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RESEARCH PAPER

Development of floral mead

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Abstract: Mead is a fermented alcoholic beverage that is made from honey, water and often other flavouring agents such as fruits, herbs or spices. It has various health benefits in humans and is enjoyed by a diverse range of people. Work on unifloral mead is very limited. Thus, an attempt was made to prepare mead from different floral honey. The different floral honey, like Acacia, Lavender, Sunflower, Orange blossom and commercial honey used for the study were procured through online platforms. Yeast strain of *Saccharomyces cerevisiae* MTCC 178 was procured from the Microbial Type Culture Collection (MTCC), Chandigarh. The physicochemical properties of floral honey were analysed to know its quality. Different floral mead and combinations were prepared and phenol, reducing sugar, alcohol content and antioxidant were estimated. Based on these parameters and sensory evaluation, the treatments of Lavender mead and combination of Lavender + Sunflower mead were selected. Combination of Lavender+ Sunflower mead recorded highest alcohol content of 8.33% followed by Lavender mead which showed 8.20%. The Lavender mead had highest polyphenol, antioxidant and reducing sugar content of 297.3mg GAE /L, 77% and 6.8mg/ml followed by combination of Lavender Sunflower mead with 267.3mg GAE/L, 71% and 6.2mg/ml, respectively. The findings of this indicate that unifloral honey such as Lavender and combination of Lavender + Sunflower honey can be used for mead preparation with unique qualities and potential health benefits.

Key words: Antioxidant, Flower honey, Mead, Yeast

Introduction

Honey is a sweet, viscous liquid produced by honeybees from the nectar of flowers. Bees collect nectar, which is primarily composed of sugars like fructose and glucose, from flowering plants and store it in their hives (Bekele *et al*., 2021). Through a process of regurgitation and evaporation, the nectar is converted into honey. It is composed mainly of carbohydrates, water, vitamins, minerals and enzymes. It is known for its nutritional value medicinal properties and use as a natural sweetener (Qamar and Rehman, 2020).

Mead is a traditional alcoholic beverage, distinguished by an alcohol content ranging from 8% to 18% by volume, produced through the fermentation of honey diluted in water by yeast. This beverage enjoys considerable popularity in Eastern Europe, particularly in Poland and Slovenia, as well as across the Baltic states (Czabaj *et al*., 2017). It also holds a strong cultural presence in England, Germany and notably in African nations. Renowned as one of the earliest alcoholic beverages consumed by humans, mead is believed to have predated wine and may even be the precursor to beer (Pereira *et al*., 2019).

Mead is produced by mixing water with honey and initiating fermentation through microbial action. The quality of the final mead largely depends on the ratio of honey to water and the inclusion of additional nutrients. According to Iglesias *et al*. (2014), mead can be crafted by combining honey and water in varying ratios such as 1:0.5, 1:1, 1:2 and 1:3. To maintain a stable pH in the honey must (Eidt *et al*., 2019). The fermentation period for honey mead can range from a few days to several months, depending on the desired characteristics of the beverage (Navratil *et al*., 2001).

Today mead is enjoyed by a diverse range of people and it has gained recognition as a unique and artisanal beverage. Because of it is gluten free alcoholic beverages, which makes it an attractive option for consumers looking for gluten-free beverages. Additionally, mead has a unique and complex flavour profile as well as a desire for healthier and more natural products with medicinal values. It contains antioxidants that promote cellular health and boost immune system due to antimicrobial properties (Kawa *et al.,*).

In this regard an attempt was made to prepare mead from floral honey by using different flower honey to produce mead by fermentation.

Material and methods

An experiment was conducted at the Department of Food Safety and Quality Assurance Laboratory and the Department of Microbiology, University of Agricultural Science, Dharwad, during 4th December, 2023 to 11th June, 2024 at 7 months of duration to investigate the fermentation of mead using unifloral honey.

Various floral honeys (Acacia, Lavender, Sunflower, Orange blossom, and Commercial) were sourced online and stored appropriately. Saccharomyces cerevisiae MTCC 178 yeast strain was obtained from MTCC Chandigarh and preserved on MGYP agar slants under refrigeration.

The physico-chemical properties of honey (moisture content, TSS, pH and titratable acidity) were assessed using standard methods. Moisture content was determined by the oven-drying method, pH with a digital pH meter (Naegel &

Laude, 1991), TSS via hand refracto meter and titratable acidity by NaOH titration (Mesallam & El-Shaarawy, 1987).

Honey was diluted with water (1:4) and adjusted to 24°B TSS. Saccharomyces cerevisiae MTCC 178 (1×10^6 CFU/ml) was inoculated, with potassium meta +09 bisulphite (150 ppm) and ammonium hydrogen phosphate (0.1%) added for nutrients. The yeast was propagated in MGYP broth at 37°C for 24 hours, then transferred to a sterilized sucrose solution. Fermentation occurred at pH 3.5 and 30°C, starting aerobically for 24 hours, then anaerobically until CO2 production stopped.

After fermentation, the mead was siphoned and filtered through a sterilized muslin cloth into sterile glass jars. Bentonite (0.1%) was added for clarification. The mead was then filtered, decanted, bottled, sealed and pasteurized at 62.5°C for 15 minutes. It was stored under refrigeration.

Various parameters like reducing sugar was measured via the 3,5-dinitrosalicylic acid method (Miller, 1959), ethanol content by the colorimetric method (Caputi *et al.,* 1968), total phenolics using the Folin-Ciocalteau method (Singleton & Rossi, 1965) and antioxidant activity through the DPPH assay (Thalisa *et al.,* 2012).

Sensory evaluation of mead was done by using 9-point hedonic scale. According to the score obtained the mead sample was graded based on grade card (Kwan and Kowalski, 1980).

Results and discussion

The initial physicochemical properties of honey, including pH, moisture, titratable acidity and TSS, were analyzed (Table 1). pH ranged from 3.5 in Lavender honey to 4.3 in Commercial honey. Acacia, Sunflower and Orange blossom honeys had pH values of 4.1, 3.9 and 3.8, respectively. The acidity is due to organic acids like gluconic acid. These pH values align with those reported by Acquarone *et al.* (2007).

Treatment details for preparation of mead from floral hone

Treatments	Details
T1	Acacia honey mead
T2	Lavender honey mead
T3	Sunflower honey mead
T4	Orange blossom honey mead
T5	Acacia honey + Sunflower honey mead
T6	Lavender honey + Orange blossom honey mead
T7	Lavender honey + Sunflower honey mead
T8	Acacia honey + Orange blossom honey mead
T9	Acacia honey + Orange blossom honey+ Sunflower honey mead+ Lavender honey mead
T10	Commercial honey mead

Table 1. Physico-chemical properties of honey from different sources

Type of Honey	pH	Moisture content(%)	Titratable acidity(meq/kg)	TSS (°B)
Lavender	3.5	18.00	32.50	79
Acacia	4.1	28.50	34.01	78
Sunflower	3.9	22.50	33.50	73
Orange blossom	3.8	16.00	35.00	75
Commercial honey	4.3	21.00	25.80	76

Moisture content varied significantly across honeys, with Acacia honey having the highest (28.50%) and Orange blossom the lowest (16.00%). Lavender, Commercial and Sunflower honeys recorded 18.00%, 21.00% and 22.50%, respectively. Lower moisture content enhances honey's resistance to fermentation and spoilage, improving stability and shelf life. Yanniotis *et al.* (2006) reported moisture content typically ranges from 16 to 20%.

Titratable acidity in floral honey ranged from 25.80 meq/kg to 35.00 meq/kg. Orange blossom honey had the highest acidity (35.00 meq/kg), followed by Acacia (34.01), Sunflower (33.50), and Lavender (32.50) honeys, indicating their higher acidity levels. Commercial honey had the lowest acidity at 25.80 meq/kg. This acidity reflects the presence of organic acids that contribute to flavor and potential health benefits. According to Bahiru *et al.* (2001), honey acidity typically ranges from 24.4 to 35.4 meq/kg.

Total Soluble Solids (TSS) were measured with a hand refractometer. Lavender honey had the highest TSS at 79°B, followed by Acacia honey at 78°B, while Sunflower honey had the lowest at 73°B. Orange blossom and Commercial honeys recorded TSS values of 75°B and 76°B, respectively, indicating high sugar concentrations, mainly glucose and fructose. This sugar content contributes to honey's sweetness and acts as a natural preservative. Kamal *et al*. (2019) reported a TSS of 76°B, confirming these findings.

Mead was prepared from various sources of honey such as Acacia honey, Lavender honey, Sunflower honey, Orange blossom honey and commercial honey and their combinations were studied for physico-chemical properties such reducing sugar content, alcohol content, antioxidant activity and polyphenol activity. The results obtained are depicted in Table 2.

Table 2 shows that T8 (Lavender + Sunflower mead) had the lowest reducing sugar content at 6.2 mg/ml, followed by T2 (Lavender mead) at 6.8 mg/ml and T9 (Lavender + Sunflower + Acacia + Orange blossom) at 7.4 mg/ml. Kim *et al.* (2014) noted a similar reduction in reducing sugars to 6.7 mg/ml during the first six days of fermentation. T5 (Acacia + Sunflower mead) and T10 (Commercial honey mead) had the highest reducing sugar levels at 8.3 mg/ml, followed by T4 (Orange blossom mead) at 8.2 mg/ml. Other combinations ranged from 7.5 to 7.9 mg/ml, indicating that these honeys have higher concentrations of fermentable sugars crucial for yeast metabolism during fermentation. Wintersteen *et al.* (2005) found that soy mead had a higher residual sugar (7.2 mg/ml) than buckwheat mead (6.8 mg/ml).

Among the treatments, T2 (Lavender mead) had the highest polyphenol content at 297.30 mg GAE/L, followed by T8 (Lavender + Sunflower mead) at 267.30 mg GAE/L and T9 (Lavender + Sunflower + Acacia + Orange blossom mead) at 261.20 mg GAE/L. Kahoun *et al*. (2008) reported similar values ranging from 267 to 298 mg GAE/L in mead. T10 (Commercial honey mead) showed the lowest at 220.00 mg GAE/L, followed by T3 (Sunflower mead) and T1 (Acacia mead) with 229.20 mg and 230.50 mg GAE/L, respectively, highlighting the influence of fermentation conditions on quality and antioxidant properties.

Table 2. Physico -chemical analysis of mead from floral honey

Treatments	Reducing sugar (mg/ml)	Polyphenol content (mg GAE/L)	Antioxidant activity (%)	Ethanol content (%)
T1 Acacia mead	7.5	230.50	63	6.12
T2 Lavender mead	6.8	297.30	77	8.20
T3 Sunflower mead	7.7	229.20	70	7.20
T4 Orange blossom mead	8.2	235.10	56	7.30
T5 Acacia + Sunflower mead	8.3	241.60	71	7.33
T6 Lavender +Orange blossom mead	7.9	251.60	72	8.10
T7 Acacia +Orange blossom mead	7.8	245.40	59	7.13
T8 Lavender +Sunflower mead	6.2	267.30	73	8.33
T9 Lavender+Sunflower+Acacia+Orange blossom mead	7.4	261.20	65	7.38
T10 Commercial honey mead	8.3	220.00	54	6.90
S. Em±	0.063	2.091	0.625	0.093
C.D. (1%)	0.248	5.962	2.872	0.420

Table 3. Sensory evaluation of mead prepared from different types of honey

	Treatments	Color	Taste	Flavor	Aroma	Mouth feel	Overall acceptability
T1	Acacia mead	7.8	7.0	7.1	7.8	7.4	7.3
T2	Lavender mead	8.9	8.4	8.0	8.6	8.0	8.4
T3	Sunflower mead	7.8	8.0	8.2	7.9	7.7	7.9
T4	Orange blossom mead	7.9	7.6	8.1	7.8	7.5	7.5
T5	Acacia mead + Sunflower mead	7.7	7.3	6.9	7.8	7.0	7.9
T6	Lavender mead + Orange blossom mead	7.1	7.6	7.7	7.0	7.8	7.5
T7	Acacia mead + Orange blossom mead	7.2	7.1	7.0	7.8	7.1	7.8
T8	Lavender mead + Sunflower mead	8.3	8.6	8	8.1	6.9	8.6
T9	Lavender + Sunflower +Acacia + Orange blossom	6.4	6.8	6.1	7.3	7.0	6.9
T10	Commercial honey mead	6.9	7.0	7.3	7.1	6.9	7.0

Note E: Nine points Hedonic scale.

Scale: Like extremely-9, Like very much-8, Like moderately-7, Like slightly-6, Neither like nor dislike-5, Dislike slightly-4, Dislike moderalety-3, Dislike very much-2, Dislike extremely-1.

In terms of antioxidant activity, T2 (Lavender mead) exhibited the highest at 77%, followed by T8 (Lavender + Sunflower mead) at 73% and T5 (Acacia + Sunflower mead) at 72%. Wintersteen *et al.* (2005) reported similar antioxidant levels in meads from clover and wildflower honeys, ranging from 72% to 77%. T4 (Orange blossom mead) and T7 (Acacia + Orange blossom mead) showed lower activities at 56% and 59%, respectively. These antioxidant levels suggest improved preservation and potential health benefits. T10 (Commercial honey mead) had the lowest activity at 54%.

The highest ethanol content was recorded in T8 (Lavender + Sunflower mead) at 8.33%, followed by T2 (Lavender mead) at 8.20% and T6 (Lavender + Orange blossom mead) at 8.10%. This high ethanol content indicates extensive fermentation due to elevated sugar levels and active yeast. Akalýn *et al.* (2017) reported similar findings with honeydew-based mead at 8.2%. The lowest ethanol levels were found in T1 (Acacia mead) at 6.12%, T10 (Commercial mead) at 6.90% and T7 (Acacia + Orange blossom mead) at 7.13%, suggesting milder fermentation and sweeter meads for lower alcohol preferences. In general, Lavender mead and combination of Lavender + Sunflower mead exhibited higher polyphenol content, antioxidant activity and ethanol content, suggesting potential health benefits, while commercial honey mead recorded the lowest values in these properties.

The sensory profile of mead is influenced by different parameters, including honey-to-water ratio, type of honey, yeast strain used for fermentation, time and temperature of fermentation and addition of spices and fruits.

Sensory evaluation using a 9-point hedonic scale involved 15 panelists and is summarized in Table 3. Treatment T8 (Lavender + Sunflower mead) achieved the highest overall acceptability score of 8.6, followed by T2 (Lavender mead) at 8.4, reflecting well-balanced attributes in color, taste, flavor, aroma and mouth feel. Roldán *et al.* (2011) noted similar acceptability scores for meads. T3 (Sunflower mead) scored 7.9, indicating rich flavor and pleasant aroma. The lowest acceptability score of 6.9 was for T9 (Lavender + Sunflower + Acacia + Orange blossom mead), which was only slightly liked, with T5 (Acacia + Sunflower) showing comparable acceptability.

Conclusion

Recently, many studies have focused on an improvement of the mead production.The characteristic parameters of mead include, ethanol concentration, reducing sugar content polyphenol content and antioxidant activity. These parameters were monitored during fermentation to control the fermentation process and achieved a high-quality product.The present study has shown that the unifloral honey can be potentially used as a substrate for the production mead. Among the various floral meads prepared, Lavender mead and combination of Lavender + Sunflower meads exhibited high, antioxidant activity, polyphenol content with enhanced alcohol.

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