The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 4, Issue 6, 2026

BENEFIT OF DATE SEED POWDER ON OBESITY AND NON-COMMUNICABLE DISEASES: A REVIEW OF THE LITERATURE

[1]Rimsha Arif, [2]Ameena Qaiser, [3]Areeba Asif, [4]Amara Bilal, [5]Dr. Hafiz Shahzad
[1]Faculty of Allied Health Sciences, Superior University Lahore
[2]Department of Human Nutrition and Food Technology (Superior University
[3]Faculty of Allied Health Sciences, Superior University Lahore
[4]Faculty of Allied Health Sciences, Superior University Lahore
[5]Department of Human Nutrition and Food Technology (Superior University)
[1]Imshigondal786@gmail.com, [2]ameena.qaiser@superior.edu.pk, [3]Ansaariba@gmail.com,
[4]ammarabilal992@gmail.com, [5]shahzad.muzammil@superior.edu.pk

DOI: https://doi.org/10.5281/zenodo.20773959

Article History
Received on 20 May 2026
Accepted on 19 June2026
Published on 20 June 2026

Corresponding Author: *

Abstract

Background: Global morbidity and mortality are significantly influenced by non-communicable diseases (NCDs), such as obesity, diabetes mellitus, and cardiovascular illnesses. Their growth and evolution are significantly influenced by dietary patterns and lifestyle factors. The potential relevance of bioactive compound-rich functional foods in controlling and preventing various chronic illnesses has drawn attention in recent years. Despite having a rich nutritional and phytochemical makeup, date seeds–a byproduct of the date fruit–are frequently neglected. Antioxidants, phenolic compounds, and dietary fiber are especially abundant in date seed powder. Date seed powder is a viable option in the context of NCD prevention and management since these bioactive components are being investigated more and more for their possible involvement in lowering oxidative stress and enhancing metabolic health. Methods: This review synthesizes findings from previously published studies investigating the effects of date seed powder on diabetes and related non-communicable diseases. Relevant literature was identified through electronic databases such as PubMed, and Google Scholar. Results: This review comprised articles that shows the potential value of date seed powder on blood sugar level and NCD'S. The results show that date seed powder is a good source of vital minerals, dietary fiber, and bioactive substances such flavonoids and phenolics. These ingredients have potent anti-inflammatory and antioxidant qualities, which may lessen the oxidative stress linked to NCDs. Research indicates that date seed powder may enhance lipid metabolism, improve diabetic management, and support gastrointestinal and cardiovascular health. Conclusion: Date seed powder demonstrates promising potential as a management of diabetes and other non-communicable diseases due to its antioxidant, anti-inflammatory, and metabolic regulatory properties.

INTRODUCTION

Date fruit, also known as *Phoenix dactylifera L.*, is a highly nutritious food that contributes significantly to human health (Therapeutic Power of Date Fruit, n.d.). It is one of the oldest cultivated fruits and holds substantial nutritional, cultural, and economic importance worldwide (Soomro et al., 2023). The fruit of the date palm has long served as a valuable source of sweetness, nutrition, and commercial value. Due to its adaptability to harsh environmental conditions and its cultural significance, the date palm is often considered a valuable natural resource. Both the flesh and seeds of date fruit are rich in bioactive compounds with anticancer, antioxidant, anti-inflammatory, antimutagenic, antidiabetic, and anti-anemia properties, making it a promising food for improving human health and food security (Soomro et al., 2023).

Approximately 10–15% of global fruit production is attributed to dates, and their increasing consumption has raised concerns regarding waste management, particularly of seeds. Several studies have explored the phytochemical composition and in vitro bioactivities of date seeds, as well as their incorporation into functional foods and beverages (Salama et al., 2019). Dates are widely consumed across regions such as Central and South America, Europe, North Africa, and the Middle East (FAOSTAT, 2022). Traditionally, they are considered an ideal dietary supplement due to their high content of sugars, dietary fiber, macronutrients, and essential minerals (Al-Shahib & Marshall, 2003).

The utilization of date by-products plays a crucial role in promoting sustainable agricultural practices. Date seed powder, in particular, has been widely investigated as a low-cost and nutritionally rich source of dietary fiber and antioxidants (Salama et al., 2019). Egypt has been the leading date-producing country since 1974, contributing approximately 1.5 million tonnes annually, which accounts for nearly 20% of global production (Salama et al., 2019).

Desert date seeds, which can make up 50–60% of the fruit, are rich in fatty acids, amino acids, and various bioactive compounds that exhibit strong antioxidant and anti-inflammatory effects. Experimental studies have demonstrated that seed extracts can reduce oxidative stress and improve glycemic control in diabetic models (Farid et al., 2024).

Date palm seeds (DPS), comprising about 6–12% of the fruit, are also known as pits, kernels, or stones. They are rich in minerals, vitamins, and macronutrients, including carbohydrates (55–65%), crude fiber (10–20%), protein (5–7%), and oil (7–10%), with their composition influenced by cultivation conditions (El-Far et al., 2016).

Date seeds, a by-product of date fruit processing, are often considered waste and are commonly used as animal feed. However, they are rich in carbohydrates, oils, dietary fiber, protein, and bioactive phenolic compounds that exhibit important biological effects (Alkhoori et al., 2022).

Mineral analysis shows that potassium is the most abundant element in date seeds, followed by phosphorus, magnesium, calcium, and sodium. Among microelements, iron has the highest concentration, followed by manganese, zinc, and copper. The major fatty acids present in date seed oil include oleic, lauric, myristic, palmitic, and linoleic acids. In addition, tryptophan is identified as the first limiting amino acid in date seed proteins, while protein digestibility and efficiency ratios are comparatively moderate (Sawaya et al., 1984).

Date seeds are increasingly recognized as functional foods due to their wide range of health benefits, including antioxidant, anti-inflammatory, antitumor, hepatoprotective, nephroprotective, antihyperlipidemic, antiaging, and memory-enhancing properties. Studies indicate that their rich antioxidant and prebiotic content helps reduce oxidative stress, improve immune function, regulate lipid profiles, and enhance physical performance (Moslemi et al., 2022).

The beneficial properties of date seeds are largely attributed to their polyphenol content, including proanthocyanins, phenolic acids, hydroxycinnamates, and flavonoid glycosides (Farag et al., 2023). These polyphenols, such as pelargonin and cinnamic acid derivatives, have been shown to enhance cellular resistance against oxidative damage (Al-Turki et al., 2010).

Due to their strong nutritional and functional properties, date fruits and their by-products are increasingly being utilized in the development of functional foods such as snack bars. These products benefit from the rich macro- and micronutrient composition and bioactive compounds present in dates, which exhibit antioxidant, anti-inflammatory, antihypertensive, antimicrobial, and anticancer activities (Barakat & Alfheeaid, 2023).

In food applications, the incorporation of date seed powder (DSP) into baked products such as muffins and shaboura has been shown to enhance nutritional value and antioxidant activity. However, higher concentrations (e.g., 10%) may negatively affect sensory acceptability (Salem et al., 2011).

Furthermore, date seed supplementation has been reported to improve muscle growth and recovery by decreasing IGF-1 binding protein-3 levels and increasing IGF-1 bioactivity. It also positively influences gut microbiota by promoting beneficial bacteria such as *Lactobacillus* and *Bifidobacterium* while reducing harmful *Clostridium* species, thereby contributing to improved athletic performance (Moslemi et al., 2022).

Date seed contains a high content of dietary fiber, which can significantly help prevent diabetes and hyperlipidemia and may also play a role in reducing hypertension, coronary heart disease, cholesterol levels, colon and prostate cancer, and bowel disorders (Hashemzadeh et al., 2023). The use of date seed powder as a flour substitute in Mafrood bread has been shown to enhance dietary fiber content; specifically, 10% coarse date seed powder significantly improved fiber content while maintaining acceptable sensory and dough quality, whereas fine powder reduced acceptability (Almana & Mahmoud, 1994).

Antioxidants such as phenolic compounds present in date seeds exhibit strong antioxidant activity by neutralizing excess free radicals, including reactive oxygen species (ROS), thereby helping to prevent aging, cancer, coronary heart disease, and Alzheimer's disease (Hashemzadeh et al., 2023).

Plant protein feeds are essential in ruminant nutrition; however, their use is often limited by the presence of anti-nutritional factors (ANFs) (Yan et al., 2025).

Ajwa date seeds are rich in phytochemicals such as polyphenols, flavonoids, iso-flavonoids, sterols, and lignin, which are effective in lowering blood cholesterol levels and reducing the risk of cardiovascular diseases. Supplementation with Ajwa date seed powder has been shown to reduce total cholesterol, LDL, and triglycerides while increasing HDL levels, with no reported adverse effects (Jubayer et al., 2020).

Date fruits are rich in nutrients and antioxidants that contribute to the prevention of chronic diseases such as high cholesterol, hyperglycemia, obesity, and cardiovascular diseases, while also improving overall health (Therapeutic Power of Date Fruit, n.d.).

Recent research aims to evaluate the potential effects of date seed powder (DSP) supplementation on patients with type 2 diabetes mellitus (T2DM), including its impact on cardiometabolic risk factors, oxidative stress, inflammation, immune response, anthropometric indices, and mental health (Mohammadi Zadeh et al., 2023).

Animal studies have demonstrated that date seed extract may help prevent or reduce diabetic complications. Treatment with date seed extract significantly lowered blood glucose levels, improved liver and kidney function, reduced oxidative stress, and enhanced antioxidant enzyme activity, with improved tissue structure observed in histological analysis (Abdelaziz et al., 2015).

In vitro studies have further shown that polyphenol-rich date seed extract exhibits antioxidant, anti-hyperglycemic, and anti-adipogenic properties. It reduces lipid accumulation, enhances glucose uptake in muscle and fat cells, and inhibits the proliferation of various cancer cell lines. These effects are attributed to bioactive compounds such as phenolic acids, catechins, and epicatechins, suggesting a potential role in preventing metabolic diseases such as diabetes, obesity, and cancer (Hilary et al., 2021).

1.1 Date seed powder and Obesity

Obesity is one of the most serious health challenges affecting populations worldwide and is closely

associated with metabolic disorders such as diabetes mellitus and cardiovascular diseases. In recent years, its prevalence has increased among children and adolescents, particularly in Eastern regions. Studies have shown that dietary fibers extracted from dates and incorporated into food products such as biscuits exhibit anti-obesity effects in animal models by improving lipid profiles, kidney function, blood glucose levels, and liver activity (Aljutaily et al., 2022). Additionally, date palm pits from the Kentichi variety have demonstrated strong inhibitory effects on key enzymes involved in diabetes and obesity, highlighting their potential use in agro-food, cosmetic, and pharmaceutical industries as natural alternatives to synthetic additives (Masmoudi-Allouche et al., 2016).

However, the exact mechanisms underlying these anti-obesity effects are not yet fully understood. It has been proposed that these effects may involve the regulation of lipogenic enzyme expression in the liver and white adipose tissue, as well as the inhibition of α-glucosidase during starch digestion, similar to the action of anthocyanins (Matsui et al., 2001; Tsuda et al., 2003). A comparable mechanism may occur in the presence of polyphenols from date seeds. Adipocytes play a vital role in maintaining lipid homeostasis and energy balance by storing triacylglycerols or circulating free fatty acids in response to changes in energy demand. Since both adipocyte hyperplasia and hypertrophy contribute to increased adipose tissue mass, the development and function of adipocytes have been a major focus of obesity research.

Adipogenesis is a complex, multistep process in which preadipocytes first undergo contact inhibition and, upon hormonal induction, initiate mitotic clonal expansion (MCE), allowing them to re-enter the cell cycle. Following MCE, preadipocytes activate a signaling cascade and express key adipogenic transcription factors, including PPARγ and C/EBPs, which are essential regulators of adipocyte differentiation. Date seed polyphenol supplementation has been shown to exhibit anti-obesity effects by preventing adipocyte growth and reducing lipid accumulation, suggesting its potential as a nutraceutical intervention (Sobhy et al., 2023).

The impact of Ajwa date seed powder on visceral fat depots and inflammatory response has also been investigated in animal studies. In one study, rats fed a high-fat diet supplemented with 2% Ajwa date seed powder showed significantly lower perinephric fat weight and reduced levels of inflammatory markers such as IL-6 compared to control groups, indicating both anti-obesity and anti-inflammatory effects (Bhatti et al., 2021).

Furthermore, randomized controlled trials in humans have demonstrated that date seed supplementation can improve glycemic control in overweight and obese individuals. Significant reductions in hemoglobin A1c and fasting plasma glucose levels were observed, along with improvements in lipid parameters among participants with pre-existing hyperlipidemia, suggesting its potential role as a nutraceutical for managing metabolic disorders (Hashemzadeh et al., 2023).

1.2 Anti oxidative properties of DSP

Oxidative stress, resulting from an imbalance between the production and elimination of reactive oxygen species, along with inflammation, is a key mechanism contributing to the development of chronic diseases. Polyphenols, due to their antioxidant and anti-inflammatory properties, may help prevent such conditions, and date seeds are particularly rich in these bioactive compounds. However, in vivo studies investigating these effects remain limited. A preclinical study in rats demonstrated that supplementation with date seed powder (DSP) for 13 weeks significantly enhanced antioxidant defense systems and reduced protein and lipid oxidative damage in serum and tissues without impairing organ function, suggesting a protective role against oxidative stress–related diseases (Meqbaali & Saif, n.d.).

Furthermore, a randomized placebo-controlled clinical trial in patients with type 2 diabetes showed that daily consumption of 5 g of DSP for eight weeks significantly improved metabolic parameters. There were reductions in insulin levels, hemoglobin A1c, and insulin resistance (HOMA-IR), along with decreased oxidative stress markers such as pentosidine and lipopolysaccharide. At the

same time, antioxidant markers including total antioxidant capacity and superoxide dismutase increased, indicating improved glucose metabolism and antioxidant status (Mohamadizadeh et al., 2024).

1.3 Date seed powder supplementation on anxiety- and depression-like behaviours, sleep quality in patients with type 2 diabetes

Functional foods are increasingly recognized as effective strategies for managing type 2 diabetes. A randomized clinical trial evaluated the effects of DSP supplementation (5 g/day for eight weeks) on psychological and metabolic parameters in diabetic patients. The findings revealed significant improvements in depression, anxiety, stress levels, sleep quality, and overall quality of life. These improvements were associated with increased anti-inflammatory markers (IL-10), higher tryptophan levels, and reduced endotoxin, cortisol, and kynurenine levels, suggesting modulation of the gut–brain axis and inflammatory pathways (Momeniyan et al., 2025).

Additionally, experimental studies using animal models of chronic mild stress have demonstrated that Ajwa date seed extracts possess antidepressant and neuroprotective effects. These effects are attributed to their antioxidant and anti-inflammatory properties, which help reduce neuroinflammation and improve behavioral outcomes (Asdaq et al., 2025).

1.4 Date seed powder and athelete performance:

Date seed polyphenols may enhance athletic performance by scavenging free radicals, inhibiting lipid peroxidation, and reducing oxidative damage. These compounds also influence several biological pathways, including increased nitric oxide production, inhibition of nuclear factor kappa B (NF-κB), modulation of mitogen-activated protein kinases (MAPK), and activation of nuclear factor erythroid 2-related factor 2 (Nrf2), which collectively improve immune and inflammatory responses (Moslemi et al., 2022).

Clinical studies further support these findings, showing that individuals engaged in moderate to high physical activity experienced reduced inflammation and muscle damage following date seed supplementation, indicating its potential role in improving exercise recovery and performance (Moslemi et al., 2023).

1.5 Date seed powder and Cancer

Date palm seeds (Phoenix dactylifera L.) are rich in polyphenols with strong antioxidant and disease-preventive properties. Studies have shown that date seed extract (DSE) can inhibit key enzymes, reduce iron-induced oxidative damage, and protect DNA and proteins from damage. Additionally, DSE has demonstrated the ability to suppress the growth of various cancer cell lines, including breast, colorectal, and liver cancer cells, by inducing apoptosis and regulating gene expression, such as decreasing BCl-2 and P21 while increasing P53 expression (Habib et al., 2022).

Further research has also explored the influence of date seed germ on P53 gene expression in cancer cells, suggesting its potential role in regulating cellular mechanisms involved in cancer development (Zare-Zardini et al., 2020).

Moreover, in vitro studies have shown that polyphenol-rich date seed extracts exhibit cytotoxic, antioxidant, anti-hyperglycemic, and anti-adipogenic properties. These extracts reduce lipid accumulation, enhance glucose uptake, and inhibit cancer cell proliferation while maintaining stability in the gastrointestinal environment, indicating their potential as functional food ingredients and therapeutic agents (Hilary et al., 2021).

CONCLUSION:

Date seed powder (DSP) – a byproduct of date fruit processing previously viewed as trash — has emerged as a very intriguing functional food ingredient with great medicinal potential. This review thoroughly shows that DSP is a rich source of dietary fiber, vital minerals, and powerful bioactive substances like flavonoids, phenolics, and polyphenols. These substances together provide powerful anti-inflammatory and antioxidant qualities that are directly related to the management and prevention of non-communicable diseases (NCDs). The multifaceted health benefits of DSP supplementation are consistently supported by evidence from preclinical, in vitro, and clinical studies: daily intake of 5 g DSP for eight weeks significantly reduced fasting blood glucose, hemoglobin A1c, insulin resistance (HOMA-IR), and oxidative stress markers in Type 2 Diabetes

Mellitus patients while improving antioxidant capacity; its polyphenols inhibit adipocyte differentiation and lipid accumulation, reduce visceral fat and inflammatory markers like IL-6, thereby contributing to anti-obesity effects; Ajwa date seed powder reduced total cholesterol, LDL, and triglycerides while increasing HDL, supporting cardiovascular protection; DSP supplementation improved depression, anxiety, stress, and sleep quality in diabetic patients by modulating the gut-brain axis through increased tryptophan and IL-10 and decreased cortisol levels; its free radical-scavenging activity and modulation of NF-kB and Nrf2 pathways contribute to improved athletic recovery and physical performance; polyphenol-rich DSP extracts inhibited the growth of breast, colorectal, and liver cancer cell lines by inducing apoptosis and Bifidobacterium. All of these results point to date seed powder as an affordable, nutrient-dense, and pharmacologically active natural supplement that can address several aspects of metabolic dysfunction. Its practical application in regular dietary interventions is further demonstrated by its incorporation into functional meals such baked goods, snack bars, and flour-based items. In summary, date seed powder is a valuable but underutilized agricultural byproduct with significant potential in the prevention and management of obesity, diabetes mellitus, cardiovascular diseases, and other non-communicable diseases. Promoting date seed powder as a functional food ingredient not only benefits public health but also promotes sustainable agricultural practices by lowering food waste.

References:

1. Abdelaziz, D. H., Ali, S. A., & Mostafa, M. M. (2015). Phoenix dactylifera seeds ameliorate early diabetic complications in streptozotocin-induced diabetic rats. *Pharmaceutical Biology, 53*(6), 792–799.
2. Aljutaily, T., Elbeltagy, A., Ali, A. A., Gadallah, M. G., & Khalil, N. A. (2022). Anti-obesity effects of formulated biscuits supplemented with date's fiber as agro-waste products. *Nutrients, 14*, 5315.
3. Alkhoori, M. A., Kong, A. S., Aljaafari, M. N., Abushelaibi, A., Lim, S. H. E., Cheng, W. H., Chong, C. M., & Lai, K. S. (2022). Biochemical composition and biological activities of date palm (Phoenix dactylifera L.) seeds: A review. *Biomolecules, 12*(11), 1626. https://doi.org/10.3390/biom12111626
4. Almana, H. A., & Mahmoud, R. M. (1994). Palm date seeds as an alternative source of dietary fiber in Saudi bread. *Ecology of Food and Nutrition, 32*(3–4), 261–270.
5. Al-Shahib, W., & Marshall, R. J. (2003). The fruit of the date palm: Its possible use as the best food for the future? *International Journal of Food Sciences and Nutrition*.
6. Al-Turki, S., Shahba, M. A., & Stushnoff, C. (2010). Diversity of antioxidant properties and phenolic content of date palm (Phoenix dactylifera L.) fruits as affected by cultivar and location. *Journal of Food, Agriculture & Environment, 8*, 253–260.
7. Asdaq, S. M., Imran, M., Alsanie, W. F., Alamri, A. S., Alhomrani, M., Alshammary, A. F., Sultana, R., Mannasaheb, B. A., Rabbani, S. I., & Almuqbil, M. (2025). Potential neuroprotective and antidepressant effects of Ajwa date extract in an animal model of chronic mild stress. *Scientific Reports, 15*(1), 39641.
8. Barakat, H., & Alfheeaid, H. A. (2023). Date palm fruit (Phoenix dactylifera) and its promising potential in developing functional energy bars. *Nutrients, 15*(9), 2134. https://doi.org/10.3390/nu15092134
9. Bhatti, F. Y., Khan, F. A., Rehan, A. M., Irum, Z., & Chiragh, S. (2021). Effect of Ajwa date seed powder on visceral fat depots and inflammatory response in high-fat-fed Sprague Dawley female rats. *Journal of Islamabad Medical & Dental College, 10*(4), 194–199.
10. El-Far, A. H., Ahmed, H. A., & Shaheen, H. M. (2016). Dietary supplementation of Phoenix dactylifera seeds enhances performance, immune response, and antioxidant status in broilers. *Oxidative Medicine and Cellular Longevity*.

11. Farag, M. A., Otify, A., & Baky, M. H. (2023). Date fruit byproducts: Phytochemical, nutritive, and medicinal merits. *Food Reviews International, 39*, 488–510.
12. Farid, A., Ahmed, A., Alaa, O., & Safwat, G. (2024). Desert date seed extract-loaded chitosan nanoparticles ameliorate hyperglycemia and insulin deficiency. *Scientific Reports, 14*(1), 5829.
13. Habib, H. M., El-Fakharany, E. M., Souka, U. D., Elsebaee, F. M., El-Ziney, M. G., & Ibrahim, W. H. (2022). Polyphenol-rich date palm fruit seed extract inhibits labile iron, enzyme, and cancer cell activities. *Nutrients, 14*(17), 3536.
14. Hashemzadeh, M., Shojaei-Zarghani, S., Heidarian Miri, H., & Kazemi, A. (2023). Effect of date seed powder supplementation on glycaemic markers and lipid profile in women with overweight and obesity. *International Journal of Food Science & Technology, 58*(6), 3032–3039.
15. Hilary, S., Kizhakkayil, J., Souka, U., Al-Meqbaali, F., Ibrahim, W., & Platat, C. (2021). In-vitro investigation of polyphenol-rich date seed extract bioactivity. *Frontiers in Nutrition, 8*, 667514.
16. Jubayer, F., Kayshar, S., & Rahaman, M. (2020). Effects of Ajwa date seed powder on serum lipids in humans: A randomized, double-blind, placebo-controlled clinical trial. *Journal of Herbal Medicine, 24*, 100409.
17. Masmoudi-Allouche, F., Touati, S., Mnafgui, K., Gharsallah, N., El Feki, A., & Allouche, N. (2016). Phytochemical profile and anti-obesity activities of date palm fruits and pits. *Journal of Pharmacognosy and Phytochemistry, 5*, 15–22.
18. Matsui, T., Ueda, T., Oki, T., Sugita, K., Terahara, N., & Matsumoto, K. (2001). α-Glucosidase inhibitory action of natural pigments. *Journal of Agricultural and Food Chemistry, 49*, 1948–1951.
19. Meqbaali, A. A., & Saif, F. T. (n.d.). The potential antioxidant and anti-inflammatory effects of date seed powder in rats.
20. Mohamadizadeh, M., Dehghan, P., Azizi-Soleiman, F., & Maleki, P. (2024). Effectiveness of date seed on glycemia and advanced glycation end-products in type 2 diabetes. *Nutrition & Diabetes, 14*(1), 37.
21. Mohammadi Zadeh, M., Dehghan, P., & Eslami, Z. (2023). Effect of date seed supplementation on cardiometabolic risk factors in type 2 diabetes mellitus. *BMJ Open, 13*(3), e066013.
22. Momeniyan, Z., Dehghan, P., Tutunchi, H., Azadi, H., & Azizi-Soleiman, F. (2025). Effect of date seed powder supplementation on anxiety, depression, and sleep quality in type 2 diabetes. *British Journal of Nutrition, 134*(10), 816–828.
23. Moslemi, E., Dehghan, P., & Khani, M. (2022). Effect of date seed supplementation on inflammation and oxidative stress biomarkers. *Contemporary Clinical Trials Communications, 28*, 100951.
24. Moslemi, E., Dehghan, P., & Khalafi, M. (2023). Effectiveness of date seed supplementation on inflammatory markers and muscle damage. *European Journal of Nutrition, 62*(5), 2001–2014.
25. Salama, A. A., Ismael, N. M., & Megeed, M. M. (2019). Using date seed powder as a sustainable source of nutraceuticals. *Journal of Food and Nutrition Sciences, 7*(3), 39–48.
26. Salem, E. M., Almohmadi, N., & AlKhataby, N. F. (2011). Utilization of date seeds powder in preparation of bakery products. *Journal of Food and Dairy Sciences, 2*(8), 399–409.
27. Sawaya, W. N., Khalil, J. K., & Safi, W. J. (1984). Chemical composition and nutritional quality of date seeds. *Journal of Food Science, 49*(2), 617–619.
28. Sobhy, R., Zou, X., Morsy, O. M., Zaky, A. A., & Khalifa, I. (2023). Date seed polyphenol pills as anti-obesity agents. *Applied Sciences, 13*(22), 12533.
29. Soomro, A. H., Marri, A., & Shaikh, N. (2023). Date palm (Phoenix dactylifera): Nutritional and health significance. In *Neglected Plant Foods of South Asia* (pp. 319–350).

30. Tsuda, T., Horio, F., Uchida, K., Aoki, H., & Osawa, T. (2003). Dietary anthocyanins prevent obesity and hyperglycemia in mice. *Journal of Nutrition, 133*, 2125–2130.
31. Yan, Z., Liu, Z., Zhou, C., & Tan, Z. (2025). Anti-nutritional factors of plant protein feeds for ruminants. *Animals, 15*(8), 1107.
32. Zare-Zardini, H., Shayegh, M. R., & Seifati, S. M. (2020). Effect of date seed germ on P53 gene expression in cancer cells. *Quran and Medicine, 5*(3), 41–48.