

Flavor Preference of Selected Food Products from Vegetables

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Selected food products were prepared from vegetables, tasted for preference, and analyzed for certain components. Several methods including deep-frying were used to prepare products from turnip root, summer and winter squash, sweet corn, soybean, and sweet potato. All samples received panel scores in the "liked" categories with one exception. Fat content ranged from a high 56.5% in deep-fried (DF) squash to a low 6.6% in DF corn-on-the-cob. A DF soybean snack had 27.3% protein and 38% fat. Acceptability of a frozen sweet potato product prepared with flavoring ingredients improved during frozen storage. Spaghetti squash, a winter type, was prepared by five recipes; samples were very acceptable. Studies show that vegetables may be used to prepare interesting and appetizing foods which should meet many of the consumer's sensory and nutritional needs.

The basic ingredients of the human diet have changed little in the past centuries; only the form in which they are served has changed (Platina, 1967). Consumers today, like those of old, continue to search for exotic methods of food preparation which result in products that satisfy their sensory but not necessarily their nutritional needs.

The civilian per capita consumption of commercially produced vegetables was 100 kg in 1974, an increase of about 10% over the past 26 years. As an average, each person ate 648 kg of food in 1974, thus vegetables comprised only 15.4% of the diet (USDA, 1975, 1976).

Consumption of snack foods as presently experienced is a relatively recent phenomenon, but per capita consumption continues to increase each year. This increase may be attributed to a spectacular growth in the number of households consisting of one person, working couples without children, working wives, and others who want more leisure time, and people who want to avoid food preparation chores (Danzansky, 1976). Many of the snack foods are deep-fried, a culinary method that imparts a distinctive flavor and texture that today's consumer enjoys. Nutritionists, however, often label these "junk food" because many of them are high in caloric content but inadequate in essential nutrients.

Vegetables provide an adequate source of most essential nutrients. Even though consumption of vegetables has increased in recent years, the obvious question remains: why is not an even greater amount consumed? One reason is, no doubt, that a sizable segment of the population enjoys eating other foods including snack foods more than eating vegetables. This situation may be changed, at least to some extent, by preparing vegetables in a more acceptable form. The food scientist can assist in attaining a more rational balance between the pleasure-producing and the nutritional qualities of foods by developing vegetable products that satisfy both of these consumer needs.

This paper reports on development of some vegetable food products from turnip root, summer squash, sweet corn, soybean, sweet potato, and winter squash. Sensory evaluations and limited proximate analyses and color measurements of samples are presented.

EXPERIMENTAL METHODS

Sensory testing was accomplished by the use of individuals from food-oriented departments of the university. None of the panelists should be considered an expert judge; however, all had considerable experience as a judge.

Persons indicating a dislike for a particular product were not selected. A majority of the testing was for product preference using a hedonic scale (Larmond, 1970; Peryam and Pilgrim, 1957). In the original studies the hedonic scale used was different among the several food types. A 5-point scale was used for DF corn; 6-point, for summer and winter squash; 7-point, for DF turnips and whole soybeans; 8-point, for sweet potatoes; and 9-point, for the soy-onion product. For ease of comparison of scores among the different products all scores other than those from the 6-point scale were recalculated to conform to the 6-point scale; 1 = liked very much, 6 = disliked very much. Testing procedures were consistent with those advocated by the Institute of Food Technologists (IFT Committee, 1971). Panel evaluation data were analyzed by analysis of variance and means were tested for differences by Duncan's Test (Li, 1957). Proximate analyses were performed according to AOAC (1965) procedures. Color was measured with the Hunter Color/Difference Meter and expressed as Hunter L, "a" and "b" values.

DEEP-FRIED VEGETABLE PRODUCTS

Many deep-fried (DF) food products have been produced from vegetables (Kelly and Baum, 1955; Lawhon et al., 1970) but the onion ring and potato chips and fries are the most popular. Fried foods of all kinds are popular mainly because of their excellent flavor and desirable textural qualities. Many of the DF foods are known to be poor sources of many nutrients, thus greater attention should be given this characteristic. The foods presented in this section obviously will vary in nutrient composition and content; however, all have reasonably high sensory panel scores.

Turnip Root. Turnips have been eaten for centuries (Platina, 1967); but until recently, the methods of cooking probably have changed very little. Consequently, turnips are quite low on the list of favorite vegetables. This is especially true for the younger segment of the population. Undoubtedly, turnips can be made more palatable to contemporary appetites.

Slices 4.75 mm thick were cut from young, succulent roots, blanched in boiling water for 2 min, and coated with batter and bread (Reddy et al., 1971). Batter was prepared from a commercial mix and water (control) but was altered by including 10% soy concentrate, or 0.5% carboxymethylcellulose (CMC), or 10% soy plus 0.5% CMC. Bread consisted of crushed saltine crackers. Breaded slices were DF at 177 °C for 3 min.

Samples were scored by a 12-member panel. Samples containing batter with 0.5% CMC or 10% soy plus 0.5% CMC were most preferred with scores of 2.2 and 2.3

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Table I. Preference Scores^a for Deep-Fried Summer Squash

Kind of squash	Heat treatment before frozen storage		Kind of squash mean
	Blanched	Un-blanch	
Zucchini	2.7	3.3	3.0 ^c
Yellow	3.3	3.8	3.6 ^b
Treatment mean	3.0 ^e	3.6 ^d	

^a 1 = liked very much; 6 = disliked very much.
^{b,c} Means are different ($P < 0.01$). ^{d,e} Means are different ($P < 0.01$).

(slightly less preferred than "liked moderately"), respectively. A score of 1.0 would have indicated that the samples were "liked very much". Samples with batter containing soy-CMC were scored highest for crispness (texture).

When the four samples were ranked in order of preference, samples containing batter with CMC or soy-CMC were preferred over the others. CMC produced an increase in crispness and this may have been the reason for the higher scores.

Proximate analyses showed that on the dry weight basis (dwb) protein ranged from 5.1–6.7%; fat, 41.3–43.7%; fiber, 4.4–5.1%; and ash, 1.9–2.7%. Samples with soy had 1.4% more protein than the control. Fat content was quite high (mean = 42.8%). All samples with the modified batter had more fat (mean = 43.3%) than the control (mean = 41.3%). The additional fat may have contributed to the higher scores for these samples.

Strips 6 × 6 mm were cut from young roots and without being blanched were coated with batter prepared from all-purpose self-rising flour and water (unpublished data, 1976). The slices were coated further with bread consisting of yellow cornmeal, a commercial preparation of bread-crumbs, or a mixture of equal amounts of meal and crumbs. The strips were DF and evaluated according to methods used for the slices.

Samples with cornmeal received the lowest preference (1.8 = slightly higher than "liked moderately") while samples with breadcrumbs or a combination of the two materials were scored 1.4 and 1.3 (slightly lower than "liked very much"), respectively.

The greater preference for the strips may be attributed to a more thorough cooking which was permitted by the smaller dimension of the strips. The more thorough cooking eliminated the strong turnip flavor and produced a crispier texture.

Summer Squash. Young yellow and zucchini-type squash were sliced to 3 mm thickness (unpublished data, 1976). One-half of the slices were blanched in water at 98 °C for 2.5 min and the remaining slices were not blanched. Slices were placed into polyethylene bags and frozen and held at -18 °C for 6 months. Slices were removed from the freezer, thawed, and coated with batter consisting of equal amounts of all-purpose self-rising flour and cornmeal with salt added for flavor. Water was used to prepare the batter. Samples were DF at 190 °C for 2.5–4 min depending on maturity of the squash. DF samples were evaluated by an eight-member panel and tested for fat content.

Panel scores indicated that the blanched samples were superior to unblanched samples. Zucchini squash samples also were preferred (Table I). Scores for all samples showed that panelists "liked" them. The fat content was high with a mean of 53.3% and a range of 51.2–56.5%. Obviously, foods such as this should be consumed in

Table II. Preference Scores,^a Moisture, and Fat Content in Deep-Fried Corn-on-the-Cob

Treatment	Score	Moisture, %	Fat, %
Fried in butter-flavored oil	1.3 ^b		
Fried in unflavored oil	1.4 ^b	57.8	4.5
Blanched, fried in unflavored oil	2.3 ^b	54.9	3.9
Frozen, fried in unflavored oil	3.4 ^c		
Raw corn		77.7	0.8

^a 1 = liked very much; 6 = disliked very much.
^{b,c} Means with same letter are not different ($P < 0.05$).

limited quantities because of the high fat content.

Comments made by panelists indicated that the unblanched samples lacked typical squash flavor while blanched samples possessed at least some squash flavor. No doubt, deteriorative changes occurred during the period of frozen storage to account for the lower acceptance of samples of unblanched squash.

Corn-on-the-Cob. When ears of sweet corn (roasting ears) are DF, they yield a product with many of the desirable qualities of boiled corn-on-the-cob and roasted (parched) ears. When prepared in this manner, the DF corn is considered a delicacy (Carrol, 1970), yet DF ears of corn have been sold only by a few fast food outlets. Collins et al. (1971) and Collins and Hill (1976) showed that this product may have greater market potential than presently exhibited.

Young ears of corn (Silver Queen, a white variety) were DF 10 min at 177 °C according to the following methods: (1) raw ears were DF in butter-flavored oil or (2) in unflavored oil, (3) raw ears were blanched 5 min in boiling water and DF in unflavored oil, or (4) raw ears were blanched and frozen at -18 °C, held 4 days, and DF in unflavored oil.

A nine-member panel evaluated the samples. Samples prepared by methods 3, and 1 and 2 were scored slightly below "liked moderately" and slightly below "liked very much", the highest category, respectively (Table II). Samples prepared by method 4 were preferred less than all others, indicating that changes which occurred during frozen storage were detrimental to quality. Frozen storage, however, is necessary for a continuous supply of corn. Moisture content was lowered 23% and fat was increased 3.7% from that of the raw corn.

In another study, ears of the same variety of corn were harvested when the soluble solids content was between 19 and 26%, blanched 6 min in boiling water, and frozen and held 6 months at -18 °C. Ears were thawed, DF 2–3 min at 175 °C depending on degree of maturity, evaluated by a panel of 30 members, and tested for moisture and fat contents (Collins and Taylor, 1976). The panel scored all samples between "liked slightly" and "liked moderately", but no significant difference was found among mean scores of samples from the different soluble solids levels. These scores are similar to those presented previously for blanched or frozen corn. Moisture was lowered by a mean of 6.8%, the small loss being due to the short time of frying. Fat averaged 4% (dwb) in raw kernels and 6.6% in DF kernels. Obviously, the fat uptake was restricted by the kernel pericarp. The small loss of moisture should render the product quite succulent, facilitating mastication. The low fat level should allow the corn to be planned in the diet of people who are calorie conscious.

Soybean Snack. Collins and Ruch (1969) prepared a DF snack food from soybeans. Mature green vegetable-type soybeans were blanched in steam 3 min, coated with batter of all-purpose flour and water and bread, and DF

Table III. Preference Scores^a for Deep-Fried Soybeans

Batter	Bread		
	Cracker meal	Wheat flour granules	Batter means
Flour	2.3 ^c	2.2 ^c	2.3
Commercial mix	3.2 ^b	2.1 ^c	2.6
Bread means	2.8 ^d	2.2 ^e	

^a 1 = liked very much; 6 = disliked very much.
^{b,c} Means with same letter are not different ($P < 0.05$).
^{d,e} Means are different ($P < 0.05$).

Table IV. Preference Scores^a for Deep-Fried Soybean-Onion Product

Maturity of beans	Score	Ratio bean: onion	Score
Mature dry	2.2 ^b	1:1	2.0
Mature green	1.9 ^c	1:2	2.1

^a 1 = liked very much; 6 = disliked very much.
^{b,c} Means are different ($P < 0.05$).

3 min at 177 °C. A 23-member panel evaluated the samples.

Three of the four treatments were scored slightly lower than "liked moderately" (Table III). The remaining treatment was scored close to "liked slightly". Flour batter and cracker meal yielded the most preferred samples. Samples had the following mean percentage (dwb) of components: protein, 27.3; fat, 38.4; fiber, 5.0; ash, 3.4; and carbohydrate, 25.9. Samples had a mean 14.6% moisture. This product due to the relatively high protein and low fat content was more nutritious than the turnip or squash items which were high in fat but low in protein. As prepared, each unit constituted a bite-size piece, making it suitable as a "finger" snack.

Soybean-Onion Snack. Another snack was prepared by combining chopped soybeans and onions (Collins and Sanders, 1973). Mature dry soybeans were soaked overnight in water and cooked 7 min at 10 psig to soften the beans, remove the strong bean flavor, and destroy trypsin inhibitor. Mature green beans were blanched 3 min. The beans and fresh onions were chopped separately, mixed with a binder and extruded into a commercial-type batter made with water, and breaded. The extruded material was cut to yield cylindrical pieces of 1.5 cm diameter and 2 cm long. The coated pieces were DF 3.5 min at 177 °C. Samples were evaluated by a 12-member panel and analyzed for proximate analysis.

All samples were scored close to "liked moderately", thus acceptability was very high (Table IV). Samples made with mature green beans were preferred over those made with mature dry beans. The ratio of onion to soybean used did not affect panel scores. When samples were compared with onion rings, the soy-onion samples received a higher score, indicating they were "slightly better" than the onion rings.

When green soybeans were used, the DF product had a mean 28.8% fat and 11.0% protein (dwb). Moisture content was 23.6%. When mature dry soybeans were used, the samples had a mean 24.6% fat and 11.4% protein (dwb); moisture was a mean 27.2%. Samples with the higher proportion of onions had 1.3% less protein.

This product has potential as a snack food: It can be made to any shape and size, the flavor may be altered by using any of the many flavoring ingredients available, it is relatively high in protein and low in fat and the nutritional value can be improved by incorporating other

Table V. Preference Scores^a for Frozen Sweet Potato Product

Treatment	Score	Variety		Frozen storage	
		Ingredient	Name	Score	Days
Raisin	2.50 ^b	Jewel	2.21 ^g	45	2.40 ^h
Pineapple	2.14 ^{de}	Jasper	2.36 ^f	90	2.22 ⁱ
Ham	2.07 ^e			135	2.22 ⁱ
Pineapple-ham	2.21 ^{cde}				
Coconut	2.43 ^{bc}				
Control	2.36 ^{bcd}				

^a 1 = liked very much; 6 = disliked very much.
^{b-e} Means with same letters are not different ($P < 0.01$).
^{f,g} Means are different ($P < 0.05$). ^{h,i} Means are different ($P < 0.01$).

vegetable materials which possess desired nutrients.

FROZEN SWEET POTATO PRODUCT FROM BAKED ROOTS

Among the once-popular foods left behind by consumers in their search for convenience is the sweet potato—consumption dropped from 13.3 kg per capita in 1919 to 2.5 kg in 1974 (USDA, 1968, 1976).

An answer to convenience needs might be a frozen, baked sweet potato dish with added ingredients such as raisins, pineapple, meat, or flavoring. Presently, the largest selling processed sweet potato product is canned small roots. This product has at least two inherent disadvantages: it lacks sufficient convenience since further preparation is required before being served and it often lacks good, typical sweet potato flavor and overall quality (Edmond and Ammerman, 1971).

Several attempts have been made to develop sweet potato products (Bogges et al., 1967; Deobald et al., 1962; Hoover and Miller, 1973). This paper describes a frozen product that only needs heating before serving.

Collins et al. (1976) baked cured roots of Jewel and Jasper varieties at 177 °C until soft. Roots were cooled, peeled, and trimmed. To each 100 g of the baked tissue were added 16 g of granulated cane sugar and 56 mg of powdered cinnamon (preliminary mixture). Six treatments were prepared by adding the following ingredients individually per 100 g of the preliminary mixture and mixing: 7 g of raisins, 7 g of chopped pineapple, and 3 mL of pineapple juice, 10 g of chopped luncheon ham, pineapple, and ham combination in amounts previously listed, 2 g of orange flavored and colored shredded coconut, and no added ingredients (control). Ninety grams of product was placed in aluminum "boats", sealed and quick frozen, and held at -25 °C for 45, 90, and 135 days.

Frozen samples were tempered to room temperature and analyzed for moisture and tested for color. Additional samples were heated at 177 °C until hot and evaluated by a 12-member panel. Preference was based on appearance, color, flavor, and texture.

Moisture ranged from 60.7 to 61.7% among samples. Color of samples was affected by the added ingredients but it is doubtful that the small differences could be detected by the human eye. The mean dominant wavelength of all samples was 587 nm (orange color).

The panel scored all samples of the Jewel variety at slightly below "liked moderately". Jewel samples were preferred over those of Jasper variety (Table V). Samples with ham were significantly preferred over control samples. Pineapple also had a favorable effect on the scores. Frozen storage up to 135 days improved the attributes of samples such that those stored 90 and 135 days were preferred over those stored 45 days.

Table VI. Preference Scores^a for Vegetable Spaghetti Squash Dishes

Spaghetti squash dish	Score	Squash pies	
		Amount of spaghetti squash, %	Score
Vegetable spaghetti salad	1.3 ^c	0	1.5
Fried vegetable spaghetti	1.8 ^{b,c}	15	1.9
Vegetable spaghetti casserole	2.0 ^b	30	2.0
Vegetable spaghetti pudding	2.3 ^b		

^a 1 = liked very much; 6 = disliked very much.

^{b,c} Means with same letters are not different ($P < 0.01$).

A convenience product such as the one reported here could be packaged in retail and foodservice sizes and heated in conventional or microwave oven with proper packaging. In addition to being an excellent source of energy and provitamin A, many individuals consider sweet potatoes a tasteful, appealing food when prepared in attractive ways.

VEGETABLE SPAGHETTI SQUASH DISHES

A winter squash, named vegetable spaghetti squash, was introduced recently into the United States. The squash is cream to orange in color and cylindrical with rounded ends. The dimensions of the squash will vary depending on many factors but a fairly typical size is about 15 cm in diameter and 23 cm long. The initial preparation for eating involves cooking the whole squash in boiling water 20–45 min. After cooking, the flesh appears as strands similar to spaghetti which are removed from the thin rind. The flesh was prepared in five recipes; four were vegetable spaghetti squash dishes and the other was a pie (Collins and Hill, 1976).

Vegetable spaghetti salad was prepared from squash, shrimp, safflower oil, cider vinegar, salt, and pepper. Ingredients were mixed and served on a slice of ripe tomato.

Fried vegetable spaghetti was prepared by mixing together fried squash, yellow cornmeal, chicken bouillon, diced ripe tomato, salt, and pepper and simmering in a sauce pan until cooked.

A vegetable spaghetti casserole of squash, sour cream, Parmesan cheese, grated ginger, salt, and pepper was prepared. Ingredients were placed in a casserole dish and covered with Parmesan cheese. The preparation was broiled until a golden brown color developed.

Vegetable spaghetti pudding was prepared to contain squash, egg, cheddar cheese sauce, bread crumbs, salt, pepper, and nutmeg. Ingredients were mixed and baked.

Pies were prepared from butternut squash and spaghetti squash cut into 2 cm lengths. The pies were prepared by replacing 0 (control), 15, and 30% of the butternut squash with spaghetti squash. Additional ingredients were sugar, cinnamon, butter, and egg. Pies were baked and tested.

A panel of 12 people evaluated the samples. Three of the spaghetti squash samples received scores from below "liked very much" to "liked moderately" (Table VI). The vegetable spaghetti salad sample was preferred over the vegetable spaghetti casserole and pudding. This vegetable, then, offers variety in menu planning and it may serve as

a substitute for products such as spaghetti for people who are allergic to cereal products.

The pies were scored from midway between "liked very much" to "liked moderately". No differences were found between mean scores of the three pies. The spaghetti squash produced textural characteristics resembling those produced by shredded coconut.

CONCLUSION

Nutritionists and others are concerned about the diet of Americans. For many, the diet is too high in snack foods which contain large amounts of fats and carbohydrates but little else which can be considered nutrients. Vegetables when consumed in variety, however, provide most of the essential nutrients. This paper reports the preparation, sensory evaluation, and limited chemical and physical tests of various vegetable foods. Most samples were highly acceptable. It should be remembered that in addition to providing foods that taste good and are nutritious, the foods must offer convenience and meet other consumer needs. Products such as those presented here should meet many of the consumer's needs.

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Received for review November 22, 1977. Accepted February 13, 1978. Presented at the Symposium on Nutrients and Flavor Quality of Plants Foods, 173rd National Meeting of the American Chemical Society, Division of Agricultural and Food Chemistry, New Orleans, La., March 1977.