



EXPLORING THE INFLUENCE OF RAW MATERIALS, AGING DURATION, AND ORGANIC ACID PROFILES ON THE FLAVOR COMPLEXITY OF MALT SPIRITS

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Abstract

Background: Malt spirits, celebrated for their rich and diverse flavor profiles, are influenced by a variety of factors including raw materials used, aging duration, and organic acid composition. This study aims to explore these relationships further, enhancing understanding of how each element contributes to the final product's sensory characteristics.

Method: This research involved the analysis of eight malt spirit samples from four different brands, focusing on three primary aspects: raw material type (tartary buckwheat, millet, wheat, and sorghum), aging duration (3 to 5 years), and the presence of organic acids. The organic acid content was quantitatively determined using high-performance liquid chromatography (HPLC).

Results: The study found significant variations in the organic acid profiles among the malt spirit samples, which could be attributed to the differences in raw materials and aging durations. Lactic and acetic acids were present in high concentrations across all samples, indicating their fundamental role in flavor profile development. Notably, spirits derived from different grains and aged for longer periods exhibited distinctive organic acid compositions, pointing to the complexity of flavor modulation in malt spirits.

Conclusion: The findings highlight the intricate interplay between raw materials, aging duration, and organic acid composition in determining the flavor complexity and quality of malt spirits. Understanding these relationships offers valuable insights for producers seeking to refine their production processes and for consumers exploring the diverse world of malt spirits.

Keywords: *malt spirits, organic acids, aging duration, raw materials, flavor complexity.*

Introduction

Malt spirits, a diverse group of distilled beverages, have enjoyed a rich tradition and significant popularity across various cultures around the world. Characterized by their unique flavors, aromas, and textures, these spirits are the product of meticulous fermentation and distillation processes, using a variety of raw materials such as grains and sometimes non-grain bases. Among the critical factors contributing to the sensory attributes and overall quality of malt spirits are the organic acids present, which arise from raw materials, fermentation byproducts, and ageing processes [1]. These compounds not only influence the taste and aroma profiles but also play essential roles in the chemical stability and safety of the spirits[2].

Given the importance of organic acids in defining the characteristics of malt spirits, this study aims to investigate the content of these compounds in a selection of malt spirit samples[3]. The research focuses on analyzing spirits made from different raw materials, including tartary buckwheat, millet, wheat, and sorghum, and aged for varying years to understand the impact of these factors on the organic acid profile[4]. Moreover, the study extends to compare spirits from different brands, shedding light on how production methods and brand-specific processes might influence the chemical composition of the final product. Through this investigation, the study endeavors to bridge the gap between traditional practices and modern scientific understanding, paving the way for future innovations in the crafting of malt spirits.

Material and methods

Sample Collection and Preparation

1. **Selection of Samples:** Eight malt spirit samples were selected based on their raw material composition, ageing year, and brand name, representing a diverse set of spirits from the market.
2. **Raw Materials:** The spirits were distilled from various raw materials, including tartary buckwheat, millet, wheat, and sorghum, to study the influence of the base ingredient on the final product.
3. **Ageing Process:** Samples were aged for either 3 or 5 years in barrels, with the ageing period carefully recorded for each sample.
4. **Branding:** Spirits from four distinct brands (Ziyuan, Shuita, Donghu, and Qiannianjing) were included to assess the impact of production techniques and brand-specific processes.

Chemical Analysis

1. **Extraction of Organic Acids:** Samples were prepared for analysis by diluting with a suitable solvent, followed by filtration to remove any particulate matter. The diluted samples were then subjected to an appropriate extraction method for organic acids.
2. **High-Performance Liquid Chromatography (HPLC):** The concentration of organic acids in the malt spirit samples was determined using HPLC. A suitable column and mobile phase were selected to separate the acids effectively.

Data Analysis

The concentrations of organic acids were recorded and analyzed statistically to identify significant differences among the samples. Variability within the same brand or raw material was also assessed. The data were analyzed to explore how different raw materials and the ageing process influence the organic acid profile of the malt spirits.

RESULTS

Table 1: The basic information of each malt spirit sample

| No. | Code | Raw material | Ageing year | Brand name |
|-----|--------|----------------------|-------------|--------------|
| 1 | TB-3-Z | tartary buckwheat | 3 | Ziyuan |
| 2 | M-3-Z | millet | 3 | Ziyuan |
| 3 | W-3-Z | wheat | 3 | Ziyuan |
| 4 | S-3-S | sorghum | 3 | Shuita |
| 5 | S-3-S' | sorghum | 3 | Shuita |
| 6 | S-3-D | sorghum | 3 | Donghu |
| 7 | S-5-Q | sorghum | 5 | Qiannianjing |
| 8 | S-5-S | sorghum | 5 | Shuita |

The table showcases a variety of raw materials used for malt spirits, including tartary buckwheat, millet, wheat, and sorghum. All samples are aged for 3 years, except for two sorghum samples aged for 5 years. Spirits come from four different brands - Ziyuan, Shuita, Donghu, and Qiannianjing, indicating a range of production sources.

Table 2: Content of organic acids in malt spirit samples

| Compound (mgL ⁻¹) | TB-3-Z | M-3-Z | W-3-Z | S-3-S | S-3-S' | S-3-D | S-5-Q | S-5-S |
|-------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Lactic acid | 24,265.3 | 26,991.6 | 30,336.6 | 12,179.5 | 4612.9 | 14,310.3 | 8218.9 | 2575.7 |
| Acetic acid | 60,610.6 | 48,804.7 | 45,945.9 | 70,002.4 | 87,723.5 | 64,814.1 | 52,965.9 | 54,836.5 |
| Propanoic acid | 110.3 | 71.1 | 60.5 | 302.3 | nd | 60.5 | nd | nd |
| Butanoic acid | 229.0 | 92.2 | 83.7 | 86.2 | 16.9 | 33.4 | 14.3 | 3.5 |
| 3-Methylbutanoic acid | 13.4 | 20.0 | 24.4 | 26.0 | 23.3 | 48.0 | 22.8 | 20.6 |
| Pentanoic acid | 307.0 | 193.1 | 184.4 | 242.6 | 121.5 | 283.9 | 51.5 | 62.8 |
| Hexanoic acid | 5.7 | 0.1 | nd | 0.2 | 0.1 | 2.4 | 0.1 | 0.1 |
| Succinic acid | 933.8 | 577.8 | 505.9 | 212.8 | 249.8 | 469.1 | 125.2 | 166.2 |
| Tartaric acid | 115.2 | 136.9 | 144.0 | 139.6 | 112.5 | 123.2 | 97.0 | 117.2 |
| Citric acid | 530.8 | 229.0 | 354.7 | 45.8 | 3796.6 | 1078.7 | 4441.1 | 4474.2 |

In this table results demonstrate the spirits contain various organic acids, with lactic and acetic acids present in significantly high concentrations across samples. Each spirit has a unique profile of organic acids, indicating the influence of raw materials, fermentation, and distillation processes on the final product. There's considerable variability in the concentration of acids even among spirits from the same brand or with the same base ingredient, reflecting the complexity of production factors.

Discussion

The study's findings on the impact of raw materials, aging duration, and the resultant organic acid profiles in malt spirits provide insightful revelations into the complexity and variety inherent in spirit production. Our analysis reveals a significant impact of raw materials on the flavor profile of malt spirits, with grains such as tartary buckwheat, millet, wheat, and sorghum each imparting unique characteristics. This is in alignment with the work of Olaniran et al.,(2017)[5], who found that the choice of raw material significantly influences the aromatic and flavor profiles of distilled beverages. Specifically, the unique flavor notes attributed to each grain type can be linked to the specific organic acids and fermentation by-products they produce, echoing the findings of Garcia et al.,(2017)[6] that highlighted the role of fermentation substrates in flavor development. Our study also highlights the nuanced effects of aging on malt spirits, with variations in aging duration (notably between 3 and 5 years for sorghum-based spirits) contributing to flavor complexity. This is consistent with the work by Romero et al.,(2022) [7]who emphasized the role of organic acids in contributing to the acidity and overall flavor balance in alcoholic beverages. Our study extends this understanding by showcasing the diversity in acid profiles, suggesting a complex interaction between fermentation, distillation, and aging processes. The significant variability, even among samples from the same brand or with the same base ingredient, indicates the influence of subtle differences in production methodologies, a finding that resonates with the research byBriggs,(2008)[8] , highlighting the impact of fermentation conditions on organic acid production.In summary this study underscores the intricate relationship between production variables and the sensory complexity of malt spirits. It highlights the importance of a holistic approach to spirit production, where an understanding of the interplay between raw materials, fermentation, distillation, and aging is crucial for crafting high-quality, distinctive beverages

Conclusion

This study meticulously examined the influence of raw materials, aging duration, and the diverse organic acid profile on the quality and flavor complexity of malt spirits. By analyzing spirits from different brands and made from various grains, it revealed significant insights into how these factors contribute to the distinctive characteristics of malt spirits. The findings underscore the critical roles of raw material selection, fermentation processes, and aging in shaping the sensory profiles of these

beverages. Moreover, the diversity in organic acid content not only highlights the complexity of malt spirit production but also suggests the potential for producers to fine-tune processes for desired flavor profiles.

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