The role of temporality and label on Consumer Acceptance of Natural Sweetener Blends in Protein Beverages



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ABSTRACT

Consumer interest in naturally sweetened protein beverages has increased in recent years. Each sweetener has unique flavor characteristics that can influence beverage sensory properties and consumer acceptability. Previous work established sensory profiles of natural, non-nutritive sweeteners in ready-to-mix (RTM) vanilla-flavored whey protein beverages using Time Intensity (TI), Temporal Dominance of Sensations (TDS), and Temporal Check all that Apply (TCATA). Based on these results, sweetener blends were formulated to more closely match the temporality of sucrose sweetened protein beverages. The objective of this study was to document the temporal profiles of natural non-nutritive sweetener blends in vanilla RTM protein beverages and consumer response with and without priming. Protein beverages (RTM, 25 g protein / 12 oz. serving in water) were sweetened with natural sweetener blends from stevia leaf extract, monk fruit extract, and crystalline fructose. Sweetener amounts were determined based on previous work that established iso-sweetness with a 7% sucrose reference. The temporal sensory properties of beverages were determined using TI, TDS, and TCATA with a trained panel (n=8). Subsequently, consumer acceptance testing (n=150) was conducted with protein beverages with and without priming statements about sweetener source. Beverages sweetened with a 25:25:50 monk fruit/stevia/fructose blend most closely matched the temporality of sucrose-sweetened beverages. Priming statements about sweetener source increased overall liking for all beverages except stevia-sweetened samples. All beverage samples scored at parity for overall liking when primed prior to tasting as well ($p<0.05$). A segment of consumers preferred sucralose control beverages when presented with the label claim. Beverages sweetened with a 25:25:50 monk fruit/stevia/fructose blend was better liked by consumers than the 25:75 stevia/monk fruit blend when tasted blind, but the sweetener blends scored at parity when primed with "all natural" label claims. Application of these findings to commercially produced RTM protein beverages aids in development of naturally sweetened beverages with reduced calories and desirable sensory properties.

INTRODUCTION

- Increased protein consumption has emerged as a trend among Americans in recent years.
- 'High protein' was also selected as the #1 trend in a 2015 Beverage Industry Survey (Jacobson, 2015).
- Previous research has demonstrated the importance of naturally sweetened protein beverages with low carbohydrate contents to consumers (Gerdes, 2012; Jacobson, 2015; Oltman et al., 2015).
- Previous work using Time Intensity (TI), Temporal Dominance of Sensations (TDS), and Temporal Check all that Apply (TCATA) identified differences in the flavor profiles of RTM vanilla protein beverages sweetened with the natural non-nutritive sweeteners stevia and monk fruit compared with sucrose control beverages.
- Sucrose sweetened beverages were dominated by sweet, sweet aromatic, and cardboard flavors; monk fruit sweetened beverages were dominated by sweet and metallic tastes, and stevia sweetened beverages were dominated by sweet, bitter, and metallic tastes.

OBJECTIVES

1. To create natural sweetener blends using monk fruit, stevia, and fructose to sweeten RTM vanilla protein beverages.

2. To characterize the temporal sensory properties of each natural sweetener blend in RTM vanilla protein beverages using three temporal sensory methods: Time Intensity (TI), Temporal Dominance of Sensations (TDS), and Temporal Check all that Apply (TCATA).

3. To determine consumer acceptance of naturally sweetened RTM vanilla protein beverages with and without priming statements.

Table 1. Beverages selected for consumer acceptance testing and respective priming statements.

Number	Sample	Priming Statement
1	Sucralose control	*The protein beverage you are about to taste is sweetened with sucralose and is sugar/carbohydrate free.*
2	Monk fruit extract control	*The protein beverage you are about to taste is naturally sweetened with monk fruit extract and is sugar/carbohydrate free.*
3	Stevia leaf extract	*The protein beverage you are about to taste is naturally sweetened with stevia leaf extract and is sugar/carbohydrate free.*
4	Blend 1	*The protein beverage you are about to taste is naturally sweetened with monk fruit and stevia leaf extracts and is sugar/carbohydrate free.*
5	Blend 2	*The protein beverage you are about to taste is sweetened with natural extracts from stevia leaf, monk fruit, and natural fructose crystals and has >50% less sugar than a regular sweetened protein beverage.*

JUSTIFICATION

Previous research has identified consumer interest in naturally sweetened protein beverages without added sugar or carbohydrates. Flavor is also a driving factor in purchase decisions. Protein beverages sweetened with only stevia leaf or monk fruit extracts contain undesirable metallic and bitter flavors, which we have previously characterized. Use of natural sweetener blends may result in minimization or elimination of undesirable flavors while still reducing sugar and carbohydrates in the sweetened beverages.

MATERIALS & METHODS

- Protein beverages were formulated using whey protein isolate (WPI, 25 grams per 12 oz. (360 mL) serving), water, sweetener, and vanilla flavoring. Beverages were sweetened using natural sweetener blends formulated with fructose (crystalline), monk fruit extract (50% Mogroside V), and/or stevia leaf extract (95% steviol glycosides).
- Formulations were calculated based on results from previous magnitude estimation scaling (n=8 panelists, 3 replications). Iso-sweet concentrations for each natural blend were confirmed in beverages by alternative forced choice (2-AFC) tests (n=40 consumers). Sweetener blend formulations included: 50:50 stevia/fructose (STV 50), 50:50 monk fruit/fructose (MF 50), 25:75 stevia/fructose (STV 25), 25:75 monk fruit/fructose (MF 25), 50:50 monk fruit/stevia (STV, MF 50), 25:75 stevia/monk fruit (STV 25, MF 75; Blend 1), 25:25:50 monk fruit/stevia/fructose (STV, MF 25; Blend 2)
- Temporal sensory profiling (TI, TDS and TCATA) was conducted for each beverage in triplicate by a trained panel (n=8). All temporal sensory profiling was conducted using Compusense Cloud software on an iPad interface (Compusense, Guelph, CA).
  - -Attributes evaluated with TI were sweet, bitter, and metallic. Parameters of maximum intensity, time at maximum intensity, total time, and area under the curve were extracted from TI data using XLSTAT (Addinsoft, New York, NY).
  - -Attributes for TDS/TCATA included sweet, bitter, metallic, sweet aromatic, and cardboard. TDS curves and band plots were constructed in XLSTAT.
- Beverages were selected for consumer acceptance testing based on similarity of temporal sensory profiles compared to the sucrose control beverage. A total of five beverages were selected.
  - -150 consumers evaluated the five samples with and without priming statements in a 2-day crossover design test. Questions were asked regarding overall liking, sweetness, vanilla flavor, thickness, aftertaste, quality, and purchase intent on each day. Test days were 4 weeks apart to eliminate memory effects.
  - -Consumers were randomly assigned to sessions (order of primed and unprimed tastings), and the order of sample presentation was balanced and randomized within each session (Table 1).

RESULTS

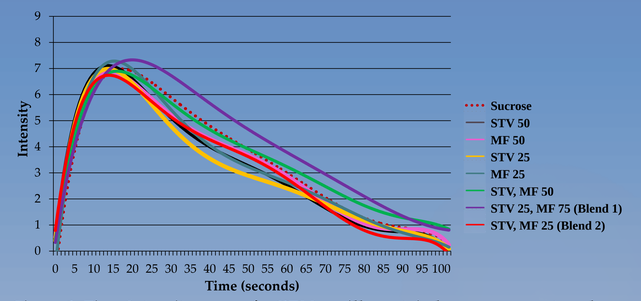
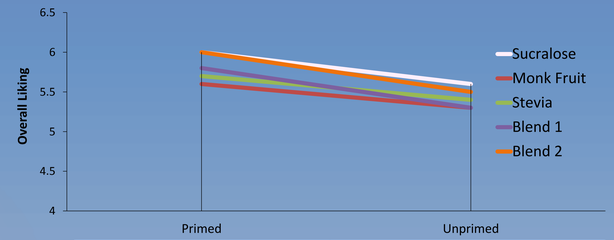


Figure 1. Time Intensity curves for RTM vanilla protein beverages sweetened with natural sweetener blends compared to sucrose sweetened control beverages (red dotted line).

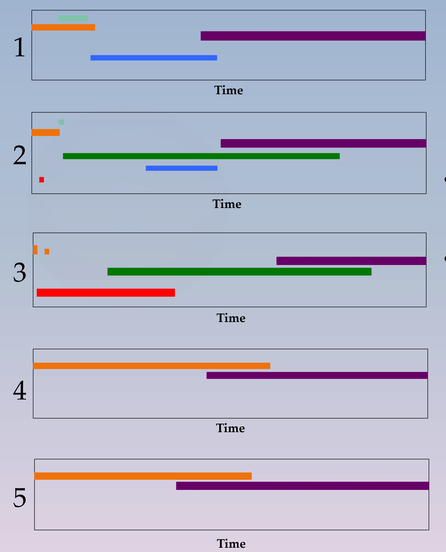
- All beverages peak at the same maximum sweetness intensity (sweet intensity=7 on a 0 to 15 point scale), but display distinct curve shapes, illustrating differences in temporal sweetness profiles.



Sucralose	Monk Fruit	Stevia	Blend 1	Blend 2	Sucralose	Monk Fruit	Stevia	Blend 1	Blend 2
6.0a	5.6abc	5.7abc	5.8ab	6.0a	5.6abc	5.3c	5.4bc	5.3c	5.5bc
Overall liking mean for all beverages with priming=5.8a					Overall liking mean for all beverages without priming=5.4b				

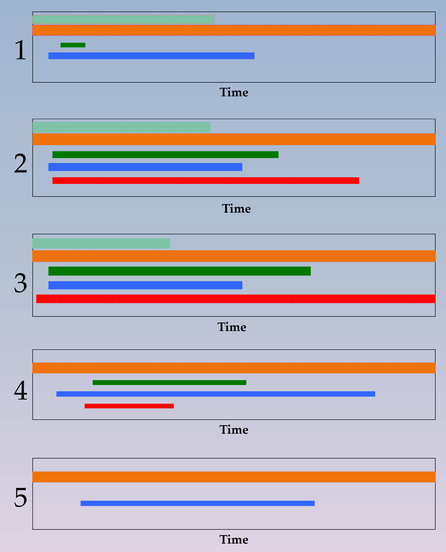
Figure 3. Effects of priming and beverage sweetener on consumer overall liking scores (n=150). The interaction between priming and sweetener was significant across all beverages. Different letters following overall liking means denote significant differences ($p<0.05$).

- Priming statements significantly increased overall liking scores for Blend 1 and Blend 2 beverages.



- Dominance band plots for Blends 1 and 2 were most similar to the sucrose control.
- Monk fruit and stevia sweetened beverages displayed dominant metallic and bitter/metallic tastes respectively, which were not detected in the sucrose control.

Figure 2a.Temporal Dominance of Sensations band plots for the five beverages selected for consumer testing. Colored bands represent *dominant* attributes (α=0.05).



- The Blend 2 band plot most closely matched control sucrose and sucralose beverages.
- As seen in TDS results, metallic and bitter/metallic tastes were detected in monk fruit and stevia sweetened beverages respectively.
- TCATA band plots display additional attributes compared with TDS, indicating these attributes were still detected but not dominant.

Figure 2b.Temporal Check-All-That-Apply band plots for the five beverages selected for consumer testing. Colored bands represent all detected attributes (α=0.05).

CONCLUSIONS

- Sweetening RTM protein beverages with natural sweetener blends minimizes undesirable metallic and bitter flavors, and more closely matches the temporal sensory profile of sucrose-sweetened beverages and the industry RTM standard, sucralose sweetened beverages.
- The three temporal methods used (TI, TDS, and TCATA) provided complementary results regarding the temporal sensory profiles of the protein beverages.
- Blend 2 beverages (25% stevia, 25% monk fruit, 50% fructose) most closely matched sucrose beverages, based on results from TI, TDS, and TCATA.
- Priming statements with information about sweetener source improved overall liking of sweetener blends suggesting that consumers react positively to 'natural sweetener' claims.
- Application of these findings to commercially produced RTM protein beverages are useful in order to develop naturally sweetened beverages with desirable sensory properties.

FUTURE WORK

- Application of sweetener blends in ready-to-drink (RTD) protein beverages and protein bars.
- Evaluation of these sweetener blends in RTM protein beverages in a home usage test (HUT).

ACKNOWLEDGEMENTS

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