The Multivariate Approach to Product Development

Challenge

Competitive markets demand change in classical recipe (pasta sauce) to suite consumer liking

Solution

Apply existing product knowledge with a systematic application of experimental design, sensory analysis & multivariate statistics to aid new ingredient composition

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The development of a new product is linked with risks and opportunities. In this context, sensory analysis can help minimizing failure risks. Sensory profiling is a systematic evaluation of the sensory attributes of a product carried out by trained assessors. Typically, the information retrieved through this type of analysis is used to describe product characteristics. These product characteristics can further be related to either consumer behavior and likings, or to industrial measurements on the products through multivariate regression.

This article presents how product developers can benefit from using sensory science combined with multivariate analysis. The improvement in the consumer liking of a pasta sauce is used as an example to illustrate a development process involving experimental design, a sensory study and multivariate analysis.

> **"The goal of this approach is to identify the ingredients with the most significant effect on the product liking, and ultimately make a recipe for a product which meets the likings of consumers."**

A producer of pasta sauce has identified a problem with a specific product on the market. The classical sauce is a well-established brand based on a recipe that has remained unchanged for a long time. Suddenly, the market seems to have lost interest in the product. A consumer preference survey is conducted, and indicates that market preference is now in favor of a new pasta sauce recently introduced on the market by a competitor. The drop in sales seen for the classical product can thus be explained by the growing popularity of the new, competitive brand.

The pasta sauce producer is afraid to make drastic changes to the classical recipe. Thus, attempts to come up with an improved recipe consist of varying a single ingredient at the time. This approach is unsuccessful despite a large number of trials. The new competing brand still tastes better. Something needs to be done to regain the position as the market leader. The producer decides to change the classical recipe to become more similar to the new competitive product by the use of multivariate analysis. This approach combines the existing knowledge of making pasta sauce with a systematic application of experimental design, sensory analysis and multivariate statistics.

The analysis in this article was performed using The Unscrambler® and Quali-Sense software programs by CAMO Software AS.

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Steps in the multivariate approach

1. Application knowledge is used in a brainstorming session to identify ingredients that are likely to have an effect in becoming more similar to the competing product. Sensory attributes are also chosen to evaluate the product.
2. Test products are made systematically through designed experiments, a process involving controlled changes of the chosen ingredients in the recipe.
3. A panel of trained assessors is used to evaluate the experimental recipes in comparison with the classic pasta sauce and the successful competitive brand.
4. The recipes are analyzed by taking into account the sensory profiling and the product composition.

1. Brainstorming session

A brainstorm sessioning was conducted to plan for screening trials. In this step, the idea is to use designed experiments with different recipes for comparison. Another goal is to identify which ingredients have effects on the sensory evaluation of the sauce. The product developers came up with 12 ingredients which they thought could have an important effect in making a recipe similar to the competitor's. These 12 ingredients were used as design variables. In addition, 12 relevant sensory attributes were identified to evaluate the sample pasta sauces (Table 1).

Design Variables (12 varied recipe ingredients)		
1. Cream	5.Mushroom	9.Garlic
2.Ricotta	6.Onion	10.Basil
3.Balsamico	7.Paprika	11.Bacon
4.Parmesan	8.Carrot	12.Smoke
Sensory attributes (12 product descriptors)		
1.Intensity	5.Mushroom	9.Rancidity
2.Cream	6.Onion	10.Sourness
3.Cheese	7.Paprika	11.Saltiness
4. Bitterness	8.Carrot	12.Smoke

2. Experimental design

Due to the high number of ingredients (12) to be varied in the screening trials, a so-called fractional factorial design was chosen. This type of experimental design is an economical and efficient way of screening effects with a low number of experiments. Using the fractional factorial design with resolution III, a total number of 16 + 2 experiments are enough to cover the design space.

3. Sensory evaluation

A sensory evaluation was then carried out on the 18 sample recipes generated from the experimental design procedure. In addition, the existing product and the competitive product were also evaluated by the sensory panel. The individual assessors in the sensory panel were checked for sensitivity, reproducibility and agreement with the rest of the panel to identify the sensory attributes which were relevant for further analysis. The analysis was carried out using the Quali-Sense software, which is used to ensure reliable quality of the data. One sensory attribute (Onion) was found to have no effect, and thus removed from the data in further analyses.

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4. Principal component analysis

Using the remaining 11 sensory descriptors and scores from the sensory evaluation, a principal component analysis was then performed to locate the experimental recipe falling closest to the competing product. As can be interpreted from the combined scores and loadings plot (Figure 1), Paprika, Intensity and Bitterness are the most important attributes for this product.

It can also be seen that the recipe in experiment 9 is closest to the competitive product. The classical product carries other significant attributes (Saltiness and Smoke), and is rather distant from the desired taste. The pasta sauce producer decides to replace the existing recipe with the composition of ingredients used in experiment 9.

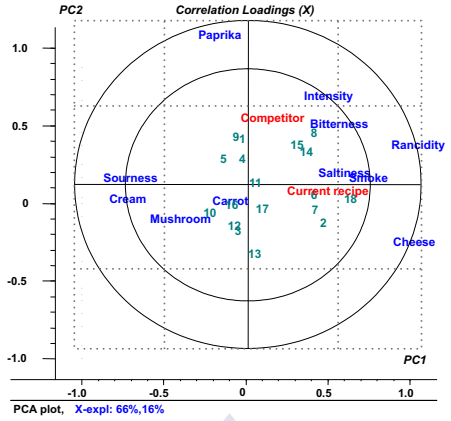

Figure 1 The pasta sauce samples and their sensory profiles shown in a Principal Component Analysis (PCA)

Conclusion

By the use of systematic experiments consisting of varying ingredients thought to be important for a specific product, multivariate analysis and sensory analysis are adequate tools to aid the recipe generation. Both qualitative and quantitative understanding of the relationship between consumer liking, sensory attributes and ingredient composition is gained during this process.

Application note overview

Software	The Unscrambler 9.7, Quali-Sense
Methods	Fractional factorial design, principal component analysis, sensitivity test, reproducibility test, panel agreement test
Data type	Sensory profiling data (12 attributes), design variables (12 ingredients)
Vertical	Food (Pasta sauce)
Added Value	Recipe generation that meets consumers' likings
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