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Development of Nutri Bar Enriched with Date Seed Powder and Psyllium Husk

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Abstract: *The food industry is rapidly shifting toward nutrient-dense, functional, and sustainable convenience foods, with Nutri bars emerging as one of the most preferred due to their portability, extended shelf life and targeted nutrition. Current market ends emphasize high-fibre formulations, clean-label ingredients. Date seed powder an underutilized agro-industrial by-product generated in large quantities during date processing, offers significant potential for value addition. The fibre content contributes to improved bowel motility, increased fullness and modulation of Glycaemic response. The functional efficacy enhanced through the addition of psyllium husk, a well-established source of soluble dietary fibre. This fibre-rich Nutri bar can be effectively integrated as a mid-morning or evening snack, pre-or post-workout supplement, or a partial meal. Also, it is well-suited for individuals with dietary concerns, including those with constipation, irregular bowel habits, prediabetes, and hyper cholesterol, owing to its low glycaemic impact and digestive benefits. This demonstrates a practical approach to waste valorisation, dietary fibre enrichment, targeted nutrition and environmental sustainability.*

Keywords: *Date seed Powder, Psyllium husk, green gram flakes, Dietary fiber, Nutri bar, Waste Valorization, Functional foods.*

I. INTRODUCTION:

The date palm, or dates *(Phoenix dactylifera L.),* is one of the most important fruit crops grown in desert climates, especially in the Middle East, North Africa, and parts of India. Over the past ten years, date output has significantly expanded due to customer demand for natural sweeteners and nutrient-dense fruits (FAO, 2021- 2024). Date processing produces a significant amount of seeds, which account for 10–15% of the fruit's weight, even though the edible pulp is frequently consumed in both fresh and processed versions. Once considered a low-value waste, date seeds have recently attracted scientific interest due to their rich nutrient profile, prospective uses, and coffee-like flavour.

Research indicates that date seeds are abundant in essential fatty acids, amino acids, micronutrients, phenolic antioxidants, and dietary fibre, which includes both soluble and insoluble types. The levels of these components often exceed those found in many common seed by-products used in the food industry (Bashir, 2025). These characteristics demonstrate the worth and excellence of date seeds as a useful component.

According to recent studies, using agricultural waste is crucial to reducing the environmental impact. Reduce waste and increase sustainability. In addition to reducing waste, roasting and powdering seeds produces a shelf- stable ingredient that is ideal for fortification. Date seed conversion benefits small businesses in areas with an abundance of seed resources and contributes to global sustainability initiatives.

Nutri bars also referred to as energy bars or functional bars have become well-liked as quick, pre-packaged snacks among the many food categories that profit from date seed powder. The market for Nutri bars has grown significantly over the last ten years due to consumers growing desire for quick, healthful snacks made from organic ingredients. Research shows that Nutri bars enhanced with plant proteins, dietary fibers, and natural binders have several benefits, including supporting digestive health and sustaining steady energy levels (Costa *et al.* Sant'Anna *et al.* in 2023;). These findings establish Nutri bars as a great way to add date seed powder, which raises fiber and nutritional value while providing a delicious roasted flavor.

Achieving the right chewiness, cohesiveness, non-crumbly structure, and moisture balance without using artificial stabilizers is a significant challenge in making clean label Nutri bars. Psyllium husk *(Plantago ovata*) plays a crucial role here. Psyllium is a natural soluble fibre known for its excellent ability to retain water, form gels, and offer prebiotic benefits. In the past ten years, psyllium has gained attention as a hydrocolloid for improving the texture, strength, and moisture retention of high-fibre, processed foods, such as baked goods, snack bars, and biscuits (Foods Journal 2021-2023). Psyllium- husk and date seed powder combine to form a cohesive matrix that greatly increases soluble fibre while strengthening the bar, preventing dryness, and improving chewiness.

Green Gram Flakes, or mung bean flakes, are added to the Nutri bars to further improve their protein and carbohydrate content. This nutrient-rich legume has long been used in South Indian cooking. It helps maintain energy balance by supplying slow-digesting carbohydrates, plant-based proteins, vitamins, and minerals. Furthermore, the flake form makes it simple to incorporate into the bar while maintaining a nice chewiness and texture (Chauhan *et al.,* 2019).

Another crucial component of Nutri bar formulation is the selection of binders. Natural substitutes like date syrup, honey, peanut butter, jaggery syrup, and fruit concentrates are used in clean-label functional foods instead of synthetic binders. Date syrup functions as a natural sweetener, humectant, and binding agent in date seed Psyllium Nutri bars. It provides a slight stickiness and aids in moisture retention while being stored. Protein, good fats, and additional binding due to fat crystallization and viscosity are all added by peanut butter. Achieving the proper ratio of dry ingredients to binders typically 70:30 is crucial to preventing textural problems like crumbling or excessive gumminess, according to recent formulation studies (Sant'Anna *et al.,* 2023).

In this sense, the current review focuses on recent research on the production of fibre-enriched Nutri bars using date seed powder and psyllium husk. It gathers the most recent studies on the nutritional composition of date seeds, how to transform them into edible powder, and how they could be utilized as a value-added component created from waste from the food sector. The review discusses the health benefits of psyllium husk, its application in functional food formulations and its value as a source of soluble fibre. Mainly are formulation strategies, processing methods and the product's functional and nutritional qualities. The primary objective is to show how Nutri bars, which are created from psyllium husk and date seed powder a sustainable, high-fibre and health- promoting snack that promotes waste valorisation and food-based dietary control (Patel & Ramesh, 2021).

II. LITERATURE REVIEW:

2.1 Nutri bar

2.1.1 Importance, Trends, Functional Role and Health Benefits

Nutri bars have gained substantial importance in recent years due to rapid urbanization, changing dietary habits, and increased awareness regarding health, fitness and preventive nutrition. They deliver concentrated nutrition in a compact, convenient and shelf-stable form making them suitable for modern consumers seeking healthy alternatives to conventional snacks (Bogue *et al.,* 2021). From a food technology perspective, Nutri bars serve as an efficient vehicle for incorporating functional ingredients such as dietary fibres, proteins, antioxidants, and bioactive compounds without compromising consumer acceptability.

Fig.2.1.1

Traditionally, Nutri bars are developed to deliver rapidly available carbohydrates, making them suitable for immediate energy replenishment. The carbohydrate-rich composition results in quick glucose availability, which is beneficial in situations requiring instant energy replenishment. However these formulations typically contain lower dietary fibre levels compared to functional or fortified Nutri bars, which limits their role in digestive and metabolic health. Earlier products were dominated by refined sugars and fats, recent formulations increasingly incorporate whole grains, natural sweeteners, and nuts to improve nutritional perception (Euromonitor, 2023). Nevertheless, normal Nutri bars continue to rely heavily on high-glycaemic carbohydrates, which may contribute to rapid postprandial blood glucose spikes (Slavin & Carlson, 2014).

Recent trends emphasize high-fibre formulations, low glycaemic index ingredients, plant-based sources and sustainability-driven innovation (Aït-Kaddour *et al.,* 2024). Dietary fibre enrichment is one of the most significant functional attributes of modern Nutri bars.

From a dietary application standpoint, Nutri bars can be integrated as a mid-meal snack, Pre or post-workout food, or partial meal replacement, depending on formulation and nutrient density. Making them suitable for gym-going

individuals and physically active populations, particularly when combined with adequate protein sources (Duda- Seiman *et al.,* 2025). Unlike, sugar-rich snack bars, high- fibre Nutri bars exhibit a lower glycaemic response, which is beneficial for endurance, recovery, and appetite control.

2.2 Date Seeds

Due to their excellent nutritional value and promise as an affordable component of high-fibre foods, date seeds *(Phoenix dactylifera L.)* have attracted a lot of study attention in the past ten years. According to published research, date seeds are rich in minerals, vital fatty acids, helpful phenolic antioxidants, and dietary fibre.

Fig.2.2.1

Date seed powder is particularly well suited for Nutri bars because of its high fibre content, which is crucial for textural stability, gradual energy release and fibre enrichment. Numerous polyphenolic chemicals including gallic acid, catechin, epicatechin, and caffeic acid, have been found in date seeds, according to recent studies. These substances may improve metabolic health and product shelf life by increasing antioxidant activity and oxidative stability (Ahmed *et al.,* 2021).

Fig.2.2.2

According to the findings of (Al-Farsi *et al.* (2022)), there is growing interest in using Date Seed Powder as a valid alternative to traditional grains to produce healthy snacks, such as nutritional bars. Date Seed Powder contains a high percentage of dietary fiber (73-80%) primarily from insoluble sources including cellulose, hemicellulose (2- 6% by weight), along with moderate amounts of fat (8- 10%), protein (5-6%) and an extensive list of vital minerals such as zinc, potassium, calcium, magnesium and iron. Due to its many health-benefits there are emerging applications outside the traditional grain products. The high level of dietary fiber also helps with the overall wellness of the individual, can control blood sugar levels and improve healthy bowel function (Al- Harthi *et al.* 2023).

2.3 Psyllium Husk

Psyllium husk *(Plantago ovata)* has gained popularity as a natural fiber supplement because of its high soluble fiber content, gel-forming ability and various health benefits. It is widely used in functional foods and high-fiber snack products (McRorie & Fahey, 2015). The husk mainly contains arabinoxylans, which are complex polysaccharides that form thick gels. These gels increase fullness, slow gastric emptying and support digestive health (Patel & Naik, 2018). These characteristics make

psyllium particularly useful in Nutri bars, where ingredient cohesion and moisture retention are important.

Fig.2.3

In addition to digestive benefits, psyllium also has positive effects on metabolism. Studies by (Pal *et al.* (2020)) found that psyllium can reduce post-meal glucose spikes due to its slow-release carbohydrate structure which has low glycemic index. It also has prebiotic effects, promoting the growth of beneficial gut bacteria like Bifidobacterium and Lactobacillus (Chutkan *et al.,* 2020). In food product formulation psyllium functions well as a natural binder. Research on cereal and fruit bars suggests that adding 2–4% psyllium improves structural stability, chewiness and reduces crumbliness (Kandhari *et al.,* 2019). This supports its inclusion in date seed Nutri bars as the high insoluble fiber content requires a hydrophilic binder to hold the ingredients together effectively. Highlighting its suitability for functional food and Nutri bar development.

2.4 Green Gram Flakes

Green Gram Flakes which is native to India and Central Asia, come from mung beans *(Vigna radiata)* which are rich in high-quality plant protein, complex carbohydrates, vitamins and minerals. They provide about 20–25% protein, 55–60% carbohydrates and 6–8% dietary fiber, along with iron, calcium and B vitamins (Chauhan *et al.,* 2019). The slow-digesting carbohydrate profile promotes sustained energy release, while the protein content helps with structural stability and chewiness in Nutri bars. Their functional properties, such as water absorption, mild gel formation and textural resilience enable them to mix well with date seed powder and psyllium husk enhancing bar cohesiveness and flavor (Patel & Ramesh, 2021).

2.5 Solar Drying

Solar drying provides an affordable and eco-friendly way to lower moisture in date seeds before grinding them into powder. In a solar dryer, the drying chamber usually operates at moderate temperatures between 50 and 65 °C. This effectively removes moisture and reduces heat damage to dietary fiber and essential minerals (Raza *et al.,* (2023)). In practice, date seeds are often dried for about 48 hours in thin layers. This approach allows for even moisture reduction and stops microbial spoilage. Controlled solar drying during this time helps keep the nutritional and functional qualities of date seed powder better than open sun drying. Open sun drying is less predictable and more likely to face contamination. Research on solar drying of date-related products shows that keeping moderate temperatures for extended periods improves quality retention, shortens drying time and creates a stable, valuable ingredient for functional food formulations (Khan *et al.,* 2024).

2.6 Drying Characteristics of Date Seed Powder:

Drying is an important step in processing date seed powder. Directly affecting moisture stability, shelf life and the powder performance. This comparison of three drying methods high-temperature short-time oven drying, low-temperature long-time oven drying, and sun drying

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looks at how effectively each method removes moisture from date seed matrices.

High-temperature oven drying (150 °C for 1 hour-Sample 1) left a higher residual moisture content (6.44%). While higher temperatures speed up surface evaporation, the quick moisture loss on the surface can cause case hardening, limiting moisture movement from inside. Therefore, short exposure even at high temperatures, is not enough for complete drying.

S.no	Time (min)	Initial Weight (g)	Final Weight (g)
1	10	10	9.96
2	20	9.96	9.84
3	30	9.84	9.73
4	40	9.73	9.56
5	50	9.56	9.33
6	60	9.33	9.33

Table 2.6.1

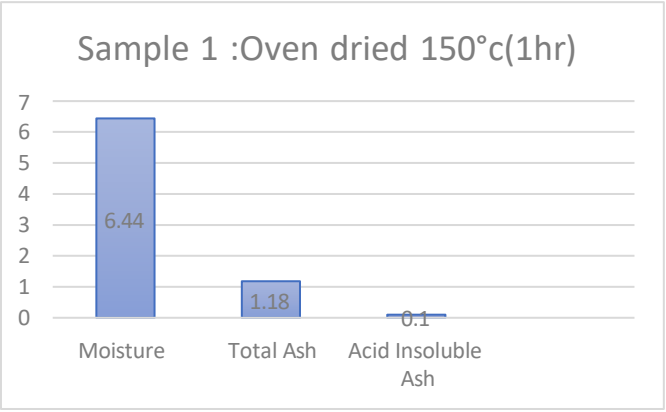

Fig.2.6.1

Sun drying for (48 hours-Sample 2) achieved a moderate moisture level (3.60%). The slow and gradual heat, decreasing the risk of thermal damage. Still, reliance on weather conditions and requires more time, making it less practical for large-scale use.

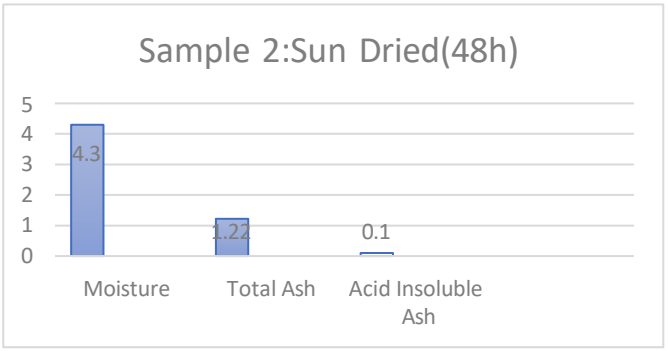

Fig.2.6.2

Moderate-temperature oven drying (110 °C for 2 hours-Sample 3) resulted in the lowest moisture content (3.34%), with better drying efficiency. The right balance of temperature and time allowed for consistent heat distribution and effective moisture movement without creating barriers to diffusion. This method is best suitable for date seed powder, as controlled drying helps maintain its stability.

For all drying methods Total-ash and acid insoluble ash values remained fairly constant. This indicates that the minerals stayed intact and that the drying conditions did not cause any contamination or damage. It shows that moisture reduction was mainly affected by the drying method, rather than any changes in composition.

S.no	Time (min)	Initial Weight (g)	Final Weight (g)
1	10	10	9.98
2	20	9.98	9.92
3	30	9.92	9.89
4	40	9.89	9.86
5	50	9.86	9.83
6	60	9.83	9.80
7	70	9.80	9.79
8	80	9.79	9.75
9	90	9.75	9.73
10	100	9.73	9.70
11	110	9.70	9.67
12	120	9.67	9.67

Table 2.6.2

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works better for date seed powder than quick high- temperature drying. These conditions promote efficient moisture removal while preserving product quality, making them ideal for food applications that add value.

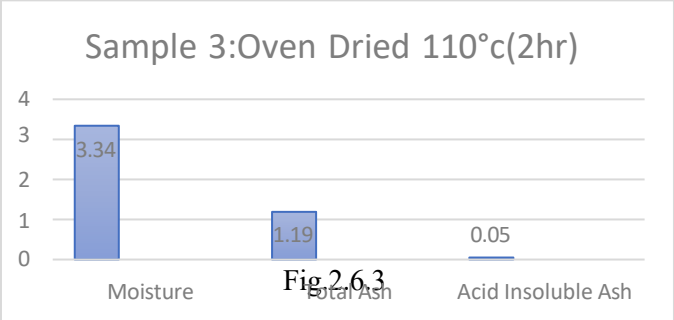

Fig.2.6.3

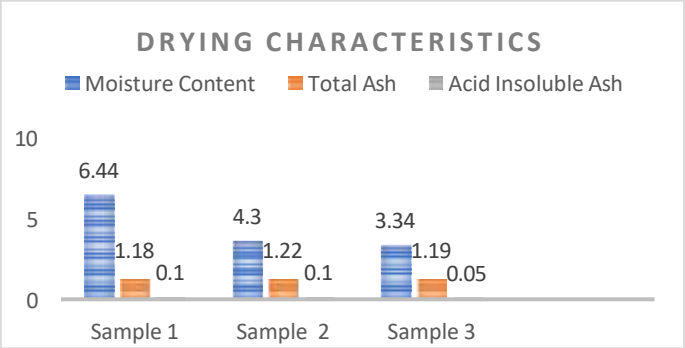

Fig.2.6.4

S. No	Drying Method	Intial Moisture Content (%)	Final Moisture Content (%)
1.	Oven dried (150 °C for 1 hr)	10	6.44
2.	Sun dried for 48 hrs	10	4.3
3.	Oven dried (110 °C for 2 hrs)	10	3.34

Table 2.6.3

Overall, evidence indicates that controlled thermal drying at moderate temperatures for an adequate time of 2 hours

2.7 Raw Material Utilization and Importance of Value Addition

Date seeds which are often seen as waste are a largely untapped source of dietary fiber, antioxidants and key nutrients. After processing the date fruit, seeds account for nearly 10–15% of the total fruit weight and are typically discarded, creating environmental waste (FAO, 2020). Recent studies show that turning date seeds into powder for functional food applications can add economic and nutritional value while minimizing waste (Ahmed *et al.,* 2021).

The high fiber content along with phenolic antioxidants and essential fatty acids, makes date seed powder perfect for Nutri bars formulations that require slow energy release, better gastrointestinal function and structural stability. According to (Hasan *et al.* (2020)), including 10–12% date seed powder in energy bars improved total dietary fiber and antioxidant activity without negatively impacting sensory acceptability. (Kandhari *et al.* (2019)) showed that fiber-rich ingredients, when paired with suitable binders like psyllium husk enhance bar cohesiveness and reduce crumbliness. This makes the final product suitable for storage, transport and consumption by health-conscious consumers.

Using date seeds also has socio-economic benefits. By transforming a low-value byproduct into a functional ingredient, small-scale processors and rural entrepreneurs

can boost income and promote sustainable, zero-waste food practices. Developing shelf-stable, nutrient-dense date seed Nutri bars fits with global trends toward health- focused, fiber-rich snacks and circular food economy (Ali *et al.,* 2022).

2.8 Advances in Fiber-Rich Nutri bar Technology

High-fiber bars depend on a careful balance of functional ingredients and binding agents to achieve the right texture, chewiness and shelf stability. Research by (Kandhari *et al.* (2019)) found that natural fibers, such as psyllium husk combined with date seed powder or other cereal fibers, create a solid substrate that effectively binds ingredients. Soluble fibers in psyllium absorb water, form gels and improve bar cohesiveness. Meanwhile, insoluble fibers add bulk and chewing resistance. (Yadav & Yadav (2015))

Studies on cereal and fruit bars highlight that ingredient ratios, fiber particle size and binder type greatly affect textural properties, moisture retention and sensory quality (Ahmed *et al.,* 2021). In date seed-based bars, adding 2– 4% psyllium husk together with natural binders like date syrup and peanut butter improves structural integrity and chewiness. Including nuts and seeds, such as cashews, almonds, pumpkin seeds, chia, flax and Green Gram Flakes boosts nutritional value, adds protein and healthy fats and enhances sensory appeal (Silva *et al.,* 2020).

Recent innovations also emphasize clean-label formulations. Reducing synthetic additives while using natural fibers, natural sweeteners and plant-based fats helps keep bars stable, extend their shelf life and attract health-focused consumers (Rahman *et al.,* 2023). These methods meet the growing consumer demand and trends for functional, sustainable and convenient snack products.

2.9 Binding and Textural Considerations

Binding agents are crucial for fiber-rich Nutri bars, ensuring they are cohesive and do not crumble during storage and transport. In date seed Nutri bars, natural binders like date syrup and peanut butter work with soluble fibers from psyllium husk to create a gel network that holds the ingredients together. (Kandhari *et al.* (2019)) demonstrated that even small amounts of psyllium (1–3%) significantly improve the binding of fruit and cereal powders, leading to a consistent, chewy texture.

The mix of high-fiber powder (date seeds), soluble fiber (psyllium husk), and sticky natural binders ensures the final product maintains moisture without becoming soggy, enhances mouthfeel, and extends shelf life. Finding the right ratio of powder to binder is important; studies suggest keeping the binder at 15–20% of the total mass to achieve optimal cohesiveness while maintaining the nutritional profile (Yadav & Yadav, 2015).

III. CONCLUSION:

In conclusion, the use of date seed powder and psyllium husk in the creation of a fiber-enriched Nutri bar as a sustainable value-added food product is amply supported by the reviewed literature. Despite being high in dietary fiber and vital minerals, date seeds are mostly thrown away by the food processing industry, which results in a large amount of waste. An efficient method of waste valorization that also improves the final product's nutritional value is to turn this under-utilized by-product into edible date seed powder. The Nutri bars functional value is further enhanced by the addition of psyllium husk which provides soluble fiber that is known to improve glycemic control, bowel regularity and gut health.

The Nutri bar is especially well-suited for people with digestive problems, those looking to improve gut health and fitness-oriented consumers like gym going individuals who need sustained energy, repletion and metabolic support because of the combined fiber profile of date seed powder and psyllium husk. According to studies when incorporated into a balanced diet, fiber-rich Nutri bars can help with digestion, encourage fullness and support general wellness. Additionally, the creation of these Nutri bars is in line with the rising demand for functional, clean-foods and natural snack options.

Nutri bars made from date seed powder and psyllium husk have a lot of potential as an environmentally friendly, nutrient-dense and consumer-relevant product according to the literature. This, strategy promotes sustainable food systems and food-based dietary management in addition to addressing waste in the food industry. The commercial viability and market acceptance of this high-fiber functional Nutri bar will be improved by additional research on formulation optimization, sensory acceptability, shelf-life stability and consumer perception.

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