

Development of Non-Dairy Butter from *Moringa Oleifera* Seeds as a Fat Replacer

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ABSTRACT

This study aimed to develop a nutritionally enriched non-dairy butter using cold-pressed *Moringa oleifera* seed oil blended with cold-pressed coconut oil and food grade beeswax, and to evaluate its application in baked products. Three oil extraction methods (Roasting & boiling, Sedimentation and Cold pressed) were comparatively assessed. Among these, the cold-pressing method yielded higher oil recovery (35-40%), exhibited superior oxidative stability and produced oil with a distinct golden yellow colour. Based on these findings, three butter formulations were prepared using different ratios of moringa seed oil to coconut oil: V1(45:50), V2 (65:30), V3 (85:10) each incorporating 5% (w/w) of edible beeswax as a structuring agent. The developed formulations were subjected to proximate analysis, Vitamin estimation, Mineral analysis, and antioxidant activity evaluation. Among the variations, V3(85:10) demonstrated the most favourable nutritional and functional characteristics. It contained Protein (1.0025grams), Fat (96.5519), Vitamin C (147.3mg), Vitamin A (15.8 iu), Iron (12.8 mg), and exhibited (68.6%) antioxidant activity, while Carbohydrate and sodium were detected. Based on its superior nutritional profile, V3(85:10) was selected for incorporation into Chocolate muffins. The evaluation conducted by 10 semi-trained panellist using a 5 point hedonic scale. The

sensory scores revealed that the Choco muffins prepared using V3 had a higher acceptability with taste (4.5±0.3), mouthfeel (4.4±0.3) and overall acceptability (4.4± 0.3) than the Standard Choco muffin. The results indicate that the formulated non-dairy butter can serve as a functional alternative to conventional dairy butter in bakery applications.

Keywords: *Moringa oleifera* seed oil, Coconut oil, Non-dairy butter, Antioxidant, Chocolate muffin

INTRODUCTION

The Global transition towards plant-based diet has significantly accelerated the innovation in dairy alternatives, especially the non-dairy versions of butter that can be used in baking and cooking [1]. Conventional butter derived from bovine milk, is unsuitable for vegan individuals and for consumers with lactose-intolerant and dairy allergies. This has created a growing demand for plant-based alternatives capable of replicating the functionality and sensory attributes. While maintaining the nutritional benefits. *Moringa Oleifera* seed oil represents a promising yet underutilized source containing (70-75%) oil, protein (32-36%) and rich in oleic acid (70-75%) along with high oxidative stability [2-3]. The structural limitations were overcome by adding the cold pressed coconut oil and beeswax, which can improve the spread

ability, firmness and retention of antioxidant [4].

Based on the rationale, the study was designed with following objectives:

- To optimize the extraction process of *Moringa Oleifera* seed oil to achieve improved yield and quality.
- To develop a stable non- dairy butter formulations using the blends of cold pressed moringa seed oil and coconut oil.
- To characterize the physiochemical properties of the formulated non- dairy butter.
- To assess the sensory acceptability of the developed product by incorporating the non- dairy butter in the Choco muffins.

LITERATURE REVIEW

Moringa oleifera seeds are recognized as a highly valuable nutritional source, containing approximately 42.15% fat and 35.54% of protein on dry matter basis [2]. The extracted oil is characterized as a high oleic acid oil comprising 74.28% of total fatty acids followed by behenic (6.09%), palmitic (5.83%), and stearic (4.67%) acids. This fatty acid profile results in a favourable monounsaturated to saturated fatty acid MUFA/SFA ratio of approximately 3.7, which has been with cardiovascular health benefits [2]. Notably, the cold pressing regarded as an optimal extraction technique moringa seed oil, as it preserves thermolabile phytochemicals and reduce oxidative deterioration. Cold pressed *Moringa* seed oil consists of 36 known phytochemicals (98.99%), cis 6 octadecenoic acid (70.68%) and triolein (32.42%) are the essential phytocompounds, and it has high thermal stability (Tonset 390.72 degC) [5]. It demonstrated a high antioxidant property (365mM TEAC, ABTS assays) and a significant anti-inflammatory property, which could be used in food, cosmetic and pharmaceutical products. [5,7]

In other side the cold pressed Coconut oil contains 45-53% lauric acid, 16-12% myristic acid, and 6-10% palmitic acid which provides a solid fat structure at ambient temperature. It exhibits superior oxidative

stability and phenolic content compare to refined coconut oil, and there by it contribute to the shelf- life extension and nutritive value [4]. The blending of high oleic liquids oil, such as moringa with solid saturated fats as coconut oil, has been showed to optimize the melting behaviour, spread ability and mouthfeel in the butter development [6]. Additionally, beeswax (3-5%) function as a natural structuring agent, stabilizing emulsions and enhancing the texture without compromising edibility [1].

MATERIALS & METHODS

1.1.Raw material Procurement:

Dehulled *Moringa oleifera* seeds were procured from a local market in Chennai. The cold- pressed coconut oil and food grade beeswax obtained from certified retail outlets. Then the baking ingredients, including wheat flour, sugar, cocoa powder and baking powder were purchased in food grade quality from local suppliers.

1.2.Oil extraction;

To extract the oil from moringa oleifera seeds, three extraction methods were evaluated based on the yield. The method employed for the extraction process are roasting and grinding, sedimentation and cold pressing. For each method 1kgs of *Moringa oleifera* seeds are used for extraction method.

a) Roasting and grinding:

The seeds are roasted at 120°C for 10 minutes, ground into a fine paste and mixed with water in a (1:3w/v) ratio. Then the mixture was boiled, and the oil layer was skimmed from the surface. (Figure 1.2.1)

b) Sedimentation:

The seeds were ground into a slurry and boiled. The was allowed stand for 24 hours, which facilitate the phase separation, after which the oil layer was collected. (Figure 1.2.2)

c) Cold pressed:

The seeds were mechanically pressed at $\leq 40^{\circ}\text{C}$ using a manual screw press to

obtain oil without degradation. (Figure 1.2.3)

1.3.Butter formulation:

The non-dairy butter was formulated in three variations (V1, V2, V3) by blending the Moringa seed oil and coconut oil in various proportions. In the first variation (V1) the moringa seed oil and coconut oil were blended in the ratios of 45:50 and the second variation (V2) had 65:30 then the third variation (V3) contains 85:10 in which 5% of beeswax were incorporated in all the three variations to enhance texture, consistency and overall stability of the non- dairy butter. The oil and the beeswax were heated to 60°C with continuous stirring, followed by cooling at 4°C for 12 hours to obtain a stable emulsion. (Figure 1.3.1)

1.4.Physiochemical analysis of formulated butter:

All three variations of moringa were subjected to physiochemical evaluation to determine their nutritional and functional properties. The Carbohydrate content was determined by the Gravimetric method, while protein content was estimated by using kjeldahl method. Standard AOAC methods were employed to determine the Fat, Crude Fibre, Ash, Moisture, Energy value and the mineral content (Calcium, Sodium and Iron). The vitamin A was analysed using spectrophotometric method and the vitamin C was estimated by performing using Iodine titration. Antioxidant activity of the butter samples was assessed using DPPH radical scavenging assay. These analyses provided a comprehensive assessment of the physiochemical characteristics of the three variations of the formulated Moringa butter. (Figure 1.4.1).

1.5.Muffin Preparation:

Based on the Physiochemical results of formulated butter, the chocolate muffin was prepared using a standard recipe as (Control) and compared with the muffins in which the dairy butter was fully replaced (100%) with the developed non – dairy butter (Variation).

The ingredients includes oats (50grams), cocoa powder (28grams), baking soda (negligible), salt (negligible), formulated moringa butter (14grams), sugar (60grams), and warm milk (105grams+20grams extra). The ingredients were blended to form an uniform batter, poured into the Molds and baked for 10- 15 minutes. (Figure 1.5.1).

1.6. Sensory Evaluation:

The sensory evaluation was conducted with 10 semi trained panellists. The prepared muffins were evaluated for sensory attributes using a 5- point hedonic scale, to assess the overall acceptability and specific quality parameter. (Figure 1.6.1).

RESULT

The oil extraction from *Moringa oleifera* seed oil was performed using three different methods. Among these, the cold-pressed method demonstrated the highest efficiency. from 1kg of seeds, an oil yield of 40% was obtained, which was comparatively higher than the yields from the roasting- boiling and sedimentation methods. In addition to improved yield, the cold- pressed moringa seed oil effectively retaining the nutrient quality. Therefore, this oil was used for butter formulation.

The physiochemical analysis of three variations of butter (V1, V2, V3) on a 100gram basis showed the absence of Carbohydrates and ash in all samples. Then the protein content ranges from 0.91 to 1.07 grams, while fat content remained high (96.55-98.23) g. the fibre content ranges from 0.99 g in V1 to 2.06 in V3. The moisture content was (0.0459-0.2401%) then the energy values ranged from 873.38 to 888.09Kcal, were the v2 showing the highest value. The calcium was present in V1 and V2 and absent in V3, while sodium ranged from 1.98 to 3.11mg.

The micronutrient content increased with moringa seed oil content, were the Vitamin C increases from 91.16mg to 147.3mg, Vitamin A ranges from (9.98 to 15.8IU), and the iron value ranges from 5.9 to 12.8mg.

The antioxidant activity also increased from 64.4% V1 to 68.8% in V3.

The sensory evaluation of the prepared chocolate muffin using moringa seed oil butter shows higher scores in terms of flavours (4.0), aroma (4.0) and the overall acceptability (3.95) compared to the standard recipe. But the appearance and the texture

was similar, where the mouthfeel was lightly higher standard sample. So, this result indicates that the non-dairy butter prepared using moringa seed oil and coconut oil improves the nutritional value and sensory acceptability of the product without compromising the quality.



Figure 1.2.1



Figure 1.2.2



Figure 1.2.3



Figure 1.3.1

Test calculated for 100 grams	V1	V2	V3
Carbohydrate	Nil	Nil	Nil
Protein (gm)	1.067	0.9128	1.0025
Fat (gm)	97.0923	98.23	96.5519
Fibre(gm)	0.9854	1.22	2.056
Ash	Nil	Nil	Nil
Moisture (%)	0.114	0.2401	0.0459
Energy in kcal (approx.)	878.49	888.09	873.38
Calcium (mg)	4.34	1.08	Nil
Sodium (mg)	1.98	3.11	2.45
Vitamin C(mg)	91.16	126.23	147.3
Vitamin A (iu)	9.98	12.93	15.8
Iron (mg)	5.9	9.5	12.8
Antioxidant Activity (%)	64.4	65.8	68.6

Figure 1.4.1



Figure 1.5.1

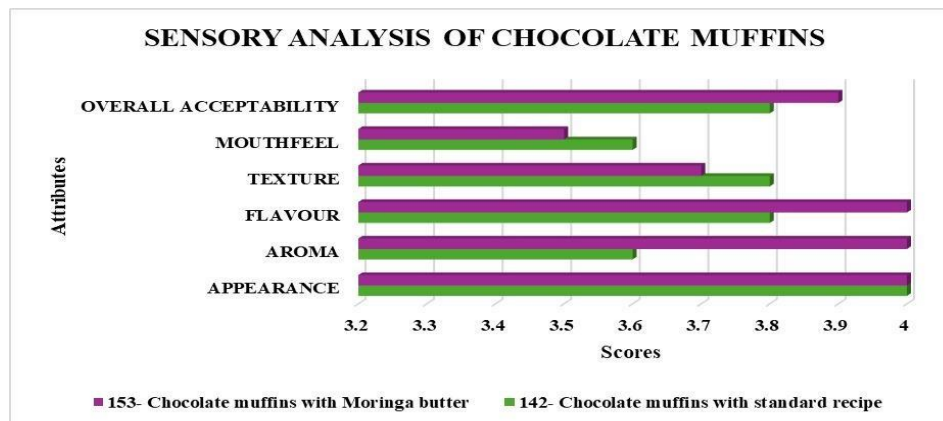


Figure 1.6.1

DISCUSSION

The cold pressing method demonstrated superior performance compared to aqueous extraction techniques, supporting the findings of [7] which reported that the oil extraction without the application of heat can preserve the oil quality and the bioactive compounds present in it. The high oleic content and favourable MUFA/SFA content indicates the potential contribution to the cardiovascular health [2].

The cold-pressed Coconut oil also significantly enhanced the functional properties of the formulation, its high lauric acid content (48.2%) and the solid fat provided the structural support necessary for achieving a butter like consistency with the observation [4]. Following oil extraction, the residual moringa seed cake also exhibited a high protein content (51.28%), as reported in [3] highlighting its potential as a nutrient-dense by product suitable for food fortification and value addition application.

The physiochemical evaluation of the three variations revealed the absence of carbohydrates and ash with fat and protein as a predominant - macronutrients. The fat

contributed to the overall energy value where the fibre content increased with higher moringa seed oil incorporation, indicates its functional properties. The low moisture content across all the sample denotes the improved storage stability. And also, the increased levels of vitamins, iron and antioxidant activity were observed with increase in the moringa seed oil incorporation, which enhance the nutritional and bioactive significance.

Sensory analysis of chocolate muffin prepared using the developed non-dairy butter revealed a mild, nutty flavour imparted by moringa seed oil which complimented the chocolate-based formulations without producing an undesirable off-flavours. The improved mouthfeel reflected the effective of fat mimicry, it's likely due to the optimized melting behaviour achieved through the blending of moringa seed oil and coconut oil.

CONCLUSION

A functional non-dairy butter was successfully formulated using the cold-pressed Moringa seed oil blended with cold-pressed Coconut oil and edible beeswax. The

developed butter formulations exhibited desirable physiochemical characteristics, superior antioxidant activity, and the high consumer acceptability when it is applied in the baked products, particularly in the preparation of chocolate muffins. The high oleic acid content of moringa seed oil combined with the structural and functional properties of Coconut oil and the edible beeswax, thus it contributed significantly to the nutritional and sensory advantages to the product. This formulation represents a sustainable, nutritious and a clean label alternative to the conventional dairy butter. The future investigation should focus on shelf- life assessment, oxidative stability kinetics and large- scale consumer validations studies to evaluate commercial feasibility.

Declaration by Authors

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