



## Original Article

Development and Characterization of *Bauhinia variegata* Linn Leaves Powder BiscuitsUswa Ahmad<sup>1\*</sup>, Shiza Ahmed<sup>2</sup>, Saleha Hameed<sup>1</sup>, Sana Azhar<sup>1</sup> and Ayesha Malik<sup>1</sup><sup>1</sup>School of Human Nutrition and Dietetics, Minhaj University, Lahore, Pakistan<sup>2</sup>Institute of Home Sciences, University of Agriculture, Faisalabad, Pakistan

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## ABSTRACT

Iron deficiency anemia is the major public health problem all over the world especially in children under 5 and pregnant females. **Objective:** To develop and explore the nutritional and sensory quality of iron and Vitamin C enriched biscuits by using leave powder of *Bauhinia variegata* and lemon juice for the study period of two months. **Methods:** Experimental research was performed to determine the levels of macronutrients, micronutrients and overall acceptability of *Bauhinia variegata* leaves powder biscuits. For this purpose, *Bauhinia variegata* leaves were collected, washed with clean water, sun-dried and finely grinded to form powder. *Bauhinia variegata* leaves powder was analyzed for proximate analysis, iron and Vitamin C levels. Functional biscuits with treatments ( $T_0$ ,  $T_1$  and  $T_2$ ) were made by using 10 g and 10 mL of *Bauhinia variegata* leaves powder and lemon juice respectively. The iron-enriched biscuits were evaluated for proximate composition, iron, Vitamin C contents and sensory traits such as color, flavor, taste, texture and overall acceptability. One-way Anova was applied on the obtained results. **Results:** The consequences found that *Bauhinia variegata* leaves powder was rich in protein and iron contents. Incorporation of *Bauhinia variegata* leaves powder and lemon juice in the biscuits significantly increased the nutritional composition of biscuits. The results related to sensory parameters proved that *Bauhinia variegata* leaves powder biscuits had high sensory acceptability as compared to control. **Conclusions:** It is concluded that by adding dried leaves powder of *Bauhinia variegata* and juice of lemon improved the nutritive value and consumer acceptability of the functional biscuits.

## INTRODUCTION

Globally, malnourished population is more severely affected from the deficiency of micronutrients. Protein-energy deficiency is more common among all the deficiencies from micronutrients. Vitamins and minerals that are included in micronutrients are essential for proper metabolism of foods and needed in minute amounts as compared to macronutrients. Amongst all the micronutrients' deficiencies, iron deficiency is the predominant public health problem which results in countless issues in children under 5 and pregnant females. According to latest studies, more than 2 billion people are facing the issue of iron deficiency anemia across the globe especially in developing countries [1]. Utilization of iron supplements is mostly practiced to overcome the

deficiency from iron but they are mostly high in cost and have low absorption rate as compared to natural sources. Therefore, to prevent and treat iron deficiency anemia natural sources can be used without any side effects as they are mostly safe and non-toxic [2]. *Bauhinia variegata* Linn commonly known as Kachnar (mountain Ebony) is medium-sized deciduous tree and belong to family of Leguminosae (Caesalpinioideae). The different parts of Kachnar such as stem, leaves, seeds, roots, bark and flowers contain numerous macronutrients (protein, fat and fiber), micronutrients (calcium, iron, phosphorous & vitamin C) and phytochemicals (saponins, terpenoids, kaempferol, cardiac glycosides, tannins, flavonoids, and quercetin has vital role in promoting human health.



Traditionally, Kachnar is a popular medicinal tree that is largely utilized to cure different diseases due to its countless therapeutic properties like anti-inflammatory, anti-diabetic, haematinic, immunomodulatory, haemagglutinating, anti-tumour, anti-microbial, hepatoprotective, anti-bacterial and anti-ulcer activity [3].

Worldwide, cereals are considered as chief staple diet for the population. Wheat is majorly consumed in the form of bakery products as compared to other cereal grains. Among all the bakery products, biscuits are ideal for fortification of micronutrients to tackle several chronic and nutrition-related diseases [4, 5]. To prevent and treat iron deficiency anemia, fortification of food items with iron is an effective method to meet the requirement of iron level in the diet. Biscuits are considered as a snack rather than a meal. They have better nutrition, palatability, acceptability, easy availability, affordability and long storage stability [6, 7].

Due to current status of iron deficiency anemia worldwide, the aim of present investigation was to develop the functional biscuits by the incorporating finely ground leaves powder of *Bauhinia variegata* and juice of lemon. Furthermore, Kachnar biscuits were determined for chemical analysis, iron, vitamin C contents and sensory attributes.

## METHODS

The present study was performed in National Institute of Food Science and Technology (NFSAT) and Institute of Home sciences, University of Agriculture, Faisalabad. Kachnar (*Bauhinia variegata* Linn.). Leaves were procured from the Ayub Agriculture Research Institute (AARI), Faisalabad. After collection, the Kachnar leaves were washed with tap water, dried under sun and then kept in air tight jars [8]. Iron and Vitamin C enriched biscuits were made by using white flour, leaves powder of *Bauhinia variegata* and juice of lemon with formulation of (100: 0:0), (90: 10: 0) and (80 :10: 10) in  $T_0$ ,  $T_1$  and  $T_2$  respectively according to the methodology of AACC Method No. 44-15A, 44-40 with slight modifications [9]. The proximate composition (moisture, ash, fat, protein, fiber contents) and nitrogen free extract (NFE) content of sun-dried Kachnar leaves powder and functional biscuits were determined by using the AOAC official Method No. 925.10, 923.03, 935.38, 979.09 and 991.43 respectively [10]. Iron and Vitamin C levels of Kachnar leaves powder and biscuits were estimated by AOAC methodology 960.0 and 961.21 accordingly [10]. The sensory traits of the functional biscuits such as color, flavor, taste, texture and overall acceptability were evaluated voluntarily by the trained judges by using 9-hedonic scale and consent was taken prior to evaluation[11]. The study period of present

investigation was two months. The findings related to all the parameters studied were statistically investigated by using SPSS software version 23.0 with the application of One-way ANOVA [12].

## RESULTS

The result of chemical composition of Kachnar (*Bauhinia variegata*) leaves powder presented in Table 1 found that the values of crude moisture, crude ash, crude protein, crude fat and NFE contents were found to be  $8.79 \pm 0.02$  %,  $4.60 \pm 0.02$ %,  $14.7 \pm 0.1$ %,  $4.06 \pm 0.04$  %,  $4.23 \pm 0.01$  % and  $38.67 \pm 0.02$  % respectively.

**Table 1:** Chemical Composition of Kachnar Leaves Powder

Proximate Composition	Quantity (%)
Crude Moisture Content	$8.79 \pm 0.02$
Crude Ash	$4.60 \pm 0.02$
Crude Protein	$14.7 \pm 0.1$
Crude Fat	$4.06 \pm 0.04$
Crude Fiber	$4.23 \pm 0.01$
NFE	$63.43 \pm 0.01$

Mean  $\pm$  SD of overall proximate composition of *Bauhinia variegata* leaves.

In the present study, the results showed that the iron and Vitamin C contents of dried Kachnar (*Bauhinia variegata*) leaves powder were  $22.08 \pm 0.02$  and  $5.5 \pm 0.04$  mg/100g respectively (Table 2).

**Table 2:** Iron and Vitamin C Contents of Kachnar Leaves Powder

Micronutrients	Quantity (mg/100g)
Iron content	$22.08 \pm 0.02$
Vitamin C	$5.5 \pm 0.04$

Lemons carry an ample number of beneficial micronutrients especially Vitamin C that is present in appreciable amount and iron content in less quantity. The consequences displayed in Table 3, depicted that lemon contained  $0.38 \pm 0.33$  mg/100mL iron and  $35.77 \pm 0.38$  mg/100mL Vitamin C.

**Table 3:** Iron and Vitamin C Content of Lemon Juice

Micronutrients	Quantity (mg/100 mL)
Iron Content	$0.38 \pm 0.33$
Vitamin C Content	$35.77 \pm 0.38$

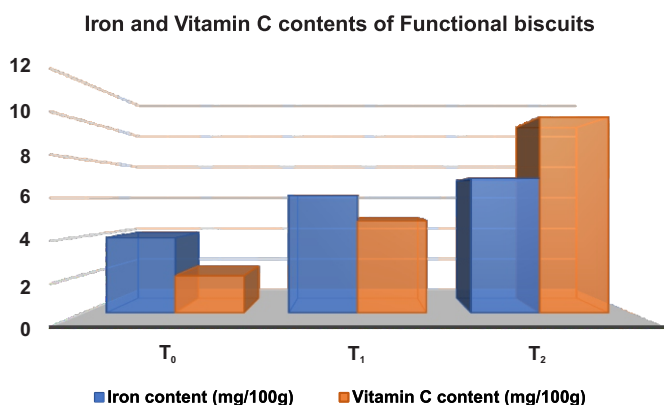
The outcomes of chemical composition of the functional biscuits are shown in table 4. According to results, the Kachnar leaves powder biscuits had more moisture content than the control cookies ( $T_0$ ). However, the crude ash, crude protein, crude fat, crude fiber and nitrogen free extract (NFE) contents of functional biscuits significantly increased from ( $2.37 \pm 0.05$ - $2.75 \pm 0.03$  %), ( $17.98 \pm 0.21$ - $18.85 \pm 0.22$  %), ( $20.23 \pm 0.35$  -  $20.35 \pm 0.18$  %), ( $4.01 \pm 0.03$ - $4.08 \pm 0.02$  %) and ( $48.24 \pm 0.41$ -  $49.52 \pm 0.44$ ) in  $T_0$  to  $T_3$  respectively.

**Table 4:** Chemical Composition of *Bauhinia variegata* Leaves Powder Biscuits

Treatments	Crude Moisture Content (%)	Crude Ash Content (%)	Crude Protein Content (%)	Crude Fat Content (%)	Crude Fiber Content (%)	Nitrogen Free Extract
T <sub>0</sub>	4.15 ± 0.04 <sup>c</sup>	2.37 ± 0.05 <sup>c</sup>	17.98 ± 0.21 <sup>c</sup>	20.23 ± 0.35 <sup>c</sup>	4.01 ± 0.03 <sup>c</sup>	48.24 ± 0.41 <sup>c</sup>
T <sub>1</sub>	4.32 ± 0.1 <sup>b</sup>	2.52 ± 0.03 <sup>b</sup>	18.54 ± 0.21 <sup>b</sup>	20.29 ± 0.35 <sup>b</sup>	4.02 ± 0.02 <sup>b</sup>	45.91 ± 0.74 <sup>b</sup>
T <sub>2</sub>	4.55 ± 0.12 <sup>a</sup>	2.75 ± 0.03 <sup>a</sup>	18.85 ± 0.22 <sup>a</sup>	20.35 ± 0.18 <sup>a</sup>	4.08 ± 0.02 <sup>a</sup>	49.52 ± 0.44 <sup>a</sup>

Values with different superscripts show statistically significantly different (p<0.05).

The results represented in figure 1 described that the iron and vitamin C contents of functional biscuits significantly increased from T<sub>0</sub> to T<sub>2</sub> (3.92 ± 0.06–7.02 ± 0.03 mg/100g) and (1.94 ± 0.03–10.2 ± 0.08 mg/100g) respectively.

**Figure 1:** Graphical Representation of Iron and Vitamin C Contents of Functional Biscuits

The outcomes related to sensory evaluation of functional biscuits as shown in table 5 found that color, flavor, taste, texture and overall acceptability of T<sub>0</sub> were given the maximum scores 7.04 ± 0.44, 7.02 ± 0.44, 7.00 ± 0.44, 7.00 ± 0.44 and 7.01 ± 0.44 out of 9 respectively. T<sub>1</sub> was given 6.68 ± 0.42/9 and T<sub>2</sub> were assigned /9. Lesser scores (6.52 ± 0.47, 6.30 ± 0.44, 6.12 ± 0.54, 6.09 ± 0.54 and 6.25 ± 0.54) were assigned to T<sub>2</sub> as compared to T<sub>0</sub>.

**Table 5:** Sensory Evaluation of Kachnar Leaves Powder Biscuits

Treat-ments	Color	Flavor	Taste	Texture	Overall Acceptability
T <sub>0</sub>	7.04 ± 0.44 <sup>a</sup>	7.02 ± 0.32 <sup>a</sup>	7.00 ± 0.48 <sup>a</sup>	7.00 ± 0.42 <sup>a</sup>	7.01 ± 0.23 <sup>a</sup>
T <sub>1</sub>	6.68 ± 0.42 <sup>b</sup>	6.42 ± 0.37 <sup>b</sup>	6.24 ± 0.56 <sup>b</sup>	6.22 ± 0.30 <sup>b</sup>	6.39 ± 0.33 <sup>b</sup>
T <sub>2</sub>	6.52 ± 0.47 <sup>c</sup>	6.30 ± 0.54 <sup>c</sup>	6.12 ± 0.54 <sup>c</sup>	6.09 ± 0.39 <sup>c</sup>	6.25 ± 0.46 <sup>c</sup>

Values with different superscripts show statistically significantly different (p<0.05).

## DISCUSSION

The findings of present study found that dried Kachnar (*Bauhinia variegata*) leaves powder contained high amount of crude moisture, crude ash, crude protein, crude fat, NFE and iron contents. While, lemon had ample amount of Vitamin C. The values obtained by this analysis were very

close to the values given by [13, 14]. Furthermore, the outcomes depicted that Kachnar leaves powder biscuits prepared with and without the supplementation of lemon juice had more moisture, crude ash, crude protein, crude fat, crude fiber, nitrogen free extract (NFE), iron and Vitamin C contents than the control cookies (T<sub>0</sub>) at time interval of two months. The leaves powder of Kachnar improved the nutritional profile of functional biscuits by enhancing their macronutrients and iron levels. Furthermore, addition of lemon juice improved the Vitamin C level of biscuits. Vitamin C affects the absorption of iron in different food items, Ascorbic acid (vitamin C) show a significant role in improving the absorption of iron [15]. The previous studies proved that daily intake of Ascorbic acid significantly enhanced the absorption of non-heme iron from plant-based food items [16]. The outcomes derived from the current research are in collaboration with the study done by Galla et al., who found out that addition of spinach powder had significant effect on chemical composition of functional biscuits [17]. According to another research, supplementation of cookies with mushroom powder significantly enhanced proximate and mineral composition as compared to control cookies [18]. The sensory parameters of the biscuits were evaluated on the basis of colour, flavour, taste, texture and overall acceptability and results found that all the parameters of the functional biscuits significantly affected by the adding leaves powder of Kachnar and juice of lemon at the study period of 8 weeks. The results of the study were similar to the previously done work by Dwivedi and Bhatt who depicted that scores for all the sensory parameters of Niger seed flour fortified cookies significantly differed with the addition of Niger seed flour as compared to control cookies but remained acceptable [19]. Another previous investigation showed that sensory attributes of biscuits prepared from blend of wheat, soybeans and orange flesh sweet potato improved significantly according to the scores given by trained panel of judges [20].

## CONCLUSIONS

The supplementation of sun-dried kachnar leaves powder and lemon juice significantly enhanced the nutritional profile and consumer acceptability of functional biscuits. Biscuits developed by utilizing Kachnar leaves powder (rich in iron) and lemon juice (natural source of Vitamin C) may play significant role in the prevention and treatment of iron deficiency anemia due to their strong therapeutic potential.

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## Authors Contribution

Conceptualization: UA

Methodology: SA

Formal analysis: SA, SH

Writing-review and editing: AM

All authors have read and agreed to the published version of the manuscript.

## Conflicts of Interest

The authors declare no conflict of interest.

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