ULST Timisoara
Multidisciplinary Conference on Sustainable Development
21-22 May 2026

NUTRITIONAL VARIABILITY OF FIGS ASSESSED BY PCA AND HIERARCHICAL CLUSTERING

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Abstract:

The aim of this study was to evaluate and differentiate the nutritional profiles of figs obtained from five distinct providers based on six key parameters: moisture, proteins, fats, fibers, minerals, and carbohydrates. Preliminary findings indicate significant variability across the providers. For instance, Provider 5 exhibited the highest fiber content (12.10%) and fat levels (1.25%), while Provider 4 showed the lowest moisture content (19.68%), suggesting a different drying degree or shelf-life potential. These results provide valuable insights for both consumers and food industry partners in selecting sources that meet specific nutritional requirements.

Introduction

In the global food market, figs are primarily consumed in their dried form, which ensures year-round availability and concentrates their nutritional density. However, the commercial quality of dried figs is far from uniform. The chemical composition and organoleptic properties are subject to significant variability influenced by different parameters: the genetic of the cultivars, environmental conditions, harvesting maturity, and, critically, the post-harvest processing techniques employed by different providers. Industrial drying methods, temperature control, and storage conditions can change the final moisture-to-solute ratio, affecting not only the shelf-life but also the bioavailability of key nutrients.

Materials and methods

The methods used to determine nutritional parameters are those used and recommended by Nik Nadira Nazua et al, 2020. Prior to multivariate analysis, data were subjected to the Shapiro-Wilk test for normality and the Levene test for homogeneity of variance (as per the "minimal standard" protocol). The Coefficient of Variation (CV%) was calculated to assess the dispersion of nutritional parameters across providers. Multivariate analysis (PCA and HCA) was performed using the R software environment.

Results and discussions

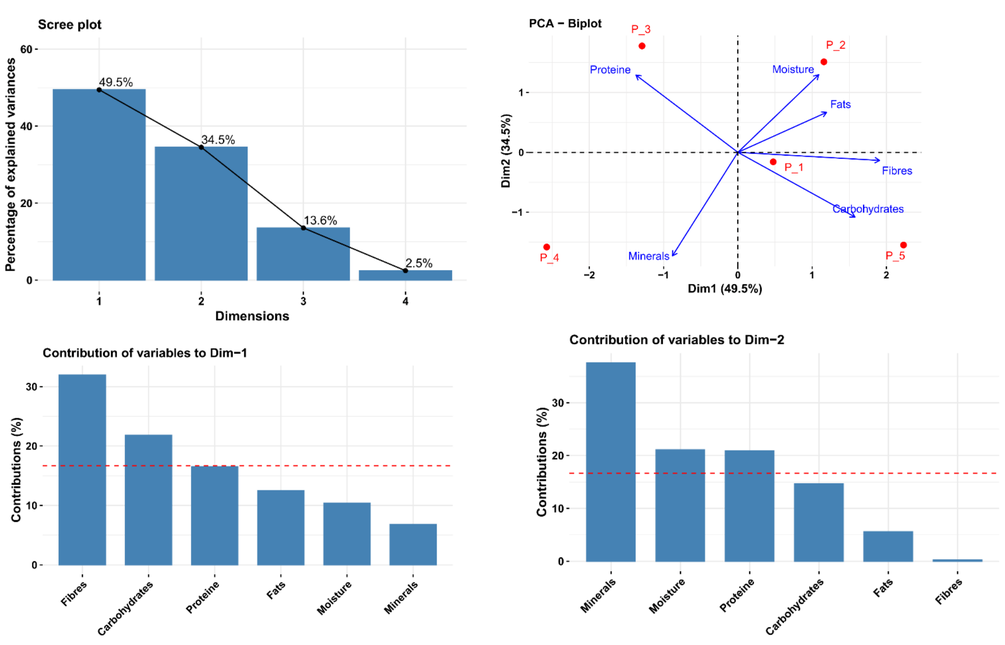

Figure 1. (A) Scree plot of PCA. (B) Biplot of PCA.
(C) Contribution of variables to the first dimension of PCA.
(D) Contribution of variables to the second dimension of PCA

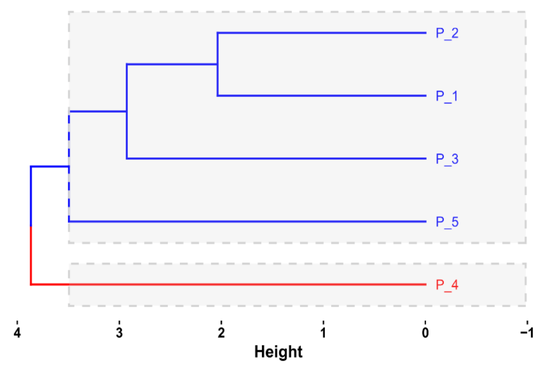

Figure 2 Cluster dendrogram

Conclusions

This study suggested that the nutritional profile of commercial figs is highly provider-dependent, emphasizing the need for robust quality control protocols. By applying PCA and Hierarchical Cluster Analysis, we effectively reduced the complexity of a six-variable dataset into a highly interpretable visual map, explaining 84% of the total nutritional variability.
Our findings lead to several key conclusions:

- **Nutritional Fingerprinting:** PCA proved to be a superior tool compared to univariate methods, allowing us to identify Fiber and Carbohydrates as the most significant discriminants for fig quality in the current market.
- **Provider Specialization:** Provider 5 represents the "nutritional benchmark" for fiber-rich products, whereas Provider 4 occupies a separate market niche due to its extreme dehydration and distinct mineral profile.
- **Industrial Application:** The HCA model categorized providers into two distinct clusters, providing a mathematical basis for industrial buyers to select suppliers based on specific nutritional requirements rather than brand perception.
- **Practical Standardization:** This multivariate workflow (combining PCA/HCA with AOAC protocols) can be adopted by food regulators as a standard for the nutritional characterization and authenticity verification of dried fruits.