Stimulating the Senses

Using the Senses to Evaluate Food Products

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Appendix

Test Form & Diagrams

Triangle Test:
Please taste the samples from left to right. Two of the coded samples are the same and one is different. Identify the odd sample and record your answer.

Duo-Trio Test:
Please taste the samples. Identify which coded sample matches the standard reference. Record your answer.

Ranking Test:
Please rank the samples in numerical order according to your preference or intensity of the flavor characteristic of the product:

Intensity/ Preference	Sample Code
1	_____
2	_____
3	_____
4	_____

Demographic Questionnaire:

Age in years: _____

Gender (circle one): Male Female Declined to state

Smoking status (circle one): Yes No

Do you have any food allergies (circle one): Yes No

If yes, please specify:_____

	Sourness	%		%		%		%
	1	1	2	2	3	3	4	4
cran-orange	0	0	0	0	1	3.33	29	96.67
nutrients added	0	0	0	0	29	96.67	1	3.33
orange mango	5	16.67	25	83.33	0	0	0	0
pulp added	25	83.33	5	16.67	0	0	0	0
	Sweetness	%						
	1	1	2	2	3	3	4	4
cran orange	25	83.33	5	16.67	0	0	0	0
nutrients added	5	16.67	25	83.33	0	0	0	0
orange mango	0	0	0	0	3	10	27	90
pulp added	0	0	0	0	27	90	3	10
	Preference							
	1	1	2	2	3	3	4	4
cran orange	1	3.33	25	83.33	3	10	1	3.33
nutrients added	26	86.67	1	3.33	1	3.33	2	6.67
orange mango	1	3.33	3	10	25	83.33	1	3.33
pulp added	2	6.67	1	3.33	1	3.33	26	86.67

Triangle Test				
	Sample Code	**Frequency Selected**	**%**	
	875	**1**	**3%**	**concentrate**
	431	**2**	**7%**	**concentrate**
	672	**27**	**90%**	**non-from concentrate**
	n=30			

Duo-Trio Test				
n=30				
	Sample Code	Frequency S	%	
Original Formula	297	26	87%	
Nutrients Added	418	4	13%	

Duo-Trio	Standard	Original Formulation
	297	Original Formulation
	418	Nutrients Added

Test	Code	Sample	
Triangle	875	Concentrate	
	431	Concentrate	
	672	Not from concentrate	
Duo-Trio	Standard	Original Formulation	
	297	Original Formulation	
	418	Nutrients Added	
Ranking	945	Cran-Orange	
	273	Nutrients Added	
	414	Orange Mango	
	518	Pulp Added	

Demographics Data

n=30

Age	Frequency	%
20	1	3.33
21	1	3.33
22	1	3.33
23	2	6.66
24	3	10
25	4	13.33
26	6	20
27	4	13.33
28	3	10
29	1	3.33
30-39	2	6.66
40+	2	6.66

Gender	Frequency	%
Male	7	23.33
Female	23	76.66
Declined to state	0	

Allergies	Frequency	%
Yes	2	6.66
No	28	93.33

Smoker	Frequency	%
Yes	0	0
No	100	100

Allergies:
Wheat
Dairy

Abstract

Sensory analysis relies on the senses sight, taste, smell, touch, and hearing to evaluate food products. The purpose of this study is to evaluate beverage products by conducting discriminative analytical tests. At YumYum Foods Sensory Evaluation Sector highly trained panelists (n=30) performed the triangle, duo trio, and the raking test in addition to completing a demographic questionnaire. For the triangle test, 90% of the panelists correctly identified the 'odd' non-from concentrate sample and 87% correctly voted for the original recipe matching for the duo-trio test. The ranking test results viewed panelist sourness, sweetness, and preference. Panelists voted pulp as the most sour (83.3%), cran orange as the most sweet (83.33%), and nutrients added as the most preferred (86.67%).The findings support an increased preference rating based on increased sweetness and decreased sourness.

Background

When determining what products to release to consumer market shelves, food companies follow specific criteria to select and evaluate food quality. Food industries implement various testing methods to measure sensory factors. Testing methods include research and development, product improvement, sales and marketing, quality assurance, nutrient analysis, and contamination detection (Brown 2011).

Furthermore, food is tested subjectively and objectively. Sensory, or subjective analysis is a multidisciplinary science. Sensory analysis relies on the human senses sight, taste, smell, touch, and hearing to measure responses to food products (Brown 2011). Sensory tests are either analytical (effective) or affective (preference or acceptance based). Analytical tests are objectively driven to distinguish food characteristics, whereas affective tests focus on individual or preference-based differences. Analytical (effective) tests are conducted by trained panelists though discriminative or descriptive tests.

Discriminative testing is particularly useful for detecting visible differences. The most common discriminative tests are the triangle, duo-trio, and ranking tests. According to a journal published by Food Research International, “Duo-trio test design ha[s] shown to be effective in improving the discrimination performance by customizing sample preference sequences” (Min 2016). Essentially, two samples are identified and compared to a standard. The objective of their study was to investigate various kinds of test instructions using the preference-reference duo-trio test design. From this study, researchers determined the most preferred preparation of commercial corn soup among 176 consumers divided into 12 tests. They concluded that the presentation of sequences used for duo-trio tests led to reduced error and improved discrimation testing. Another experiment conducted by the Department of Food Science and Technology contrasted the perception of stimuli for salt concentrations of tomato juice at 30, 50, and 70% concentration with duo-trio tests. The test was conducted using 11 female participants ranging from ages 23-26 years old. The study revealed when presenting 3 stimuli the reference

stimuli served as a particularly useful when a low concentration of salt was used in discriminating the two stimuli (Min 2010). The test confirms the duo-trio test is advantageous in terms of distinguishing key characteristics among food.

The triangle test involves tasting three samples from left to right in which one sample is the same and one is different. The objective is to determine which of the two samples is different from the two identical samples presented. In one specific study published by PLOS, 89 children from ages 5 to 12 were asked to discriminate between sugar-sweetened beverages and non-nutritive sweetened beverages. Beverage flavors were lemon, mango, peach, forest fruits given as non-nutritive sweetened (A) and sugar-sweetened beverages (S). Samples were presented as sequences SAA, ASA, AAS, ASS, SAS, and SSA. Results supported 1 in 4 children discriminated against the odd sample of non-nutritive sweeteners and non-nutritive sweeteners; both of which were equally liked. Non-nutritive sweeteners are beneficial because they can be substituted for sugar-sweetened beverages for children (Ruthyer 2016). Overall, triangle tests help indicate detectable differences in existing food products when undergoing reformulation.

Ranking tests present two or more samples which are ranked from high to low depending on specific sensory attributes (flavor, odor, color). A study published by the Journal of Dairy Science evaluated the impact of particles on cheese texture by isolating the particles at 5, 15, and 25% (wt/wt) to smooth cream cheese. The panel consisted of 15 untrained subjects instructed to rank the cheeses based on a scale of 1 (most gritty) to 4 (least gritty). The sample with the 25% (wt/wt) was perceived as the most gritty supporting increased size and amount of particles added increased the perceived grittiness in cheese. In another study done by Nofima Food, 11 trained participants compared reduced sugar and regular sugar in commercial apple juice. The samples were prepared based on the standard commercial concentrate with six total blends of sugar and acid.

The results concluded most of the subjects preferred the sweeter samples (commercial apple juice). Compared to the triangle, and duo-trio tests, raking tests tend to be easier to perform and are more affordable too. In addition, raking tests also reflect independent product preferences amongst several samples by ranking their most notable attributes.

The purpose of this study is for YumYum Foods to evaluate beverage products by conducting analytical tests, specifically discriminative tests involving 30 highly trained participants.

Methods

Environment

Sensory evaluation tests are held at YumYum Foods headquarters in the sensory evaluation sector. In order to properly form sensory evaluation tests among panelists a suitable environment must be established.The sensory area is free distraction, walls neutral, lighting is uniform, and temperature is comfortable. Additionally, the testing room must be noise-free, and odor-free.Testing takes place mid-morning or mid afternoon to ensure testers are not too hungry or full. The beverage samples presented are at room temperature, equally fresh, and with equal amounts of juice per serving.

For the most accurate measurements, a combination of measuring utensils such as graduated cylinders, volumetric flasks, and glass beakers are used. Sampling is presented using clear or white cups to not interfere with panelists' color perceptions. Samples varying in color will be exposed under red light conditions to prevent opinions based on color perceptions. Plain, salt-free crackers and water are provided to avoid taste fatigue among panelists.

Panelists

Panelist information (n=30) is obtained using a demographic questionnaire asking their age in years, gender, smoking status, and food allergies. Age distribution is 60% ranging from ages 20 to 25 and 40% aged 26 to 40 or more years. Males represent 23% of the total

population, thus the remaining 77% are female. Amongst the group, 6% of the population have either a wheat or dairy allergy. All panelist members are considered non-smokers.

Difference Tests

Triangle Test

The Triangle Test is performed to compare the concentrate and the non-concentrate products. There are 3 numerically coded samples, 2 of which are identical juice concentrates, and a single, unique not-from-concentrate juice. Samples are presented and coded labeled as 875, 431, and 672. Samples coded 875 and 431 are the concentrate samples and 672 is the non from concentrate sample. The samples are presented simultaneously to the panelists (n = 30). Panelists are instructed to consume the juices in order from left to right. The panelist guesses which sample is odd and records their answer on their test form.

Duo-Trio Test

The Duo-Trio Test is completed to compare the original recipe from the nutrients added recipe. For the test, the panelist must taste a total of 3 juice samples, two originally formulated and one with added nutrients. The panelists need to determine which of the two coded samples presented as 297 and 418 match the standard. The labeled standard is the original formulation, 297 is also the original formulation, and 418 contains the nutrients added.

Ranking Test

The ranking test is necessary to generate information on new flavor offerings. The samples are ranked in numerical order based on preference and intensity of the flavor or characteristic of the product (sweetness and sourness). There are four coded samples: cran-orange (945), nutrients added (273), orange mango (414), and pulp added (273). Each is presented and compared to one another coded as samples 945, 273, 414, and 518. Panelists

score (1) preference on a 4-point hedonic scale, that is, 1 being the most preferred and 4, being the least preferred. The same scale of measure was used for sweetness and sourness.

Statistical Analysis

YumYum Foods scientists performed statistical analysis of results from the 30 trained panelists.The data was obtained and compiled into an excel spreadsheet and expressed as percentages. Percentages were calculated for each of the sensory evaluation tests: triangle, duo-trio, and ranking tests as well as from demographic questionnaires.

Results

Triangle Test

In the triangle test, samples coded 875 and 431 are the concentrate samples and 672 was the not-from concentrate sample. 90% of the panelists correctly identified the ‘odd’ non-from concentrate sample and 3% of panelists chose concentrate sample 875. Another 7% also voted the other concentrate sample (sample 431) as the odd sample. Below is a pictorial illustration of the values obtained from the triangle test.

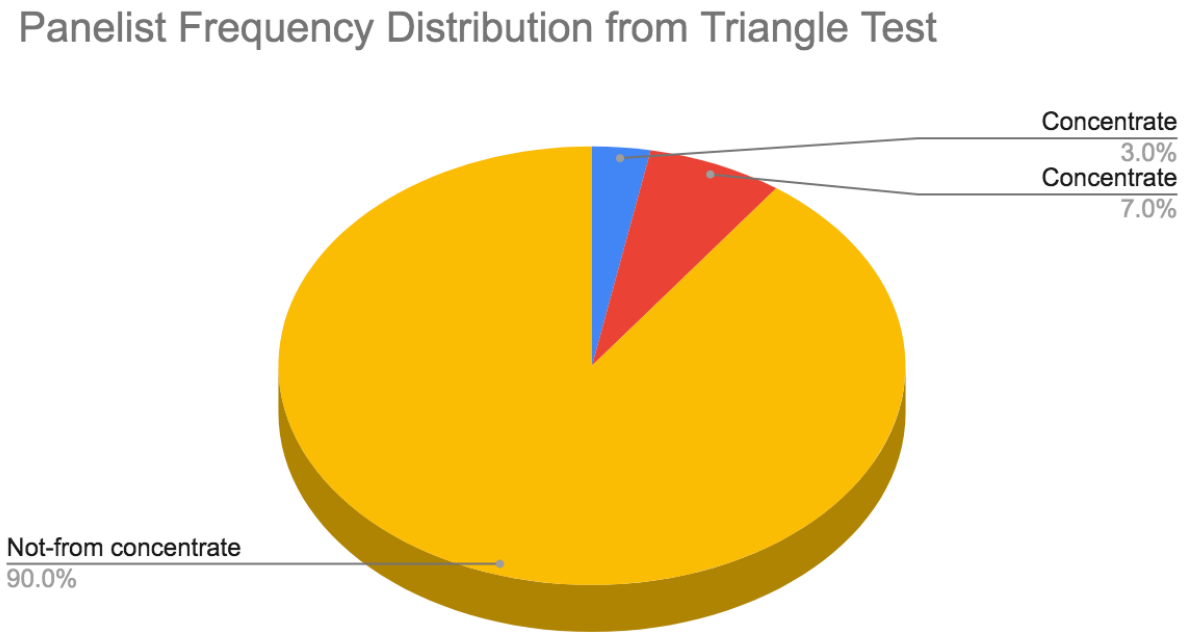
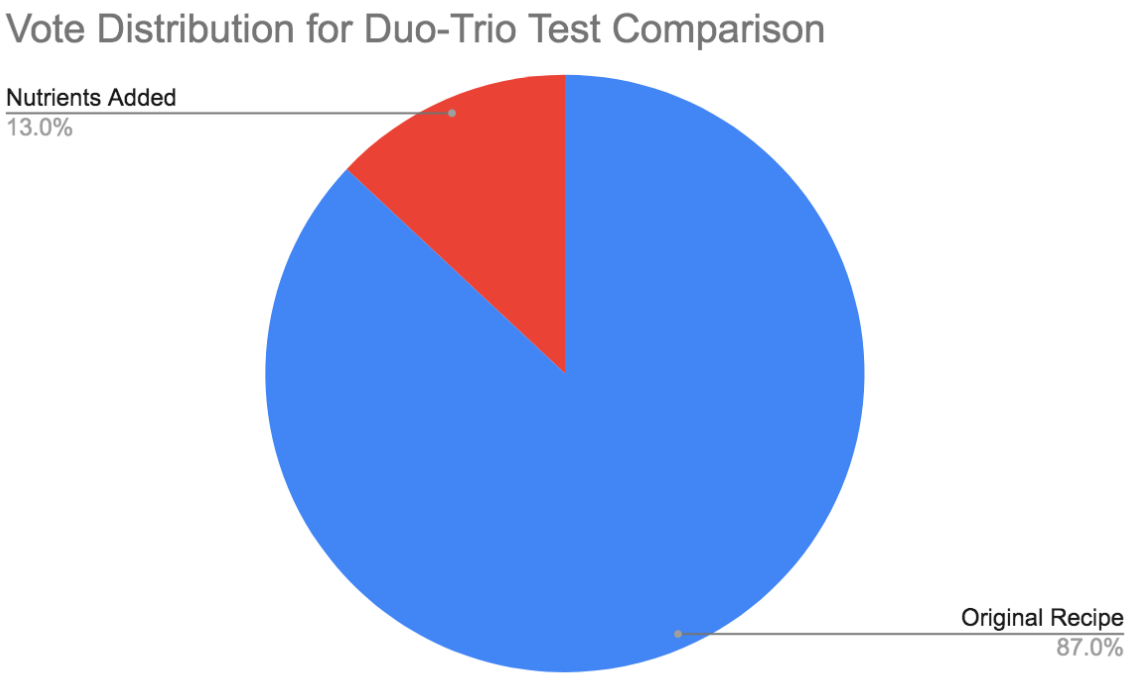


Figure 1: Panelists who chose the non-from concentrate sample correctly identified the odd sample

Duo-Trio Test

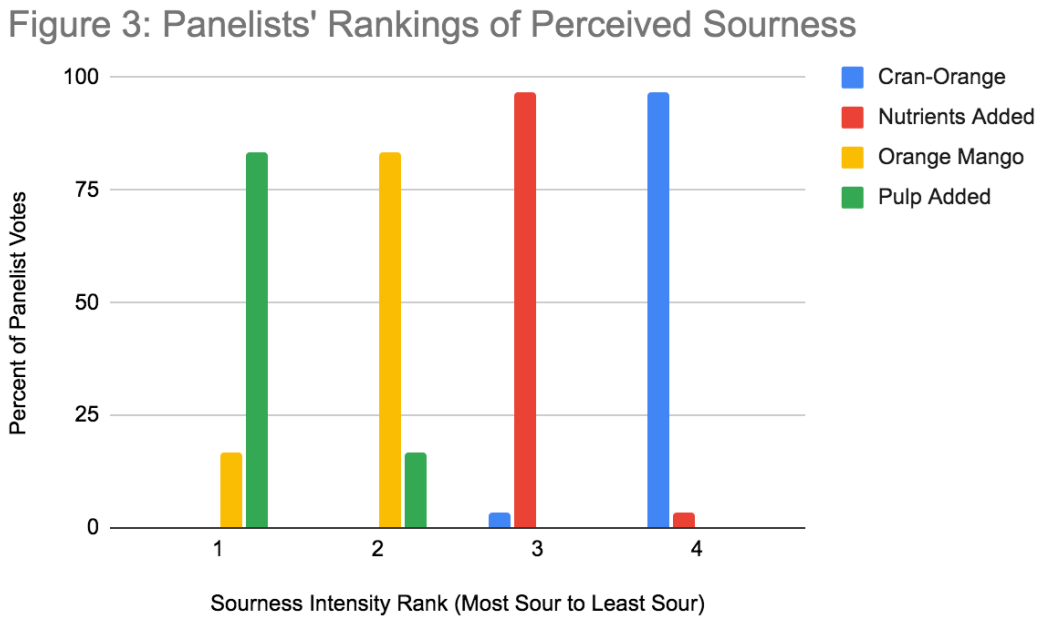
In the duo-trio test, sample 297 matched the standard containing the original formula of juice. However, sample coded 418 was the nutrients added recipe. Figure 1 below illustrates among the 30 trained panelists who performed the duo-trio test 87% correctly voted for the original recipe that matched the standard and 13% incorrectly identified the nutrients added recipe as the standard recipe.

Fig 2: Votes for Original Recipe represent correct identification of the standard recipe.



Raking Tests

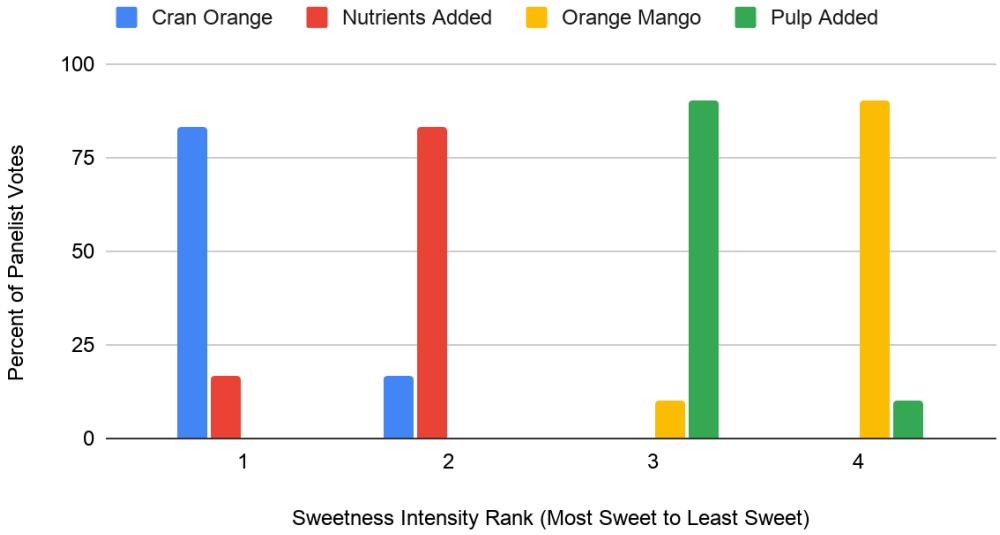
The ranking test results viewed panelist sourness, sweetness, and overall preference of orange juices. Figure 3 represents panelists' rankings of perceived sourness of cran-orange, nutrients added, orange mango, and pulp added. Eighty-three point three percent of panelists ranked the pulp added recipe as the most sour. The second highest ranked in sourness was orange mango (83.33%). Ninety-six point seven percent of votes rated nutrients added recipe



as less sour than the pulp added and orange mango. The fourth ranked juice, cran orange (96.67%) was perceived as the least sour.

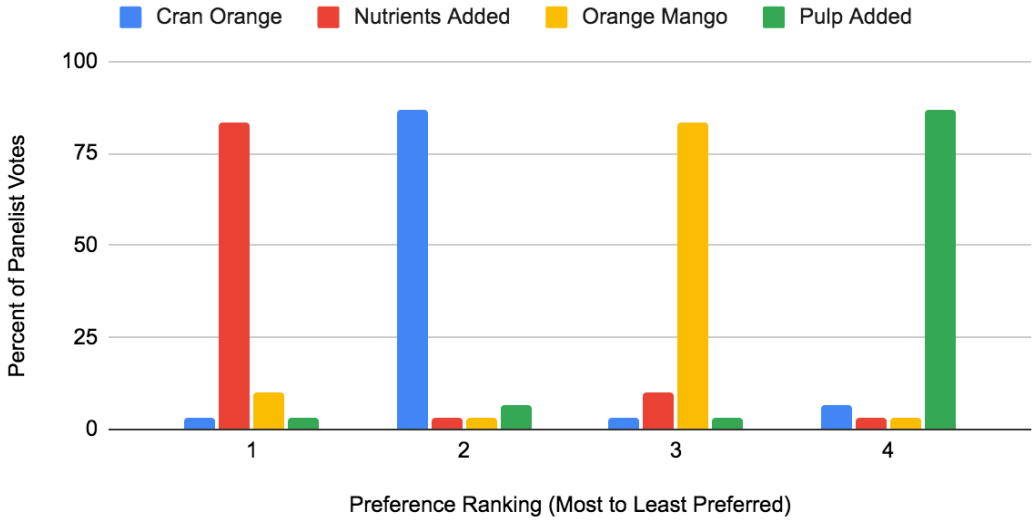
When panelists ranked which samples were the most sweet in figure 4, 83.33% of panelists voted cran orange as the most sweet. Nutrients added ranked 2nd sweetest (83.33%) and pulp added as 3rd most sweet (90%). Orange mango was ranked the least sweet (90% vote).

Figure 4: Panelists' Rankings of Perceived Sweetness



At the final stage of rank testing panelists determined which of the 4 samples they preferred the most as seen in figure 5. The most preferred orange juice (rank 1) was the nutrients added recipe (86.67%). Second ranked was the cran orange (83.33%). The less preferred juice, ranked 3rd was orange mango (83.33%). The fourth ranked juice, or least preferred was the pulp added juice (86.67%).

Figure 5: Panelists Rank of Preference for Various Orange Juices



Discussion

The results of each of the performed tests; triangle, duo trio, and ranking tests were observed to determine if YumYum Foods can proceed to make product changes. One of their proposed changes was to create a high end, not from concentrate juice option that could be sold in a glass bottle at a higher price. Based on the panelist ratings conducted from the triangle test, there is a distinguishable difference that can be identified when comparing a concentrate from a not-from-concentrate juice. If 90% of panelists correctly identified the not from concentrate sample, then it would make sense to invest in non from concentrate juice if consumers could taste the difference. As stated in the literature, these results support the duo-trio test effectively improved discrimination among the concentrate from the not from concentrate juices and reduced error. However, error was not completely eliminated; 13% of panelists chose the nutrients added to match with the standard.

The second task of the sensory lab was to reformulate the original recipe with added nutrients calcium, Vitamin D, and Vitamin B12 to market towards parents and health conscious individuals. The duo-trio test supported adding nutrients would in fact result in a notable

difference. Eighty-seven percent of participants were able to correctly identify the original recipe as the standard recipe. However, panelists ranked the nutrients added as the most preferred orange juice. Similarly to duo-trio tests conducted with sugar-sweetened and non-nutritive sweetened beverages, although the subjects were able to differentiate the two samples the healthier alternative was liked as much as the original. An explanation may be due to increased perceived sweetness, the nutrients added were ranked the second most sweet. It was also raked less sour on the sourness intensity scale (ranked 3rd).

The final proposed task was to add additional flavor offerings such as cran-orange, extra pulp, and orange mango. The ranking test assisted in determining which potential flavorings could be offered based on sourness, sweetness, and preference. For the panelist ranking test cran orange was voted as the most preferred beverage followed by orange mango, and extra pulp. The rankings illustrate a trend of increased preference ratings based on increased sweetness and decreased sourness. The graph for figure 3 shows cran orange, the highest ranked prefered beverage also ranked as the sweetest beverage and the lowest ranked in sourness. These results could possibly indicate increased sweetness and decreased sourness is attributed to an increased preference for a particular food or beverage.

The Journal of Dairy Science had a similar trend, particle size and shape was associated with perceived grittiness in cream cheese. Thus, ranking tests assist in navigating specific product preferences based on specific sensory attributes (sweetness and sourness). The findings are in agreement with Nofima Food study regarding that most of the subjects preferred the sweetest sample of juice. The preference for the beverage increased as the sourness decreased. According to their findings, sucrose suppresses the sourness of citric acid.

Factors that might have contributed to error could’ve been a result of samples not being served in a randomized enough order. Beverage samples also might’ve not been served at room temperature. If panelists did not eat their salted crackers and or water in between tasting

samples it would've resulted in taste fatigue, thus causing the panelists to give inaccurate votes.

Limitations may be due to the amount of panelists able to participate in the study. In addition to the limited amount of sensory tests that were performed. In the future, it would be recommended that more subjects are used for testing as well as including more types of sensory tests.

In conclusion, YumYum Foods can proceed with creating changes in their orange juice sector. These changes are the following: adding nutrients to their original formula, a not-from-concentrate juice option, and including new flavors, specifically, cran orange. The findings support an increased preference rating based on increased sweetness and decreased sourness.

Citations

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