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Standardization and formulation of mixed fruit bar incorporated with mahua flowers

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Abstract
The current study aimed to standardize a formulation for mixed fruit bars incorporating mahua flowers. The precise formulation of any product is a crucial factor that determines its sensory acceptability and marketability. Therefore, several treatments, namely T_0 (80:20:0) T_1 (70:20:10), T_2 (60:20:20), and T_3 (50:20:30), were employed to standardize the mixed fruit bar by varying the concentration of mango pulp, papaya pulp, and mahua flower pulp in the formulations. While the papaya pulp concentration was kept constant, the mango pulp and mahua flower pulp were varied in each treatment. The fruit bar was prepared by first preparing a puree of mango fruit pulp, papaya fruit pulp, and mahua flower pulp, followed by heating the mixture for 15 minutes at 70–80 °C to reach 50 ^{0}Bx, after that the puree mixture was poured into glycerin-polished plates and then dried in cabinet dryer at 65 °C for 7-8 Hrs. Among the above treatments it was found that sample T_2, which contained mango pulp, papaya pulp, and mahua flower pulp in the ratio of 60:20:20, respectively, received the highest hedonic score 8.2 from the semi-trained sensory panel, hence it was selected successfully for final formulation.

Keywords: Mixed fruit bar, mahua flowers, *Madhuca indica*

Introduction
Madhuca indica (Mahua) is a saponaceous tree having high economic value producing two most important non-timber forest product i.e., mahua flower and mahua seed. It is one of the multipurpose forest tree species that offers a solution for the three key namely food, fodder, and fuel. Madhuca is also known as Madhuka, Madhudruma, Madhupuspa, Madhusakha, and 'Gudapuspa' in Sanskrit. It is also known as Mahua or Mowarh in the North, Mahula in Odisha, and Illipi in the Southern portion of India. The name is derived from the Sanskrit word madhu, which means honey because of its very sugar-rich flowers. It is native to the Indian subcontinent and is widely dispersed in the central India's dry deciduous forests (Madhya Pradesh, Orissa, Chhattisgarh, Bihar, Jharkhand, and portions of Rajasthan, Gujarat, Andhra Pradesh, and Tamil Nadu). One of the most significant non-timber forest products collected in the nation is mahua flowers (M. Patel, 2008) [15].
Mahua's potential annual production is only 4.9 million MT, which is less than its anticipated annual production of 85 million MT. Mahua flowers are sold daily by collectors during the harvest season to cover their daily expenses, sometimes after preliminary drying and sometimes in raw form. Mahua flowers are traded on average for 5,730 MT, 2,100 MT, 13,706 quintals (value 8.4 million rupees), and 6,188 quintals of mahua seeds (worth 6.5 million rupees) in Madhya Pradesh, Odisha, and Andhra Pradesh, respectively (Thakur & Babu 2008) [21]. Mahua, also known as *Madhuca longifolia*, is a member of the *Sapotaceae* family. Sugars found in abundance in mahua flowers give them their sweet flavour. Vitamin C, which is present, has antioxidant properties. Additionally, vitamin A is present. Several minerals, including calcium and phosphorus, as well as small amounts of proteins and lipids are found in mahua flowers. Madhuca flowers have a variety of medicinal uses, including antibacterial, antioxidant, anti-inflammatory, analgesic, antipyretic, ulcer-healing, and wound-healing characteristics (Jha & Mazumber, 2018) [8].
Mahua flowers' chemical composition and nutritional potential can also be used for producing valuable food products like fruit bars, toffee, and syrups. Mango, guava, papaya, bale, and pineapple fruit pulp are preferred by confectioners to be used as a bulking ingredient while making fruit bar The mixed fruit bar made from these ingredients has high nutritive value.
The mango is the most significant fruit crop in India. It is known as the "King of Fruits" because to its fabulous flavour, extremely appealing flavour, lovely colour, and outstanding nutritional value (Nagaharshitha *et al*., 2014) [14].

The family *Anacardiaceae* of flowering plants comprises over 30 tropical fruiting trees in the genus Mangifera, which also includes mangoes (Mangifera indica). It is the most significant commercially grown fruit crop and the second-highest producing tropical crop.

Mango is one of the most widely grown fruits in the world, with 58.3 million metric tons in 2021. Mango production and exports are primarily concentrated in India. Mango fruit secures the 2nd position as a tropical crop that is grown in nearly 87 countries in the world. In 2021, India came in at number one in mango production with 3.4 million metric tons, followed by Indonesia at 3.4 million, China at 1.8 million, and Mexico at 1.2 million.

Mango pulp is desirable to consumers because of its high levels of organic acids, particularly citric acid, and high levels of fibre and water. The presence of the hormone ethylene, which helps in the production of endogenous hydrolytic enzymes like amylases and chlorophyllase, is responsible for this biochemical activity. These concentrations decrease as the fruit matures and the content of soluble solids (sugars) increases (Bose & Mitra, 2001) [3].

Mangoes are rich in organic acids, carbohydrates, dietary fibre, vitamin C, and other vitamins and minerals. The most commonly found soluble sugars in mango are sucrose, fructose, and glucose, whereas the most dominant organic acids are citric and malic acid (Medlicott & Thompson, 1985) [12].

Papaya is mostly grown in India, Brazil, Mexico, Nigeria, Indonesia, Ethiopia, Thailand, Peru, Columbia, Guatemala, and the Philippines. It is grown in practically all tropical and subtropical areas of India. The top producers are Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, and Tamil Nadu. India is the world's top papaya-producing nation with a productivity of 43.40 MT/h and an annual production of 5989,000 MT from an area covering of 138,000 hectares. Andhra Pradesh is the leading papaya producer in India, growing 1.6 million tons. While Gujarat securing second position, with its production figure of almost 1.2 million tons. Papaya is also produced in Karnataka, Maharashtra, West Bengal, Chhattisgarh, Madhya Pradesh, Assam, Tamil Nadu, and Kerala (Anonymous, 2018) [1].

Papaya is a highly nutritious fruit having good amount of Vitamin A, B1, B2, and C, minerals like potassium, magnesium, boron, iron, calcium, and phosphorous, and copper are also present in papaya. Additionally, it contains 0.6% protein, 10-13% sugar, and 85–90% water. Papaya has an energy content of 200 kJ/100 g. Papaya contains glucose, fructose, and sucrose among other sugars (Prasad& Paul 2021) [18].

For better utilization of these perishable goods such as mango, papaya and mahua flower there is great need to develop technology. The processing technologies on blending of fruit pulp may result not only in better utilization of these less exploited fruit crops but also help to utilize the produce at the time of glut to save it from spoilage. The production of value-added products will give employment opportunities by starting small scale processing unit or cottage industry.

Fruit bars, also known as fruit leather or fruit slab, are a type of confection made by drying fruit pulp and combining it with the right amount of sugar, pectin, acid, and color. The fruits that can be used to prepare them include guava, banana, papaya, mango, sapota, apple, and jackfruit. When made with natural fruit pulp, fruit bars are not only more palatable but also healthier since they contain higher levels of dietary fiber, minerals, and vitamins in the final product (Chauhan *et al*., 1993) [4]. Fruit bars are a delicious and nutritious snack that can be enjoyed by people of all ages.

Fruit bars can be used as a natural and wholesome alternative to conventional sweets, cookies, and cakes that are high in fat or sugar. Fruit bars are a delightful and simple food that can be eaten anywhere and are a highly accessible product in terms of packing and distribution. Fruit processing into fruit bars or fruit leather is therefore particularly advantageous because it allows for the utilisation of both fully ripe fruits with more sugar, superior colour, flavour, and carotenoid content, as well as over-ripe fruits (Singh &Tiwari, 2019) [20].

Material and Methods

Well matured mango, papaya fruits and dried mahua flowers were selected to prepared good quality mix fruit bar.

Ingredients: Mango, papaya fruits, mahua flowers, powder sugar, citric acid and glycerin.

Packaging material: Low density polyethylene (LDPE), Aluminium foil (ALF), were purchased from local market of Parbhani.

Chemicals and Glasswares

The chemicals and glassware used during the present investigation were taken from the Department of Food Process Technology, College of Food Technology, Parbhani

Equipments and Machineries

Equipments including weighing balance, pulper, hot air oven, muffle furnace and vernier caliper were taken from the Department of Food Process Technology, College of Food Technology, Parbhani.

Methods

Physical properties of fruits different physical properties *viz*., size, shape, colour, diameter, length, percent waste, percent yield and percent seed weight were assessed as per the method given by Polat *et al*., (2008); Mikdat (2010) [13].

Chemical composition of fruits

Chemical properties like moisture, fat, protein, carbohydrates, crude fiber, ash and ascorbic acid were analyzed as per the method given by A.O.A.C. (2000) [2]. pH, TSS, Titratable acidity, reducing sugar and non-reducing sugar determine by Ranganna (1995) [19].

Result and Discussion.

Physical properties of mango, papaya fruits and mahua flowers

Physical properties play a key role in fruit processing. Physical properties like size, shape average weight, pulp percentage etc. fruit size and shape play a key role designing fruit processing machines and equipment because if the fruits having same size and shape then operations of fruit processing like blanching, cutting, slicing will be got easier and vice versa for non-uniform size and shape.

Table 1: Physical properties of fresh mango, papaya fruit.

Physical parameters	Fruits	
	Mango	Papaya
Color	Yellowish	Yellowish
Weight(g)	328.45	821.79
Length(cm)	6.79	19.21
Peel weight(g)	36.79	161.9
Stone/seed (g)	48.82	23.4
Pulp weight(g)	244.79	636.49
Pulp recovery (%)	74.57	77.45

*Each value is an average of three determination

Table 1. presents data on the physical properties of fresh mangoes and papayas. For the mango fruit, three fruits were randomly selected, and their physical parameters were studied. The color of the mango fruit was yellowish, and the average weight was found to be 328.45 g, with a length of 6.79 cm. The peel weight and stone were found to be 36.79 g and 48.82 g, respectively. After peeling, the pulp recovery was 74.57%, with a weight of 244.79 g. The physical properties of mango are consistent with the findings of Harshitha *et al*. (2016) [6] and Jayswal *et al*. (2015) [7].

The findings of a study on papaya fruit have revealed that the fruit exhibits yellowish skin and reddish-yellow flesh. The average weight of each papaya was determined to be 821.79 g, consisting of 161.9 g of peel and 23.4 g of seeds. The pulp weight of the fruit was measured at 636.49 g, implying that the edible portion constituted 77.45% of the total weight. Additionally, the mean length of the papaya fruit was calculated to be 19.21 cm. These values are consistent with those published by Kumar *et al*., (2017) [10].

Table 2 represents the physical properties of the mahua flowers used for producing mixed fruit bars. The flowers had a dark brown color, fleshy texture, globular shape, sweet taste, and an average weight of 1.8 g per unit. These physical characteristics of the mahua flowers correspond with the findings of Patel *et al*., (2011) [17].

Table 2: Physical properties of mahua flower

Physical Parameters	Mahua flower
Color	Dark Brown
Shape	Globular
Texture	Fleshy
Taste	Sweet
Average weight	1.8 g

Chemical properties of mango, papaya fruits and mahua flowers

Chemical properties play a key role in products nutritional value as well as safety of food products every food product contained unique bioactive compounds or nutrient that gives more health benefits hence to determine chemical composition is very important. The obtained results were denoted in table 3.

The moisture content of papaya fruits was highest at 83.62%, followed by mango fruits (82.46%). On the other hand, mahua flowers contains lowest moisture content (16.29%). Mahua flowers shows the highest fat content (0.94%), as compare to papaya fruits (0.39%) and mango fruits (0.31%). In terms of protein content, mahua flowers revealed the highest protein with (6.39%), followed by mango fruits (0.92%) and papaya fruits (0.69%). Mahua flowers also contain the highest ash content at 4.38% than papaya fruits (2.1%) and mango fruits (1.63%). Finally, mahua flowers revealed the highest carbohydrate content at 69.79%, followed by mango fruits (13.29%) and papaya fruits (8.42%). When it came to crude fiber content, papaya fruits reported the highest fiber content (4.6%), followed by mahua flowers (1.72%) and mango fruits (1.4%).

Table 3: Chemical properties of mango, papaya fruits and mahua flowers.

Constituents	Fruits		Mahua flower
	Mango	Papaya	
Moisture (%)	82.46 ±1.1	83.62±1.2	16.79±0.21
Fat (%)	0.31±0.03	0.39±0.2	0.94±0.03
Protein (%)	0.92±0.04	0.69±0.02	6.39±0.12
Carbohydrate (%)	13.29±0.98	8.42±0.17	69.79±0.11
Ash (%)	1.63±0.06	2.1±0.30	4.38±0.34
Crude fibre (%)	1.4±0.03	4.6±0.15	1.72±0.08
TSS (^{0}Bx)	16.5±0.32	13±0.21	28±0.80
pH	3.71±0.04	4.31±0.05	4.9±0.40
Acidity (%)	0.28±0.02	0.48±0.03	0.41±0.03
Total sugar (%)	13.10±0.39	9.97±0.8	34.5±1.10
Reducing sugar (%)	8.42±0.21	5.78±0.14	30.7±8.4
Ascorbic acid (mg/100 g)	28.61±0.81	58.49±1.31	13.24±0.35

*Each value is an average of three determination

In terms of protein content, mahua flowers revealed the highest protein with (6.39%), followed by mango fruits (0.92%) and papaya fruits (0.69%). Mahua flowers also contain the highest ash content at (4.38%) than papaya fruits (2.1%) and mango fruits (1.63%). Finally, mahua flowers revealed the highest carbohydrate content at (69.79%), followed by mango fruits (13.29%) and papaya fruits (8.42%). When it came to crude fiber content, papaya fruits reported the highest fiber content (4.6%), followed by mahua flowers (1.72%) and mango fruits (1.4%). Mahua flower had the highest TSS (total soluble solids) content at (28.0°Bx), indicating a higher concentration of soluble solids in comparison to mango (16.5 °Bx) and papaya (13.0 °Bx). Mango had the lowest pH (3.71), signifying higher acidity compared to papaya (pH 4.31) and mahua flower (pH 4.9). Papaya displays the highest acidity (0.48%), followed by Mahua flower (0.41%) and mango (0.28%). In terms of total sugar content, Mahua flower shows the highest percentage (34.5%), followed by mango (13.10%) and papaya (9.97%). Both mahua flower and mango had relatively higher sugar content compared to papaya. Among the three it was found that mahua flower contains the highest percentage of reducing sugars (30.7%), while mango and papaya contain lower values (8.42% and 5.78% respectively). Non-reducing sugars were higher into the mango (4.68%) compared to papaya (4.19%) and mahua flower (3.8%). Papaya exhibits the highest ascorbic acid content at 58.49 mg/100 g, followed by mango (28.61 mg/100 g) and mahua flower (13.24 mg/100 g). Based on the results, it can be concluded that mahua flower has an exceptionally high sugar content and moderate acidity, while papaya shows high ascorbic acid levels. The obtained results of the analysis on mango, papaya fruit, and mahua flower pulp are in close agreement with Jayswal *et al*., (2015) [7]. Lebaka *et al*., (2021) [11], Chukwuka *et al*., (2013) [5] and Patel& Naik (2010) [16] respectively.

Process of preparation of mixed fruit bar

The preparation of the mixed fruit bar was done in accordance with (Avhad *et al*., 2019) [22] The raw material were used for

preparation of control mixed fruit bar mango, papaya and sugar where mahua flowers used for preparation of mahua flower incorporated mixed fruit bar. Fully ripen fruits were selected and washed with water. Fruits were passed through pulper to obtained pulp. Mango and papaya washed under tap water then peeled made slices, remove the stones, and passed through the pulper to get mango pulp then papaya fruits also washed with clean water then peeled it cut fruits into pieces, removes the seeds and passed through pulper to extract the papaya pulp. The mahua flower pulp was obtained by soaking the previously cleaned flowers for 4-5 Hrs. followed by grinding by the grinder. TSS was adjusted of both fruits. The fruits pulp was used in different proportions for preparation of mixed fruit bar (100:0, 90:10, 80:20, and 70:30). The prepared samples were examined for sensory evaluation and based on results obtained the superior sample was selected for further development of mixed fruit bar incorporate with mahua flower at the different level such as 10 g, 20 g, and 30 g. The mixture is then heated for 15 minutes at 70–80 °C to reach 50 ^{0}Bx. After that poured boiled puree in tray layered with glycerin then keeps the tray in cabinet dryer at 60 °C for 7-8 hrs after proper drying cut the bar into small pieces and packed into air tight packaging material and stored at room temperature.

Sensory evaluation of developed mixed fruit bar

Sensory evaluation is important for determination of consumer acceptability of the product The sensory evaluation of prepared mixed fruit incorporated with mahua flower bar was carried out based on 9-point hedonic scale to colour, flavour, taste, texture and overall acceptability which was compared with control mixed fruit bar sample and obtained results are presented in Table

Table 4: Sensory evaluation of mixed fruit bar incorporated with mahua flower

Sample code	Sensory Attributes					
	Appearance	Color	Taste	Flavour	Texture	Overall acceptability
Control	8.3	8.2	8.4	8.1	7.9	8.0
T_1	8.0	7.9	7.8	7.7	7.8	8.1
T_2	8.2	8.0	8.1	8.0	8.2	8.2
T_3	7.6	6.8	7.0	7.4	6.8	7.5
SE	0.1142	0.1212	0.1795	0.1375	0.1118	0.1269
CD@5%	0.3466	0.3676	0.5446	0.4171	0.3307	0.3851

Where,

Control = 80% mango pulp + 20% papaya pulp + 10% sugar + 1% citric acid

T_1 = 70% mango pulp + 20% papaya pulp+10% Mahua Flower pulp + 10% sugar + 1% citric acid

T_2 = 60% mango pulp + 20% papaya pulp+20% Mahua Flower pulp + 10% sugar + 1% citric acid

T_3 = 50% mango pulp + 20% papaya pulp +30% Mahua Flower pulp+ 10% sugar + 1% citric acid

The data presented in Table 4. Indicated that the sample T_2 secured highest score for overall acceptability (8.2). The lowest score recorded about sample T_3 was (7.5). The highest score for flavour was obtained for control sample (8.1) followed by the sample T_2 (8.0), while the lowest score of flavour was obtained for sample T_3 (7.4) On the basis of sensory evaluation and scores obtained for overall acceptability.

Physico-chemical parameters of mixed fruit bar incorporated with mahua flower

The data pertaining to Table 5 showed the physio-chemical characteristics of prepared mixed fruit bar incorporated with mahua flower.

Table 5: Physico-chemical composition of mixed fruit bar incorporated with mahua flower

Physicochemical parameters	selected sample (T_2)
Moisture (%)	18.26±0.78
Protein (%)	3.12±0.07
Fat (%)	0.406±0.04
Carbohydrate (%)	72.94±1.21
Ash (%)	3.12±0.07
Crude fibre (%)	2.09±0.23
TSS (^{o}Bx)	77.4±1.76
Total sugar (%)	64.83±1.47
Reducing sugar (%)	53.42±1.
pH	4.19±0.07
Acidity (%)	1.39±0.41
Ascorbic acid mg/100 g	53.2±0.97

*Each value is an average of three determination.

Data obtained from Table 5 represented the physico- chemical characteristic of prepared mixed fruit bar incorporated with mahua flower. The analysis of the samples revealed Physicochemical characteristics of mixed fruit bar incorporated with mahua flower i.e., moisture content (18.26%), protein (3.12%), fat (0.406%), carbohydrate (72.94%), ash (3.12%), crude fibre (2.09%), TSS 77.4 ^{0}Bx, total sugar (64.83%), reducing sugar (53.42), pH (4.19), acidity (1.81%) and ascorbic acid (53.2mg/100 g). The results were in close resemblance with Kourany *et al*., (2017) [9].

Microbial load of a selected sample of mixed fruit bar incorporated with mahua flower

Microbial analysis of food products is a crucial aspect of ensuring food safety and quality. It provides valuable information about the shelf life, spoilage, and hygienic conditions during the preparation of food products. The specific storage period and shelf life of product can be determined by estimating the microbial population including bacteria, yeast, and mold, through serial dilution and solidification in petri plates using nutrient agar and potato dextrose agar. In this study, the microbial load estimation for selected samples at 30-day intervals for up to 90 days was carried out. The results of microbial characteristics are described in Table 6.

Table 6: TPC and Yeast and Mold count mixed fruit bar incorporated with mahua flower

Storage life Days	Microbial load (cfu/g)	
	Total plate count	Yeast and Mold
0	ND	ND
30	0.4 X 10^2	ND
60	0.7 X 10^2	ND
90	1.2 X 10^2	1.4 X 10^2

ND – Not Detected

Table 6 it was observed that there was no total bacterial count detected on day of preparation of product. It was found that gradually increased in the microbial count of selected sample

of mixed fruit bar with the increase of storage period. The increase in total plate count (TPC) for selected sample observed in the range of 0.4×102 to 1.2×10^2 cfu/g up to 90 days of storage. The maximum increase in TPC was observed upon 90thday of storage study. The yeast and mold count were not observed upto the 60 days of the storage of fruit bar. Yeast and mold content observed on 90^{th} day was 1.4 X 10^2.

As per the guidelines established by the Food Safety and Standards Authority of India (FSSAI) in 2018, the acceptable maximum limit for the total plate count (TPC) of microbial contaminants in fruits and vegetables products is stipulated as not exceeding 40000/gm. Based on FSSAI guidelines product was safe to consumption up to 90 days. The similar findings for microbial study of papaya guava mixed fruit bar for 60 days were observed by Kumar *et al*., (2017) [10].

Conclusion

The exact formulation of a product plays a crucial role in its acceptance and popularity in the market. This is primarily because a well-formulated product is likely to receive a higher sensory score, indicating a superior quality in terms of the sensory parameters. In view of this, it can be concluded that food products with high hedonic scale are likely to be in demand. Consequently, standardization of the product to be prepared or commercialized becomes imperative to meet the market demand for high-quality food products.

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