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Utilization of Germinated date seeds as a Source of Functional Ingredients in Biscuits

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ABSTRACT

In order to increase the nutritional value of date seed and optimize the financial worth of these wastes, this study was conducted to assess the advantages of date seed (DSP) powder and germinated date seed powder (GDSP) by replacing them with wheat flour (WF) (72% extraction.). The composition of (DSP) and (GDSP) showed a significantly higher concentration of fiber (16.35–10.90%), ash (1.30–2.50%), fat (7.90–10.50%), total phenolic content (1150.86–3050.10 mg GAE/100g), antioxidant activity DPPH (60.1–90.45%), and flavonoids content (540.80–870.54 mg RE/100 g DW). K (370–510 mg/100g), Ca (450–920 mg/100g), P (410–560 mg/100g), Fe (3.3–5.01 mg/100 g), and Zn (1.20–2.58 mg/100g). DSP and GDSP were then substituted for the WF in a ratio of 10, 20, and 30%. This allowed for the determination of the concentrations of the two substances based on sensory evaluation, chemical composition, mineral elements, phenols, and flavonoids to produce biscuits. These chemicals also have a positive impact on overall body health. However, it was discovered that GDSP outperforms DSP in every way. Except for a decrease in crude fiber. Furthermore, the judges found that the sensory evaluation of the biscuits of the biscuits was satisfactory in terms of both their physical attributes and acceptability, as well as the possibility of substituting DSP and GDSP with other bakery products.

1. Introduction

Functional foods, which are described as foods that may offer health advantages above and beyond basic nourishment, Biologically active chemicals found in functional foods, along with fiber supplementation, may be utilized to reduce metabolic syndrome and associated risk factors, including hypercholesterolemia, hypertriglyceridemia, and hyperglycemia. In addition to enhancing food's nutritional content to promote individual health and lower the incidence of sickness among consumers, maintaining the necessary organoleptic qualities is also important (Aleixandre and Miguel 2016).

A potential by product of date production is the date seeds. The buildup of date seeds in agricultural areas disrupts the equilibrium in agroecosystems, with significant negative environmental impacts. Finding practical uses for date seeds that produce value-added goods and build a a healthy ecosystem is crucial to addressing these concerns. Additionally, the circular economy might benefit from this. Date seeds are an interesting choice for value-added application in the development of innovative food and nutraceutical products because of their rich nutritional profile (Najjar et al., 2022).

People from arid and semiarid regions of the world mostly engage in the cultivation of date seeds (Phoenix dactylifera L.) as their source of income. The number of dates produced rises year over year. Furthermore, there is an increase in the export of pitted dates and a significant production of date seeds. Manufactures businesses have challenges as a result of date seed. Currently, date seeds are typically discarded or added to animal feed. But because of their favorable chemical makeup, this promising alternative" can be utilized for a variety of additional purposes (Mrabet et al., 2020).

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The date palm has long been one of the most important fruit crops for southern Mediterranean countries, where dates are the main income source and staple food for some local populations. In addition, this crop is not only a source of income from an economic point of view but also a key for fixing populations and creating or maintaining centers of life. The cultivation of date fruit has been increasing in recent decades, from 1.05 million hectares of cultivated area and 6.44 million tons of production in 2000 to 1.09 Mha and 8.53 MT in 2018. These data also suggest an important increase in the crop yield of FAOSTAT (2020).

Germination is an easily controlled and effective process to enhance the nutritional qualities of grains (Komatsuzaki et al., 2007). Grain in water is soaked, then allowed to germinate at a precise temperature in a humidity chamber. When seeds germinate, key components, including starch, fibers, and protein, are disintegrated, and hydrolytic enzyme activity in the seeds increases, facilitating texture improvement (Kaneko et al., 2002). In addition, germination enhances protein content, bioactive compounds, and antioxidant properties. Thus, the consumption of germinated grains has potential benefits to human health (Chung et al., 2014; Suwanmanon and Hsieh, 2014). Recently, germinated grains have drawn more attention than raw grains because of their increased nutritional and functional characteristics (Suwanmanon and Hsieh, 2014; Li et al., 2017). Understanding the physicochemical and functional characteristics of flours is vital for improved control of industrial manufacturing processes, as the food sector is becoming more and more interested in using germinated grain flours. (Falade and Christopher, 2015). Biscuits hold a place as a convenient dietary staple across all social classes in Egypt. Their widespread popularity stems from several factors: affordability, diverse flavors and varieties, readily available in stores, and a long shelf life (Sudha et al., 2007). In the daily diet, bakery products are a major source of macro- and micronutrients. Cookies are the most widely consumed products among them, both as a breakfast food and as a midday snack (Ortola et al., 2022). The aim of this study was to investigate the impact of the germinated process on the physicochemical characteristics of flours made from date seed powder and germinated date seed powder.

2. Materials and Methods

Materials

Wheat flour (72% extraction) was obtained from South Cairo Mills Company, Giza, Egypt.

Date seeds used in this study were obtained from the Agricultural Research Center (ARC), Palm Research Department, in 2022.

Dry skimmed milk powder, cocoa powder, sugar, corn oil, baking powder, vanilla, and salt were purchased from the local market in Giza, Egypt.

Methods

Chemical composition

Moisture, ash, protein, crude fiber, and fat were determined according to the methods described in AOAC (2019). Carbohydrate content was estimated by the difference.

Total calories were calculated according to (FAO/ WHO 1973) as follows:

$E = 4\times(\text{carbohydrate\%} + \text{protein\%}) + 9\times(\text{fat\%})$

Where: E = energy as kcal per 100 g.

Rheological properties of dough

A farinograph test was carried out to determine the water absorption, arrival time, dough development time, dough stability, and degree of weakening according to the method described in AACC (2016).

An extensograph test was carried out to determine resistance to extension (BU), extensibility (mm), proportional number, and energy (cm^2) according to the method described in AACC (2016).

Mineral profile

Samples were processed, and the determination of minerals was analyzed. A microwave digestor (Multiwave GO Plus 50 HZ) was used prior to spectrophotometric analysis of the samples by MPAES (Microwave Plasma-Atomic Emission Spectroscopy) (Agilent, Mulgrave, Victoria, Australia), according to the method of Agilent Technologies, Inc. (2021).

Preparation of germinated date seeds

The germination process was carried out by Hejri-Zarifi et al. (2014), with some minor modifications. After the date seeds were extracted from the fruits, they were soaked in water for 48 hours, changing the water every 8 hours to stimulate and accelerate germination, rinsed the date seeds to remove any remaining date flesh, and then covered with a damp cloth and let sit at room temperature for a period of 28 days, maintaining the fabric's moisture content. Once germination reached 2–3 cm, it was finished. The seeds that germinated were cleaned, dried at 50 °C for an hour, and ground into a powder (100 mesh). Before being used, they were stored at room temperature in polyethylene bags. Before being used and kept in a deep freezer (-18°C).

Preparation of biscuits

Different formulations of biscuits were prepared by substituting the level of date seed powder (DSP) and germinated date seed powder (GDSF) with wheat flour at levels of 0, 10, 20, and 30% (based on the weight of the flour) by Sai Manohar and Haridas Rao (1997), which is displayed in Table 1 and is as follows: 100 g of flour, 25 g of corn oil, 35 g of sugar, 3 g of baking powder, 3 g of cocoa powder, and 0.50 g of vanillin were the ingredients for the biscuits. Water absorption using a Farinograph. A flat beater was used to combine maize oil, sugar, and vanillin in a dough mixer for one minute, and the mixture was then combined at a high speed for three minutes. The mixture was then stirred slowly while flour and baking powder were added, and the biscuits were baked at 170 to 180 °C, for 12 minutes. After letting the biscuits cool for an hour at room temperature, they were packed in metalized -oriented polypropylene bags and kept there.

Table 1. The recipe formulation of biscuits

Ingredients (gm)	C	T1	T2	T3	T4	T5	T6
Wheat flour (WF)	100.0	90.0	80.0	70.0	90.0	80.0	70.0
Date seeds powder (DSP)	-	10.00	20.0	30.0	-	-	-
Germinated date seeds powder (GDSP)	-	-	-	-	10.00	20.0	30.0
Dry skimmed milk powder	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Cocoa powder	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Corn oil	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Cocoa powder	3	3	3	3	3	3	3
Sugar	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Baking powder	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Vanilla	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Salt	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Water	According to Farinograph water absorption						

Total phenolic content assay

Total phenolic content was assessed colorimetrically using the Folin Ciocalteau reagent as explained by Al-Farsi et al. (2005), with minor changes.

Total flavonoid content assay

The total flavonoid content was estimated according to the method of Amira et al. (2012).

Physical properties of biscuits

The physical properties of biscuits were determined according to the method described in AACC (2016). Width (mm), Thickness (mm), Spread ratio (W/T), Weight (gm), Volume (Cm3), and Specific Volume (V/W) (Cm3/gm).

Sensory evaluation of biscuits

The biscuits were evaluated for their sensory characteristics after being baked by ten panelists from the staff of bread and pastry, research department., Food Tech. Res. Institute, Giza.

Statistical analysis

The analytical data were analyzed using SPSS 20.0. Means and standard deviations were determined using descriptive statistics. Comparisons between samples were determined using analysis of one-way variance (ANOVA) and multiple range tests. Statistical significance was defined at P≤ 0.05.

3. Results and Discussion

Effect of Farinograph and Extensograph on wheat flour (WF) (72% ext.) dough replaced with different levels of date seeds powder (DSF) and germinated date seeds powder (GDSF). Farinograph analysis was used to investigate the effect of replacing wheat flour (WF) with different levels of date seed powder (DSP) and germinated date seed powder (GDSP) on dough properties (Table 2). Water absorption was highest for T3 (30% DSP) and lowest for T4 (10% GDSP) compared to the control (WF). This decrease in water absorption with germinated date seed powder (GDSP) may be due to the action of enzymes during germination, which break down starch molecules into dextrins with lower water binding capacity (Gernah et al., 2011). Overall, water absorption increased with the addition of both DSP and GDSP compared to WF, likely due to their higher protein and dietary fiber content (Rasper and Walker, 2000). Arrival time, which reflects the time required for dough development, was highest for T3 (4.0 min) likely due to the increased fiber content in the dough. Dough stability, indicating resistance to mixing, was highest for the control wheat flour dough (7.0 min). Dough weakening, measured in arbitrary units (BU), ranged from 120 to 140 BU for DSP and 110 to 125 BU for GDSP, indicating a generally stronger dough structure compared to the control.

Table 2. Rheological properties of dough samples

Parameters dough samples	Control	T1	T2	T3	T4	T5	T6
				Farinograph			
Water absorption (%)	53	58	65	70	55	59	64
Arrival time (min)	1	1.50	2.00	2.5	1	1.5	2.00
Dough development time (min)	2	2.50	3.00	4.00	2.00	2.50	2.90
Dough stability (min)	7	5	4	3	6	5	4
Dough weakening (B.U)	100	120	130	140	110	120	125
				Extensograph			
Resistance to extension (R)(B.U)	500	530	560	570	520	530	550
Extensibility (E) (mm)	150	120	100	80	130	110	90
Proportional number (R/E)	3.33	4.58	5.60	6.95	4.00	4.82	6.11
Energy (Cm^2)	100	90	80	60	95	90	85

C=100 % wheat flour (WF)
T1=90 % wheat flour (WF) + 10 % Date seeds powder (DSP)
T2= 80 % wheat flour (WF) + 20 % Date seeds powder (DSP)
T3= 70 % wheat flour (WF) + 30 % Date seeds powder (DSP)
T4 = 90% wheat flour (WF) + 10 % Germinated date seeds powder (GDSP)
T5= 80% wheat flour (WF) + 20 % Germinated date seeds powder (GDSP)
T6= 70% wheat flour (WF) + 30 % Germinated date seeds powder (GDSP)

Extensograph analysis was used to assess the impact of substituting wheat flour with different levels of date seed powder (DSP) and germinated date seed powder (GDSP) on dough extensibility properties (Table 2). As the substitution level of DSP and GDSP increased, resistance to extension (BU) and proportional number (R/E) increased, while dough extensibility (mm) and dough energy (cm²) decreased. This can be attributed to the presence of fiber in date seeds, which dilutes the gluten content in the dough, affecting its stretching ability. Dough extensibility (mm) significantly decreased compared to the control sample (150 mm). Substitutions with 10%, 20%, and 30% DSP and GDSP resulted in extensibility values of 120, 100, 80 mm and 130, 110, 90 mm, respectively. These findings align with Alamri et al. (2014), who reported a decrease in dough extensibility (from 136.3 to 72.3 mm) and an increase in resistance to extension (from 456.3 to 1034 BU) with increasing date pit powder substitution in hard red spring wheat flour.

The observed decrease in dough energy (data in Table 2) might indicate reduced dough expansion during baking, potentially affecting loaf volume.

Chemical composition of raw materials

The results shown in Table 3 refer to the chemical composition of wheat flours (72%), date seed powder (DSP), and germinated date seed powder (GDSP). The highest level of protein content was scored in GDSP at 14.05%, followed by wheat flour (72% ext.) at 11.00%, while the lowest level of protein content was found in DSP at 5.01%. On the other hand, fats, ash, and crude fiber contents of the DSF and GDSP were (7.90, 10.50%), 1.30 , 2.50%, and 16.35, 10.90%, respectively. The germination process affected reducing the crude fiber contents in date seeds compared to un-germinated date seeds. It also affected an increase in protein, fat, and ash. These results, similar to those of Besbes et al. (2004) and Alharbi et al. (2021), found that the date seeds are a rich source of fat, ash, and fiber.

Table 3. Proximate composition of raw materials

Material	Protein*	Fat*	Ash*	Fiber*	Available carbohydrate*
Wheat flour72%	11.00	1.00	0.50	0.70	86.80
Date seeds powder (DSF)	5.01	7.90	1.30	16.35	69.44
Germinated date seeds powder (GDSP)	14.05	10.50	2.50	10.90	62.05

***(g/100g dry weight basis)**

Total phenol compounds, flavonoids, and antioxidant activity in date seed powder.

The outcomes were summarized in Table 4 for date seed powder (DSP) and germinated date seed powder (GDSP). The findings showed that the total phenol content, total flavonoid content, and antioxidant activity (DPPH) of DSP and GDSP are abundant. Phenolic chemicals are the most powerful antioxidant and antibacterial agents found in nature. Moreover, all fruit, vegetables, and seeds extracts have been shown to inhibit microbiological deterioration and lipid oxidation. (Kryževičūtė et al., 2017). Date pit powder exhibited the strongest chelating activity, reducing power, radical scavenging capability, and lipid peroxidation suppression. This enhanced antioxidant potential can be attributed to the increased levels of both antioxidants and phenolic compounds following germination (Cherif et al., 2014).

Table 4. Total phenol content in in date seeds powder (DSP) and germinated date seeds powder (GDSP) extracts using water.

Total phenol contents	(DSF)	(GDSP)
Antioxidant activity DPPH (%)	60.11	90.45
Total phenolic content (mg GAE/100 g DW)	1150.86	3050.10
Flavonoids content (mg RE/100 g DW)	540.80	870.54

Mineral composition of wheat flour (WF) (72ext.), date seeds powder (DSP), and its germinated date seeds powder (GDSP).

When comparing the mineral composition (Table 5.) of date seed powder (DSP) and its germinated date seed powder (GDSP) to wheat flour (WF) (72ext.), Table 4. revealed that potassium (K), calcium (Ca), phosphorus (P), sodium (Na), magnesium (Mg), manganese (Mn), iron (Fe), and zinc (Zn) were present in higher amounts in (GDSP) and (GDSP) compared with (WF). It was found that K, Ca, P, Na, Mg, Mn, Fe, and Zn in DSP were recorded as (370, 450, 410, 18, 66.5, 1.8, 3.3, and 1.2 mg/100 g), respectively, while the minerals in GDSP were (510, 920, 650, 29, 92.04, 2.8, 5.01, and 2.58 mg/100 g), respectively. Compared to the WF sample, which recorded the lowest metal content. Also, results of mineral analysis in the same table showed that Ca was the most abundant mineral element in both seeds, followed by P and K, and K, which had the next highest concentration. These results are consistent with (Ali and Khamis 2004).

Table 5. Minerals content of raw materials

Minerals	Wheat flour (72ext.)	Date seeds powder (DSP)	Germinated date seeds powder (GDSP)
K	129.09^{c} ± 0.23	370^{b} ± 0.02	510^{a} ± 0.50
Ca	29.55^{c} ± 0.12	450^{b} ± 0.33	920^{a} ± 0.55
P	12.70^{c} ± 0.22	410^{b} ± 0.25	650^{a} ± 0.41
Na	4.20^{c} ± 0.01	18^{b} ± 0.22	29.0^{a} ± 0.11
Mg	60.00^{c} ± 0.61	66.5^{b} ± 0.42	92.04^{a} ± 0.04
Mn	1.32^{c}± 0.02	1.8^{b}± 0.03	2.8$^{0\ a}$ ± 0.11
Fe	1.30^{c} ± 0..01	3.30^{b}±0.12	5.01^{a} ± 0.03
Zn	1.14^{b} ± 0.02	1.20^{b} ± 0.1	2.58^{a} ± 0.14

C=100 % wheat flour (WF)
T1=90 % wheat flour (WF) + 10 % Date seeds powder (DSP)
T2= 80 % wheat flour (WF) + 20 % Date seeds powder (DSP)
T3= 70 % wheat flour (WF) + 30 % Date seeds powder (DSP)
T4 = 90% wheat flour (WF) + 10 % Germinated date seeds powder (GDSP)
T5= 80% wheat flour (WF) + 20 % Germinated date seeds powder (GDSP)
T6= 70% wheat flour (WF) + 30 % Germinated date seeds powder (GDSP)

Chemical composition of substituted biscuits

The chemical composition of the substituted and control biscuits is shown in Table 6. When compared to date seed and germinated date seed substitution biscuits, the control group exhibits the lowest levels of fat, ash, and fiber. The protein content increased when date seeds were substituted with germinated ones, going from 9.95% for the control group to 10.86, 11.20, and 11.82% for groups of 10, 20, and 30%. According to research by (Jahan et al., 2023), adding date seed powder to breads decreased the amount of protein while increasing ash, fat, and dietary fiber. The findings, which are less than those of (Esrafil et al., 2024), show that biscuits containing 15% date seed powder have about the following compositions: 1.18% ash, 16.71% protein, 6.38% fat, 5.51% crude fiber, and 74.19% total carbohydrates. Concerning fat, when comparing the fat content of the fortified biscuits to the control samples, there was a significant increase. The fat content rose linearly for substations including 10, 20, and 30% of date seeds, from 13.2% for the control to 14.69, 15.90, and 16.85%. However, when 10, 20, and 30% substitution were used, the fat content of the germinated date seeds increased more, reaching 14.95, 16.38, and 17.07% respectively. The results are consistent with (Platat et al., 2015). Table 6. shows the variances in ash content between biscuits. The ash level of the strengthened biscuits was significantly higher than that of the control samples. For date seeds numbered 10, 20, and 30%, the ash content rose from 0.3% for the control group to 0.58, 0.63, and 0.74. The ash content increased with the germination of date seeds, going from 0.3% for the control group to 0.70, 11.21, and 1.1% for substitutions of 10, 20, and 30%. The presence of date seed and powdered dates in the composite cookies could be the cause of this rise. The ash content of the composite samples differs significantly from the control sample due to the date seed powder's high ash content, particularly in the case of germinated date seeds. Elevated ash content is a sign of elevated mineral content. Mineral content has been discovered to be high in date seeds (Nehdi et al., 2010) and enhanced mineral content was noted in the combined baked goods. Since ash and minerals are contained in composite cookies, adding more date seed powder could raise their content. Different varieties of dates have different chemical compositions, which can be related to post-harvest treatments, fertilizer use, and harvest timing. (Ibrahim and Habib 2009). It is therefore expected to find variations in the varieties' results. As a result, DSP can be added to bakery goods to increase their nutritional content.

Table 6. Chemical composition of substituted biscuits

Treatment	Protein (%)	Fat (%)	Ash (%)	Fiber (%)	Total carbohydrates (%)	Energy (Kcal)
Con.	9.95^{c} ±0.02	13.20^{e} ±0.05	0.30^{g} ±0.001	0.56^{f} ±0.21	75.99^{a} ±0.18	462.56^{c} ±0.50
T1	8.75^{d} ±0.55	14.69^{d} ±0.22	0.58^{f} ±0.005	2.26^{c} ±0.21	73.72^{b} ±0.25	462.09^{c} ±0.30
T2	7.50^{e} ±0.03	15.90^{c} ±0.07	0.63^{e} ±0.003	3.83^{b} ±0.35	72.14^{c} ±0.02	461.66^{c} ±0.90
T3	6.82^{f} ±0.21	16.85^{a} ±0.03	0.74^{c} ±0.013	5.39^{a} ±0.01	70.20^{e} ±0.05	459.73^{d} ±0.20
T4	10.86^{b} ±0.41	14.95^{d} ±0.33	0.70^{d} ±0.002	1.72^{e} ±0.02	71.77^{d} ±0.23	465.07^{b} ±0.53
T5	11.20^{b}±0.32	16.38^{b} ±0.21	0.90^{b} ±0.005	2.74^{c} ±0.05	68.78^{f} ±0.15	467.34^{a}±0.11
T6	11.82^{a} ±0.01	17.07^{a} ±0.02	1.10^{a} ±0.05	3.76^{b} ±0.44	66.25^{g} ±0.08	465.91^{b} ±0.07

C =100 % wheat flour (WF)
T1=90 % wheat flour (WF) + 10 % Date seeds powder (DSP)
T2= 80 % wheat flour (WF) + 20 % Date seeds powder (DSP)
T3= 70 % wheat flour (WF) + 30 % Date seeds powder (DSP)
T4= 90% wheat flour (WF) + 10 % Germinated date seeds powder (GDSP)
T5= 80% wheat flour (WF) + 20 % Germinated date seeds powder (GDSP)
T6= 70% wheat flour (WF) + 30 % Germinated date seeds powder (GDSP).

Sensory evaluation of biscuits

Sensory evaluation is very important in determining consumer preferences. The results in Table 7. indicate that the sensory properties of biscuits produced from wheat flour substituted with date seed powder (DSP) and germinated date seed powder (GDSP) were acceptable compared to the control made from wheat flour (72 ext.). The addition of cocoa had no significant differences in color (Yaseen et al., 2012). On the contrary, in the rest of the sensory characteristics, where significant differences were found between them, it was seen that adding date seeds generally gave a good smell, taste, and crispy texture to the biscuits. It was also clear from the sensory evaluation that the samples replaced with germinated date seeds from (T4 to T6) had an advantage over the samples replaced with ungerminated date seeds from (T1–T3).

Table 7. Sensory evaluation of biscuits

Treatments	Color (9)	Odor (9)	Taste (9)	Crispy(9)	Overall acceptability (9)
C	9.00^{a}±0.05	8.00^{b}±0.10	7.8^{b}±0.50	7.70^{b}± 0.80	7.00^{b}± 0.20
T1	8.80^{a}±0.03	8.50^{a}± 0.70	8.60^{a}±0.70	8.55^{a}± 0.20	8.60^{a}± 0.10
T2	8.95^{a}±0.11	8.70^{a}± 0.80	8.50^{a}±0.90	8.80^{a}±0.70	8.70^{a}± 0.30
T3	8.50^{a}±0.04	8.88^{a} ±0.10	8.50^{a}± 0.60	8.00^{a}±0.40	8.9^{a}± 0.50
T4	8.76 ^{a}±0.55	8.60^{a}± 0.20	8.60^{a}± 0.50	8.50^{a}± 0.50	8.50^{a}±0.60
T5	8.90^{a}±0.23	8.75^{a}±0.30	8.68^{a}± 0.80	8.60^{a}±0.60	8.70^{a}±0.50
T6	8.94^{a}±0.01	8.95^{a}±0.50	8.80^{a}± 0.60	8.91^{a}±0.90	8.95^{a}±0.10

C=100 % wheat flour (WF)
T1=90 % wheat flour (WF) + 10 % Date seeds powder (DSP)
T2= 80 % wheat flour (WF) + 20 % Date seeds powder (DSP)
T3= 70 % wheat flour (WF) + 30 % Date seeds powder (DSP)
T4 = 90% wheat flour (WF) + 10 % Germinated date seeds powder (GDSP)
T5= 80% wheat flour (WF) + 20 % Germinated date seeds powder (GDSP)
T6= 70% wheat flour (WF) + 30 % Germinated date seeds powder (GDSP)

Mineral content of substituted biscuits

Table 8. illustrates the mineral content of the biscuits including both germinated and substitute date seeds. The findings demonstrated that the mineral content rose for both biscuit replacements with varying addition rates (10, 20, and 30%). The biscuits that had date seeds planted in place of the biscuits showed a significant increase. This could, however, be the result of germination, which has also been shown to enhance the concentration of minerals.

Table 8 shows the ratios of sodium to potassium (Na/K) and calcium to phosphorus (Ca/P). The recommended Na/K ratio is less than one. Since each biscuit had a Na/K ratio of less than one, replacing them all would probably reduce the occurrence of elevated blood pressure. Together, calcium and phosphorus are always present in the body, supporting the body's structural integrity and aiding in the production of blood (Ogunlade et al., 2005). If the Ca/P ratio (low calcium, high phosphorus consumption) is low, more calcium than usual may be lost in the urine, reducing the calcium concentration in the bones. As per (Nieman et al., 1992), food is classified as "good" if the ratio exceeds one and as "poor" if it is less than 0.5. Ca/P ratios for wheat flour (72 ext.) in the current study were 2.33; however, for DSP and GDSP, they were 1.10 and 1.42, respectively, indicating that these would be great sources of minerals for proper bone development.

Table 8. Minerals content of substituted biscuits

Minerals	C	T1	T2	T3	T4	T5	T6
K	$120.01^{g} \pm 0.31$	$153.18^{f} \pm 0.05$	$179.50^{d}\pm0.02$	$201.36^{c}\pm0.11$	$167.18^{e}\pm 0.22$	$208.27^{b} \pm 0.02$	$246.39^{a}\pm0.21$
Ca	$32.50^{g}\pm 0.03$	$75.60^{f} \pm 0.42$	$113.69^{e}\pm0.50$	$155.69^{C}\pm0.25$	$118.6^{d}\pm 0.15$	$225.64^{b} \pm 0.32$	$296.61^{a}\pm0.20$
P	$15.11^{g}\pm0.1\ 0$	$52.43^{f}\pm 0.50$	$99.16^{d}\pm0.13$	$133.89^{c}\pm0.25$	$76.43^{e}\pm 0.04$	$139.16^{b}\pm 0.11$	$210.89^{a}\pm0.53$
Na	$3.90^{f}\pm 0.02$	$5.58^{e}\pm 0.11$	$6.99^{d}\pm0.11$	$8.34^{c}\pm0.15$	$7.20^{d} \pm 0.35$	$9.00^{b}\pm0.22$	$11.64^{a}\pm0.05$
Mg	$52.01^{g}\pm 0.22$	$60.65^{f}\pm 0.03$	$61.3^{e}\pm 0.34$	$61.95^{d}\pm0.25$	$63.20^{c}\pm 0.11$	$66.41^{b}\pm0.55$	$69.61^{a}\pm0.11$
Mn	$1.20^{d}\pm 0.13$	$1.37^{c}\pm0.05$	$1.42^{c}\pm0.60$	$1.46^{b}\pm0.05$	$1.47^{b}\pm0.31$	$1.46^{b}\pm0.05$	$2.44^{a}\pm0.15$
Fe	$0.70^{c}\pm.0.11$	$1.50^{b}\pm0.03$	$1.70^{b}\pm.90$	$2.12^{ab}\pm0.51$	$1.68^{b}\pm0.23$	$2.04^{a}\pm0.71$	$2.91^{a}\pm0.45$
Zn	$0.80^{d}\pm0.53$	$1.15^{c}\pm0.52$	$1.16^{c}\pm0.\ 50$	$1.25^{b}\pm0.42$	$1.28^{b}\pm0.30$	$1.40^{a}\pm.03$	$1.60^{a}\pm.01$
Na/K	$0.03^{a}\pm0.01$	$0.04^{a}\pm0.03$	$0.04^{a}\pm0.02$	$0.04^{a}\pm0.01$	$0.04^{a}\pm0.01$	$0.04^{a}\pm0.01$	$0.04^{a}\pm0.03$
Ca/P	$2.32^{a}\pm0.22$	$1.44^{ab}\pm0.53$	$1.15^{b}\pm0.7$	$1.16^{b}\pm0.32$	$1.55^{ab}\pm.04$	$1.84^{ab}\pm.15$	$1.41^{ab}\pm.25$

C=100 % wheat flour (WF)
T1=90 % wheat flour (WF) + 10 % Date seeds powder (DSP)
T2= 80 % wheat flour (WF)+ 20 % Date seeds powder (DSP)
T3= 70 % wheat flour (WF)+ 30 % Date seeds powder (DSP)
T4 = 90% wheat flour (WF)+ 10 % Germinated date seeds powder (GDSP)
T5= 80% wheat flour (WF) + 20 % Germinated date seeds powder (GDSP)
T6= 70% wheat flour (WF) + 30 % Germinated date seeds powder (GDSP).

Physical properties of substituted biscuits

Physical Properties: Table 9. presents the findings of the physical analysis of the date seed powder (DSP) and germinated date seed powder (GDSP) substituted wheat flour biscuits. The results indicate that the levels of DSP and GDSP have a notable impact on the substituted biscuits' width, thickness, and spread ratio. The outcome matched those of (Jurasova and Kukurova 2011). As the ratio of substitution of date seed powder (DSP) and germinated date seed powder (GDSP) increases, the biscuit's width reduces from 5.8 to 4.5 and from 5.8 to 4.8. Results indicate that T4 (5.4), T1 (5.2), T5 (5.00), T6 (4.8), T2 (4.70), and T3 (4.5) have the highest widths, with the control having the widest at 5.8 cm. T3 (4.5) observed the lowest width. With increasing substitution levels, however, biscuit thickness rises from 0.72 to 0.99. The biscuit with the highest thickness is T3 (0.99 cm), followed by T2 (0.82 cm), T6 (0.80 cm), T5 (0.79 cm), T1 (0.75 cm), and T4 (0.73 cm). The control group has the thinnest biscuits (0.72 cm). Similarly, the spread ratio decreases (10–20–30%) as the levels of dietary soluble fiber (DSP) and guar gum dietary soluble fiber (GDSP) increase. This is likely due to the high fiber content in both DSP and GDSP. As expected, the data confirms that increasing the replacement ratios leads to higher weight, volume, and specific volume. The increased weight might be caused by the higher water holding capacity of fiber.

Table 9. Physical properties of biscuits

Samples	Width, W	Thickness, T	Spread ratio W/T	Weight (g)	Volume (cm^3)	specific volume (cm^3/g)
C	5.80 ^{a} ± 0.03	0.72^{a} ± 0.25	8.06 ^{a} ± 0.35	11.90^{c}±0.20	20.00^{e} ± 0.23	1.68^{a} ± 0.28
T1	5.20 ^{bc} ± 0.24	0.75^{a} ± 0.03	6.93^{ab} ± 0.52	12.40 ^{bc}±0.33	21.00^{d} ±0.24	1.69^{a} ± 0.33
T2	4.70 ^{de}± 0.15	0.82^{a} ± 0.16	6.27 ^{bc} ± 0.21	13.50^{a}±0.88	23.00 ^{c}± 0.89	1.70^{a} ± 0.14
T3	4.50 ^{e} ± 0.25	0.99^{a} ± 0.04	5.49^{c} ± 0.05	14.00^{a}±0.50	24.00 ^{c} ±0.61	1.71^{a} ± 0.59
T4	5.40 ^{b} ± 0.01	0.73^{a} ± 0.22	7.40^{ab} ± 0.90	12.00^{c}±0.21	24.00^{c} ± 0.32	2.00^{a} ± 0.11
T5	5.00^{cd} ± 0.22	0.79^{a} ± 0.33	6.33^{bc} ± 0.81	13.00^{ab}± 0.25	26.00^{b} ±0.25	2.00^{a}± 0.23
T6	4.80^{de}± 0.02	0.80^{a} ± 0.26	6.08^{bc} ± 0.23	14.00^{a}±0.22	27.00 ^{a} ±0.50	1.93^{a}± 0.16

C=100 % wheat flour (WF)
T1=90 % wheat flour (WF) + 10 % Date seeds powder (DSP)
T2= 80 % wheat flour (WF) + 20 % Date seeds powder (DSP)
T3= 70 % wheat flour (WF) + 30 % Date seeds powder (DSP)
T4 = 90% wheat flour (WF) + 10 % Germinated date seeds powder (GDSP)
T5= 80% wheat flour (WF) + 20 % Germinated date seeds powder (GDSP)
T6= 70% wheat flour (WF) + 30 % Germinated date seeds powder (GDSP).

Hardness and fracturability of biscuits

Hardness refers to the force required to compress the material by a given amount. Table 10. shows that with increasing replacement ratios, the hardness increases, as it was found that the maximum hardness was in the treatments (T1:T3) (42.00 to 57.78 N), followed by the samples (T4:T6) (38.35 to 45.65 N). This may be due to the high amount of fiber in DSF and GDSF, and the minimum hardness was for the control sample (30.00), and Table 1. showed that the level of date seed powder (DSP) and germinated date seed powder (GDSP) had a positive effect on the hardness of biscuits. As the storage period increased, the hardness increased due to the decrease in moisture content. Fracturability refers to the ease with which the material will break. The fracturability of the high-fiber and high-protein biscuit ranged between 40.56 N and 61.70 N (Table 1). The minimum fracturability was obtained for control (33.44 N), whereas the maximum was obtained for T3. (Table 10) showed that the levels of date seed powder (DSP) and germinated date seed powder (GDSF) had a positive effect on the fracturability of biscuits, with the effect of DSP being most pronounced. It was observed that as the level of substitution increased, the fracturability increased. These results are in conformity with the findings of (Singh et al., 2015) and (Banerjee et al., 2014), who've shown that hardness and fracturability increase with added fiber.

Table 10. Hardness and fracturability of biscuit

Characteristics	Hardness (N)			Factorability (N)		
Storage time	Zero	1mon	3mon	zero	1mon	3mon
C	30.00 ^{e}±0.50	33.20 ^{e}±0.80	43.30 ^{g}±0.30	33.44 ^{g}±0.30	36.64 ^{g}±0.50	42.36 ^{f}±0.30
T1	42.00 ^{c}±0.70	49.61 ^{c}±0.60	57.50 ^{c}±0.50	50.20 ^{c}±0.10	53.13 ^{c}±0.20	58.23 ^{c}±0.90
T2	53.50 ^{b}±0.20	56.19 ^{b}±0.10	62.57 ^{b}±0.70	56.10 ^{b}±0.20	58.02 ^{b}±0.30	62.82 ^{b}±0.80
T3	57.78 ^{a}±0.40	62.99 ^{a}±0.30	67.89 ^{a}±0.90	61.70 ^{a}±0.90	63.50 ^{a}±0.10	69.80 ^{a}±0.70
T4	38.35 ^{f}±0.30	42.52 ^{d}±0.20	48.02 ^{f}±0.80	40.56 ^{f}±0.30	43.20 ^{f}±0.70	50.10 ^{e}±0.50
T5	42.85 ^{d}±0.50	47.11 ^{c}±0.30	53.60 ^{e}±0.30	44.00 ^{e}±0.50	48.70 ^{e}±0..9	54.70 ^{d}±0.30
T6	45.65 ^{c}±0.10	50.20 ^{c}±0.70	55.98 ^{d}±0.20	47.05 ^{d}±0.40	50.10 ^{d}±0.70	58.30 ^{c}±0.10

C=100 % wheat flour (WF)
T1=90 % wheat flour (WF) + 10 % Date seeds powder (DSP)
T2= 80 % wheat flour (WF) + 20 % Date seeds powder (DSP)
T3= 70 % wheat flour (WF) + 30 % Date seeds powder (DSP)
T4 = 90% wheat flour (WF) + 10 % Germinated date seeds powder (GDSP)
T5= 80% wheat flour (WF) + 20 % Germinated date seeds powder (GDSP)
T6= 70% wheat flour (WF) + 30 % Germinated date seeds powder (GDSP).

4. Conclusion

Through the production of innovative functional bakery products that satisfy industry standards and consumer expectations, this search will help concentrate future research in the area of date by-product value-adding. This will benefit the relevant industry by producing revenue and significantly reducing environmental impact. Like burden that this trash and its by products cause. According to this study, date seeds and germinated date seeds can be a great source of dietary fiber, protein, and minerals, all of which are found in significant amounts in the seeds. Is a fantastic source of ingredients for functional foods

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