

Sensory Characteristics Analysis of Honey Using Generalized Procrustes Analysis

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Abstract— Sensory evaluation of honey constitutes a complex analytical chain encompassing visual, olfactory, gustatory, and tactile assessments. In food science, the primary objective of sensory profiling is to align product characteristics with consumer demands to optimize industrial production. This study utilizes Generalized Procrustes Analysis (GPA) to evaluate the assessments of 20 trained panelists regarding the organoleptic and physicochemical attributes of both comb and extracted honey. The variables analyzed included flavor profiles, chemical constituents, aroma, color, viscosity, and overall aesthetic presentation. Results showed that color, view and viscosity were found effective variables for comb honey and sucrose, taste, color and viscosity were found significant variables for extracted honey. Consensus of panelists was found 92% for comb honey and 89% for extracted honey. The results demonstrate that Generalized Procrustes Analysis is a robust and successful methodology for the sensory quantification of honey, providing a high-fidelity mapping of product characteristics and evaluator consistency.

Keywords— Generalized Procrustes Analysis, Honey, Honey quantification, Sensory Evaluation.

I. INTRODUCTION

Honey is a natural, high-energy food produced by bees from plant nectar or secretions of living organisms, which they combine with their unique substances to create a rich paste. In addition to simple sugars like glucose and fructose, it contains enzymes, amino acids, vitamins, and phenolic compounds, giving it antioxidant, antibacterial, and anti-inflammatory properties. With a wide range of medicinal uses, from wound healing to gastrointestinal health, honey also plays a critical role in the food industry as a natural sweetener and preservative. From a biodiversity perspective, the pollination activity of bees in honey production is an indispensable element for agricultural sustainability and global food security [1,2].

Honey's sensory profile consists of parameters such as color, aroma, taste, and texture, which vary widely depending on the nectar source, production region, and processing techniques. From a sensory perspective, honey's color can range from water white to dark amber, while its viscosity and crystallization directly affect its texture. These characteristics are the most important factors determining a consumer's perception of

quality. Biochemically, honey is rich in phenolic compounds, flavonoids, and enzymes. These components give honey antioxidant, antimicrobial, and anti-inflammatory properties, making it indispensable in apitherapy (treatment with bee products). Furthermore, honey's low water activity and high osmotic pressure allow it to act as a natural preservative, increasing its value in the food industry [1,3].

In sensory analyses, panelists often have different scaling habits or differences in terminological perception when evaluating products. Generalized Procrustes Analysis (GPA) minimizes "panelist variations" resulting from these individual differences, creating a common level of consensus. GPA combines data from different panelists into a common configuration using mathematical transformations such as rotation, reflection, and scaling. This method allows for the objective mapping of fundamental similarities and differences between products, even when panelists use their own descriptive terminology, especially in free choice profiling techniques. In complex matrix foods like honey, it is a critical tool for identifying the interaction of sensory dimensions such as color, viscosity, and aroma, and for determining panelist agreement [4,5].

In this study, evaluation of 20 panelists on the characteristics of honey (comb honey and extracted honey) such as taste and chemical variables, smelling, color, viscosity, view and fancy were analyzed by Generalized Procrustes.

II. MATERIALS AND METHODS

Pure comb and extracted flower honeys and sucrose additive honey produced in Ondokuz Mayıs University in 2014 was used as data. 20 panelist were evaluated the sensorial characteristics such as smelling, color, viscosity, view and fancy. Idiogrid software was used to analyze the data.

III. RESULTS AND DISCUSSION

Principal Component Analysis (PCA) results were given in Table 1.

TABLE I: PCA RESULTS

Comb Honey	Eigenvalue	Variance Explained (%)
PC-1	6.25	62.48
PC-2	3.75	37.52
Extracted Honey		
PC-1	7.18	71.77
PC-2	2.83	28.23

Both for comb and extracted honey two component exactly

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explain the total variance.

and viscosity for the extracted honey.

Figure 1 and 2 showed the PCA graphs.

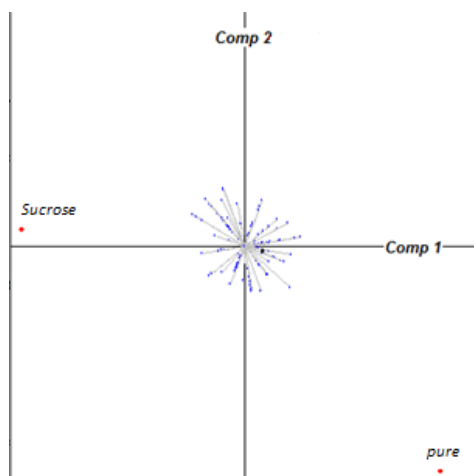


Fig. 1. PCA results for comb honey.

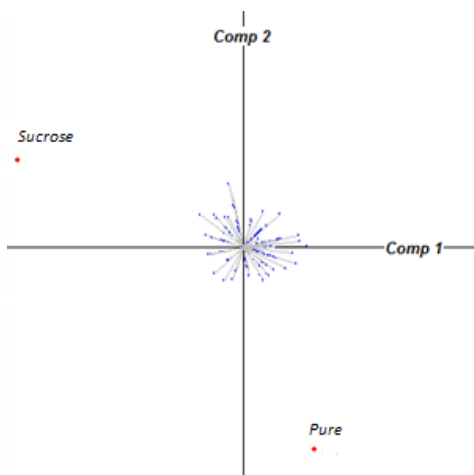


Fig. 2. PCA results for extracted honey.

Results showed that;

- Color, view and viscosity were found effective variables for comb honey and sucrose.
- Taste, color and viscosity were found significant variables for extracted honey.
- Consensus of panelists was found 92% for comb honey and 89% for extracted honey. Results indicated that Generalized Procrustes analysis can be successfully applied to honey sensory evaluation.

IV. CONCLUSION

The results of this study showed that the Generalized Procrustes Analysis can be used successfully for the sensory analysis of both comb and extracted honey. For the comb honey the most important variables were color, view and viscosity while the most important variables were taste, color

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