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ORIGINAL ARTICLE

Nutritional Quality of Low-Calorie Biscuits Enriched with Date Press Cake

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ABSTRACT

Background: Date press cake (DPC) as a fibrous by-product of date syrup contains high levels of dietary fiber, minerals, and antioxidant compounds; while a large volume of it is still discarded. This study assessed the nutritional quality of low calorie biscuits enriched with DPC.
Methods: DPC was added to standard tea-biscuit dough at 0 (Control), 5, 10, 15 and 20% (w/w) concentrations. Dietary fiber, energy (Kcal/100 g), color, and sensory acceptability were measured later. Antimicrobial assay was also undertaken.
Results: Dietary fiber increased from 1.3% (control) to 5.7%, 10.0%, 14.3%, and 18.6% when 5, 10, 15 and 20% concentrations of DPC were added, respectively. The energy decreased from 457.8 Kcal/100 g (control) to 444.4, 430.7, 417.4, and 403.8 Kcal/100 g at 5, 10, 15, and 20% (w/w) concentrations of DPC, respectively. Antimicrobial assay demonstrated dose-dependent inhibitory effects of DPC against food spoilage microorganisms of *Escherichia coli*, *Bacillus subtilis* and *Saccharomyces cerevisiae* with its alcoholic extract (200 mg/mL) and exhibits a strong activity appeared as a12 mm inhibition zone. Sensory evaluation (n=10) showed an overall acceptability and remained high (8 out of 10) at 10% concentration of DPC; but declined markedly at 15% and 20% concentrations.
Conclusion: It was shown that incorporation of DPC into tea-biscuit dough up to 10% (w/w) can effectively increase (3 times) the dietary fiber content, reduce the caloric density (~3%), and retains a high sensory acceptability. Higher levels of ≥15% can impair the color and the texture acceptability. DPC valorization in biscuits was shown to offer an eco-friendly route to reduce agro-industrial waste, enrich bakery products with functional fiber, and contribute to healthier diets.

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Introduction

Dates (*Phoenix dactylifera L.*) are considered as traditional and widespread nutrient-rich fruits to promote health status with broad applications in food and beverage products (1). The date palm fruits are a prevalent food source in Middle East and North Africa yielding over 8 million of fruit annually (2, 3). They have a prominent nutritional, health, and economic value that can be consumed in dried or fresh fruit form. They are also consumed for by-products such as syrups, energy bars, pastes, jams, sauces, desserts and pickled dates (4, 5). When dates are fermented, other products can be reached including alcoholic beverages such as beer, wine and liquor, and also non-alcoholic beverages such as vinegar and juices (6). As scientific researches and global market interests are increasingly driving towards healthy food and lifestyle by use of herbal in traditional medicine (7); dates based on their health benefits have opened a door in treatment of many diseases too (8-10).

Date liquid sugar, date syrup, date paste, date juice, date jam, date powder, date vinegar, fermentation products (such as organic acids, date alcohol, baker's yeast, wine, antibiotics, and single-cell protein), enzymes, etc. were categorized as the products of date processing, while date seeds, low-quality dates and the date press cake (DPC) were demonstrated as the by-products of date processing (11). DPC is a fibrous by-product of date syrup that contains high levels of dietary fiber, minerals, and antioxidant compounds DPC as "Dibs syrup" or juice covers 17-28% of the fresh fruit mass (12-14). The date fruit by-products are beneficial in health status based on their chemical composition including vitamins, minerals (such as potassium, magnesium and calcium), organic acids, antioxidants, sugars, pigments, dietary fibers, pectin, flavonoids, phenolic, antibacterial, or antifungal compounds (12, 15-17). Addition of DPC to cakes was shown to improve the dietary fiber content of this product and to have many health benefits for the consumer (18). Improper disposal of DPC can pose environmental and economic concerns (13, 19), yet its composition has made it a promising functional ingredient in bakery products (19-21). Fortification with fruit by-products as a functional bakery has improved nutritional value and shelf life; while has received the consumer acceptance too, e.g., apple pomace in cookies (22), mango peel in biscuits (23), and pomegranate peel in biscuits (24). Also, incorporation of DPC has been undertaken in date jam (15) and protein bars (21), but its application in biscuits still remains under-investigated. So this study assessed the potential of DPC as a fiber-rich, low-cost additive in tea-biscuit dough. We measured proximate composition changes, estimated caloric reduction, instrumental color, and sensory acceptability when DPC is added.

Materials and Methods

Iraqi Zahdi dates were used to prepare DPC. After removal of the seeds, water was added in twice volume to the dates. The mixture was further heated until melting and homogenizing the produced juice. The juice was then removed, and the powder was dried at 60°C to reach less than 4% moisture content. The powder was ground (less than 0.25 mm) and stored at 4°C until use (12, 15). In next step, commercial wheat flour, white sugar, vegetable oil, baking powder, and other standard biscuit ingredients were obtained locally. Also, the needed microorganisms were obtained from the laboratories of the Department of Food Sciences at the University of Baghdad, Iraq. The aqueous and alcoholic extracts of DPC were prepared at concentrations of 100 and 200 mg/mL as described before (25).

Regarding extract preparation (12, 14), aqueous and ethanolic extracts of DPC (100 and 200 mg/mL) were assessed by disc diffusion method and employing Mueller-Hinton agar, Sabouraud dextrose agar; and 6-mm sterile discs that were impregnated with the extracts to be evaluated. The zones of inhibition were measured post-incubation (37°C/24 h for bacteria; 30°C/48 h for yeast) (26). For biscuit preparation, 5 formulations were utilized and replaced for a portion of the wheat flour of DPC at different concentrations of 0% (control), 5%, 10%, 15% and 20% (w/w). The basic recipe per 100 g of flour was consisted of 25 g of sugar, 20 g of oil, 1 g of baking powder, 1 g of salt and 28 mL of water (25). The ingredients were whisked and mixed into dough; while prepared in 3.5 mm thick strips, cut into 45 mm diameter discs, and baked at 180°C for 15 minutes. All samples were finally cooled at room temperature before analysis (Figure 1).

Regarding the determination of proximate composition and energy, moisture, ash, crude protein (Kjeldahl N×6.25), crude fat (Soxhlet), and crude fiber contents (Official methods of analysis of AOAC) were used (27). Available carbohydrate (%) was calculated by the difference and the estimated energy (Kcal/100g) was assessed using the Atwater factors including protein=4, carbohydrate=4, fat=9 and fiber=2 Kcal/g (21, 28). For sensory evaluation, trained employees (n=10) randomly evaluated the samples utlizing a 10-point Hedonist scale for appearance, color, texture, flavor and overall acceptability (29); while a score of ≥7 indicated an acceptable quality (Figure 1).

Results

Considering the chemical composition of DPC, water content was 4.8%, protein=1.1%, total carbohydrates=1.8%, fiber=87.1%, fat=0.1% and ash=5.0%. Table 1 shows that DPC addition could progressively altered biscuit composition.

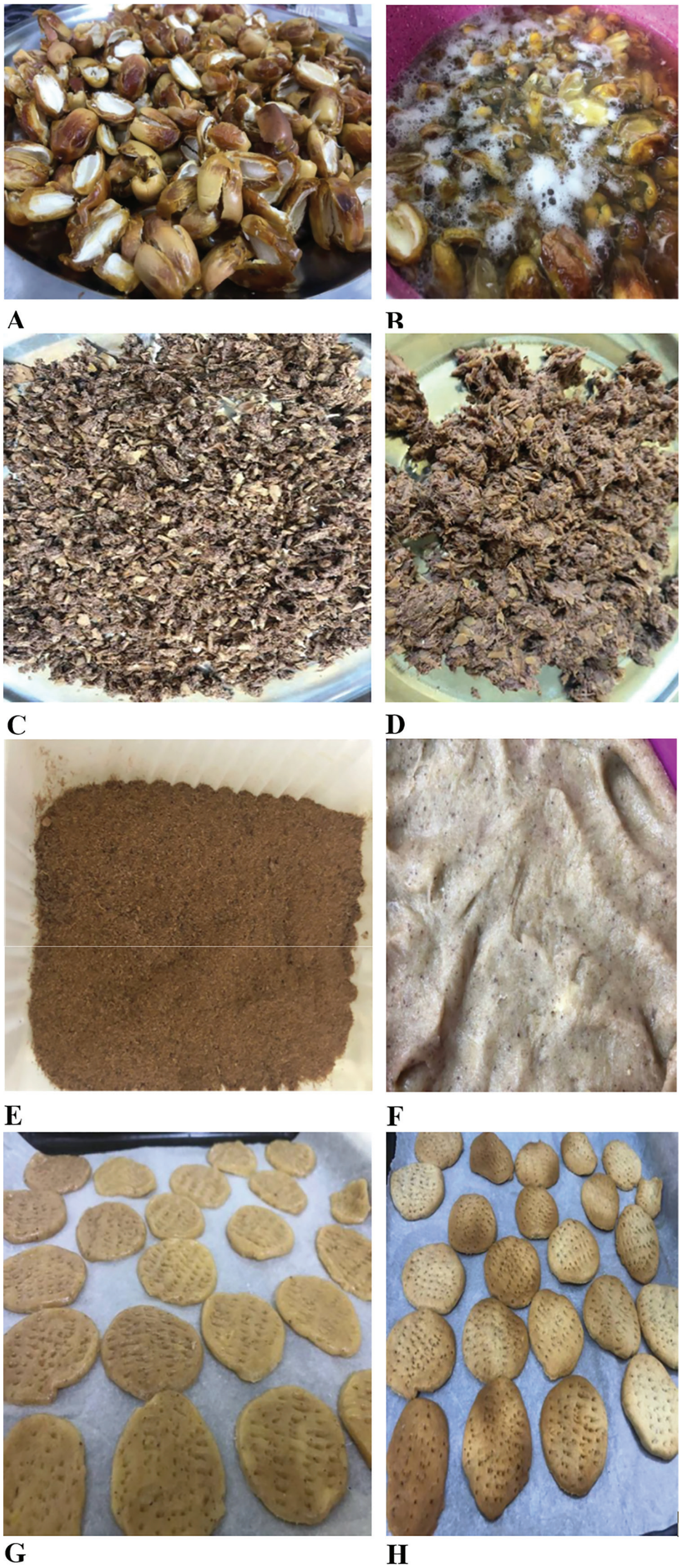

Figure 1: DPC processing steps.

Table 1: Proximate composition and energy of biscuits provided from DPC.

DPC (%)	Moisture (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Fiber (%)	Ash (%)	Energy (kcal/100 g)
0 (Control)	5.4±0.1	13.7±0.3	19.2±0.2	56.9±0.4	1.3±0.05	3.4±0.1	457.8±2.0
5	5.3±0.1	13.1±0.2	18.2±0.3	54.2±0.2	5.7±0.1	3.5±0.1	444.4±1.5
10	5.3±0.1	12.4±0.2	17.3±0.3	51.4±0.3	10.0±0.2	3.6±0.1	430.7±2.1
15	5.2±0.1	11.8±0.3	16.2±0.2	48.7±0.4	14.3±0.1	3.7±0.1	417.4±1.8
20	5.1±0.2	11.2±0.2	15.4±0.2	45.9±0.3	18.6±0.2	3.8±0.1	403.8±2.3

DPC: Date press cake.

Dietary fiber increased from 1.3% (control) to 5.7%, 10.0%, 14.3%, and 18.6% at concentrations of 5%, 10%, 15% and 20% (w/w) of DPC, respectively. Available carbohydrates and fat declined slightly, while the protein and ash content increased modestly. The energy decreased from 457.8 Kcal/100 g (control) to 444.4, 430.7, 417.4, and 403.8 Kcal/100 g at concentrations of 5%, 10%, 15% and 20% (w/w) of DPC, respectively.

Table 2 shows the sensory evaluation of biscuit samples containing various concentrations of DPC. Higher ratios were illustrated to be less rated in relation to sensory evaluation. Table 3 demonstrated the antimicrobial activity of DPC extracts. The highest inhibition was 12 mm in diameter for *B. subtilis* at a concentration of 200 mg/mL of the alcoholic extract. The inhibition was 11 mm in diameter at the same concentration for both *S. cerevisiae* and the *E. coli*.

Discussion

The beneficial effects of many fruits on health status have been verified before (30) (31-33). Among different fruits, date palm has a highly cultural and economic value in Middle East and North Africa. Date syrup is a famous and attractive product in date industry as it is widely used as a natural sweetener and flavoring. The date syrup extraction can produce a large amount of a by-product known as DPC that has unique properties. It contains about 0.67-5.37% fat, 0.46-6.41% protein, and 41.3-83.3% carbohydrates such as 6.67-33.81% fibers and significant amounts of cellulose, hemicellulose and lignin that make it a prominent source of fermentable sugars (29, 34, 35).

Considering the chemical composition of DPC, It was shown that DPC addition could progressively change the biscuit composition. Dietary fiber increased at different concentrations of DPC that mirrors a high fiber content of DPC (~87% by dry weight define before (17). Available carbohydrates and fat declined slightly, while protein and ash increased modestly, reflecting DPC's mineral richness as mentioned before (13, 17). The energy decreased at various concentrations of DPC that is consistent with fiber's lower metabolizable energy describe before (36). It was demonstrated that the 5% and 10% ratios were more acceptable than those without, with fiber being more acceptable to the reviewers; while higher ratios were less rated in relation to sensory evaluation. The alcoholic extract was exhibited to be more effective than the aqueous extract regarding the studied microorganisms.

Table 2: Sensory evaluation of biscuit samples containing various concentrations of DPC.

Sensory variable	Maximum score	0% (Control)	5%	10%	15%	20%
External appearance	20	19	19	19	17	15
Surface texture	15	15	14	13	12	10
Texture (Mouthfeel)	10	10	9	9	8	6
Crumb color	10	10	10	10	8	6
Taste and flavor	25	23	23	24	21	19
Softness	10	9	10	10	7	6
Overall acceptance	10	8	10	10	6	5
Total score	100	94	95	95	79	67

DPC: Date press cake.

Table 3: Antimicrobial activity of DPC extracts.

Test organism	Aqueous extract (100 mg/mL)	Aqueous extract (200 mg/mL)	Alcoholic extract (100 mg/mL)	Alcoholic extract (200 mg/mL)
Escherichia coli	–	7	8	11
Bacillus subtilis	7	9	9	12
Saccharomyces cerevisiae	–	7	9	11

DPC: Date press cake.

The highest inhibition zone was 12 mm in diameter for *B. subtilis* at a concentration of 200 mg/mL of the alcoholic extract and was 11 mm in diameter at the same concentration for *S. cerevisiae* and *E. coli*. This reflects that addition of these dietary fibers has benefits for digestive tract, reduces the number of calories, and extends the shelf life of the product that are in agreement with previous studies (17, 21, 28, 36). It seems that the ingredients of a diet such as DPC has a pivotal role in health status of people that must be considered when utilized (37-39).

Conclusion

It was shown that incorporation of DPC into tea-biscuit dough up to 10% (w/w) can effectively increase (3 times) the dietary fiber content, reduce the caloric density (~3%), and retains a high sensory acceptability. Higher levels of ≥15% can impair the color and the texture acceptability. DPC valorization in biscuits was shown to offer an eco-friendly route to reduce agro-industrial waste, enrich bakery products with functional fiber, and contribute to healthier diets. Future work should evaluate DPC's impact on glycemic response, shelf-life stability, and nutritional bioavailability.

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Authors' Contribution

The concept, experiment, and general supervision were designed by JMA. prepared the mixture and carried out the kneading and grilling process by HQH . supervised the other experiments by ZAA.

Conflict of Interest

The authors declare no conflict of interest.

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