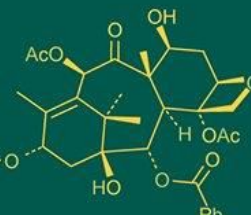
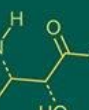
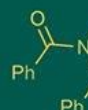


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(1): 1242-1246
www.biochemjournal.com
Received: 01-11-2025
Accepted: 06-12-2025

Akanksha Kesharwani
Department of Forestry,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

RK Prajapati
Department of Forestry,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Sarita Bodalkar
Department of Forestry,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Deeptimayee Das
Department of Forestry,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Corresponding Author:
Akanksha Kesharwani
Department of Forestry,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Development and nutritional evaluation of honey based immunity booster balls from *Madhuca longifolia*, a non-timber forest product

Akanksha Kesharwani, RK Prajapati, Sarita Bodalkar and Deeptimayee Das

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i1So.7271>

Abstract

Madhuca longifolia, often known as Mahua, is a commercially economic Non-Timber Forest Product (NTFP) that indigenous populations use extensively for food, medicine, alcohol, and livelihood. The flowers have a strong potential for the development of functional foods and it is rich in natural sugars, phenolic compounds, vitamins, and minerals. In this study, medicinal herbs such as Tikhur (*Curcuma angustifolia*), Ashwagandha (*Withania somnifera*), Shatavari (*Asparagus racemosus*), and Babul gum (*Acacia nilotica*) were combined with Mahua flowers as a base material to prepare a honey-based immune booster balls. The evaluation of the processed honey-based immunity booster balls' recipe was developed after the ball formation its physicochemical and nutritional properties were examined. In this experiment total seven treatments in a completely randomized design (CRD) were laid to develop a recipe. After preparation of final product from the preparation date onwards every 30 days interval, the physico-chemical and nutritional quality analyses were carried out till 150 days. According to the findings, Treatment "T6" had the best sensory acceptability in terms of flavour, texture, colour, and aroma. Whereas, Protein and fat percentage reduced as storage time increasing, although total sugars decreased and reducing sugars increased. Moisture level marginally increased during storage. According to the study's findings, honey-based Immunity Booster Balls are a nutritious, shelf-stable functional food with lot of medicinal properties that has great potential for commercialization and improving livelihoods in communities who rely on forests based produces. The self-life of the product was excellent till 60 days thereafter the microbial and fungal infection increases and it is not safe for human consumption. There is urgent need that smart packaging it may be nitrogen tetra pack or vacuum packaged product self-life may extend.

Keywords: *Madhuca longifolia*, non-timber forest products, honey-based product

Introduction

Madhuca longifolia, a well-known minor forest product, is native to the Indian subcontinent, which comprises several Indian states, Sri Lanka, Myanmar, and Nepal. It is a member of the Sapotaceae family. Because it meets three fundamental needs—fuel, food, and fodder—this multipurpose tree is vital to the way of life of traditional cultures. It goes by several vernacular names, such as Illipi (South), Mahul (Orissa), and Mahua or Mowarh (North), and it is extensively distributed throughout various Indian states. The Sanskrit word "madhu," which means "honey," is the source of its name, Madhuka, which alludes to the unusually high sugar content (66-72% of dry weight) in its flowers (Chand and Mahapatra, 1983) ^[1]. The perennial *Madhuca longifolia* tree can reach a height of 70 feet. When ripe, the fruits are ovoid, meaty, and greenish-yellow in colour; the blossoms are small, fleshy, and pale white. It can continue to give fruit for up to 60 years, beginning between the ages of 8 and 15. Since mahua trees typically begin to bloom during the lean agricultural season (March-April), they are a significant source of income for underprivileged communities. The meaty corollas of the flowers are edible and a fantastic source of natural sugars, vitamins, and minerals (Sinha *et al.*, 2017) ^[2]. For edible Mahua (*Madhuca longifolia*) flowers to be safe, tasty, and nutritious, a sustainable sanitary collection approach is essential. The medicinal rhizome *Curcuma angustifolia*, also called the Tikhur, grows in the forests of Madhya Pradesh and Chhattisgarh.

Fresh tikhur rhizomes are used by primitive tribes like the Abhujmaria to manufacture starchy flour that has cooling properties and is excellent for treating stomach ulcers. It also has antipyretic, diuretic, and heart tonic properties (Ravindran 2007) [3].

Withania somnifera, often known as winter cherry or Indian ginseng, is a valuable medicinal herb used in many Ayurvedic medicine formulations. Its name, which comes from the Sanskrit words "ashwa" (horse) and "gandha" (fragrance), symbolizes the idea that eating its root bestows horse vigour. The plant's roots, which have sedative, anti-inflammatory, and nervous system-tonic qualities, are its primary medicinal component.

Asparagus racemosus, commonly referred to as the Shatavari, is another important herb in Ayurveda. The roots were mostly used in the traditional medical system. In modern Ayurvedic traditions, Shatavari is acknowledged as a galactagogue (raising milk production), rejuvenator, and aphrodisiac. Additionally, it is classified as a "medhya" herb, meaning that it enhances learning, memory, and intelligence. (Orwa *et al.*, 2009) [4]

Acacia gum is the dried exudate gum from the trunks and branches of the babul tree (*Acacia nilotica*). This gum is highly nutritious and has been used for millennia as a binding element in food and medicine. For nursing mothers in the Indian subcontinent, it is a vital part of wholesome meals.

Mahua flowers are anticipated to have a significant influence on the food and beverage sector in the future as the demand for natural and health-conscious products

continues to grow following COVID. The goal of this research was to develop a ball that boosts immunity. The Immunity Booster ball recipe was created to make greater use of mahua flowers in the off-season while preserving quality and fulfilling storage needs. To evaluate the nutritional, physicochemical, and processed honey-based immunity booster balls.

Materials and Methods

The study was carried out in the Department of Forestry, College of Agriculture, IGKV, Raipur, between 2023-2024 (C.G. The invention of honey-based immunity booster balls enhanced with the base material Mahua (*Madhuca longifolia*) and strengthened with immunomodulatory and adaptogenic herbs used in Ayurvedic therapy. The concentrations of Mahua, Tikhur (*Curcuma angustifolia*), and honey were varied to create seven different treatments (T₁ to T₇), while the amounts of Ashwagandha, Satavar, Babool gum, dry fruit, Ghee, and Elaichi remained unchanged. The goal of each treatment was to investigate how these elements could work together to improve texture, palatability, and possible therapeutic efficacy. Treatments for Immunity Booster Balls (T₁-T₇) based on honey and three replications and a completely randomized design (CRD) were used in this experiment. The storage duration of the Immunity Booster Balls was examined at intervals of 1 month over a period of 150 days at ambient room temperature. The packaging plastic containers utilized for marketing purposes.

Ingredient Composition Mahua-Enriched Honey Based Immunity Booster Balls.

S. No.	Ingredient	T ₁ (g)	T ₂ (g)	T ₃ (g)	T ₄ (g)	T ₅ (g)	T ₆ (g)	T ₇ (g)
1	Mahua (<i>Madhuca longifolia</i>)	30	35	40	45	50	55	60
2	Satavar (<i>Asparagus racemosus</i>)	3	3	3	3	3	3	3
3	Ashwagandha (<i>Withania somnifera</i>)	3	3	3	3	3	3	3
4	Tikhur (<i>Curcuma angustifolia</i>)	26	23	20	17	14	11	8
5	Babool Gum (<i>Acacia nilotica</i>)	3	3	3	3	3	3	3
6	Honey	14	12	10	8	6	4	2
7	Dry Fruit (e.g., almonds, raisins)	10	10	10	10	10	10	10
8	Ghee	10	10	10	10	10	10	10
9	Elaichi (Cardamom)	1	1	1	1	1	1	1

Results and Discussion

Above preparation, the chemical analysis of immunity booster balls revealed that the percentage of total sugar, fat, and protein decreased as the storage period increased, but the percentage of reducing sugar and moisture increased as the storage period increased from 0 to 1 month interval up to 150 days.

Moisture content was recorded highest for the treatment T₆ (10.18), while T₄ had the lowest (8.32). Moisture retention has a direct impact on microbiological safety and texture, according to earlier research on traditional sweets (Verma and Patel, 2023; Raval, 2013) [7, 8]. Although the decreased moisture retention may lead to somewhat improved microbiological safety, it also causes the texture to become tougher with time, a problem seen in other candies (Saikia and Islam, 2020) [5].

Total sugar was resulted highest for the treatment T₆ (27.66), whereas T₁ had the lowest (22.21). Hydrolysis and microbiological or enzymatic activity, which gradually transform sugars into reducing sugars, are responsible for the decrease in sugar content in honey-based formulations

(Pandey and Sangwan, 2018) [6]. These results are consistent with previous findings that value addition with natural sweeteners improves traditional sweets' customer appeal and storage stability (Raval, 2013; Saikia and Islam, 2020) [8, 5]. Non-reducing sugar was recorded highest for the treatment T₇ (2.70), whereas, T₁ had the lowest (2.12). The breakdown of non-reducing sugars into simpler reducing sugars during storage, which is sped up by enzymatic activity, is the main cause of the steady increase in reducing sugars in honey-based formulations (Pandey and Sangwan, 2018) [6]. Due to honey's inherent inhibitory effect on enzyme activity and microbiological development, the lower Mahua content and higher honey content displayed the least increase (Mandal and Mandal, 2011) [9].

Fat percentage was recorded highest for the treatment T₆ had the highest fat percentage (13.49), whereas T₁ had the lowest (12.14). Lipid oxidation and hydrolysis during storage, which are frequently increased by oxygen exposure and storage time, are indicated by the gradual decrease in fat content during both seasons (Rao and Goyal, 2007) [10]. Overall, honey-based formulations maintained higher fat

percentages, suggesting that honey's antioxidant properties may play a role in delaying lipid breakdown (Mandal and Mandal, 2011)^[9]. The highest protein percentage was recorded for the treatment T₆ (6.61), while T₁ had the lowest (6.19). The steady decrease in protein concentration is indicative of natural deterioration during storage, most likely as a result of denaturation and hydrolysis processes that are sped up by exposure to the environment and time (Rao and Goyal, 2007)^[10]. However, protein degradation seemed to be slowed by honey's inherent antioxidant and antibacterial qualities, which is consistent with Mandal and Mandal's (2011)^[9] observation that honey stabilizes biomolecules. Bacterial Count was recorded highest in T₇ (36) and lowest in T₃ (30). Honey-based Immunity Booster Balls recorded lower bacterial loads throughout the storage period, reinforcing the preservative potential of honey as a functional sweetener (Mandal and Mandal, 2011; Singh *et al.*, 2023)^[9, 11]. These findings indicate that honey's antimicrobial properties—derived from low water activity, acidity, and hydrogen peroxide production—initially

delayed bacterial growth but became less effective after 90-120 days (Mandal and Mandal, 2011; Singh *et al.*, 2023)^[9, 11]. Fungal count recorded highest in T₇ (38) and lowest in T₄ (32). honey's natural antifungal mechanisms, including its high osmotic pressure, low water activity, and the presence of hydrogen peroxide and phenolic compounds, which inhibit fungal spore germination (Mandal and Mandal, 2011; Singh *et al.*, 2023)^[9, 11]. Similar storage-related fungal proliferation has been reported in other fruit-and cereal-based laddus after three months of ambient storage (Pandita *et al.*, 2018; Wadhwan and Bansal, 2018)^[12, 15]. Organoleptic Evaluation resulted highest overall acceptability for treatment T₆ (19.43) and lowest for treatment T₁ (14.21). Similar patterns of taste decline have been documented in Mahua-based products and nutritionally enriched energy balls, where storage is associated with diminished aromatic sharpness and loss of fresh notes due to moisture migration and biochemical changes (Chinmaya *et al.*, 2016; Ahirwar *et al.*, 2023)^[13, 14]

Table 1: Physico-Chemical analysis of Immunity Booster Balls during storage

Treatments	Total Sugar %	Reducing Sugar%	Moisture %	Fat %	Protein %
T ₁	22.21	2.12	9.55	12.14	6.19
T ₂	22.79	2.16	8.56	12.47	6.26
T ₃	23.66	2.24	9.18	12.49	6.33
T ₄	24.59	2.36	8.32	13.49	6.40
T ₅	25.61	2.50	8.96	13.31	6.47
T ₆	27.66	2.61	10.18	13.49	6.61
T ₇	26.63	2.70	9.80	12.83	6.54

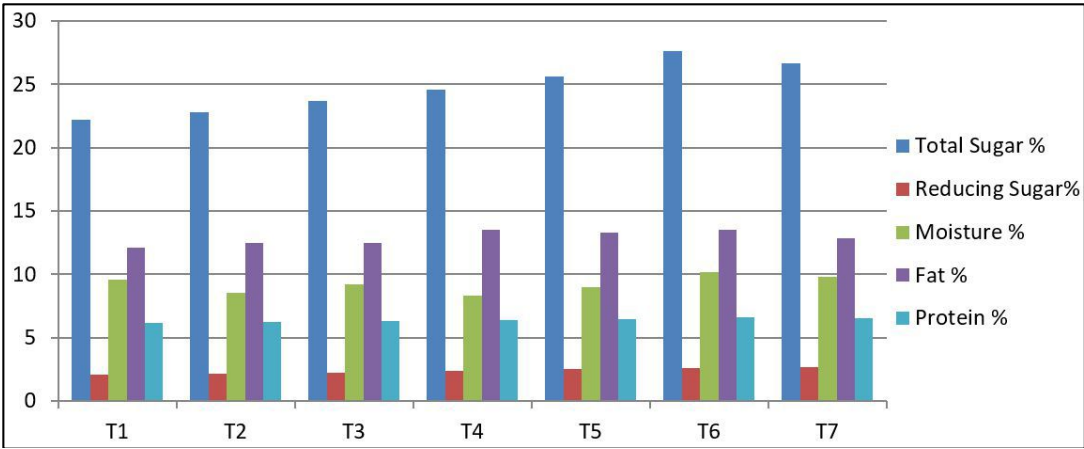


Fig 1: Mean physico-chemical and nutritional analysis of Honey Based Immunity Booster Balls *Madhuca longifolia* over storage period of 6 months (January-June 2024)

Table 2: Effect of storage duration on Bacterial load of Honey based Immunity Booster Balls

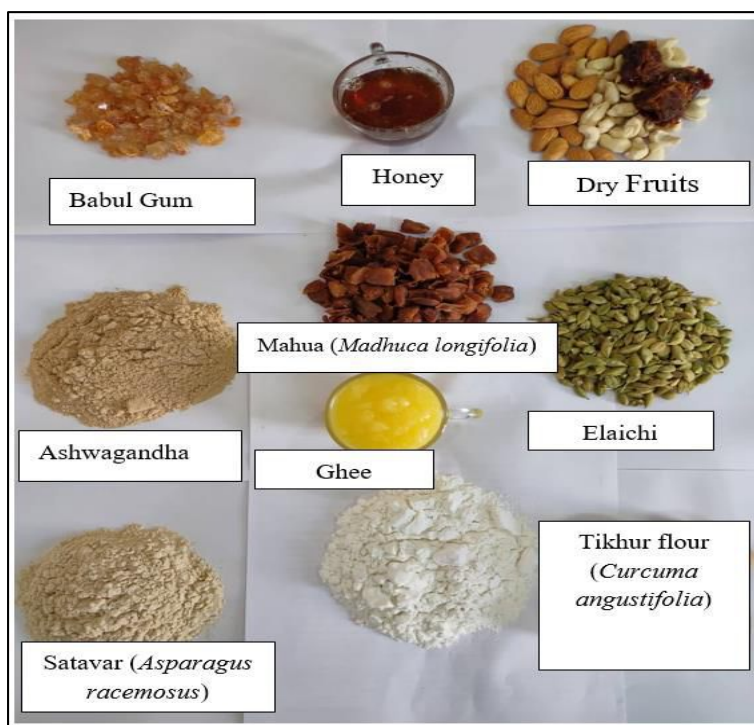
Treatment	0 Days	30 Days	60 Days	90 Days	120 Days	150 Days	Mean
T ₁	NG	NG	NG	2	13	17	32
T ₂	NG	NG	NG	3	11	22	36
T ₃	NG	NG	NG	3	12	15	30
T ₄	NG	NG	NG	2	10	18	30
T ₅	NG	NG	NG	4	13	17	34
T ₆	NG	NG	NG	3	14	17	34
T ₇	NG	NG	NG	3	11	22	36

Table 3: Effect of storage duration on fungal load of Honey based Immunity Booster Balls

Treatment	0 Days	30 Days	60 Days	90 Days	120 Days	150 Days	Mean
T ₁	NG	NG	NG	3	13	20	36
T ₂	NG	NG	NG	2	11	23	36
T ₃	NG	NG	NG	2	16	19	37
T ₄	NG	NG	NG	3	11	18	32
T ₅	NG	NG	NG	3	12	21	36
T ₆	NG	NG	NG	2	11	22	35
T ₇	NG	NG	NG	3	15	20	38

Table 4: Effect of storage duration of organoleptic evaluation of Honey based Immunity Booster Balls

Treatment	Colour	Grittiness	Aroma	Taste	Overall Acceptability
T ₁	3.23	3.58	3.75	3.67	14.21
T ₂	4.25	4.65	4.83	4.70	18.47
T ₃	4.09	4.44	4.63	4.48	17.69
T ₄	3.89	4.25	4.46	4.30	16.92
T ₅	3.67	4.03	4.19	4.12	16.03
T ₆	4.53	4.90	5.06	4.90	19.43
T ₇	3.44	3.83	3.98	3.91	15.16





Conclusion

The final product, Honey-based immunity booster balls, were stored and acceptable consumption up to 60 days from the day of preparation; all chemical parameters showed a decreasing trend as the storage period increased, with the exception of reducing sugar and moisture, which showed the opposite trend; the bacterial load and fungal load showed the decreasing trend with the increasing storage period. It can be concluded that Treatment 6 was the best and most accepted of all the treatments in excellent test and quality as compared with the other treatments.

References

- Chand S, Mahapatra SN. Production of sugar syrup from mahua (*Madhuca longifolia*) flower. Res Ind. 1983;28:29-31.
- Sinha J, Singh V, Singh J, Rai AK. Phytochemistry, ethnomedical uses and future prospects of mahua (*Madhuca longifolia*) as a food: a review. J Nutr Food Sci. 2017;7:573. doi:10.4172/2155-9600.1000573.
- Ravindran PN. Turmeric: the genus *Curcuma*. In: Nirmal Babu K, Sivaraman K, editors. Florida (USA): Taylor and Francis Group; 2007. p. 10-11.
- Orwa C, Mutua A, Kindt R, Jamnadass R, Anthony S. Agroforestry database: a tree reference and selection guide. Version 4.0. Nairobi: World Agroforestry Centre; 2009.
- Saikia H, Islam M. Development and formulation of value-added products from *Musa paradisiaca* L. Int J Chem Stud. 2020;8(2):2694-2700.
- Pandey N, Sangwan V. Storage stability of traditional Indian laddus: microbial and chemical perspectives. J Food Process Preserv. 2018;42(3):e13522.
- Verma N, Patel S. Value addition and process standardization of nutri-rich ragi (*Eleusine coracana*) products. Int J Food Sci Nutr. 2023;8(1):10-18.
- Raval DM. Shelf life of thabdi peda using different packaging materials and techniques. Indian J Dairy Sci. 2013;66(4):321-328.
- Mandal MD, Mandal S. Honey: its medicinal property and antibacterial activity. Asian Pac J Trop Biomed. 2011;1(2):154-160.
- Rao KH, Goyal PK. Effect of packaging and storage on sensory quality of kalakand. J Dairy Sci. 2007;90(2):517-524.
- Singh R, Gupta R, Sharma S. Antimicrobial and antifungal activities of honey: mechanisms and applications in food preservation. Food Biosci. 2023;53:102780.
- Pandita A, Sharma N, Singh R. Storage stability of fruit-based traditional sweets: microbial and physicochemical perspectives. J Food Process Preserv. 2018;42(5):e13529.
- Chinmaya KR, Kumar P, Ranjan S. Sensory and storage studies of mahua-based value-added products. J Food Process Preserv. 2016;40(5):1074-1082.
- Ahirwar A, Gupta V, Singh A, Yadav A. Development and quality evaluation of nutritionally enriched energy balls. Int J Food Sci Nutr. 2023;8(2):34-41.
- Wadhwan S, Bansal S. Packaging technologies for extending the shelf life of Indian traditional sweets. Food Packag Shelf Life. 2018;4(2):52-61.