Optimizing consumer acceptance of Lucuma ice cream based on health perception segments using DOE

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Introduction

- As companies expand their product portfolio, they often encounter a more diverse set of customers due to factors such as geographic reach, product diversification, and market penetration. Differences in consumer behavior are linked to their taste preferences, and companies must consider if a one-product-fits-all approach is the most appropriate way to move forward.
- Segmenting the consumer base, provides a way to organize consumers into more precise categories, enabling companies to gain deeper insights and develop products according to the distinct requirements of each consumer group.

Objective

To design lucuma ice cream formulations [based on Lucuma fruit powder (LFP)], starting from the sensory preferences of health conscious and indulgent consumer segments using an optimization technique with an optimal mixture design approach.

Material and methods

- LFP, milk fat, and sucrose were chosen as independent variables, other ice cream formulation ingredients served as base material. LFP (range 1.5% to 7.0%), milk fat and sucrose (range 6.0% to 13.0%) were used in the liquid mix (wt./wt.) of the ice cream formulation.
- Optimal mixture design using Statease 360 software determined a total of 11 lucuma ice cream formulations.
- A CLT with (n=104) respondents from the Kansas City area was conducted over two days using a complete balanced randomized design. Consumers were segmented into health-conscious (n=53) and indulgent (n=51) groups using k-means.
- Consumers psychographic data from the health and taste attitudinal scale (HTAS) was used for clustering.

Analysis

- Hedonic scores were analyzed using the Scheffe's linear mixture model to predict the optimal levels of ingredients in the formulations for each consumer segment.
- Desirability function analysis (DFA) is utilized for the simultaneous optimization of lucuma ice cream. The desirability values ranged (0 to 1), zero means no desirability, and 1 indicates the highest possible desirability within the set constraints.

Results

- Formulations were significantly different on overall and texture liking at α=0.05.
- Regression analysis R^2=0.96 for both overall liking and texture liking for health-conscious segment, and R^2=0.97 (overall liking) and R^2=0.95 (texture liking) for indulgent segment suggests that the independent variables LFP, milk fat, and sucrose collectively account for a large variation.
- Contour plots illustrates the distribution of overall liking and texture liking of both segments, showing the formulations with the highest predicted likeability scores in red followed by other colors indicating varying levels of response.

Maximum Likability for Optimized Formulation

Predicted Optimal lucuma Ice cream formulation: 1.5% LFP 13% Sucrose 6% Fat	Predicted score for Overall Liking	Predicted score for Texture Liking
Health-conscious consumer segment	**7.6**	**8.0**
Indulgent consumer segment	**7.1**	**7.6**

Ideal Formulations for each Segment

Predicted Optimal lucuma Ice cream formulation:	Predicted score for Overall Liking	Predicted score for Texture Liking
Health-conscious consumer segment 2.5% LFP 11.4% Sucrose 6% Fat	**7.0**	**7.4**
Indulgent consumer segment 1.7% LFP 12.3% Sucrose 6% Fat	**6.9**	**7.5**

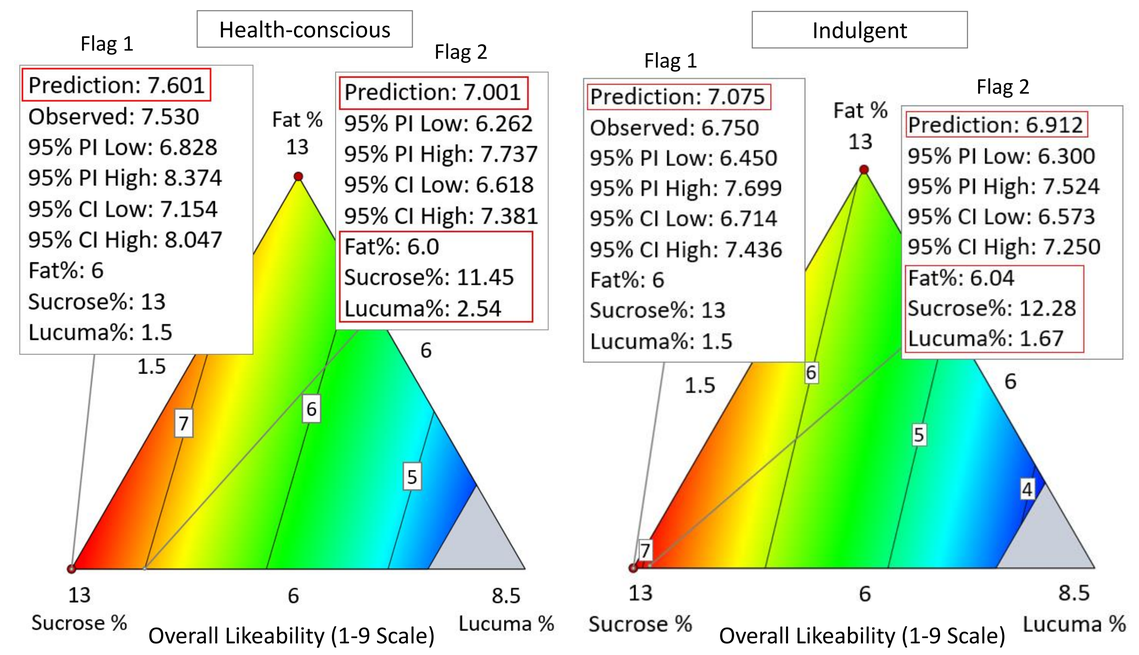
Design Formulas

Codes	Fat (%)	Sucr. (%)	LFP (%)
LIC-1	6.0	13.0	1.5
LIC-2	10.3	9.9	1.5
LIC-3	13.0	6.0	1.5
LIC-4	12.7	12.8	1.5
LIC-5	7.4	9.6	3.0
LIC-6	13.0	7.4	4.0
LIC-7	9.4	6.6	4.0
LIC-8	9.3	10.3	4.2
LIC-9	6.0	7.9	6.1
LIC-10	12.5	7.8	6.7
LIC-11	10.0	6.0	7.0

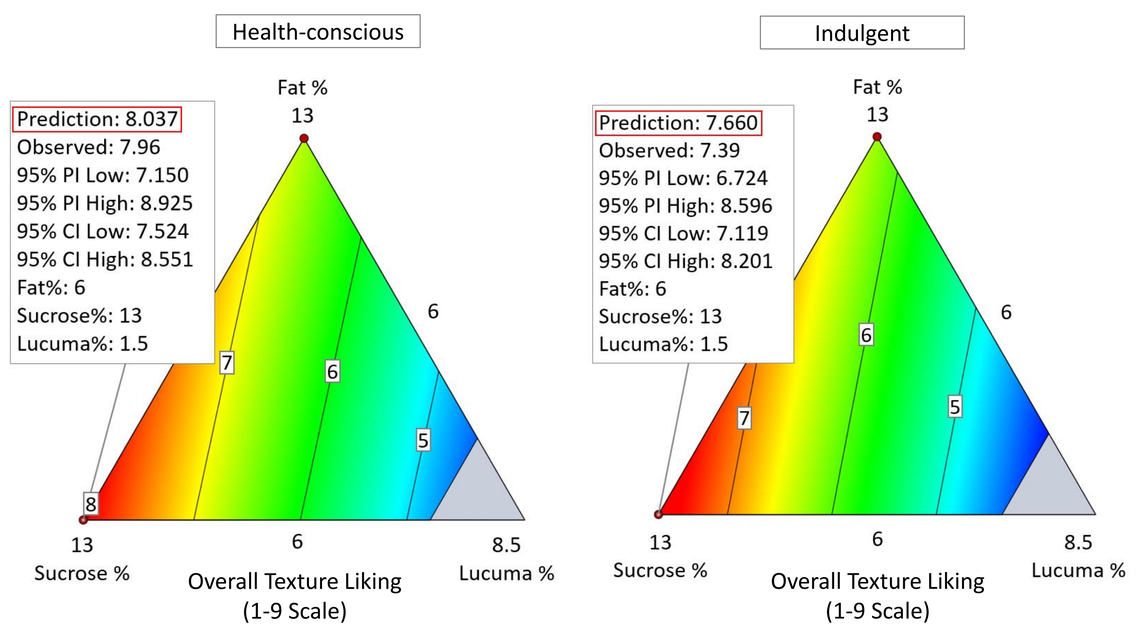
Sucr.- Sucrose, LFP*- Lucuma Fruit Powder*

Lucuma Ice Cream Samples

Overall Liking : Health-conscious vs Indulgent consumers



Texture Liking : Health-conscious vs Indulgent consumers



Conclusion

- ✓ This study leveraged psychographic segmentation and sensory optimization to develop optimized lucuma ice cream formulations, catering to the unique preferences of health-conscious and indulgent consumer segments.
- ✓ Health-conscious consumers had a strong preference for lucuma ice cream, highlighting the importance of segment-specific product development. Notably, this segment was more receptive to higher levels of lucuma fruit powder in the ice cream compared to the indulgent segment.
- ✓ No significant difference in overall liking was observed between high-fat and low-fat lucuma ice cream prototypes, indicating that lucuma fruit powder can facilitate fat reduction without compromising consumer acceptance.