Consumer-based Optimization of Juice Blends Using the ABCD Mixture Design Model

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Objectives

- **Objective 1:** Utilize a mixture design model to **optimize** a blackberry, blueberry, and Concord juice blend
- **Objective 2:** Assess how health information impacts purchase intent

Justification

- Blackberry and blueberry juice are especially rich in anthocyanins but lack the natural sweetness needed to appeal to consumers. **Blending** naturally sweet Concord with berries enhances sensory quality.

- Consumers may derive **utility from potential health benefits**, and this should be considered when measuring liking and purchase intent.

Blackberries, Blueberries, and Concord Grapes: Sources of Anthocyanins

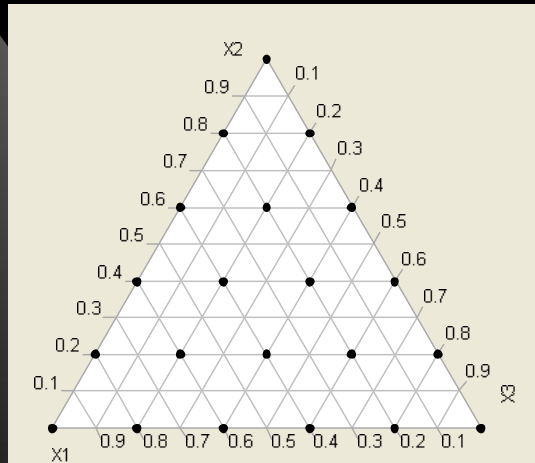Antimutagenic

Promote heart health

Promote brain health
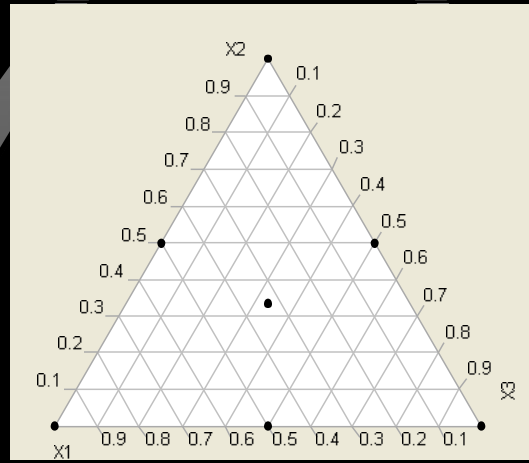
Anticarcinogenic

Antioxidant

Explanation of Mixtures

- Components of the experiment represented by their relative proportions
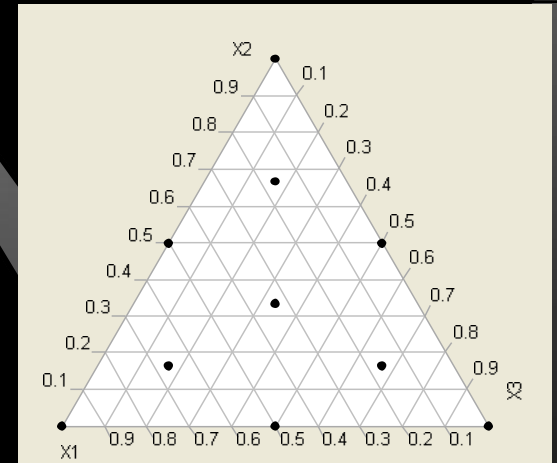 - Sum of all components' proportions must equal one

Simplex Lattice

Simplex Centroid

ABCD Design

Study Structure

Step 1: Consumer Study
Panelists: 108
Location: University of Arkansas Sensory Service Center
Samples: 10 total (5/day)
Software: JMP 8.0

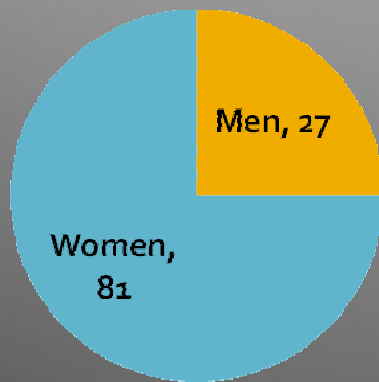**Step 2: Validation Study**
Panelists: 78
Location: University of Arkansas Sensory Service Center
Samples: 7 total
Software: JMP 8.0

Panel Demographics for Step 1

Gender

Men, 27
Women, 81

Education

Graduate school	25
4-yr college degree	45
2-yr college degree	4
Some College	23
High School	11

0   10   20   30   40   50

Income

$90,000 or more	11
$60,000-$89,999	25
$30,000-$59,999	36
$29,999 or less	36

0   5   10   15   20   25   30   35   40
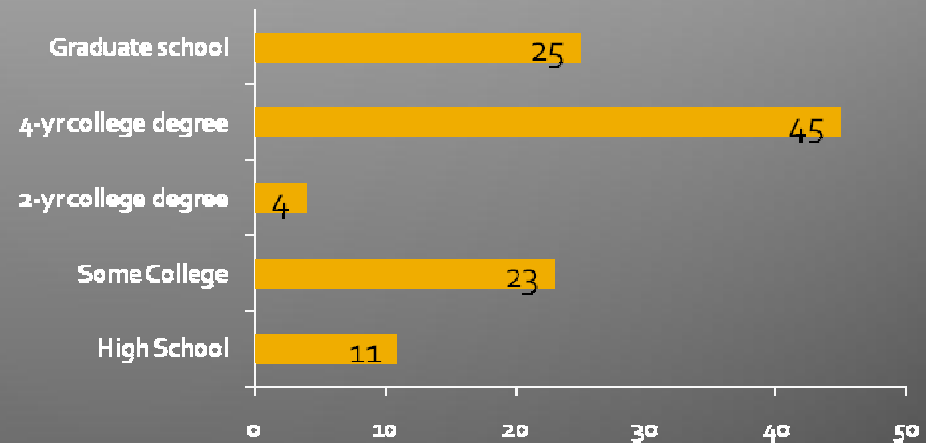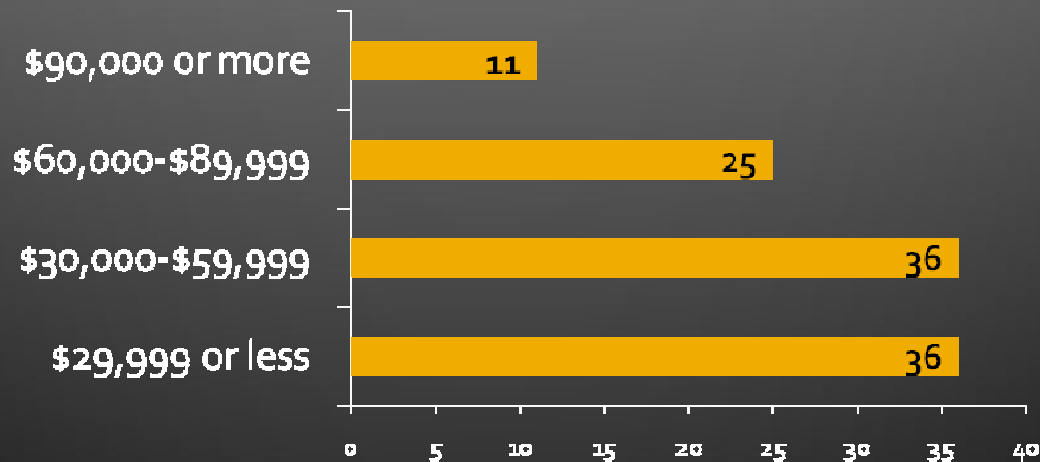
Panel Demographics for Step 2

Gender

Male, 17

Female, 61

Education

Graduate school	20
4-yr College Degree	36
Some college	13
High school	9

0 5 10 15 20 25 30 35 40

Income

$90,000 or more	7
$60,000-$89,999	18
$30,000-$59,999	26
$29,999 or less	27

0 5 10 15 20 25 30
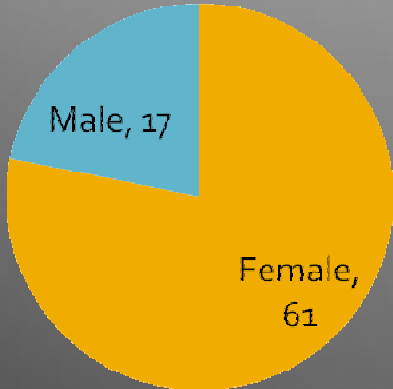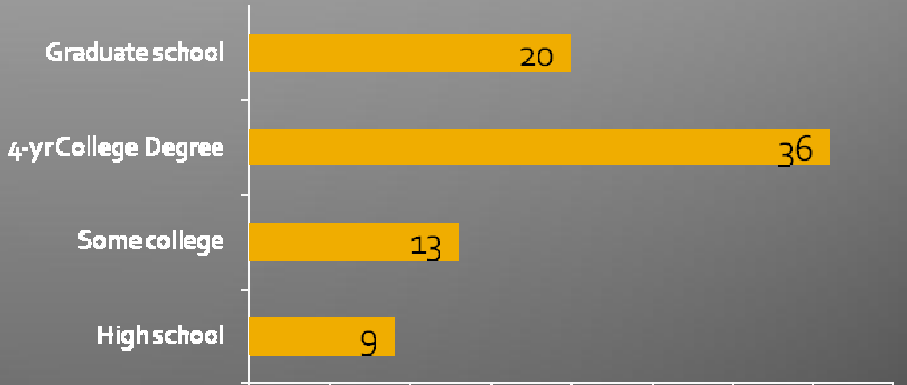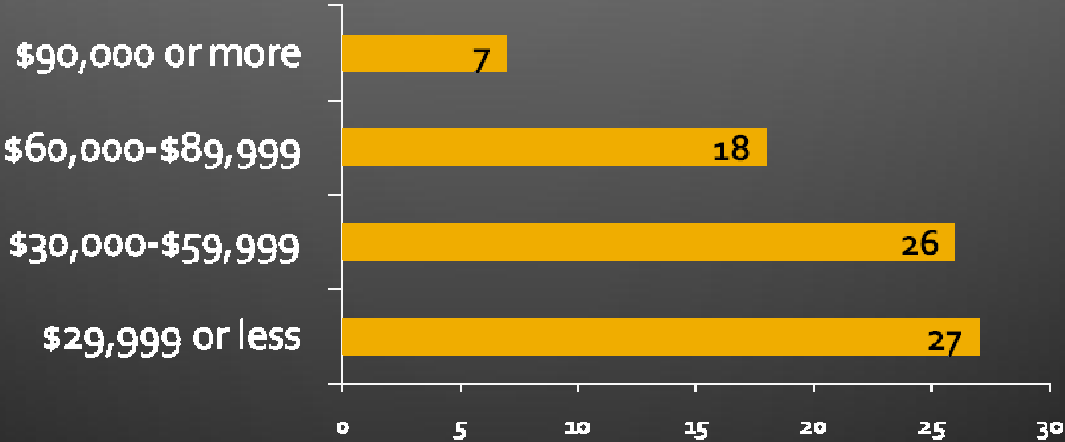
The Mixture Design
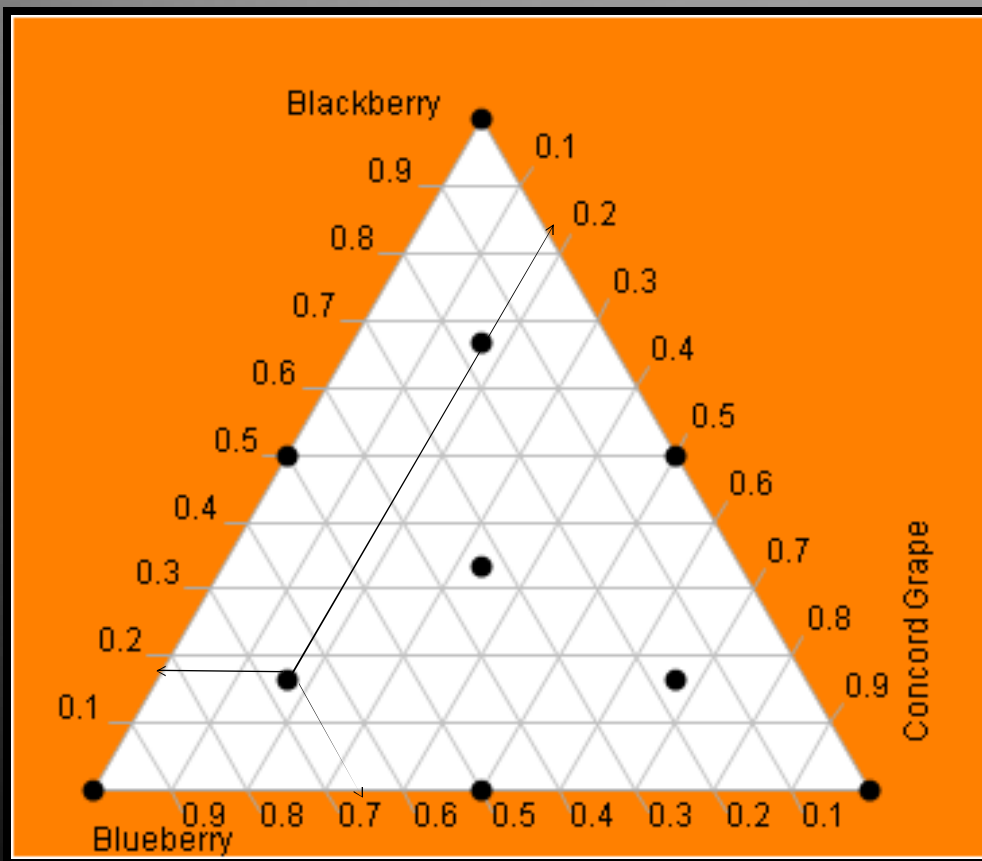
Treatments	Blueberry (Blk)	Blackberry (Blu)	Concord (Con)
1	1/6	1/6	2/3
2	Blueberry		
3	1/2	1/2	0
4	2/3	1/6	1/6
5	1/3	1/3	1/3
6	0	1/2	1/2
7	Blackberry		
8	1/6	2/3	1/6
9	1/2	0	1/2
10	Concord		

Initial Study Means

Blending Treatment	Overall Impression Mean	Significant Differences
1/1 Con	7.79	A
1/6 Blu,1/6 Blk,2/3 Con	7.74	A
1/2 Blu, 1/2 Con	7.16	AB
1/2 Blk, 1/2 Con	6.92	B
1/3 Blu, 1/3 Blk, 1/3 Con	6.67	BC
2/3 Blu, 1/6 Blk, 1/6 Con	6	CD
1/1 Blu	5.47	D
1/6 Blu, 2/3 Blk, 1/6 Con	4.35	E
1/2 Blu, 1/2 Blk	4.06	E
1/1 Blk	2.95	F

Optimization Technique 1: The Visual Layering Method using Consumer Hedonic Scores
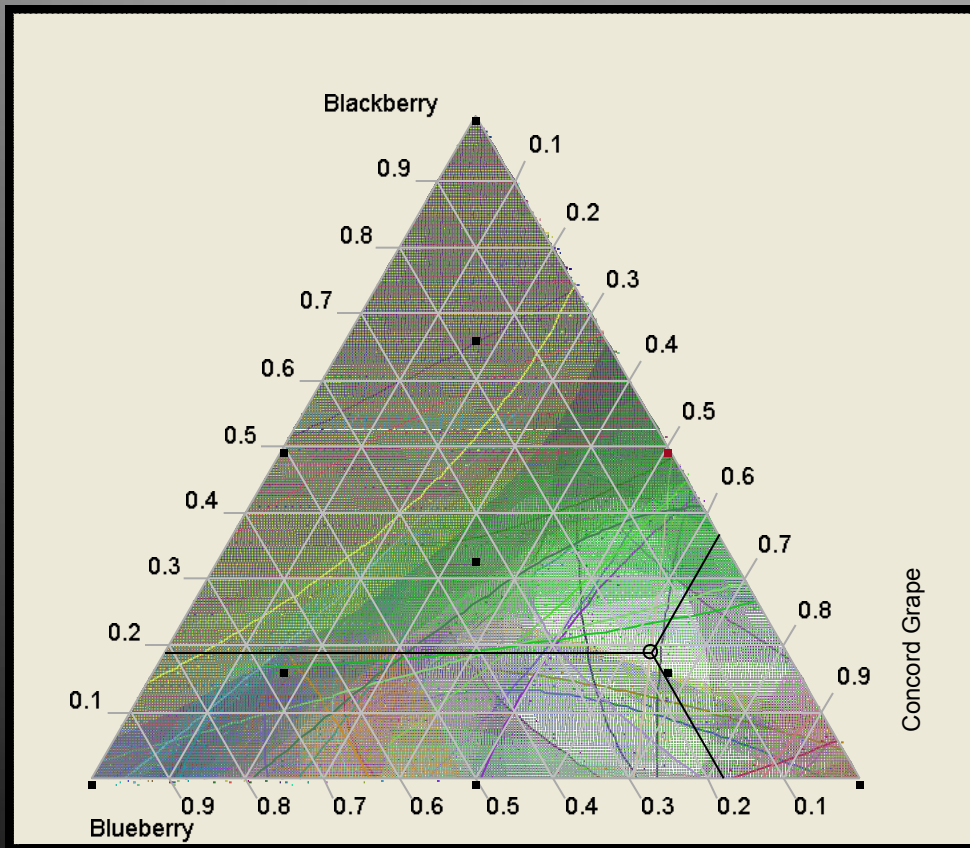
Sample	Panelist 1	Panelist 2
1/1 Blk	1	1
1/1 Blu	6	3
1/1 Con	7	9
1/2 Blk, 1/2 Con	7	7
1/2 Blu, 1/2 Blk	2	3
1/2 Blu, 1/2 Con	6	8
1/6 Blu, 2/3 Blk, 1/6 Con	8	6
1/6 Blu,1/6 Blk,2/3 Con	4	2
2/3 Blu, 1/6 Blk, 1/6 Con	9	8
1/3 Blu, 1/3 Blk, 1/3 Con	6	1

Solution: Blackberry 0.19 + Blueberry 0.18 + Concord 0.63

Optimization Technique 2: Minimizing Distance from Ideal through Attribute Intensity Scores
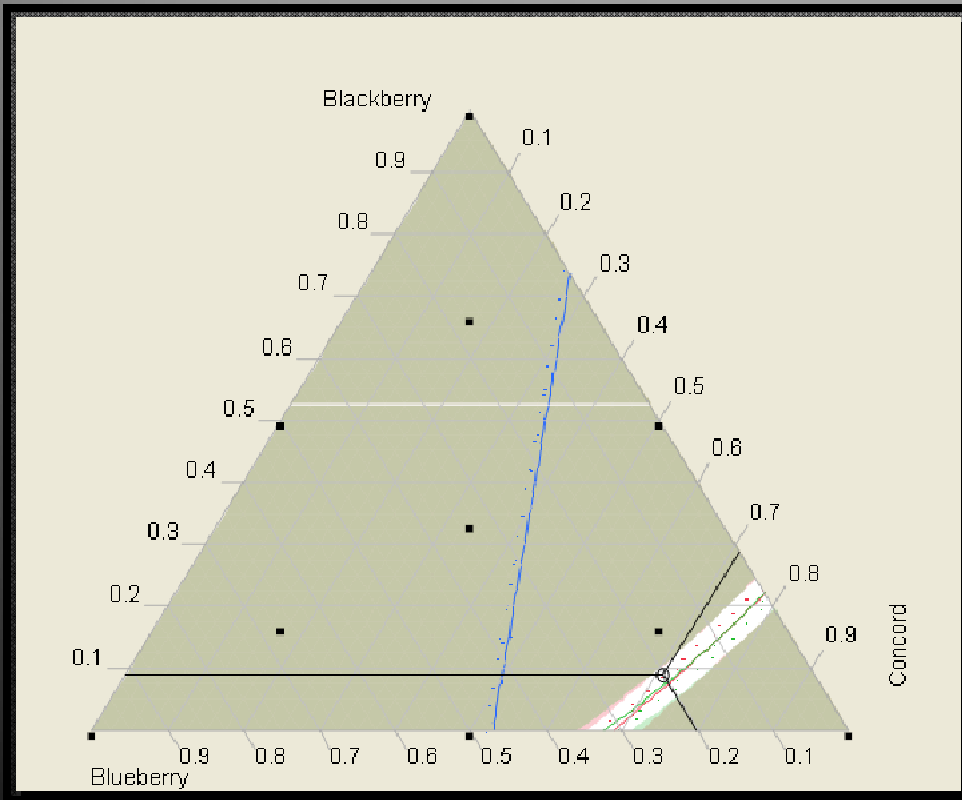
How sour is *this* fruit juice?

_____

not at all   extremely
   sour   sour

How sour is your *ideal* fruit juice?

_____

not at all   extremely
   sour   sour

Solution: Blackberry 0.09 + Blueberry 0.20 + Concord 0.71

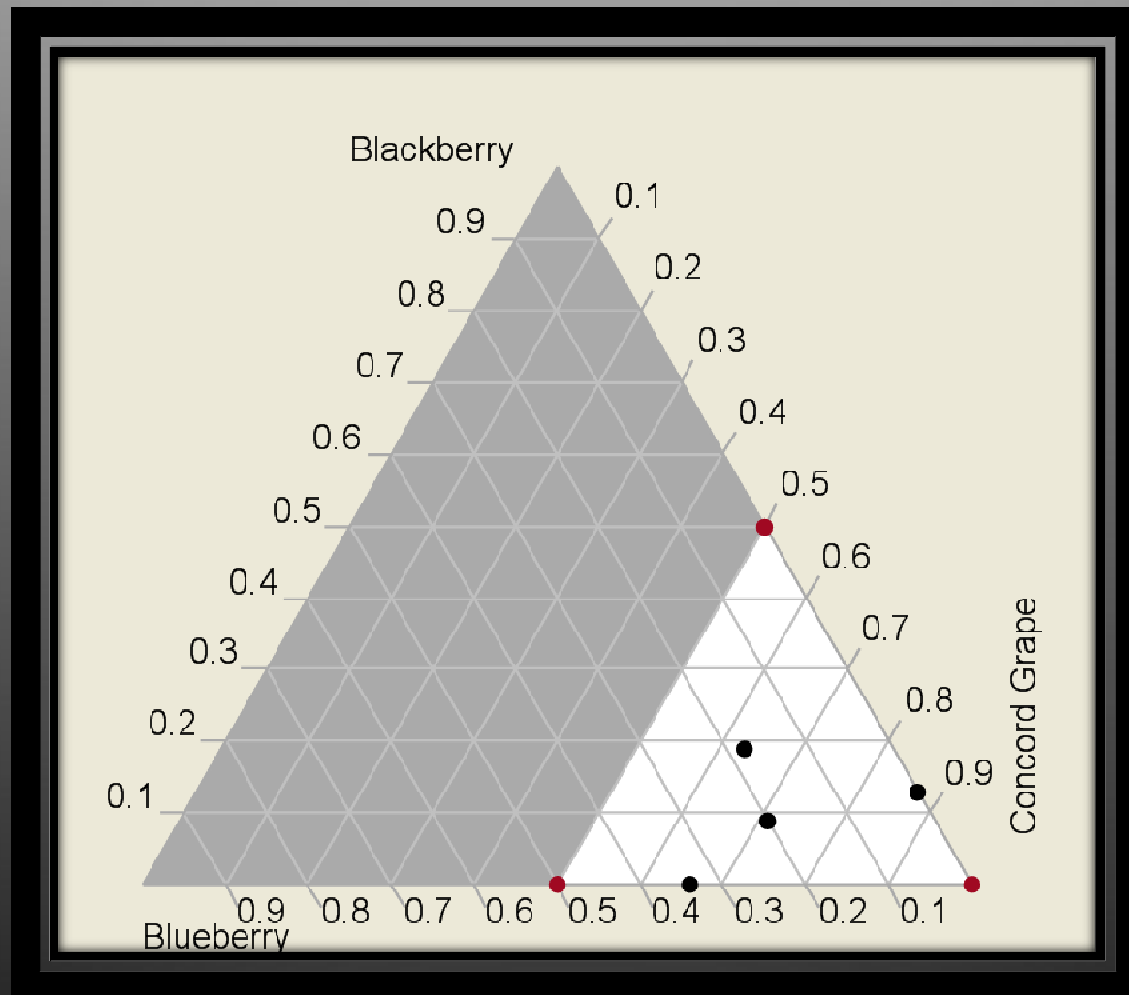# Optimization Technique 3: Maximize Desirability
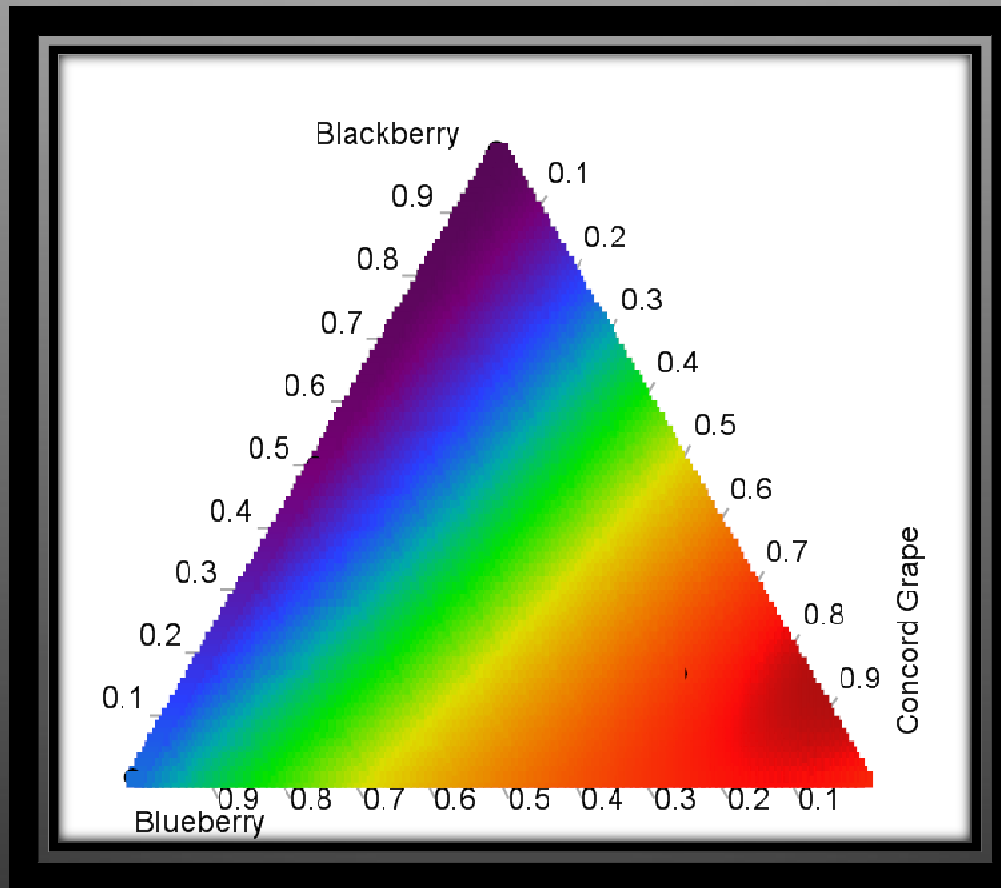
Solution: Blackberry 0.13 + Blueberry 0 + Concord 0.87

Optimization Technique 4: Intuition

Solution: Blackberry 0 + Blueberry 0.34 + Concord 0.66

Validation of the Juice Blend Optimizations

Introduction to Study

Today, you will be asked to sample several fruit juices. These juices may contain blends of blackberry, blueberry, and Concord grape juice.

All of these juices are high in anthocyanins and show promise in helping to maintain human health. The anthocyanin content of pure Concord grape juice is 159 mg/kg, the anthocyanin content of pure blackberry juice is 480 mg/kg, and the anthocyanin content of pure blueberry juice is 628 mg/kg.

We are interested in your honest opinions about these juices. There are no right or wrong answers.

Validation Study Results

Method for solution obtained	Blackberry	Blueberry	Concord	Overall Impression Mean	Significant Differences*
Maximize Desirability	0.13	0	0.87	**7.51**	**A**
Optima Framer	0	0	1	**7.33**	**A**
Minimize Distance from Ideal	0.09	0.2	0.71	**6.95**	**AB**
Intuitive Optimum	0	0.34	0.66	**6.9**	**AB**
Consumer Hedonic Scores: The Visual Layering Method	0.19	0.18	0.63	**6.55**	**B**
Optima Framer	0	0.5	0.5	**6.31**	**B**
Optima Framer	0.5	0	0.5	**5**	**C**

Informed Purchase Intent

1. Considering only the **flavor** of this product, how likely would you be to purchase it…?

Definitely would not buy	Probably would not buy	May or may not buy	Probably would buy	Definitely would buy

Initial Purchase Intent Results

Method for solution obtained	Black-berry	Blue-berry	Con-cord	Ranking (anthocyanin content)	Mean Purchase Intent for Flavor	Significant Differences
Maximize Desirability	0.13	0	0.87	6	**3.95**	**A**
Optima Framer	0	0	1	7	**3.87**	**AB**
Intuitive Optimum	0	0.34	0.66	3	**3.63**	**BC**
Minimize Distance from Ideal	0.09	0.2	0.71	5	**3.59**	**C**
Consumer Hedonic Scores: The Visual Layering Method	0.19	0.18	0.63	4	**3.38**	**CD**
Optima Framer	0	0.5	0.5	1	**3.21**	**D**
Optima Framer	0.5	0	0.5	2	**2.23**	**E**

Informed Purchase Intent

2. During this taste test, you are tasting juice blends that contain blueberry, blackberry, and/or Concord grape juice. Dark purple fruits such as Concord grapes, blueberries, and blackberries have been shown to contain anthocyanins. Anthocyanins are antioxidants, which have been shown to promote better eyesight, protect against declines in age-related brain function, and prevent lipid oxidation that can lead to clogged arteries.

The anthocyanin content in your current sample is ____ of all the samples you will see today. Considering the **anthocyanin content** and the **flavor** of this sample, how likely would you be to purchase this product…?

Definitely would not buy	Probably would not buy	May or may not buy	Probably would buy	Definitely would buy

Informed Purchase Intent Results

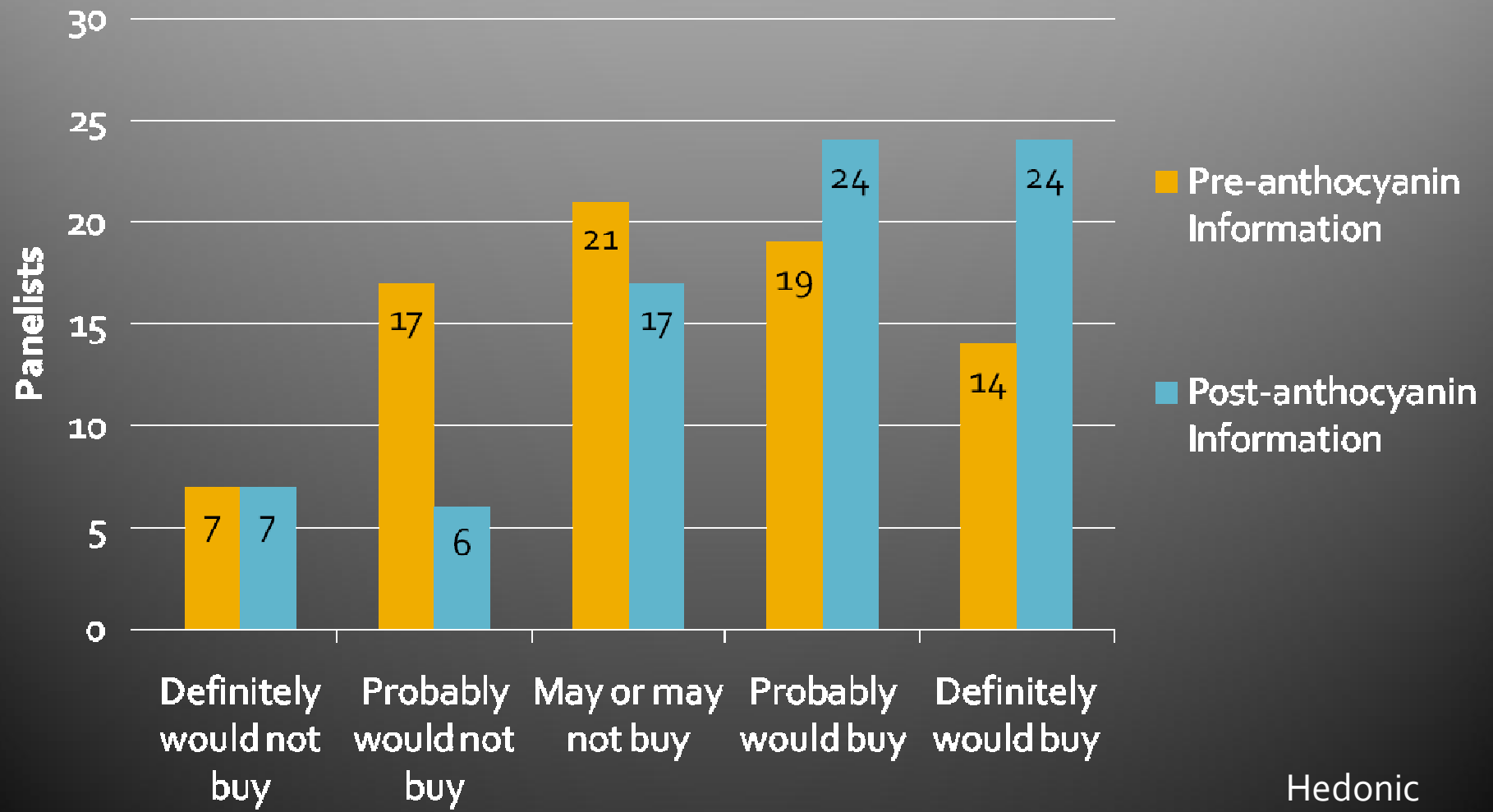| Method for solution obtained	Blackberry	Blueberry	Concord	Ranking (anthocyanin content)	Purchase Intent for Flavor and Anthocyanin Information	Significant Differences
Intuitive Optimum	0	0.34	0.66	3	**3.76**	**A**
Optima Framer	0	0.5	0.5	1	**3.67**	**AB**
Maximize Desirability	0.13	0	0.87	6	**3.65**	**AB**
Minimize Distance from Ideal	0.09	0.2	0.71	5	**3.49**	**BC**
Optima Framer	0	0	1	7	**3.38**	**C**
Consumer Hedonic Scores: The Visual Layering Method	0.19	0.18	0.63	4	**3.30**	**C**
Optima Framer	0.5	0	0.5	2	**2.55**	**D**

Changes in Purchase Intent

Method for solution obtained	Black-berry	Blue-berry	Con-cord	Ranking (anthocyanin content)	Anthocyanin Content (mg/kg)	Purchase Intent Significance
Optima Framer	0	0.5	0.5	1	393	**Shift upward**
Optima Framer	0.5	0	0.5	2	320	**Shift upward**
Intuitive Optimum	0	0.34	0.66	3	318	**Shift upward**
Hedonic Scores: Visual Layering	0.19	0.18	0.63	4	304	**Not significant**
Minimize Distance from Ideal	0.09	0.2	0.71	5	282	**Not significant**
Maximize Desirability	0.13	0	0.87	6	202	**Shift downward**
Optima Framer	0	0	1	7	159	**Shift downward**

Changes in Purchase Intent

Method for solution obtained	Blackberry	Blueberry	Concord	Purchase Intent for Flavor	Purchase Intent for Flavor and Anthocyanin Information	Change	Significance
Intuitive Optimum	0	0.34	0.66	3.63	3.76	0.13	**Significant**
Optima Framer	0	0.5	0.5	3.21	3.67	0.46	**Significant**
Maximize Desirability	0.13	0	0.87	3.95	3.65	-0.29	**Significant**
Minimize Distance from Ideal	0.09	0.2	0.71	3.59	3.49	-0.10	**Not significant**
Optima Framer	0	0	1	3.87	3.38	-0.49	**Significant**
Consumer Hedonic Scores: The Visual Layering Method	0.19	0.18	0.63	3.38	3.30	-0.08	**Not significant**
Optima Framer	0.5	0	0.5	2.23	2.55	0.32	**Significant**

Purchase Intent for ½ Blueberry + ½ Concord

Hedonic Mean: 6.31

Conclusions

- **Conclusion 1:** Predominantly Concord blends are the most sensorially acceptable.
- **Conclusion 2:** When given information about anthocyanin content, consumers are more likely to purchase juice blends high in anthocyanins.

Questions?

Descriptive Analysis