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Chemical Composition Study of Three Varieties of Date seeds (Iraqi, Saudi and Yemeni) and their Utilization as caffeine-free coffee alternative

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Abstract: The study aimed to investigate the chemical composition of three widely available types of date seed in the Yemeni market (Iraqi, Saudi, and Yemeni) and their potential use as caffeine-free coffee alternative.

Quantitative estimation was conducted for moisture, ash, protein, fiber, fat, carbohydrates, and caffeine, along with a descriptive estimation for alkaloids, tannins, and resins. Date seed coffee was prepared and sensory evaluation was performed by trained panelists.

The results showed that Yemeni date seeds had the highest extraction Rate on average (30%), while Saudi date seeds had higher moisture, protein, fat, and fiber contents on average (8.997, 6.897, 11.167, and 16.333%, respectively).

Yemeni date seeds contained the highest carbohydrate content on average (58.290%). All tested date seeds were caffeine-free, while the chemical composition for Yemeni coffee were 7, 0.9, 13.9, 14.4, 12.8, 4.1, and 1.5% for moisture, ash, protein, fat, fiber, carbohydrates, and caffeine, respectively. Descriptive estimation results showed the absence of alkaloids in all date seeds and coffee samples, with the presence of both tannins and resins. For sensory evaluation indicated high values for all attributes of date seeds coffee alternative, with Saudi date seeds coffee outperforming other types, suggesting its potential use as a caffeine-free coffee alternative and its associated health benefits.

Keywords: Date seeds, *Phoenix dactylifra*, Yemeni coffee, chemical composition, coffee alternative.

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1. Introduction

Date seeds constitute an essential part of the date fruit (Phoenix dactylifera L), with their percentage ranging from 13 to 15% on average of the whole date fruit [48]. Date processing factories generate thousands of tons of date seeds annually, which are usually ground to feed animals [4]. However, the discarded date seeds from households and restaurants end up in waste bins in most Arab countries, resulting in their underutilization and wastage [47]. Considering the health hazards associated with coffee consumption due to its caffeine content, which significantly contributes to high blood pressure and reduces iron absorption in the intestines, leading to anemia and osteoporosis [14]. Date seeds possess various health benefits, as researchers have found them effective in treating urinary tract infections and fever reduction similar to chemical antipyretics [32]. They also act as immune system stimulants and general body tonics, beneficial for asthma treatment, uterine contraction postpartum, mucous membrane soothing, and certain skin conditions [49]. Additionally, date seeds contain biologically active proteins that may play a significant role in cancer detection, with lactins and trypsin inhibitors being among the important proteins [50]. They are used to strengthen vision, treat hair and scalp conditions[34]. Moreover date seeds have shown promise in utilizing wasted natural resources. Consequently, alternative approaches have emerged to study the potential use of date seeds as a viable source for consumption. Thus, the study aimed to investigate the chemical composition of three types of date seeds (Iraqi, Saudi, and Yemeni) and explore their potential utilization a caffeine-free coffee alternative.

2. Materials and Methods

2.1. **Materials Used** :Three varieties of date palm fruits (Yemeni, Saudi, and Iraqi) were procured from the markets of Ibb city. The mesocarp was manually removed, and only the endocarp (kernel) was retained. Additionally, Yemeni coffee purchased from the Bani Hammad region in Taiz Governorate were included for comparison.

2.2. **Chemicals:** Chemicals and solutions used in the study adhered to high analytical grade standards and were obtained from BDH Chemical Ltd .

2.3. Methods:

2.3.1. Sample Preparation: All date palm fruits from the three varieties (Iraqi, Saudi and Yemeni) were obtained from the local market in Ibb city, ensuring recent harvest. The seeds were separated from the mesocarp manually, and their weight was recorded to calculate the percentage of adherent mesocarp. Subsequently, the seeds underwent a process of cleaning with distilled water, drying, and roasting at 220°C for 6 hours [18]. The roasted seeds were then pulverized using an electric blender and stored in sealed glass containers at 15°C until further analyses.

2.3.2 Chemical Analyses: Various chemical analyses were conducted:

2.3.2.1.Quantitative Estimations: Moisture, ash, protein, fiber, fat, carbohydrates, and caffeine content were quantified following the methodologies endorsed by the Association of Official Agricultural Chemists [6] .

2.3.2.2. Descriptive Analyses: Alkaloids, tannins, and resins were detected using methods validated by [11, 20].

2.4. **Sensory Assessment of coffee:** Coffee alternatives were prepared by brewing date seed coffee and Yemeni coffee, with 45g of coffee powder added to 100ml of water and boiled for two minutes [18]. Subsequently, sensory evaluation was conducted by 10 experienced coffee consumers from the Faculty of Agriculture and the Faculty of Science at the Ibb University. A 10-point hedonic scale was employed for each attribute assessment, where zero represents the absence of the attribute, and ten indicates the highest intensity[49]. The attributes assessed included taste, aroma, color, palatability, appearance, and overall acceptability.

2.5. **Statistical Analysis:** The experiment was conducted with three replicates and statistically analyzed using a complete randomized design with ten sensory replicates. Statistical analysis was performed using SAS-2006 (Statistical Analysis System) software, utilizing a two-way analysis of variance (ANOVA TWO WAY) to determine the F-value. Mean readings were compared using the least significant difference (LSD) test at a significance level of 5%.

3. Results and Discussion

3.1. Calculation of Extraction Rate:

Analysis of the results presented in Table (1) revealed that the superiority of the Yemeni variety in terms of seeds extraction rate, obtaining the highest percentage (30%) of date seeds, with the remaining fleshy part comprising 70%. The Saudi variety followed suit, while the Iraqi variety exhibited the lowest seeds extraction rate. However, these findings align with the observations made by [16] , who reported extraction rates ranging from 40.8 to 90.8% for dates. Extraction rate served as a determinant of date quality, with higher flesh content indicating superior quality. Conversely, an increase in seeds weight diminished date quality. This principle also applied to coffee, where a higher pulp content signified better quality and preference.

Table 1. Extraction rate, Flesh, and seeds percentage in the studied date varieties

Types	%Flesh (Misocarb)	% Seeds
Iraqi Dates	83.33	16.67
Saudi Dates	81.82	18.18
Yemeni Dates	70	30
Yemeni Coffee	66.67	33.33

3.2. Quantitative Estimations:

Moisture content: The outcomes delineated in Table 2 unveil the absence of statistically significant disparities in moisture content between Saudi and Yemeni date seeds, as well as between Iraqi and Yemeni date seeds. Nevertheless, statistically significant distinctions surfaced between Iraqi and Saudi date seeds, alongside Yemeni coffee vis-à-vis all other treatments.

Notably, Saudi date seeds exhibited the most diminished moisture content (8.997%), succeeded by Yemeni date seeds and Iraqi date seeds. These findings coalesce with the empirical evidence posited by [26], endorsing a moisture content spectrum in date seeds oscillating between 3.1 and 12.5%. The variances in moisture content could plausibly be ascribed to varietal typologies, climatic modalities, harvest chronology, desiccation methodologies, and warehousing conventions, with ambient humidity imparting a discernible influence on the hygroscopicity of desiccated entities like date seeds [23, 37]. The ascertained moisture content of Yemeni coffee converges with the findings proffered by[38], wherein it was ascertained to be 6.99%. The attenuation in moisture content discerned in Yemeni coffee connotes a salutary marker of quality.

Ash content: Scrutiny of the tabulated results in Table 2 divulged that an absence of statistically significant disparities in ash content across all treatments of date seeds. However, statistically significant deviations transpired between Yemeni coffee and all alternative treatments. Yemeni coffee evinced the most trifling ash content (1.790%), succeeded by Saudi date seeds, whereas Iraqi date seeds delineated the most pronounced ash content (2.16%). These findings according with the investigatory findings _ articulated by [15], who asseverated an ash content spectrum in Tunisian date seeds specimens oscillating between (1.79 and 2.16%). The vicissitudes in ash content might be ascribed to botanical varietals, agrarian methodologies, harvesting and post-harvesting protocols, or environmental nuances (inclusive of climatic variances and edaphic fertility) [15, 24, 36]. Disparities in ash content pertaining to Yemeni coffee comparison the findings propounded by [38], wherein ash content was posited at 4.16%, could be imputed to discrepancies in the subject varieties scrutinized.

Protein content: The results presented in Table 2 revealed that significant variations between the Yemeni coffee and all other treatments, as well as notable differences between the Saudi date seed treatment and the rest of the samples. Conversely, no statistically significant disparities were observed between the Iraqi date seed and the Yemeni type. Notably, the Yemeni coffee treatment exhibited the highest protein content, followed by the Saudi date seed and then the Iraqi date seeds,while the Yemeni date seed displayed the lowest protein content. These findings align with previous investigations conducted by [1, 5, 7, 8, 9, 13, 21, 22, 37,41, 43] reporting protein content in date seeds ranging from 4.8 to 12.5%. Date seeds are known to contain water-soluble proteins like globulin, albumin, prolamin, and glutelin [35]. Furthermore, the protein content in Yemeni coffee (10.95%) closely resembles the findings reported by [38].

Fat content: The results presented in Table 2 demonstrated that no significant differences among all date seeds studied, while significant differences were found between Yemeni coffee and the other treatments. From the results, we observed the superiority of Saudi date seeds treatment over the others, showing the highest fat content (11.167%), followed by Yemeni date seeds and then Iraqi date seeds. Conversely, the fat content in Yemeni coffee was 14.40%. This criterion is particularly important for flavor stability, as an increase in fat content led to the emergence of

coffee flavor, considered a quality factor in coffee. The fat content in date seeds depended on several factors, including the date palm tree variety, growth conditions, and extraction method. Values ranged in numerous studies from 3.9 to 13.8% [1, 5, 8, 9, 21, 22, 37]. On the other hand, several studies indicated that date seeds fat contained numerous saturated and unsaturated fatty acids, implying that date palm kernel could be considered an important source of edible oils or pharmaceutical oils [7, 3, 37, 33]. Conversely, the fat percentage in Yemeni coffee (6.13%) differed from that found by [38].

Table 2. Results of Moisture, Ash, Protein, and Fat for Date seeds.

Types	Moisture		Ash		Protein		Fat	
	%	LDS%5	%	LDS%5	%	LDS%5	%	LDS%5
Iraqi	11.377		2.160		5.267		10.167	
Saudi	8.997		1.980		6.897		11.167	
Yemeni	10.113	1.434	1.790	0.1434	5.090	0.2121	10.833	1.1568
Yemeni coffee	7.000		0.900		13.900		14.400	

Fiber content: The results presented in Table 3 indicated that no significant differences among all treatments under study. Additionally, the Yemeni coffee outperformed all other treatments, exhibiting the lowest fiber content, followed by the Iraqi date palm kernel . Conversely, the highest fiber content was observed in the Saudi and Yemeni date seeds (16.33%). It is noteworthy that an increase in fiber in coffee led to increased mouth dryness after consumption, while lower fiber content correlated with better coffee quality. These findings are consistent with those reported by [28], who found that date seeds contained approximately 16.20% fiber [19]. It is worth mentioning that date palm kernel fiber consists primarily of insoluble fibers, which find application in various food industries, including bakery products, breakfast cereals, and certain types of ice cream[10,12, 27, 40].

Carbohydrate content: Analysis of the results in Table 3 revealed that no significant differences between Saudi and Iraqi date seeds, while significant differences were found between Yemeni date seeds and other treatments, as well as between Yemeni coffee and the rest treatments. The Yemeni date seeds treatment exhibited the highest carbohydrate content (58.290%), followed by the Iraqi date seeds, and then the Saudi date seeds sample. Conversely, the Yemeni coffee showed the lowest carbohydrate content. These results align with those reported by [28], who found that date seeds contained carbohydrates ranging from 55 to 66%, while [26] reported that lower values in samples from Omani date seeds (70.9-86.9%). The variation in carbohydrate content among date seeds may be attributed to differences in cultivars.

Caffeine content: The results in Table 3 indicated that no significant differences among different types of date seeds. However, significant differences were observed between Yemeni coffee beans and all types of date seeds, as caffeine was not detected in all date seeds, consistent with findings reported by [42, 18] Conversely, Yemeni coffee beans showed increasing caffeine content, which can adversely affect human health by inducing cardiac muscle stress and being considered stimulants[14].The lower the caffeine content, the better for overall health. Several studies have indicated that continuous caffeine consumption lead to stress and anxiety [31] , headaches [17] , and infertility [31]. Additionally, caffeine inhibits collagen biosynthesis, increases toxicity levels in the body, raises blood pressure, and elevates metabolic rate [25, 46, 30]. The caffeine content results for coffee beans align with those reported by [38], indicating that the caffeine content of Yemeni coffee beans was 1.49%.

Table 3. Results of fiber, carbohydrates, and caffeine content in date seeds.

Types	Fibers		Carbohydrate		Caffeine
	%	LSD%5	%	LSD%5	%
Iraqi	16.000		56.030		0
Saudi	16.333		54.843		0
Yemeni	16.333	3.9648	58.290	1.4132	0
Yemeni coffee	12.800		4.100		1.5

3.3. Descriptive estimations

Detection of alkaloids, tannins, and resins: The results obtained in Table 4 showed the absence of alkaloids in all studied samples, as indicated by a negative result upon alkaloid detection. These findings align with those of [18], who also reported the absence of alkaloids in date seeds extract. However, tannins and resins were present in all studied samples, with positive results. This finding corroborates the presence of tannins and resins in date seeds extract, as reported by [2, 29] mentioned that tannins and resins found in date seeds exhibited antimicrobial activity, particularly against pathogenic microorganisms.

Table 4. Results of Alkaloids, Tannins, and Resins in the date deeds.

Detection	Iraqi	Saudi	Yemeni	Yemeni Coffee
alkaloids	-	-	-	-
Tannins	+	+	+	+
Resins	+	+	+	+

3.4. Sensory evaluation of date seeds coffee alternative

The results obtained for the coffee flavor attribute in Table 5 revealed no significant differences among all types of roasted date seeds studied and regular coffee. Regarding the types, the Saudi roasted date seeds powder exhibited superiority over the rest other types, as it received the highest score from the panelists, reaching 9.417. The taste was remarkably similar to Yemeni coffee

according to the panelists' assessment. In terms of aroma, the Yemeni roasted date seeds aroma outperformed the other types (9.250) compared to regular coffee, which ranked highest among the panelists' assessment of the aroma of the studied roasted date seeds powder. It was close to the aroma of coffee, which scored (9.33). In terms of color, the Saudi roasted date seeds powder surpassed all other types and received the highest score from the panelists at 8.417, while the color was similar to Yemeni coffee (8.667). Regarding taste, the Saudi roasted date seeds powder outperformed all rest other types of roasted date seeds powder, scoring the highest among the studied roasted date seeds coffees at (9.333), and it was consistent with Yemeni coffee in terms of taste, according to the evaluators. In the overall appearance of the coffee, the Saudi roasted date seeds powder outperformed the other types, scoring the highest among the evaluators at 8.667, similar to the appearance of coffee, which scored 8.750. In terms of overall acceptability of the coffee alternative, Saudi roasted date seeds powder was rated the best according to the panelists' opinion (9.250), ranking second after Yemeni coffee (9.500). [18] indicated that date seeds coffee cupping results were comparable to Arabica coffee, especially concerning taste and aroma. Similarly [39,44,45] mentioned that date seeds coffee was comparable to Arabica coffee and received acceptable results from the panelists.

Table 5. Sensory evaluation of roasted date seeds coffee alternative.

Attribute	Taste	Aroma	Color	Palatability	Appearance	Overall acceptability
Iraqi	8.8333	8.250	7.917	8.083	8.250	8.250
Saudi	9.417	8.167	8.417	9.333	8.667	9.250
Yemeni	7.500	9.250	7.917	7.083	8.167	7.500
Yemeni Coffee	9.417	9.333	8.667	9.333	8.750	9.500
Mean	8.583	8.556	8.084	8.166	8.361	8.333
LCD%5	0.8086	0.9016	1.0772	0.8519	0.9514	0.9806

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