ALEXANDRIA
SCIENCE EXCHANGE JOURNAL
VOL. 29 OCTOBER- DECEMBER 2008

General Characteristics and Storage Stability of Beef Burger Containing Citrus Wastes Mixture

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ABSTRACT

The Effect of adding 2% mixture of (Raw, steamed and water blanched) dried free seeds citrus wastes on the chemical composition, storage stability at -18°C for 90 days, sensory properties and microbiological quality of beef burger patties were studied. Such addition caused a slight reduction in moisture and protein, a noticeable rise in carbohydrates, fat retention, WHC, pH and energetic value of beef burger patties. On the other side, frozen storage of such products led to rise in fat retention, WHC, pH, TBA values and a reduction in count of total viable, Psychrophilic, Enterobactereaceae and Coliform bacteria. The evaluation of sensorial attributes of beef burger patties free and containing 2% mixture of free seeds citrus wastes showed nearly closed acceptability before and after frozen storage. Addition of the formentioned waste led to product with low fat and high and antioxidant content.

INTRODUCTION

Beef burger is one of meat popular products over the world. However fat plays a major role in acceptability, structural properties and storage stability of this product. Many consumers think that reducing fat in this product is important for health, fitness and avoiding the risks of subjecting to chronic diseases such as heart diseases, cancer, hypertension, obesity, diabetes … etc… (Garcia *et al*., 2002). Therefore trials were made to use fat substitutes and/or replacers in preparing such product. Fernandez-Gines *et al*., (2003) used dietary fibers as fat replacers due to their nutritional, functional and technological properties. Fernandez-l?pez *et al*., (2004) showed that in addition to the good quality of citrus dietary fibers, it had also some bioactive compounds such as flavonoids, polyphenols and carotenes. These compounds have antioxidant properties. Different types of citrus fiber have been successfully used in processing fresh, cooked and non fermented and dried cured meat products (Fernandez-Lopez *et al*., 2008). These fibers increased cooking yield and improved texture of cooked meat products due to their good ability to bind water and fat (Cofrades *et al*., 2000). Accordingly this study was carried out to investigate the influence of adding a mixture of dried free seeds orange, grapefruit and mandarin wastes on the quality, acceptability and storage stability of the beef burger patties.

MATERIALS AND METHODS

Materials:

Boneless lean beef meat, beef tallow, fresh onion, common salt and Isis spices mixture were brought from the local market at Alexandria City, Egypt. Equal amounts of the wastes of each of the orange, grapefruit and mandarin juice extraction were collected from the Pilot Plant of Food Science and Technology Dept., faculty of Agriculture Alexandria University, Egypt. The seeds were removed from these wastes before mixing to form a mixture. This mixture was divided into there parts. The first part was minced 3 times through a meat mincer then dried at 50°C ± 5°C in an air oven until drying (24 hr.) and ground to pass through 60 mesh sieve. The second part was first steamed in an autoclave at 90-95°C for 20 min., (Wafaa and Samia, 2008), then minced, dried and ground as mentioned above. The third part was dipped in boiled water at 100°C for 5 min (Wafaa and Samia, 2008), then minced, dried and ground as above. The three dried ground wastes were packed in polyethylene bags and kept at room temp. (22°C ± 2°C) until used.

Methods:

Technological Methods:

Beef burger preparation: The boneless lean beef meat was minced after mixing with beef tallow at ratio

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Received October 19, 2008, Accepted December 1, 2008

of 9:1 w/w by passing 3 times through a 5 mm plate of meat mincer. To the resulted meat fat mixture, 4% fresh peeled minced onions, 2% common fine salt, 1.5% spices mixture, 2% free seeds citrus dried wastes (of lean beef meat) and 17.5% cold water were added, and well mixed before chopping using Luska chopper to obtain the beef burger texture. Beef burger patties were formed in around forms with 10 cm. diameters, ½ cm. thicknesses and 60 g. weights. Each piece was surrounded with two pieces of butter paper before filling in polyethylene bags. Each bag was electronic sealed before storing at -10°C in deep freezer (Wafaa and Samia ,2008).

Cooking properties: 5 Patties from each beef burger formulation were roasted at 140°C until their geometrical center reached to 72°C using a digital probe thermometer. After roasting and cooling at room temperature (20°C ± 2°C) the cooking yield, both fat and moisture retentions values were calculated using the following equations as mentioned by Aleson-Carbonell *et al*., (2005 b).

$$1\text{- Cooking yield (\%)} = \frac{\text{Weight of cooked patties (g)}}{\text{Weight of raw patties (g)}} \times 100$$

$$2\text{- Fat retention (\%)} = \text{(\%) cooking yield} \times \frac{\text{Fat (\%) in cooked patties}}{\text{Fat (\%) in raw patties}}$$

$$3\text{- Moisture retention (\%)} = \text{(\%) cooking yield} \times \frac{\text{Moisture (\%) in cooked patties}}{\text{Moisture (\%) in raw patties}}$$

Analytical methods: Moisture, crude protein, ether extract and ash contents of beef burger patties were determined according to the AOAC (1995). Dietary fiber was calculated according to (Wafaa and Samia,2008). Carbohydrate content was calculated by difference. PH was measured after blending 15 g burger with 150 ml deionized water for 2 min. using Digital 500 Eutch Cybernetics Scan pH meter. Thiobarbituric acid (TBA) as mg malondialdehyde/kg burger was spectrophotometrically determined at 532 nm using Spectronic 601-Milto-Ray spectrophotometer as mentioned by Siu and Draper (1978). Total calories (K cal) of 100 g uncooked beef burger patties were calculated using Atwater values, (fat = 9, protein = 4.02 and carbohydrates = 3.87 Kcal/g) (Cengiz and Gokoglu, 2005). Water holding capacity (WHC) of beef burger was determined using the filter paper press method of Aman (1983). Feder value of beef burger was calculated as described by Pearson (1991) as follows:

$$\text{Feder value} = \frac{\text{\% Water}}{\text{\% Organic non-fat}}$$

Where:

Organic non-fat = 100 – (% moisture + % fat + % ash).

Microbiological analysis: Ten grams of beef burgers were blended with 90 ml of sterilized peptone water for 5 min in a sterilized stomacher 400 (Colworth, London, UK) for 1 min. Appropriate dilution from 10^{-1} to 10^{-6} were prepared in sterilized peptone water to select the suitable one for enumeration using microbiological pour plate technique and recommended culture media (Gerhardt *et al*., 1994). Coliform were enumerated on Lauryl Sulphate Broth (Oxoid, England) after incubating at 30°C for 48 hrs, while Psychtrophic and Mesophilic bacterial counts were counted on plate Count Agar (PCA) after incubating at 7°C for 10 days and at 37°C for 48 hrs, respectively. Violet Red Bile Glucose Agar (VRBGA) media with pH 7.4 ± 0.2 was used to isolate Enterobacteriaceae (Gibbons *et al*., 2005) .

Sensory Evaluation: Colour, odour, taste and texture of the roasted beef burger patties was subjectively evaluated using 10 panelist of Food Technology Res. Inst. (A.R.C.), El-Sabahia Station, Alex., Egypt and hedonic rating test where 9= extremely acceptable to 1= extremely rejected as described by Kramer and Twigg (1970).

Statistical Analysis: Standard deviation of the data was calculated using the method described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

General Characteristics of Beef Burger Patties:

Proximate composition, calories and Feder value. Table (1) shows the proximate composition of fresh beef burger free and those containing 2% of the different types of citrus waste mixtures. Addition of such wastes caused a slight reduction in moisture, small increase in fat, ash, nearly non changes in protein and a noticeable rise in carbohydrates contents of beef burger. Generally the moisture, protein, ether extract, ash and carbohydrates were ranged from 68.95 to 70.99, 15.32 to 15.60, 10.24 to 11.67, 2.29 to 2.34 and 1.05 to 1.92%, respectively. According to this result the different types of the prepared beef burger in this study were low in fat content. Miles *et al* .,(1984) found that hamburger patties from beef meat contained 16.4 ± 0.0% protein, 23.5 ± 1.8% fat and 0.7 ± 0.1% ash on wet weight basis. Data of Greenfield *et al*., (1981) showed that commercial hamburger contained 10.7-13.6% protein, 11.2-13.3% fat, 1.8-1.9% ash, 3.4-4.1% sugar and 16.6-18.5% starch on wet weight basis.

The calories value of beef burger patties free from citrus wastes was 158.25 Kcal/100 g (Table 1). This

value was increased by 4-7% due to the addition of citrus waste mixtures. Addition of untreated dry free seeds citrus waste mixtures caused the highest increase of calories value of beef burger patties follow by that subjected for water blanching and steaming before drying respectively. In previous work it was reported that addition of citrus fiber significantly increased energy values (Garcia *et al*., 2002, and Cengiz and Gokoglu, 2005). Garcia *et al*., (2007) showed that energy value of sausage was reduced when fruit fibers was added at 15 and 30 g Kg^{-1} levels to minced meat.

As seen in Table (1) Feder values of the different types of beef burgers were in the range of 3.94 to 4.13. This is an indication that these products had a good quality as mentioned by Pearson (1991).

The above results showed that the general characteristics of the fresh beef burger patties prepared in this study did not affect by addition either untreated or heat treated (steaming or blanching) dried free seed citrus waste mixtures. According to Fernandez-Lopez *et al*., (2004) citrus wastes consider a good source of dietary fiber, carotenoides, polyphenols and flavonoids, the important component for human health. Presence of such components will improve the functional properties of beef burger.

Technological Properties: The denaturation of meat protein of beef burger during roasting or cooking is usually accompanied with shrinkage, increase density and firming of its patties in addition to enhances the flavour and changes the colour from red to gray or brown of beef burger patties (Anderson and Berry, 2001). Results in Table (2) illustrated that addition of 2% free seeds citrus waste mixtures caused a slight increase in cooking yield, moisture retention and a market rise in fat retention of beef burger patties after roasting. Beef burger patties containing water blanched dried free seed citrus mixture had the higher fat retention comparing to those having the dried and/or steamed dried wastes. This phenomenon may be attributed to the fat absorption by the citrus waste mixture fibers and to the matrix which may be formed due to the interaction of the swelled fibers of citrus waste during cooking with the protein of the beef burger patties to act as a barrier to prevent release of fat from the patties during roasting. Aleson-Carbonell *et al.*, (2005 a) mentioned that the lipid binding capacity of some dietary fibers increased with increase their content of insoluble fiber content. On the other hand the slight rise in both cooking yield and moisture retention of burger patties containing free seeds citrus waste mixtures could be due to the some heat stable hydrogen bonds forming between the water molecules and cellulose fibers of these wastes. Ang (1993) showed that the hydrogen bonds are easily weakened with the cooking temperature.

Storage Stability of Beef burger Patties:

Physicochemical properties and TBA content: As seen from the data in Table (3) slight changes were noticed in water holding capacity and pH value of beef burger patties free or containing heat treated and/or untreated free seeds citrus waste mixtures during storage for 3 months at -18°C. The WHC and pH of beef burger ranged from 59.49 – 60.74% and 5.74-5.87 before storage, 58.27 – 60.43% and 6.03-6.08 after 3 months of storage at -18°C, respectively. Such slight changes were mainly due to the protein aggregation during frozen storage (Sanchez-Alonso *et al*., 2007). Yoon and Lee (1990) recommended the addition of 2% cellulose to surimi to improve its firmness during frozen storage. Aleson-Carbonell *et al* (2004) reported that commercial hamburger had 34.13-49.22%. WHC and 5.24-6.4 pH values.

The pH values of frozen hamburger were slowly increased while WHC values were relatively lowered respectively during storage.

According to Fernandez-Gine's *et al*., (2003) pH values did not much vary between minced meat products free and having varying concentrations of citrus fibers.

Table (3) shows the changes in TBA values of beef burger patties free and containing citrus wastes during frozen storage for 90 days at -18°C. Generally a gradual increase in TBA values was noticed with extending the storage period of burger. This may be attributed to the oxidation and hydrolysis of fat in burger and formation of secondary oxidation products of fat such as aldehydes. The rate of this was much pronounced in burger free from citrus wastes, control. Among the burgers containing free seeds citrus wastes, the lowest TBA values were noticed in product containing untreated dried wastes followed by that having dried steamed and dried water blanched citrus wastes, respectively. This is an indication that either steaming or water blanching caused losses in bioactive compounds (which play a rate as antioxidants) such as flavonoids, polyphenols and ?-carotenes in citrus wastes before drying. Wafaa and Samia (2008) showed that polyphenoles and ?-carotene were reduced by 31.68% and 35.85%, respectively after steaming at 90-95°C for 20 min, 65.59% and 75.09%, respectively after water blanching for 5 min at 95°C.

Bacterial Count: It is known that freezer temperature (-18°C) does not kill microorganisms but able to completely stop their growth and to slow the rate

Table 1. General properties of beef burger patties (on wt weight basis)

Treatment	Proximate composition (%)						Calories (Kcal/100 g)	Feder value
	Moisture	Crude protein	Crude ether extract	Ash	Dietary* fiber	Carbohydrates		
1- Control	70.99 ± 0.01	15.43 ± 0.21	10.24 ± 0.10	2.29 ± 0.14	0.00	1.05 ± 0.03	158.25 ± 1.01	4.19 ± 0.08
2- Containing 2% citrus wastes mixture as:								
Dried form	69.34 ± 0.13	15.32 ± 0.04	11.67 ± 0.05	2.34 ± 0.03	0.62	0.71 ± 0.03	169.36 ± 0.37	4.13 ± 0.10
Steamed dried form	69.65 ± 0.47	15.38 ± 0.30	10.98 ± 0.19	2.30 ± 0.01	0.80	0.89 ± 0.03	164.09 ± 0.27	4.06 ± 0.06
Water blanched dried form	68.95 ± 0.03	15.60 ± 0.28	11.20 ± 0.01	2.33 ± 0.03	0.93	0.99 ± 0.04	167.34 ± 0.80	3.94 ± 0.11

*Dietary fiber was estimated by calculation.

Table 2. Cooking Properties of Beef Burger Patties (on wt weight basis)

Treatment	Cooking Yield %	Fat Retention %	Moisture Retention %
Control	59.12 ± 0.51	58.85 ± 0.05	52.23 ± 0.54
Containing 2% citrus wastes mixture as :			
Dried Form	60.85 ± 0.05	65.86 ± 0.12	53.05 ± 0.07
Steamed dried form	60.53 ± 0.47	65.93 ± 0.23	53.12 ± 0.28
Water blanched dried form	62.26 ± 0.11	68.04 ± 0.03	54.82 ± 0.15

Table 3. Changes in physiochemical properties and TBA content of beef burger patties during frozen storage

Property	WHC (%)				pH Value				TBA Value as mg mal./kg			
Storage period (month) / Treatment	0	1	2	3	0	1	2	3	0	1	2	3
1- Control	59.49 ± 0.08	59.21 ± 0.43	58.86 ± 0.14	58.27 ± 0.07	5.87 ± 0.02	5.92 ± 0.05	5.94 ± 0.04	6.08 ± 0.03	1.01 ± 0.14	1.55 ± 0.26	1.64 ± 0.01	2.20 ± 0.11
Containing 2% citrus wastes mixture as:												
Dried form	60.37 ± 0.031	60.06 ± 0.24	60.08 ± 0.24	60.07 ± 0.11	5.74 ± 0.02	5.80 ± 0.01	5.98 ± 0.03	6.03 ± 0.02	0.48 ± 0.05	0.53 ± 0.03	1.10 ± 0.02	1.74 ± 0.04
Steam dried form	60.72 ± 0.04	60.81 ± 0.56	60.50 ± 0.09	60.37 ± 0.06	5.79 ± 0.05	5.84 ± 0.03	6.01 ± 0.01	6.07 ± 0.01	0.64 ± 0.11	0.78 ± 0.08	1.41 ± 0.22	1.88 ± 0.08
Water blanched dried form	60.74 ± 0.04	60.88 ± 0.12	60.57 ± 0.05	60.43 ± 0.06	5.79 ± 0.02	5.83 ± 0.006	6.00 ± 0.01	6.05 ± 0.005	0.64 ± 0.16	0.70 ± 0.18	1.26 ± 0.16	2.15 ± 0.16

In a column, means having the same common superscript letter are not significantly different at 5% level.

Table 4. Changes in bacterial count of beef burger patties during frozen storage

Bacterial count (cfu/g)	TVC count				Psychrophilic				Enterobacteriaceae				Coliform			
Storage period (month) / Treatment	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
1- Control	4.52×10^3	6.8×10^2	5.9×10^2	1.27×10^2	1.79×10^4	1.00×10^3	5.3×10^2	1.8×10^2	4.1×10^2	3.0×10^2	1.4×10^2	8.8×10	N.D	N.D	N.D	N.D
2- Containing 2% citrus wastes mixture as:																
Dried form	1.07×10^3	N.D*	N.D	N.D	1.50×10^3	1.4×10^2	360	N.D	1.7×10^2	N.D	N.D	N.D	N.D	N.D	N.D	N.D
Steam dried form	1.66×10^3	1.9×10^2	1.76×10^2	32	4.50×10^2	3.9×10^2	1.02×10^2	5.1×10	1.8×10^2	6.3×10	N.D	N.D	N.D	N.D	N.D	N.D
Water blanched dried form	1.14×10^3	N.D	N.D	N.D	1.67×10^3	8.9×10^2	1.51×10^2	7.2×10	3.0×10^2	9.0×10	N.D	N.D	N.D	N.D	N.D	N.D

*N.D: Not Detected

Table 5. Changes in sensory properties of beef burger patties during frozen storage

Property	Colour		Odour		Taste		Texture	
Storage period (Month)	0	3	0	3	0	3	0	3
Treatment								
1-Control	V.Ac	V.Ac	V.Ac	V.Ac	V.Ac	V.Ac	V.Ac	V.Ac
2-Containing 2% citrus wastes as:								
Dried form	Ac	Ac	Ac	Ac	Ac	Ac	Ac	Ac
Dried steamed form	Ac	Ac	V.Ac	V.Ac	V.Ac	V.Ac	V.Ac	Ac
Dried water blanched form	Ac	Ac	V.Ac	V.Ac	V.Ac	V.Ac	V.Ac	Ac

Ac: Acceptable V.Ac: Very Acceptable

of both enzymatic and nonenzymatic changes. Data in Table (4) showed that a steady reduction in counts of TVC, Psychrophilic and Enterobacteriacease was observed during frozen storage of beef burger at -18°C for 3 months of storage. The rate of this reduction was depended on type of bacteria and kind of dried free seed citrus waste mixtures which added to beef burger. Among the determined bacteria, the Psychrophilic one was more resistance to frozen storage condition followed by TVC and Enterobacteriacease, respectively.

In the other hand, addition of 2% dried free seeds citrus waste mixtures reduced the growth of all determined bacteria. This effect was more noticeable when dried untreated free seeds citrus waste mixtures was added, then steamed and water blanched ones were incorporated in beef burger. This means that such citrus wastes contained antibacterial compounds. Also such compounds were more reduced by blanching treatment than water steaming one. As shown From Table (4) Coliform bacteria did not detect before and after frozen storage of been burger patties. This is an indication that this product was produced under clean and sanitary conditions. Jay (1986) reported that most food have TVN less than 10^6 /g have an acceptable quality, which those having 10^7 to 10^8 cfu/g are generally have detectible off flavour. Capita *et al* (2004) stated that the enumeration of total aerobic count and Enterobacteriacease gives information about the hygienic performances of meat production.

Organoleptic Properties: Results in Table (5) showed that panelists accepted the determined organoleptic properties of beef burger patties free and containing citrus wastes mixtures. Addition of the citrus wastes affected the colour of burger patties and reduced their degree of acceptability. Treating such wastes before drying either with steaming or water blanching improved the degree of flavour (Odour and Taste) acceptability of this product comparing to untreated one. Frozen storage for 3 months reduced from the degree of flavour and texture acceptability of the control. The same observation was also noticed for the texture of the burger containing different types of citrus wastes. In conclusion incorporation of citrus wastes in cooked meat products increased the cooking yield, water and fat retention, improved from either flavour, texture and storage stability. The burger patties prepared in this study were also low in fat and containing the functional compounds such as polyphenols, flavonoids and carotenoides (Fernandez-L?pez *et al*., 2004) common in citrus wastes. Such compound had a good healthy effect to man (Cofradis *et al*., 2000).

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الملخص العربي

الخصائص العامة والثبات التخزيني للبيف برجر المحتوي علي مخلوط مخلفات الموالح

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تم دراسة تأثير اضافة ٢% من مخلوط مخلفات عصير الموالح الخالي من البذور(سواء فى صورتها الخام أو المعاملة بالبخار أو المسلوقة بالماء) والمجفف علي التركيب الكيماوي والثبات التخزيني علي-١٨°م لمدة ٩٠ يوم والجودة الميكروبية والخواص الحسية لأقراص البيف برجر المصنعة من اللحم البقري.

وبينت النتائج ان اضافة مخلوط مخلفات الموالح ادي الي انخفاض طفيف في المحتوي الرطوبي والبروتين وزيادة محسوسة في محتوي الكربوهيدرات والارتباط بالدهن والقدرة علي مسك الماء ورقم الحموضة والقيمة السعرية، بينما ادي التخزين بالتجميد لمدة ثلاثة أشهر علي-١٨°م الي زيادة قدرة أقراص البيف برجر علي الارتباط بالدهن والماء وقيم رقم الحموضة وحمض الثيوباربيتوريك وانخفاض في العد الكلي، البكتريا المحبة لدرجات الحرارة المنخفضة وبكتريا الكوليفورم. واظهرت نتائج الاختبارات الحسية انه لا توجد اختلافات كبيرة بين عينات البيف برجر الخالية وتلك المحتوية علي مخلوط مخلفات الموالح وذلك قبل وبعد التخزين على الحالة المجمدة. وادت هذه الاضافة الي انتاج بيف برجر فقير في الدهن غني في محتواة من مضافات الاكسدة الطبيعية وله خواص مقبولة من الناحية التكنولوجية.