

# What Are Burpless Cucumbers?

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**SUMMARY.** Burpless cucumbers are listed in many seed catalogs as being milder in taste (or easier on the digestion) than the American slicing type. It has been suggested by researchers that burpless cucumbers 1) contain less of a burp-causing compound, 2) are genetically bitterfree, or 3) are just the marketing term for oriental trellis cucumbers sold in the U.S. The objective of this experiment was to determine whether oriental trellis cucumbers cause less burping when eaten, and whether they are genetically bitterfree. An American slicer ('Marketmore 76'), a bitterfree slicer ('Marketmore 80'), and a burpless oriental trellis slicer ('Tasty Bright') were compared. Burpiness of the fruit was determined in the field in two seasons (spring and summer) and two replications. Six judges were grouped into burp-susceptible and burp-resistant. They evaluated the cultivars over two harvests by eating a 4-inch (100-mm) length of one fruit of the three cultivars (in random order) on three consecutive days. Burpiness was rated 0 to 9 (0 = none, 1 to 3 = slight, 4 to 6 = moderate, 7 to 9 = severe). Bitterness of the plants was determined (using different judges) by tasting one cotyledon of six seedlings per cultivar. Cotyledon bitterness is an indicator of plant bitterness; bitterfree plants lack cucurbitacins, and have mild-tasting fruit. Results of taste tests indicated that burpiness ratings were not significantly different

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for burp resistant judges. However, oriental trellis cucumbers were slightly but significantly milder than american slicers for judges susceptible to burping. 'Marketmore 76' and 'Tasty Bright' were normal-bitter, and 'Marketmore 80' was bitterfree. An additional 11 oriental trellis cultivars were also tested for bitterness to determine whether Tasty Bright was typical in bitterness; they were all normal-bitter. In conclusion, oriental trellis cucumbers are not bitterfree, but are slightly milder for burp-susceptible people to eat. Finally, burpless is the marketing term for oriental trellis cucumbers in the United States.

**B**urpless cucumbers (*Cucumis sativus* L.) are marketed in the United States to specialty growers and home gardeners. Consumers often ask whether burpless cultivars cause less burping when the fruit are eaten. Plant breeders working on cucumber in the United States were questioned about the burpless trait; they hypothesized that burpless cucumbers 1) produce fruit that cause less burping when eaten, 2) are genetically bitterfree, or 3) are the marketing term for oriental trellis cucumbers in the United States.

The first hypothesis is based on the observation that some people who eat cucumbers occasionally experience a mild stomach upset due to the production of stomach gas, and may benefit by eating certain cucumber types other than american slicers. The second hypothesis is based on the fact that greenhouse cucumbers bred in The Netherlands usually are genetically bitterfree. The benefit of bitterfree plants is that their fruit are milder in taste than normal types, and will not become bitter if the plants are grown under drought stress. The third hypothesis is based on the fact that oriental trellis cucumbers marketed in the United States by companies such as Burpee Seed are referred to as a burpless cucumber type. However, the same type is marketed in Japan as trellis cucumber without using the term, burpless.

Cucumber market types include american pickle, american slicer, middle-eastern slicer, and oriental trellis (Fig. 1). American slicers have fruit that are warty, thick skinned, uniform-green colored, with a length to diameter ratio (LD) of 4, whereas oriental trellis cul-

vars have fruit that are ridged, thin skinned, uniform green colored, with LD of 7 (Wehner and Horton, 1986). The oriental trellis type offers higher eating quality because of its thinner skin, but does not ship as well as a result. The thin skin makes for easier eating, and may be part of the reason it is considered burpless.

Although all commercial cucumbers have fruit with low cucurbitacin content, bitterfree plants have no cucurbitacins in the foliage and fruit if they are homozygous recessive for either the *bi* (Andeweg and DeBruyn, 1959) or *bi-2* (Wehner et al., 1998) genes. This provides milder-tasting fruit that may be burpless. Cucurbitacins are involved in more than fruit quality, and their primary purpose appears to be protection from herbivores. Plants with genotype *bi bi* or *bi-2 bi-2* are more resistant to cucumber beetles [*Diabrotica undecimpunctata howardi* Barber (spotted cucumber beetle), *Acalymma vittata* Fabricius (western striped cucumber beetle), and *Diabrotica balteata* LeConte (banded cucumber beetle)] (da Costa and Jones, 1971), but more susceptible to spider mites (*Tetranychus urticae* Koch) (de Ponti, 1980). Most american pickling cultivars are normal-bitter (not genetically bitterfree). Pickling cucumber fruit occasionally develop noticeable bitterness due to environmental stress. However, since bitterness can be prevented by adequate irrigation, and since bitterness is removed by brining or pasteur-

ization, it is usually not a problem in that type. Other genes can affect fruit bitterness as well. Some of the feral cucumber lines such as PI 173889 (Hanzil Medicinal cucumber) have extremely bitter fruit, a condition determined by the *Bt* gene (Barham, 1953).

The objective of this experiment was to determine whether oriental trellis cucumbers are genetically bitterfree, and whether the fruit cause less burping and stomach upset when eaten than american slicing type cucumbers.

## Methods and materials

**BURPINESS TESTING.** Three cultivars were used: Marketmore 76 (normal-bitter), Marketmore 80 (bitterfree), and Tasty Bright (burpless). Seeds were obtained from Dr. Henry Munger, Cornell University, Ithaca, NY ('Marketmore 76' and 'Marketmore 80'), or Sakata Seed America ('Tasty Bright'). Fruit from seedlings were rated for bitterness as described in the next section.

Burpiness was evaluated using field-grown cucumbers. The experiment was a split plot with two replications and two harvests. Whole plots were two seasons (spring and summer within 1 year), subplots were the three cultivars (Marketmore 76, Marketmore

**Fig. 1. (left to right) American slicer, oriental trellis (without warts), and oriental trellis (with warts) cucumbers. Fruit are grouped top to bottom into grades 1, 2, and cull.**



**Table 1. Cotyledon bitterness and fruit burpiness of three cultivars as rated by burp-susceptible and burp-resistant judges.<sup>z</sup>**

Cultivar name	Cultivar type	Bitterness rating (cotyledon)	Fruit burpiness rating by judge group <sup>y</sup>	
			Susceptible	Resistant
Marketmore 76	American slicer	1.0	3.0	3.0
Marketmore 80	American slicer	0.0	3.5	2.5
Tasty Bright	Oriental trellis	1.0	1.0	2.9
LSD ( $p = 0.05$ , all burp ratings)		---		1.0
Mean (all judges)		---		2.6
F ratio	Season			0.37 <sup>NS</sup>
	Replication (season)			1.08 <sup>NS</sup>
	Judge group			0.54 <sup>NS</sup>
	Cultivar			5.76 <sup>**</sup>
	Bitterfree vs. normal-bitter			2.71 <sup>NS</sup>
	American vs. oriental type			11.51 <sup>**</sup>
	Judge group × cultivar			8.83 <sup>**</sup>
	Season × cultivar			4.73 <sup>*</sup>
	Season × judge group			2.78 <sup>NS</sup>
	Season × cultivar × judge group			0.51 <sup>NS</sup>

<sup>z</sup>Bitterness was rated 0 or 1 (0 = bitterfree, 1 = normal-bitter) after tasting the cotyledons of 5 plants; burpiness was rated 0 to 9 (0 = none, 1 to 3 = slight, 4 to 6 = moderate, 7 to 9 = severe) for burpiness after eating one half of a cucumber fruit of one cultivar on 1 d (three cultivars tasted on three consecutive days in random order). Data are means of two seasons, two replications, two harvests, and three judges using fruit from 20-plant plots.

<sup>y</sup>Judges were grouped into susceptible or resistant to burping according to their previous experience with cucumbers.

<sup>NS,\*,\*\*</sup>Nonsignificant or significant F ratio from analysis of variance at the 0.05 or 0.01 level, respectively.

80, and Tasty Bright) and six judges.

Plots were planted by hand with 30 seeds in a 20-ft (6.1-m) length, and were thinned to 20 plants at the first true leaf stage. Rows were on raised, shaped beds 5 ft apart. Plots were separated by a 5-ft alley at each end, and there were border rows planted on each side of the trial, and border tiers at the ends of each row. Plots were planted on 27 May for spring and 2 July for summer season. Fruit were harvested 19 and 22 July for spring, and 19 and 27 Aug. for summer season.

The experiment was conducted using recommended cultural practices (Schultheis, 1990). Fertilizer was incorporated before planting at a rate of 80–35–66 lb/acre (90–39–74 kg·ha<sup>-1</sup>) of N–P–K, with an additional 30 lb/acre (34 kg·ha<sup>-1</sup>) of N applied as a side-dressing at the vine-tip-over stage (four to six true leaves). Seeds of the different cucumber cultivars were planted on raised, shaped beds with centers 5 ft (1.5 m) apart. The soil was an Onslow loamy fine sand (Fine-loamy, siliceous, thermic; Spodic Paleudults) with a pH of 6.4. Overhead irrigation was applied when needed for a total of 1 to 1.5 inches (25 to 40 mm) water per week (including rainfall). A tank mix of 2 lb/acre (2.2 kg·ha<sup>-1</sup>) of naptalam (2-[(1-naphthalenylamino) carbonyl] benzoic acid) and 4 lb/acre (4.4 kg·ha<sup>-1</sup>) of bensulide (O,O-bis(1-methylethyl) S-

[2-[(phenylsulfonyl) amino] ethyl] phosphorodithioate) was applied pre-plant for weed control.

Fruit were harvested Mondays and Thursdays to keep the plants producing fruit. Fruit used in the experiment were taken from the second and third Mondays (harvests three and five) of the harvest period. Each judge received three cucumbers, one per cultivar, to eat in a 3-d period. The three cultivars were assigned to be eaten in random order, rotated over the judges, seasons, and replications. For example, the order was abc, bca, cab, acb, cba, and bac for cultivars a, b, and c assigned to the judges 1 to 6 for the first season, replication, and harvest.

Judges were grouped (three each) into susceptible or resistant to burping based on their previous experience with cucumbers. Fruit were evaluated for burpiness using six judges eating a 4-inch (100-mm) length of fruit per cultivar per day. Burpiness was measured on a 0 to 9 scale with 0 = none, 1 to 3 = slight, 4 to 6 = moderate, and 7 to 9 = advanced. Fruit were washed, peeled, and sliced before eating, but not eaten with any other food or drink. Ratings of burpiness were made within an hour of eating. Judges did not eat any other cucumbers during the test period, and waited until the following day to eat a sample of the next cultivar. Data were analyzed using the ANOVA, CORR

and MEANS procedures of SAS (SAS Institute, Cary NC).

**BITTERNESS TESTING.** Bitterness was evaluated in a diverse group of 12 oriental trellis cultivars: Jin Chun #4, Jin Za #2, Jin Yan #4 (Tianjin Academy of Agricultural Sciences, Tianjin, P.R. China); BAU #14 (Beijing Agricultural University, Beijing, P.R. China); Tasty Bright, Tasty Green (Sakata Seed America, Morgan Hill, Calif.); Summer Top (American Takii, Salinas, Calif.); Sky Horse (Japan); Fengyan (Taiwan), Yangzhou String, Yangzhou Green Skin (Yangzhou, P.R. China); and Hongzhou Green 55 (Hongzhou, P.R. China). The control cultivar for the test was Marketmore 80 (bitterfree).

Seedlings were rated for bitterness using six plants per cultivar grown in the greenhouse in flats. Methods were similar to those of Andeweg and DeBruyn (1959), with judges chosen for their ability to distinguish reliably between check inbreds. Plants were tasted using one half of a cotyledon per judge. Judges rinsed their mouths with water after tasting the seedling cotyledons from each plot. Bitterfree lines were verified by a second judge.

## Results and discussion

As expected, 'Marketmore 76' was normal-bitter in the cotyledon taste test, and 'Marketmore 80' was bitterfree. The surprise was that 'Tasty Bright'

was normal-bitter, not bitterfree as hypothesized by some researchers. Bitterness of the other oriental trellis cultivars sampled in this experiment was the same as for 'Tasty Bright', with all having bitter foliage. In retrospect, it is not surprising that oriental trellis cucumbers are normal-bitter, since that is the case for most cucumber cultivars (with the exception of bitterfree greenhouse cucumber cultivars and bitter-fruited feral cucumbers).

The largest effects on burpiness were cultivar (mainly due to the american vs. oriental contrast) and judge group  $\times$  cultivar (Table 1). Resistant judges (those who were not normally bothered by burping after eating cucumbers) could not distinguish among cultivars for burpiness. In addition, neither resistant nor susceptible judges could distinguish between american slicers that were bitterfree or normal-bitter. Differences among days (eating order, where the fruit were held for 1 to 3 d) ranged only 1.0 unit for burpiness.

Regarding the susceptible judges, they found oriental cucumbers to be significantly less burpy than either of the american slicer cultivars, bitterfree or normal-bitter. Those judges found american slicers to be slight to moderate (mean rating of 3.0 to 3.5) in burpiness, whereas the oriental trellis cucumber was none to slight (mean rating of 1.0) in burpiness. The most susceptible judge in the experiment rated the bitterfree cultivar moderate (4.3) and the oriental trellis cultivar none (0.5) for the spring season. Reviewing the raw data, judges in this experiment rated the fruit samples none to severe in burpiness for the 4-inch (100-mm) cucumber fruit sample on the day it was eaten, with burp ratings for particular treatment combinations ranging from 0 to 7 before averaging over season, replication, harvest, and judge.

Therefore, hypothesis 1 (oriental trellis cucumber fruits cause less burping, and have some burpless traits) appears to be at least partially correct, because judges who were susceptible to burping found the oriental trellis cucumber to be milder than the american slicers that were either normal-bitter or bitterfree. Hypothesis 2 (oriental trellis cucumbers are the same as bitterfree cultivars) is not correct, since none of the twelve oriental trellis cultivars evaluated were bitterfree. In

addition, the bitterfree cultivar was no better than the normal-bitter cultivar to burp-susceptible judges. Hypothesis 3 (burpless is the marketing term for oriental trellis cucumbers in the United States) also appears to be correct, since oriental trellis cucumbers are not advertised as burpless in Japan. However, since that is the normal type in Japan, such a trait may be taken for granted, making it unnecessary to advertise.

In conclusion, burpiness experienced by people eating cucumbers is slightly affected by the cultivar type, and by the susceptibility of the person. Oriental trellis cucumbers such as 'Tasty Bright' had a small advantage over normal-bitter and bitterfree american cultivars for burpiness, but only for people susceptible to burping. The term "burpless" mainly indicates cultivars of oriental trellis type marketed in the U.S. Finally, oriental trellis cultivars (and burpless cultivars) are not genetically bitterfree.

Additional research is needed on cucumbers of all types to identify cultivars that are free of burping for susceptible judges, and to identify the compound responsible for the burping effect.

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