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Nut butters incorporation as substitute for shortening in Nankhatai

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Abstract
Background: Bakery goods usually contain a lot of fat, it can be difficult to formulate them with less fat in order to lower the risk of acquiring illnesses like cancer, coronary heart disease, and obesity. Plant-based fat substitutes, like nut butter made from almonds, cashews, and peanuts, can be utilized to alleviate this problem and reduce the fat content of baked goods. Incorporating nut butter instead of other butters helps lower the risk of obesity, heart disease, and cancer and also improves the nutritional value and texture of the baked goods, making them more accepted.
Objective: The objective of the study was to develop Nankhatai incorporating different nut butters (Almond, peanut and cashew) as a shortening substitute.
Methodology: Experimental study was conducted to develop Nankhatai incorporating different nut butters, analyzing chemical characterization of nut butters and evaluating sensory attributes.
Results: The study revealed that peanut butter was found to be rich in saturated fatty acids and short chain fatty acids whereas the oxidation level and free fatty acids had minimal content. The majority of the panel preferred Nankhatai made with peanut butter over those made with cashew butter and almond butter. The peanut butter Nankhatai received a significantly higher mean score of 8.85±0.55 compared to the almond butter Nankhatai and cashew butter Nankhatai, which had mean scores of 8.27±0.78 and 8.00±0.77, respectively. This difference in mean scores was statistically significant at a confidence level of ($p \leq 0.05$), indicating a strong preference for the peanut butter-based Nankhatai among the panelists.
Conclusion: This study emphasizes that the utilization of peanut butter in the preparation of Nankhatai yields numerous advantages, rendering it to be more nutritional and palatable substitute for conventional Nankhatai, the complete incorporation of peanut butter contributes to cost-effectiveness in the production process, as it does not significantly alter the flavor profile of the final products, thereby ensuring consistent flavor.

Keywords: Nut butter, chemical analysis, sensory evaluation, Nankhatai

Introduction
Nuts have long been a staple in the diets of many nations and civilizations due to their high energy and nutritious content, as well as their vast range of flavors and distinctive taste (Rico *et al.*, 2016) [18]. It is well recognized that tree nuts are rich in unsaturated fatty acids (FA), including mono- and polyunsaturated FA, as well as a wide range of vitamins, minerals, amino acids, phytosterols, and fiber. Almonds (*Prunus dulcis*) have a low moisture content, a variety of minor bioactive components, and roughly 50% of their weight is made up of lipids, 25% of proteins, and 20% of carbohydrates. The benefits of consuming almonds with low cholesterol are attributed to their beneficial lipid composition and fiber content. Almonds' distinct nutrient composition makes them a potential benefit for reducing various preventable cardiovascular and diabetes risks, including inflammation, oxidative stress, body weight, and glucose homeostasis (Barreca *et al.*, 2020) [6]. Peanuts (*Arachis hypogaea)* are popular globally as a plant protein (23–35%) and fat source (45–52%) and due to their great nutritional and commercial value peanuts are derived from the presence of fatty acids, protein, carbs, minerals, and vitamins (Muzoora *et al.*, 2017) [15]. The nutrients (lipid profiles) and bioactive substances found in peanuts, including phytosterols, phenolic compounds, stilbenes, lignans, and isoflavonoids, have a good impact on human health. These bioactive substances offer defense against cancer, type 2 diabetes, and cardiovascular disease. Cashew (*Anacardium occidentale*), an evergreen perennial plant belonging to the family Anacardiaceae that consists of 400-600 species (Iqbal *et al.*, 2021) [10]. Cashew (*Anacardium occidentale*) consisting of 400–600 species, an evergreen perennial plant, are members of the Anacardiaceae family (Iqbal *et al.*, 2021) [10]. Many benefits can be found in cashew nuts, such as their ability to reduce inflammation, fight cancer, and act as an antioxidant.

Bioactive compounds such as β-carotene, lutein, zeaxanthin, α- and γ-tocopherol, thiamin, stearic acid, oleic acid, and linoleic acid have been found in cashew nuts (Trox *et al.* 2010) [20].

A baked treat with a round, dome shape, nankhatai cookies have their origins in the Indian subcontinent. Most often, Nankhatai cookies are baked until they are crisp (Gurjar and Raj, 2022) [8]. These mouthwatering, crumbly, sweet cookies combine buttery richness with delicately warmed spices for a flavor and texture that makes them a great choice for a snack or dessert (Mounika *et al.*, 2017) [14]. It is thought that nankhatai first appeared in Surat during the 16th century, when Indians and Dutch were the main spice traders. In Surat, a Dutch couple opened a bakery to serve the community's Dutch population. The term "fat" can refer to either fat or oil and is used to describe the lipid food group. Fat is a necessary component of a diet; the flavor of the fat has a big impact on baked goods' flavor. The fat used in the formulation of fortified blended foods for vulnerable populations enhances the energy density by imparting flavor, texture, and appearance to the baked good (Islamiyat *et al.*, 2016) [11]. Conversely, eating too much fat in the diet can increase risk of developing conditions like obesity, cancer, and coronary heart disease (Akoh, 1988) [1]. It is challenging to prepare bakery goods like biscuits, Nankhatai, and the like by lowering the fat content in their formulation to reduce the risk of such diseases because they usually have a higher fat content. Nut butters made from almonds, cashews, and peanuts are examples of plant-based fat substitutes that can be used to lower the fat content of baked goods. By substituting nut butter, baked goods will have improved nutritional value, as well as sensory and organoleptic qualities, and a lower risk of obesity, cancer, and coronary heart disease (Wilkes, 2012). The development of Nankhatai using nut butters as a shortening substitute, nut butter chemical characterization, and sensory assessment of Nankhatai made with various nut butters are the major objectives of this research.

Materials and Methods

Collection of Raw Material: Plant Nuts like almond, peanut and cashew nuts, were collected from Dehradun, Uttarakhand for analysis. High-quality nuts and seeds were meticulously chosen, subjected to a rigorous cleaning process, DE husked thoroughly desiccated, and subsequently crushed utilizing a laboratory electric grinder prior to the initiation of butter preparation.

Preparation of Nut Butter

Figure 1 illustrates how almond, peanut, and cashew butter were made. The nut butter used to make Nankhatai was freshly made. To get rid of dirt and damaged nuts, the purchased nuts were graded and sorted. 52g of salt was soaked with 1000g of the sorted nuts for 20 minutes. After covering the nuts with water, the soaked nuts were drained and spread out to dry on a tray. After heating fine sand in a pan over a flame, the nuts were added and allowed to roast for ten minutes while being constantly stirred and cooked. To finish the cooking process, the roasted nuts were spread out on a tray and allowed to cool. By rubbing the roasted nuts between your palms, you can remove the skins from the cooled nuts and get rid of any spoiled or discolored nuts. After cleaning the nuts, they were ground in a roller mill, and the nut butter was then sealed in a glass jar and kept at room temperature.

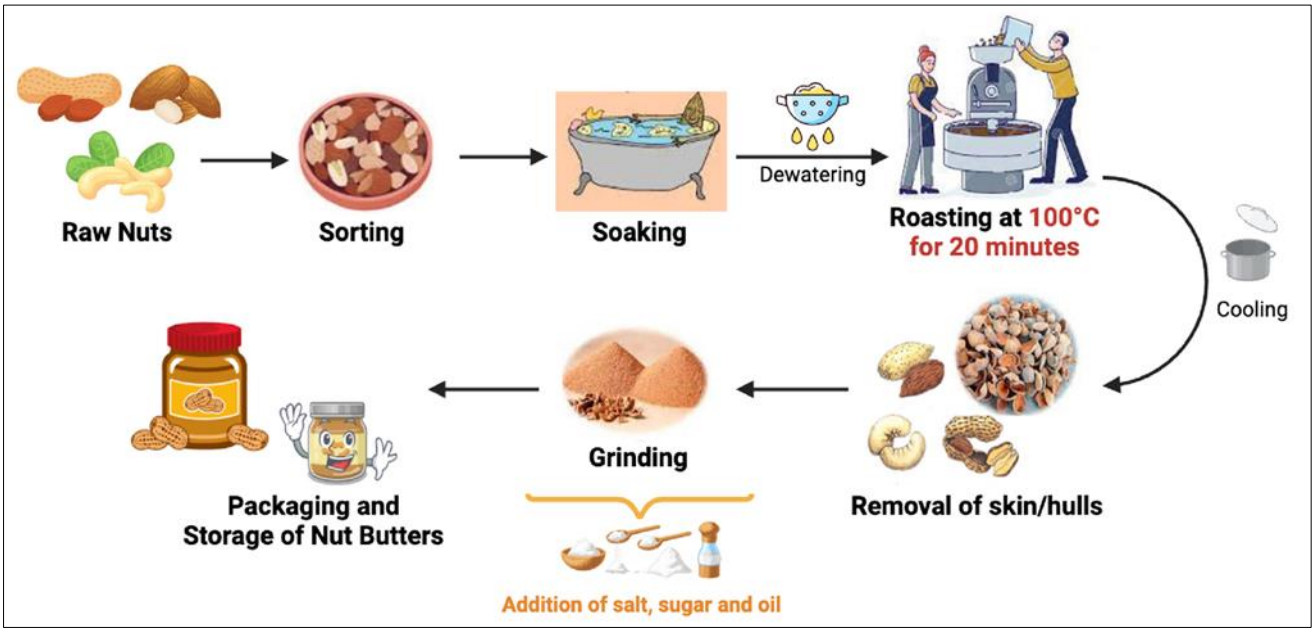

Fig 1: Flow Diagram of Nut Butter Production

Chemical Characterization of Nut butter: Acid value, iodine value, saponification value and Peroxide value were estimated by standard procedures of Association of Official Analytical Chemists (AOAC, 2017) [3].

Product Development (Nankhatai): In a pan, sugar and nut butter were combined and worked into a smooth dough. Blending was done while adding baking powder. Salt, baking soda, nut butter, and wheat flour were gradually added to the dough mixture. Using a rolling pin on a lightly floured table, the dough was flattened. After rolling out the dough to a 1.2 mm thickness, round cookies were sliced, put on baking trays that had been greased, and baked for 15 minutes at 190 °C (Gurjar and Raj, 2022) [8].

Sensory evaluation: The evaluation of the developed food products were carried out by using 5 point composite score with respect to various attributes namely; appearance, color, flavor, texture, and taste whereas overall acceptability was assessed by 9-point hedonic rating scale.

Statistical analysis: The results obtained were expressed as Mean±SD and Paired t-test of three determinations and also statistically analyzed its significance. The significance was determined at ($p \leq 0.05$ Level).

Results and Discussion

Table 1: Mean Scores of chemical quantitative analysis of nut butters

Butters	Saponification Value (mgKOH/g)	Iodine value ($mgI_2/100g$)	Acid value (mgKOH/g)	Per-oxide value ($meqO_2/Kg$)
Standard cow's butter	192.2±0.12	41.63±0.15	3.49±0.21	1.1±0.18
Almond butter	75.7±0.11*	83.80±0.52*	3.45±0.11^{NS}	2.9±0.21*
Peanut butter	67.2±0.73*	86.50±0.61*	2.65±0.64*	1.0±0.23^{NS}
Cashew butter	106.2±0.84*	63.01±0.43*	3.28±0.52^{NS}	2.1±0.14*

Data expressed as Mean±SD. All different types of butters (almond, peanut and cashew) were compared with the standard butter. *$p \leq 0.05$ and NS-non significant

Table 1 depicts chemical quantitative analysis such as saponification value, iodine value, acid value and peroxide value of different nut butters in comparison to standard (cow's butter). Among all nut butters, the highest saponification value (mgKOH/g) was obtained in cashew butter i.e., 106.2±0.84 mgKOH/g and the lowest value was observed in peanut butter 67.2±0.73 mgKOH/g. This reveals that an increased saponification value correlates with a greater proportion of short-chain fatty acids (Samuel *et al.*, 2017) [19]. The data indicates significant saponification value of all nut butters at $p \leq 0.05$ level, when compared to standard butter 192.2±0.12mgKOH/g which reveals that nut butter variants show less monounsaturated fatty acids as compared to standard. Aremu, (2006) [4] analyzed that the saponification value of the almond oil was 128 mgKOH/g which was lower than the values obtained for some vegetable oil ranging from 188-196 mgKOH/g. The iodine value ($mgI_2/100g$) was obtained highest in peanut butter i.e., 86.50±0.61 $mgI_2/100g$ and the lowest value was observed in cashew butter 63.01±0.43$mgI_2/100/g$. The butter's low iodine value signifies an abundance of saturated fatty acids, which in turn guarantees its resistance to oxidation and the development of rancidity (Ivanova *et al.*, 2022) [12]. The data indicates significant iodine value of all nut butters at $p \leq 0.05$ level, when compared to standard butter 41.63±0.15$mgI_2/100g$. In consonance, a study by Samuel *et al.*, 2017 [19] reported the iodine value of Shea nut oil (Shea butter) was 70.00g/100g. This value was significantly ($p \leq 0.05$) higher than the crude palm oil (57.33g/100g).

The highest acid value (mgKOH/g) among all nut butters was found in almond butter i.e., 3.45±0.11 and the lowest acid value was found in peanut butter i.e., 2.65±0.64 mgKOH/g. The data indicates that an increased acid value corresponds to higher levels of free fatty acids, resulting in diminished butter quality (Hassanzadazar *et al.*, 2018) [9]. The data indicates that the acid value in almond butter and cashew butter was found to be non-significant at $p \leq 0.05$ level when compared with standard butter 3.49±0.21mgKOH/g and significant in peanut butter depicting an acceptable quality Nankhatai. The acid value of the unrefined fluted pumpkin seed oil was 1.4 mgKOH/g. This value is lower than 3.97, 3.56, 3.48, and 2.22 mgKOH/g reported by Akubugwo *et al.*, (2008) [2]. The highest Peroxide value ($meqO_2/Kg$) evaluated among all nut butters was in almond butter i.e., 2.9±0.21 $meqO_2/Kg$ and the lowest value was found in peanut butter i.e., 1.0±0.23 $meqO_2/Kg$. This suggests that a high peroxide value serves as an indicator of the degree of oxidation, and the greater the peroxide value, the more oxidized the butter becomes (Aw *et al.*, 2019) [5]. The peroxide value indicates that the almond butter and cashew butter was found to be significant at $p \leq 0.05$ level when compared to standard butter 1.1±0.18 $meqO_2/Kg$ and insignificant in peanut butter depicting a satisfactory grade Nankhatai. A study by Oderinde, (2009) [16] reported that the peroxide value obtained for the oil 2.8 $meqO_2/Kg$ is lower than the recommended standard peroxide value for all edible oils as per Codex Alimentarius Commission, (2007) [13].

Table 2: Sensory mean scores of different variants of nankhatai

Attributes	Standard	Variant A	Variant B	Variant C
Appearance	4.86±0.31	4.81±0.45*	4.84±0.23*	3.56±0.65^{NS}
Color	4.88±0.31	4.85±0.31*	4.86±0.21*	3.71±0.55^{NS}
Flavor	4.86±0.56	4.45±0.55*	4.55±0.11*	4.43±0.11*
Texture	4.89±0.23	4.38±0.26^{NS}	4.69±0.26*	4.39±0.24^{NS}
Taste	4.87±0.25	4.55±0.22^{NS}	4.80±0.23^{NS}	4.02±0.59^{NS}

Data expressed as Mean±SD, of twenty panels each. All different types of Nankhatai Variant A (Almond butter Nankhatai), Variant B (Peanut butter Nankhatai) and Variant C (Cashew butter Nankhatai) were compared with the standard Nankhatai (Cow's butter Nankhatai). *$p \leq 0.05$ and ^{NS}-non significant.

Fig 2: Nankhatai developed from different nut butters

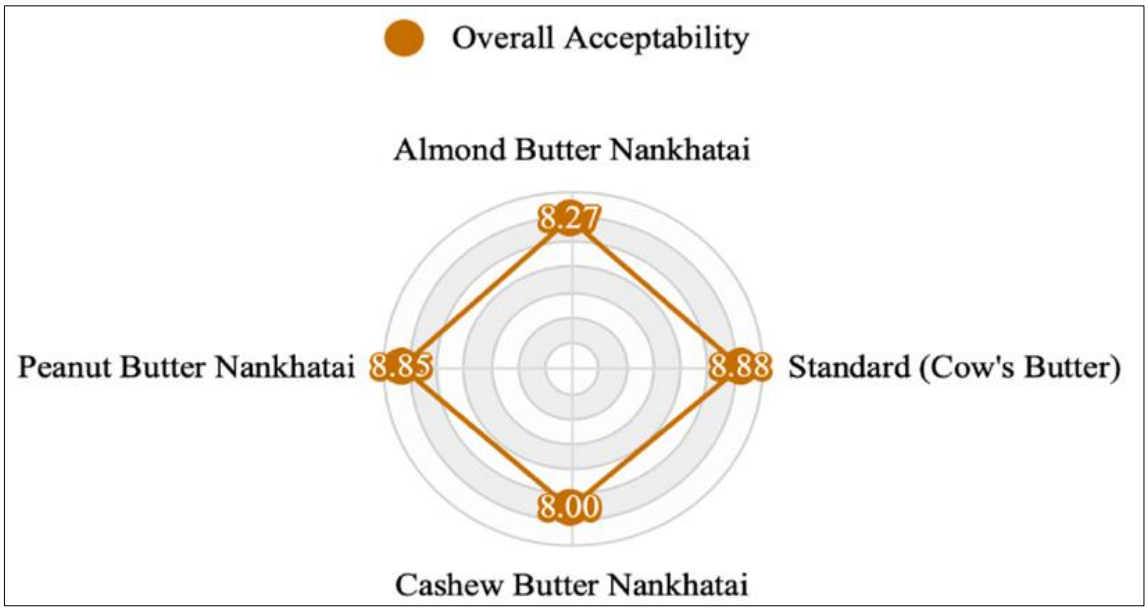

Fig 3: Overall acceptability evaluation of nut butters Nankhatai variants.

Table 2 illustrates the sensory mean scores of Nankhatai developed from nut butters using 5-point composite score, representing Variant A (Almond butter Nankhatai); Variant B (Peanut butter Nankhatai) and Variant C (Cashew butter Nankhatai). Variant B was recorded significantly higher scores in appearance (4.84±0.23), color (4.86±0.21), flavour (4.55±0.11), texture (4.69±0.26) and taste (4.80±0.23) when compared to Variant A and C at ($p \leq 0.05$) level. The overall acceptability (Figure 3) of peanut butter Nankhatai exhibits significantly highest mean score of 8.85±0.55 at ($p \leq 0.05$) level when compared to almond butter Nankhatai (8.27±0.78) and cashew butter Nankhatai (8.00±0.77). The above results showed that peanut butter Nankhatai was found to be extremely liked according to the 9-point hedonic rating scale among all variants. In consonance with this study the sensory evaluation of functional cookies enriched with chestnut shells extract unveiled excellent scores on overall acceptability (Pinto *et al.*, 2023) [17]. A study by Chopra *et al.*, 2018 [7] revealed the organoleptic acceptability of cookies developed from quinoa, sweet potato and wheat flour blends were most preferred by the sensory panel with an overall acceptability score of 7.8 consisting 80% whole wheat flour, 10% quinoa flour and 10% sweet potato.

Conclusion

The elevated content of monounsaturated and polyunsaturated fatty acids in nut butters has been demonstrated to effectively decrease LDL cholesterol and triglyceride levels, thereby mitigating the potential for metabolic syndrome, heart disease, and type 2 diabetes. In the domain of culinary exploration, Nut butter Nankhatai offers an appealing blend of numerous cultural influences, integrating flavour, texture, and nutritional value. Our findings show that Nankhatai formulations containing various types of butter, particularly peanut butter, have higher acceptability than standard Nankhatai. Furthermore, the use of peanut butter in Nankhatai formulation has various benefits, making it a healthier and more appealing option for standard Nankhatai. Furthermore, incorporating peanut butter completely into the recipe might help to cost reductions during production without drastically changing the product's flavour profile. As a result, it is advised that this formulation be used to promote the broad manufacture and distribution of Nankhatai, as it can provide customers with a healthy and wholesome confectionary alternative.

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