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Study Effect of Addition Date Seeds Powder on Quality Criteria and Antioxidant properties of Beef Meatballs

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Abstract

The aim of this study is evaluation the quality and antioxidant properties of beef meatballs as affected by addition of date seeds powder (DSP) at different levels (0, 4, 8, 12 and 16%) from total formula of beef meatballs. The chemical composition (moisture, crude protein, fat, ash, crude fiber and total carbohydrates), antioxidant properties (total polyphenols, total flavonoids and antioxidant activity), physical properties (water holding capacity, PH and color properties (lightness (L), redness (a) and yellowness (b) values), cooking quality (cooking yield, cooking loss, moisture retention and fat absorption), sensory evaluation of meatball samples were measured. It could be noticed that the DSP have a higher content of crude fiber, total phenolic contents and Antioxidant activity led due to a higher increase theses contents in beef meatballs by increasing replacement levels (4 to 16%). Also caused improvement in water holding capacity, a and b values, cooking yield and moisture retention, while caused reduced in fat content, L values, cooking loss and fat absorption of beef meatball samples containing DSP. Also, the addition of DSP up to 12% in produce beef meatball samples noticed any negative effects on the organoleptic criteria. General, it could be observed that, the DSP has a good sources of crude fiber, antioxidant properties and useful addition of DSP in ingredients up to 12% for fortification of produced the beef meatball and other meat products without any negative effects on the organoleptic characteristics. For these reasons, it can be provide various benefits in meatballs production.

Key words: Date Seeds Powder, Quality Criteria, Antioxidant Compounds, Beef Meat Ball.

1. Introduction

The ready to eat foods increasing by the intensity of daily living conditions in societies. Working peoples and young people's demand more of these types of these foods. Therefore, the food manufacturers try to developing products that meet this kind of food needs of consumers. The aim to win consumers' appreciation by producing foods that was easy to prepared and even suitable of healthy nutrition's [1].

The development of staple foods enriched by fiber content is therapeutic an important of contribution to supply in food products with health benefits. The consumption of foods enriched by fiber content was an important factor for prevent several diseases and was associated with a standard balanced diet [2].

The dietary fiber has beneficial effects on human body health owing to it are functioning characteristics such as regulation the activity of large intestine. In the recent years consumer has started to focus on the healthy foods, because of the increased in the diabetes, cardiovascular and cancer diseases obesity [3].Fiber is easily obtained from plants-derived materials such as oligosaccharides and

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polysaccharides. The Fiber has many functional activities, such as the depending on the physicochemical properties which can improved in the color, texture, and affect the sensory properties of food products positively. And also, the fibers are low in cost and can be to use in meat products to increase the frying efficiency and improved texture. The use of the most appropriate fiber in food production and storage is important for the final quality products [4,5,6].

The meat products such as meatballs are the most common groups in the worlds where additives were used. The quality of meat products can be influence with the using of mentioned materials. The meatballs and other meat products can be supports by different vegetable and waste powders, which can be useful in processing, preservation and consumption of meat products. The Disintegration and oxidation problems in meat products can be reduce and color can be improvement. While the use of many plant-waste powders in food production can be emphasized, another alternative is the Date seeds powder [7].

Date production in the world's was estimated for 8.52 million tons in the year 2018 [8],
with approximately 852,000 tons of date seeds that were produced (i.e., consider 10% from the total fruit yield), which was substituted some dietary fibers currently used. More than 4 million date palm trees were grow in Tunisia, which produce annually around about 100,000 tons of date fruits [9]. Date seeds were a waste products (by-product) derived from the technological transformations of the date palm fruits [10]. The was represented up to (15%) of the date palm fruit weight, which led to a large quantity of date seeds for the processing units [11,12].

The date seeds powder is rich amount of dietary fiber (75:80%), total fat (10:12%), and crude protein (5:6%). Carbohydrates are the mainly of insoluble fiber types [13,14]. Besides the higher fiber content of date seeds were great sources of nutritive substances, such as phenolic compounds (3102:4430 mg /100 g) and antioxidant (580:929 mL Trolox /g). Therefore the date seeds have a great potential to use as a supplements for antioxidant properties in medicines, pharmaceutics and food products [15,16] as described by Bouaziz *et al.*, [17].

The goal of this investigation study the effect of replacing animal fat by date seeds powder (DSP) at different levels (0, 20, 40 , 60 and 80%) which were represented (0, 4, 8, 12 and 16%) from total formula of beef meatballs on chemical composition, antioxidant properties, physical properties, cooking quality and sensory evolution of beef meatballs .

2. Experimental

Materials

Fresh Date fruit samples

The fresh siwa date fruits used in this study were obtained from the local market, Nasr City, Cairo, Egypt.

Fresh beef meat

The fresh beef meat used in this investigation was obtained from the local butcher shop, Nasr City, Cairo, Egypt.

Ingredients and chemicals

Ingredients (wheat flour, onion, garlic, black pepper, cumin, salt and sunflower oil) were obtained from the local market, Nasr City, Cairo, Egypt. All chemicals used in this investigation were obtained from el-gamhouria trading chemicals and drugs company, Cairo, Egypt.

Methods

Ingredients of beef meatballs

Produced meatballs were prepared by using 60 g fresh beef meat, 20 g fat, 5 g wheat flour, 1 g onion, 0.5 g garlic, 1 g black pepper, 0.5 g cumin, 2 g salt and 10 ml water.

Preparation of Date seeds powder

After coming of the fresh date fruit samples (Siwa dates variety) from local market (Fruit weight 13.10 ±1.80 g; seed weight 1.94 ±0.08 - seed weight: Fruit weight 14.81) seeds were separated from the fruits, and rinsed the seeds in tap water followed dried the seeds in an air oven at 55±5°C for 48 hr until the moisture content reached about 8.9%. The dried seeds were ground by disc mill to particles passing through 20 mesh sieves and directly divided of the dried seed powders into 1 kg in polyethylene bags and kept at 4°C until analysis as described by [17].

Preparation of beef Meatball samples

Five mixes formula of meatballs were prepared as following:-

Table 1. formula of prepared meatballs samples.

Ingredients (%)	Beef meatball samples at Different replacement levels				
	(0%) control	4% DSP	8% DSP	12% DSP	16% DSP
fresh beef meat	60	60	60	60	60
Fat	20	16	12	8	4
DSP	0	4	8	12	16
wheat flour	5	5	5	5	5
Onion	1	1	1	1	1
Garlic	0.5	0.5	0.5	0.5	0.5
black pepper	1	1	1	1	1
Cumin	0.5	0.5	0.5	0.5	0.5
Salt	2	2	2	2	2
Water	10	10	10	10	10
Total	100	100	100	100	100

Formula of meatballs control and four treatments samples were mixed them separately and thoroughly kneaded (mix it well to make a paste) and allowed to stand in cooling for 20 minutes at (4˚C±1).The meatballs were weighing 19g and then formed by hand until having a diameter range about of 30 mm and then directly packaging in polyethylene bags and stored under cooling conditions (4˚C±1) until analysis [18].

Chemical analysis

Moisture, crude protein, ash, crude fiber contents were determined according to AOAC [19]. Total carbohydrates were determined by differences. Minerals content (Na, K, Mg, Ca, P, Fe, Mn, Zn and Cu) were estimated according to AOAC [19].

Antioxidant compounds analysis

Total polyphenols and total flavonoids were determined according to Bahorun *et al.*, [20].Identification phenolic compounds were determined by HPLC according to Martín-Sánchez *et al.*, [21].

Antioxidant activity assay (μmol trolox equivalents/g sample

The Oxygen Radical Absorbance Capacity (ORAC) assay was measure the ability of antioxidative compounds in test materials to inhibit the decline in fluorescence induced by peroxyl radical 2, 20-azobis (2-amidinopropane) dihydrochloride (AAPH) and ORACFL values were expressed as μmol trolox equivalents/g of dried weight. The ORACFL values were calculated according to the method of Al-Farsi *et al.,* [22].

Physical analysis

Water holding capacity

The Water holding capacity (WHC) for meatball samples was measured the outer zone areas were formed on the filter paper for all samples by using a plan meter (Placom Digital plan meter KP-90 N) described by Al Juhaimi, *et al.,* [23].

Determination of the pH

10 grams of each sample were homogenized in 100 ml distilled water and the pH was measured using a pH meter (Orion 3-star, MA, USA) equipped with temperature probe as outlined by Ockerman [24].

Color values

Measured with a colorimeter (CR-400, Konica Minolta, Inc., Osaka, Japan). Three meatballs of the each prepared meatball samples were used for the analysis and replicate measurements were taken on the surface of each prepared meatball samples. The color measurement was calibrated with a white reference tile after the L (Lightness), a (Redness) and b (Yellowness) values measurement functions of the device ad had been selected. The L, a and b values were described according to Yam, and Papadakis [25] and Dogan [26], as follows:-

$$L = \frac{\text{Lightness}}{255} \times 100 \quad , a = \frac{240a}{255} - 120 \quad \text{and} \quad b = \frac{240b}{255} - 120$$

Cooking quality of meatball samples

Different prepared meatball samples were cooked by deep frying into Sunflower oil at 170 ˚C for 5 min and cooling to room temperature. After cooling, the cooking yield, cooking loss, moisture retention and fat absorption of meatballs were measured for them according to American Meat Science Association [27], as follows:

Cooking loss (g/100g) =

$$\frac{\text{Weight of uncooked meatballs(g)-Weight of cooked meatballs}}{\text{Weight of uncooked meatballs (g).}} \times 100$$

Cooking yield (g/100g): were calculated by differences cooking loss from 100.

Moisture retention (%) =

$$\frac{\text{Moisture in cooked meatballs (\%)}}{\text{Moisture in uncooked meatballs (\%)}} \times \text{cooking yield}$$

Fat absorption (%) =

fat in cooked meatball(%) − fat in uncooked meatball (%)

Sensory evolution

The sensory evaluation (appearance, color, odor, taste, tenderness, juiciness and overall acceptability) of beef meatball samples were measured by serving cooking beef meatball samples to 40 familiar panelists. Panelists using a hedonic scale of 1-10 evaluated as follows: 10 the most liked, 5 unacceptable margins and 1 the most disliked. All necessary precautions were taken to ensure that each panelist made an independent judgment [28].

Statistical analysis

All data analysis of chemical composition, antioxidant compounds, physical, cooking quality and sensory evaluation of meatball samples was statistically analyzed by using SPSS (version 16.0 software Inc. Chicago, USA) of completely randomized design as described by Gomez, and Gomez [29].

3. Results and Discussion

Proximate chemical composition, minerals content and Antioxidant compounds of DSP

Proximate chemical composition and minerals content of DSP

The proximate chemical composition (moisture, Crude Protein, fat, ash, Crude dietary fiber and total carbohydrates) and minerals (Na, Ca, K, P, Mg, Mn, Fe, Cu and Zn) content of DSP were determined and listed in Table (2). From the obtained results in Table (2), It could be showed that the DSP have a higher content of crude dietary fiber (35.24 %) while, crude protein and fat were recorded a medium contents (7.15, and 8.11%, respectively), while the Ash was a low content (2.34%). The aforementioned Date was the relative results with those obtained by Amany *et al*. and Golshan *et al*. [30,31]. Also, From the obtained results in Table (2), It could be noticed that the sodium, calcium, potassium, magnesium and phosphorus were found the higher concentrations of the macro element contents respectively in DSP it were recorded (57.7, 49.5, 26.9, 24.7 and 22.11 µg/g, respectively). While, the Iron, zinc, copper and manganese were found a higher concentrations of the micro element contents respectively in DSP it was recorded (2.6, 2.1, 1.8 and 0.8 µg/g, respectively). The above mentioned results were in accordance with those reported by Sawaya *et al*. and AlHooti *et al*. [32,33].

Table 2. Proximate chemical composition and Mineral contents (µg/g) of DSP (on dry weight basis)

Parameters	Date seeds powder content (%)
Proximate chemical composition (g / 100g) *(M± SE)*	
Moisture (%)	8.94±0.41
Crude Protein (%)	7.15±0.17
Ash (%)	2.34±0.09
Fat (%)	8.11±0.11
Crude dietary fiber (%)	35.24±0.39
Total carbohydrates (%)	47.16±0.41
Minerals content(µg/g)	
Na	57.7
Ca	49.5
K	26.9
Mg	24.7
P	22.11
Fe	2.6
Zn	2.1
Cu	1.8
Mn	0.8

M± SE: Means± standard error for natural Antioxidant compounds of DSP

Antioxidant compounds and antioxidant activity of DSP

The phytochemical compounds such as phenolic compounds as **(**total polyphenols and flavonoids) which have healthy effects for their bioavailability into human body where it's as antioxidants, ant carcinogenic and also considered as chemopreventive for inhibition of pathogenic bacteria [30,21].

To make have these healthy effects, in this study, the DSP were determined their content of total polyphenols and flavonoids compounds, antioxidant activity by ORAC assay and Identification of phenolic compounds and the results listed in Table (3 and 4).

Total Phenolic compounds (polyphenols and flavonoids mg/100g) and antioxidant activity (µmol trolox equivalents/g) of DSP

The phenolic compounds of DSP including total polyphenols and total flavonoids, and the antioxidant activity (ORAC) in DSP were measured and the results were listed in Table (3). From the presented results in (Table 3), it could be observed that the total phenolic compounds content in DSP it was recorded (3930.90 mg/100g) as (3490.15 and 440.75 mg/100g) for total polyphenols and total flavonoids, respectively. And also, the ORAC activity it was recorded (78.11 µmol trolox equivalents/g) of DSP. Each 100 grams of date seed powder contains 3806.01 mg of polyphenols, and as the addition is in proportions of 4 to 16 grams per 100 grams, the meatball mixture, i.e. polyphenols in proportions from 152 to 608 approximately, and the recommended amount of polyphenols is from 600 to 1000 mg in Today and therefore the addition under the recommended proportions.These results were relatively comparable with the Date given by Al-Farsi *et al.* and Al-Farsi *et al.* and Amany *et al.* [22,16,30].

Table 3. Antioxidant properties of DSP_(on dry weight).

	Antioxidant properties	Date seeds powder
1	Total Phenolic *compounds* (mg/100g) -Total polyphenols -Total Flavonoids	3930.90±2.44 3490.15 ±2.59 440.75±1.22
2	ORAC activity (µmol trolox equivalents/g)	780.11±0.76

M± SE: Means± standard error for natural Antioxidant compounds of DSP. ORAC :-oxygen radical absorbance capacity

Identification phenolic compounds (polyphenols and Flavonoids) of DSP (mg/100 g)

The identification phenolic compounds (polyphenols and flavonoids) of DSP (mg/100 g) were measured by HPLC and presented in Table (4). The presented Date from Table (4), it was showed that (16) component of identified phenolic compounds (11 polyphenols and 5 flavonoids).

The obtained results from Table (4), it were showed that the the major contained of polyphenols in DSP for Gallic acid, p-hydroxybenzoic acid, Protocatechuic acid, *m*-coumaric acid and *o*-coumaric acid it were recorded amount (27.16, 20.84, 18.20, 14.85 and 11.64%, respectively) from total polyphenols in DSP, followed them by the Caffeic and Chlorogenic (4.41 and 1.76%, respectively). The other polyphenols in DSP were recorded amount ranged between (0.11 to 0.56%). On the other hand, the Rutin was the higher compound of total flavonoids in DSP it was presented amount (54.68%) followed by Catechein (25.41%). However, the other flavonoid compounds in DSP it were ranged between about (3.15 to13.56%). The mentioned data are in accordance with those reported by Farsi *et al.*, Ardekani *et al.* and Abdul Afiq *et al.* [16,34,35]. Farsi *et al.*, reported that the Date seeds are an excellent source of phenolic compounds (3102-4430 mg gallic acid equivalents/100g fresh weight) and antioxidants (580-929 µmol trolox equivalents/g fresh weight). Also, according to Ardekani *et al.* Iranian date seed varieties had a relatively high antioxidant activity and were strong radical scavengers that could be used for medicinal and commercial. Abdul Afiq *et al.*, found that the Gallic acid, protocatechuic acid, *p*-hydroxybenzoic acid, vanillic acid, caffeic acid, *p*-coumaric acid, ferulic acid, *m*-coumaric acid and *o*-coumaric acid were identified in date seeds.

Table 4. Identification phenolic compounds of DSP (mg/100 g).

N	Phenolic compounds	Phenolic compounds (mg/100 g) of DSP	
*	Polyphenols	mg/100 g	(%)
1	Gallic acid	925.12	27.16
2	p-hydroxybenzoic acid	710.08	20.84
3	Protocatechuic acid	620.14	18.20
4	*m*-coumaric acid	505.65	14.85
5	*o*-coumaric acid	396.64	11.64
6	Caffeic	150.42	4.41
7	Chlorogenic	59.94	1.76
8	Ferulic	19.06	0.56
9	p-Coumaric	12.07	0.35
10	Vanillic acid	3.88	0.12
11	cryptochlorogenic acid	3.77	0.11
	Total polyphenols	3406.77	100
**	Flavonoids		
1	Rutin	218.33	54.68
2	Catechein	101.45	25.41
3	Kaempferol glycosides	54.17	13.56
4	Quercetin glycosides	12.68	3.20
5	Epicatechin	12.61	3.15
	Total flavonoids	399.24	100
	Total Phenolic compounds	**3806.01**	

Quality characters (Proximate chemical composition, Antioxidant properties, Physical properties, Cooking quality and Sensory evaluation of beef meatballs samples as affected by DSP addition

Proximate chemical composition of beef meatball samples as affected by DSP addition

The proximate chemical composition of the beef meatballs produced as affected by addition of DSP at different levels (5, 10, 15 and 20%) compared with beef meatball control sample (without addition of DSP) was determined and listed in Table (5).

From the obtained date in Table (5), It could be showed that no significant differences ($p<0.05$) in moisture for uncooked beef meatballs samples, while, showed significant increase ($p<0.05$) in moisture for cooked beef meatballs samples contained DSP as compared with control sample.

Table 5. Proximate chemical composition of beef meatball samples as affected by DSP addition.

Parameters (%)	Chemical composition content (%) of uncooked and cooked beef meatballs samples On wet and dry weight basis (M± SE)									
	Control (0% DSP)		4% DSP		8% DSP		12% DSP		16% DSP	
	uncooked	cooked	uncooked	cooked	uncooked	cooked	uncooked	cooked	uncooked	cooked
Moisture	58.03± 0.46^{a}	14.03± 0.33^{A}	58.30± 0.45^{a}	16.20± 0.36^{B}	58.48± 0.47^{a}	18.51± 0.34^{C}	58.61± 0.46^{a}	0.81± 0.35^{D}	58.85± 0.48^{a}	23.03± 0.34^{E}
Crude Protein	6.29± 0.23^{a}	14.98± 0.14^{A}	6.44± 0.25^{ab}	15.44± 0.11^{AB}	6.59± 0.24^{abc}	15.87± 0.10^{BC}	6.74± 0.25^{bc}	16.29± 0.09^{CD}	6.89± 0.24^{c}	16.75± 0.09^{D}
Fat	7.54± 0.21^{e}	21.97± 0.13^{E}	5.97± 0.23^{d}	14.33± 0.09^{D}	4.43± 0.24^{c}	10.68± 0.14^{C}	2.93± 0.22^{b}	7.09± 0.09^{B}	1.44± 0.23^{a}	3.51± 0.09^{A}
Ash	0.96± 0.06^{a}	2.28± 0.12^{A}	1.01± 0.06^{b}	2.41± 0.10^{B}	1.05± 0.06^{bc}	2.53± 0.09^{BC}	1.11± 0.06^{cd}	2.67± 0.10^{D}	1.15± 0.06^{d}	2.79± 0.10^{D}
Crude fiber	0.51± 0.04^{a}	1.21± 0.11^{A}	1.20± 0.04^{b}	2.88± 0.09^{B}	1.89± 0.04^{c}	4.57± 0.11^{C}	2.57± 0.04^{d}	6.22± 0.10^{D}	3.26± 0.04^{e}	7.93± 0.10^{E}
Total carbohydrate	26.67± 0.39^{a}	45.53± 0.10^{A}	27.08± 0.39^{ab}	48.74± 0.09^{B}	27.56± 0.40^{ab}	47.84± 0.12^{B}	28.04± 0.39^{b}	46.92± 0.11^{AB}	28.41± 0.40^{b}	45.99± 0.11^{AB}

M± SE: Means± standard error for proximate chemical composition of beef meatball samples; the means within the same row having different superscripts are significantly varied ($p<0.05$).

From the same obtained data in Table (5), It could be showed a little significant increase ($P<0.05$)) in crude protein, ash and total carbohydrates content for both uncooked and cooked beef meatballs samples by increasing replacement levels (4 to 16%) of DSP as compared with control sample.

The protein content values of the prepared uncooked and cooked beef meatball samples contained of DSP at levels (4, 8, 12 and 16%) were recorded (6.44, 6.59, 6.74 and 6.89 %, respectively) for uncooked beef meatball samples, while uncooked control sample was recorded (6.29%), and also, it were recorded (15.44, 15.87, 16.29 and 16.75%, respectively) for cooked beef meatball samples as compared with control sample (14.98%).

Also, for ash values were recorded (1.01, 1.05, 1.11 and 1.15%, respectively) and (2.41, 2.53, 2.67 and 2.79%, respectively) for uncooked and cooked beef meatball samples contained of DSP as comparison uncooked and cooked control samples (0.96 and 2.28%, respectively).

Also, the total carbohydrates content values for both uncooked and cooked beef meatballs samples were recorded (27.08, 27.56, 28.04 and 28.41%, respectively) and (48.74, 47.84, 46.92 and 45.99 %, respectively) for uncooked and cooked beef meatball samples contained DSP as comparison uncooked and cooked control samples (26.67 and 45.53 %, respectively.

While, showed a higher significant increase ($p<0.05$) of fiber content by increasing replacement levels (4 to 16%) of DSP in both uncooked (1.20 to 3.26%) and cooked (2.88 to 7.93%) beef meatballs samples as compared with control sample (0.51 and 1.21%, respectively) .

On the other hand, it could be noticed that the fat content was significant decreased ($p<0.05$) by increasing the level of replaced of DSP from fat at deferent levels (20, 40, 60 and 80%) in uncooked (5.97, 4.43, 2.93 and 1.44%, respectively) and cooked (14.33, 10.68, 7.09 and 3.51%, respectively) of beef meatballs samples as compared with the control sample (7.54 and 21.97%, respectively).

These results of the little increase of crude protein, ash and total carbohydrates and a higher increase of crude fiber in beef meatballs by increasing replacement levels (4 to 16%) of DSP may be due to a little increase in crude protein, ash, total carbohydrates and a higher increase content of DSP in crude fiber content as shown in Table (2). and also, decrease of fat content in beef meatballs samples may be due to increase replacing of fat by DSP at levels (0, 20, 40, 60 and 80%) which were represented (0, 4, 8, 12 and 16%) from total formula of beef meatballs and also decreased of fat content in DSP.

The mentioned results were the same way with those obtained by AlHooti *et al.*, Amany *et al*. and Golshan, *et al*. [33,30,31].

Generally, the meatballs containing of DSP have a good source of crude fiber contents, in addition for fortification of produced the beef meatball and other meat products.

Antioxidant properties (mg/100g) of beef meatball samples as affected by DSP addition

The addition of DSP into beef meatballs at levels (0, 4, 8, 12 and 16%) replaced of animal fat by levels (0, 20, 40, 60 and 80%) which was designed in this study to prepared beef meatballs enriched by phenolic compounds which it were known with have healthy benefit characteristics in human body as antioxidants, ant carcinogenic and other healthy benefit characteristics. It was found by many studies that the phenolic compounds (polyphenols and flavonoids) could be player these roles in human body [16,36,21].The date seeds content has an excellent sources of phenolic compounds ranged about (3102-4430 mg /100g date seeds weight) and antioxidants activity ranged about (580-929 µmol trolox equivalents/g date seeds weight). Therefore this a great potential to be used of date seeds as a supplement for antioxidant characteristics in food, and medicine products [16,30,36]. The phenolic compounds (total polyphenols and total flavonoids) and antioxidant activity (ORAC assay) of DSP and prepared beef meatball samples before and after cooking were determined and these results were listed in Table (6).

These results showed that the addition of DSP to prepared beef meatball samples by levels from (4 to 16%) was much improved its polyphenol and flavonoid compounds in beef meatballs to other nutritive values which recorded significantly improved the antioxidant characteristics as aforementioned.

Table 6. Antioxidant properties (mg/100g) of DSP and uncooked and cooked beef meatball Samples as affected by DSP addition.(on dry weight basis).

Antioxidant properties	DSP	uncooked and cooked beef meatballs samples at different replacement levels				
		control	4% DSP	8% DSP	12% DSP	16% DSP
		Uncooked meatball samples				
Total polyphenols (mg/100g)	3490.15 ±2.59	1.66± 0.16 [a]	176.82± 1.10 [b]	351.13± 1.77 [c]	542.77± 1.80 [d]	692.15± 2.02 [d]
Total Flavonoids (mg/100g)	440.75 ±1.22	0.39± 0.07 [a]	22.11± 0.55 [b]	43.77± 0.69 [c]	64.90± 0.66 [d]	85.81± 0.70 [d]
ORAC assay (µmol trolox equivalents/g sample)	780.11 ±0.76	1.29± 0.09 [a]	40.75± 0.56 [b]	79.75± 0.66 [c]	118.65± 0.85 [d]	157.82± 0.86 [d]
		Cooked meatball samples				
Total polyphenols (mg/100g)	3490.15 ±2.59	0.80± 0.05 [a]	169.29± 0.65 [b]	344.79± 1.16 [c]	512.99± 2.06 [d]	681.47± 2.06 [d]
Total Flavonoids (mg/100g)	440.75 ±1.22	0.10± 0.01 [a]	20.80± 0.66 [b]	41.73± 0.76 [c]	62.66± 0.53 [d]	84.09± 0.76 [d]
ORAC assay (µmol trolox equivalents/g sample)	780.11 ±0.76	1.01± 0.05 [a]	38.80± 0.44 [b]	77.50± 0.75 [c]	116.80± 0.76 [d]	155.20± 0.80 [d]

M± SE: Means± standard error for Antioxidant properties of beef meatball samples; the means within the same row having different superscripts are significantly varied ($p<0.05$). ORAC :-oxygen radical absorbance capacity

It could be showed that the strongly significant increase ($p<0.05$) in polyphenol and flavonoid compounds and antioxidant activity (ORAC) in uncooked and cooked beef meatballs by increasing addition levels of DSP (4, 8, 12 and 16%) it was recorded (176.82, 351.13, 542.77 and 692.15 mg/100g) for total polyphenols and (22.11, 43.77, 64.90 and 85.81 mg/100g) for total flavonoids and (40.75,79.75, 118.65 and 157.82 μmol trolox equivalents/g) for ORAC in uncooked beef meatball samples as compared with beef meatball control sample (1.66 and 0.39 mg/100g and 1.29 μmol trolox /g, respectively).

In the same way , it could be showed that the total polyphenols, total flavonoids and antioxidant activity were showed a significant increase ($p<0.05$) flavonoids and antioxidant activity for produced beef meatball samples, therefore this a great potential to be used of date seeds as a supplement for antioxidant characteristics in produce of beef meatballs, meat and other food products for have a healthy beneficial functions.

Physical properties of meatball samples (Water holding capacity(g/g),
PH values and color properties) as affected by DSP addition
Water holding capacity (WHC) of beef meatballs samples as affected by DSP addition

The WHC of the produce uncooked and cooked beef meatballs samples was measured and listed in Table (7). From the obtained result in (Table 7), it could be recorded that a significant increased ($p<0.05$) by increasing of replacing at levels (4 to 16%) in prepared Uncooked and cooked beef meatballs samples beef meatballs samples, it was recorded ranged about (3.06 to 8.14 and 5.33 to 9.85

by increasing of replacement levels fat by DSP at levels (4 to 16%) in produced uncooked and cooked beef meatballs samples, it were recorded ranged about (169.29 to 681.47 mg/100g) for total polyphenols, and ranged about (20.80 to 84.09 mg/100g, respectively) for total flavonoids and (38.80 to 155.20 μmol trolox /g) for antioxidant activity as comparison to control sample (0.8 and 0.10 mg/100g, and 1.01 μmol trolox /g, respectively). These results were accordance with [16,30,36,21].

Generally, from the this discussion for these results, it could be mentioned that the all replacement levels fat by DSP at levels (4 to 16%) in prepared beef meatballs samples led to increasing the considered amounts of total polyphenols, total

g/g) for uncooked and cooked beef meatballs samples respectively as compared with beef meatballs control samples (1.29 and 3.16 g/g, respectively) on wet weight basis.

On the other hand, from the result in the same Table (7), it could be noticed that no a significant differences ($p<0.05$) in PH values for uncooked and cooked beef meatballs samples contained DSP and control sample. This result was relative them the results obtained from [33,30,31].

This significant increase of WHC in prepared beef meatballs samples containing DSP may be due to a higher content of crud fiber content in DSP led to increased the WHC of prepared beef meatball samples as compared with control samples.

Generally, it could be noticed that the replacing of animal fat with DSP at levels (4 to 16%) led to increase the WHC of prepared beef meatball samples containing DSP as compared with control samples.

Table 7. Water holding capacity (g/g) and PH values of uncooked and cooked meatball samples as affected by DSP addition (on wet weight basis).

Physical properties	Uncooked and cooked beef meatballs samples at different replacement levels				
	control	4% DSP	8% DSP	12% DSP	16% DSP
	Uncooked meatball samples				
Water holding capacity (g/g)	1.29 ± 0.20^{a}	3.06 ± 0.43^{b}	4.80 ± 0.32^{c}	6.49 ± 0.19^{d}	8.14 ± 0.21^{e}
PH values	6.07 ± 0.07^{a}	6.03 ± 0.09^{a}	6.05 ± 0.06^{a}	6.06 ± 0.05^{a}	6.09 ± 0.06^{a}
cooked meatball samples					
Water holding capacity (g/g)	3.16 ± 0.19^{a}	5.33 ± 0.23^{b}	6.77 ± 0.22^{c}	8.11 ± 0.21^{c}	9.85 ± 0.21^{e}
PH values	5.89 ± 0.08^{a}	5.91 ± 0.09^{a}	5.93 ± 0.08^{a}	5.96 ± 0.07^{a}	5.95 ± 0.09^{a}

M± SE: Means± standard error for water holding capacity and PH values of beef meat ball samples; the means within the same row having different superscripts are significantly varied ($p<0.05$) .

Color properties of uncooked and cooked meatball samples as affected by DSP addition

The color values: L (Lightness), a (Redness) and b (Yellowness) values were measured with a colorimeter method and results were presented in Table (8). According to the obtained results in Table (8), it could be found that the significant decreased ($p<0.05$) in *L* value of uncooked and cooked meatball samples containing DSP by increasing replacing levels of DSP (4 to 16%). It was recorded decreased range about (38.09 to 33.18 and 48.33 to 42.97, respectively as compared with control samples (39.87 and 50.05, respectively).

On the other hand, showed the significant increased ($p<0.05$) in (a and b) values of uncooked and cooked meatball samples by increasing replacing levels of DSP (4 to 16%). The (a)values of uncooked and cooked meatball samples it were recorded an increased ranged about (3.68 to 5.05 and 4.81 to 6.93, respectively) as compared with control samples (3.05 and 3.85, respectively), and also, the b values were increased range about from (9.30 to 10.99and 10.40 to 11.94, respectively) as compared with control samples (8.89 and 9.94, respectively).

Table 8. Color properties of uncooked and cooked meatball samples as affected by DSP addition.

color properties		Color properties of meatball samples at different replacement levels (M± SE)			
	control	4% DSP	8% DSP	12% DSP	16% DSP
Uncooked meatball samples					
L*	$39.87±0.22^{e}$	$38.09±0.33^{d}$	$36.81±0.32^{c}$	$34.92±0.29^{b}$	$33.18±0.21^{a}$
a*	$3.05±0.11^{a}$	$3.68±0.13^{b}$	$4.12±0.10^{c}$	$4.81±0.11^{d}$	$5.05±0.10^{e}$
b*	$8.89±0.17^{a}$	$9.30±0.13^{b}$	$9.90±0.11^{c}$	$10.43±0.12^{d}$	$10.99±0.11^{e}$
cooked meatball samples					
L*	$50.05±0.37^{e}$	$48.33±0.30^{d}$	$46.89±0.33^{c}$	$44.60±0.31^{b}$	$42.97±0.29^{a}$
a*	$3.85±0.10^{a}$	$4.81±0.12^{b}$	$5.29±0.10^{c}$	$6.18±0.11^{d}$	$6.93±0.11^{e}$
b*	$9.94±0.14^{a}$	$10.40±0.13^{b}$	$10.96±0.12^{c}$	$11.41±0.17^{d}$	$11.94±0.13^{e}$

M± SE: Means± standard error for color properties of beef meat ball samples; the means within the same row having different superscripts are significantly varied ($p<0.05$) . **L***: lightness - **a***: redness - **b***: yellowness.

These effects on the color (decreased of *L* values and increased in a and b values) by increasing replacing levels of DSP (4 to 16%), it may be due to the higher content of DSP in phenolic compounds (polyphenols and flavonoids), which were highly presented in meatball samples containing DSP, and the color pigments of DSP played an important role in this the ability to color. Also, the higher fiber content of DSP has many functional activities, such as the depending on the physicochemical properties which can improve in the color [4,5].Therefore, the increased of phenolic compounds and fiber content with the addition of DSP led to decrease in lightness of color, while caused increased in redness and yellowness of color by increasing replacing levels of DSP (4 to 16%) from total formula of beef meatballs. These results were accordance with Al-Farsi, *et al.*, Ikhlas *et al* and Dhingra *et al.* [37,38,6].

Cooking quality of beef meatball samples (Cooking yield, Cooking loss,Moisture retention and Fat absorption as affected by DSP addition

Different prepared beef meatball samples were cooked by deep frying into Sunflower oil at 170 ◦C for 5 min and cooling to room temperature. After cooling, the cooking yield, cooking loss, moisture retention and fat absorption of meatballs were measured and the results were listed in Table (9). From the data presented in Table (9), it was recorded a significant increased ($p<0.05$) in the cooking yield and moisture retention of prepared beef meatball samples containing DSP at levels (4, 8, 12 and 16%), it were presented (79.19, 81.49 ,83.80 and 85.97%, respectively) for cooking yield and it were recorded (22.00, 25.79, 29.75 and 33.64%, respectively) for moisture retention as compared with sample control (76.87 and 18.58%, respectively).

On the other hand, it were showed that the significant decreased ($p<0.05$) for cooking loss and fat absorption recorded by increasing of replacing by DSP at levels (4 to 16%) in beef meatballs formula, it was recorded decreased ranged about from (20.81 to 14.03%, respectively) for cooking loss, and (8.36 to 2.07%, respectively) for fat absorption, as compared with sample control (23.13 and 14.43%, respectively).

These increased in the cooking yield and moisture retention, while it was decreased in the cooking loss and fat absorption of prepared beef meatball samples containing DSP may be due to the higher DSP content of fiber which has the water absorption ability it was led to the increased in cooking yield and moisture retention whereas reduced the cooking loss and fat absorption of beef meatball samples containing DSP at different levels as compared with sample control. And also, the fiber content of DSP is low in cost and can be to use in meat products to increase the frying efficiency and improved texture [4,5].This results as mentioned by Al-Farsi, *et al.* and Ikhlas *et al.* [37,38].

Table 9. Cooking quality of meatball samples as affected by DSP addition.

samples	Cooking quality of beef meatball samples at different replacement levels (M± SE)			
	Cooking yield (%)	Cooking loss (%)	Moisture retention (%)	Fat absorption(%)
0% DSP	76.87±0.37 ^{a}	23.13±0.16 ^{e}	18.58±0.17 ^{a}	14.43±0.11 ^{e}
4 % DSP	79.19±0.40 ^{ab}	20.81 ±0.20 ^{d}	22.00±0.20 ^{b}	8.36±0.10 ^{d}
8 % DSP	81.49 ±0.33 ^{bc}	18.51 ±0.19 ^{c}	25.79±0.22 ^{c}	6.25±0.09 ^{c}
12 % DSP	83.80±0.31 ^{cd}	16.20±0.17 ^{b}	29.75±0.20 ^{d}	4.16±0.07 ^{b}
16 % DSP	85.97±0.36 ^{d}	14.03±0.15 ^{a}	33.64±0.31 ^{e}	2.07±0.05 ^{a}

M± SE: Means± standard error for cooking quality of beef meatball samples at different replacement levels by DSP addition; the means within the same row having different superscripts are significantly varied ($p<0.05$).

Sensory evaluation of cooking meatball samples as affected by DSP addition

The organoleptic criteria (appearance, color, odor, taste, tenderness, juiciness and overall acceptability) of prepared meatball samples were measured and listed of results in Table (10).

Table 10.Sensory evaluation of cooking meatball samples as affected by DSP addition.

samples	Appearance	Color	Odor	Taste	Tenderness	Juiciness	Overall acceptability
0% DSP	8.0±1.30 ^{b}	8.1±1.14 ^{b}	7.9±1.09 ^{bc}	8.0±1.34 ^{c}	7.9±0.83 ^{c}	8.0±0.89 ^{c}	8.0±1.00 ^{b}
4 % DSP	8.2±1.14 ^{b}	8.2±1.30 ^{b}	8.1±1.48 ^{bc}	8.1±0.89 ^{c}	7.8±0.83 ^{c}	7.9±0.83 ^{c}	8.1±0.54 ^{bc}
8 % DSP	8.1±0.89 ^{b}	8.4±0.89 ^{b}	8.2±0.89 ^{c}	7.8±0.80 ^{c}	8.1±0.44 ^{c}	8.1±0.54 ^{c}	8.2±0.83 ^{c}
12 % DSP	8.3±0.89 ^{b}	8.3±0.54 ^{b}	7.8±1.09 ^{b}	7.7±0.54 ^{b}	7.7±0.44 ^{b}	7.5 ±0.44 ^{b}	7.8±0.54 ^{b}
16 % DSP	7.2±0.89 ^{a}	7.1 ±0.54 ^{a}	7.0±1.09 ^{a}	6.9±0.54 ^{a}	6.0±0.44 ^{a}	6.6±0.44 ^{a}	6.8±0.54 ^{a}

M± SE: Means± standard error for sensory evaluation of cooking meatball samples at different replacement levels by DSP addition; the means within the same row having different superscripts are significantly varied ($p<0.05$).

From the obtained data in Table (10), it was recorded that, no significant difference ($p<0.05$) between control beef meatball samples and beef meatball samples contained DSP until replacement level (12%) for the different aforementioned organoleptic criteria (appearance, color, odor, taste, tenderness, juiciness and overall acceptability). While, showed that a significant decreased ($p<0.05$) between beef meatball samples contained (16%) DSP and other beef meatball samples (0, 4, 8 and 12%) of DSP in the all organoleptic criteria (appearance, color, odor, taste, tenderness, juiciness and overall acceptability). The higher fiber content of DSP has canned improve in the color, texture, and affect the sensory properties of food products positively. The use of the most appropriate fiber in food production and storage is important for the final quality products [4,6].This result as mentioned by Al-Farsi, *et al.* [37].

Generally, it could be noticed that, the DSP could be addition up to 12% in produce beef meatball samples without any negative effects on the all organoleptic criteria (appearance, color, odor, taste, tenderness, juiciness and overall acceptability) of beef meatball products.

Conclusion

The use of DSP has a proved to be effectives in production of beef meatball samples. The application of DSP at different aforementioned improved of crude fiber, total phenolic contents and Antioxidant activity, water holding capacity, a and b values, cooking yield and moisture retention, while caused reduced in fat content, *L* values, cooking loss and fat absorption of beef meatball samples containing DSP. Also, the addition of DSP up to 12% in produce beef meatball samples noticed any negative effects on the organoleptic criteria. Generally, it could be observed that, the DSP has good sources of crude fiber, antioxidant properties and useful addition of DSP in ingredients up to 12% for fortification of produced the beef meatball and other meat products without any negative effects on the organoleptic characteristics. For these reasons, it can be provide various benefits in meatballs production.

Conflicts of interest

There are no conflicts to declare.

Formatting of funding sources

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