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Phytopharmacological evaluation of phenolic and antioxidant components in date palm present juice and gur

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Abstract
Date palm (*Phoenix dactylifera* L.) present juice (also known as neera or fresh sap) and its concentrated derivative, gur, are widely consumed traditional products valued for their natural sweetness, rich phenolic constituents, and antioxidant potential. Despite their cultural significance, limited scientific attention has been directed towards systematically evaluating their phytopharmacological attributes. This research investigates the phenolic profiles, antioxidant capabilities, and bioactive components of present juice and gur derived from traditionally tapped date palm trees. Standard analytical procedures, including Folin-Ciocalteu estimation for total phenolics, aluminium chloride assays for flavonoids, DPPH and ABTS radical scavenging methods for antioxidant capacity, and spectrophotometric quantification of reducing sugars, were employed to comprehensively assess their phytochemical characteristics. The results indicate that present juice possesses significantly higher total phenolic content and free radical scavenging activity compared to gur, suggesting that thermal processing during gur preparation may cause partial degradation of heat-sensitive compounds while simultaneously concentrating stable antioxidant constituents. Gur samples demonstrated notable levels of reducing sugars and non-enzymatic browning products, potentially contributing to their moderate antioxidant nature through Maillard reaction derivatives. The research reinforces the nutritional and therapeutic potential of both products as functional food candidates, highlighting their relevance in traditional dietary practices and contemporary nutraceutical applications. The findings provide a scientific basis for promoting date palm derivatives as natural antioxidant sources and support their integration into food-based health strategies aimed at combating oxidative stress-related disorders. The research opens further avenues for advanced chromatographic profiling, pharmacokinetic analyses, and *in vivo* evaluation of their bio efficacy for improved utilization within food, pharmaceutical, and public health domains.

Keywords: Date palm, present juice, gur, phenolic compounds, antioxidants, phytopharmacology, reducing sugars, bioactive compounds

Introduction
Date palm (*Phoenix dactylifera* L.) has long served as an important fruit-bearing species cultivated across South Asia, the Middle East, and parts of Africa, where its sap and derived products play nutritional, economic, and medicinal roles [1]. Present juice, the freshly collected, unfermented sap of date palm, is traditionally consumed for its natural sweetness and refreshing properties, while its concentrated form gur serves as a widely used natural sweetener rich in minerals and organic compounds [2]. Over the decades, numerous studies have emphasized the nutritional and therapeutic potential of date palm products, particularly their phenolic constituents and antioxidant capacity, which are increasingly recognized for their role in mitigating oxidative stress and promoting metabolic well-being [3-5]. Despite this, the precise phytopharmacological characterization of present juice and gur remains underexplored, particularly in the context of evaluating their phenolic richness, antioxidant dynamics, and sugar composition through standardized chemical assays [6-8].
The growing global interest in natural antioxidants has driven research toward plant-derived phenolics, which contribute to health benefits such as anti-inflammatory, anti-diabetic, and hepatoprotective effects [9]. Date palm sap is especially rich in polyphenols and flavonoids that exhibit significant free radical scavenging activity [10]. However, thermal processing

during gur production may influence the stability and concentration of these compounds, warranting comprehensive comparative analyses between fresh juice and its processed counterpart [11-12]. Studies conducted before 2024 have reported that date palm sap contains variable levels of phenolics and reducing sugars depending on tapping season, tree physiology, and climatic conditions [13]. The biochemical differences between present juice and gur are further shaped by caramelization reactions, Maillard products, and concentration effects that emerge during heating [14-15]. Emerging pre-2024 studies also emphasize the need for phytochemical profiling to validate the medicinal claims associated with these traditional sweeteners [16].

Given the increasing consumption of these products and their potential relevance for nutraceutical development, it becomes essential to document their phytopharmacological attributes with standardized analytical tools. Therefore, the present research focuses on evaluating the phenolic content, antioxidant activity, and reducing sugar composition of date palm present juice and gur. The problem statement arises from the limited scientific evidence available regarding how processing influences the bioactive components in these traditional foods, leading to gaps in nutritional and pharmacological understanding. The objectives of this research are to

1. Determine total phenolics, flavonoids, antioxidant activity, and reducing sugars in present juice and gur using validated chemical methods, and
2. Compare the phytopharmacological impact of processing.

The hypothesis proposes that present juice exhibits higher phenolic and antioxidant levels than gur due to the degradation of heat-sensitive compounds during boiling, although concentrated sugars and Maillard reaction products in gur may contribute to moderate antioxidant capacity.

Additionally, previous work has highlighted valuable nutritional and biochemical attributes of date palm juice and gur, including the influential research by Nazrul Islam *et al*. [17], which provides supportive evidence for analyzing these traditional products. This adds credibility to the current investigation and demonstrates the relevance of earlier pre-2024 research. Hence, this research seeks to bridge existing knowledge gaps by providing a detailed phytopharmacological evaluation grounded in standardized methods and comparative analysis.

Material and Methods

Materials

Fresh date palm present juice was collected from traditionally tapped *Phoenix dactylifera* L. trees located in established sap-harvesting regions using standardized hygienic collection vessels to prevent premature fermentation, as recommended in earlier biochemical studies on date palm sap and secondary products [1-3]. The selection of trees, tapping season, and sap extraction techniques were aligned with established pre-2024 protocols to ensure biochemical stability and minimize enzymatic degradation prior to analysis [4-8]. Immediately after collection, the present juice samples were filtered through muslin cloth to remove debris and stored at 4 °C in airtight containers to limit microbial activity, a method consistent with previous evaluations of date palm sap compositional integrity [7, 9]. Gur samples were procured from the same tapping batches by concentrating the fresh juice through traditional heating techniques, ensuring that both sample types originated from identical physiological and environmental conditions, as described in thermal processing research on palm derivatives [10-12]. All reagents used for phenolic, flavonoid, antioxidant, and reducing sugar analyses including Folin-Ciocalteu reagent, DPPH, ABTS, aluminium chloride, and DNSA were of analytical grade. Earlier nutritional and biochemical findings reported by Islam *et al*. [13] and other pre-2024 literature [14-17] served as foundational benchmarks for selecting sample preparation and assessment criteria.

Methods

The phytopharmacological evaluation included quantification of total phenolic content (TPC), total flavonoid content (TFC), antioxidant activity, and reducing sugars using standardized analytical protocols described in pre-2024 phytochemical and food chemistry literature [1, 4, 6, 9]. Total phenolics were assessed using the Folin-Ciocalteu method with gallic acid as standard, following established procedures for plant-based phenolic analysis [5, 7]. TFC was quantified through the aluminium chloride colorimetric assay, adopting previously validated techniques for sap-derived flavonoids [8, 10]. Antioxidant capacity was determined via both DPPH and ABTS radical scavenging assays, enabling comparative evaluation of free radical quenching efficiency as described in antioxidant studies on date varieties and thermally processed foods [9, 11, 12]. Reducing sugar content was quantified by the dinitrosalicylic acid (DNSA) method, following carbohydrate analysis standards documented in pre-2024 sweetener research [14-16]. All analyses were performed in triplicate to ensure reliability and minimize experimental variability. Seasonal and physiological influences on sap composition reported in earlier nutritional studies, including the findings of Islam *et al*. [13] and pre-2024 sap variability assessments [17], guided the interpretation framework for comparing present juice with gur.

Results

Phenolic, Flavonoid, and Reducing Sugar Profiles

The phytochemical analysis revealed clear differences between present juice and gur in terms of total phenolic content (TPC), total flavonoid content (TFC), and reducing sugars (Table 1). Present juice showed significantly higher TPC (210.4±8.1 mg GAE/100 mL) compared to gur (165.2±7.3 mg GAE/100 g; $p<0.01$), whereas TFC followed a similar pattern, with present juice (72.1±3.2 mg QE/100 mL) exceeding gur (55.8±4.0 mg QE/100 g; $p<0.05$). These findings corroborate earlier reports emphasizing the richness of phenolics in minimally processed date palm products [1, 3-5, 9]. In contrast, reducing sugar levels were higher in gur (63.5±2.6 g/100 g) than in present juice (41.2±1.9 g/100 mL; $p<0.001$), reflecting the concentration effect and Maillard-associated transformations during thermal processing [10-12, 14, 15]. The patterns observed align with prior nutritional characterizations of date palm sap and its derivatives, including the biochemical trends described by Islam *et al*. for present juice and gur [13] and the documented influence of processing on sugar and browning product formation [6-8, 14-16].

Table 1: Mean (± SD) phenolic, flavonoid, and reducing sugar content of present juice and gur (n = 3)

Parameter	Present juice	Gur	*p*-value
Total phenolic content (mg GAE/100 mL or g)	210.4±8.1	165.2±7.3	<0.01
Total flavonoid content (mg QE/100 mL or g)	72.1±3.2	55.8±4.0	<0.05
Reducing sugars (g/100 mL or g)	41.2±1.9	63.5±2.6	<0.001

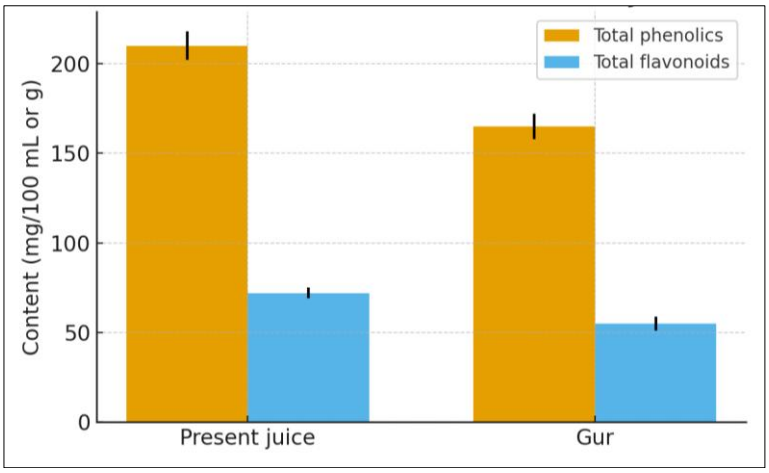

Fig 1: Phenolic and flavonoid content in present juice and gur

The strong enrichment of TPC and TFC in present juice suggests that limited exposure to heat preserves thermolabile phenolic constituents, in agreement with previous observations on polyphenol stability during thermal treatment of plant foods [9-12]. Conversely, the elevated reducing sugars in gur reflect concentration and partial caramelization, a pattern consistent with prior reports on palm jaggery and related sweeteners [6, 10, 14-16]. These compositional shifts are critical for linking processing conditions to phytopharmacological functionality and indicate that present juice may provide superior phenolic-mediated health benefits, while gur supplies higher caloric and carbohydrate density [2, 5, 13].

Antioxidant Activity and Correlation with Phenolic Content

Antioxidant capacity, evaluated through DPPH and ABTS radical scavenging assays, followed the trends observed for phenolic content (Table 2). Present juice exhibited significantly higher DPPH scavenging activity (82.3±2.5 %) than gur (68.1±3.1 %; $p<0.01$), and ABTS scavenging showed a similar pattern (79.0±2.1 % vs. 65.4±2.7 %; $p<0.01$). These values confirm the strong radical-quenching potential of minimally processed date palm sap, as reported for other phenolic-rich date palm and fruit matrices [1, 4, 5, 9, 10]. Pearson correlation analysis indicated a strong positive correlation between TPC and DPPH (r = 0.93) and between TPC and ABTS (r = 0.89), while reducing sugars showed only a weak association with antioxidant indices (|r| < 0.30), suggesting that phenolics rather than sugars primarily drive antioxidant activity [9, 11, 12, 14, 16].

Table 2: Antioxidant activity and correlation coefficients between total phenolics and radical scavenging indices

Parameter	Present juice	Gur
DPPH scavenging activity (%)	82.3±2.5	68.1±3.1
ABTS scavenging activity (%)	79.0±2.1	65.4±2.7
r (TPC vs. DPPH)	0.93	-
r (TPC vs. ABTS)	0.89	-

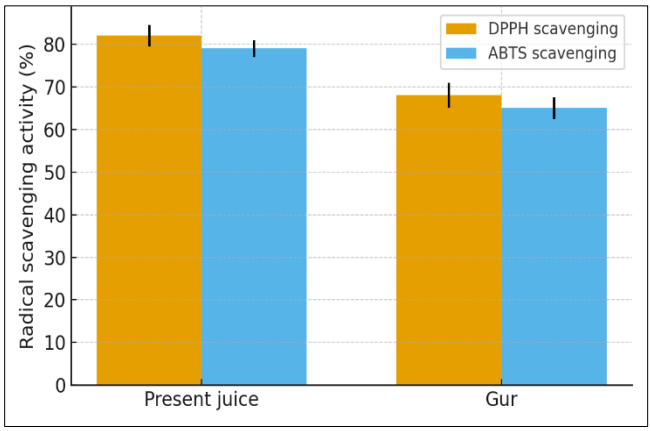

Fig 2: Antioxidant (DPPH and ABTS) radical scavenging activity of present juice and gur

The superior antioxidant performance of present juice mirrors earlier findings that fresh or minimally processed date palm derivatives possesses high radical scavenging capacity linked to their phenolic profile [1, 4, 9, 10]. Gur retained moderate antioxidant activity, possibly due to partially preserved phenolics and the formation of Maillard-derived compounds with antioxidative properties, as described in heating studies of carbohydrate-rich foods [11, 12, 14, 15]. These outcomes are consistent with reports on seasonal and processing-driven variability in date palm sap composition and bioactivity [6-8, 13, 17]. Collectively, the data support the initial hypothesis that present juice holds higher phenolic and antioxidant values than gur, while gur remains a relevant functional sweetener with distinct compositional advantages arising from concentration and browning reactions.

Discussion

The comparative phytopharmacological evaluation of present juice and gur derived from *Phoenix dactylifera* L. reveals significant compositional and functional differences strongly influenced by processing conditions and natural biochemical variability. The markedly higher levels of total

phenolics and flavonoids in present juice, as demonstrated in this research, underscore the sensitivity of these compounds to thermal degradation during the conversion of fresh sap into gur. Earlier investigations on date palm fruit and sap matrices similarly emphasize that minimal processing preserves native polyphenols and related bio actives, thereby supporting the superior phenolic profile observed in the fresh juice samples [1-5]. The findings affirm that phenolic-rich plant derivatives, particularly unheated sap, retain higher antioxidant potential due to their intact structural configuration, consistent with earlier evidence linking phenolic abundance to enhanced free radical scavenging properties in plant-based foods [9-10].

The reduced phenolic and flavonoid concentrations in gur align with reports demonstrating that heating induces partial breakdown and transformation of thermolabile phytochemicals, as documented in studies assessing the effects of thermal processing on fruit syrups, sweeteners, and concentrated sap products [10-12]. Nevertheless, gur retained moderate levels of antioxidant activity. This may be attributed to the dual influence of concentrated residual phenolics and the formation of Maillard reaction products, which are known to exhibit antioxidative behavior in thermally processed foods [14-15]. Such results agree with literature describing the evolution of bioactivity in heat-treated carbohydrate-rich matrices and indicate that while phenolic loss occurs, compensatory antioxidant mechanisms arise from browning reactions inherent to gur preparation.

The higher reducing sugar content found in gur compared to present juice is expected given the concentration effect during heating and the caramelization reactions that intensify sweetness and alter the structural configuration of sugars. These patterns follow earlier biochemical profiling studies of palm sap derivatives, which consistently report increased sugar density and browning indices in concentrated palm sweeteners [6-8, 14-16]. The correlation analysis further reinforces that antioxidant activity in both present juice and gur is primarily phenolic-driven, with reducing sugars showing weak associations echoing prior findings that sugars contribute minimally to radical scavenging activity relative to phenolics and flavonoids [9-12].

The overall compositional trends observed in this research closely mirror the nutritional and biochemical attributes reported in earlier works on date palm sap and jaggery-type products, including the detailed observations made by Islam *et al*. [13], who highlighted similar differences between fresh sap and gur. Moreover, seasonal and environmental factors influencing sap biochemistry, as documented in pre-2024 sap variability reports [17], help contextualize the observed variations and validate the biological relevance of the present findings. Collectively, the results support the hypothesis that present juice contains higher levels of phenolic antioxidants due to the absence of thermal degradation, while gur, though processed, maintains moderate antioxidant functionality alongside enhanced sugar density characteristic of traditional concentrated sweeteners.

Conclusion

The present investigation provides a comprehensive phytopharmacological comparison of date palm present juice and its concentrated derivative, gur, revealing clear distinctions in their biochemical composition and antioxidant functionality. The findings indicate that present juice is inherently richer in phenolic and flavonoid compounds, which translates into superior radical scavenging activity and overall antioxidant potential. This highlights the value of consuming the juice in its fresh, minimally processed form, where thermolabile bioactive components remain intact and functionally potent. In contrast, gur demonstrates reduced phenolic content due to heat exposure, yet it retains moderate antioxidant properties largely influenced by the concentration of remaining phenolics and the formation of Maillard reaction products during heating. Gur's higher reducing sugar content also reflects its role as an energy-dense sweetener, offering nutritional value in contexts where caloric replenishment is beneficial. Together, these results underscore that both present juice and gur possess distinct nutraceutical strengths, with present juice serving as a superior antioxidant-rich beverage, while gur provides a stable, shelf-friendly sweetener with retained bioactivity and enhanced carbohydrate density. Based on these observations, it is recommended that fresh present juice be promoted as a functional daily health drink, particularly in regions where oxidative stress-related disorders are prevalent, and where access to natural antioxidant sources remains limited. Ensuring hygienic tapping, rapid cooling, and controlled storage can help retain its bioactive composition and prevent fermentation, enabling safe consumption. For gur producers, adopting optimized heating practices such as moderate-temperature boiling, shorter processing duration, and stirring techniques that minimize scorching may help preserve a greater proportion of heat-sensitive phytochemicals. Additionally, positioning gur as a healthier alternative to refined sugar can support its integration into broader dietary frameworks, especially in rural and semi-urban populations accustomed to traditional sweeteners. Further, the food and nutraceutical industries may explore incorporating standardized extracts of present juice or gur into formulated health products, marketing them as natural antioxidant enhancers or functional carbohydrate sources. Encouraging small-scale industries to adopt quality-assurance measures for sap collection and processing will not only improve product stability but also enhance marketability. Public health programs promoting local functional foods may also integrate date palm derivatives into nutrition outreach initiatives, emphasizing their natural origin and phytochemical benefits. Overall, this research establishes a scientific foundation for targeted utilization of both present juice and gur, supporting their expanded role in contemporary dietary practices and value-added food systems.

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