

Development of Mahua (*Madhuca longifolia*) Flower enriched Wheat based Laddoo

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ABSTRACT: Pregnancy and lactation are the two crucial stages in women's life. A satisfactory diet during pregnancy will ensure a good store of nutrients or satisfactory breast feeding. Hence the present research study entitled "Development of mahua (*Madhuca longifolia*) flower enriched Wheat based Laddoo" was taken with an idea to prepare and standardize mahua flower enriched wheat based nutritious Laddoo. Mahua flower, wheat and finger millet were selected as major ingredients. Mahua flower was selected as it was found to be rich in carbohydrates, protein, fat, calcium, iron and phosphorus whereas the cereals/millet contain certain important minerals. Composite rotatable experimental design (CRD) was adopted to standardize the formulation of Laddoo. Sensory evaluation of developed laddoo was done using 9-point hedonic scale, the maximum score of color, taste, aroma, body and texture and overall acceptability were found to be 7.99, 7.99, 7.88, 7.77 and 7.77 respectively. It was observed that there was significant effect of interactions among ingredients on organoleptic parameters. The physico chemical analysis of final product showed moisture, protein, fat, crude fibre, ash and carbohydrate were 10.36, 13.74, 12.09, 3.09, 2.08 and 46.36 percent respectively whereas vitamin C, calcium, iron and phosphorus content of Laddoo were 1.33, 132.56, 4.05 and 188.05 mg/100 g respectively, which cater the elevated nutritional demand of lactation period. Apart from lactating women the developed laddoo is also suitable to meet the dietary needs of growing children.

Keywords: Lactating Women, Laddoo, Mahua, Nutri-cereals, Wheat, Finger millet.

INTRODUCTION

Pregnant and lactating women are responsible for maintaining the healthy status of both fetus and infant, thus an adequate diet is needed during both the period in order to produce milk through which not only she feed the infant but also nourish the growing fetus (Ramadas *et al.*, 2011). These women require the additional amount of nutrients than ordinary women. The pregnant and lactating women requires 2580 Kcal per day, lactating women of 0 to 6 months needs 2830 Kcal per day while lactating women of 6 to 12 months needs 2750 Kcal per day. Pregnant women need 78 g of protein per day while lactating women of 0 to 6 months and lactating women of 6 to 12 months require 74 g per day and 68 g per day of protein respectively. However, 30 g of fat per day, 1200 mg of calcium per day and 35 mg of iron per day is needed in both the periods

(ICMR, 2011).

Galactagogue foods are those that helps to produce more milk as they are enriched with all the necessary nutrients for both the mother and fetus or infant and hence the galactagogue food is given to these women during the time of pregnancy and lactation to fulfill the requirement of all the important nutrients (Ramadas *et al.*, 2011).

Now a days aromatic and medicinal plants are essential not only for producing medicine but also as a food itself (Kathuria and Singh 2015). One of the medicinal plants mahua (*Madhuca longifolia*) belongs to sapotaceae family which has all the essential nutrients important for women in pregnancy and lactating stage (Sinha *et al.*, 2017).

Mahua has significant amounts of calcium, phosphorus, and vitamins A and C. Mahua seeds are loaded with not just energy giving carbohydrates, but also essential fatty

acids like linoleic and arachidonic. Mahua is said to help increase milk production and secretion in lactating mothers (Mishra and Padhan 2013). Mahua flowers contains Vitamin-C which is responsible for their antioxidant activity (Indu and Annika 2014).

The flowers of mahua are produced between the months of March and May and serve as a source of income for weaker sections of the society (Ranjana *et al.*, 2018). They are manually collected from the ground and are dried under sun before storage. As dried flowers are hygroscopic in nature, they are easily spoiled by absorbing moisture from the atmosphere. Mahua flowers are either consumed fresh, cooked or fried in different parts of the country (Bakhara *et al.*, 2016).

Most popular use of mahua is in liquor making, due to its high sugar content. Mahua flower is not only used in preparation of liquor but can also utilized as a food ingredient for preparation of biscuit, cake, laddoo, candy, bar, jam jelly, sauces and many more (Sinha *et al.*, 2017).

Apart from these medicinal plants, cereals and millets are said to be good source of nutrients such cereal and millet include wheat and finger millet respectively.

The main staple cereal crop in India is wheat (*Triticum* spp.). Wheat provides nearly 346 kcal per 100 g of energy. It contains 71.2 per cent of carbohydrate, 11.8 per cent of protein, 1.5 per cent of fat, 1.5 per cent of minerals and considerable proportions of vitamins (thiamine and vitamin B) (Gopalan *et al.*, 2009). As it provides good amount of calories and protein, it is an essential cereal for lactating women (Kumar *et al.*, 2011).

Finger millet has been perceived as a potential “super cereal” by the United States National Academies being one of the most nutritious among all major cereals (National Research Council, 1996). In India it is also known as ragi or madua (Kumar *et al.*, 2016; Agrawal *et al.*, 2015). It is a richest source of macro and micro minerals (Chethan and Malleshi 2007). It provides 72 per cent of carbohydrates, 7.3 per cent of protein, 1.3 per cent of fat, good amount 3.6 per cent of crude fibre (Gopalan *et al.*, 2009). Finger millet is also loaded with good amount of calcium (344 mg/100 g).

Epidemiological studies have demonstrated that regular consumption of whole grain cereals and their products can protect against the risk of cardiovascular diseases, type II diabetes, gastrointestinal cancers and a range of other disorders (Mckeown, 2002).

Laddoo is a round in shaped renowned sweet in India. Wheat based Laddoo is made up of mixes of different flours and functional food ingredient. ‘Mahua’ is a galactagogue ingredient, but there is less information available about Mahua as a food (Bakhara *et al.*, 2016), hence research work has to be carried out to make use of essential nutrients of Mahua for a healthy society.

Keeping in view, the nutritional profile of mahua flower, wheat and finger millet, an attempt has been made in the current research project to develop a mahua (*Madhuca longifolia*) flower enriched Wheat based

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Laddoo for lactating women with the following objectives.

1. To evaluate compositional and nutritional characteristics of raw ingredients namely germinated wheat and finger millet flour, and dry mahua flower.
2. To standardize formulation of mahua flower enriched Wheat based Laddoo.
3. To analyse the physico-chemical, microbiological, and nutritional qualities of the standardized product.

MATERIALS AND METHODS

The present research study was conducted at College of Food Processing Technology and Bio Energy.

Materials. In this study laddoo was made using raw materials such as dried mahua flower, wheat flour and finger millet flour as major ingredients and minor ingredients like sugar and ghee.

Collection of Raw Materials. The raw ingredients such as Mahua flowers were procured from the local market of Chhota Udaipur, Gujarat, India. They were cleaned, dried and powdered by using a grinder and stored in an air tight container. The other ingredients such as wheat, finger millet, sugar and ghee were procured from local market. Wheat and finger millet were cleaned, soaked, germinated, dried, roasted and milled separately. Sugar was grounded and sieved to desired particle size.

Chemicals & Glassware. The chemicals used for the analysis were of analytical grade and procured from Molychem, Mumbai – 400002.

Methods

Formulation of Laddoo. The independent and dependent variables with their levels in percent shows in below table

Table 1: Different ingredient with their levels.

Ingredient	Level (per cent)
Dried mahua flower	5-15
Sugar	15-25
Wheat flour	40
Finger millet flour	15
Ghee	15

Table 2: Treatments given to standardized formulation of mahua flower enriched Wheat based Laddoo.

Treatments	Dried Mahua Flower (per cent)	Sugar (per cent)
T1	5	25
T2	7	23
T3	9	21
T4	11	19
T5	13	17
T6	15	15

Above table illustrates the six treatments with their respective per cent of ingredients. For the preparation of Laddoo, the amount of germinated and dried wheat flour (40 per cent) & germinated and dried finger millet

flour (15 per cent) were taken as Patel (2016) standardized for development of Laddoo and the amount of ghee was 15 per cent whereas the amount of incorporation of dried mahua flower and sugar were

fluctuated in order to make 100 g of recipe as shown in above Table 2.



Fig. 1. Dried mahua flower.



Fig. 2. Germinated and dried wheat.



Fig. 3. Germinated and dried finger millet.

Flow Diagram for the Manufacturing of Laddoo

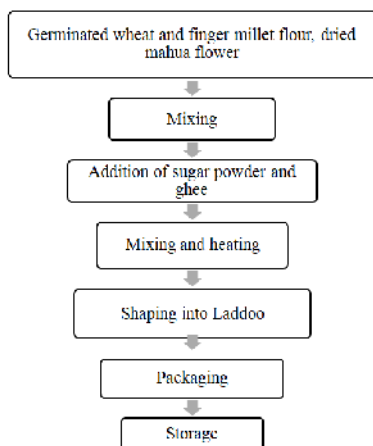


Fig. 4. Flow diagram for manufacturing of Laddoo.

Sensory Score Card- Mahua Flower Enriched Wheat Based Laddoo. With the help of professional panelists, sensory evaluation of product was carried out. The sensory parameters were color & appearance, taste, aroma, consistency and overall acceptability which were scored on the basis of 9-point hedonic scale, where 9- like extremely, 8- like very much, 7- like moderately, 6- like slightly, 5- neither like nor dislike, 4- dislike slightly, 3-dislike moderately, 2- dislike very much and 1- dislike extremely.

Compositional Attributes Analysis. Proximate analysis of raw ingredient samples and mahua flower enriched nutria-cereals based Laddoo was done by using protocols as described and prescribed by AACC (AACC 2000) and AOAC (AOAC 2001).

Vitamins and minerals analysis of raw ingredient samples and Mahua flower enriched nutria-cereals based Laddoo was done by using protocols as per the standard protocols of Ranganna (1986).

Microbiological analysis of Laddoo samples were analyzed for the Standard Plate Count (SPC), Coliform count and Yeast and Mold count (YMC) as per the standard procedure given by Ranganna, (1986).

Analytical Tool. The data in the present investigation were subjected to analysis of variance (ANOVA) technique and thus analyzed according to one factorial completely randomized design.

RESULT AND DISCUSSION

Standardized Formulation of Mahua Flower Enriched Wheat Based Laddoo. The experiments for optimization of Wheat based Laddoo from dried mahua flower, germinated and dried wheat flour and finger millet flour were conducted as per the CCRD experimental design. The sensory score was based on 9-point hedonic scale. Numerical optimization technique of the software Design Expert 10.0.3 was used for simultaneous standardized composition for

development of Wheat based Laddoo. During the standardization process, specific constraints were applied on the variables. Attributes to be considered were color and appearance, taste, aroma, body and texture and overall acceptability and which were scored on 9point scale.

For standardization of formulation of mahua flower enriched Wheat based Laddoo, one factor (at six levels of each factor) second order composite rotatable experimental design (CRD) was adopted. The design suggested 6 different trials (runs) with different proportion of independent factors. The independent

factors were the level of dried mahua flower (A) and sugar (B). While dependent factors were the level of germinated and dried wheat and finger millet flour and ghee. Quadratic model fitted well to the color, flavor, texture, taste and overall acceptability.

From the results obtained through various analytical data and using the suitable combination of dried mahua flower and sugar were calculated. As a result, T3 which has a 9 per cent dried mahua flower and 21 per cent sugar were selected for the development of the mahua flower enriched Wheat based Laddoo.

Table 3: Result obtained as per sensory analysis.

No.	Treatments	Color and appearance	Taste	Aroma	Body and texture	Overall acceptability	Desirability
1	T3	7.66	7.66	7.72	7.58	7.58	0.79
2	T6	7.16	7.20	7.38	7.08	7.35	0.49
3	T4	7.23	7.13	7.25	6.97	7.12	0.42
4	T5	7.18	7.12	7.19	7.08	7.05	0.40
5	T2	7.00	7.12	7.20	6.77	6.99	0.33
6	T1	7.06	7.06	7.06	6.93	6.97	0.32

It can be observed from Table 3 that T3 scored best. It got highest desirability of 0.791 among all six treatments with scores of 7.66 for color and appearance, 7.66 for taste, 7.22 for aroma, 7.58 for body and texture and 7.58 for overall acceptability. Thus the product had a good acceptability and was finalized.

Profiling of Mahua Flower Enriched Wheat Based Laddoo. The final mahua flower enriched Wheat based Laddoo was prepared using optimized parameters. The product, so prepared was tested for physico-chemical properties, vitamin and mineral profiling and microbiological studies and the results are presented in

Table 4, 5 and 6 respectively.

Physico-Chemical Analysis of Mahua Flower Enriched Wheat Based Laddoo. The results of physico-chemical properties of Wheat based Laddoo are presented in Table 4. The Table shows that the moisture, protein, fat, carbohydrates, ash and crude fiber were 10.36, 13.74, 12.09, 46.36, 3.09 and 2.08 per cent respectively, the total sugar and reducing sugar were 41.29 and 37.74 per cent whereas the hardness was 175.22 N.As the selected ingredients are rich sources of nutrients, the developed laddoo was found to be highly nutritious.

Table 4: Physico-chemical properties of mahua flower enriched Wheat based Laddoo.

Parameters	Result
Hardness (N)	175.22 ± 1.35
Moisture (per cent)	10.36 ± 0.2
Protein (per cent)	13.74 ± 0.42
Fat (per cent)	12.09 ± 0.11
Carbohydrates (per cent)	46.36 ± 0.17
Ash (per cent)	3.09 ± 0.49
Crude fiber (per cent)	2.08 ± 0.51
Total sugar (per cent)	41.29 ± 0.37
Reducing sugar (per cent)	37.74 ± 0.53

All values are means ± standard deviation (n=3)

Vitamin and Mineral Analysis of Mahua Flower Enriched Wheat Based Laddoo. The vitamin and mineral composition of the product for vitamin C, calcium, iron and phosphorus was analyzed and shown

in Table 5. The product, thus obtained had very good amounts of calcium and iron which are most essential for pregnant/lactating women.

Table 5: Vitamin and Mineral analysis of mahua flower enriched Wheat based Laddoo.

Parameters	Result
Vitamin C (mg/100 g)	1.33 ± 0.75
Calcium (mg/100 g)	132.56 ± 0.3
Phosphorus (mg/100 g)	188.05 ± 0.26
Iron (mg/100 g)	4.05 ± 0.21

All values are means ± standard deviation (n=3)

The vitamin C, calcium, iron and phosphorus content of Laddoo were 1.33, 132.56, 4.05 and 188.05 mg/100 g respectively.

Microbiological Analysis of Mahua Flower Enriched Wheat Based Laddoo. The microbiological quality in

terms of the standard plate count, coliform count and yeast and mold count of optimized of mahua flower enriched Wheat based Laddoo was tested and the results are presented in Table 6.

Table 6: Microbiological analysis of mahua flower enriched Wheat based Laddoo.

Parameters	Result
Standard plate count (log cfu/g)	4.43
Coli form (log cfu/g)	Absent
Yeast and Mold (log cfu/g)	1.17

All values are means ± standard deviation (n=3)

The standard plate count, coliform and yeast and mold count observed in Wheat based Laddoo were 4.431, Nil and 1.17 log (cfu per g) respectively which was in compliance with the FSSAI standard of a khoya (FSSAI, 2011). The antimicrobial activity of Mahua flowers (Verma *et al.*, 2010) contributed to the less microbial count in the developed laddoo.

CONCLUSION

The present investigation resulted in the development of a mahua flower enriched nutria-cereals based galactogoue product with highly acceptable quality attributes. In view of the findings of the present study, it may be concluded that the Wheat based Laddoo developed under the study showed a nutritional profile which is highly suitable for lactating women. Also in terms of organoleptic quality, the product was found to be highly acceptable. It was also observed that microbiological quality of freshly prepared Wheat based Laddoo was satisfactory. The developed mahua flower enriched Wheat based Laddoo possessed ample amount of minerals. If four servings of the product are given in a day, a pregnant/lactating women can get 19-20 per cent protein, 16-18 per cent fat, 12-21 per cent Iron, 68-71 per cent Calcium and 10-12 per cent Phosphorus of her daily recommended requirements by ICMR (2009).

FUTURE SCOPE

1. Study on drying techniques of mahua flower.
2. Shelf-life studies of the developed mahua flower enriched wheat based Laddoo.

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Conflict of interest. None.

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