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# Texture, Sensory Attributes and Antioxidant Activity of Spreadable Processed Cheese with Adding Date Seed Powder

**Aliaa A. Darwish*; Meranda A. Tawfek and Enas A. Baker**

Dairy Research Dept., Food Technology Research Institute, Agricultural Research Center, Giza, 12613, Egypt


## ABSTRACT

Effect of supplementation with roasted date seed powder (DSP)on the texture and sensory properties of spreadable processed cheese was carried out. Four different formulas of processed cheese were prepared (F-C, F-1, F-5, and F-10) with added 0, 1, 5, and 10 % of roasted DSP.Results revealed that the DSP is of higher total phenolic (TPC, 38.3 mg GAE/g) and flavonoid (TFC, 33.4 mg QE/g) contents, and antioxidant activity (AOA, 83.9%).Adding DSP resulted in significant differences ($P < 0.05$) in total solids and fiber contents, and insignificant differences in fat content, fat/dry matter, and protein. The lowest ash content of 3.20% and the lowest soluble nitrogen of 1.68% were detected in treatment F-10. pH values significantly ($P < 0.05$) increased by adding DSP, while decreased with the progress of storage time. Meltability and oil separation index significantly increased ($P < 0.05$) over time,while it significantly decreased by adding DSP.Texture parameters increased ($P<0.05$) over time. Hardness increased while springiness, cohesiveness, gumminess, and chewiness values decreased by adding DSP. A proportional increase ($P < 0.05$) in TPC, TFC, and AOA was detected by increasing the added DSP.Thus, F-10 treatment contained the higher TPC, TFC, and AOA %.A slight increase in TPC, TFC, and AOA was found by prolonging the storage period.As with the sensory evaluation, all formulations were acceptable, and F-5 followed by F-1 acquired the highest scores of overall acceptability. Thus, this study demonstrated the possibility of using roasted DSP in the manufacturing of processed cheese with high-quality properties,antioxidant activity,and sensory acceptability.

***Keywords:*** date seed powder; processed cheese; antioxidant and polyphenols; quality and sensory attributes

## INTRODUCTION

Nowadays, processed cheese gained more popularity worldwide. Moreover, it has a prolonged shelf life and attractive to all ages (Aly *et al.,* 2016). Thus, its consumption per capita has been increased among the Egyptians which raised from 2 kg in 2003 up to 2.46 kg in 2010. This gained popularity is accompanied by increased production. The production of processed cheese in Egypt represents one of the most active and diverse sectors of the food industry.

For the making of processed cheese, natural cheeses of various degrees of maturity are mixed in the presence of emulsifying salts under heating at ambient pressure or under partial vacuum, until a homogenous mass is obtained. However, other ingredients including dairy-based derivatives (powdered milk, whey proteins…) and non-dairy-based derivatives (preservatives, spices, fruit, stabilizers, meat, and water) can be added. Therefore, the diversity of these products in terms of taste, color, and composition, which is reflected in increasing their acceptability, and thus their economic return (Guinee, 2004 and Hladká *et al.,* 2014).

Wastes of agricultural industries represent a big environmental problem and its disposal results in the loss of many important nutrients that can be used to improve the added value of food. In this regard, the date palm industry produces more than 150000 – 225000 tons of date seed annually since Egypt is the first producer of the date palm fruit. Functional ingredients including antioxidants, polyphenols, and dietary fiber will be lost when not in use. Date seed powder was used in making bio-yoghurt, ice cream, and yoghurt. Moreover, roasted date seed powder was used in the preparation of coffee-like beverages in some Arabic countries. In this regard, the roasting process applied to date seeds varies in time and temperature and aims to obtain a distinctive taste similar to that of coffee or cocoa. This process changes its composition and affects its antioxidants and polyphenols content (Al-Farsi and Lee, 2008, Khalil, and Blassey, 2016; Ghnimi *et al.,* 2015; 2017, El-Kholy, 2018).

Given the above, date seed represents a cheap source of several ingredients including dietary fiber which could be exploited as prebiotic (Al-Thubiani and Khan, 2017). Therefore, the present study investigated the possibility of using DSP in formulating the processed cheese spread and its impact on its quality characteristics including texture, antioxidant and sensory attributes.

## MATERIALS AND METHODS

### Materials, chemicals, and reagents

The cheese-base (mature and fresh Ras cheeses) was purchased from a local market, Giza, Egypt. Siwi date seed (*Phoenix dactylifera L. cultivar Siwi*) was obtained from palm date dehydration factory, Food Technology Research Institute (FTRI), Agricultural Research Center (ARC), Giza, Egypt. Cooking salt (Joha S9s emulsifying

* **Corresponding author.**
**E-mail address: aliaa-2006-55@hotmail.com**
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salt special) produced by El-Nasr Saline's Company. 2,2-diphenyl-1-picrylhydrazyl (DPPH) was obtained from Sigma-Aldrich (Steinheim, Germany) while gallic acid monohydrate and Folin-Ciocalteu's phenol reagent were obtained from Fluka (Madrid, Spain). All reagents used were of analytical grade.

**Roasted date seed powder (DSP) preparation**

The date seed powder was prepared according to Darwish *et al*. (2018). The date seeds were washed and air-dried in the laboratory at ambient temperature for 3 days, and they were roasted at 150ºC for 4 h (Vertical oven, Germany), grounded using hammer's mill (Athelzion, HZ:50, H: I, V:220, Italy), and then sieved through a 60 mesh sieve (250 microns). The obtained powder was kept in polyethylene bags and stored at 5 ºC until use.

**Processing of spreadable processed cheese**

For the preparation of the various formulations of spreadable processed cheeses, mature and fresh cheeses were used in the control formula (F-C) while the examined cheeses treatments were prepared by adding different concentrations of the roasted DSP, namely F-1, F-5, an F-10 that contain 1, 5, and 10 % roasted DSP, respectively. Control processed cheese was prepared without adding DSP (named F-C). The preparation of the experimental treatments was conducted according to Awad (1996). All blends were prepared by adjustment to contain approximately 2.5% emulsifying salts, 35% fat per dry matter, and 68 % moisture. In the DSP-containing treatments, DSP has been added in proportions of 1, 5, and 10% as a substitute for cheese. The cooking process of the mixture has been conducted at 80 - 85 ºC for 10 min. using indirect steam at pressure 2-2.5 kg/cm$^2$ using a double jacket pan with a batch capacity of 2 kg and stirring velocity of 120 – 140 rpm. Then, the obtained processed cheese was hot-filled into suitable glass containers and capped immediately after cooking, and kept at 5ºC for 90 days. At 1, 45, and 90 days of cold storage, the resultant cheese samples were subjected to analysis. Table (1) shows the different formulations of spreadable processed cheese prepared with or without adding roasted DSP. The chemical composition of DSP and Ras cheese samples used in formulating spreadable processed cheese is shown in Table (2).

**Table 1. Formulations of spreadable processed cheese prepared with or without adding roasted date seed powder (DSP), g/100g.**

| Parameter | F-C | F-1 | F-5 | F-10 |
|---|---|---|---|---|
| Mature cheese | 12.9 | 12.63 | 11.50 | 10.30 |
| Fresh cheese | 45.7 | 45.4 | 44.20 | 42.70 |
| Emulsifying salts | 2.5 | 2.5 | 2.5 | 2.5 |
| Roasted DSP | - | 0.43 | 1.70 | 3.40 |
| Water | 38.9 | 39.13 | 40.10 | 41.10 |
| Total | 100 | 100 | 100 | 100 |

**F-C: control spreadable processed cheese without adding DSP. F-1, F-5, and F-10: spreadable processed cheese with added 1, 5, and 10 % date seed powder (DSP).**

**Analytical methods**

Processed cheese variants have been analyzed in triplicates and the obtained data were expressed as mean ± standard deviation of three independent replicates. The prepared samples were subjected to the following analyses:

**Chemical composition**

Contents of total solids (dry matter), total protein, fat, fat/dry matter, fiber, ash, and pH were determined as reported by AOAC (2007). To calculate the total protein, the total nitrogen content was multiplied using a factor of 6.25 for DSP and 6.38 for dairy products. pH values were measured using a digital pH meter (Hana instrument, Barcelona, Spain), with a combined glass electrode (Electric Instruments Limited). The soluble nitrogen content was estimated as described by Ling (1963). Minerals content (Na, K, Fe, and Zn) of DSP was determined according to Mohamed *et al.* (2011) using atomic absorption spectrophotometer (Perkin Elmer, US instrument Division Norwalk, CT, USA).

Meltability was determined as described by Karan & Ak (2003), while the oil separation index was estimated according to Thomas (1973).

Texture parameters were measured at 23°C as described by Bourne (1982) using an Instron Universal Testing Machine model 1195, Stable Micro System (SMS) Ltd., Godalming, UK, loaded with Dimension Software SMS program.

**Phenolic compounds and antioxidant activity**

For extracting the phenolic compounds, the processed cheese (2g) have been mixed with an aqueous methanolic solution (30 ml, 70:30 v/v) with stirring for 24 h at ambient temperature protected from the light to avoid polyphenols degradation by photo-oxidation. After centrifugation for 20 min at 4000 g, the supernatant was collected and the residue was re-extracted with an additional 30 ml of the same solution and recombined together. The obtained supernatant has been utilized in the estimation of TPC, TFC, and AOA.

Total phenols content (TPC), and total flavonoid content (TFC) have been estimated according to Elfalleh *et al.* (2009) and Nasri *et al.* (2011), respectively. The results were expressed as mg GAE/g and mg QE/g for TPC, and TFC, respectively. The antioxidant activity has been estimated using DPPH as radical scavenging activity of methanolic extracts according to Okonogi *et al.* (2007).

**Sensory evaluation**

Processed cheese treatments (F-C, F-1, F-5, and F-10) were subjected to sensory analysis according to Meyer (1973). Ten expert panelists belonging to Dairy Research Dept., Food Technology Research Institute, Giza, Egypt were recruited to conduct the sensory evaluation using the following descriptors: color (20 points), texture (40 points), flavor (40 points), and overall acceptability (100 points).

**Statistical analysis**

The obtained data were expressed as mean ± SD of three independent replicates. The data were statistically analyzed according to the Statistical Analyses System user's guide using the liner Model (GLM). Duncan's multiple range was used to separate among means of three replicates at $P < 0.05$.

## RESULTS AND DISCUSSION

**Chemical composition of raw materials**

Results in Table (2) show the chemical composition of the mature and fresh cheeses and roasted DSP. Mature Ras cheese is of a higher content of total solids (65.3%), fat

(30.4%), protein (25.3%), and ash (4.30 %), as compared to fresh Ras cheese. Similar results were obtained by Tawfek (2018). Concerning the roasted DSP, it could be obtained that the total solids, fat, protein, ash, fiber were 98.1, 8.0, 5.2, 1.2, and 76.6 %, respectively. The obtained data came in agreement with those found by Khalil and Blassey (2016), and Darwish *et al.* (2018). Slight differences between the present results from those obtained by the former researchers could be attributed to the applied roasting time and temperature. Regarding the fiber content of DSP, it could be observed coincidence between the obtained results and those obtained by Al-Farsi & Lee (2008), who reported that the level of the fiber content of DSP varied between 64.5 and 80.15%. It could also be revealed in Table (2) that TPC, TFC, and antioxidant activity (%) of roasted DSP were 38.3 mg GAE/g, 33.5 mg QE/g, and 83.9 %, respectively, which came in harmony with those obtained by Jambi (2018), and Darwish *et al.* (2018). Polyphenols compounds are considered the main contributor to antioxidant activity. DSP is considered an excellent source of polyphenols, which are reflected in its high antioxidant activity, and improved the antioxidant capacity of the enriched products. Regarding the mineral content of DSP, potassium was found of the highest content (688.6 mg/100g), followed by Na, Fe, and Zn., which coincided with Darwish *et al.* (2018).

**Table 2. Chemical composition of mature and fresh Ras cheese and roasted date seed powder used for making of spreadable processed cheese.**

| Parameter | | Mature Ras cheese | Fresh Ras cheese | Roasted DSP |
|---|---|---|---|---|
| Total solids (%) | | 65.3 ± 0.1 | 34.9 ± 2.7 | 98.1 ± 0.39 |
| Fat % | | 30.4 ± 0.1 | 23.5 ± 1.1 | 8.0 ± 1.2 |
| Protein (%) | | 25.3 ± 0.06 | 22.4 ± 0.9 | 5.2 ± 0.06 |
| Ash (%) | | 4.30 ± 0.01 | 3.85 ± 1.5 | 1.2 ± 0.18 |
| Fiber (%) | | - | - | 76.6 ± 1.05 |
| TPC (mg GAE /g) | | ND | ND | 38.3 ± 0.9 |
| TFC (mg QE/g) | | ND | ND | 33.4 ± 1.2 |
| AOA (%) | | 5.61 ± 0.5 | 1.49 ± 0.05 | 83.9 ± 1.7 |
| Mineral (mg/100g) | K | ND | ND | 688.6 ± 1.7 |
| | Na | ND | ND | 5.1 ± 1.1 |
| | Fe | ND | ND | 2.7 ± 0.2 |
| | Zn | ND | ND | 1.5 ± 0.1 |

**Values are means ± SD of three independent replicates. TPC: total phenolic content, GAE: gallic acid equivalent, TFC: total flavonoid content, QE: quercetin equivalent, AOA: antioxidant activity calculated as radical scavenging inhibition %. ND: not determined.**

### Chemical composition of spreadable processed cheese

Data presented in Table (3) illustrates the chemical composition of the experimental treatments of fresh spreadable processed cheese. All formulations of spreadable processed cheese were of the similar content of total solids (ranged between 31.1 and 31.7%), fat (ranged between 11.45 and 11.61 %), fat/dry matter (ranged between 36.82 and 37.45%), protein (ranged between 9.3 and 9.4 %), soluble nitrogen (ranged between 1.68 and 1.83), and ash (ranged between 3.2 to 3.29 %). Adding DSP increased the contents of total solids, fat, FDM, and fiber, and decreased the contents of protein, soluble nitrogen, and ash. The F-10 treatment contained higher concentration of total solids (31.7 %), fat (11.61%), fat/dry matter (37.45%), and fiber (0.29%), and the lowest values of protein (9.30%), soluble nitrogen (1.68%), and ash (3.20%). Adding DSP in different concentrations resulted in a reduction in the total protein and ash contents in DSP-treatments. This observation is related to the lower values of protein and ash in DSP, as compared to mature or fresh Ras cheese being used in formulating the processed cheese samples (Table 2).

Insignificant changes could be detected in fat, fat/dry matter, and protein contents between treatments due to the previous adjustment of the composition of all the formulations before cooking. A similar trend was reported by Awad et al. (2014) and Abdeen et al. (2018). Incorporating DSP led to a proportional reduction in the soluble nitrogen content, as compared to the control treatment (F-C), which was of the highest soluble nitrogen content. Similar results regarding soluble nitrogen content were detected by Abdeen et al. (2018) and Tawfek (2018). This effect could be attributed to the melting salt-action in dissolving the protein. Tawfek (2018) ascribed this phenomenon to the lower content of soluble nitrogen in black rice flour as compared to the used raw cheeses.

Regarding fiber content, milk or its products are known to be fiber-free food, therefore control treatment (F-C) was found to has no fiber content. As DSP is a rich source of fibers, their addition to the examined formulae resulted in a proportional increase in the content of fiber in DSP-processed cheese samples.

**Table 3. Chemical composition of the formulations of the fresh spreadable processed cheese prepared with or without adding roasted date seed powder (DSP).**

| Parameter | F-C | F-1 | F-5 | F-10 |
|---|---|---|---|---|
| Total solids (%) | 31.1 ± 0.01 $^{d}$ | 31.3 ± 0.01$^{c}$ | 31.5 ± 0.01 $^{b}$ | 31.7 ±0.01 $^{a}$ |
| Fat (%) | 11.45 ± 0.01 $^{a}$ | 11.54 ± 0.01$^{a}$ | 11.56 ± 0.01 $^{a}$ | 11.61 ±0.01 $^{a}$ |
| FDM (%) | 36.82 ± 0.01 $^{a}$ | 36.87 ± 0.01 $^{a}$ | 36.69 ± 0.01 $^{a}$ | 37.45 ± 0.01 $^{a}$ |
| Protein (%) | 9.4 ± 0.005 $^{a}$ | 9.37 ± 0.005 $^{a}$ | 9.32 ± 0.003 $^{a}$ | 9.30 ± 0.002 $^{a}$ |
| Soluble nitrogen (%) | 1.83 ± 0.001 $^{cd}$ | 1.75 ± 0.005$^{bc}$ | 1.72 ± 0.002 $^{ab}$ | 1.68 ± 0.005 $^{a}$ |
| Ash (%) | 3.29 ± 0.01 $^{a}$ | 3.26 ± 0.02 $^{ab}$ | 3.22 ± 0.05$^{bc}$ | 3.20 ± 0.01 $^{c}$ |
| Fiber (%) | ND | 0.09 ± 0.002 $^{c}$ | 0.20 ± 0.001 $^{b}$ | 0.29 ± 0.003 $^{a}$ |

**Values are means ± SD of three independent replicates. Means that do not share similar letters in each row are significantly different (P < 0.05). F-C: control spreadable processed cheese without adding DSP. F-1, F-5, and F-10: spreadable processed cheese with added 1, 5, and 10 % date seed powder (DSP). FDM: fat/dry matter (FDM = % fat/% dry matter * 100).**

### Physicochemical properties of processed cheese

Data presented in Fig. (1) illustrate that the pH values of all samples gradually decreased during the cold storage period for 90 days. Adding roasted DSP increased pH values. The highest pH value (5.91) was detected in processed cheese with added 10 % DSP (F-10), compared with the lowest value of 5.34 in the control cheese (F-C).

The hydrolysis of emulsifying salt and its interaction with proteins are considered the main contributor to pH reduction during storage time .The changes in pH values were almost insignificant. Similar findings were reported by Shamsia & El-Ghannam (2017) and Tawfek (2018). However, the partial breakdown of emulsifying salts and their interactions with proteins could be related to the pH decline during storage time (Awad and Salama, 2010).

Meltability is an important property in the processed cheese quality. It assesses the sensitivity of processed cheese to the temperature changes that occurred during transportation and storage.

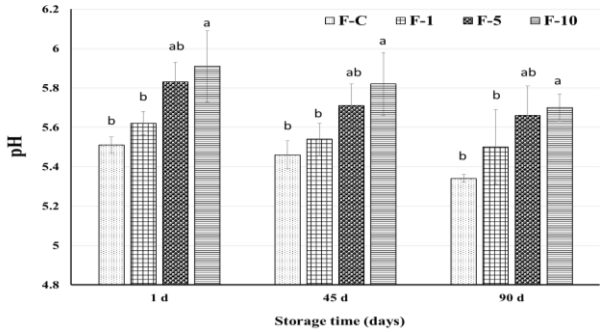


**Fig. 1. pH values of the formulations of the spreadable processed cheese prepared with or without adding roasted date seed powder (DSP).**

**Values are means ± SD of three independent replicates. Column charts that do not share similar letters in the same corresponding storage time are significantly different (P < 0.05). F-C: control spreadable processed cheese without adding DSP. F-1, F-5, and F-10: spreadable processed cheese with added 1, 5, and 10 % date seed powder (DSP).**

The changes in meltability values of spreadable processed cheese are presented in Fig. (2A). Adding DSP proportionally reduced the meltability values, as compared to the control cheese sample. Thus, cheese with added 10 % DSP (F-10 sample) was of the lowest melting properties (32 mm), compared with control cheese of the highest meltability (74 mm). Reduction of meltability by adding DSP could be ascribed to the increased hardness of DSP-containing cheese samples, which agrees with El-Shibiny *et al.* (2013). Along with the cold storage period, the meltability values increased in all treatments including the control sample as compared to the corresponding values recorded in fresh samples. This observation could be due to the occurred changes in pH, and also protein degradation occurred in cheese (Awad and Salama, 2010; Shamsia and El-Ghannam (2017). In this context, it is worth noting that processed cheese properties are strongly impacted by the food matrix and the composition of the ingredients used in its formulation.

Oil separation index is considered as a serious described defect of the processed cheese. The separated oil spoils quickly as a result of being subjected to oxidation. The data exist in Fig. (2B) showed that the oil separation index proportionally decreased by adding DSP, while it increased over the cold storage time.

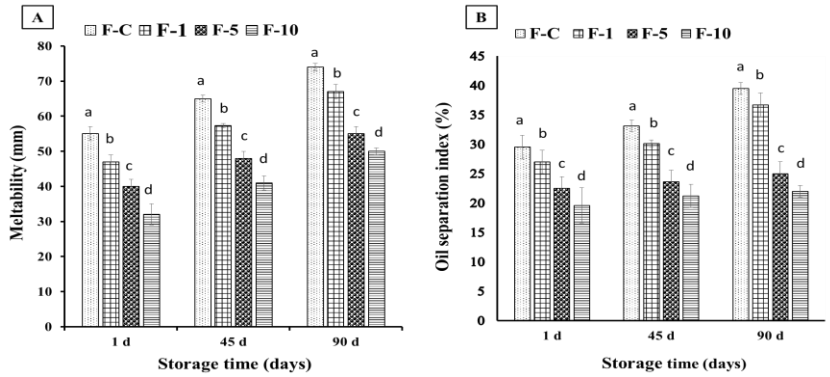


**Fig. 2. A) Meltability (mm) and B) oil separation index (%) values of the formulations of spreadable processed cheese prepared with or without adding roasted date seed powder (DSP) during the cold storage period.**

**Values are means ± SD of three independent replicates. Column charts that do not share similar letters in the same corresponding storage time are significantly different (P < 0.05). F-C: control spreadable processed cheese without adding DSP. F-1, F-5, and F-10: spreadable processed cheese with added 1, 5, and 10 % date seed powder (DSP).**

The highest values of the oil separation index of 29.5, 33.1, and 39.5 %, respectively, were recorded for F-C control cheese after 1, 45, and 90 days of cold storage while the lowest values were observed in F-10 treatment (19.6, 21.2, and 22 %, respectively). During storage time, the changes in pH and soluble nitrogen content along with the melting salt-protein interactions could be the main contributors to increasing the oil separation. Similar results were obtained by Awad & Salama (2010), and Tawfek (2018).

**Texture properties of processed cheese**

The texture properties (hardness, springiness, gumminess, cohesiveness, and chewiness) are among the most important characteristics of food products that participate in determining their quality and acceptability. Data presented in Table (4) displayed the texture parameters of the tested formulae of spreadable processed cheese after 1, 45, and 90 days of cold storage. All texture parameters increased with the progress of cold storage, and the control sample was of the highest values of springiness, gumminess, cohesiveness, and chewiness (6.98 mm, 16.4 N, 0.52 ratio, and 116.57 m.j.) respectively) at 90 days of cold storage as compared to the DSP-containing treatments. Adding of DSP led to significant changes ($P < 0.05$) in all texture parameters.

The results in Table 4 indicated that hardness values have been proportionally increased with adding DSP. Unlike control cheese that contains casein as the main protein, DSP-added treatments contained different concentrations of DSP protein together with casein protein.

Thus, the variation of the occurring protein properties could participate in the variation in textural properties observed in the different treatments (Fox *et al.*, 2000). Similarly, higher hardness values have been described for processed cheese incorporated with rice bran (El-Shibiny *et al.*, 2013) or black rice flour (Tawfek, 2018). An increase in hardness was observed during storage time. This could be attributed to the detected increase in viscosity of the tested cheese treatments (Montesinos-Herrero *et al.* 2006). It could also be attributed to the less water availability and reduction in moisture content during storage time. Consistent with the

current results. cheese of higher hardness was obtained at the end of cold storage by Awad *et al.* (2006); Shamsia and El-Ghannam (2017).

Results in Table (4) displayed slight differences in springiness between control and treatments when fresh and after storage. Adding DSP resulted in a reduction in the springiness of DSP-containing treatments, while it slightly increased during the storage period, which agreed with the results obtained by Awad *et al.* (2014). Concerning the gumminess (N), adding DSP resulted in its decrease in the fresh and stored samples. Meanwhile, cold storage increased the gumminess of all treatments including control cheese. The obtained data coincided with those mentioned by El-Baz *et al.* (2011).

**Table 4. Texture properties of the formulations of the spreadable processed cheese prepared with or without adding roasted date seed powder (DSP) during the cold storage period.**

| Parameter | Storage period (days) | F-C | F-1 | F-5 | F-10 |
|---|---|---|---|---|---|
| Hardness (N) | 1 | 26.4 ± 0.1 $^{d}$ | 28.3 ± 0.2 $^{c}$ | 35.9 ± 0.4 $^{b}$ | 38.1 ± 0.4 $^{a}$ |
| | 45 | 28.9 ± 0.6 $^{c}$ | 30.1 ± 0.7 $^{c}$ | 39.1 ± 0.9 $^{b}$ | 42.1 ± 0.5 $^{a}$ |
| | 90 | 32.2 ± 0.1 $^{d}$ | 33.6 ± 0.2 $^{c}$ | 44.4 ± 0.2 $^{b}$ | 47.3 ± 0.3 $^{a}$ |
| Springiness (mm) | 1 | 6.1 ± 0.02 $^{a}$ | 5.8 ± 0.01 $^{b}$ | 4.9 ± 0.01 $^{c}$ | 4.4 ± 0.03 $^{d}$ |
| | 45 | 6.5 ± 0.1 $^{a}$ | 6.4 ± 0.14 $^{a}$ | 5.4 ± 0.1 $^{b}$ | 4.9 ± 0.1 $^{c}$ |
| | 90 | 6.9 ± 0.01 $^{a}$ | 6.8 ± 0.01 $^{b}$ | 5.9 ± 0.03 $^{c}$ | 5.3 ±0.01 $^{d}$ |
| Gumminess (N) | 1 | 11.3 ± 0.02 $^{a}$ | 10.7 ± 0.02 $^{b}$ | 9.2 ± 0.03 $^{c}$ | 8.9 ± 0.02 $^{d}$ |
| | 45 | 13.9 ± 0.2 $^{a}$ | 13.2 ± 0.5 $^{b}$ | 11.7 ± 0.2 $^{c}$ | 10.8 ± 0.3 $^{d}$ |
| | 90 | 16.4 ± 0.02 $^{a}$ | 16.2± 0.02 $^{b}$ | 15.3 ± 0.03 $^{c}$ | 15.2 ± 0.02 $^{d}$ |
| Cohesiveness (ratio) | 1 | 0.43 ± 0.01 $^{a}$ | 0.38 ± 0.01 $^{b}$ | 0.26 ± 0.01 $^{c}$ | 0.2 ± 0.01 $^{d}$ |
| | 45 | 0.48 ± 0.01 $^{a}$ | 0.43 ± 0.01 $^{b}$ | 0.32 ± 0.01 $^{c}$ | 0.28 ± 0.01 $^{d}$ |
| | 90 | 0.52 ± 0.02 $^{a}$ | 0.46 ± 0.01 $^{b}$ | 0.35 ± 0.02 $^{c}$ | 0.32 ± 0.01$^{d}$ |
| Chewiness (m.J.) | 1 | 68.9 ± 0.01 $^{a}$ | 63.8 ± 2.33 $^{b}$ | 45.8 ± 0.03 $^{c}$ | 38.8 ± 0.02$^{d}$ |
| | 45 | 84.8 ± 1.2 $^{a}$ | 79 .3 ± 1.3 $^{b}$ | 66.7 ± 0.8 $^{c}$ | 58.1 ± 0.8 $^{d}$ |
| | 90 | 116.6 ± 0.03 $^{a}$ | 105.5 ± 0.01 $^{b}$ | 92.2 ± 0.03 $^{c}$ | 79.6 ± 0.07 $^{d}$ |

**Values are means ± SD of three independent replicates. Means that do not share similar letters in each row are significantly different (P < 0.05). F-C: control spreadable processed cheese without adding DSP. F-1, F-5, and F-10: spreadable processed cheese with added 1, 5, and 10 % date seed powder (DSP). N: Newton, m.J.: millijoule, mm: millimeter**

A slight reduction was also observed in the cohesiveness of fresh and cold-stored samples. A similar trend has been obtained by Awad *et al.* (2014). Regarding the chewiness parameter, it proportionally decreased with the increased added amount of DSP while it is highly increased with the progress of cold storage.

**Phenolic compounds and antioxidant activity of processed cheese**

Data presented in Table (5) illustrate the phenolic compounds (TPC, and TFC) and antioxidant activity of processed cheese containing DSP during 90 days of cold storage. Control cheese (F-C sample) does not contain any of these compounds because of their absence in milk and milk products. However, control cheese showed modest antioxidant activity that slightly increased with the progress of storage time, which could be explained by the formation of some antioxidant peptides which can behave like polyphenols. Increasing added concentration of DSP highly increased ($P < 0.05$) TPC and TFC values. This phenomenon could mainly due to that DSP is an excellent source of polyphenols which in turn is reflected in its antioxidant activity. Thus, the F-10 cheese sample had the highest values of TPC, TFC, and antioxidant activity, followed by F-5 and then F-1 cheese samples. Similar findings have been obtained by Tawfek (2018) and Darwish *et al.* (2018).

**Table 5. Polyphenols compounds content and antioxidant activity of the formulations of the spreadable processed cheese prepared with or without adding roasted date seed powder (DSP).**

| Parameter | Storage period (days) | F-C | F-1 | F-5 | F-10 |
|---|---|---|---|---|---|
| TPC (mg GAE/g) | 1 | ND | 35.3 ± 0.3 $^{c}$ | 78.1 ± 0.03 $^{b}$ | 99.5 ± 0.02 $^{a}$ |
| | 45 | ND | 37.59 ± 0.5 $^{c}$ | 82.49 ± 0.7 $^{b}$ | 102.66 ± 1 $^{a}$ |
| | 90 | ND | 37.89 ± 1 $^{c}$ | 82.72 ± 1.5 $^{b}$ | 102.73 ± 1 $^{a}$ |
| TFC (mg QE/g) | 1 | ND | 10.3 ± 0.05 $^{c}$ | 25.1 ± 0.03 $^{b}$ | 35.8 ± 0.04 $^{a}$ |
| | 45 | ND | 12.37 ± 1 $^{c}$ | 27.55 ± 0.5 $^{b}$ | 38.85 ± 1 $^{a}$ |
| | 90 | ND | 12.93 ± 1 $^{c}$ | 29.05 ± 0.05 $^{b}$ | 40.06 ± 1 $^{a}$ |
| AOA (%) | 1 | 7.65 ±0.5 $^{d}$ | 12.8 ± 0.5 $^{c}$ | 18.1 ± 0.05 $^{b}$ | 24.7 ± 0.06 $^{a}$ |
| | 45 | 9.32 ± 1.5 $^{d}$ | 12.87 ± 1 $^{c}$ | 20.51 ± 1.5 $^{b}$ | 27.55 ± 1 $^{a}$ |
| | 90 | 11.89 ± 1 $^{d}$ | 13.34 ± 0.75 $^{c}$ | 22.64 ± 0.05 $^{b}$ | 29.44 ± 1 $^{a}$ |

**Values are means ± SD of three independent replicates. Means that do not share similar letters in each row are significantly different (P < 0.05). F-C: control spreadable processed cheese without adding DSP. F-1, F-5, and F-10: spreadable processed cheese with added 1, 5, and 10 % date seed powder (DSP). TPC: total phenolic content, GAE: gallic acid equivalent, TFC: total flavonoid content, QE: quercetin equivalent, AOA: antioxidant activity calculated as radical scavenging inhibition %. ND: not determined.**

**Mineral content of processed cheese**

Data presented in Table (6) showed the mineral content in the different samples of processed cheese. Mineral content proportionally increased ($P < 0.05$) with increasing the added level of DSP, except Na which insignificantly increased in DSP-containing cheese. Thus, F-10 cheese had the highest values of Na, K, Fe, and Zn, compared to other DSP-cheese samples and control cheese which had the lowest values of these minerals. This could be due to that DSP is considered a rich source of some minerals, especially, potassium (Darwish *et al.*, 2018). For this reason, F-10 cheese sample had the highest potassium content.

**Table 6. Minerals content (mg/100g) of the formulations of the spreadable processed cheese prepared with or without adding roasted date seed powder (DSP).**

| Mineral | F-C | F-1 | F-5 | F-10 |
|---|---|---|---|---|
| Na | 66.0 ± 4 [a] | 66.05 ± 0.02[a] | 66.15 ± 0.03[a] | 66.25 ± 0.03 [a] |
| K | 190.0 ± 2 [d] | 194.2 ± 2 [c] | 202.5 ± 0.01[b] | 208.9 ± 0.01 [a] |
| Fe | 0.3 ± 0.01 [d] | 0.4 ± 0.05[c] | 0.6 ± 0.03 [b] | 0.9 ± 0.01 [a] |
| Zn | 0.3 ± 0.02 [d] | 0.4 ± 0.03 [c] | 0.6 ± 0.02 [b] | 0.7 ± 0.01 [a] |

**Values are means ± SD of three independent replicates. Means that do not share similar letters in each row are significantly different (P < 0.05). F-C: control spreadable processed cheese without adding DSP. F-1, F-5, and F-10: spreadable processed cheese with added 1, 5, and 10 % date seed powder (DSP).**

**Sensory properties**

Results illustrated in Table (7) show the sensory evaluation of fresh and stored spreadable processed cheese samples with adding DSP. These findings revealed that all processed cheese samples were acceptable and gained high overall acceptability scores ranging between 92 – 96 when fresh, and between 83 – 88.7 at the end of the cold storage period. F-5 sample had the highest scores of overall acceptability at 1, 45, and 90 days of cold storage (96, 92, and 88.7, respectively). The results showed that the acceptability decreased with the progress of the cold storage. Generally, adding 10 % of DSP (F-10) led to the lowest scores of color, and flavor during 90 days of cold storage. During storage time, the changes that occurred in the various sensory parameters were ascribed to the slight changes in the chemical composition of the spreadable processed cheese (Hamed *et al.*, 1997 and Abeid *et al.*, 2001). Similar findings reported by Awad and Salama (2010) displayed a reduction in sensory acceptability of processed cheese with the progress of cold storage time.

**Table 7. Sensory evaluation of the formulations of the spreadable processed cheese prepared with or without adding roasted date seed powder (DSP) during the cold storage period.**

| Parameter | Storage time (days) | F-C | F-1 | F-5 | F-10 |
|---|---|---|---|---|---|
| Color (20) | 1 | 19 ± 1 [a] | 19 ± 1 [a] | 19 ± 1 [a] | 18 ± 1 [a] |
| | 45 | 18 ± 1 [a] | 18 ± 1 [a] | 18 ± 1 [a] | 17 ± 1 [a] |
| | 90 | 17 ± [ab] | 18 ± 1 [a] | 17.7 ± 0.6 [ab] | 16 ± 1 [b] |
| Texture (40) | 1 | 37 ± 1 [b] | 38 ± 1 [a] | 39 ± 1 [a] | 37 ± 1 [b] |
| | 45 | 35 ± 1 [a] | 36 ± 1 [a] | 37 ± 1 [a] | 36 ± 1 [a] |
| | 90 | 34 ± 1 [b] | 35 ± 1 [a] | 36 ± 1 [a] | 35 ± 1 [ab] |
| Flavor (40) | 1 | 36 ± 1 [b] | 37 ± 1 [ab] | 38 ± 1 [a] | 37.3 ± 0.6 [ab] |
| | 45 | 35 ± 1 [ab] | 36 ± 1 [ab] | 36 ± 1 [a] | 34 ± 1 [b] |
| | 90 | 33 ± 1 [bc] | 34 ± 1 [ab] | 35 ± 1 [a] | 32 ± 1 [c] |
| Overall acceptability (100) | 1 | 92 ± 2.6 [a] | 95 ± 1 [a] | 96 ± 2.6 [a] | 92.3 ± 2.5 [a] |
| | 45 | 90 ± 1.7 [ab] | 91 ± 1 [a] | 92 ± 1 [a] | 88 ± 1.7 [b] |
| | 90 | 84 ± 3 [ab] | 88 ± 2.6 [a] | 88.7 ± 2 [a] | 83 ± 2.6 [b] |

**Values are means ± SD of three independent replicates. Means that do not share similar letters in each row are significantly different (P < 0.05). F-C: control spreadable processed cheese without adding DSP. F-1, F-5, and F-10: spreadable processed cheese with added 1, 5, and 10 % date seed powder (DSP).**

## CONCLUSION

Date seed powder is considered a valuable and cheap agro-industrial waste and it can be exploited in formulating processed cheese characterized by its high acceptability, and its elevated antioxidant activity.

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## الخواص التركيبية والحسية والنشاط المضاد للاكسدة للجبن المطبوخ القابل للفرد باضافة مسحوق نوى البلح

**علياء علي درويش، ميراندا عبدالمجلي توفيق و ايناس علي بكر**

**قسم بحوث الالبان، معهد بحوث تكنولوجيا الاغذية، مركز البحوث الزراعية، جيزة، ١٢٦١٣، مصر**

تم دراسة تأثير نوى البلح المحمص على الخواص التركيبية والحسية للجبن المطبوخ القابل للفرد. الاربعة انواع من الجبن المطبوخ المحضرة هي F-C, F-1, F-5, and F-10 وكانت تحتوي على ٠، ١، ٥ و١٠ % من نوى البلح المحمص. اظهرت النتائج ان نوى البلح المحمص له محتوى عالي من الفينولات الكلية (38.3 mg GAE/g) والفلافونويدات الكلية (33.4 mg QE/g) كما ان له نشاط مضاد للاكسدة عالي (83.9 %). وقد ادت اضافة مسحوق نوى البلح المحمص الى حدوث اختلافات معنوية في محتوى الجوامد الصلبة الكلية والالياف، بينما حدثت اختلافات غير معنوية في محتوى الدهن، الدهن/المادة الجافة، والبروتين. وقد إحتوى الجبن المطبوخ المصنع بإضافة ١٠ % من مسحوق نوى البلح المحمص على اقل محتوى من الرماد (3.20 %) و اقل محتوى من الأزوت الذائب (١،٦٨%). كما زادت قيم ال pH زيادة معنوية باضافة مسحوق نوى البلح المحمص فى حين انخفضت هذه القيم بالتقدم في وقت التخزين. كما زادت قيم القابلية للانصهار ومعدل فصل الدهن زيادة معنوية بمرور الوقت، بينما انخفضت هذه القيم معنويا باضافة مسحوق نوى البلح المحمص. اما بخصوص صفات التركيب فقد زادت بمرور الوقت. وفيما يتعلق بقيم الصلابة فقد زادت باضافة مسحوق نوى البلح بينما ادت اضافته الى انخفاض قيم المرونة والتماسك والصمغية والمضغية. وبالنسبة لمحتوى الجبن من الفينولات والفلافونويدات الكلية والنشاط المضاد للاكسدة فقد زادت هذه القيم باضافة نوى البلح المحمص زيادة تناسبية مع التركيز المستخدم. ولذلك فقد إحتوت معاملة الجبن F-10 على أعلى قيم للفينولات والفلافونويدات الكلية والنشاط المضاد للاكسدة. اما بخصوص تأثير التخزين على هذه الصفات، فقد لوحظ زيادة طفيفة في قيم كل من محتوى الفينولات والفلافونويدات الكلية والنشاط المضاد للاكسدة بالتقدم في التخزين. اما بخصوص التقييم الحسي، كانت جميع تركيبات الجبن المطبوخ مقبولة وحصلت المعاملة F-5 متبوعة بـالمعاملة F-1 على أعلى درجات القبول الكلي. وهكذا أظهرت الدراسة إمكانية استخدام مسحوق نوى البلح المحمص في تصنيع جبن مطبوخ ذو خصائص جودة ، ونشاط مضاد أكسدة ، وقبول حسي عالي.