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Influence of Caper (*Capparis spinosa* L*)* Seeds Powder Addition as Source of Bioactive Phytochemicals on Quality Attributes and Shelf Life Extension of Beef Burger Patties

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ABSTRACT

The aim of this study was to investigation the effect replaced of spices mixture by caper seeds powder (CSP) individually (0, 25, 50, 75 and 100%), which represented (0, 0.5, 1.0, 1.5 and 2%) from total formula of beef burger patties on chemical, physical, microbiological and sensory characteristics of beef burger patties during frozen storage period at (–18±2°C) up to three months. The caper seeds powder as source of bioactive compounds as polyphenols, flavonoids, glucosinolates and unsaturated fatty acids, which are having anti-oxidant, anti-microbial, lowering cardiovascular disease risk and chemo preventive the carcinogenic diseases properties. The obtained results showed that the CSP was rich in most determined matters (on dry weight), as total polyphenols (621.82 mg/100g), total flavonoids (170.65 mg/100g) and total glucosinolates (as allyl isothiocyanate) (413 mg/100g), and high content of most essential fatty acid especially oleic acid (44.75%) and linoleic acid (27.98%). In addition, the CSP contained high amount of crude fiber (13.66 g/100g), crude fat (26.55 g/100g) and minerals especially phosphorous (679 mg/100g), calcium (419 mg/100g), ferrous (6.8 mg/100g) zinc (5.5 mg/100g) and manganese (3.30 mg/100g). Moreover, the incorporation of the CSP into the beef burger patties, substitute of spices mixture, caused an improvement of the healthy safe quality as that inhibited the microbial growth and activity, and the oxidation of lipids in tested prepared product, as well as the improvement or the retention of physicochemical quality criteria (pH value, WHC, shrinkage, TVB-N content and TBA value in the save limit) throughout frozen storage, when compared to control sample. Also, beef burger patties containing the CSP exhibited a good sensory properties and better acceptability, especially those contained 1 and 1.5 % of the CSP, even after stored for 90 days under frozen storage. The present results are useful and it should be directed toward the utilization of CSP in production and fortification of meat products as a good and available inexpensive source of phytochemical compounds as polyphenols, flavonoids and glucosinolates and addition of essential fatty acids especially (oleic acid and linoleic acid), fiber, minerals especially (P, Ca, Fe, Zn and Mn) which are deficient in the most foodstuffs to improve the nutritional, healthy safe, physicochemical and sensory quality criteria, and their stability during handling, marketing and storage.

Key words: Caper seeds, *Capparis Spinosa*, Spices, Beef burger, Shelf life, Fatty acid, Phenols, Flavonoids, Glucosinolates

Introduction

The genus Capparis (caper) includes about 250 species many of them distributed in the Mediterranean regions, Taxonomic classification of the different species is mainly based on quantitative and qualitative morphological traits such as leaf shape, flowers and presence/absence of spines (Inocencio *et al.*, 2006). Most of the species are used as food and have some application in traditional medicine. According to the official food legislation commercial capers consumed as condiment are the flower buds of *Capparis spinosa L* (Rivera *et al.*, 2003).

Caper is the type species of the genus. It is a spiny, prostrate, and perennial little shrub. It has a wide distribution in the Old World from South Europe, North and East Africa, Madagascar, Southwest and Central Asia to Australia and Oceania (Fici, 2004). Although sometimes considered as a weed, *Capparis spinosa* has a long history as an archaeophyte. Immature flower buds, unripe fruits and shoots are consumed as foods or condiments; flower buds, fruits, seeds, shoots and bark of roots were traditionally used for pharmacological purposes, especially for rheumatism (Rivera *et al.*, 2003).

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Caper plants used industrially are generally referred to as *Capparis spinosa*, however, the less defined taxonomy and the fact that several cultivars and some species overlap with others may produce economic implications due to the quality variability of the commercial products (Argentieri, *et al.*, 2012).

Flower buds and fruits of Caper are commercialized in the Mediterranean countries where they are used as food ingredient or condiment and are highly appreciated for their pungent and strong flavor. Capers are also known in folk medicine for their diuretic, astringent, tonic and ant rheumatic properties (Rivera *et al.*, 2003). Furthermore, it has been shown that extracts from caper plants have antihepatotoxic and antioxidant activity and more recently a protein with antiproliferative, antifungal and HIV-1 reverse transcriptase inhibitory effects has been isolated from the *Capparis spinosa* seeds (Sze-Kwan and Tzi-Bun, 2009).

The seeds of Caper unearthed from archaeological sites were usually considered as weeds (Van der Veen and Hamilton-Dyer, 1998). However, the seeds have various uses. Caper seeds are rich in protein, oil, and fiber, and have a potential as food (Akgül and Ôzcan, (1999). It has a peppery flavor, and could be used as a condiment. Seeds of caper medicinal value, due to the presence of ferulic acid and sinapic acid. The seeds, boiled in vinegar can be used to relieve toothache (Cooremans, 1999); the other parts of caper are important in medicine, also root bark of caper was consumed for curing different illness, including cough, asthma, paralysis, scrofula, toothache, spleen disease, and skin disease, the therapeutic properties of caper were kept on using to date (Anonymous, 2005). In today fruits of capers are collected by the indigenous pharmacologists as a very important source of medicine for curing rheumatism (Anonymous, 1977).

Many food products are perishable by nature and require protection from spoilage during their preparation, storage and distribution to give them desired shelf life. Because food products are now often sold in areas of the world far remote from their production sites, the need for extended safe shelf-life for these products has also expanded. Improvements in the cold distribution chain have made international trade of perishable foods possible, but refrigeration alone cannot assure the quality and safety of all perishable foods. Although the value of traditional food preservatives has been recognized, their safety has been questioned (Holley and Patel, 2005).

The increased interest in ‘‘ready to eat’’ and easy to consume products enhances the obligation for greater control on food quality and safety. Outbreaks of foodborne diseases brought the necessity for alternative methods in controlling microbial growth in food products (Appendini and Hotchkiss, 2002).

Beef burger patties are considered one of the most popular food items which are played a significant role in the modern nutritious diets, as a core member of fast food family prepared in restaurants and at home (Oroszvári *et al.*, 2006).

Antioxidants are widely used as additives in meat processing because they increase the storage stability. There is a large amount of literature on the effects of antioxidants on lipid oxidation processes, whereas literature on the effect on the N-nitrosamines (NAs) formation in meat products is limited (Li e*t al.*, 2013). The presence of antioxidant in meat plays the important role in the kinetic aspects of the nitrite reactions. These antioxidants may reduce the nitrous acid formed from nitrite ion (Skibsted, 2011). Thus, the production of NAs may be limited by the presence of ascorbate because it adds to the several reactions that NO from nitrite can participate (Hill *et al*., 1988).

The aim of this study was to investigation the effect substitution of spices mixture individually (0, 25, 50, 75 and 100%), which represented (0, 0.5, 1.0, 1.5 and 2%) from total formula of beef burger patties by caper seeds powder (CSP) on chemical, physical, microbiological and sensory characteristics of beef burger patties during frozen storage period at (–18±2°C) up to three months.

Materials and Methods

1- Materials:

A. Caper fruits: Fresh caper fruits (*Capparis spinose L*) were obtained from the Saint Catherine, South Sinai Governorate, Egypt.

B. Beef meat: The beef meat of binned quarter was used in this investigation, which obtained from the local butcher shop in the day before each experiment.

C. **Soybean flour:** It was obtained from Food Technology Research Institute, Agriculture Research Center, Giza, Egypt.

D. **Spices:** Spices mixture containing of (Cumin 57.0 % - Coriander 20.0% - Black pepper 6.0% - Cloves 6.0% - Cubeb 3.0% - Nutmeg 3.0% - Cardamon 2.0% - Red pepper 2.0% and Thyme 1.0%) was obtained from Harraz market, Cairo, Egypt.

E. **Another ingredients:** Fresh eggs, onion and salt (sodium chloride) were obtained from local market in Cairo City, Egypt. While, sodium tripolyphosphate, sodium ascorbate and sodium nitrite were purchased from El- Gamhouria Trading Chemicals and Drugs Company, Egypt.

Fig. 1: Fresh and dried caper fruits.

2-Methods:

I-Experimental treatments:

a) Preparation of caper seeds powder:

The caper fruits are collected, and the seeds are separated from the fruits. After this process, the seeds were rinsed in tap water and dried in an air oven provided with a motor fan, at 50-55°C for 10-12 hr. till its moisture content reached to 7-9 %. The dehydrated seeds were ground by using a laboratory disc mill to particles passing through 20 mesh sieve which is similar to the same size of wheat flour to be blended as described by Yamazaki *et al*., (1988) and Olmez *et al.*, (2004).

b) Preparation of spices mixture - caper seeds powder (SM-CSP) blends:

Spices mixture (SM) was replaced individually by 0, 25, 50, 75 and 100% of CSP, which represented (0, 0.5, 1.0, 1.5 and 2%) from total formula of beef burger patties. The SM-CSP blends were individually blended and homogenized, then kept in polyethylene bags at (4 ±1°C) in a refrigerator for the further processing.

c) Preparation of beef burger patties:

1- Ground beef was prepared by using aseptic procedures, sterile utensils and sanitized equipment. The meat was ground in meat grinder (Italmans, Motore Asincrono monoface, Italy) through 6mm grinder plate at ambient temperature (about 25°C).

2- Beef burger formulation:

The SM with and without CSP were hydrated by adequate portion of water; another portion of water was used to dissolve salt and other additives. Ground beef, hydrated SM with and without CSP, salt and another ingredients were mixed by mixer (Braun AG, No, 4122, Germany) for 5min. to ensure good distribution. After mixing each batch, about 3kg, used individually in making beef burger patties, 80 g weight, 1.0 cm thickness and 10.0 cm diameter for each. The beef burger patties were placed on plastic foam meat trays, wrapped with polyethylene film and kept at (-18±2°C) frozen until further cooking and analysis (Dreeling *et al*., 2000 and Oroszvari *et al*., 2005b).

Table 1: Ingredients (%) of the beef burger patties

Ingredient	%
Lean meat	63.0
Soybean flour	11.0
Fresh eggs	6.5
Fresh onion pastes	6.0
Salt (sodium chloride)	1.5
Iced water	10.0
Spices mixture	2.0
Sodium tripolyphosphate	0.30
Sodium ascorbate	0.03
Sodium nitrite	0.015

3- Cooking of beef burger patties:

The beef burger patties were cooked for measuring the diameter shrinkage and organoleptic evaluation for them. The beef burger patties were thawed at 4±1ºC overnight in a refrigerator before frying. Burgers were pan-fried on a laboratory grill (Suteskv, Russia), the size of the flat was 300x300 mm, and a pan temperature of 160±5 º C was used. Burgers were cooked for 6 min for each side, as described by Ou and Mittal, (2006).

II-Analytical Methods:

Analytical methods for prepared beef burger patties were carried out initially and periodically at 30 days intervals throughout frozen storage at (-18±2 ºC) for 90 days as follows:

A) Chemical analysis:

a) Chemical composition:

Moisture, protein (Nx6.25), fat, ash, and fiber contents of caper seeds powder and beef burger patties were determined using the methods described of the A.O.A.C. (2000). Total carbohydrates were calculated by differences as followed:

Carbohydrates (%) =100- the sum of (% moisture + % protein + % fat + % ash + % fiber).

b) Minerals:

Calcium, magnesium, iron, zinc and manganese were determined according to the method of A.O.A.C. (2000), using Atomic Absorption Spectrophotometer-Perkin Elmer, Model 5000, and Germany. Phosphorus was determined by spectrophotometer using molybdovandate method according to A.O.A.C. (2000), while sodium and potassium contents were determined by Flame Photometer (CORNING 400, serial No. 4889.UK).

c) Fatty acids composition:

Fatty acids composition of caper oil sample was determined using gas liquid chromatography. Methylation of all fats was carried out using BF3 in methanol (20%) A.O.A.C. (2000).

d) Total phenolic:

Total phenolic (TP) content was conducted according to the modified Folin– Ciocalteu colorimetric method of Singleton *et al.* (1999).

e) Phenolic compounds:

Phenolic compounds were determined by HPLC according to the method of Goupy *et al.,* (1999).

f) Total flavonoid:

Total flavonoid was analyzed according to the method described by Bahorun *et al*. (2004).

g) Glucosinolates content:

Glucosinolates content was determined as allyl isothyocianate (mg/100g dry weight basis) according to the method described by Mukhopadhyay and Bhattacharyya (2006).

h) DPPH %:

DPPH free radical scavenging activity assay was estimated according to the method of Hatano *et al*. (1988). Each extract (500 µl) was added to a methanolic solution (1 ml) of DPPH radical (final concentration of DPPH was 0.2 m M). The mixture was shaken vigorously and left to stand at room temperature for 30 min. The absorbance of the resulting solution was measured spectrophotometrically at 517 nm. In this test, the percentages of DPPH reduction by each extract were compared to that of BHT. Scavenging activity was expressed as the percentage inhibition calculated using the following formula:

Anti-radical activity (%) = (control absorbance - sample absorbance) × 100/control absorbance.

i)Total volatile basic- nitrogen (TVB-N):

Total volatile basic- nitrogen (TVB-N) content in prepared beef burger patties and caper seeds powder sample was determined by macro-distillation method as described by Pearson (1976).

j)Thiobarbituric acid (TBA):

Thiobarbituric acid (TBA) values of prepared beef burger patties were estimated by colorimetric method at 538nm using digital spectrophotometer Spekol 11 No. 849101 (as mg malonaldehyde / kg sample) according to the method of Pearson (1976).

B) Physical analysis:

a) The Water holding capacity (WHC)

The Water holding capacity (WHC) for beef burger patties was determined by the filter press method as described by Soloviev (1966). A planimeter (PLACOM Digital planimeter KP- 90 N) was used for measured the outer zone areas were formed on the filter paper for all samples.

b) pH:

pH value was determined according to the procedure described by Schoeni *et al*. (1991), using a calibrated pH meter (Beckman model 3550, USA).

c) The diameter shrinkage:

The shrinkage percentage was calculated as described by American meat science association (Oroszvari *et al*. 2006).

$$\text{Shrinkage (\%)} = \frac{(a-b)+(c-d)}{a+c} \times 100$$

a=Thickness of un cooked burger b= Thickness of cooked burger,
c=Diameter of un cooked burger d= Diameter of cooked burger

C) Microbiological aspects:

The microbiological analysis of prepared beef burger patties was carried out including the determination of total bacterial count (TBC) using nutrient agar medium, psychrophilic bacteria count was enumerated on nutrient agar medium, yeast and mold count using malt extract agar medium and coliform bacteria counted on Mac Conky's agar medium, according to the method described by Oxoid 1982, UK. The arithmetic mean viable count of three replicates per one gram of sample was recorded.

D) Sensory evaluation of beef burger patties:

Samples of beef burger patties containing a CSP as a substitute of spices mixture at different ratios of (0, 25, 50, 75 and 100 %) were subjected to sensory evaluation according to Cross *et al*. (1978). Sensory evaluation was carried out by 10 panels from educational organization members of Food Science and Technology Department, Faculty of Agriculture, Al-Azhar University. The sensory technique was carried out by using a hedonic test ten-point scale to evaluate color, taste, odor, tenderness, juiciness, appearance and overall acceptability of the tested product samples.

E) Statistical analysis:

Data of chemical composition, physicochemical properties, microbiological aspects and sensory evaluation were statistically analyzed by using SPSS (version 16.0 software Inc. Chicago, USA) of completely randomized design as described by Gomez and Gomez (1984).

Results and Discussion

Nutritional value and antioxidant character of caper seeds powder (CSP):

1- Chemical composition:

The chemical composition of CSP are listed in Table (2), namely moisture, protein, fat, ash, dietary fibers and total carbohydrates content of CSP. As shown in Table (2), the gross chemical constituents of CSP were 18.03, 26.55, 5.69, 13.66 and 36.07 (g/100g) for protein, fat, ash, fiber and carbohydrates content, on dry weight basis; respectively. Thereupon, the CSP is considered a good source of fat, fiber and protein; therefore, it may be utilized in human nutrition. The present results are in accordance with those obtained by Özcan and Aydın, (2004) and Tlili *et al.*, (2009)

Table 2: Chemical composition of CSP (g/100g).

Chemical composition (g/100g)	CSP (M± SE)	
	W/W*	D/W**
Moisture	81.97±1.83	-
Protein	3.25±0.57	18.03±0.83
Fat	4.78±0.44	26.55±0.83
Ash	1.03±0.14	5.69±0.83
Fiber	2.47±0.09	13.66±0.83
Carbohydrates	6.50±0.81	36.07±0.83

M± SE: Means± standard error for chemical composition. W/W: wet weight. D/W**: dry weight*

2- Fatty acid composition:

For further nutritional evaluation of CSP, the fatty acids composition was determined by gas liquid chromatography analysis. The obtained data are listed in Table (3). The obtained results indicated that caper oil had high content of unsaturated fatty acids (78.87%) and low amount of saturated fatty acids (21.13%). The fatty acid $C_{16:0}$ showed the highest value among saturated fatty acid (14.66%), while the unsaturated fatty acid $C_{18:1}$ exhibited the highest values among saturated fatty acids (44.75%) in oil caper sample. The above mentioned data are in accordance with those results given by Akgül and Ôzcan, (1999) and Matthäus and Özcan, (2005).

Therefore, the incorporation of CSP in beef burger patties which deficient in the unsaturated fatty acids (oleic, linoleic and linolenic acids) may be have a nutritional value in human nutrition in Egypt.

Table 3: Fatty acid composition (%) of caper seeds oil

Fatty acids %	Caper seeds oil
Lauric ($C_{12:0}$)	0.41
Myristic ($C_{14:0}$)	0.69
Palmitic ($C_{16:0}$)	14.66
Palmitoleic ($C_{16:1}$)	4.49
Stearic ($C_{18:0}$)	5.37
Oleic ($C_{18:1}$)	44.75
Linoleic ($C_{18:2}$)	27.98
Linolenic ($C_{18:3}$)	0.95
Arachidic ($C_{20:0}$)	0.70
Total saturated fatty acids	21.13
Total unsaturated fatty acids	78.87

3-Minerals content:

The nutritional value of CSP as sources of macro and micro elements was also considered beside of fatty acid composition. Considering the macro mineral elements Na, K, P, Ca and Mg was determined. However, for micro mineral elements Fe, Zn and Mn were estimated. The results are listed in Table (4).

Table 4: Minerals content (mg/ 100 g) of CSP (on dry weight)

Minerals	CSP (mg/100g)	*RDA (mg/ day)
		Adults
Ca	419	800 – 1200
Mg	213	280 – 350
K	157	--------
Na	652	---------
P	679	800 – 1200
Fe	6.8	10 – 15
Zn	5.5	12 - 15
Mn	3.30	12 - 15

RDA*: *Recommended Dietary Allowances* ***A.O.A.C. (2000)***

From this Table, it could be observed that the CSP is containing high amounts of phosphorous (679 mg/100g), sodium (652 mg/100g), calcium (419 mg/100g), magnesium (213 mg/100g) and potassium (157mg/100g), and reasonable amounts of ferrous (6.8 mg/100g), zinc (5.5 mg/100g) and manganese (3.30 mg/100g). The above mentioned data for CSP are in comparable with those investigated by Özcan and Aydın, (2004). Thereupon, CSP characterizes with its richness with the most tested minerals (macro and micro-elements), and therefore it may be utilized in food fortification. Generally, they are considered as a good source of macro and micro-elements.

4-Natural antioxidant characteristic of CSP:

Phytochemical compounds such as phenolic compounds that have much more valuable materials that known to be have healthy effect for their bioavailability in human body where it acts as antioxidants, anticarcinogenic and also considered as chemo preventive for inhibition of pathogenic bacteria. It was found by many workers that phenolic compounds in diets could play this role in our bodies (Picchi *et al.*, 2012 and Gowers, 2010). Therefore, it was established as healthy materials, as reported by other workers (Dixon, 2007 and Clout, 2009). To make beef burger patties, in present work, CSP was partially substituted from spices mixture in produced beef burger at different (0, 0.5, 1.0, 1.5 and 2%) for the improving the antioxidant potential of beef burger by increasing its phenolic compounds content without compromising its sensory quality.

The health promoting phytochemicals including total phenols, total flavonoids, glucosinolates content (as allyl isothiocyanate contents as antioxidant compounds and the total antioxidant activities (TAA) by determination of DPPH activity test percentage in CSP were determined and the obtained results are shown in Table (5). From the obtained data (Table 5), it could be noticed that the total polyphenols compounds content was the major antioxidants compounds found in CSP, it was represented about (621.82 mg/100g), followed by glucosinolates content which was (413 mg/100g),

while the total flavonoids in CSP was lower than the total polyphenols which was (170.65 mg/100g). From the same Table (5), it could be also observed that the DPPH activity test percentage of CSP was recorded (95.46%). Their results were relatively comparable with the data given by Özcan and Aydın, (2004). From the former discussion, it could be mentioned that all substitution level of spices mixture by CSP led to addition to produced beef burger considered amounts of natural antioxidants, so the addition of CSP to beef burger causes the prolongation of its shelf-life as well as the maintenance or enhancement its original quality properties, especially the healthy safe quality, with providing the consumer of food containing the CSP with the healthy beneficial functions.

Table 5: Total phenolic, flavonoid, glucosinolates content (mg/100g) and DPPH activity % of CSP (on dry weight)

Natural antioxidants	CSP (M± SE)
Total polyphenols (as gallic acid)	621.82±2.80
Total flavonoids as rutin	170.65±1.53
Glucosinolates content (as allyl isothiocyanate)	413±1.89
DPPH activity (%)	95.46±1.03

Identification of phenolic compounds in CSP:

The health promoting phytochemicals such as phenolic compounds as antioxidants which are naturally occurred in caper seeds powder were determined by HPLC analysis in powder, as shown in Table (6).

Table 6: Phenolic compounds (ppm) of CSP (on dry weight)

Phenolic compounds	Phenolic compounds (ppm) of CSP
Gallic	20.77
Pyrogallol	829.38
4-Amino-benzoic	90.86
Protocatchuic	102.12
Chlorogenic	601.15
Epi-Catachin	301.20
Catechein	211.30
Catechol	715.5
Caffeine	992.15
P-OH-benzoic	548.23
Caffeic	612.32
Vanillic	750.50
P-coumaric	321.20
Ferulic	30.41
Iso-ferulic	39.80
Reversetrol	19.89
Ellagic	155.70
e-vanillic	698.90
Alpha-coumaric	50.45
Benzoic	56.16
3,4,5-methoxy-cinnamic	34.30
Coumarin	14.76
Salycilic	170.33
Cinnamic	1.11
Total	6186.78

The obtained results (Table 6), indicated that It could be observed that in through 24 components of identified phenolic constituents, CSP was higher content of 7 compounds; these were Caffeine (992.15 ppm), Pyrogallol (829.38 ppm), Vanillic (750.50 ppm), Catechol (715.5 ppm), e-vanillic (698.90 ppm), Caffeic (612.32 ppm), Chlorogenic (601.15 ppm) and P-OH-benzoic (548.23 ppm), followed by P-coumaric, Epi-Catachin, Catechein, Salycilic, Ellagic, Protocatchuic and Amino-benzoic were represented (321.20, 301.20, 211.30, 170.33, 155.70, 102.12 and 90.86 ppm, respectively), on the ether hand the other phenolic compounds was identified in extracts of CSP, were amount ranged between 1.11-56.16 ppm. The mentioned data are in accordance with those reported by Argentieri, *et al.* (2012).

Effect of storage period on quality characteristics of beef burger patties containing different levels of CSP instead of spices mixture during frozen storage at (-18±2°C for 90 days):

The influence of incorporating the CSP into the beef burger patties at different levels (0, 0.5, 1.0, 1.5 and 2%) instead of spices on frozen stability for the most important quality criteria, including gross chemical composition, physicochemical quality criteria (pH, WHC, shrinkage, TVB-N and TBA values) and health safe quality properties with regards the microbiological quality aspects (TBC, yeast & mold, psychrophilic bacteria and coliform bacterial) was investigated initially and periodically at 30 days intervals throughout frozen storage at -18 ±2ºC for 90 days as the following:

1- Effect of frozen storage period on the chemical composition of beef burger patties sample:

The chemical composition of prepared beef burger patties (moisture, protein, fat, ash, fiber and total carbohydrate) in present work which are beef burger patties (control) and that contained CSP at levels of (0, 0.5, 1.0, 1.5 and 2%) instead of spices mixture of both were determined at zero time; 30, 60 and 90 days at -18 ±2ºC. The results presented in Table (7).

Table 7: Chemical composition of beef burger patties containing different levels of CSP instead of spices mixture during frozen storage at (-18±2°C for 90 days).

Properties / Storage period (days)	Addition level of the CSP (M± SE)									
	0%		0.5%		1%		1.5%		2%	
	W.W	D.W	W.W	D.W	W.W	D.W	W.W	D.W	W.W	D.W
Moisture%										
0	70.27±1.27^{a}	-	70.30±1.30^{a}	-	70.35±1.31^{a}	-	70.38±1.29^{a}	-	70.41 ±1.31^{a}	-
30	70.66±1.21^{a}	-	70.34±1.28^{a}	-	70.44±1.29^{a}	-	70.47±1.26^{a}	-	70.53 ±1.30^{a}	-
60	70.78±1.24^{a}	-	70.39±1.29^{a}	-	70.50±1.28^{a}	-	70.58±1.28^{a}	-	69.60 ±1.29^{a}	-
90	70.83±1.25^{a}	-	70.47±1.27^{a}	-	70.58±1.29^{a}	-	70.63±1.28^{a}	-	69.69 ±1.26^{a}	-
Protein%										
0	18.80±0.97^{a}	60.18±1.21^{a}	18.85±0.92^{a}	60.27 ±1.27^{a}	18.88±0.90^{a}	60.63 ±1.27^{a}	18.92±0.91^{a}	60.71 ±1.11^{a}	18.93 ±0.93^{a}	60.97±1.22^{a}
30	18.51±0.94^{a}	59.87±1.17^{a}	18.53±0.91^{a}	59.90 ±1.22^{a}	18.60±0.91^{a}	59.53 ±1.28^{a}	18.65±0.92^{a}	59.77 ±1.17^{a}	18.54 ±0.92^{a}	59.90±1.27^{a}
60	18.13±0.96^{a}	58.25±1.11^{a}	18.45±0.95^{a}	59.11 ±1.21^{a}	18.27±0.92^{a}	59.22 ±1.29^{a}	18.19±0.94^{a}	59.31 ±1.15^{a}	18.22 ±0.91^{a}	59.46±1.25^{a}
90	17.94±0.95^{a}	57.92±1.16^{a}	17.98±0.93^{a}	58.03 ±1.18^{a}	18.01±0.90^{a}	58.07 ±1.26^{a}	18.04±0.93^{a}	58.10 ±1.19^{a}	18.06 ±0.90^{a}	58.12±1.27^{a}
Fat %										
0	4.59 ±0.87^{a}	15.03±0.88^{a}	4.70±0.90^{ab}	15.27 ±0.91^{ab}	4.84±0.88^{bc}	15.46 ±0.97^{bc}	4.97±0.93^{cd}	15.63 ±0.90^{cd}	5.09 ±0.92^{d}	15.87±0.96^{d}
30	4.55 ±0.82^{a}	14.98±0.87^{a}	4.62±0.91^{ab}	15.21 ±0.93^{ab}	4.76±0.89^{bc}	15.40 ±0.94^{bc}	4.90±0.97^{cd}	15.58 ±0.92^{cd}	4.99 ±0.90^{d}	15.81±0.93^{d}
60	4.49 ±0.80^{a}	14.83±0.83^{a}	4.55±0.89^{ab}	15.17 ±0.97^{ab}	4.70±0.90^{bc}	15.33 ±0.92^{bc}	4.86±0.94^{cd}	15.51 ±0.91^{cd}	4.93 ±0.93^{d}	15.73±0.92^{d}
90	4.40 ±0.81^{a}	14.81±0.80^{a}	4.51±0.91^{ab}	15.13 ±0.98^{ab}	4.64±0.91^{bc}	15.30 ±0.91^{bc}	4.79±0.91^{cd}	15.47 ±0.97^{cd}	4.89 ±0.91^{d}	15.70±0.97^{d}
Ash %										
0	3.31 ±0.31^{a}	10.54±0.97^{a}	3.35±0.27^{a}	10.61 ±0.87^{a}	3.39±0.27^{a}	10.65 ±0.83^{a}	3.43±0.26^{a}	10.67 ±0.87^{a}	3.45 ±0.27^{a}	10.74±0.87^{a}
30	3.27 ±0.30^{a}	10.50±0.98^{a}	3.32±0.25^{a}	10.54 ±0.88^{a}	3.37±0.25^{a}	10.59 ±0.87^{a}	3.40±0.26^{a}	10.61 ±0.85^{a}	3.42 ±0.24^{a}	10.68±0.80^{a}
60	3.23 ±0.33^{a}	10.44±0.94^{a}	3.29±0.21^{a}	10.50 ±0.90^{a}	3.31±0.27^{a}	10.55 ±0.88^{a}	3.33±0.27^{a}	10.58 ±0.87^{a}	3.38 ±0.25^{a}	10.61±0.84^{a}
90	3.19 ±0.31^{a}	10.40±0.93^{a}	3.23±0.27^{a}	10.43 ±0.89^{a}	3.27±0.22^{a}	10.48 ±0.87^{a}	4.30±0.21^{a}	10.50 ±0.89^{a}	3.32 ±0.27^{a}	10.53±0.89^{a}
	Fiber %									
0	0.30 ±0.08^{a}	0.84±0.09^{a}	0.31±0.10^{a}	0.89 ±0.07^{a}	0.33±0.10^{b}	0.96 ±0.07^{b}	0.34±0.09^{b}	1.01 ±0.07^{b}	0.36 ±0.08^{c}	1.13 ±0.07^{c}
30	0.29 ±0.09^{a}	0.79±0.10^{a}	0.30 ±0.08^{a}	0.85 ±0.07^{a}	0.33±0.08^{b}	0.93 ±0.07^{b}	0.34±0.08^{b}	0.99 ±0.08^{b}	0.37 ±0.07^{c}	1.11 ±0.08^{c}
60	0.28 ±0.08^{a}	0.75±0.07^{a}	0.30±0.07^{a}	0.79 ±0.07^{a}	0.32±0.07^{b}	0.90 ±0.07^{b}	0.33±0.07^{b}	0.99 ±0.07^{b}	0.35 ±0.07^{a}	1.10 ±0.07^{c}
90	0.27 ±0.09^{a}	0.71±0.08^{a}	0.29±0.07^{a}	0.73 ±0.09^{a}	0.31±0.07^{b}	0.88 ±0.09^{b}	0.33±0.07^{b}	0.98 ±0.09^{b}	0.34 ±0.09^{a}	1.10 ±0.07^{c}
	Carbohydrates %									
0	2.76 ±0.10^{e}	13.41±0.10^{e}	2.36±0.09^{d}	12.82 ±0.07^{d}	1.94±0.07^{c}	12.0 ±0.07^{c}	1.62±0.07^{b}	11.56 ±0.07^{b}	1.31 ±0.10^{a}	10.86±0.11^{a}
30	2.74 ±0.11^{e}	13.37±0.11^{e}	2.31±0.11^{d}	12.76 ±0.09^{d}	1.89±0.10^{c}	11.92 ±0.09^{c}	1.56±0.07^{b}	11.50 ±0.07^{b}	1.27 ±0.08^{a}	10.81±0.07^{a}
60	2.73 ±0.12^{e}	13.35±0.10^{e}	2.30±0.09^{d}	12.69 ±0.07^{d}	1.81±0.08^{c}	11.85 ±0.11^{c}	1.50±0.09^{b}	11.42 ±0.11^{b}	1.23 ±0.09^{a}	10.73±0.11^{a}
90	2.71 ±0.11^{e}	13.33±0.09^{e}	2.29±0.08^{d}	12.61 ±0.07^{d}	1.73±0.11^{c}	11.74 ±0.09^{c}	1.43±0.08^{b}	11.36 ±0.07^{b}	1.18 ±0.11^{a}	10.61±0.07^{a}

M± SE: *Means± standard error for chemical composition; the means within the* ***same row*** *having different superscripts are significantly varied (P ≤ 0.05).*

From statistical analysis of these data in Table (7), it could be noticed that no significant differences (P≤ 0.05) in moisture, protein and ash content of all prepared beef burger patties containing the CSP when compared with the control at initial zero time or observed throughout frozen storage period. From the obtained results Table (7), it could be noticed that total carbohydrates content of beef burger patties containing the CSP were recorded significant decreased (P≤ 0.05) with increasing the incorporated levels of the CSP, when compared with the control beef burger sample. On the other hand, the results presented in Table (7), it could be noticed that significant increased (P≤ 0.05) in fat and fiber contents of beef burger patties containing the CSP with increasing the incorporated levels of the CSP, when compared with the control beef burger sample. These observations may be due to the variation between the CSP and spices mixture in their contents from the former gross chemical components.

Generally, it could be seen that beef burger patties containing the CSP had a good nutritional quality even after frozen storage for 90 days at -18 ±2ºC, and the incorporation of the CSP into the beef burger patties, as a substitute of spices mixture, could be improved their nutritional quality with regards fat and crude fiber contents (Akgül and Ôzcan, 1999).

2- Effect of frozen storage period on the physicochemical quality criteria of beef burger patties samples:

Frozen storage stability for the most important physicochemical quality criteria of prepared beef burger patties; including the pH value, water holding capacity (WHC), shrinkage, total volatile basic-nitrogen (TVB-N) content and thiobarbituric acid (TBA) value, as affected by the addition different levels from CSP was investigated. The obtained results are listed in Table (8). From this Table (8), the addition of CSP, instead of spices mixture to beef burger patties recorded no significant decrease (P≤ 0.05) in pH values when compared with control sample containing spices mixture. On the other hand, the pH value was increased continuously in all prepared beef burger patties throughout frozen storage. The increment rate in that value was slight decreased as the addition level of the CSP increase, whereas, the control sample of beef burger patties exhibited the highest pH value. The increase in the pH values of the tested beef burger trials throughout frozen storage may be attributed mainly to breakdown and degradation of beef burgers protein during storage resulting in formation of some basic compounds such as volatile basic nitrogen compounds, amines and hydrogen sulfide, leading to increase the pH value (Stahnke, 1995).

From the same previous data (Table 8), it could be also observed that the water holding capacity (WHC) of the tested beef burger patties was increased by increasing the incorporation levels of the CSP from 1% to 2% into the beef burger patties, as the result of increasing crude fiber and carbohydrates, by incorporating the CSP into the product, which characterized with a highly efficiency to bound water. During frozen storage, the WHC values were reduce continuously in all tested beef burger patties, especially in control sample, with extending the frozen storage period as the result of breakdown the hydrogen bonding between the water molecules and the other components of beef burgers by the effect of freezing process. In general, it could be observed that the addition of the CSP improved the WHC of beef burger patties.

With regards diameter shrinkage which is considered one of the most important physical quality changes that occurs in beef burgers during frying process due to the protein denaturation and squeezing out fat and water from beef burger patties (Oroszvári *et al*., 2005b). As given in Table (8), the percentage of diameter shrinkage in beef burger patties was decrease continuously with increasing the addition levels of CSP. In addition, the shrinkage increased linearly for all tested beef burger patties during frozen storage, but it was more evident in the control sample than the other samples containing the CSP at level of 0.5 –2 %. These results are in accordance with those found by Oroszvári *et al*. (2005a).

Concerning the total volatile basic-nitrogen (TVB-N) and thiobarbituric acid value (TBA) content of beef burger patties as affected by CSP addition and frozen storage period, as given in Table (8), it could be showed that the incorporation of the CSP into the beef burger patties caused the reduction in their TVB-N and TBA contents, as the addition level of CSP was increased from 0.5 to 2%. Beef burger patties contained CSP represented the TVB-N and TBA content of (10.03 : 11.18 mg/100g) and (0.43 : 0.76 mg/kg) respectively on wet weight basis, while, the control sample was recorded 11.70 mg/100g and 0.91 mg/kg, respectively on wet weight basis at zero time storage, On the other hand, a gradual increase in the TVB-N and TBA values of all tested beef burger patties was observed throughout frozen storage up to 90 days, but the control sample represented significant increased (P≤0.05) when compared with prepared beef burger patties containing CSP, that observation

could be attributed to the antioxidants, antimicrobial properties and inhibition effect on proteolysis enzymes activity of the polyphenols, flavonoids, glucosinolates content and DPPH activity for CSP, which are naturally occurrence at a high concentration in the CSP (Zhang et al.,2005). It is worth to mention that the TVB-N values for all prepared beef burger patties were within the permissible value (30 mg/100g, on wet weight basis) reported by Egyptian Organization for Standardization and Quality Control (2005)

Table 8: Physicochemical properties of beef burger patties containing different levels of CSP instead of spices mixture during frozen storage at (-18±2°C for 90 days), (on wet weight).

Physicochemical properties / Storage period(days)	Addition level of the CSP (M± SE)				
	0%	0.5%	1%	1.5%	2%
	PH value				
0	6.93±0.27^{a}	6.91±0.29^{a}	6.89±0.22^{a}	6.74±0.27^{a}	6.71±0.25^{a}
30	7.21±0.33^{a}	7.06±0.26^{ab}	6.99±0.25^{ab}	6.86±0.26^{ab}	6.83±0.26^{b}
60	7.44±0.29^{a}	7.26±0.28^{ab}	7.18±0.26^{ab}	7.05±0.28^{b}	7.02±0.27^{b}
90	7.73±0.28^{a}	7.50±0.27^{ab}	7.41±0.29^{ab}	7.33±0.29^{b}	7.25±0.28^{b}
	Total Volatile Nitrogen (TVN) mg/ 100g sample				
0	11.70±0.37^{a}	11.18±0.31^{a}	10.51±0.32^{b}	10.37±0.29^{b}	10.03±0.28^{b}
30	17.12±0.32^{a}	16.53±0.34^{a}	13.82±0.31^{b}	13.44±0.30^{bc}	13.12±0.29^{c}
60	22.19±0.34^{a}	20.69±0.37^{b}	19.09±0.35^{c}	16.22±0.37^{d}	15.00±0.31^{e}
90	27.10±0.35^{a}	25.83±0.33^{b}	23.20±0.37^{c}	21.06±0.35^{d}	20.01±0.34^{e}
	Thiobarbituric acid value (TBA) mg/kg sample				
0	0.91±0.10^{a}	0.76±0.12^{b}	0.59±0.09^{c}	0.54±0.07^{d}	0.43±0.08^{e}
30	1.17±0.17^{a}	0.99±0.16^{b}	0.71±0.11^{c}	0.63±0.08^{d}	0.47±0.09^{e}
60	1.54±0.14^{a}	1.28±0.15^{b}	0.84±0.12^{c}	0.76±0.09^{d}	0.52±0.08^{e}
90	2.05±0.19^{a}	1.84±0.18^{b}	1.19±0.16^{c}	0.95±0.11^{d}	0.76±0.10^{e}
	Water Holding Capacity (WHC) bound water %				
0	83.15±1.18^{a}	83.32±1.15^{a}	83.39±1.11^{a}	83.44±1.10^{a}	83.55±1.13^{a}
30	82.73±1.17^{a}	83.12±1.16^{a}	83.31±1.10^{a}	83.57±1.11^{a}	83.81±1.10^{a}
60	81.94±1.11^{a}	82.37±1.10^{a}	82.64±1.09^{a}	82.97±1.13^{a}	83.08±1.11^{a}
90	80.59±1.12^{a}	81.73±1.11^{a}	82.13±1.03^{a}	82.53±1.10^{a}	82.62±1.12^{a}
	Shrinkage %				
0	9.52±0.45^{a}	9.40±0.44^{a}	9.33±0.43^{a}	9.17±0.45^{a}	9.05±0.46^{a}
30	10.50±0.48^{a}	10.02±0.49^{ab}	10.00±0.49^{b}	9.52±0.47^{b}	9.23±0.49^{b}
60	12.14±0.51^{a}	10.89±0.48^{b}	10.13±0.47^{c}	9.60±0.49^{d}	9.46±0.44^{d}
90	13.18±0.59^{a}	11.29±0.44^{b}	10.80±0.49^{c}	10.01±0.48^{d}	9.67±0.48^{d}

M± SE: *Means± standard error for chemical composition; the means within the* ***same row*** *having different superscripts are significantly varied (P ≤ 0.05).*

3- Effect of frozen storage period on the microbiological aspects of beef burger patties samples:

In view of safety evaluation of any processed foods, either after preparation or after storing, to be ready for human consumption, the microbiological quality is mainly undertaken (Lin *et al*., 2000).

It is known that meat and their products are considered one of the most perishable foods, and therefore, it is of great importance to follow up the microbiological case of the prepared beef burger trials to protect consumers health against microbiological illnesses among food-borne diseases and to achieve the healthy safe quality of the final product for a long storage period (Rhee *et al.,* 2003).

The bacteriological load of meat products depends upon the microbial load of the raw meat used for mincing, sanitary conditions, time and temperature of storage. Other sources of microorganisms in beef burgers include spices, condiments, salt, onion, egg and binders. Total bacterial counts have been used to assess sanitary quality, organoleptic ability, safety and utility of various meat products (Fliss *et al.,* 1991).

In present work, frozen storage at (-18±2ºC for 90 days) stability for microbiological aspects of beef burger patties samples including; total bacterial count (TBC), mold and yeast counts (M&Y), Psychrophilic bacteria and coliform bacterium group were examined periodically at 30 days intervals during frozen storage for 90 days. The obtained results are recorded in Table (9).

From statistical analysis of these data in Table (9), it could be noticed that no significant differences (P≤0.05) in microbiological counts (TBC, M&Y, Psychrophilic bacteria and coliform bacterium counts) of all prepared beef burger patties samples at the beginning (zero time) of frozen

storage. After that, the counts of the former microbiological aspects were recorded significant increase (P≤0.05) throughout frozen storage up to 90 days, as the result of their adaptation on freezing conditions. On the other hand, the reduction rate in the former microbial aspects count for beef burger patties samples containing CSP was increased with increasing the addition levels of CSP to the product and also much higher than that for control sample no containing CSP (Keum *et al*., 2004 and Argentieri, *et al.,* 2012).

Table 9: Microbiological aspects (log cfu /g) of beef burger patties containing different levels of CSP instead of spices mixture during frozen storage at (-18±2°C for 90 days).

Microbiological aspects / Storage period(days)	Addition level of CSP (M± SE)				
	0%	0.5%	1%	1.5%	2%
	Total bacterial count (TBC)				
0	4.23±0.10^{a}	4.20±0.11^{a}	4.20±0.10^{a}	4.18±0.11^{a}	4.12±0.10^{a}
30	4.39±0.11^{b}	4.18±0.10^{ab}	4.14±0.11^{a}	4.09±0.10^{a}	4.07±0.09^{a}
60	4.44±0.09^{b}	4.32±0.11^{ab}	4.23±0.09^{a}	4.19±0.08^{a}	4.15±0.08^{a}
90	4.69±0.12^{b}	4.47±0.09^{a}	4.40±0.10^{a}	4.33±0.09^{a}	4.29±0.08^{a}
	Molds & yeasts				
0	3.10±0.08^{a}	3.06±0.07^{a}	3.04±0.09^{a}	3.03±0.07^{a}	3.02±0.09^{a}
30	3.05±0.07^{b}	2.98±0.08^{ab}	2.88±0.07^{a}	2.82±0.08^{a}	2.80±0.07^{a}
60	3.31±0.06^{b}	3.02±0.06^{ab}	2.98±0.08^{ab}	2.95±0.07^{a}	2.92±0.08^{a}
90	3.65±0.07^{b}	3.36±0.08^{a}	3.30±0.09^{ab}	3.20±0.09^{a}	3.15±0.09^{a}
	Psychrophilic bacteria				
0	2.78±0.07^{a}	2.75±0.08^{a}	2.74±0.08^{a}	2.73±0.09^{a}	2.70±0.08^{a}
30	3.19±0.08^{b}	3.14±0.07^{b}	2.94±0.07^{a}	2.86±0.07^{a}	2.82±0.09^{a}
60	3.34±0.09^{b}	3.29±0.08^{b}	3.10±0.08^{a}	3.08±0.08^{a}	3.06±0.07^{a}
90	3.43±0.08^{b}	3.36±0.07^{b}	3.19±0.07^{a}	3.11±0.07^{a}	3.08±0.08^{a}
	Coliform group				
0	2.20±0.07^{a}	2.15±0.07^{a}	2.13±0.07^{a}	2.13±0.07^{a}	2.11±0.08^{a}
30	2.41±0.09^{c}	2.14±0.07^{b}	2.09±0.08^{b}	1.88±0.08^{a}	1.85±0.07^{a}
60	2.48±0.07^{c}	2.09±0.09^{b}	1.96±0.07^{ab}	1.89±0.09^{a}	1.87±0.08^{a}
90	2.55±0.09^{c}	2.11±0.07^{b}	2.04±0.09^{ab}	1.93±0.07^{a}	1.89±0.09^{a}

M± SE: *Means± standard error for chemical composition; the means within the* ***same row*** *having different superscripts are significantly varied (P ≤ 0.05).*

It is worth to note that the tested microbial quality criteria of all prepared beef burger trials were within the permissible counts reported by Egyptian Organization for Standardization and Quality Control (2005), that recommended the total bacterial and coliform bacterium group counts not exceed 5 and 3 log cfu/g; respectively for frozen beef burgers and as free from *Staphylococcus aureus*.

Generally, it could be seen that the reducing rate of microbial aspects count for beef burger patties samples containing CSP during frozen storage could be mainly attributed to the antibacteriological and antioxidant properties of polyphenols, flavonoids, glucosinolates content and DPPH activity for CSP, and their breakdown products, especially allyl isothiocyanate, which are naturally occurred at a high concentration in the CSP.

4- Effect of frozen storage period on the organoleptic quality criteria of beef burger patties samples:

As in all food, organoleptic tests are generally the final guide to the quality from the consumer's point of view. The organoleptic quality properties of meat products are greatly affected by the ingredients used in processing treatments and by storage conditions. They also correlated significantly with physicochemical and microbiological quality criteria of these products. Sensory evaluation, together with estimation the former criteria have been used extensively to assess the quality of meat products. Therefore, the organoleptic evaluation was carried out in order to evaluate the color, taste, odor, tenderness, juiciness, appearance and overall acceptability of beef burger treatments as affected by addition of CSP at levels of (0, 0.5, 1.0, 1.5 and 2%) instead of spices mixture during frozen storage at –18±2˚C up to 90 days compared with the control samples, using ten experienced panelists; members of Food Science and Technology Dept., Faculty of Agric., Al-Azhar Univ., Egypt. The obtained data are statistically analyzed and recorded in Table (10).

As show in Table (10), it could be noticed that there was no significant alteration in all sensory quality criteria between beef burger patties containing CSP up to the level of 1.5 % and control beef burger sample. While, the increase of the incorporation level of the CSP up to the level of 2 % into the product than the former caused a significant decreased in sensory judging scores of the tested organoleptic quality properties on beef burger patties when compared with the control sample. Beef burger patties containing the CSP at level of 1.5% had the highest sensory scores for tenderness, juiciness, appearance and overall acceptability, also, there was no significant variation between it and other characteristics judging scores and the corresponding scores for the control sample. On the other hand, there was a negligible alteration in the sensory evaluation scores for the tested organoleptic properties of the control sample and beef burger patties containing CSP up to the addition level of 1.5%, after which no significant variation in the most properties was occurred throughout frozen storage, when compared to the control sample. While, the beef burger patties containing CSP up to the level of 2 % showed a significant decrease in the tested organoleptic quality properties of beef burger patties when compared with the control sample especially at the end of storage period.

In general, it could be showed that beef burger patties containing the CSP exhibited a good sensory properties and better acceptability when compared with control sample, especially with incorporation of 1 and 1.5 % of CSP, even after stored for 90 days under frozen storage conditions at (-18±2°C for 90 days).

Table 10: Sensory evaluation of beef burger patties containing different levels of CSP instead of spices mixture during frozen storage at (-18±2°C for 90 days)

Storage period (days)	Addition level of CSP				
	0%	0.5%	1%	1.5%	2%
	Color				
0	8.00±0.79^{a}	8.00±0.81^{a}	8.05±0.80^{a}	8.20±0.81^{a}	7.35±0.79^{b}
30	8.00±0.81^{a}	7.90±0.80^{a}	7.90±0.79^{a}	8.10±0.78^{a}	7.30±0.81^{b}
60	7.85±0.78^{a}	7.85±0.79^{a}	7.85±0.73^{a}	8.00±0.76^{a}	7.25±0.77^{b}
90	7.90±0.80^{a}	7.80±0.80^{a}	7.75±0.71^{a}	7.90±0.77^{a}	7.20±0.79^{b}
	Taste				
0	8.05±0.70^{a}	8.00±0.70^{a}	8.05±0.70^{a}	8.25±0.72^{a}	7.30±0.69^{b}
30	7.80±0.72^{a}	7.90±0.71^{a}	7.95±0.72^{a}	8.00±0.71^{a}	7.10±0.77^{b}
60	7.90±0.77^{a}	7.80±0.72^{a}	7.85±0.70^{a}	7.90±0.70^{a}	6.90±0.74^{b}
90	7.80±0.71^{a}	7.80±0.73^{a}	7.80±0.71^{a}	7.80±0.71^{a}	6.70±0.70^{b}
	Odor				
0	8.10±0.70^{a}	8.10±0.71^{a}	8.15±0.71^{a}	8.20±0.70^{a}	6.80±0.70^{b}
30	8.000.72^{a}	8.00±0.72^{a}	8.00±0.70^{a}	7.90±0.71^{a}	6.90±0.73^{b}
60	7.80±0.71^{a}	7.80±0.70^{a}	7.80±0.69^{a}	7.90±0.73^{a}	6.30±0.67^{b}
90	7.60±0.70^{a}	7.60±0.71^{a}	7.70±0.72^{a}	7.75±0.72^{a}	6.30±0.70^{b}
	Tenderness				
0	7.90±0.80^{a}	7.90±0.76^{a}	8.00±0.70^{a}	8.05±0.70^{a}	7.45±0.66^{b}
30	7.70±0.77^{a}	7.80±0.71^{a}	7.80±0.71^{a}	7.80±0.71^{a}	7.30±0.65^{b}
60	7.80±0.71^{a}	7.60±0.77^{a}	7.65±0.72^{a}	7.90±0.72^{a}	7.20±0.67^{b}
90	7.40±0.76^{a}	7.60±0.70^{a}	7.50±0.70^{a}	7.70±0.72^{a}	7.00±0.69^{b}
	Juiciness				
0	8.00±0.70^{a}	8.00±0.73^{a}	8.05±0.71^{a}	8.10±0.60^{a}	7.40±0.69^{b}
30	8.00±0.77^{a}	8.00±0.74^{a}	7.90±0.70^{a}	7.90±0.65^{a}	7.50±0.68^{b}
60	7.85±0.71^{a}	7.90±0.70^{a}	7.85±0.71^{a}	7.90±0.69^{a}	7.35±0.67^{b}
90	7.65±0.69^{a}	7.70±0.71^{a}	7.70±0.70^{a}	7.80±0.61^{a}	7.15±0.66^{b}
	Appearance				
0	8.00±0.70^{a}	8.05±0.71^{a}	8.10±0.70^{a}	8.20±0.71^{a}	7.50±0.66^{b}
30	7.90±0.77^{a}	8.00±0.72^{a}	8.05±0.71^{a}	8.15±0.69^{a}	7.55±0.67^{b}
60	7.80±0.68^{a}	7.80±0.71^{a}	7.90±0.73^{a}	8.00±0.70^{a}	7.30±0.68^{b}
90	7.60±0.77^{a}	7.70±0.74^{a}	7.75±0.71^{a}	7.80±0.72^{a}	7.10±0.67^{b}
	Overall acceptability				
0	8.00±0.71^{a}	8.00±0.70^{a}	8.10±0.72^{a}	8.20±0.69^{a}	7.40±0.66^{b}
30	7.90±0.70^{a}	7.90±0.71^{a}	8.05±0.71^{a}	8.10±0.70^{a}	7.10±0.67^{b}
60	7.70±0.73^{a}	7.70±0.71^{a}	7.80±0.73^{a}	7.95±0.71^{a}	7.20±0.70^{b}
90	7.60±0.71^{a}	7.70±0.73^{a}	7.75±0.70^{a}	7.80±0.70^{a}	7.00±0.68^{b}

M± SE: *Means± standard error for chemical composition; the means within the* ***same row*** *having different superscripts are significantly varied (P ≤0.05).*

Conclusion

In general, it could be concluded that the present results are useful and it should be directed toward the utilization of CSP in production and fortification of meat products as a good and available inexpensive source of phytochemical compounds as polyphenols, flavonoids and glucosinolates and addition of essential fatty acids especially (oleic acid and linoleic acid), fiber, minerals especially (P, Ca, Fe, Zn and Mn) which are deficient in the most foodstuffs to improve the nutritional, healthy safe, physicochemical and sensory quality criteria, and their stability during handling, marketing and storage.

References

A.O.A.C., 2000. Official Methods of Analysis. 17th ed. of the association of official analytical chemists. Gaithersburg, M. D. USA.

Akgül, A. and M. Ôzcan, 1999. Some compositional characteristics of capers (Capparis spp,) seed and oil. Grasas y Aceites Vol.50. Fase. 1, 49-52

Anonymous, 1977. Medicinal Flora of Xinjiang. Xinjiang People's Publishing House, Urumqi in Chinese: 74–75.

Anonymous, 2005. Material Medical of China. Volume of Uighur Medicine. Shanghai Sci. and Tech. Press, Shanghai in Chinese, 68(102): 191–192.

Appendini, P., and J. H. Hotchkiss, 2002. Review of antimicrobial food packaging. Innovative Food Sci. and Emerging Tech., 3: 113–126.

Argentieri, M., F.Macchia, P.Papadia, F.P. Fanizzi and P.Avato, 2012. Bioactive compounds from Caper spinosa subsp. Rupestris. Industrial Crops and Products, 36: 65–69.

Bahorun, T., A.Luximon-Ramma, A.Crozier, and O.I. Aruoma, 2004. Total phenol, flavonoid, proanthocyanidin and vitamin C levels and antioxidant activities of Mauritian vegetables. J. Sci. Food Agric.,84: 1553–1561.

Clout, L., 2009. Broccoli beats heart disease". Daily Express. http:// www. express. co. UK /posts /view /125136/Broccoli-beats-heart-disease.

Cooremans, B., 1999. An unexpected discovery in Medieval Bruges (Flanders, Belgium): seeds of the caper (Caper spinosa L.). Environmental Archaeology, 4: 97–101.

Cross, H.R., R.Moen and M.S. Stanfield, 1978. Training and testing judges for sensory analysis of meat quality. Food Technology, 36: 48 – 52, 54.

Dixon, G.R., 2007. Vegetable brassicas and related crucifers. Genistein. Phytochem., 60: 205-211.Wallingford: CABI. ISBN 9780851993959.

Dreeling, N., P. Allen and F.Butler, 2000. Effect of the degree of comminution on sensory and texture attributes of low-fat beef burger. Lebensm-Wissu-Tech.,33:290–294.

Egyptian Organization for Standardization and Quality Control, 2005. Frozen beef burger No. 1688/2005.

Fici, S., 2004. Micromorphological observations on leaf and pollen of Caper L. Sect. Caper (Capparaceae). Plant Biosystems, 38: 125–134.

Fliss, L., R. E. Sinard and A.Ettriki, 1991. Composition of three sampling techniques for microbiological analysis of meat science. J. Food Science, 56(1): 249-260.

Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedures for Agricultural Research 2nd Edn. John Wiley, New York, USA.

Goupy, P., M.Hugues, P.Biovin and M.H. Amiot, (1999): Antioxidant composition and activity of barley (Hordeum vulgare) and malt extracts and of isolated phenolic compounds. J. Sci. Food Agric., 79: 1625-1634.

Gowers, S., 2010. Swedes and Turnips, Root and Tuber Crops, Chapter (8) Handbook of Plant Breeding 7. New Zealand Institute for Plant and Food Research Limited, Private Bag 4704, Christchurch 8140.

Hatano, T., H.Kagawa, T.Okuda, and T.Yasuhara, 1988. Antioxidant Activity and volatile components of Egyptian Artemisia judaica L. Chem Phar Bull 36:2090–2097.

Hill, M. J., R. C.Massey, D.E.G.Shuker, S.Leach, A.R. Tricker, R.Preussmann, and J.R. Rowland, 1988. Nitrosamines. Toxicology and microbiology. 169 pp. Ellis Horwood Ltd., UK.

Holley, R.A. and D.Patel, 2005. Improvement in shelf-life and safety of perishable foods by plant essential oils and smoke antimicrobials. Food Microbiology, 22: 273–292

Inocencio, C., D.Rivera, M.C.Obon, F.Alcaraz, and J.A. Barre˜na, 2006. A systematic revision of Caper section Caper (Capparaceae). Ann. Missouri Bot. Gard., 93: 122–149.

Keum, Y. S., W. S.Jeong and A.N.T. Kong, 2004. Review: Chemoprevention by isothiocyanates and their underlying molecular signaling mechanisms. Mutation Research, 555: 191-202.

Li, L., J. Shao, X. Zhu, G. Zhou, and X.Xu, 2013. Effect of plant polyphenols and ascorbic acid on lipid oxidation, residual nitrite and n-nitrosamines formation in dry-cured sausage. International J. of Food Sci and Tech., 48(6): 1157-1164.

Lin, C.M., J.F. Preston, and C.I. Wei, 2000. Antibacterial mechanism of allyl isothoicyanates. J. Food protection, 63 (6): 727 – 734.

Matthäus, B. and M.Özcan, 2005. Glucosinolates and fatty acid, sterol and tocopherol composition of seed oils from Capparis spinosa var. spinosa and Capparis ovata Desf. var. canescens (Coss.) Heywood. J. Agric. Food Chem., 53: 7136–7141.

Mukhopadhyay, S. and D.K. Bhattacharyya, 2006. Colorimetric estimation of allyl isothyocianate content in mustard and rapeseed oil. Wiley. International Sci., 85(8):309-311.

Olmez, Z., Z.U. Yahyaoglu and A.O. Ler, 2004. Effects of H2SO4, KNO3 and GA3 treatments on germination of caper (Caper ovata Desf.) seeds. Pakistan J. of Biological. Sci., 7(6): 879–882.

Oroszvári, B.k., E. Bayod I., Sjohölm, and Tornberg, E. (2005b): The mechanisms controlling heat and mass transfer on frying beef burgers. 2. The influence of the pan temperature and patty diameter. J. of Food Engineering, 71: 18–27.

Oroszvári, B.K., C.S.Rocha, I.Sjöholm and E.Tornberg, 2006. Permeability and mass transfer as a function of the cooking temperature during the frying of beef burgers. J. Food Engineering, 74; 1 – 12.

Oroszvári, B.K., I.Sjohölm and E.Tornberg, 2005a. The mechanisms controlling heat and mass transfer on frying beef burgers. 1. The influence of the composition and comminution of meat raw material. J. of Food Engineering, 67: 499 – 506.

Ou, D. and G.S. Mittal, 2006. Double-sided pan-frying of unfrozen/frozen hamburgers for microbial safety using modelling and simulation. Food Research International, 39 (3): 133-144.

Oxoid, 1982. The Oxoid Manual of Culture Media, Ingredients and other Laboratory Services. Fifth Edithion. Published by oxoid limited wade Road, Basingstoke Hampshire RG24 OPW. UK.

Özcan, M. and C.Aydın, 2004. Physico-mechanical Properties and Chemical Analysis of Raw and Brined Caperberries. Biosystems Engineering, 89 (4): 521–524.

Pearson, S., 1976. Chemical analysis of food. 8th Ed. Harold Egan, Ronald S. Kirk Roland Saweyer (London).

Picchi, V., C.Migliori, R. L.Scalzo, G.Campanelli, and V.Ferrari, 2012. Phytochemical content in organic and conventionally grown Italian cauliflower. Food Chem., 130: 501–509.

Rhee, M.S., S.Y.Lee, R.H. Dougherty and D.H. Kang, 2003. Antimicrobial effects of mustard flour and acetic against Escherichia coli 0157: H7, Listeria monocytogenes and Sallmonella enterica Servar typhimurium. Applied and Envir. Microb., (5): 2959 – 2963.

Rivera, D., C.Inocencio, M.C. Obon and F.Alcaraz, 2003. Review of food and medicinal uses of Caper L. Subgenus Caper (Capparidaceae). Econom. Bot., 57: 515–534.

Schoeni, J. L., K.Brunner and M.P. Doylle, 1991. Rates of thermal inactivation of Listeria monocytogenes in beef and fermented beaker sausage. J. Food Protection, 54: 334 -337.

Singleton, V.L., R.Orthofer and R.M. Lamuela-Raventos, 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin–Ciocalteu reagent. Oxidants and Antioxidants. 299: 152-178.

Skibsted, L. H., 2011. Nitric oxide and quality and safety of muscle based foods. Nitric oxide, 24(4): 176-183.

Soloviev, A.A., 1966. Meat aging in "Food Industry" Pub. (Moscow) 53 -81, 82 -164, 242 -303.

Stahnke, L.H., 1995. Dried sausage fermented with Staphylococcus xylosus at different ingredient levels Part I. Chemical and bacteriological data. Meat Sci., 41(2): 179-191.

Sze-Kwan, L. and N.Tzi-Bun, 2009. A protein with antiproliferative, antifungal and HIV-1 reverse transcriptase inhibitory activities from caper (Caper spinosa) seeds Phytomedicine, 16: 444–450.

Tlili, N., S. M. Bosch, N.Nasrý, E.Saadaouý, A.Khaldý and S.Trýký, 2009. Fatty Acids, Tocopherols and Carotenoýds From Seeds of Tunýsýan Caper “Capparýs spinosa. Journal of Food Lipids 16: 452-464.

Van der Veen, M. and S.Hamilton-Dyer, 1998. A life of luxury in the desert? The food and fodder supply to Mons Claudianus. Journal of Roman Archeology, 11:101–116.

Yamazaki, H., H.W.Modler, J.D. Jones and J.I. Elliot, 1988. Process for preparing flour from Jerusalem artichoke tubers. Canadian Plant Filed, 544021.

Zhang, Y., J.Liu and L.Tang, 2005. Cancer-preventive isothoicyanates: dichotomous modulators of oxidative stress. Free Radical Biology and Medicine, 38: 70 – 77.