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# Understanding American and Chinese consumer acceptance of ‘Redglobe’ table grapes

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## Abstract

‘In-store’ consumer acceptance tests were performed on a group of 400 American consumers and 250 native Chinese consumers to determine the relationship between ripe soluble solids concentration (SSC) and titratable acidity (TA) on consumer acceptance of ‘Redglobe’ grapes for different ethnic groups. For this, a group of Caucasian, Hispanic and Chinese-American consumers and a group of native Chinese consumers tasted monadically four individual berry half samples at room temperature with SSC ranging from 10 to 20% and TA from 0.30 to 1.80%. Grapes with SSC < 16.1% were accepted by 70% of the American consumers and 47% of the Chinese consumers. However, the percentage of consumers that disliked these grapes was the same (~ 21) for both ethnic groups. The difference in the percentages of Chinese and American consumers accepting the grapes was due to the ‘neither like nor dislike’ category. Chinese consumers chose the ‘neither like nor dislike’ category in approximately 34% of the cases, while approximately only 7% of the American consumers chose it. Our data confirmed that ‘Redglobe’ consumer acceptance is highly related to SSC:TA ratio but within a given SSC and TA level. In contrast to American consumers, Chinese consumer acceptance was not related to SSC:TA ratio when TA > 0.80%. Thus, our work indicates that high TA affects consumer acceptance in relation to SSC:TA ratio depending on ethnic background. © 2002 Elsevier Science B.V. All rights reserved.

*Keywords:* Ethnic; Consumer acceptance; In-store consumer acceptance tests; Soluble solids concentration; Titratable acidity; Degree of liking

## 1. Introduction

Consumers consider high quality fruit to be those with nice appearance, high nutritional value, and good taste (Bruhn et al., 1991). The

relationship between consumer preference and fruit chemical composition has been studied in different commodities. Several researchers have established that consumer preference is well related with fruit soluble solids concentration (SSC), titratable acidity (TA) and SSC:TA ratio in kiwifruit (Gorini and Lasorella, 1990; Crisosto and Crisosto, 2001); peaches (Parker et al., 1991); cherries (Kappel et al., 1996; Drake and Fellman,

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1987); grapes (Rodan, 1988; Nelson et al., 1963, 1972, 1973; Guelf-Reich and Safran 1971); and oranges (Pehrson and Ivans, 1988). Recently, it has been reported in mango that sugars and acid enhance human perception of specific flavor notes, including aromatics (Malundo et al., 2001). Controlled sensory studies on the relationship between SSC and TA fruit composition and consumer preferences were performed on 'Thompson Seedless' and 'Perlette' table grapes in California (Nelson et al., 1972, 1973), and in Israel (Guelf-Reich and Safran, 1971). Based on these studies, it was concluded that consumers were more sensitive to SSC:TA ratio than SSC. Furthermore, there is no information on the relationship between SSC and TA composition of 'Redglobe' table grapes (seeded, dark red skin cultivar) and consumer acceptance. In addition, the potential role of ethnic background on table grape consumer acceptance has not been reported. Since production of California and Chilean 'Redglobe' table grapes is still increasing, and these grapes are mainly consumed in Hong Kong and Taiwan, understanding the role of fruit SSC and/or TA on native Chinese consumer acceptance has become important. The availability of this information will help to maintain or expand both the American and Chinese markets long term.

## 2. Materials and methods

### 2.1. Consumer test

A group of 400 American consumers consisting of Caucasian, Hispanic, and Chinese-American ethnic backgrounds were interviewed at two major supermarkets located in the Fresno area, California. The Caucasian and Hispanic consumers were interviewed at the Reedley Save Mart and the Chinese-American consumers were interviewed at the R-N Market in north Fresno with a predominantly Asian clientele of Chinese descent. The native Chinese consumer test was conducted at the Doong Kong Seafood Restaurant, Honolulu, Hawaii (caters to native Chinese tour groups) over 2 days. A group of 250 native Chinese consumers were interviewed. Of the Chinese

consumers, 80 of them were sailors from two commercial vessels. Chinese interpreters were used during the interviews. The SSC and TA combinations of the 'Redglobe' grape samples tested were selected based on previous seasons' California (Dokoozlian et al., 1999) and Chilean (Crisosto unpublished data) SSC and TA surveys.

In all of the tests, all samples were prepared away from the testing area prior to the consumer test. Firmness was measured non-destructively on each berry using a Durafel-10 (Copa Informatique, S.A., France) with a 2.3 mm diameter tip. Any berries with firmness outside the 35–50 Durafel range were not used in these sensory evaluation tests. For each sample, the berry was cut in half longitudinally, i.e. from the stem end to the blossom end. Each half was placed in a labeled 44.3-ml soufflé cup. One half was used for tasting and the other for chemical analysis. The juice was extracted from one half of each berry (approximately, 6 g) and analyzed for SSC and TA expressed as percentage of tartaric acid, which is the predominant acid in this species. This allowed us to study the single consumer response relative to the SSC and TA. Each consumer, after being asked if he/she was willing to taste fresh table grapes in a University of California research project, was asked to indicate his/her age range on a chart and the interviewer recorded his/her gender and ethnic group. Each consumer that said he/she ate grapes was asked to taste monadically four one-half grape samples with the seeds intact. For each test, each consumer was presented the four proposed SSC:TA combinations of 'Redglobe' table grapes in random order in coded 44.3 ml soufflé cups at room temperature. The consumer was asked if he/she 'liked,' 'disliked,' or 'neither liked nor disliked' the sample. Then the consumer was asked his/her degree of liking/disliking: slightly, moderately, very much, or extremely. The consumer's response was recorded using a 9-point hedonic scale (1—dislike extremely to 9—like extremely). In between samples the consumer was instructed to sip bottled water to cleanse his/her palate.

Consumer acceptance was measured as both degree of liking and a percentage. The percentage of consumers liking the grape sample (consumer

acceptance) was calculated as the number of consumers liking the grape sample (score > 5.0) divided by the total number of consumers within the sample (Lawless and Heymann, 1998). The percentage of consumers disliking the grape sample (score < 5.0) was calculated as the number of consumers disliking the grape sample divided by the total number of consumers within the sample. The percentage of consumers that neither liked nor disliked the grape sample was calculated as the number of consumers that neither liked nor disliked the grape sample (score = 5.0) divided by the total number of consumers within the sample. The degree of liking data was subjected to analysis of variance (ANOVA) prior to the least significant difference (LSD) means separation using the SAS program.

### 3. Results and discussion

#### 3.1. American consumer test

For the American consumer test, individual 'Redglobe' berry SSC varied from 10.0 to 18.8% and TA ranged from 0.36 to 1.40%. Degree of liking and percentage acceptance of 'Redglobe' table grapes was related to SSC, TA and SSC:TA ratio. These relationships were not different between the ethnic groups interviewed in the American consumer test. Grapes with  $\geq 12.1\%$  SSC were accepted by American consumers but with different degrees of liking (Fig. 1A). Consumer acceptance increased from 62 to 88% according to SSC (Fig. 1B). American consumers degree of liking varied from like 'slightly' for grapes within the 12.1–15.0% SSC range (average 66% consumer acceptance), to like 'moderately' for grapes within 15.1 to >17.0% (average 84% consumer acceptance).

Based on the SSC:TA ratio, American consumer acceptance of 'Redglobe' grapes ranged from like 'slightly' to 'moderately' (Fig. 2A). 'Redglobe' with a SSC:TA ratio greater than 25.0 were liked the most ('moderately') and percentage consumer acceptance ranged from 67 to 92% (Fig. 2B). Percentage consumer acceptance for 'Redglobe' with a SSC:TA ratio < 20.1 reached 67%,

while grapes within the SSC:TA ratio range of 20.1 to 22.5 were accepted by 76% of the American consumers (Fig. 2B).

American consumer acceptance decreased as TA increased in the berries although they were always liked (Fig. 3A and B). 'Redglobe' grapes degree of liking data was divided into three groups according to a statistical means separation (Fig. 3A): grapes with  $TA \leq 0.70\%$  ('moderately'), grapes with TA between 0.71 and  $\leq 0.80\%$  ('slightly'), and grapes with  $TA > 0.80\%$  ('slightly', lowest consumer acceptance). Percentage consumer acceptance of grapes decreased from 84 to 59% as the TA increased (Fig. 3B).

As SSC and TA affected degree of liking and consumer acceptance, the interaction between different SSC and TA levels on consumer acceptance was studied. American consumers liked grapes with  $TA \leq 0.70\%$  from 'slightly' to 'moderately.'

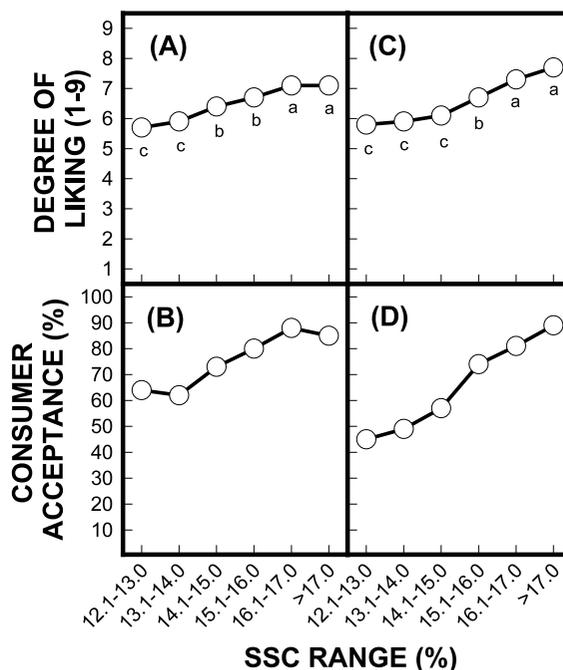


Fig. 1. Degree of liking and percentage consumer acceptance of 'Redglobe' table grapes at different levels of SSC by American (A) and (B) and Chinese (C) and (D) consumers. Degree of liking measured on 9-point hedonic scale (1, dislike extremely; 5, neither like nor dislike; and 9, like extremely). Different letters within a given SSC range indicate a significant difference between means by  $LSD_{0.05}$ .

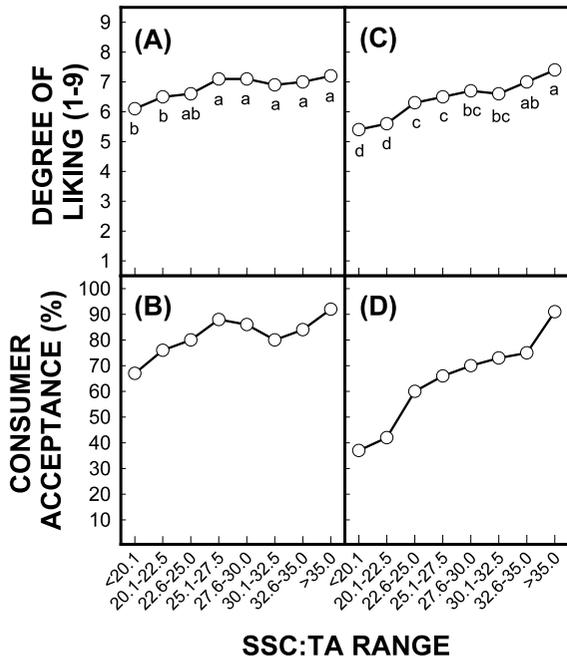


Fig. 2. Degree of liking and percentage consumer acceptance of 'Redglobe' table grapes at different SSC:TA ratio ranges by American (A) and (B) and Chinese (C) and (D) consumers. Degree of liking measured on 9-point hedonic scale (1, dislike extremely; 5, neither like nor dislike; and 9, like extremely). Different letters within a given SSC range indicate a significant difference between means by  $LSD_{0.05}$ .

Degree of liking was significantly higher for grapes with  $SSC \geq 15.1\%$  than for grapes with  $SSC < 15.1\%$ . There was a significant difference in the degree of liking of grapes in the SSC range 14.1 to 15.0% and SSC range  $< 14.1\%$  (Table 1). Consumer acceptance of grapes at this level of TA in relation to SSC ranged from 73 to 89%. The percentage of consumers disliking these grapes varied from 18 to 7%. The 'neither like nor dislike' option ranged from 3 to 9% of the consumers at this TA level (Table 1). American consumers liked 'Redglobe' grapes with TA between 0.70 and  $\leq 0.80\%$ , from 'slightly' to 'moderately'. Grapes with  $SSC \geq 15.1\%$  had the highest degree of liking within this TA range. Grapes within the SSC ranges below 15.1% all had the same degree of liking. Grapes within the SSC ranges between 14.1–

16.0% also all had the same degree of liking (Table 1). Consumer acceptance of grapes at this level of TA varied from 58 to 88%. The percentage of consumers disliking these grapes varied from 32 to 7%. The 'neither like nor dislike' option ranged from 5 to 10% of the consumers at this TA level (Table 1). American consumers liked 'Redglobe' grapes with  $TA > 0.80\%$ , from 'neither like nor dislike' to like 'moderately.' Consumer acceptance of these grapes varied from 45 to 88%. Only 45% of American consumers accepted 'Redglobe' grapes with  $SSC < 14.1\%$  and  $TA > 0.80\%$ . The percentage of consumers disliking these grapes varied from approximately 45 to 6%. The 'neither like nor dislike' option ranged from 10 to 4% of the consumers at this TA level (Table 1).

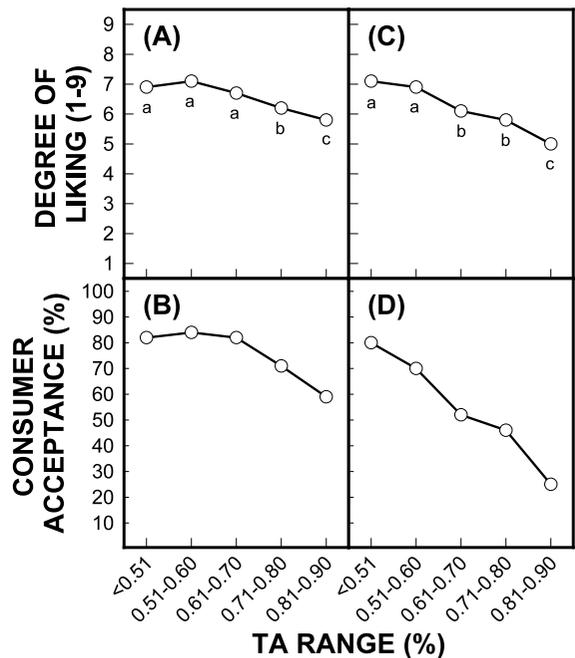


Fig. 3. Degree of liking and percentage consumer acceptance of 'Redglobe' table grapes at different TA ranges by American (A) and (B) and Chinese (C) and (D) consumers. Degree of liking measured on 9-point hedonic scale (1, dislike extremely; 5, neither like nor dislike and 9, like extremely). Different letters within a given SSC range indicate a significant difference between means by  $LSD_{0.05}$ .

Table 1  
Degree of liking and percentage consumer acceptance of 'Redglobe' table grapes by American consumers at different levels of SSC and TA measured as percentage tartaric acid

SSC range (%)	Mean SSC (%)	TA ≤ 0.70				0.70 < TA ≤ 0.80				TA > 0.80			
		Degree of liking <sup>a</sup> (1–9)	Acceptance (%)	Neither like nor dislike (%)	Dislike (%)	Degree of liking (1–9)	Acceptance (%)	Neither like nor dislike (%)	Dislike (%)	Degree of liking (1–9)	Acceptance (%)	Neither like nor dislike (%)	Dislike (%)
<14.1	13.4	6.3 <sup>c</sup>	73	9	18	5.7 <sup>c</sup>	58	10	32	5.0 <sup>c</sup>	45	10	45
14.1–15.0	14.7	6.7 <sup>b</sup>	83	3	14	6.1 <sup>bc</sup>	65	6	29	6.1 <sup>b</sup>	63	8	29
15.1–16.0	15.7	6.9 <sup>ab</sup>	83	7	10	6.5 <sup>ab</sup>	77	9	14	6.4 <sup>ab</sup>	79	4	17
16.1–17.0	16.6	7.2 <sup>a</sup>	89	4	7	6.8 <sup>a</sup>	88	5	7	7.4 <sup>a</sup>	88	6	6
>17.0	17.6	7.1 <sup>a</sup>	85	6	9	NA <sup>c</sup>	NA	NA	NA	NA	NA	NA	NA
LSD <sub>0.05</sub>		0.4				0.6				1.0			
P-value		0.0001				0.0031				0.0001			

<sup>a</sup> Degree of liking measured on 9-point hedonic scale (1, dislike extremely; 5, neither like nor dislike; and 9, like extremely).

<sup>b</sup> Same letters within the same column indicate no significant difference between means.

<sup>c</sup> NA, data not available due to an insufficient number of responses.

### 3.2. Chinese consumer test

For the Chinese consumer test, individual 'Redglobe' berry SSC varied from 12.0 to 20.0% and TA ranged from 0.30 to 1.80%. Chinese consumer degree of liking and percentage acceptance of 'Redglobe' table grapes was related to SSC, TA and SSC:TA ratio. Grapes with  $\geq 12.1\%$  SSC were accepted by Chinese consumers but with different degrees of liking (Fig. 1C). Consumer acceptance increased from 45 to 89% depending on SSC (Fig. 1D). Chinese consumers liked 'slightly' grapes within the 12.1–15.0% SSC range (average 50% consumer acceptance); liked 'moderately' grapes within the 15.1 to 17.0% SSC range (average 78% consumer acceptance); and liked 'moderately' to 'very much' grapes within  $> 17.0\%$  SSC range (89% consumer acceptance).

Based on the SSC:TA ratio, Chinese consumers liked 'Redglobe' grapes from 'neither like nor dislike' to 'moderately' (Fig. 2C). Grapes were liked 'moderately' with ratios  $> 25.0$ . Grapes were liked 'slightly' within the SSC:TA ratio range of 20.1–25.0, and neither liked nor disliked when they had SSC:TA ratios  $\leq 20.1$ . Overall, percentage acceptance ranged from 37–91% (Fig. 2D). Only 37% of Chinese consumers accepted 'Redglobe' grapes with a SSC:TA ratio  $< 20.1$  and 42% of Chinese consumers when the grapes had a SSC:TA ratio in the range of 20.1–22.5 (Fig. 2D).

Chinese consumer acceptance decreased as TA increased in the berries although they were always liked; except when the grapes had a TA  $> 0.80\%$  (Fig. 3C and D). 'Redglobe' grapes degree of liking data was divided into three groups according to a statistical means separation (Fig. 3C): grapes with TA  $\leq 0.60\%$  ('moderately'); grapes with TA between 0.61 and  $\leq 0.80\%$  ('slightly'); and grapes with TA  $> 0.80\%$  ('neither like nor dislike'). TA significantly affected consumer acceptance of 'Redglobe' grapes; as TA increased, consumer acceptance decreased from 80 to 25% (Fig. 3D).

SSC and TA affected degree of liking and consumer acceptance the same as for American consumers, so the interaction between different SSC and TA levels on consumer acceptance was stud-

ied. Chinese consumers liked 'Redglobe' grapes with TA  $\leq 0.60\%$  from 'slightly' to 'moderately.' Degree of liking was significantly higher for grapes with  $\geq 16.1\%$  SSC ('moderately') than for grapes with  $< 16.1\%$  ('slightly' to 'moderately'). There were no significant differences between the degrees of liking of grapes at the SSC ranges  $\leq 16.0\%$  (Table 2). Consumer acceptance of grapes with TA  $\leq 0.60\%$  in relation to SSC level ranged from 57 to 88% (Table 2). The percentage of consumers disliking these grapes varied from 13 to 1% while the 'neither like nor dislike' option ranged from 32 to 11% of the consumers (Table 2). Chinese consumers liked 'Redglobe' grapes with TA between 0.60 and  $\leq 0.80\%$  from 'slightly' to 'moderately'. Grapes with SSC  $\geq 16.1\%$  had the highest degree of liking within this TA range. Grapes within the SSC ranges less than 16.1% all had the same degree of liking. Also, grapes in the SSC ranges between 15.1 and 17.0% all had the same degree of liking. The percentage of consumers disliking these grapes varied from 20 to 5%, while the 'neither like nor dislike' option ranged from 36 to 15% of the Chinese consumers (Table 2). Consumer acceptance of grapes with TA between 0.60 and  $\leq 0.80\%$  varied from 45 to 77%. At the same level of SSC, Chinese consumer acceptance of 'Redglobe' grapes was higher with TA  $\leq 0.60\%$  than for grapes within the 0.60 to  $\leq 0.80\%$  TA range (Table 2).

'Redglobe' grapes with  $< 16.1$  SSC were accepted by 70% of the American consumers and 47% of the Chinese consumers. If we use the mean SSC for the SSC range to calculate a SSC:TA ratio of 20 within the three TA levels, American consumer liking and acceptance did not change across TA level. The degree of liking ranged from 6.4 to 6.7 and acceptance from 83 to 79%. In contrast, Chinese consumer acceptance decreased if TA increased with a SSC:TA ratio of 20. The degree of liking varied from 6.2 to 5.0 and acceptance from 57 to 20%.

For both American and Chinese consumers, grapes with  $\leq 16.0\%$  SSC, degree of liking varied according to TA level indicating that consumer acceptance is more sensitive to the SSC:TA ratio than SSC alone. However, for grapes with  $> 16.0\%$  SSC, TA level did not affect acceptance.

Table 2  
Degree of liking and percentage consumer acceptance of 'Redglobe' table grapes by Chinese consumers at different levels of SSC and TA measured as percentage tartaric acid

SSC range (%)	Mean SSC (%)	TA ≤ 0.60			0.60 < TA ≤ 0.80			TA > 0.80					
		Degree of liking <sup>a</sup> (1–9)	Acceptance (%)	Neither like nor dislike (%)	Dislike (%)	Degree of liking (1–9)	Acceptance (%)	Neither like nor dislike (%)	Dislike (%)	Degree of liking (1–9)	Acceptance (%)	Neither like nor dislike (%)	Dislike (%)
<14.1	13.4	6.2 c <sup>b</sup>	57	32	11	5.8 b	45	36	19	4.9	22	50	28
14.1–15.0	14.7	6.5 c	65	22	13	5.7 b	46	34	20	4.8	26	32	42
15.1–16.0	15.7	6.8 bc	76	14	10	6.7 ab	67	28	5	5.0	20	60	20
16.1–17.0	16.6	7.3 ab	82	14	4	7.3 a	77	15	8	NA	NA <sup>c</sup>	NA	NA
>17.0	17.6	7.4 a	88	11	1	NA	NA	NA	NA	NA	NA	NA	NA
LSD <sub>0.05</sub>		0.4				1.1				NS <sup>d</sup>			
P-value		0.0001				0.0042				0.096			

<sup>a</sup> Degree of liking measured on 9-point hedonic scale (1, dislike extremely; 5, neither like nor dislike; and 9, like extremely).

<sup>b</sup> Same letters within the same column indicated no significant difference between means.

<sup>c</sup> NA, data not available due to an insufficient number of responses.

<sup>d</sup> NS, no significant differences.

Changes in consumer acceptance due to TA levels were more sensitive for Chinese than American consumers. For example, Chinese consumers liked 'slightly' to 'moderately' grapes with TA  $\leq$  0.60%, while American consumers liked 'slightly' to 'moderately' grapes with  $\leq$  0.70% TA. Chinese consumers neither liked nor disliked grapes with TA  $>$  0.80% despite their SSC level. Chinese consumers liked 'Redglobe' grapes 'moderately' (score  $\geq$  6.5) when they had  $\geq$  14.1% SSC and  $\leq$  0.60% TA. In the TA range of 0.60 to  $\leq$  0.80%, a SSC of  $\geq$  15.1% was needed to maintain this level of liking (score  $\geq$  6.5). American and Chinese consumers chose the 'neither like nor dislike' option in different ways. American consumers chose the 'neither like nor dislike' option only a few times (average 7%), whereas Chinese consumers chose it frequently (average 34%).

Our data confirmed that 'Redglobe' consumer acceptance is more sensitive to SSC:TA ratio than SSC alone as has been reported for 'Perlette' and 'Thompson Seedless' grown in California and Israel (Nelson et al., 1963, 1972, 1973; Guelf-Reich and Safran, 1971). However, the relationship between consumer acceptance and SSC:TA ratio is highly related to consumer acceptance within a TA or SSC range. For example, 'Redglobe' consumer acceptance for both American and Chinese consumers was not related to SSC:TA ratio when SSC was  $\geq$  16.1%. In spite of the SSC:TA ratio, Chinese consumer acceptance was low for grapes with TA  $>$  0.80%. This is the first report that points out that Chinese consumers are more sensitive to TA than the SSC:TA ratio. Our work also demonstrates the importance to evaluate the 'dislike,' 'like,' and 'neither like nor dislike' options to understand consumer acceptance.

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