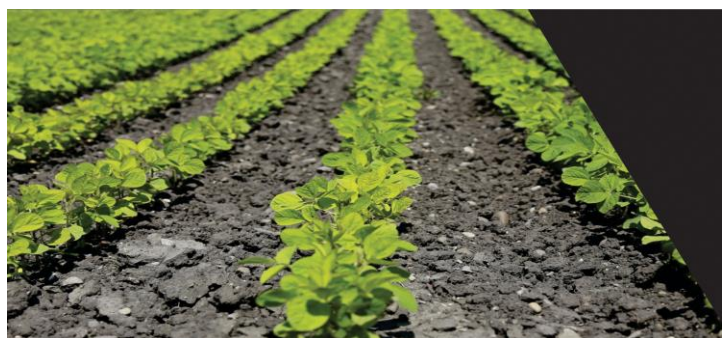




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Development of value-Added products from moringa (*Moringa oleifera*) leaf powder

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Abstract

The present study evaluated the use of dehydrated Moringa leaf powder for development and nutritional enrichment of biscuit. The experiment was conducted during January–August, 2025 in the Post-Harvest Laboratory, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences. The analysis was laid out in completely randomized design (CRD) with 13 treatments including control with 3 replications. Treatments comprised of moringa leaf powder incorporated at different levels (10, 20 and 30%) combined with drying temperature at 40, 60 and 80 °C, and air drying and control. Moringa leaf drying at 60 °C produced promising quality leaf powder for the development of nutritionally enriched biscuit and Treatment T6 (30% Moringa leaf powder dried at 60 °C) of biscuit and recorded the highest moisture (10.40%), crude fat (2.57%), crude fiber (11.19%), ash (11.76%), crude protein (21.38 g), energy (314.39 kcal), iron (85.75 mg), Vitamin C (38.93 mg), zinc (7.79 mg), calcium (1440.49 mg), carbohydrate (58.33 g), phosphorus (62.53 mg), total sugar (20.14) and TSS (9.08 °Brix). However, treatment T5 (20% moringa leaf powder dried at 60 °C) was found best in terms of sensory evaluation providing a more acceptable balance between quality and nutritional improvement in biscuit.

Keywords: Moringa leaf powder; Drying, Sensory evaluation

Introduction

Moringa oleifera, commonly known as drumstick or horseradish tree, is a multipurpose plant native to India and widely distributed in tropical and subtropical regions. Its leaves are valued for their nutritional composition and contain protein, fiber, minerals and vitamins. The thesis literature review describes Moringa leaves as a useful source of calcium, iron, vitamin C, beta-carotene and other nutrients, while dehydration offers a practical approach for preservation, storage and incorporation into food products. Moringa leaf powder has consequently been investigated as an ingredient in bakery products and other value-added foods (Fahey, 2005; Gopalakrishnan *et al.*, 2016; Joshi and Mehta, 2010; Alakali and Kucha, 2015) [4, 5, 7, 2].

The utilization of Moringa leaf powder in bakery products can increase the nutritional value of familiar foods while providing a convenient form for processing and storage. Previous studies cited in the thesis have reported the use of Moringa powder in biscuits, bread, cookies, cakes and other products “(Kar *et al.* (2013)” Premi and Sharma, (2014); Abraham *et al.*, (2013); Kolawole *et al.*, (2013) [8, 14, 1, 9]. However, the quality of dehydrated leaf powder and its level of incorporation are important because processing conditions and higher incorporation levels can influence nutritional and sensory characteristics.

Therefore, the present investigation focused on standardizing dehydration conditions for Moringa leaves and evaluating MLP incorporation in biscuit formulation through proximate, mineral and quality analyses. The study was designed to identify a treatment that could provide nutritional enrichment without compromising product acceptability.

Biscuit are baked food products made mainly from flour, sugar, fat, and other ingredients such as milk, salt, and flavoring agents. The ingredients are mixed to form dough, shaped into different sizes and designs, and then baked until they become crisp and golden brown. Biscuit have a pleasant taste, aroma, and crunchy texture. They are commonly consumed as snacks with tea, coffee, or milk. Different types of biscuit include sweet, salty, cream, butter, and nutritious

biscuit. Ingredients such as oats, nuts, fruits, and moringa powder can also be added to improve their nutritional value.

Materials and Methods

The experiment entitled Development of Value-Added Products from Moringa (*Moringa oleifera*) Leaf Powder was conducted in the Post-Harvest Laboratory, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, during January–August, 2025. The required quantity of drumstick leaves was dried at 40 °C, 60 °C and 80 °C for 4 hours, the sample dried at 60 °C produced satisfactory-quality powder after grinding which was selected for the preparation of moringa biscuit. The analysis was laid out in completely randomized design with 13 treatments including control replicated thrice viz. T₀: Control, T₁: 10 % moringa leaves powder dried at 40°C, T₂: 20 % moringa leaves powder dried at 40°C, T₃: 30 % moringa leaves powder dried at 40°C, T₄: 10 % moringa leaves powder dried at 60°C, T₅: 20 % moringa leaves powder dried at 60°C, T₆: 30 % moringa leaves powder dried at 60°C, T₇: 10 % moringa leaves powder dried at 80°C, T₈: 20 % moringa leaves powder dried at 80°C, T₉: 30 % moringa leaves powder dried at 80°C, T₁₀: 10 % moringa leaves powder air dried, T₁₁: 20 % moringa leaves powder air dried,

T₁₂: 30 % moringa leaves powder air dried. Different biscuit samples were evaluated for moisture, crude fat, crude fiber, ash content, carbohydrate, crude protein, energy, iron, Vitamin C, phosphorus, total sugar, zinc and calcium and Total Soluble Solids (TSS).

Results and Discussion

Biochemical Proximate analysis of biscuit

The results showed significant differences among the treatments presented in Table 1. Maximum moisture content was present in Treatment T₆ (10.40) and minimum was found in T₀ (4.68), maximum crude fat content was present in Treatment T₆ (2.57) and minimum was found in T₀ (2.21), maximum crude fibre content was present in Treatment T₆ (11.19) and minimum was found in T₀ (7.95), maximum ash content was present in Treatment T₆ (11.76) and minimum was found in T₀ (8.18), maximum carbohydrate content was present in Treatment T₆ (58.33) and minimum was found in T₀ (71.66), maximum crude protein content was present in Treatment T₆ (21.38) and minimum was found in T₀ (16.15), maximum energy content was present in Treatment T₆ (314.39) and minimum was found in T₀ (262.25).

Table 1: Biochemical Proximate analysis of biscuits

Treatment	Treatment Combination	Moisture (%)	Ash (%)	Energy (kcal)	Crude Protein (g)	Crude fat (%)	Carbohydrate (g)	Crude fiber (%)
T ₀	Control	4.68	8.18	262.25	16.15	2.21	71.66	7.95
T ₁	10 % moringa leaves powder dried at 40 °C	6.40	9.15	280.39	19.44	2.32	61.00	9.76
T ₂	20 % moringa leaves powder dried at 40 °C	6.43	9.17	280.43	19.48	2.34	63.00	9.79
T ₃	30 % moringa leaves powder dried at 40 °C	6.45	9.21	280.46	19.51	2.37	66.00	9.82
T ₄	10 % moringa leaves powder dried at 60 °C	10.33	11.40	314.18	21.31	2.51	53.33	11.15
T ₅	20 % moringa leaves powder dried at 60 °C	10.38	11.43	314.26	21.35	2.54	56.00	11.17
T ₆	30 % moringa leaves powder dried at 60 °C	10.40	11.76	314.39	21.38	2.57	58.33	11.19
T ₇	10 % moringa leaves powder dried at 80 °C	7.35	10.37	305.38	20.37	2.40	45.66	10.12
T ₈	20 % moringa leaves powder dried at 80 °C	7.39	10.40	305.42	20.41	2.42	48.33	10.15
T ₉	30 % moringa leaves powder dried at 80 °C	7.53	10.43	305.46	20.45	2.45	51.00	10.17
T ₁₀	10 % moringa leaves powder air dried	4.75	8.29	262.31	16.18	2.24	39.00	8.13
T ₁₁	20 % moringa leaves powder air dried	4.78	8.32	262.43	16.22	2.26	41.33	8.15
T ₁₂	30 % moringa leaves powder air dried	4.80	8.35	262.46	16.24	2.28	44.33	8.17

Mineral analysis of Biscuit

The results showed significant differences among the treatments presented in Table 2. Maximum Iron content was present in Treatment T₆ (85.75) and minimum was founded in T₀ (81.59), maximum vitamin C content was present in Treatment T₆ (38.93) and minimum was founded in T₀ (35.15), maximum Phosphorus content was present in Treatment T₆ (62.68) and

minimum was founded in T₀ (59.96), maximum Total Sugar content was present in Treatment T₆ (20.14) and minimum was founded in T₀ (17.47), maximum Zinc content was present in Treatment T₆ (7.79) and minimum was founded in T₀ (4.38). The maximum Calcium content was present in Treatment T₆ (1440.49) and minimum was founded in T₀ (1437.26).

Table 2: Mineral analysis of Biscuit

Treatment	Treatment Combination	Iron (mg)	Calcium (mg)	Zinc (mg)	Phosphorus (mg)	Total Sugar	Vitamin-C (mg)
T ₀	Control	81.59	1,437.26	4.38	59.96	17.47	35.15
T ₁	10 % moringa leaves powder dried at 40 °C	84.27	1,439.35	6.66	61.50	19.32	37.82
T ₂	20 % moringa leaves powder dried at 40 °C	84.29	1,439.37	6.68	61.19	19.34	37.83
T ₃	30 % moringa leaves powder dried at 40 °C	84.33	1,439.41	6.71	61.23	19.36	37.84
T ₄	10 % moringa leaves powder dried at 60 °C	85.69	1,440.44	7.74	62.44	20.10	38.91
T ₅	20 % moringa leaves powder dried at 60 °C	85.72	1,440.46	7.77	62.53	20.11	38.92
T ₆	30 % moringa leaves powder dried at 60 °C	85.75	1,440.49	7.79	62.68	20.14	38.93
T ₇	10 % moringa leaves powder dried at 80 °C	83.18	1,438.28	5.51	60.32	18.55	36.73
T ₈	20 % moringa leaves powder dried at 80 °C	83.21	1,438.29	5.55	60.34	18.58	36.75
T ₉	30 % moringa leaves powder dried at 80 °C	83.23	1,438.32	5.58	60.37	18.61	36.79
T ₁₀	10 % moringa leaves powder air dried	82.00	1,437.18	4.56	59.41	17.67	35.64
T ₁₁	20 % moringa leaves powder air dried	82.03	1,437.21	4.59	59.44	17.70	35.67
T ₁₂	30 % moringa leaves powder air dried	82.06	1,437.25	4.62	59.48	17.73	35.70

Quality analysis of Biscuit

Total Soluble Solid

The results showed significant differences among the treatments

presented in Table 3. Showed. The maximum TSS content was present in Treatment T6 (9.08) and minimum was founded in T0 (4.91).

Table 3: Quality analysis of Biscuit

Treatment	Treatment Combination	Total Soluble Solids (TSS) (°Brix)
T ₀	Control	4.91
T ₁	10 % moringa leaves powder dried at 40 °C	6.60
T ₂	20 % moringa leaves powder dried at 40 °C	6.96
T ₃	30 % moringa leaves powder dried at 40 °C	7.09
T ₄	10 % moringa leaves powder dried at 60 °C	8.95
T ₅	20 % moringa leaves powder dried at 60 °C	9.00
T ₆	30 % moringa leaves powder dried at 60 °C	9.08
T ₇	10 % moringa leaves powder dried at 80 °C	7.30
T ₈	20 % moringa leaves powder dried at 80 °C	7.96
T ₉	30 % moringa leaves powder dried at 80 °C	8.83
T ₁₀	10 % moringa leaves powder air dried	4.94
T ₁₁	20 % moringa leaves powder air dried	4.97
T ₁₂	30 % moringa leaves powder air dried	5.09

Conclusion

From the present investigation it was concluded that Moringa (*Moringa oleifera*) leaves powder Dried at 60 °C Produced satisfactory moringa leaf powder for development of biscuit. Treatment T6 (30% Moringa leaf powder dried at 60 °C) recorded the highest values for moisture, ash content, energy, crude protein, crude fat, carbohydrate, crude fiber, iron, calcium, zinc, phosphorus, total sugar, vitamin C, Total soluble solids for the developed product Biscuit . Whereas, treatment T5 (20% Moringa leaf powder dried at 60 °C) was found most acceptable for sensory evaluation of biscuit.

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