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Sensory and Nutritional Evaluation of the Development of Cookies with the Incorporation of Different Concentrations of Aerial parts (Fruit, Flower and Seed) of Mahua

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ABSTRACT

Cookies are among the most widely consumed baked products across diverse demographics. The study investigates the incorporation of Mahua longifolia aerial parts (fruit, flower,and seed) into cookie formulations to enhance their nutritional profile. Madhuca longifolia, commonly known as Mahua, is a medical plant recognised for its high content of carbohydrates, proteins, vitamins, and bioactive compounds. The study aimed to assess the development of cookies with varying concentrations of Mahua aerial parts and evaluate their sensory attributes. Results indicating that cookies were formulated with different proportions of Madhuca longifolia, including the Control (100% wheat) and eight treatments incorporating varying proportions of Mahua components in the form of powder, were subjected to sensory evaluation using a 9-point Hedonic Scale. The cookie formulation, consisting of 30% mahua flower powder and 70% wheat flour, was rated as the most acceptable by a panel of 25 judges based on sensory evaluation. This formulation received the highest preference in terms of colour, appearance, flavour, taste, texture, and overall acceptability compared to other variations tasted. The findings suggest that Mahua flowers can be effectively utilised in nutrition-rich cookie formulations, with promising commercialisation prospects in the health and organic food sector. Further research is recommended to optimise formulations and explore fortification strategies for improved sensory and functional attributes.

I. INTRODUCTION

In India, the terms " biscuits" and "cookies" are often used interchangeably to refer to small, sweet baked treats that are typically flat in shape (1). These snacks are usually made with common flour, oil, and fat, and come in various styles that incorporate ingredients such as sugar, spices, chocolate, butter, peanut butter, nuts, or dried fruits. The texture of cookies can vary, ranging from crisp to soft, depending on the baking time. India is the world's second-largest producer of biscuits, surpassed only by the United States (2).

The Mahua tree, belonging to the Sapotaceae family, is one of the most valuable forest plants, with every part serving a purpose (3). The tree has two main species- *Madhuca longifolia* and *Madhuca indica*, both native to India and sharing many similarities, and also known as the Indian Butter Tree (4, 5). Meanwhile, Mahua is a medium-to-large-sized sizes deciduous tree (16-20 m) that thrives in dry tropical and subtropical climates, even in rocky soil. It is an evergreen and larger species found mainly in Uttar Pradesh, Maharashtra, Bengal,

Madhya Pradesh, chhatisgharh, Gujarat, and Andhra Pradesh (6). Mahua holds significant religious and cultural value within tribal communities. The flowers and seeds are prized for their medicinal and nutritional benefits and are typically collected and dried (7). Studies on Mahua's phytochemistry have found in containing sugar, vitamins, proteins, alkaloids, phenolic compounds, and other nutrients in the various parts of Mahua like roots, stem, leaf, flower, fruit, seed, and break etc (8, 9, 10, 11). mahua flowers are commomly used in food preparation, such as in biscuits, cakes, ladoo, candies, bars, jams, jellies, sauces, and other baked items. They are also used to make liquor (12, 13, 14). Traditionally, Mahua is known to help increase milk production and secretion in lactating mothers, which is crucial as a women's nutritional needs are heightened during lactation and pregnancy (15, 16). A well-balanced diet during pregnancy supports fetal growth and adequate breastfeeding, while poor nutrition during lactation can impact milk quality and quantity (16). This study aims to developed cookies from aerial parts of *Madhuca longifol*ia.

II. METHODOLOGY

2.1 Collection of data

The collection of aerial parts (fruit, flower, seed) of *Madhuca longifolia* from the agriculture company Somani Treading in Chhattisgarh.

2.2 Preparation of cookies

Firstly, fresh Mahua flowers were cleaned with water, and then they were spread evenly in trays to remove excess water for about seven days. After drying, the flowers, fruits, and seeds were ground into powder separately. The powders were then sieved and packaged in airtight containers at room temperature for further preparation of cookies. Dough was sheeted with a rolling pin and cut into the desired size and shape with a cutter. The prepared cookies were baked in an oven at 160℃ for 25 min (17).

- Dry aerial parts of *Madhuca longifolia*
- Grinding
- Mixing of dry aerial part powder with wheat flour + leavening agent + oil + sugar
- Knead the dough for 15 min
- Proofing for 30-45 min
- Sheeted with a rolling pin, cut into different sizes
- Baking in the oven at 160℃ for 25 min
- Cooling for an hour
- Packing and Storing

Table 2.1:- Formulations for each cookie sample are as follows:

	Ingredients				
Sample no.	**Wheat flour (g)**	**Mahua fruit (g)**	**Mahua flower (g)**	**Mahua seed (g)**	**Total**
Control	100	-	-	-	100
S 1	70	30	-	-	100
S 2	80	20	-	-	100
S 3	70	-	30	-	100
S 4	80	-	20	-	100
S5	70	-	-	30	100
S6	80	-	-	20	100
S7	70	14	14	02	100
S8	80	9	9	2	100

2.3 Optimization of Mahua aerial parts-based cookies (18)

Sensory evaluation was considered an essential analytical tool in the present-day competitive environment to judge the acceptability of food among potential consumers; a panel was an analytical tool in sensory evaluation. The value of food depends on the objectivity, precision, and responsibility of the judgment of the panellist, before a panel can be used with confidence. The ability of the panellist, motivation, general attitude, and emotional state of the panellist may be responsible for reliable and valid judgment. The person as a panellist should be absent when suffering from conditions that might interfere with the normal function of taste and smell. The price of information was passed to the panellist. The motivation of the panellists affects the response to a great extent. Therefore, the panellists were made to feel that they were doing an important activity and that their contribution was significant. The panellist explained the sensory attributes they were supposed to measure.

- Sensitivity: Panel members should have typical olfactory and gustatory sensitivity, which training can improve.
- Age: All interested persons, regardless of their age, were admitted.
- Avoidance of disturbance during the test: Sensory analysis requires intense concentrations by the panel members; therefore disturbance such as noise, off odors, etc., much be avoided. In addition, test subjects should not have the chance to influence each other through facial expressions or by conveying results orally.
- Additional points to be considered: The panel member should rinse the mouths correctly before starting the test.
- Methods for selecting panel members: The selection involved screening 30 postgraduate students of the Home Science department in Banasthali Vidyapith. All of these were subjected to a triangle difference test, and 25 students with sharp discrimination, discretion, and communication powers were selected and then proceeded to the other evaluation.

2.3.1 Triangle difference taste

This test was named so because it involved presenting three samples to the panel members in a triangle form, but in practice, they were kept in a straight line. In the present study, a triangle difference test was conducted using prantha. Two of three samples were the same, and one was different. The panel members were asked to choose a different sample for each triangle test. The samples were prepared in the following order.

- A well-prepared questionnaire for a triangle test was provided to the panel members.
- The subject was asked to identify the odd sample.
- After some time, the questionnaires were collected from each other.
- The evaluation was done based on the subject's ability to discriminate.

Through this testing, 25 semi-trained panellists with better sensory attributes were selected, and the difference was identified.

2.3.2. 9- Point Hedonic Scale

Hedonic rating relates to pleasure or unpleasant experience. The bread of difference was evaluated for sensory quality characteristics on a 9-point hedonic scale to test liking and disliking for the following attributes: color, appearance, taste, flavour, texture and overall acceptability. Selected semi-trained panel members evaluated it after they were given detailed instructions regarding the scoring method and the significance of their judgment.

Then, determine the proximate composition of the most acceptable cookie and the standard cookie by the standard method of the Association of Official Analytical Chemists (19).

III. RESULTS

3.1 Sensory evaluation

Sensory evaluation is a scientific discipline that involves the application of experimental design principles and statistical analysis to assess food products using human senses, including sight, smell, and taste. In this section of the study, A semi-trained panel of 25 judges, selected through the triangle difference test, conducted the sensory evaluation. The 9-point hedonic scale was used. The following attributes were selected for

organoleptic evaluation: Color, appearance, Flavour, Taste, and Overall acceptability. The data obtained by sensory evaluation were quantified by calculating the mean and standard deviation of the scores.

Table 3.1: Sensory evaluation of Cookies Developed from Different Proportions of aerial parts of *Madhuca longifolia*

Cookies	Colour	Appearance	Flavour	Taste	Texture	Overall acceptability
Control	9±0.0	8.9±0.19	8.8±0.32	8.9±0.04	8.8±0.32	9±0.0
S 1	7.3±0.48	7.6±0.79	7.5±0.90	7.7±0.78	7.0±0.27	7.6±0.7
S 2	7.9±0.90	7.4±0.85	7.9±0.65	7.5±0.70	7.5±0.76	7.4±0.7
S 3	8.9 ± 0.48^{NS}	8.9 ± 0.39^{NS}	8.8 ± 0.42^{NS}	8.9 ± 0.27^{NS}	8.8 ± 0.54^{NS}	8.9 ± 0.04^{NS}
S 4	7.1±0.97	7.1±0.40	7.2±0.36	7.0±0.50	7.0±0.19	7.3±1.2
S 5	7.7±0.88	7.0±0.77	7.4±0.50	7.6±0.48	7.5±0.71	6.2±0.95
S 6	7.8±0.69	7.9±0.82	7.5±0.50	7.8±0.86	7.6±0.70	6.8±0.84
S 7	8.2 ± 0.40^{S}	8.4 ± 0.64^{S}	7.9 ± 0.72^{S}	8.7 ± 0.43^{NS}	8.6 ± 0.47^{NS}	8.8 ± 1.24^{NS}
S 8	7.1±0.39	7.7±0.82	7.8±0.96	7.3±0.48	7.6±0.49	7.7±1.1

The data reported as Mean ± Standard Deviation (n=25); S denotes Significant , NS denotes non-significant at P-Value ≤ 0.05, Control = 100% Wheat, S 1 = 70%Wheat: 30% Mahua fruit, S 2 = 80%Wheat:20% Mahua fruit, S 3 = 70%Wheat:30% Mahua flower, S 4 = 80% Wheat: 20% Mahua flower, S 5 = 70% Wheat 30 Mahua seed, S 6 = 80% Wheat:20% Mahua seed, S 7= 70 % Wheat:30% mixture, S 8 = 80% Wheat:20% mixture.

The sensory evaluation of cookies incorporating different proportions of *Madhuca longifolia* aerial parts showed significant variations in key sensory attributes, including colour, appearance, flavour, texture, and overall acceptability.

The standard cookie (100% wheat flour) received the highest sensory scores in all parameters, with colour (9±0.0), appearance (8.9±0.19), flavour (8.8±0.32), taste (8.9±0.04), texture (8.8±0.32), and overall acceptability (9±0.0). These scores serve as a reference for comparing formulated samples.

Among all formulations, **Sample 3 (70% wheat: 30% Mahua flower)** received the highest sensory scores, closely similar to standard cookies. The differences were statistically non-significant at the **p≤0.05** level for **colour (8.9±0.48), appearance (8.9±0.39), flavour (8.8±0.42), taste (8.9±0.27), texture (8.8±0.54), and overall acceptability (8.9±0.04).** Sample 7 (70% wheat flour: 30% mixture powder) also received the highest sensory score on the bases of taste (8.7±0.43), texture (8.6±0.47), and overall acceptability (8.8±1.24), while showing a non-significant difference p **≤0.05** level. Samples 1, 2, 4, 5, 6, and 8 showed moderate sensory scores, ranging from 7.0 to 7.9 for different parameters. Sample 4 (80% Wheat: 20% Mahua Flower) had the lowest scores, particularly for taste (7.0±0.50) and texture (7.0±0.19). Similarly, Sample 5 (70% Wheat: 30% Mahua Seed) had the lowest overall acceptability (6.2±0.95), indicating reduced consumer preference.

Table 3.2:- Proximate Composition of Most Acceptable Cookies (Sample 3) and Standard Cookies

Parameters (g/100g)	Standard Cookies	Acceptable Cookies
Moisture	8.4±0.02	4.0 ± 0.01^{S}
Ash content	2.3±0.08	2.9 ± 0.02^{S}
Fat Content	2.2±0.10	4.9 ± 0.0^{S}
Crude Protein	10.8±0.08	14.4 ± 0.03^{S}
Crude Fibre	3.5±0.01	4.7 ± 0.02^{S}
Carbohydrate	72.8±0.02	69.0 ± 0.02^{S}

Values are expressed as Mean±SD, S3- Acceptable cookie S- denotes significant at p≤ 0.05 level; NS- non significant at p≤0.05

The proximate composition analysis of the most acceptable cookies (Sample 3) and standard cookies showed significant differences ($p \leq 0.05$) across several parameters. The moisture content of the acceptable cookies (4.0±0.01 g/100g) was significantly lower than that of the standard cookies (8.4±0.02 g/100g). Similar results were observed by Solanki. (2020), where the moisture content of mahua flower-based cookies ranged from 5.2%.

The ash content of the acceptable cookies (2.9±0.02 g/100g) was higher compared to the standard cookies (2.3±0.08 g/100g). Comparable results were observed by Solanki (2020), where the ash content of mahua flower-based cookies was recorded at 2.1%. The fat content in the acceptable cookies (4.9±0.0 g/100g) was significantly higher than in the standard cookies (2.2±0.10 g/100g). Similar results were observed by solanki, (2020), where mahua flower-based cookies exhibited a fat content of 8.1%.

The protein content in the acceptable cookies (14.4±0.03 g/100g) was significantly higher compared to the standard cookies (2.2±0.10 g/100g). These results align with those observed by Solanki (2020), who reported a protein content of 14.58% in mahua flower-based cookies. The fiber content in the acceptable cookies (4.7±0.02 g/100g) was also significantly higher than in the standard cookies (72.8±0.02 g/100g). Similar values were reported by Solanki (2020), who recorded a fiber content of 4.78% in mahua flower-based cookies.

However, the carbohydrate content of the acceptable cookies (69.0±0.02 g/100g) was significantly lower than that of the standard cookies (72.8±0.02 g/100g). These findings indicate that the acceptable cookies had enhanced protein, fat, fiber, and mineral content while maintaining lower moisture and carbohydrate levels.

CONCLUSION

The present potential, cookies were formulated using *Madhuca longifolia* aerial parts and evaluated by a semi-trained panel selected via a triangle test. Sensory attributes, including colour, appearance, taste, flavour, texture, and overall acceptability, were assessed using a 9-point hedonic scale. Results indicating that the formulation containing 70% wheat flour and 30% Mahua flower (Sample 3) was statistically comparable to the standard cookies. Nutritional analysis showed that the enriched cookie had significantly increased moisture, while fat, protein, fibre, and ash content were reduced, compared to the standard cookies. Thus, the findings of this study indicate that the formulated cookies exhibited favourable organoleptic acceptance while also demonstrating an improved nutritional profile, which may highlight the potential of incorporating underutilised *Madhuca* as a valuable ingredient in bakery products.

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