



Impact of Date Seed Powder as A Natural Antioxidant for Improving Oxidative Stability of Beef and Chicken Burgers

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Abstract

The main objective of this study is to explore the potential use of date seed powder in improving the oxidative stability of some meat products; beef and chicken burgers. The phytochemical analysis of date seed powder revealed its significant antioxidant potential, including high DPPH scavenging activity (81.38%), low IC₅₀ value (0.59 mg/mL), and substantial levels of phenolics (2.53 mg/g), flavonoids (1.37 mg/g), saponins (287 mg/100g), and anthocyanins (238 mg/100g). These properties, attributed to phenolics content, position date seed powder as a valuable source of natural antioxidants. When assessing the impact of date seed powder (DSP) supplementation on the oxidative stability of beef and chicken burgers, distinct outcomes were observed. Beef burgers with 1 to 10% DSP exhibited consistently lower peroxide values, indicating improved oxidative stability. On the contrary, chicken burgers showed varied peroxide values across all DSP concentrations (1, 3, 5, 7, and 10%). The Thiobarbituric Acid (TBA) values of beef and chicken burgers with varying DSP concentrations also displayed divergent trends. Specifically, the 3 and 10% DSP beef burger samples showed potential for maintaining or enhancing oxidative stability. Conversely, the influence of DSP addition on chicken burgers' oxidative stability varied across different concentrations. In this context, the findings suggest that DSP has the potential to improve the oxidative stability of beef burgers, while its impact on chicken burgers remains inconclusive.

Keywords: Thiobarbituric acid, Cold storage, Antioxidant, Burger

Introduction

The quest for natural, sustainable, and effective food additives has led to a surge in research focusing on non-traditional sources in recent years. Plant sources used to improve meat product shelf life include grape fibers (Sáyago-Ayerdi, *et al.*, 2009), cereal grains (Ramadan *et al.*, 2013; 2016), kiwi fruit peel powder (El-Nassag and Refaat, 2017), and date seed (Amany *et al.*, 2012; Sayas-Barberá *et*

al., 2020). Date seed powder, derived from date fruits, has garnered attention for its potential ability to enhance the oxidative stability of meat products (Al-Juhaimi *et al.*, 2012). Date seeds have shown potential antioxidative properties, which can prolong the shelf life of various food products (Al-Juhaimi *et al.*, 2012). The oxidative stability of meat products is crucial for their quality, safety, and consumer acceptability (Lin *et al.*, 2011). Oxidative processes are known to cause deterioration in meat products, resulting in off-flavors, discoloration, and an overall reduction in product quality (Lin *et al.*, 2011). Date seed powder has emerged as a potential natural solution due to its rich composition of bioactive compounds, including phenolic compounds, flavonoids, and antioxidants, which have demonstrated significant antioxidative and antimicrobial effects in various food systems (Sayas-Barberá *et al.*, 2020; Kelany and Yemiş 2023).

Many studies have shown that date seed powder exhibits promising potential in enhancing the oxidative stability of meat products. Studies have highlighted its ability to mitigate lipid oxidation, a key process contributing to the deterioration of meat quality (Baliga *et al.*, 2011). This natural additive has been found to scavenge free radicals and inhibit the formation of reactive oxygen species, thereby retarding the oxidative degradation of lipids in meat matrices. Furthermore, the incorporation of date seed powder has shown positive effects on the color, texture, and overall sensory attributes of meat products, indicating its multifaceted impact on product quality (Sirisena *et al.*, 2015).

The acceptability of date seed powder as an additive for meat products encompasses various aspects, including technological, nutritional, and sensory considerations. From a technological perspective, the compatibility of date seed powder with meat matrices, its impact on product processing, and its influence on the physical and chemical properties of meat formulations are critical factors to be evaluated. Additionally, the nutritional attributes of date seed powder, such as its fiber content, mineral composition, and potential health-promoting properties, contribute to its overall acceptability in meat products from a consumer health and wellness standpoint (Ghnimi *et al.*, 2017).

Sensory attributes, including taste, aroma, and overall consumer preference, play a pivotal role in determining the acceptability of meat products enriched with date seed powder. It is imperative to assess the sensory impact of date seed powder addition on meat products to ensure that the organoleptic properties meet consumer expectations and preferences (Ramadan *et al.*, 2013; 2016). Additionally, considerations regarding the economical and sustainable utilization of date seed powder within the meat industry are integral to its acceptability, reflecting the broader implications of its adoption in commercial meat product formulations (Sayas-Barberá *et al.*, 2020).

The focus of this research was to investigate the use of date seed powder (DSP) as a natural antioxidant additive to enhance the oxidative stability of beef and chicken burgers. Specifically, DSP was added in varying proportions (1, 3, 5, 7, and 10%) to the beef and chicken burger formulations. Subsequently, the burgers

were stored at 5°C for varying durations (3, 6, 9, 12, and 15 days) to evaluate their oxidative stability compared to untreated burgers. Additionally, the overall acceptability of the burgers was also assessed as part of the study.

Materials and Methods

Materials

The date seed (*Phoenix dactylifera* L.) from Saily variety, which is one of the most widely grown commercial date varieties in Egypt, were used. All reagents and chemicals were obtained from Merck (Darmstadt, Germany) and Sigma (Steinheim, Germany) in analytical grade. Distilled water used in all experiments was obtained from a water purification system (Elga, Purelab DV25, UK).

Date seed powder (DSP) preparation

Date fruit seeds (*Phoenix dactylifera* L.) were obtained at Tamar stage (complete maturity) of the commercially available date palm 'Saily' variety which grown in New Valley governorate, Egypt. The seeds were soaked in water (2 hr at 25°C), washed to remove any remaining date flesh, and then air dried for 48h. Date seeds were milled using a heavy-duty grinder or a hammer mill to pass 1-2 mm screens and then preserved at -4°C until analysis. The powder obtained was identified as date seed powder (DSP).

Preparation of beef and chicken burgers

The fresh beef and chicken burger samples were prepared following the method outlined by Ramadan *et al.* (2013). The ingredients were minced twice and then manually shaped into round discs of 10 cm diameter and 0.5 cm thickness using a patty marker (stainless steel model "Form"), with an average weight of 50 g. These burgers were then packaged in polyethylene bags within foam dishes and stored in a cooling environment at 5±2°C for a period of up to 15 days. The studied burger formulas were divided into six parts. The first formula served as the control and contained bread crust powder, while the other five formulas individually replaced the bread crust powder with 1, 3, 5, 7, and 10% DSP.

Methods

The total phenolic content determination

Folin-Ciocalteu method was used to determine the total phenolic content of date seed powder. Diluted date seed methanol extract aliquots were mixed with Folin-Ciocalteu and Na₂CO₃ solutions and then stored in the dark at room temperature for 2 hours. Following incubation, the absorbance was measured at 760 nm against a blank as a reference. Total phenolic content was calculated using a calibration curve of gallic acid, the results expressed as mg gallic acid equivalents (GAE)/g (Sengul *et al.*, 2009).

The total flavonoids content determination

The total flavonoids content of date seed powder was assessed using a colorimetric assay outlined by Zhishen *et al.* (1999). The diluted date seed methanol extract was mixed with sodium nitrite, aluminum chloride, and sodium hydroxide. The resulting absorbance at 510 nm was compared to a blank using

catechin as a standard for quantification. The flavonoids content was expressed as mg catechin equivalents per gram sample (mg/g).

DPPH radical scavenging activity

The process involved re-dissolving 0.2 g of each dried extract in 10 mL of methanol, followed by mixing 2 mL of a DPPH solution (0.025 g in 1000 mL methanol) with 100 μ L of the sample extract/methanol solution and transferring the mixture to a cuvette. After a 30-minute incubation at room temperature, the reaction solution was measured using a spectrophotometer at 517 nm (Ramadan, *et al.*, 2012).

Total antioxidant capacity (TAC) assay

The total antioxidant capacity of date seed powder (DSP) was assessed (Prior *et al.*, 2005). A 0.5 ml aliquot of DSP methanol extract (0.02g/ml) was mixed with a 4.5 ml reagent solution and incubated in a boiling water bath. The absorbance of each sample was then measured at 695 nm against a blank using a UV-2450 spectrophotometer.

Total anthocyanin content assay

The method described by Giusti and Wrolstad (2001) was used to determine the anthocyanin content in DSP. This involved dissolving 1g of DSP in 10ml acidic methanol, centrifuging, and quantifying anthocyanin by measuring the absorbance difference at 525 nm and 585 nm (A₅₂₅) per gram of sample.

Saponin content assay

The saponin content in date seed powder (DSP) was assessed by Hiai *et al.* (1976) method. 0.1g of DSP was extracted three times using 95% ethanol. The clear supernatants were combined to a volume of 10 ml, then 0.5 ml of the ethanol extract was mixed with 0.5 ml of 8% vanillin in ethanol. Subsequently, 5 ml of 72% sulfuric acid was added, and the mixture was heated in a water bath at 60°C for 10 min, followed by cooling in an ice-cold water bath. The absorbance was measured at 544 nm.

Peroxide value determination (PV)

Peroxide values (PV) were monitored in burger samples with added plant extracts and reference antioxidant BHT. A blank sample was run without any additives. Most extracts were hydrophilic and their homogenization in the meat was rather easy. The samples (10 g) were placed in open beakers (250 ml volume) and kept in a ventilated thermostat. PV measurements were performed, and values determined according to, AOAC, (2000). Burger samples (approximately 1 g) were taken from the beakers, accurately weighed and dissolved in 25 ml of a chloroform/acetic acid mixture (3:2). Then 0.5 ml of saturated potassium iodide solution in distilled water was added, the samples were shaken for 1 min and 25 ml of distilled water was added. The liberated iodine was titrated with 0.01 M sodium thiosulphate solution using a 1 % starch solution as indicator. Peroxide values (M. EQUIV. /KG FAT) were calculated using the formula:

$$PV = 0.01 \times N \times 1000 / m,$$

where N is the volume of sodium thiosulphate used for the titration of a sample in ml and m is the mass of meat sample in g.

Thiobarbituric acid values (TBA)

The TBA values in burger samples were measured following Lemon's (1975) method to assess the effectiveness of natural antioxidants. Absorbance was recorded at 538nm using an ultraviolet-visible scanner spectrophotometer (LKB 4054, Cambridge, England). TBA values were calculated by multiplying the absorbance by 7.8 and expressed as mg of malondialdehyde per kg sample.

Statistical analysis

Measurements (in triplicate) were conducted within the period of 15 days. Data were statistically analyzed by analysis of variance (ANOVA) using the statistical package MSTATC program, and least significant differences (L.S.D) at $P \leq 0.05$.

Results and Discussions

Phytochemical characteristics of date seeds

Data in Table (1) illustrated the phytochemical characteristics of date seed powder which reveal significant antioxidant potential due to the high content of total phenolics (2.53 mg/g) and flavonoids (1.37 mg/g) contributes to its antioxidative properties. The DPPH scavenging activity of 81.38%, and a low IC₅₀ value of 0.59 mg/mL, indicating strong antioxidant capacity. Furthermore, the presence of saponins (287 mg/100g) and anthocyanins (238 mg/100g) further enhances its potential health benefits. Date seeds are abundant in phenolic compounds and are often an underutilized industrial by-product (Sirisena *et al.*, 2015). Sady date seed variety exhibits a high content of phenolic compounds (2.40±0.23 mg/g), consistent with findings of Mistrello *et al.* (2014), which indicated a total phenolic content ranged of 2.58-2.83 mg GAE/100 g fresh weight. Similarly, Hamada *et al.* (2002); Habib and Ibrahim (2011); Bouhlali *et al.* (2015) have also reported a high presence of phenols in date seeds. Al Juhaimi *et al.* (2012) found the total phenolic content of date seed powder to be within the range of 1.98 - 4.65 mg GAE/100 g DW, suggesting potential varietal and growing condition influences on phenolic content.

Regarding the total flavonoid content, various studies have indicated the rich source of flavonoids in date seeds. For instance, Bouhlali *et al.* (2015) revealed a total flavonoid content of 1.659-1.844 mg RE/100 g DW in date seeds, while Mistrello *et al.* (2014) reported a range of 1.27-1.93 mg CE/100 g FW. Additionally, Maqsood *et al.* (2015) observed a lower flavonoid content in water date seed extract.

Studies have also proposed that the phenolic compounds in date seeds vary depending on factors such as variety, growing conditions, geographic origin, cultivar, maturity, soil type, season, fertilizers, sampling, extraction conditions, and storage conditions. Yada (2004) reported the presence of phenolic compounds and carotenoids responsible for the dark colors and astringent taste of some fruits in date seeds. Furthermore, Sundar *et al.* (2017) highlighted the abundance of

tannins, saponins, phenols, alkaloids, and sterols in date seeds. These findings underline the potential variability in phenolic and flavonoid content based on a range of factors. The antioxidant activity of date seeds extract has been linked to the content of phenolic compounds, as evidenced by a DPPH scavenging activity of 78.77 ± 0.24 and an IC_{50} of 0.64 ± 0.04 mg/ml in the present study. Notably, Al-Farsi and Lee (2008) reported that date seed extract exhibits high antioxidant activity approximately 27 times that of date fruit, further emphasizing the potential of date seeds as a source of antioxidants due to their phenolic compounds content.

Table 1. Phytochemical analysis of Saidy date seeds (DSP)

Phytochemical characteristics	Date Seeds Powder*
DPPH scavenging activity (%)	81.38 ± 0.34
IC_{50} of DPPH (mg/mL)	0.59 ± 0.15
Total phenolics (mg/g)	2.53 ± 0.17
Total flavonoids (mg/g)	1.37 ± 0.23
Total antioxidant activity (TAC) (mg/100g)	2.41 ± 0.13
Saponin (mg/100g)	287 ± 0.91
Anthocyanin (mg/100g)	238 ± 0.21

*Data for means for three replicates of each sample.

Effect of DSP addition on Thiobarbituric values (TBA) of beef burger during cold storage

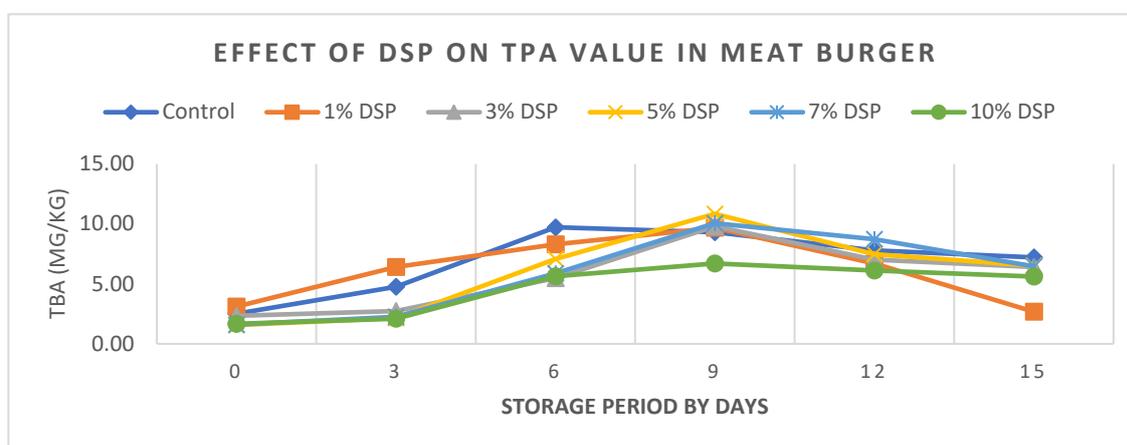
The TBA values are commonly utilized to gauge lipid oxidation, reflecting the development of rancidity or undesirable flavors in food products (Salejda *et al.*, 2018). The data in table (2) and figure (1) present the thiobarbituric acid (TBA) values, of beef burgers with different date seed powder (DSP) levels up to 15-day cold storage period. Data revealed that the TBA values (mg malondialdehyde/kg) of the control group (0% DSP), increased from 2.51 at zero time to 9.72 on day 6, followed by a gradual decrease over the remaining storage period. The 1% DSP group shows an increasing TBA value, (9.67 mg/kg) on day 9, and sharply decreasing to 2.68 on day 15. The 3% DSP group exhibits stable TBA values throughout the storage period, with a slight increase observed on day 9. Burgers samples contained 5% DSP display fluctuating TBA values, reaching up to 10.84 mg/kg on day 9. Similarly, the 7% DSP group shows varied values (10.05 mg/kg) on day 9 and subsequent fluctuations. The 10% DSP group demonstrates a steady decline in TBA values over the storage period, reaching 5.60 (mg/kg) on day 15.

These results indicate that the inclusion of DSP influences the oxidative stability of beef burgers. The 1% DSP shows a distinct peak in TBA values on day 9, while the 5% and 7% DSP exhibit peaks on the same day with subsequent fluctuations. In contrast, the 3% DSP group maintains relatively stable TBA values, suggesting potential oxidative stability. Moreover, the 10% DSP group displays a steady decline in TBA values, implying enhanced oxidative stability as the storage duration progresses as the results of Essa and Elsebaie (2022). Therefore, the incorporation of DSP significantly impacts the oxidative stability of the beef burgers, with distinct effects dependent on the concentration of DSP as indicated by Abdel-Maksoud *et al.* (2022) and Sayas-Barberá *et al.* (2020).

Table 2. Effect of different addition levels of DSP on TBA value (mg/kg) in beef burger during cold storage.

DSP level %	TBA (mg malondialdehyde /kg)						LSD
	Storage period (Day)						
	Fresh (0)	3	6	9	12	15	
0 (Control)	2.51±0.03 _c	4.75±0.09 _d	9.72±0.07 _a	9.30±0.17 ^a	7.79±0.02 _b	7.20±0.27 _c	0.435 5
1	3.10±0.11 _d	6.40±0.12 _b	8.29±0.05 _b	9.67±0.02 ^a	6.71±0.27 _c	2.68±0.09 _d	0.753 9
3	2.33±0.09 _f	2.73±0.13 _e	5.48±0.09 _d	9.80±0.21 ^a	7.01±0.14 _b	6.41±0.3 ^c	0.314 5
5	1.56±0.02 _c	2.15±0.11 _c	7.08±0.13 _b	10.84±0.09 _a	7.46±0.02 _b	6.51±0.01 _b	2.424 9
7	1.60±0.04 _f	2.25±0.01 _e	5.86±0.02 _d	10.05±0.22 _b	8.73±0.07 _a	6.45±0.02 _c	0.317 7
10	1.67±0.08 _e	2.09±0.02 _d	5.63±0.08 _c	6.70±0.17 ^a	6.12±0.11 _b	5.60±0.12 _c	0.182 7

*Data for means for three replicates of each sample, DSP date seed powder, TBA Thiobarbituric acid values, Different

**Figure 1. Effect of DSP addition on TBA value (mg/kg) in beef burger during cold storage up to 15 days**

Effect of DSP addition on Thiobarbituric values (TBA) of chicken burger during cold storage

The data in table (3) and figure (2) provides valuable insights into how the addition of date seedspowder (DSP) impacts the Thiobarbituric Acid (TBA) value, which serves as an indicator of oxidative stability in chicken burgers over a 0 to 15-day storage period. In the control group (0% DSP), the TBA value starts at 1.28 mg/kg on day 0 and steadily rises to 6.88 (mg/kg) on day 15, indicating a notable increase over the storage period. Conversely, the 1% DSP group displays varied TBA values throughout the storage period, reaching 4.48 mg/kg at the end of storage, demonstrating a fluctuating pattern in oxidative stability. The 3% DSP group maintains relatively stable TBA values with minor fluctuations, indicating moderate oxidative stability. On the other hand, the 5% DSP group exhibits varied TBA values (8.19 mg/kg in day 15), indicating a substantial increase in oxidative stability by the end of the storage period. Similarly, the 7% DSP group shows fluctuating TBA value (7.42 mg/kg in day 12), followed by a slight decrease in day

15, suggesting varying oxidative stability. With the 10% DSP group, the TBA value (6.81 mg/kg) was observed at day 12, followed by a decrease to 5.78 mg/kg on day 15, indicating relatively stable oxidative stability later in the storage period similar results were reported by Abdelrahman *et al.* (2022).

In summary, the addition of different levels of DSP yields varied effects on the oxidative stability of chicken burgers, contributing to fluctuating TBA values over the storage period (Sáyago-Ayerdi *et al.*, 2009). The 5% DSP group notably demonstrates a substantial increase in oxidative stability, while the 10% DSP group exhibits relatively stable TBA values in the later storage period (Abdel-Maksoud *et al.*, 2022). Additionally, the 3% DSP group maintains moderate oxidative stability, while the other groups display varying patterns of oxidative stability over the storage period (Essa and Elsebaie 2022).

Table 3. Effect of different addition levels of DSP on TBA value (mg/kg) in chicken burger during cold storage

DSP level %	TBA (mg malondialdehyde /kg)						LSD
	Fresh (0)	Storage period (Day)					
0 (Control)	1.28±0.02 ^c	1.35±0.01 ^c	2.09±0.13 ^c	4.94±0.31 ^b	6.16±0.14 ^a	6.88±0.12 ^a	1.1898
1	1.42±0.11 ^b	1.75±0.16 ^{ba}	1.59±0.31 ^{ba}	3.12±0.25 ^{ba}	3.32±0.27 ^{ba}	4.48±0.22 ^a	2.9769
3	1.65±0.09 ^c	1.31±0.11 ^d	1.65±0.27 ^c	3.40±0.01 ^a	3.47±0.32 ^a	2.99±0.34 ^b	0.1480
5	1.16±0.07 ^d	2.82±0.21 ^c	3.49±0.18 ^c	4.45±0.02 ^b	4.40±0.13 ^b	8.19±0.02 ^a	0.8522
7	1.33±0.07 ^c	2.97±0.10 ^d	3.39±0.02 ^c	5.84±0.21 ^b	7.42±0.02 ^a	7.34±0.12 ^a	0.2383
10	2.23±0.13 ^d	2.72±0.17 ^{dc}	3.16±0.23 ^c	5.69±0.13 ^b	6.81±0.22 ^a	5.78±0.32 ^b	0.7063

*Data for means for three replicates of each sample, DSP date seed powder, TBA Thiobarbituric acid values, Different characters display significance in the comparison of storage periods at a level of (P ≤ 0.05).

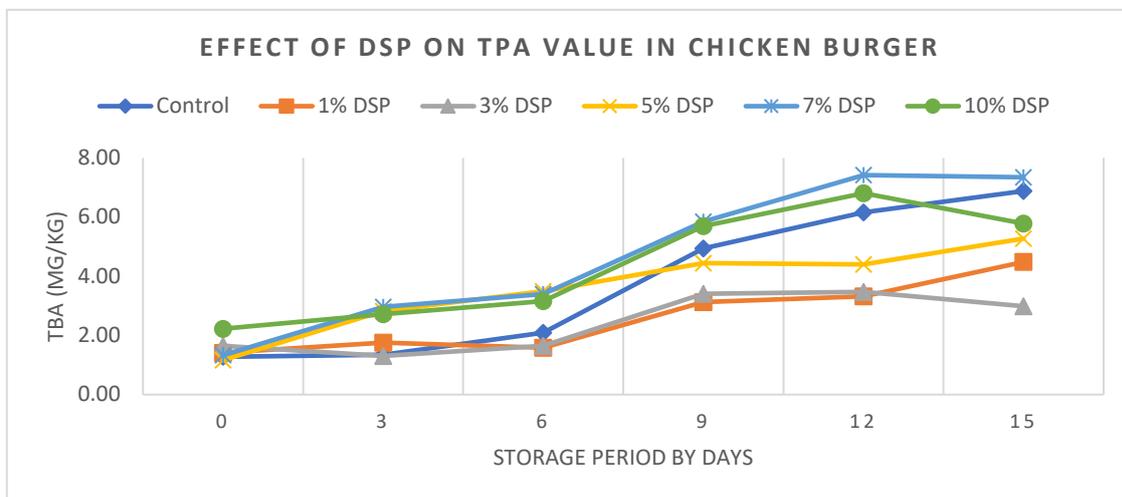


Figure 2. Effect of DSP addition on TBA value (mg/kg) in beef burger under cold storage up to 15 days

Effect of DSP addition on peroxide value (PV) of beef burger during cold storage

The peroxide values of beef burgers with various concentrations of date seedspowder (DSP) over a 15-day storage period are detailed in Table 4, while Figure 3 provides visual representation. These peroxide values serve as crucial indicators of lipid oxidation in beef burgers, where lower values correspond to

improved oxidative stability. Upon thorough analysis of the data, distinct patterns emerge: The control group displays fluctuating peroxide values, with an initial increase up to day 6, subsequently followed by a decrease towards the end of the storage period. Notably, beef burgers with 1% DSP consistently exhibit lower peroxide values than the control group throughout the storage period, signifying enhanced oxidative stability. Similarly, the 3% DSP samples demonstrate relatively lower peroxide values, particularly noticeable from day 6 to day 15, suggesting the potential of 3% DSP in maintaining oxidative stability. The 5% and 7% DSP samples also exhibit promising results, showcasing generally lower peroxide values compared to the control group, albeit with minor fluctuations. Additionally, the 10% DSP consistently shows a decline in peroxide values throughout the storage period, indicating substantial improvement in oxidative stability (Mansour, and Sindi, 2024). In summary, the incorporation of date seeds powder, particularly at lower level (1 to 10%), demonstrates potential for enhancing the oxidative stability of beef burgers during storage, evident from the consistently lower peroxide values compared to the control group (Morsy and Elsabagh 2021). Nonetheless, further investigation and analysis are essential to ascertain the optimal DSP concentration for maximizing oxidative stability and to evaluate its long-term impact on beef burger quality (Morsy and Elsabagh 2021).

Table 4. Effect of different addition levels of DSP on PV value (M. EQUV. /KG FAT) in beef burger during cold storage

DSP Level %	PV value (M. EQUV. /KG FAT)					LSD	
	Fresh	Storage period (day)					
		3	6	9	12	15	
0 Control	12.93±0.11 ^d	14.47±0.02 ^c	19.52±0.13 ^a	16.33±0.31 ^b	10.29±0.14 ^e	8.42±0.43 ^f	0.2769
1	10.91±0.18 ^c	12.13±0.35 ^b	17.36±0.35 ^a	10.07±0.22 ^d	8.89±0.12 ^c	5.34±0.15 ^f	0.2722
3	10.33±0.68 ^c	12.94±0.41 ^b	13.44±0.14 ^a	12.57±0.42 ^b	9.71±0.46 ^d	6.38±0.21 ^e	0.2621
5	9.87±0.71 ^d	12.44±0.23 ^b	17.56±0.41 ^a	11.89±0.31 ^c	8.74±0.47 ^e	6.31±0.14 ^f	0.3277
7	10.13±0.13 ^b	13.77±0.14 ^a	15.24±0.17 ^a	12.09±0.36 ^a	7.93±0.76 ^c	5.66±0.47 ^d	2.1392
10	9.76±0.15 ^c	11.59±0.25 ^b	13.21±0.23 ^a	10.41±0.19 ^d	8.63±0.37 ^e	4.89±0.23 ^f	0.1746

*Data for means for three replicates of each sample, DSP date seed powder, PV peroxide value as malonaldehyde equivalent, Different characters display significance in the comparison of storage periods at a level of ($P \leq 0.05$).

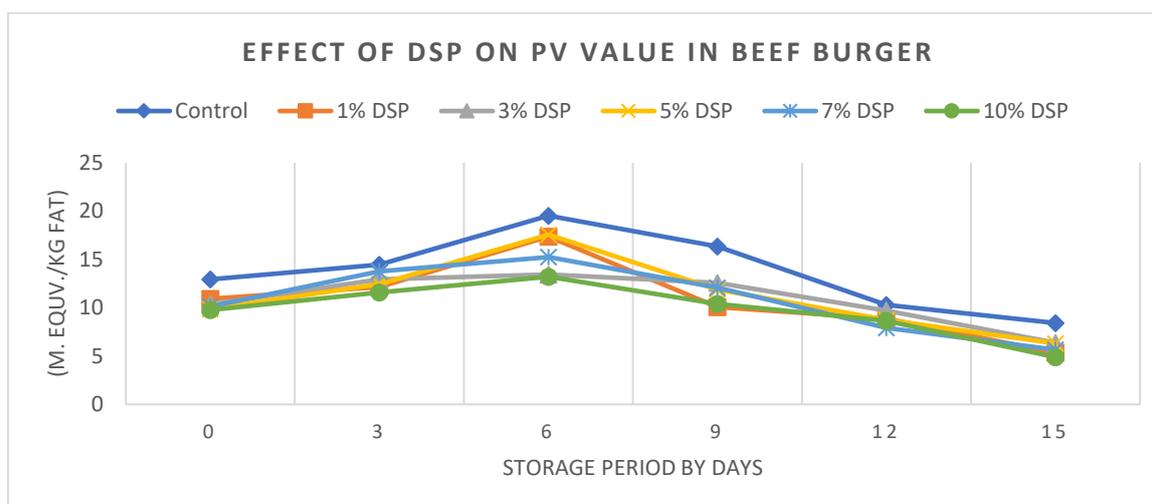


Figure 3. Effect of DSP addition on PV value (M. EQUV. /KG FAT) in beef burger under cold storage up to 15 days

Effect of DSP addition on peroxide value (PV) of chicken burger during cold storage

After evaluating the peroxide values of chicken burgers with different concentrations of date seeds powder (DSP) across various storage periods, distinct trends and observations emerge (Table 5 and Fig. 4) The control group displays fluctuating peroxide values throughout the storage duration, initially escalating up to day 6 and then declining towards the end of the 15-day period. Chicken burgers contained 1% DSP, generally exhibit peroxide values comparable to or slightly higher than the control group, with fluctuations observed during storage. Similarly, burgers with 3% DSP demonstrate a pattern akin to the 1% DSP burgers, with peroxide values fluctuating throughout the 15-day storage period. The 5% and 7% DSP samples show marginally lower peroxide values than the control group, with relatively consistent fluctuations over the storage period. In the case of 10% DSP, peroxide values were similar to or slightly lower than the control group, displaying fluctuations throughout the storage period.

Table 5. Effect of different concentrations of DSP addition on PV value(M. EQUV. /KG FAT) in chicken burger during cold storage

DSP level %	PV value (M. EQUV. /KG FAT)						LSD
	Storage period (Day)						
	Fresh	3	6	9	12	15	
0 (Control)	10.98±0.15 ^c	12.56±0.23 ^b	17.32±0.13 ^a	12.71±0.14 ^b	6.39±0.14 ^d	5.23±0.23 ^c	0.2391
1	11.36±0.14 ^d	12.15±0.25 ^c	16.23±0.25 ^a	14.85±0.42 ^b	8.31±0.12 ^c	7.14±0.12 ^f	0.2709
3	10.23±0.34 ^c	12.08±0.41 ^b	15.88±0.13 ^a	12.45±0.12 ^b	9.85±0.51 ^c	6.89±0.31 ^d	0.4823
5	10.69±0.26 ^d	12.13±0.35 ^c	14.56±0.71 ^a	12.47±0.42 ^b	9.35±0.16 ^c	7.32±0.19 ^f	0.1756
7	11.14±0.12 ^c	11.99±0.61 ^b	13.79±0.53 ^a	11.55±0.19 ^c	7.68±0.56 ^d	6.38±0.31 ^e	0.3230
10	10.91±0.15 ^c	12.09±0.26 ^b	13.33±0.14 ^a	12.43±0.48 ^b	8.36±0.34 ^d	5.47±0.27 ^e	0.5367

*Data for means for three replicates of each sample, DSP date seed powder, PV peroxide value as malonaldehyde equivalent, Different characters display significance in the comparison of storage periods at a level of (P ≤ 0.05).

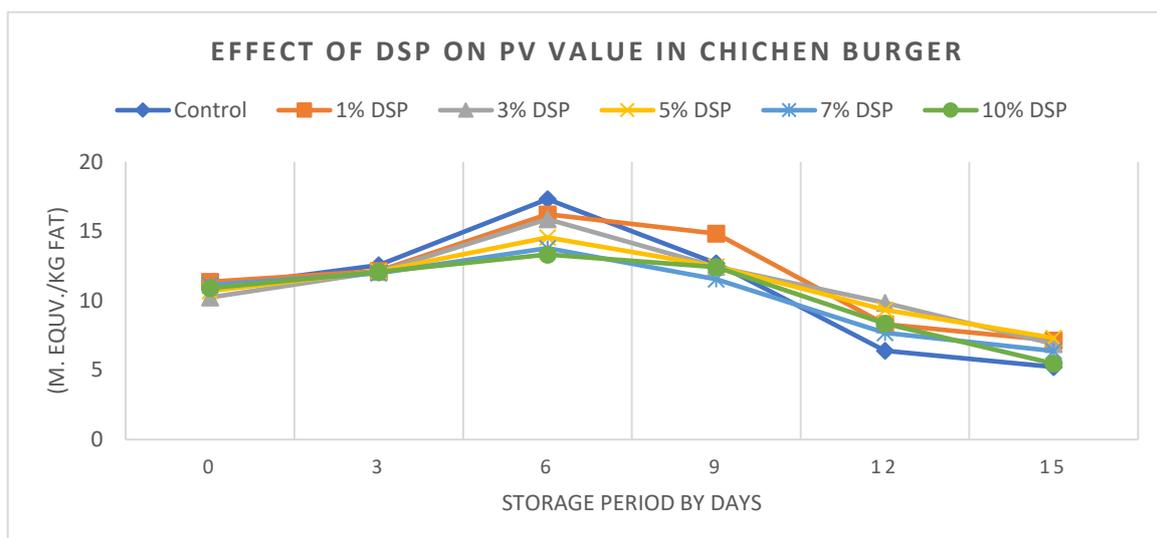


Figure 4. Effect of DSP addition on PV value in chicken burger under cold storage up to 15 days

In summary, the addition of DSP in varied concentrations does not consistently exhibit a decisive impact on the peroxide values of the chicken burgers

compared to the control group during the 15-day storage period (Al-Khalili *et al.*, 2023). The varying patterns in peroxide values across all levels and the control group indicate the need for further investigation to determine the effect of DSP on the oxidative stability of chicken burgers during storage. Additional tests and analysis are essential to identify the optimal DSP concentration for enhancing the oxidative stability of chicken burgers.

Conclusion

The phytochemical analysis of date seeds powder uncovered its substantial antioxidant potential, evident through a DPPH scavenging activity of 81.38%, a low IC₅₀ value of 0.59 mg/mL, and elevated total phenolic (2.53 mg/g) and flavonoid (1.37 mg/g) content. Furthermore, the presence of saponins (287 mg/100g) and anthocyanins (238 mg/100g) contributes to its health benefits. Variations in phenolic and flavonoid content are attributed to factors such as variety, growing conditions, and extraction methods. The antioxidant activity of date seeds extract holds promise as a significant source of natural antioxidants. When examining the impact of date seedspowder (DSP) addition on the oxidative stability of beef and chicken burgers, distinct patterns emerged. Beef burgers showed improved oxidative stability with 1 to 10% DSP, while chicken burgers displayed varied results, necessitating further investigation to determine the optimal DSP concentration for enhancing oxidative stability in both burger types during storage.

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تأثير مسحوق نوى التمر كمضاد طبيعي للأكسدة لتحسين الثبات التأكسدي لبرجر اللحم البقري وبرجر الدجاج

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الملخص

تهدف هذه الدراسة الى تقييم إمكانية استخدام مسحوق نوى التمر في تحسين الثبات التأكسدي لبعض منتجات اللحوم (برجر اللحم البقري وبرجر الدجاج). وبتقدير المواد الفعالة في مسحوق نوى التمر تبين ارتفاع النشاط المضادة للأكسدة (81.38%) باستخدام DPPH وانخفاض قيمة IC_{50} (0.59 مجم/مل)، وكان محتوى الفينولات 2.53 مجم/جم، والفلافونويدات 1.37 مجم/مل، السابونين 287 مجم/100 جم، والأنثوسيانين 238 مجم/100 جم. وهذا المحتوى المتميز من المواد الفينولية، يجعل مسحوق نوى التمر مصدرًا قيمًا لمضادات الأكسدة الطبيعية. وعند تقييم تأثير اضافة مسحوق نواة التمر على الثبات التأكسدي لبرجر اللحم البقري وبرجر الدجاج، فقد تبين من النتائج المتحصل عليها انخفاض تدريجي في قيم البيروكسيد لبرجر اللحم البقري بزيادة محتواه من مسحوق نوى التمر من 1 إلى 10%، مما يشير إلى تحسين الثبات التأكسدي للمنتج. وعلى العكس من ذلك، فقد تنوعت قيم البيروكسيد لبرجر الدجاج المحتوي على مستويات مختلفة من مسحوق النوى (1، 3، 5، 7، 10%). كما أظهرت قيم حمض الثيوباربيتوريك (TBA) لبرجر اللحم البقري وبرجر الدجاج عند التركيزات المختلفة من مسحوق نوى التمر اتجاهات متباينة، وعلى وجه التحديد، فقد اتضح أن استخدام مسحوق النوى بنسبة 3، 10% في برجر اللحم البقري قد أدى الى إمكانية الحفاظ على الثبات التأكسدي أو تعزيزه. وعلى العكس من ذلك، فإن تأثير إضافة مسحوق نوى التمر على الثبات التأكسدي لبرجر الدجاج قد اختلف باختلاف التركيزات المستخدمة منه. وفي هذا السياق، تشير النتائج إلى أن مسحوق نوى التمر قد أدى الى تحسين الثبات التأكسدي لبرجر اللحم البقري، في حين أن هذا التأثير كان غير محدد في عينات برجر الدجاج

الكلمات المفتاحية: الحفظ بالتبريد، برجر اللحم البقري، برجر الدجاج، الفينولات، مضادات الأكسدة، الثبات التأكسدي.