to the panel members.

#### Sample Presentation

Randomizing samples assures the panel member is discriminating rather than memorizing and learning the differences (11). Coded samples and individual interpretation are needed to aid in obtaining accurate results (3,26).

The temperature of the sample may or may not be significant; citrus fruit juice exhibited little difference in preference when tasted at controlled temperatures (35).

The environment and atmosphere during tasting are important factors which can range from a quiet undisturbed

table to a very elaborate tasting room such as McCormick and Company use for tasting spices (16).



## CHAPTER II

### PROCEDURE AND OBSERVATIONS

#### Location and Description of Plot

Four varieties of guar used were G-40, G-101, G-135, and G-137 all of which are used for food in India. See Appendix A. The plot of guar, planted June 9, 1960, was located on Agronomy farm 8400 Block (corner of 6th Avenue and Western Road, Stillwater, Oklahoma). The plot was divided into ranges and border rows, the guar in the ranges being sufficient for this work. Each range was approximately 12 feet long and 14 rows wide, and was laid out so the rows ran north and south as described in Appendix B.

#### Picking the Guar

The guar was picked by the author in August and September. In the beginning this was done in the morning the hour previous to preparation and cooking. While working with small amounts of guar this procedure was satisfactory, but later this proved impractical as there was not sufficient time to pick the whole plot and still meet time deadlines. The guar plant was hairy which caused irritation to the arms of the picker. A blouse with long sleeves corrected this (yet at no time were shorts uncomfortable). The hairy

leaves served to hold the dust blown on them by traffic on the road-construction project bordering the guar plot. This dust necessitated bathing before laboratory work could begin. After the third tasting session the guar was picked the hour just prior to sundown on the evening preceding preparation and tasting. It soon became simple to judge the depth of the sun's descent, know how much guar needed to be picked, and how long it would take to pick the necessary amount. After a heavy rain the guar was very prolific and more time was needed to pick.

#### Setting Up Standards

Standards for harvesting and preparation of guar could not be obtained so it was necessary to set standards as the study progressed. They were: (a) daily picking during the hour just prior to sunset, (b) picking from west to east in the plot meant the pods showed up on the vines and color differences could be noted.

#### Characteristics of Variety G-40

An outstanding characteristic of the G-40 variety was the presence of two kinds of pods. One kind had a very "slick" feel, was glossy, and appeared yellow-green. The pods ranged in length from three to four inches, the beans felt flat and were far apart. It was difficult to snap the pods off the vine. In addition there were some furry-feeling pods which had a blue-green color. These were as small as one and one-half inches in length and came off the vine

easily when grasped and pulled down.

On August 23 (thirteen days after the first beans were picked) only the hairy, blue-green pods were picked. The length continued to range from one and one-half to three inches. They came off the vine with no effort and felt tender and pliable, and the beans inside the husk felt well rounded and filled the pod. Clusters of five, seven and sometimes only two, were prominent, facilitating picking. Any pods which did not respond easily to the grasp were not forced. These beans were simple to pick as the leaves could be held back with the left arm and the pods picked with the right hand. The glossy yellow-green pods were easy to distinguish.

A severe rain and wind storm on August 24 hampered entering the plot, but from one standing position 35 pods, the same description as August 23, were picked. On the following day results of the storm were obvious because the vines further along the rows had blown to the ground and tangled making picking difficult. By August 28 the length of the hairy, blue-green pods was two to three and one-quarter inches and the vines were mostly all up-right again by September 1. Their height was only two feet and at this point they very closely resembled snap bean vines. The pod description continued as earlier but on September 12, it was noted that the bottom leaves on the stalks were beginning to fall off. This made it easier to see the pods as the leaves no longer had to be pulled aside. Many clusters of buds were on the vines.



### Characteristics of the Variety G-101

Characteristics of the variety G-101 included: average length of three to three and one-half inches; beans inside the pod were not prominent and were far apart; the pod seemed flat to touch. The vines were tall and pods were all over them. When pods that looked full of beans and had a dull yellow-green color with a hairy feel were given a slight quick jerk with the index finger and thumb, a hollow snap occurred and the pod came off the vine easily. Pods not at this stage gave a feel of being rubbery and resisted breaking. The "snap" sound was definite and picking them was swift, as a quick touch to the unready bean indicated its difference. These hairy pods with the snap proved to be "mature" and tough when they were cooked. After the hard rain and wind storm on August 24 some of this variety did not return to the upright position but none of the vines tangled with each other. On August 27 all the pods three inches in length were picked. These ranged from yellow-green to blue-green pods which were separated when prepared and cooked or frozen.

### Characteristics of Variety G-135

Variety G-135 was chosen to be tested first because the stalks had many pods which were well rounded by the beans inside. Bean sizes from one and one-half inches to two and one-half inches long were normal at all times for this variety. The vines were more like stalks with leaves, and

the pods seemingly grew from the stalks. The stalks were noted to be down on the ground as early as August 21. Other varieties did not bend over until after the rain and wind storm on August 24. By August 23 the leaves were dropping off the vines, and it was easy to note the clusters. Some clusters had one long (two inches) and four or five short pods while other clusters would have as many as five two inch pods. Because there were so many pods on each stalk they were not difficult to pick. There was no visible growth noted from day to day but the pods felt more tough during preparation than those picked prior to August 23.

On August 25 many of the vines were still on the ground. The pods showed almost no color difference and were picked entirely by length and feel when grasped. On grasping, the short pods were more difficult to pull free than the longer ones which broke away with a slight downward jerk.

No pods were picked from August 25 to September 13 at which time the following notes were made: "picked green pods near top of stalk; leaves nearly all off and vines are down although some are beginning to grow upright." Two colors were described; one as green, fresh-looking and the other white-green and dried looking. In the clusters the white pods were on the outside and the green pods were near the stalk. The color difference facilitated picking as did the fact that the vines were full of pods. The length was noted as one and one-half to two inches long.

## Characteristics of Variety G-137

Characteristics of variety G-137 were high vines, three to three and one-half feet, which were full of leaves with the pods difficult to find. It was laborious to pick as many as 36 pods on August 21. The pod length was three inches. Hardy high vines were noted on August 23 and the average size pod was recorded as two to two and one-half inches. These pods were so difficult to remove from the vine that they were cut off with the thumb nail. The beans inside the husk were prominent and the pods appeared mature. They were tough to tip during preparation and strings were also difficult to cut off. The clusters had from two to five pods.

August 24 brought a noticeable difference in the ease of picking as some pods pulled off the vines with quick easy jerks; a few still had to be cut with the thumb nail. By sight, these pods were not noticeably different from those picked earlier except a few had a full look indicating the beans filled the pod. On the whole these pods were more easily tipped and strings removed than on the previous day. The average length was two and one-fourth to three and one-fourth inches.

A visual difference in the pods was noted on August 25. All the picked pods appeared yellow-green and just past a transparent stage. They felt full and were more dull than the smaller and less full pods. Length was recorded as one and three-fourths to three and three-fourths inches. Pods



continued to feel full and a roughness due to hair was noted.

No changes in picking characteristics were observed until September 1 (fourteen days after the rain storm) when the vines and leaves appeared very limp. The pods felt limp "as though they had not enough water" and there was resistance to pulling pods off the vines. Because of the height of the plant it was possible to stand while picking. Leaves near the ground were beginning to fall off. Lengths were one and seven-eighths to three inches. On September 3 the beans were soft. These beans were picked as late as September 13 but no significant changes were noted.

#### Preparation of Samples

At first the guar was prepared the hour following evening picking by washing, stemming (or cutting off the tips), and removing the inside seam with a paring knife. The pods with beans were measured, sorted, counted, placed in small plastic bags, and refrigerated until the following day. The week after the rain storm of August 24 there were so many mature pods it was impossible to prepare them all at once. Therefore part of the samples were refrigerated unwashed. Some were prepared and tasted the following morning. The remaining pods were prepared and frozen in the afternoon.

The pods were washed in a colander by running cold water over them. This method was quick, easy, and at no time caused any difficulty. It was simple to align the pods on a chopping board and cut off the tips with a French knife;

but each pod had to have the seam cut off individually. This step was the time-consuming part of preparation. Thirty-six pods were then sorted by size and color and either were put in plastic bags or were weighed and cooked.

Thirty-six pods were chosen as the number to be included in one sample. This number was chosen since it assured three pods for each panel member to taste with extra pods for emergencies or visitors. Three pods fitted very well on one paper butter chip and usually this amount was sufficient for tasting. Henceforth references to one sample will mean thirty-six pods. Any variations in sample sizes were equated to the original thirty-six. Each sample was weighed prior to cooking, freezing or after preparation.

In this study pods are the beans and the husk covering.

Prepared pods are pods which have been washed, had the tips or stems removed, and the inside seam cut off.

Pods were divided into three groups on the basis of maturity according to handling notations: (a) color of pod, (b) tenderness when strings were removed, and (c) color of cooking water. The "young" group had yellow-green pods with yellow-green cooking water, were very tender, and it was easy to remove the inside seam. The "mature" group had a more blue-green to white-green pod color and the cooking water ranged from blue-green to brown-green; it definitely did not have the bright color exhibited in the young group. The "mixed and undetermined ages" were actually samples of young and mature pods or were samples used before standards had been set by the author. The pH of the cooking water was

taken after an aluminum pan darkened while cooking a sample. Water in which mature pods had been cooked showed pH 7.0, while that for young pods had pH 6.8.

The first procedure for cooking was as follows; to one cup boiling water and one-fourth teaspoon salt in one quart saucepan one sample was added, the cover put on, and heat reduced to simmer for 15 minutes (10,27,29, and 35). For pressure cooking one-fourth teaspoon salt was used with one-half cup water, and 15 pounds pressure in a two-quart pressure saucepan for five minutes (1,34, and 35). In both cases at the end of the cooking period the liquid was drained off and the pods were served.

By the fifth tasting session (see below) the basic recipe and cooking procedure was as follows; to one cup boiling water, one-fourth teaspoon salt and one teaspoon sugar per sample was added. If the sample was frozen the time the water resumed boiling was noted, and a simmer heat maintained for 15 minutes; if a fresh sample was used the time of addition to the water was noted, in five minutes the cover was put on the saucepan and simmering maintained for 15 minutes more.

#### Taste Panel

The taste panel functioned during a four-week period, each morning of tasting being identified as a session.

The sessions were held every other morning the first week and each day of the two weeks following. During the fourth week there were two sessions on Wednesday and one on

Saturday. In sixteen sessions and with four different samples each time there was a total of sixty-four different samples tasted by ten panel members. These members had an overall attendance record of 75 per cent.

The tasting room for the panel was in the food laboratory of the research department, Division of Home Economics. Since the guar varieties were expected to mature from about mid-July and into August these dates were set originally with the panel. In choosing the panel members the time of the year was significant because the study was carried out in a University town where August is the vacation period. Thus the choice of panel members was limited to students who were doing research themselves and to faculty members who resided in town and were not leaving on vacation. Fortunately there were two women from the Food, Nutrition, and Institution Administration department and two men from the Animal Husbandry department who had had previous training on taste panels and who were planning to be in town. Other people available and willing to help were the mother of one of the professors, a librarian, a secretary, a graduate student in chemistry, a former student of the author and his small daughter. There were four men and six women.

The age range of the panelists was from over 60 to four years; one was in late teens, four in the twenties, and three of them were over thirty. Two of the women and three of the men were regular smokers. It was felt that to

eliminate smokers would discriminate against a large section of population (26). Six members were native Oklahomans and one each were from Minnesota, Wisconsin, Mississippi and Texas.

The panel members received verbal instruction and explanation of the purpose, known problems, and expected results. No formal training was given; no research on the part of the panel member was expected nor encouraged.

#### Room Arrangement at Session Time

The room and equipment, together with a tentative time schedule, were ready by July 15 but the guar was only in the bud stage. Finally, on August 10 there were sufficient beans of a size to pick that a trial panel was scheduled the following day. The two women of the department tasted as arranged and made appropriate suggestions for changes.

Cooking and freezing directions are explained in Appendix C and D. After cooking, samples of three pods each were portioned out on paper butter chips on individual sampling dishes, covered with clear plastic wrap and set aside for the panel members.

Blue china dishes were used and each individual sample was placed on a small white paper butter chip. Each chip was marked with the number of the sample; each plate had the number of the panel member on it. The samples were randomized and four samples at a time were presented (15, 16 and 26). No effort was made to control the temperature of the guar (33).

Each panel member was able to come into the room, gather the equipment (score sheet, pencil, cup for water, fork, napkin, and dish with guar samples) in the same manner as one would go through a cafeteria line. This equipment was carried to a separate table where tasting was done individually (11). The room was quiet and uncluttered. Circulating floor fans provided ventilation for the comfort of the panel members (11,15).

The time of day was chosen, for the convenience of panel members, to correspond to coffee break time or to immediately precede the lunch hour (16,26).

#### Score Sheet

The score sheet (see Appendix E) was set up using word descriptions of various qualities deemed important in food acceptability. The purpose of this study had been explained to a graduate seminar group and in turn these students offered suggestions for descriptive words and the form which was used. Word descriptions were suggested but the panel members were instructed to deviate wherever they desired. To obtain a more exact figure with which to work, acceptability was assigned a numerical value on a scale one to fifteen, fifteen being the most acceptable.

Four samples were used at each session. This number was chosen because of the reported bitter flavor to be expected in guar which would cause fatigue in a short time (15,16, and 26).



After samples were cooked for tasting the remainder of the guar from each picking was frozen. Procedure was similar to that for snap beans. See Appendix D.

### Chemistry

Total nitrogen analyses were run on frozen samples of guar in October, 1960. The pods were prepared by oven drying at 65.5°C for 56 hours (partially thawed when placed in oven), followed by grinding in Wiley Mills to a coarse powder. This powder was analyzed by the Kjeldahl (12) method in the laboratories of the Department of Biochemistry. A total of sixteen samples (36 pods each) of representative stages of maturity and variety were run. Moisture content of the green pod was also determined (see Tables I, II, and III).

### Guar Cooked for Groups Other Than The Taste Panel

Guar was prepared and cooked for two other less formal groups than the taste panel. One group included the staff and secretaries in Agriculture Hall on the campus. The other group was the Institutional Food Purchasing class in the Food, Nutrition, and Institution Administration Department (11,13, and 16).

### Procedure and Results for Agriculture Hall Staff

For those in Agriculture Hall, 175 grams of guar variety G-137 was picked at sundown on September 14 and

TABLE I

YOUNG PODS: SUMMARY OF PROTEIN  
AND MOISTURE CONTENT

VARIETY	PROTEIN %	MOISTURE %	DRY %
G-40	20.13	93.79	6.21
	20.15		
	20.59		
G-40	20.63	93.62	6.38
	17.80		
	19.73		
G-101	21.53	95.57	4.43
	21.63		
	20.73		
G-101	20.73	93.91	6.09
	19.18		
	19.78		
G-135	19.76	92.99	6.81
	19.74		
G-137	22.36	95.27	4.73
	22.63		
	21.79		
G-137	21.85	95.13	4.87
	21.98		
	21.98		
G-137	21.98	95.45	4.55
	21.98		

TABLE II

MATURE PODS: SUMMARY OF PROTEIN  
AND MOISTURE CONTENT

VARIETY	PROTEIN %	MOISTURE %	DRY %
G-40	-	-	-
G-101	20.53 20.23	92.52	7.48
G-135	18.84 18.66	94.25	5.75
G-137	22.35 22.32	94.68	5.32

TABLE III

MIXED AND UNDETERMINED AGE PODS: SUMMARY OF  
PROTEIN AND MOISTURE CONTENT

VARIETY	PROTEIN %	MOISTURE %	DRY %
G-40	20.73 18.91	93.77	6.23
G-101	20.63 21.64	94.75	5.25
G-135	-	-	-
G-137	-	-	-

refrigerated overnight. The following morning these pods were prepared and cooked in two cups of boiling water with three-fourths teaspoon salt and two teaspoons of sugar. The first five minutes the lid was off; then the pods were covered and cooked on simmer for 20 minutes. The cooking water was drained off, the pot and its contents wrapped in a tea towel, and taken to Agriculture Hall a block away. Time and room were arranged to coincide with the normal coffee break. On a bulletin board in this room Mr. Nymowitz (22) announced "Free Guar." Reluctance to taste followed. Later he changed the name guar to cluster beans which resulted in a willingness to try the beans.

Some tasted because others were "brave" and an astonished look of approval followed in most cases. Comments included: "not bad," "pretty good," "alright," "like to have them cooked with a ham bone," "little less sweet, too sweet for me," "like English peas," and "like lentils." One person expressed a dislike but she "didn't like green beans either." The secretaries said "yes, they would open a frozen package after work for their suppers."

Since people come in for the coffee break in two shifts, by the time the second shift arrived the color of the beans was a darker brown. The pods were not as bright green as the earlier ones had been but apparently this did not adversely influence acceptability.

A total of about thirty persons tasted.

## Procedure and Results for Institutional Food Purchasing Class

Guar was cooked for about thirty students in the Institutional Food Purchasing class by the same methods used for the taste panel. Food, Nutrition, and Institution Administration and Hotel and Restaurant Administration majors, both male and female, who were especially interested in feeding people were represented. At the opening of the class session each student was given a blank sheet of paper and asked to record his thoughts on "if he were to go into a restaurant in the United States and see 'Guar' as an item on the menu." The purpose and findings of the study to October 29, 1960 were explained. The name "cluster bean" was suggested. When these students were asked if they would buy or try cluster beans, a positive reaction was noted. There was some complaint about the taste but many asked to try guar in mixtures. The name "guar" had led to such thoughts as a "fad food," "fish," "a squash dish," and just plain "wonderment."

The pods were tasted and put aside. At the end of the class hour the remaining beans had become a very dark brown color which had been noted in previous work.

### Incorporation of Guar Into Recipes

Positive acceptability to guar had been shown by the various tasting groups. An experiment was conducted using a four-member panel to determine acceptability of guar incorporated into recipes. Margarine, hydrogenated fat and

cotton seed oil were used as cooking media.

The name cluster bean was used throughout this work.

The following recipe was used and hereafter will be referred to as the "basic recipe."

36 pods cluster beans

fat

10 grams margarine or

10 grams hydrogenated fat or

2 teaspoons cottonseed oil

24 grams diced onion

1 teaspoon sugar

$\frac{1}{2}$  teaspoon salt

Heat fat; add onions and seasonings; sauté until onions are brown.

Add cluster beans, note the time and heat until unfrozen.

Add water or liquid as necessary; cover and cook on simmer for 30 minutes from the time the cluster beans were added.

Add one tablespoonful of cooked rice; serve.

Variations:

- A. 100 grams canned tomatoes with liquid added after cluster beans thawed (three minutes later); proceed as in basic recipe.
- B. 60 grams chopped (bite size) stew beef; sauté with the onions and seasonings; proceed as in basic recipe and add one tablespoonful vinegar after the cluster beans are added.
- C. 90 grams canned tuna fish and one tablespoon of fresh lemon juice added as in B.
- D. Tomatoes and beef or tuna fish added as in B.
- E. One clove garlic added with onion and seasonings.
- F. Suet rendered in skillet until an excess to cover the bottom of the pan was noted; proceed as in basic recipe.

Appropriate household recipes are in Appendix F.

Frozen cluster bean samples were removed from the freezer about thirty minutes before using and allowed to stand at room temperature. No effort was made to thaw them completely before cooking (29,34).

Instant rice was prepared and set aside while measuring and cooking proceeded. All ingredients were measured and arranged in order of use. Heavy iron skillets with glass

lids were heated, the fat melted, onions and seasonings added, and this mixture was sautéed at a low temperature. When meat or fish was used they were combined at this point and afterwards the beans were added. The time was noted, the temperature adjusted to simmer, and the lid placed over the skillet. The mixture cooked for a total of thirty minutes from the time of addition of the beans, being stirred only as needed to keep all the mixture moist. When only tomatoes were added, they were put into the skillet after the beans had completely thawed. Lemon juice or vinegar was added after the beans had thawed. At the end of thirty minutes of simmering the heat was turned off and the prepared rice added. The panel members tasted as soon as their own laboratory work allowed them time.

Three varieties (G-40, G-101, and G-137) of cluster beans, frozen three months previously, were used. The first day of tasting a control of snap beans was included. No taster knew the snap beans were present until after all scoring had been completed.

In choosing foods to be mixed with the cluster beans, points considered were the familiarity of the mixture to the United States at the present time, and the cost of products. Rice and onions were incorporated in all recipes. Tomatoes were used to see the color effect and to note if their acidity would alter the cluster beans in any way. Stew beef, canned fish, and ham scraps were used. Garlic was the only strong flavor added. Lemon juice or vinegar was used to give an acid medium when tomatoes were not included.

Three different fats--margarine, hydrogenated fat, and cottonseed oil--were chosen because of their availability and acceptance as cooking media.

Since only three surface elements were available on the electric range, one sample each period was cooked over gas flame. The experimenter was not familiar with either range before the study and in the beginning needed to become acquainted with their operation. Later four elements were used, which gave similar results. The behavior of the three different fats became apparent and simple to manage.

All ingredients were measured by gram weight except the oil for which standard household teaspoon measurement was used. Water, when necessary, was added by the tablespoonful.

Measuring was completed before the first sample was put on to cook. In this way all samples finished cooking within a short range of time.

Early in the study the addition of tomatoes indicated a good color retention in the pods. Lemon juice and vinegar were incorporated into the recipes as a check to determine if acid alone was the cause of color retention.

Mild flavors were cooked first and gradually stronger flavors were added. The abundant use of spices would have been beneficial to check, but would have introduced more variables and required more time than this experiment allowed. Snap beans cooked in ham appear at least once a day on the cafeteria lines in the Foods Units and Student



Union at Oklahoma State University because there is a constant demand for this food. Ham was added in the very last testing period to avoid prejudice from the outset.

All panel members were native Oklahomans. One member had tasted for the summer panel.

The scoring was designed to show numbered values assigned to various characteristics. Terminology used was taken from word descriptions appearing on the score sheets used by the summer panel. For sample score card see Appendix G.

## CHAPTER III

### RESULTS AND DISCUSSION

The first three tasting sessions revealed the following average acceptability score on a scale one to fifteen (fifteen being the greatest acceptability): (a) pressure cooked with strings, 3.66; (b) three samples which were cooked without strings, 9.66; (c) six samples which were cooked with strings, 4.33. On the basis of this unfavorable acceptability the pressure cooking method was discontinued and the seams removed. Wheeler et al. (37) and Gordon and Noble (10) have reported similar results with other vegetables cooked by pressure.

Tables IV, V, and VI show the effect of age on variety and cooking method.

The young pods cooked by three methods were rated highest in acceptability (Table VII). The mature pods were not far below the young ones. The number of samples for mature pods was only nine while there were 27 samples of young pods of variety G-40 cooked covered for 15 minutes (Table V). More work needs to be done with the problem of the effect of maturity. For both young and mature pods the frozen samples cooked 15 minutes were rated highest. The pod samples of mixed and undetermined ages (Table VI) were scored

TABLE IV

## YOUNG PODS. SUMMARY OF VARIETY AND COOKING METHODS

Variety	Unc.5 Cover 15 <sup>1</sup>		Frozen, Cooked 15 <sup>2</sup>		Covered 15 <sup>3</sup>	
	No.S. <sup>4</sup>	Av.Acc. <sup>5</sup>	No.S.	Av. Acc.	No. S.	Av. Acc.
G-40	7	7.81	3	7.35	-	-
G-101	-	-	8	9.12	2	7.14
G-135	2	8.23	1	7.70	-	-
G-137	1	9.20	3	9.32	-	-
Total	10		15		2	
Average		8.03		8.71		7.14

<sup>1</sup>Unc. 5 covered 15 means that after adding pods to boiling cooking water 5 minutes was allowed to pass before covering. After covering the pods were simmered an additional fifteen minutes.

<sup>2</sup>Frozen, Cooked 15 indicates frozen samples were used and these were simmered fifteen minutes after returning to the boiling point.

<sup>3</sup>Covered 15 means the pods were covered as soon as they were placed in the boiling water, the total cooking time was fifteen minutes on simmer.

<sup>4</sup>No. S. means number of samples used in this category.

<sup>5</sup>Av. Acc. means the average acceptability of these samples.

TABLE V

## MATURE PODS. SUMMARY OF VARIETY AND COOKING METHODS

VARIETY	Unc.5 Cover 15 <sup>1</sup>		Frozen, Cooked 15 <sup>2</sup>		Covered 15 <sup>3</sup>	
	No.S. <sup>4</sup>	Av. Acc. <sup>5</sup>	No. S.	Av. Acc.	No. S.	Av. Acc.
G-40	4	6.94	-	-	1	10.00
G-101	1	7.00	3	7.23	-	-
G-135	-	-	-	-	-	-
G-137	-	-	-	-	-	-
Total	4		3		1	
Average		6.95		7.23		10.00

See Table IV for <sup>1,2,3,4,5</sup>.

TABLE VI

MIXED AND UNDETERMINED AGE PODS. SUMMARY OF  
VARIETY AND COOKING METHODS

VARIETY	Unc. 5		Cover 15 <sup>1</sup>		Frozen. Cooked 15 <sup>2</sup>		Covered 15 <sup>3</sup>		
	No.	S. <sup>4</sup>	Av.	Acc. <sup>5</sup>	No.	S.	Av.	Acc.	
G-40	3		8.13		-		-	1	6.33
G-101	-		-		-		-	-	-
G-135	2		5.43		3		9.72	9	6.73
G-137	2		8.01		1		9.10	2	7.10
Total	7				4			12	
Average			7.32				9.75		6.12

See Table IV for 1, 2, 3, 4, 5.

TABLE VII

SUMMARY BY AGE--REGARDLESS OF COOKING  
METHOD OR VARIETY

AGE	Number of Samples	Average Acceptability
Young	27	3.37
Mature	9	3.16
Mixed or Undetermined	28	7.39
Total	64	7.97

highest in acceptability of the frozen samples although only flour were tasted.

The young samples revealed a close range of protein percentage values (Table I). One sample of G-40 had a lower percentage of protein (17.20 - 19.73) while all varieties ranged 19.18 to 22.63 per cent. Only one sample of G-135

was analyzed, but it had lower protein and less percentage moisture than the other varieties. Within each variety results were consistently close. Average percentage of dry material in the young pods was 5.438 per cent, in the mature pods 5.74 per cent. Only two samples of mixed and undetermined age pods were analyzed.

Examination by varieties showed the G-40 and G-135 to be lowest in acceptability, based on 21 and 20 samples respectively (Table VIII).

TABLE VIII

## SUMMARY BY VARIETY

VARIETY	Number of Samples	Average Acceptability
G-40	21	7.64
G-101	14	8.84
G-135	20	6.87
G-137	9	8.48
<u>Total</u>	<u>64</u>	<u>7.98</u>

The higher acceptability of 14 samples of G-101 and nine samples of G-137 may have been due to greater care taken in cooking method and handling as a result of poorer acceptability recorded for the first two varieties.

The procedure of freezing samples, then cooking them 15 minutes after returning to a boil showed the highest acceptability (see Table IX).

Comments on the score sheets indicated a dislike for

the strings which prompted the removal of the inside seam on all samples after the third session. Retention of the outside seam saved time and kept a greater number of beans in the pod.

At first salt was the sole addition to the cooking water but in only one case was acceptability greater than 5.75. When the strings were removed and sugar added, acceptability began to increase.

TABLE IX

SUMMARY BY COOKING METHODS--REGARDLESS OF  
AGE OR VARIETY

METHOD	Cooking Time (minutes)	Number of Samples	Average Acceptability
Uncovered	5		
covered	15	24	7.52
Frozen			
cooked	15	22	8.56
Covered	15	15	7.62
Pressure	5	3	3.66
Total		64	6.84

The guar was by no means unacceptable to those who tasted it. There was evidence of curiosity toward a new product and in general it was accepted as a new food stuff. The potential use of guar on the table is anticipated by those who became acquainted with it.



When guar was mixed with familiar foods and presented as cluster bean sauce satisfactory acceptability was indicated by a four-member taste panel (Table X). The experience of cooking guar in combination aided in clarifying the effect of pH on color retention. Color was retained in a weak acid medium. Three acidic foods were used with good acceptability: vinegar, lemon juice, and tomatoes.

TABLE X

EFFECT OF THREE COOKING MEDIA ON THE ACCEPTABILITY, COLOR, TEXTURE, FLAVOR, AND ODOR

FAT USED	ACCEPTABILITY	COLOR	TEXTURE	FLAVOR	ODOR
Margarine					
G-40	3.25 <sup>1</sup>	3.56	3.62	3.49	2.88
G-101	2.69	3.44	3.21	2.68	3.25
G-137	3.99	3.25	4.00	4.00	4.00
Average	3.36	3.81	3.83	3.54	3.66
Hydrogenated					
G-40	2.75	3.99	2.75	2.75	3.50
G-101	2.45	3.49	2.95	2.45	2.80
G-137	1.99	4.00	3.00	2.00	2.99
Average	2.39	3.83	2.90	2.30	3.09
Cottonseed					
G-40	2.75	3.16	3.08	2.58	3.25
G-101	2.38	3.62	2.62	1.93	2.62
G-137	3.00	3.00	3.99	3.00	3.99
Average	2.71	3.26	3.23	2.50	3.28

<sup>1</sup>All figures for acceptability are based on 5.00 as perfect score.

It is recommended that further work be carried out with frozen samples of guar of mixed and undetermined ages, and particularly with the mature fresh variety G-40, using

different cooking methods. Because the variety G-135 was very prolific and easy to pick more extensive testing could determine its versatility. Varieties G-101 and G-137 certainly deserve more attention because of their higher taste acceptability, regardless of the picking problem encountered. (Table VIII). If it can be shown that age differences in these varieties are not important, valuable time for picking and sorting can be saved.

All three fats were acceptable cooking media with margarine ranking first, followed by cottonseed oil and hydrogenated fat (Table X). There were not enough tests carried out to draw conclusions on variety acceptance although G-137 showed highest while G-40 and G-101 were next in acceptability (Table XI).

TABLE XI  
ACCEPTABILITY BY VARIETY FOR ALL FATS

VARIETY	ACCEPTABILITY	COLOR	TEXTURE	FLAVOR	ODOR
G-40	2.92 <sup>1</sup>	3.57	3.15	2.94	3.54
G-101	2.56	3.18	2.93	2.35	2.39
G-137	2.99	3.42	3.66	3.00	3.66

<sup>1</sup>All figures for acceptability are based on 5.00 as perfect score.

While it is obvious that more work in other parts of the United States needs to be done using more spices and cooking in quantity, this initial study indicates that cluster beans can be used successfully and various fats

may be combined with them advantageously. The use of a weak acid for color retention is recommended.

## CHAPTER IV

### SUMMARY AND CONCLUSIONS

Guar--Cyamopsis tetragonoloba (L.) Taub--has been grown in the southwest United States as a field crop, a cattle feed, and as a source of vegetable gum. These uses of guar have given it great importance as well as the fact that it is a drought-tolerant legume which matures over a six to eight week period. Although a bitter taste has been reported by Indian and Pakistani students who consume guar, its value as a source of protein is considered outstanding. The protein composition as shown by this study is comparable to dried legumes (31).

During the summer and fall of 1960 four edible varieties of guar which had been grown near Stillwater, Oklahoma, were evaluated by taste panels. Varieties G-40, G-101, G-135 and G-137 were tasted by a ten-member panel over a four-week period beginning as soon as the pods were large enough to pick. Four cooking methods were used: (a) in boiling water--uncovered, 15 minutes; (b) in boiling water--uncovered five minutes, then covered 15 minutes; (c) simmered for 15 minutes after unthawed frozen guar was placed in boiling water; and (4) under pressure--15 pounds for five minutes. Workable standards for distinguishing age were

established. Appropriate amounts of sugar and salt were added to the cooking water. The panel scored with word descriptions for flavor, kinesthetic value, and color and gave a numerical value for acceptability.

A total of 64 samples was tasted; thus only trends can be noted. Of the four varieties of guar, G-101 and G-137 were assigned the highest acceptability by the panel but their decision was based only on 23 samples (Table VIII). More work needs to be done to determine the preference between the frozen and the fresh samples cooked five minutes without the cover and 15 minutes with the cover.

The common name "cluster bean" aroused curiosity when presented to informal panels of approximately sixty persons.

A four-member panel tasted guar which had been incorporated into a recipe using a mixture of foods including tomatoes, stew beef, ham scraps, and tuna fish. Each of these was cooked with three readily available fats: margarine, hydrogenated fat, and cottonseed oil. The addition of an acidic material to the mixture resulted in longer color retention of the guar.

Kjeldahl analyses and moisture content were determined on sixteen frozen samples which revealed the protein content to be comparable to that of dried legumes.

Since these are the only flavor acceptance studies known to have been carried out in this country, the reactions to plain guar were considered most important. These results have been favorable, but it is recognized that more

work needs to be done, especially with the addition of familiar spices and herbs.

With recognition of the limitations of this study, guar is an acceptable green vegetable. It can be used frozen or fresh and be prepared plain or in recipes as an inexpensive source of plant protein.



#### LITERATURE CITED

1. American Home Economics Association. Handbook of Food Preparation. Washington, D. C. 1959.
2. Block, R. J., and K. W. Weiss. Amino Acid Handbook. 3rd. ed. Springfield, Illinois, Charles C. Thomas. 1956.
3. Davis, J. G., and H. L. Hanson, Sensory Test methods I. The triangle intensity (T-1) and related test systems for sensory analysis. Food Tech. 8: 335. 1954.
4. Dean, R. F. A. Treatment and Prevention of Kwashiorkor. World Health Organization Bul. 9. 1953.
5. Dudley, D. T., M. E. Moore and E. M. Sunderlin. Childrens' attitudes toward food. J. Amer. Home Ec. Assoc. 52: 678. 1960.
6. Esser, J. A. Guar gains after long effort for farm and market progress. Chemurg. Digest. 15: No. 12, 4. 1956.
7. \_\_\_\_\_ Guar: Its development and uses. Chemurg. Digest. 17: No. 4, 9. 1958.
8. Food and Drug Administration. Code Federal Regulations Dressings for Foods. Federal Security Agency. Section 25. p. 54. 1949.
9. Goldfrank, H. Guar: Its commercial uses. Chemurg. Digest. 16: No. 2-3, 10. 1957.
10. Gordon, J., and I. Noble. Application of the paired comparison method to the study of flavor differences in cooked vegetables. Food Res. 25: 257. 1960.
11. Harper, R. Fundamental problems in the subjective appraisal of foodstuffs. App. Stat. 4: 145. 1955.
12. Harrow, B. et al. Laboratory Manual of Biochemistry. Philadelphia, W. B. Saunders. 1960.
13. Ishler, H. H., E. A. Lane and A. J. Janish. Reliability of taste testing methods. II. Code bias in consumer testing. Food Tech. 8: 335. 1954.

14. King, C. G. The world search for good quality proteins. Food Tech., Vol. II Suppl.: 26. 1957.
15. Lane, E. A. and W. H. Ishler. Reliability of taste testing and consumer testing methods. I. Fatigue in taste testing. Food Tech. 3: 387. 1954.
16. Little, A. D., Inc. Flavor Research and Food Acceptance. New York. Reinhold Pub. 1953.
17. Leung, S. T. W., R. K. Pekot and B. K. Matt. U. S. Dept. of Agr. Composition of Foods Used in Far Eastern Countries. Agriculture Handbook No. 34. Bureau of Human Nutrition and Home Economics. 1952.
18. Love, B. Experimental Cookery. 4th ed. New York. John Wiley and Sons, Inc. 1955.
19. Malakar, M. C., and S. M. Banerjee. Studies on the retention of ascorbic acid during blanching of some Indian vegetables. Food Res. 24: 749. 1959.
20. Mehta, D. R., and G. V. Ramakrishnan. Studies on guar seed oil. J. Amer. Oil Chem. Soc. 34: 459. 1957.
21. Nielsen, J. R. New food products. J. Amer. Dietet. Assoc. 36: 107. 1960.
22. Oklahoma State University, Stillwater, Oklahoma. Personal interviews with T. Fymowitz, graduate student, and R. S. Matlock, Professor, Department of Agronomy. March, June, August, and December, 1960.
23. \_\_\_\_\_ Stillwater, Oklahoma. Personal interviews with Indian and Pakistani graduate students. April and September, 1960.
24. \_\_\_\_\_ Stillwater, Oklahoma. Personal interviews with R. J. Siny, Associate Professor, Department of Biochemistry. October and November, 1960.
25. Pangoora, R. S. Taste interrelationships. Food Res. 25: 245. 1960.
26. Paulk, J. F. [Unpublished research] Some fundamentals of taste testing procedures. Oklahoma State University, Department of Food, Nutrition, and Institution Administration. 1957
27. Ramachandran, M., and S. V. Phansalkar. Essential amino acid composition of certain vegetable foodstuffs. Ind. Jour. Med. Res. 44: 501. 1956.

28. Ramakrishnan, C. V. Amino acid composition of crude and germinated guar seed flour protein. Experientia 13: 73. 1957. Original not available for examination; abstracted in Nutrition Abstr. Rev., 27: 686. 1957.
29. Rombauer, I. S., and M. C. Becker. The Joy of Cooking. Indianapolis, The Bobbs-Merrill Company, Inc. 1953.
30. Ross, E., R. H. Pauls and M. M. Ward. Uniformity of color measure in green beans. Food Tech. 13: 711. 1959.
31. Stamburg, O. E., and W. P. Leherer, Jr. Composition of widely used edible dry legumes. Food Res. 12: 270. 1947.
32. Thompson, L. Sorghum versus sorghum-guar mixtures for forage and protein production. Oklahoma Academy of Science Proceedings. 38: 31. 1958.
33. Tompkins, M. D., and G. B. Pratt. Comparison of flavor evaluation methods for frozen citrus concentrate. Food Tech. 13: 149. 1959.
34. VanDuyne, F. O. Recipes for using soybeans--Fresh green soybeans and dry soybeans. III. Agr. Ext. Circular No. 662. 1952.
35. VanDuyne, F. O., and V. R. Charles. Palatability and retention of ascorbic acid of vegetables: cooked in tightly covered saucepan and waterless cooker. J. Home Econ. Assoc. 46: 659. 1954.
36. Voorhees, J. New form of cornstarch excellent freeze-thaw stability. Food Processing. 21: 43. 1960.
37. Wheeler, E. H., M. C. Titus and F. O. VanDuyne. Thiamine in and palatability of soybeans. J. Amer. Dietet. Assoc. 37: 387. 1960.

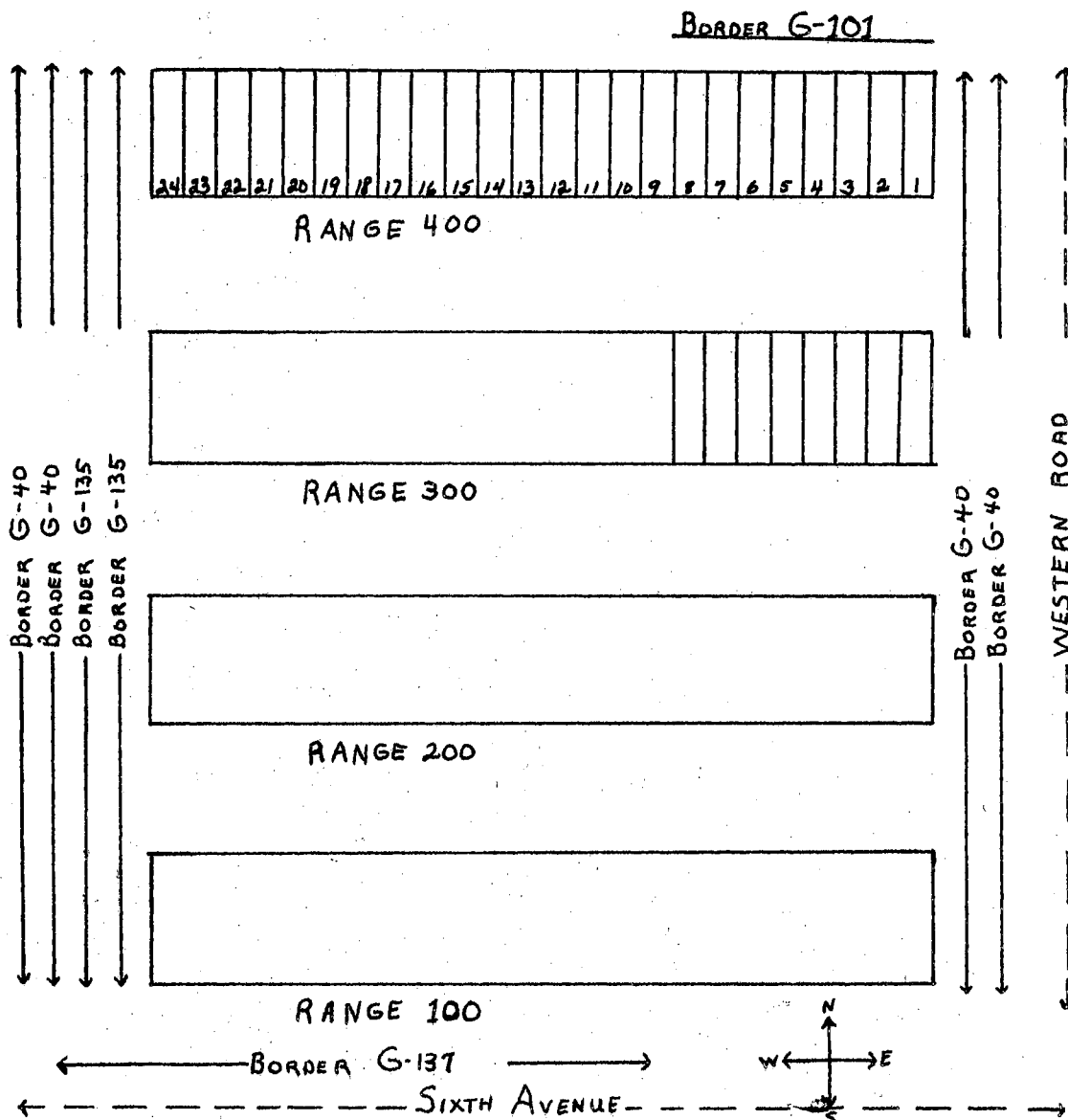
APPENDIX A

History of guar plant introductions

- G-40 --Plant Introduction 164299  
#8935 from Coimbatore, Madras, India 2-26,27--1948  
Collected by Walter N. Koelz U. S. D. A. (Kataveri)  
Elevation 1500-1000 feet above sea level  
Green pods eaten
- G-101--Plant Introduction 164765  
#9193 from Belgaum, Bombay and vicinity, India  
3-20, 1948  
Collected by Walter N. Koelz U. S. D. A. (Guar)  
Elevation sea level to 3000 feet above sea level  
Garden type unusually large pods
- G-135--Plant Introduction 164477  
#8770 from Jaipur and vicinity, India 2-4,5,6,--1948  
Collected by Walter N. Koelz U. S. D. A. (Gawar)  
Green pods eaten
- G-137--Plant Introduction 164779  
# 9229 from Poona, Bombay and vicinity 3-24,25--1948  
Collected by Walter N. Koelz U. S. D. A. (Guar)  
Green pods eaten.

APPENDIX B

Location and Description of Plot



LOCATION OF VARIETIES

- G-40--- RANGE 400, ROWS 8-15
- G-101-- RANGE 300, ROWS 5-8, RANGE 400, ROWS 4-7
- G-135-- RANGE 400, ROWS 16-24
- G-137-- RANGE 300, ROWS 1-4, RANGE 400, ROWS 1-3

## APPENDIX C

### Cooking for Summer Taste Panel

One cup boiling water was measured into a one quart saucepan. One teaspoon sugar and one-fourth teaspoon of salt were added and the water was brought to a boil. Prepared, weighed pods/sample were added to the boiling water; time was noted. The lid was placed on immediately for samples cooked covered 15 minutes. If the sample was uncovered, five minutes elapsed before the lid was placed on the sample. In each case a simmer temperature was maintained and cooking was terminated in fifteen minutes. The pH was recorded for the water which was then drained off and the pods served.

Frozen samples were taken from the freezer one-half hour before cooking time. When the cooking water, seasoned as for other cooking methods, came to a boil pods were added. Time was noted when boiling began again, the lid was placed over the pan and a simmer temperature maintained for 15 minutes. Again the pH of cooking water was determined, water was drained off and pods were served.

## APPENDIX D

### Procedure for Freezing Beans

1. Wash and prepare pods.
2. Drop one sample into boiling water and blanch for one minute.
3. Determine pH of water and record.
4. Drain off water; cool sample by running cold water over it.
5. Place sample in plastic freezer bags, one pint size, close with rubberband and put in freezer.

APPENDIX E

Score Card Used for Taste Panel

---

PROJECT OF HELEN ANNE NORRIS

DATE \_\_\_\_\_ 1960

PANEL MEMBER \_\_\_\_\_

External  
Appearance    Kinesthetic    Flavor    Acceptability

---

Sample I  
Description  
Remarks

---

Sample II  
Description  
Remarks

---

Sample III  
Description  
Remarks

---

Sample IV  
Description  
Remarks

---

Explanation:

External appearance---consistency; smooth, rough, glossy,  
wrinkled; color: bright, grey,  
brownish, dull, green

Kinesthetic--mouth feel: pungent, furry, slick

Flavor---sweet, sour, salty, bitter

Acceptability---Use these values:

Like 11-15

Neither like or dislike 6-10

Dislike 1-5

---



## APPENDIX F

### CLUSTER BEAN SAUCE: HOUSEHOLD MEASUREMENTS

#### Ingredients

3 ounces frozen cluster beans  
 $\frac{1}{4}$  cup onions diced  
Fat  
4 teaspoons margarine or  
4 teaspoons hydrogenated fat or  
4 teaspoons oil  
 $\frac{1}{2}$  teaspoon salt  
2 teaspoon sugar  
Water as needed  
 $\frac{1}{4}$  cup uncooked rice

#### DIRECTIONS:

1. Cook rice according to directions for kind used.
2. Heat fat in frying pan.
3. Add onions and seasonings.
4. Sauté until onions are clear.
5. Add unthawed cluster beans, heat until thawed.
6. Cover and simmer.
7. Add water if necessary to prevent burning.
8. Stir occasionally to insure even cooking.
9. Cook mixture 30 minutes after addition of beans.
10. Remove from heat; add rice and serve.

YIELD: Approximately 2 servings.

#### VARIATIONS:

- A. Eight ounces canned tomatoes without liquid; add after cluster beans are thawed; proceed as in basic recipe using liquid from tomatoes rather than water.
- B. Four ounces of stew beef or ground beef; sauté with the onions and seasonings; proceed as in the basic recipe and add two tablespoons vinegar after the cluster beans are added.
- C. Four to six ounces canned tuna fish and two tablespoons of lemon juice added as in B.
- D. Four ounces tomato and four ounces beef or tuna added as in A. and B.

- E. Garlic added with onion and seasonings as desired.
- F. Four to six ounces ham and two tablespoons lemon juice added as in B.
- G. Suet can be used as cooking medium; render enough to give an excess on the bottom of frying pan. (piece approximately two inches square was sufficient in this work.)

Note: B. C. D. and F. are considered meat extenders. The yield for these variations is three servings.

APPENDIX G

SCORE CARD USED BY PANEL TASTING GUAR IN RECIPES

Cluster Bean Sauce Project of Helen Anne Norris Date Taster  
 Time tasted  
 Please taste for acceptability of each sample noting color, texture, flavor, and odor.

Scoring:

Color-(of the bean) Green 5, Yellow Green 4, Grey Green 3, Brown Green 2, Brown 1.

Texture- Firm but tender 5, Tender 4, Soft 3, Soft and furry 2, Furry 1, Mushy 1.

Flavor- Typical of mixture 5, Rancid 1, Sour 1, Bitter 1.

Odor- Pleasant (conforming to foods cooked with it) 5, Unpleasant 1, Rancid 1, Off 1.

(a range 2-4 may be used for odor and flavor if applicable)

Acceptability- Like 4-5, Neither like nor dislike 3, Dislike 1-2.

Sample	code	Color	Texture	Flavor	Odor	Acceptability
	1					
	2					
	3					
	4					

APPENDIX H

TABLE XII ACCEPTABILITY: YOUNG, COOKED UNCOVERED 5 MINUTES, COVERED 15 MINUTES

VARIETY G-40			VARIETY G-101			VARIETY G-135			VARIETY G-137		
Number	Sample	Accept.	Number	Sample	Accept.	Number	Sample	Accept.	Number	Sample	Accept.
Taste	Code		Taste	Code		Taste	Code		Taste	Code	
7	1-29	9.19	-		-	8	2-2	8.25	9	2-14	9.20
8	1-31	7.75				9	1-14	8.2			
8	2-31	9.75									
8	1-2	5.88									
10	4-6	8.80									
9	2-14	4.10									
7	2-17-B	9.28									
Averages:											
8.1		7.81	-		-	8.5		8.23	9		9.20
Total: 10 samples. average acceptability 8.03											

TABLE XIII ACCEPTABILITY: MATURE, COOKED UNCOVERED 5 MINUTES, COVERED 15 MINUTES

VARIETY G-40			VARIETY G-101			VARIETY G-135			VARIETY G-137		
Number	Sample	Accept.	Number	Sample	Accept.	Number	Sample	Accept.	Number	Sample	Accept.
Taste	Code		Taste	Code		Taste	Code		Taste	Code	
10	1-25	7.0	8	2-26	7.00	-		-	-		-
8	3-26	6.87									
8	4-26	8.25									
8	3-31	5.62									
Averages:											
8.5		6.94	8		7.00						
Total: 5 samples. average acceptability 6.95											

TABLE XIV ACCEPTABILITY: MIXED AND UNDETERMINED AGES, COOKED UNCOVERED 5 MINUTES, COVERED 15 MINUTES

VARIETY G-40			VARIETY G-101			VARIETY G-135			VARIETY G-137		
Number	Sample	Accept.	Number	Sample	Accept.	Number	Sample	Accept.	Number	Sample	Accept.
Taste	Code		Taste	Code		Taste	Code		Taste	Code	
9	1-22	8.25	-		-	10	3-24	6.25	10	2-25	7.30
9	2-23	7.33				10	4-24	4.20	7	2-29	8.71
10	2-24	8.80									
8	3-2	7.12									
8	4-2	8.25									
Averages:											
8.8		7.95				10		5.43	8.5		8.01
Total: 9 samples, average acceptability 7.40											

TABLE XV ACCEPTABILITY: YOUNG, FROZEN COOKED 15 MINUTES AFTER RETURN TO BOIL

VARIETY G-40			VARIETY G-101			VARIETY G-135			VARIETY G-137		
Number	Sample	Accept.	Number	Sample	Accept.	Number	Sample	Accept.	Number	Sample	Accept.
Taste	Code		Taste	Code		Taste	Code		Taste	Code	
7	4-30	4.85	8	1-25	9.75	10	2-6	7.7	7	1-30	10.85
8	4-31	7.62	7	3-30	9.57				7	2-30	7.71
7	1-18-B	9.57	9	1-1	8.11				10	2-6	9.40
			9	2-1	7.33						
			9	3-1	10.77						
			9	4-1	8.88						
			10	1-6	9.40						
			7	4-17-B	9.14						
Averages:											
7.3		7.35	8.5		9.12	10		7.7	8		9.32
Total: 15 samples, average acceptability 8.71											

TABLE XVI ACCEPTABILITY: MATURE, FROZEN, COOKED 15 MINUTES AFTER RETURN TO BOIL

VARIETY G-40		VARIETY G-101		VARIETY G-135		VARIETY G-137	
Number Sample Accept.	Taste Code	Number Sample Accept.	Taste Code	Number Sample Accept.	Taste Code	Number Sample Accept.	Taste Code
-	-	9	4-14	10.70	-	-	-
		7	4-29	10.55			
		7	3-17-B	7.43			
Averages:							
		7.6		7.23			
Total: 3 samples, average acceptability 7.23							

TABLE XVII ACCEPTABILITY: MIXED AND UNDETERMINED AGES, FROZEN, COOKED 15 MINUTES AFTER RETURN TO BOIL

VARIETY G-40		VARIETY G-101		VARIETY G-135		VARIETY G-137			
Number Sample Accept.	Taste Code	Number Sample Accept.	Taste Code	Number Sample Accept.	Taste Code	Number Sample Accept.	Taste Code		
-	-	-	-	9	4-23	9.88	7	3-29	9.10
				10	3-25	10.00			
				10	3-25	9.3			
Averages:									
				9.6		9.72	7		9.10
Total: 4 samples, average acceptability 9.75									

TABLE XVIII ACCEPTABILITY: YOUNG, COOKED COVERED 15 MINUTES

VARIETY G-40		VARIETY G-101		VARIETY G-135		VARIETY G-137	
Number Sample	Accept.	Number Sample	Accept.	Number Sample	Accept.	Number Sample	Accept.
Taste Code		Taste Code		Taste Code		Taste Code	
-	-	8	2-22	6.75	-	-	-
		9	1-23	8.22			
Averages:		8.5	7.14				
Total: 2 Samples, average acceptability 7.14							

TABLE XIX ACCEPTABILITY: MATURE, COOKED COVERED 15 MINUTES

VARIETY G-40		VARIETY G-101		VARIETY G-135		VARIETY G-137	
Number Sample	Accept.	Number Sample	Accept.	Number Sample	Accept.	Number Sample	Accept.
Taste Code		Taste Code		Taste Code		Taste Code	
10	1-24	10.00	-	-	-	-	-
Averages:		10	10.00				
Total: 1 Sample, average acceptability 10.00							

TABLE XX ACCEPTABILITY: MIXED AND UNDETERMINED AGES, COOKED COVERED 15 MINUTES

VARIETY G-40			VARIETY G-101			VARIETY G-135			VARIETY G-137		
Number	Sample	Accept.	Number	Sample	Accept.	Number	Sample	Accept.	Number	Sample	Accept.
Taste	Code		Taste	Code		Taste	Code		Taste	Code	
9	3-23	6.33	-		-	8	2-15	4.87	8	3-15	6.37
						8	4-15	10.37	8	3-22	7.66
						8	2-17	4.00			
						8	3-17	3.52			
						8	4-17	9.87			
						8	2-19	4.31			
						8	3-19	5.75			
						8	4-19	8.75			
						8	4-22	8.71			
Averages:											
9		6.33				8		6.73	8		7.01
Total: 12 samples, average acceptability 6.72											

TABLE XXI ACCEPTABILITY: MIXED AND UNDETERMINED AGES, COOKED UNDER PRESSURE 5 MINUTES

VARIETY G-40			VARIETY G-101			VARIETY G-135			VARIETY G-137		
Number	Sample	Accept.	Number	Sample	Accept.	Number	Sample	Accept.	Number	Sample	Accept.
Taste	Code		Taste	Code		Taste	Code		Taste	Code	
-		-	-		-	8	1-15	3.25	-		-
						8	1-17	3.87			
						8	1-19	3.87			
Averages:											
						8		3.66			
Total: 3 samples, average acceptability 3.66											



VITA

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MASTER OF SCIENCE

Thesis: THE ACCEPTABILITY OF FOUR EDIBLE VARIETIES OF  
GUAR--CYAMOPSIS TETRAGONOLOBA (L.) TAUB.--BY  
A TASTE PANEL IN RELATION TO MATURITY, METHODS  
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