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UTILIZATION OF FRUITS AND VEGETABLES BY-PRODUCTS IN THE MANUFACTURE OF BEEF BURGER

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ABSTRACT: This investigation was carried out to evaluate the chemical, physical, and sensory properties as well as bioactive compounds, and antioxidant activity of beef burgers formulated by replacing meat with different levels (5, 10, and 15%) of guava and tomato waste powders (peels or seeds) during cold storage (4±1°C for 28 days). Replacing both tomato and guava waste powders (peels or seeds) at all levels during the manufacture of beef burgers increased ($P \leq 0.05$) their means content from protein, fat, crude fiber, and bioactive compounds compared to control beef burgers. The beef burger means content from fat, protein, crude fiber, water holding capacity, and bioactive compounds were decreased ($P \leq 0.05$) with an increasing cold storage period. Also, thiobarbituric acid (TBA), shrinkage, and cooking loss means value of beef burgers were gradually increased ($P \leq 0.05$) with increasing the cold storage period. The increment in the beef burger containing guava and tomato waste powders was lower values in the previous parameters as compared with the control beef burger. Beef burger prepared with tomato peel powder had higher ($P \leq 0.05$) means value of a* and b* than the control and other beef burger samples. The beef burgers containing 5% guava and tomato waste powders (peels or seeds) can be recommended as good quality beef burgers with acceptable sensory quality and a good source of food-grade bioactive compounds.

Keywords: Guava, tomato, seeds, peels, bioactive compounds, antioxidant, beef burger, chemical properties, physical properties, sensory properties.

INTRODUCTION

Processing of fruits and vegetables is one of the largest manufacturing processes for waste production in the environment after sanitation. Fruits and vegetables processing wastes represent nearly 30 to 50% of the total fresh product which contains high percentages of high-value materials that can be reused again; such wastes like peels and seeds of fruits and vegetables have a high economic value. Thus, the use of these by-products in the production of food additives or dietary supplements of nutritional importance has gained increasing attention and therefore their recovery of use is economically attractive (Gowe, 2015).

Tomatoes are seasonal fruits consumed in fresh or processed forms, such as juice, soup, puree, ketchup, and paste. Processed tomato-based products use only pulp, while the peels and seeds are considered by-products. In addition to the large volume of by-products generated annually, the residues of this product has generated interest mainly due to its composition, which represents a considerable amount of potentially bioactive compounds that can be used as additives or ingredients in functional foods. The tomato by-products correspond to a maximum of 14% of the fruit's weight, which is mainly made up of fibers, proteins, fats, and ash, with fibers as its main component (25.4-50%). Studies available in the literature seek to evaluate and quantify the total fibers present in pomace as well as their fractions, although insoluble fiber presents in more significant amounts than soluble fibers. Tomato seed oil and tomato seed extract can be used in food preservation because of their thermal stability and antioxidant capabilities (Lu

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et al., 2019). In addition, tomato seeds and peels are considered a good source of lycopene, phenolic compounds, proteins, fats and essential amino acids (Vorobyova, 2022).

Guava fruits are often processed for different products, such as juice, nectar, jelly, squash, wine, confectionery, and jam, resulting in so-called guava processing residues including peel, pulp, and seeds (Khalifa, 2022). The guava seeds are of utmost importance because they are highly nutritious and contain several bioactive compounds in good amounts. Guava seeds constitute 6-12% of the fruit and contain low calories (182 kcal/ 100 g), very high dietary fiber (63.94 g/ 100 g), iron (13.8 mg/ 100 g), zinc (3.31 mg/ 100 g), and protein (11.19 g/ 100g). Khalifa *et al*. (2016) analyzed bioactive compounds in flour made from guava by-products added to cupcakes, which showed high antioxidant activity due to phenolic compounds that may improve shelf-life stability and restrain oil oxidation. The guava, tomato seeds and peels are excellent sources of bioactive components and fiber as mentioned by the reviewers above. These by-products contain a variety of phytochemical components, including phenolic, flavonoid, and other compounds. These residues could be used as functional ingredients in food products because of their potential health benefits and potent antioxidant properties.

The aim of this research to utilize the bioactive components and fibers from untraditional sources (guava and tomato waste powders) as functional ingredients to enhance and improve the shelf-life of beef burger during cold storage with different periods.

MATERIALS AND METHODS

1. Materials

1.1. Raw Materials

Guava seeds and peels (*Psidium guajava*) were obtained from Kaha Company for Preservative Food, Kaha, Kalyobia Governorate, Egypt. Tomato peels and seeds (*Lycopersicun esculentum*) processing wastes were obtained from Paste and Juices Co., El-Sadat City, Menoufia Governorate, Egypt. Beef burger ingredients (beef meat, soya flour, fat, whole egg, fresh onion, bread crust, salt, and gelatin) were obtained from local markets in Giza City, Giza Governorate, Egypt.

1.2. Chemicals and reagents

Methanol, ethanol, acetone, and di-ethyl ether were obtained from Central Drug House Co., New Delhi, India 2,2-Diphenyl-1-picrylhydrazyl (DPPH), Folin-Ciocalteu reagent, sodium hydroxide, sodium chloride, phenolphthalein, methyl orange, quercitin and gallic acid were obtained from El-Nasr Pharmaceutical Chemicals, Cairo, Egypt.

2. Methods

2.1. Preparation of raw materials

The guava and tomato waste powders (peels or seeds) were separated from the fruit pulp with water using the pulse mode in a blender, and then the guava and tomato waste powders (peels or seeds) were dehydrated at 50±1°C in a drying oven for 36 hours. Dried guava and tomato waste powders (peels or seeds) were ground and sifted. Then, kept individually in polyethylene bags and stored in the refrigerator at 5 ± 1° C until used.

2.2. Preparation of beef burger

Beef burger was prepared according to the procedure of Heinz and Hautzinger (2007). Burger blends were prepared by replacing meat with 5, 10, and 15% tomato and guava waste powders (peels or seeds) as shown in Table (1), and there was one sample prepared as a control with zero additives. All formulations were aerobically packaged in a foam plate, wrapped with polyethylene film, and stored at 4°C for 28 days. Beef burger samples were fried for 10 min in the least amount of corn oil then served hot for sensory evaluation immediately after manufacturing, and at the end of cold storage period. Chemical and physical properties of beef burger were successively evaluated every week.

Table (1): Beef burger blends formulated by partially replacing meat with different levels of 5, 10, and 15% of tomato and guava waste powders (peels or seeds).

Ingredients	Control	Blend1	Blend2	Blend3
Meat	60	57	54	51
Tomato or guava waste powders (peels or seeds)	0	3	6	9
Fat	7.10	7.10	7.10	7.10
Rehydrated soya (1 gm: 2 ml water)	12	12	12	12
Fresh egg	5.50	5.50	5.50	5.50
Fresh onion	5.0	5.0	5.0	5.0
Ground bread crust	1.4	1.4	1.4	1.4
Salt	1.5	1.5	1.5	1.5
Spices	1.5	1.5	1.5	1.5
Water	6	6	6	6

2.3. Chemical analysis

2.3.1. Chemical composition

Moisture, protein, fat, ash, and crude fiber contents were determined according to the methods described by the AOAC (2012).

2.3.2. Determination of bioactive components, antioxidant activity and thiobarbituric acid

The total phenolic content was determined using Folin-Ciocalteu reagent according to the method described by Maurya and Singh (2010). Total flavonoid content was determined according to the method described by Jia *et al.* (1999). Antioxidant activity was determined by the 2, 2'-Diphenyl-1- picrylhydrazyl (DPPH) radical scavenging activity, according to the calorimetric method of Brand-Williams *et al*. (1995). The percentage inhibition of the DPPH radical by the samples was calculated according to the formula of Yen and Duh (1994). Thiobarbituric acid (TBA) was determined according to the method of Pearson *et al.* (1976).

2.4. Physical properties of beef burger

The color was determined according to Abonyi *et al.* (2002). The cooking loss was determined according to Jama *et al.* (2008). The shrinkage was determined by Vu *et al.* (2022). Water holding capacity was measured using the method of El-Seesy (2000).

2.5. Sensory properties of beef burger

Sensory evaluation of the beef burger was carried out by (10) panelists of staff and graduate students of the Food Science and Technology Department, Faculty of Agriculture, Menoufia University. Samples were coded using random six-digit numbers. Panelists were provided with a glass of water and instructed to rinse and swallow water between samples. They were asked to evaluate the burger for acceptability based on their appearance, texture, color, taste, flavor and overall acceptability using nine-point hedonic scale where (1) = dislike extremely to (9) = like extremely as per the method recommended by Lindley *et al*., (1993).

2.6. Statistical analysis

The statistical analysis was carried out using one and two-way analysis of variance (ANOVA) under a significant level of 0.05 for the whole results using the statistical program CoStat (Ver. 6.400) and data were treated as a complete randomization design according to Steel *et al*., (1997). To ascertain the significance among means of different samples, an LSD test was applied.

RESULTS AND DISCUSSION

1. Chemical composition, bioactive compounds and antioxidant activity of guava and tomato waste powders (peels and seeds)

1.1. Chemical composition of guava and tomato waste powders (peels or seeds)

The chemical composition data of guava and tomato waste powders (peels or seeds) were recorded in Table (2). Significant ($P \leq 0.05$) differences were observed in the content of macronutrients among raw materials. The moisture contents of guava peel powder, guava seed powder, tomato peel powder and tomato seed powder were 8.18, 3.12, 9.32 and 6.88%, respectively. The highest ($P \leq 0.05$) protein content was found in tomato seed powder (28.25%), followed by guava seed powder (12.79), tomato peel powder (11.75%), and guava peel powder had the lowest ($P \leq 0.05$) protein value (8.63%). These results agree with those recorded by El-Seesy and Hamed (1998). Tomato seed powder had the highest ($P \leq 0.05$) ash level (4.49%), followed by tomato peel powder (3.85%), then guava peel powder (1.82%), while guava seed powder had the lowest ($P \leq 0.05$) ash value (0.89%). The highest ($P \leq 0.05$) fat content was found in tomato seed powder (25.05%), followed by guava seed powder (10.97%), then tomato peel powder (5.75%), while guava peel powder had the lowest ($P \leq 0.05$) (3.86%). On the other hand, the highest ($P \leq 0.05$) fiber content was recorded in guava peel powder (46.83%), followed by guava seed powder (39.07%), then tomato peel powder (37.90%), while the lowest ($P \leq 0.05$) value was (21.69%) in tomato seed powder. These results are in accordance with those reported by Elbadrawy and Sello (2016). It was noted that tomato peel powder had the highest ($P \leq 0.05$) values of total carbohydrate (40.75%), followed by guava peel powder (38.86%), then guava seed powder (36.28%), and the lowest ($P \leq 0.05$) value (20.52%) was in tomato seed powder. These results match those stated by Ammar and Aboalfa (2017).

Table (2): Chemical composition of guava and tomato waste powders (seeds and peels) (On dry weight basis).

Constituents (%)	Samples				LSD
	Guava		Tomato		
	Seeds powder	Peels powder	Seeds powder	Peels powder	
Moisture	$3.12^{d}\pm0.20$	$8.18^{b}\pm0.03$	$6.88^{c}\pm0.08$	$9.32^{a}\pm0.09$	0.32
Protein	$12.79^{b}\pm0.09$	$8.63^{d}\pm0.03$	$28.25^{a}\pm0.53$	$11.75^{c}\pm0.03$	0.76
Fat	$10.97^{b}\pm0.02$	$3.86^{d}\pm0.01$	$25.05^{a}\pm0.25$	$5.75^{c}\pm0.02$	0.36
Crude fiber	$39.07^{b}\pm0.18$	$46.83^{a}\pm0.05$	$21.69^{d}\pm0.04$	$37.90^{c}\pm0.13$	0.32
Ash	$0.89^{d}\pm0.03$	$1.82^{c}\pm0.01$	$4.49^{a}\pm0.03$	$3.85^{b}\pm0.03$	0.08
Total carbohydrates**	$36.28^{c}\pm0.16$	$38.86^{b}\pm0.02$	$20.52^{d}\pm0.02$	$40.75^{a}\pm0.01$	0.05

** Total Carbohydrate calculated by difference.
Means ± standard deviation of means of three replicates.
LSD: Least significant difference.
Values in the same row with different letters are significantly different at ($P \leq 0.05$).

1.2. Bioactive compounds and antioxidant activity of guava and tomato waste powders (peels or seeds)

The results in Table (3) showed that there were significant ($P \leq 0.05$) differences in total phenolic, total flavonoids, and antioxidant activity among waste powder samples. Guava seed powder had the highest ($P \leq 0.05$) value in total phenolic (9.27 mg gallic/ g sample) and antioxidant activity (74.33%), these results agree with those reported by Donegà *et al*. (2015). The highest ($P \leq 0.05$) total flavonoids were found in tomato peel powder (1.07 mg quercitin/ g sample) then both seed powders of guava and tomato (0.53 and 0.56 mg quercitin/ g sample, respectively) which are similar ($P \leq 0.05$), and the lowest ($P \leq 0.05$) value was observed in guava peel powder (0.27 mg quercitin/g sample). Antioxidant activity of guava peel (74.33%) and seed (64.54%) powders had higher ($P \leq 0.05$) antioxidant activity than tomato peel (25.85%) and seed (37.94%) powders. These results are nearly the same as that found by Kong and Ismail (2011).

2. Changes in the chemical, physiochemical, and sensory properties of beef burgers prepared by partial replacement of meat with tomato and guava waste powders (peels and seeds) during cold storage

Evaluate the proximate chemical composition, physiochemical, and sensory properties as well as bioactive compounds, and antioxidant activity of beef burgers formulated by replacing meat with different levels (5, 10, and 15%) of guava and tomato waste powders (peels or seeds) during cold storage (4±1°C for 28 days).

2.1. Proximate chemical composition of beef burger

The proximate chemical composition (moisture, protein, fat, and crude fiber) data of beef burgers as affected by replacement of meat with tomato and guava waste powders (peels and seeds) and cold storage period are shown in Table (4). The proximate chemical composition of beef burger was affected ($P \leq 0.05$)) by the cold storage period and the waste powder types.

The obtained data showed a significant ($P \leq 0.05$) decrease in moisture content of prepared beef burger samples with the increasing of tomato and guava waste powders (peels and seeds) concentration and also during storage periods. The control and beef burger with guava seeds 5% samples showed non-significant ($P > 0.05$)) differences in means of moisture content. However, significant ($P \leq 0.05$) decrease in means moisture content of beef burger was observed by all replacing levels, tomato, and guava waste powders (peels and seeds). These results agree with those of Hayes *et al*., (2013) and Ethur *et al*., (2010) who reported that in order to prolong the product time, the moisture content should be reduced because it reduces the growth of living organisms by decreasing the available water for interaction.

Table (3): Bioactive compounds and antioxidant activity of guava and tomato waste powders (seeds and peels).

Constituents	Samples*				LSD
	Guava		Tomato		
	Seeds powder	Peels powder	Seeds powder	Peels powder	
Total phenolics (mg gallic acid/ g sample)	9.27^a±0.02	7.15^b±0.01	6.91^c±0.03	4.76^d±0.02	0.06
Total flavonoids (mg quercetin/ g sample)	0.53^b±0.00	0.27^c±0.01	0.56^b±0.02	1.07^a±0.02	0.05
Antioxidant activity (%) (DPPH)	74.33^a±0.02	64.54^b±0.47	25.85^d±0.05	37.94^c±1.00	1.53

Means ± standard deviation of means of three replicates.
LSD: Least significant difference
Values in the same row with different letters are significantly different at ($P \leq 0.05$).

Table (4): Chemical composition of beef burger prepared by partial replacement of meat with tomato and guava waste powders (peels and seeds) during cold storage (4±1°C for 28 days).

Chemical composition (%)	Storage period (days)	Replacer levels (%)													Mean 1	LSD
		Control	Tomato peels powder			Tomato seeds powder			Guava peels powder			Guava seeds powder				
		(0.0)	5	10	15	5	10	15	5	10	15	5	10	15		
Moisture	0	66.32	65.22	63.12	62.35	65.52	64.88	63.62	65.52	64.87	63.84	66.02	65.89	65.23	64.81^{a}	0.033
	7	61.78	60.28	58.68	57.05	60.38	58.72	57.68	61.27	60.68	59.38	61.48	61.18	60.71	59.96^{b}	
	14	56.32	55.12	54.09	53.00	55.42	54.14	53.09	55.92	55.01	54.11	56.00	55.42	53.99	54.74^{c}	
	21	55.12	54.53	53.72	52.98	54.73	53.83	53.00	54.62	54.11	53.29	54.72	54.01	53.19	53.99^{d}	
	28	51.94	53.32	53.04	52.82	53.42	53.10	52.91	53.42	53.00	52.61	53.42	53.05	52.71	52.99^{e}	
Mean 2		58.30^{a}	57.69^{d}	56.53^{i}	55.66^{k}	57.89^{c}	56.93^{g}	56.06^{j}	58.17^{b}	57.54^{e}	56.65^{h}	58.33^{a}	57.91^{c}	57.17^{f}		
LSD		0.054														
Protein	0	16.82	17.42	18.08	18.72	18.22	19.62	21.12	17.23	17.72	18.15	17.44	18.12	18.81	18.27^{a}	0.016
	7	15.72	15.82	16.94	17.62	17.12	18.62	20.02	16.12	16.72	17.00	16.35	17.00	17.65	17.13^{b}	
	14	14.92	15.51	16.02	16.52	16.32	17.81	19.21	15.36	15.81	16.23	15.55	16.21	16.86	16.34^{c}	
	21	14.02	14.62	15.12	15.72	15.42	16.92	18.32	14.41	14.92	15.32	14.62	15.33	15.93	15.44^{d}	
	28	13.67	14.07	14.85	15.03	15.11	16.57	18.01	14.11	14.52	15.00	14.31	14.96	15.60	15.06^{e}	
Mean 2		15.05^{l}	15.48^{j}	16.19^{g}	16.72^{d}	16.44^{e}	17.91^{b}	19.34^{a}	15.45^{k}	15.94^{h}	16.34^{f}	15.66^{i}	16.32^{f}	16.97^{c}		
LSD		0.027														
Fat	0	9.22	9.32	9.63	9.91	10.42	11.70	12.93	9.53	9.64	9.86	9.82	10.34	10.92	10.25^{a}	0.015
	7	8.94	9.14	9.54	9.84	10.10	11.34	12.64	9.42	9.32	9.54	9.51	10.00	10.58	9.99^{b}	
	14	8.82	9.09	9.35	9.52	9.98	11.12	12.37	9.00	9.25	9.43	9.38	9.93	10.45	9.82^{c}	
	21	8.63	8.91	9.03	9.13	9.73	10.93	11.73	8.84	9.03	9.23	9.15	9.69	10.28	9.56^{d}	
	28	8.48	8.65	8.73	8.81	9.64	10.58	11.59	8.63	8.89	9.05	9.00	9.51	10.10	9.35^{e}	
Mean 2		8.82^{l}	9.02^{k}	9.25^{h}	9.44^{f}	9.97^{d}	11.13^{b}	12.25^{a}	9.09^{j}	9.23^{i}	9.42^{f}	9.37^{g}	9.89^{e}	10.47^{c}		
LSD		0.025														
Crude fiber	0	1.68	3.56	5.48	7.32	2.81	3.79	4.92	4.00	6.35	8.68	3.66	5.71	7.63	5.04^{a}	0.014
	7	1.54	3.44	5.32	7.24	2.61	3.69	4.82	3.91	6.24	8.57	3.59	5.54	7.55	4.93^{b}	
	14	1.42	3.31	5.20	7.11	2.56	3.58	4.68	3.72	6.13	8.42	3.43	5.45	7.44	4.80^{c}	
	21	1.38	3.21	5.08	7.05	2.43	3.47	4.51	3.69	6.03	8.35	3.34	5.36	7.33	4.71^{d}	
	28	1.28	3.12	4.98	6.88	2.35	3.36	4.48	3.58	5.93	8.29	3.23	5.27	7.29	4.62^{e}	
Mean 2		1.46^{m}	3.33^{k}	5.20^{f}	7.12^{c}	2.54^{l}	3.58^{i}	4.68^{g}	3.78^{h}	6.14^{d}	8.46^{a}	3.45^{j}	5.46^{e}	7.45^{b}		
LSD		0.023														

Each value in the table is the mean of three replicates.

LSD: Least significant difference

[1]Means (storage) in the same row with different letters are significantly different ($p \leq 0.05$).

[2]Means (treatment) in the same column with different letters are significantly different at ($p \leq 0.05$).

Significant ($P \leq 0.05$) differences were observed among the proximate compositions of beef burger blends. As expected, beef burger with tomato seeds 15% had the highest ($P \leq 0.05$) mean value of protein content (19.34%), followed by beef burger with tomato seeds 10% (17.91%), then burger with guava seeds 15% (16.97%), while the lowest ($P \leq 0.05$) value was in control (15.05%) at zero time. This may be due to the increasing replacer levels of tomato and guava waste powders (peels and seeds), which are rich in protein (Table 2). As for, the protein content values after 28 days of cold storage at 4±1°C showed a significant ($P \leq 0.05$) decreased, this may be due to loss of soluble protein associated with the loss of water content of beef burger and may be associated with the activity of proteolytic bacterial enzymes. These results agree with those of Verma *et al.*, (2013).

Also, the fat content means increased ($p \leq 0.05$) with increasing the replacement levels of tomato and guava waste powders (peels and seeds), and this may be due to the higher fat content of the raw materials (tomato and guava waste powders). Beef burger with tomato seeds 15% had the highest ($P \leq 0.05$) mean value of fat content (12.25%), followed by beef burger with tomato seeds 10% (11.13%), then beef burger with guava seeds 15% (10.47%), while the lowest ($P \leq 0.05$) mean value was in control (8.82%) at zero time. In contrast, the fat content of prepared beef burger samples was increased as the replacing ratio increased; these results agree with Ramadan *et al*., (2011). As for, the fat content values after 28 days of cold storage at 4±1°C showed a significant ($P \leq 0.05$) decreased this may be associated with the activity of lipolytic bacterial enzymes. Similar findings were reported by Taludkar and Sharma (2009). The fat content increased ($P \leq 0.05$) with increasing replacement levels of tomato and guava waste powders (peels and seeds) and this may be due to the higher fat content of the raw materials (Table 2).

Regarding the crude fiber content of differently prepared beef burger samples, it could be noticed that beef burger with guava peels 15% had the highest ($P \leq 0.05$) mean value of crude fiber content (8.46%), followed by beef burger with guava seeds 15% (7.45%), then beef burger with tomato peels 15% (7.12%), while the lowest ($P \leq 0.05$) mean value was in control (1.46%) at zero time. As for, the crude fiber content values after 28 days of cold storage at 4±1°C showed a significant ($P \leq 0.05$) decreased. Meat products are very poor in crude fiber. Therefore, the beef burger prepared with these fibrous materials enhances and improves the nutritional quality and functionality of the products.

2.2. Bioactive compounds, antioxidant activity and thiobarbituric acid (TBA) of beef burger

Some bioactive compounds (phenolic and flavonoids) antioxidant activity and TBA were determined in the of beef burger prepared by replacing different levels of tomato and guava waste powders (peels and seeds) and the results were presented in Table (5). There were significant ($P \leq 0.05$) differences in antioxidant activity, total phenolic, and total flavonoids between beef burger with tomato and guava waste powders (peels and seeds), whereas total phenolic of beef burger prepared by replacing with guava seeds 15% had the highest ($P \leq 0.05$) mean value (32.78% mg gallic/ g sample), while the beef burger with the control sample had the lowest ($P \leq 0.05$) mean value (30.97% mg gallic/ g sample) at zero time. A significant ($P \leq 0.05$) decrease in antioxidant activity, total phenolic and total flavonoids was observed by the increasing storage period. Replacement of meat with tomato and guava waste powders (peels and seeds) in beef burgers produces high bioactive material content and consequently high antioxidant activity levels which causes enhanced shelf-life stability and restrained oil oxidation.

Table (5): Bioactive compounds, antioxidant activity and thiobarbituric acid (TBA) of beef burger prepared by partial replacement of meat with tomato and guava waste powders (peels and seeds) during cold storage (4±1°C for 28 days).

Bioactive compounds	Storage period (days)	Replacer levels (%)													Mean 1	LSD
		Control (0.0)	Tomato peels powder			Tomato seeds powder			Guava peels powder			Guava seeds powder				
			5	10	15	5	10	15	5	10	15	5	10	15		
Total phenolics (mg gallic acid/ g sample)	0	39.11	39.37	39.64	39.91	39.51	39.86	40.18	39.57	39.93	40.26	39.71	40.09	40.61	39.83^{a}	0.009
	7	32.76	33.04	33.26	33.55	33.15	33.53	33.94	33.19	33.71	34.16	33.28	33.69	34.25	33.50^{b}	
	14	28.35	28.67	28.87	29.18	28.79	29.07	29.78	28.86	29.49	29.86	29.08	30.27	30.61	29.30^{c}	
	21	27.58	27.86	28.11	28.49	27.96	28.32	28.65	28.06	28.75	28.94	28.43	29.53	29.91	28.51^{d}	
	28	27.06	27.35	27.68	27.89	27.49	27.84	28.19	27.73	27.88	28.23	27.96	28.16	28.54	27.85^{e}	
Mean 2		30.97^{m}	31.26^{l}	31.51^{i}	31.80^{f}	31.38^{k}	31.72^{g}	32.15^{d}	31.48^{j}	31.95^{e}	32.29^{c}	31.69^{h}	32.35^{b}	32.78^{a}		
LSD		0.015														
Total flavonoids (mg quercitin/ g sample)	0	20.09	21.18	21.61	21.98	20.68	21.02	21.23	20.29	20.56	20.69	20.65	20.86	21.18	20.92^{a}	0.009
	7	19.26	20.38	20.73	20.95	19.61	20.00	20.68	19.43	19.62	19.97	19.54	19.93	20.59	20.05^{b}	
	14	17.95	19.05	19.38	19.77	18.44	18.85	19.15	18.16	18.55	18.65	18.38	18.78	19.08	18.78^{c}	
	21	14.76	15.86	15.99	16.57	15.26	15.53	15.72	15.03	15.13	15.25	15.13	15.46	15.67	15.49^{d}	
	28	14.13	15.24	15.58	15.83	14.71	14.96	15.27	14.39	14.55	14.72	14.64	14.89	15.16	14.93^{e}	
Mean 2		17.24^{k}	18.34^{d}	18.66^{b}	19.02^{a}	17.74^{h}	18.07^{e}	18.41^{c}	17.46^{j}	17.68^{i}	17.86^{g}	17.67^{i}	17.98^{f}	18.34^{d}		
LSD		0.014														
Antioxidant activity % (as DPPH)	0	25.19	27.08	29.03	30.89	26.50	27.81	29.09	28.33	31.65	34.71	28.95	32.73	36.36	29.87^{a}	0.008
	7	24.21	26.12	28.01	29.91	25.51	26.82	28.11	27.46	30.60	33.95	27.93	31.69	35.39	28.90^{b}	
	14	21.59	23.61	25.39	27.31	22.91	24.20	25.55	24.74	27.69	31.32	25.38	29.19	32.84	26.29^{c}	
	21	20.86	22.76	24.66	26.57	22.13	23.48	24.77	24.10	27.33	30.67	24.67	28.39	32.09	25.57^{d}	
	28	19.31	21.28	23.11	25.01	20.65	21.93	23.22	22.46	25.78	29.06	23.03	26.83	30.44	24.01^{e}	
Mean 2		22.23^{m}	24.17^{k}	26.04^{g}	27.94^{e}	23.54^{l}	24.84^{j}	26.15^{f}	25.42^{i}	28.61^{d}	31.94^{b}	25.99^{h}	29.77^{c}	33.42^{a}		
LSD		0.014														
Thiobarbituric acid (TBA) (mg malonldhyde/ Kg sample)	0	0.264	0.221	0.204	0.186	0.236	0.217	0.197	0.196	0.179	0.149	0.189	0.168	0.135	0.19^{e}	0.005
	7	0.452	0.395	0.347	0.316	0.419	0.359	0.331	0.393	0.388	0.341	0.378	0.336	0.298	0.37^{d}	
	14	0.797	0.671	0.642	0.598	0.693	0.657	0.612	0.687	0.649	0.612	0.653	0.621	0.583	0.65^{c}	
	21	1.113	0.968	0.926	0.893	0.977	0.933	0.902	0.886	0.866	0.816	0.871	0.833	0.798	0.91^{b}	
	28	1.277	1.210	1.136	1.063	1.228	1.179	1.098	1.188	1.123	1.032	1.176	1.112	1.024	1.142^{a}	
Mean 2		0.781^{a}	0.693^{c}	0.651^{f}	0.611^{i}	0.711^{b}	0.682^{d}	0.628^{h}	0.670^{e}	0.641^{g}	0.590^{j}	0.653^{f}	0.614^{i}	0.568^{k}		
LSD		0.007														

Each value in the table is the mean of three replicates.

LSD: Least significant difference

[1]Means (storage) in the same row with different letters are significantly different ($p \le 0.05$).

[2]Means (treatment) in the same column with different letters are significantly different at ($p \le 0.05$).

The results indicated that the total phenolic contents in the beef burger replacement with guava waste powders (peels and seeds) were significantly higher ($P \leq 0.05$) mean value than the control sample. The guava waste powders were found to be rich in the most of phenolic which have antioxidant activity. These results agree with those obtained by Ayoola *et al.,* (2008) and Uchôa-thomaz *et al.,* (2014).

The TBA values of beef burgers formulated replacement with different levels of tomato and guava waste powders (peels and seeds). There were significant ($P \leq 0.05$) differences in TBA means value between control and all samples. Control had the highest ($P \leq 0.05$) mean value of TBA content (0.781 mg malonaldehyde/ kg sample), followed by beef burger with tomato seeds 5% (0.711 mg malonaldehyde/ kg sample), then beef burger with tomato peels 5% (0.693 mg malonaldehyde/ kg sample), while the lowest ($P \leq 0.05$) mean value was in guava seeds 15% (0.568 mg malonaldehyde/ kg sample). This may be due to the fact that guava seeds and peels have higher levels of phenolic, and flavonoid content, and they can be used as sources of free radical scavenging agents, so can be used as antioxidants, which caused a decrease in TBA values (Fernandez *et al.,* 1997).

2.3. Physiochemical properties of beef burger

2.3.1. Color measurements of beef burger

Data in Table (6) showed the changes in the color of beef burger prepared with different levels of tomato and guava waste powders (peels and seeds). The color means of the beef burger were affected ($P \leq 0.05$) by the replacer types and concentration as well as the storage period. L* means value (lightness) varied ($P \leq 0.05$) among treatments and storage days. The control and beef burger with tomato seeds 5% samples showed the non-significant ($P \leq 0.05$) differences in L* mean value. On the other hand, a significant ($P \leq 0.05$) decrease in L* mean value of beef burger was observed by all replacing levels of tomato and guava waste powders (peels and seeds). These results indicated that the emulsions containing tomato and guava products were darker than the controls (Calvo *et al.*, 2008) also reported a decrease in L* value in tomato peels incorporated beef and beef products. Escalante *et al.,* (2003) reported greater ($p \leq 0.05$) a* values in lycopene-treated beef burger than in red pepper-treated ones. The a* means value decreased ($P \leq 0.05$) during storage in all the replacing levels, and these observations are in agreement with previous reports in meat products incorporated with tomato products (Kim *et al.,* 2009; Escalante *et al.,* 2003; Candogan 2002). This might be due to a decrease in lycopene content during storage. Hence, this can be interpreted as a* value depending on the concentration of lycopene in the meat. Also, it could be noticed that when the concentration of tomato and guava waste powders increased in the beef burger, the yellowness b* increased and could be noticed that the beef burger with tomato peels 15% had the highest ($P \leq 0.05$) means value of a*, b* and Chroma (13.35, 16.32 and 15.79, respectively).

2.3.2. Shrinkage measurements of beef burger

Data in Table (7) showed that the shrinkage means of the beef burger were affected ($P \leq 0.05$) by the replacer types and the storage period. Guava peels at 15% showed the lowest ($P \leq 0.05$) mean value of the shrinkage reduction (19.64%). While the control sample showed the highest ($P \leq 0.05$) mean value of the shrinkage reduction after the end of storage period (30.60%). Also, the positive effect of the replacement of guava peel and seed powders in improving the cooking characteristics of prepared beef burger samples was observed especially as the concentration of guava peel and seed powders was increased. The shrinkage of the beef burger samples is an important parameter for consumer acceptance, so 5% powder in different proportions of tomato and

Table (6): Color measurements of beef burger prepared by partial replacement of meat with tomato and guava waste powders (peels and seeds) during cold storage (4±1°C for 28 days).

Color measurements	Storage period (days)	Replacer levels (%)													Mean 1	LSD
		Control (0.0)	Tomato peels powder			Tomato seeds powder			Guava peels powder			Guava seeds powder				
			5	10	15	5	10	15	5	10	15	5	10	15		
L*	0	39.99	39.62	37.55	34.92	39.73	38.65	36.12	37.06	35.54	33.41	38.13	36.67	35.37	37.14^{a}	0.053
	28	36.95	36.25	34.75	32.68	36.89	34.75	33.92	35.58	33.86	31.74	36.43	34.17	33.64	34.87^{b}	
Mean 2		38.47^{a}	37.93^{b}	36.15^{e}	33.80^{j}	38.47^{a}	37.41^{c}	35.02^{g}	36.32^{d}	34.70^{h}	32.57^{k}	37.28^{c}	35.42^{f}	34.51^{i}		
LSD		0.14														
a*	0	10.48	11.68	12.32	13.95	10.26	10.08	9.78	10.39	10.21	9.98	10.36	10.25	10.06	10.75^{a}	0.009
	28	9.14	10.57	11.43	12.76	9.47	9.18	8.65	9.19	9.53	8.78	9.13	9.36	9.14	9.72^{b}	
Mean 2		9.81^{e}	11.12^{c}	11.87^{b}	13.35^{a}	9.86^{d}	9.63^{g}	9.21^{j}	9.79^{e}	9.87^{d}	9.38^{i}	9.75^{f}	9.81^{e}	9.60^{h}		
LSD		0.023														
b*	0	12.36	13.76	15.28	16.97	12.78	13.13	13.68	12.89	13.31	13.94	12.74	12.98	13.32	13.63^{a}	0.009
	28	11.68	12.54	14.13	15.68	11.69	12.16	12.71	11.93	12.57	12.88	11.69	11.89	12.29	12.60^{b}	
Mean 2		12.02^{l}	13.15^{e}	14.71^{b}	16.32^{a}	12.23^{k}	12.65^{h}	13.19^{d}	12.41^{j}	12.94^{f}	13.41^{c}	12.22^{k}	12.44^{i}	12.81^{g}		
LSD		0.024														
Chroma	0	12.38	13.97	15.18	16.26	12.17	11.92	11.79	12.21	12.02	11.88	12.15	11.94	11.73	12.74^{a}	0.008
	28	11.18	12.87	14.23	15.32	11.27	10.85	10.81	11.19	11.06	10.92	11.24	10.89	10.68	11.73^{b}	
Mean 2		11.78^{d}	13.42^{c}	14.70^{b}	15.79^{a}	11.72^{e}	11.38^{i}	11.30^{j}	11.70^{ef}	11.54^{g}	11.40^{hi}	11.70^{f}	11.41^{h}	11.21^{k}		
LSD		0.023														
Hue	0	95.10	92.31	90.26	84.54	92.11	87.42	82.26	93.10	86.66	78.14	94.96	92.78	87.32	88.99^{b}	0.009
	28	96.82	94.11	92.17	87.01	94.54	89.31	84.72	95.12	88.12	80.42	96.05	94.84	89.11	90.95^{a}	
Mean 2		95.95^{a}	93.21^{f}	91.21^{g}	85.77^{k}	93.32^{e}	88.36^{h}	83.49^{l}	94.11^{c}	87.39^{j}	79.28^{m}	95.51^{b}	93.81^{d}	88.22^{i}		
LSD		0.024														

Each value in the table is the mean of three replicates.

LSD: Least significant difference

[1]Means (storage) in the same row with different letters are significantly different ($p \leq 0.05$).

[2]Means (treatment) in the same column with different letters are significantly different at ($p \leq 0.05$)

Table (7): Physiochemical properties of beef burger prepared by partial replacement of meat with tomato and guava waste powders (peels and seeds) during cold storage (4±1°C for 28 days).

Physiochemical properties	Storage period (days)	Replacer levels (%)													Mean 1	LSD
		Control (0.0)	Tomato peels powder			Tomato seeds powder			Guava peels powder			Guava seeds powder				
			5	10	15	5	10	15	5	10	15	5	10	15		
Shrinkage	0	29.83	24.79	19.72	17.59	23.52	20.63	19.78	21.55	18.83	15.89	27.65	23.43	21.75	21.92^{e}	0.009
	7	30.27	25.52	21.81	19.45	24.98	23.67	22.58	22.87	20.67	17.97	27.98	25.97	24.17	23.68^{d}	
	14	30.64	26.02	22.67	20.62	25.74	24.52	23.32	23.74	21.96	19.53	28.69	27.87	25.68	24.69^{c}	
	21	30.96	26.43	23.82	21.58	26.11	24.87	23.89	24.93	23.56	21.35	29.14	28.76	26.98	25.57^{b}	
	28	31.32	26.86	24.55	22.61	26.32	25.29	24.12	26.34	25.11	23.48	30.53	29.67	28.22	26.49^{a}	
Mean 2		30.60^{a}	25.92^{d}	22.51^{j}	20.37^{l}	25.34^{f}	23.79^{h}	22.74^{i}	23.88^{g}	22.03^{k}	19.64^{m}	28.79^{b}	27.14^{c}	25.36^{e}		
LSD		0.016														
Cooking lose	0	38.12	35.16	23.18	18.27	29.79	24.16	21.20	26.29	24.48	20.92	29.12	27.57	25.33	26.43^{e}	0.010
	7	39.26	36.77	26.27	21.88	31.98	26.68	23.94	31.63	25.28	24.42	33.57	31.72	29.56	29.46^{d}	
	14	40.32	38.12	28.41	24.31	33.35	27.82	25.65	32.85	27.37	26.27	34.62	32.86	31.19	31.01^{c}	
	21	41.76	39.47	30.76	27.66	35.46	29.06	27.26	34.66	30.16	28.88	36.47	33.98	32.26	32.91^{b}	
	28	43.39	41.89	32.79	30.31	37.69	31.34	29.53	36.59	32.41	30.53	38.36	35.06	33.45	34.87^{a}	
Mean 2		40.57^{a}	38.28^{b}	28.28^{h}	24.47^{m}	33.66^{d}	27.81^{j}	25.52^{l}	32.40^{e}	27.94^{i}	26.20^{k}	34.42^{c}	32.24^{f}	30.36^{g}		
LSD		0.016														
Water holding capacity (WHC)	0	7.96	8.21	8.46	8.91	8.16	8.27	8.66	8.68	8.86	9.12	8.13	8.24	8.59	8.48^{a}	0.010
	7	7.29	7.78	8.08	8.65	7.49	7.68	7.96	8.05	8.25	8.81	7.42	7.63	7.93	7.92^{b}	
	14	6.87	7.39	7.72	8.04	7.21	7.35	7.57	7.69	7.90	8.36	7.18	7.31	7.54	7.55^{c}	
	21	5.48	6.67	7.05	7.57	6.19	7.03	7.29	7.03	7.34	7.68	6.06	6.88	7.06	6.87^{d}	
	28	4.64	5.14	5.69	6.24	4.89	5.39	6.05	6.27	6.67	6.98	4.85	5.32	5.89	5.69^{e}	
Mean 2		6.45^{l}	7.04^{i}	7.40^{f}	7.88^{b}	6.79^{j}	7.14^{g}	7.51^{e}	7.54^{d}	7.80^{c}	8.19^{a}	6.73^{k}	7.08^{h}	7.40^{f}		
LSD		0.015														

Each value in the table is the mean of three replicates.

LSD: Least significant difference

[1]Means (storage) in the same row with different letters are significantly different ($p \leq 0.05$).

[2]Means (treatment) in the same column with different letters are significantly different at ($p \leq 0.05$).

guava waste powders (peels and seeds) were replacement to the processed beef burger to keep these cuts at their lowest levels, especially during cold storage. As expected, beef burger samples with low cooking loss and high moisture losses showed the highest reduction in shrinkage after 28 days of cold storage.

2.3.3. Cooking loss of beef burger

The cooking properties of beef burger samples containing different levels of tomato and guava waste powders (peels and seeds) are shown in Table (7). The replacement of tomato and guava waste powders led to a reduction ($P \leq 0.05$) in cooking loss means of beef burger samples, especially at levels 10 and 15%. However, the cooking loss was significantly ($P \leq 0.05$) increased as the cold storage period progressed. These results agree with those obtained by Madkour *et al.,* (2000). The cooking loss means of the beef burger was affected ($P \leq 0.05$) by the replacement types and concentration. A significant ($P \leq 0.05$) decrease in cooking loss was observed by increasing the replacement levels of tomato and guava waste powders (peels and seeds) and increase by the increasing storage period this may be due to loss of moisture content and soluble protein during storage.

2.3.4. Water holding capacity (WHC) of beef burger.

Data in Table (7) showed the replacement of different concentrations of tomato and guava waste powders (peels and seeds) had a significant ($P \leq 0.05$) effect on WHC means value of different prepared beef burger samples at the beginning of the storage period. As the storage period increased, the WHC of different prepared beef burger samples was significantly ($P \leq 0.05$) decreased during all storage periods. The control had the lowest ($P \leq 0.05$) mean value of the WHC (6.45), while the beef burger sample that contained 15% guava peel powder had the highest ($P \leq 0.05$) value of the WHC (8.19) after 28 days of cold storage. This may be due to the increasing fiber content, which enhanced water holding capacity of beef burger, as mentioned by Naveena *et al.* (2008).

2.3.5. Sensory properties of beef burger

Data in Table (8) showed the changes in sensory properties of beef burger prepared with different levels of tomato and guava waste powders (peels and seeds). The beef burger with tomato peels 5% had the highest ($P \leq 0.05$) mean value of appearance. The beef burger with tomato peels 15% and guava seeds with 15% had the lowest ($P \leq 0.05$) means value of appearance. Texture of the beef burger with guava seeds 5% had the highest ($P \leq 0.05$) mean value (8.63). The beef burger sample containing guava peels 5% had a higher ($P \leq 0.05$) means score in aroma and taste sensory scores, whereas beef burger with tomato seed 15% had the lowest ($P \leq 0.05$) mean value in overall acceptability. Appearance, texture, color, aroma, taste and over all acceptability means score were significantly ($P \leq 0.05$) decreased by increasing storage period. Our results showed improvement by replacement meat with both tomato and guava waste powders by up to 5%. Incorporation of tomato and guava waste powders in beef burger improves the amount of beneficial components they contain and the eye-catching appearance of the finished product. Therefore, the beef burger replacement with 5% tomato and guava waste powders (peels and seeds) can be recommended as a good quality beef burger with acceptable sensory quality.

Conclusion

From the above-mentioned results, it could be concluded that high-quality beef burger can be produced by replacing the meat in beef burger with tomato and guava waste powders (peels and seeds). Moreover, at the same time it is a good source of dietary fiber and bioactive compounds.

Table (8): Sensory evaluation of beef burger prepared by partial replacement of meat with tomato and guava waste powders (peels and seeds) during cold storage (4±1°C for 28 days).

Sensory Evaluation	Storage period (days)	Replacer levels (%)													Mean 1	LSD
		Control	Tomato peels powder			Tomato seeds powder			Guava peels powder			Guava seeds powder				
		(0.0)	5	10	15	5	10	15	5	10	15	5	10	15		
Appearance	0	**8.75**	**9.00**	**6.25**	**5.50**	**9.00**	**7.75**	**6.25**	**8.65**	**7.25**	**5.50**	**8.75**	**7.25**	**5.50**	**7.34^{a}**	**0.00**
	28	6.65	7.85	5.85	4.27	7.25	7.12	4.65	7.05	6.55	4.35	7.95	6.15	4.25	6.15^{b}	
Mean 2		7.7^{e}	8.43^{a}	6.05^{i}	4.88^{l}	8.13^{c}	7.44^{f}	5.45^{j}	7.85^{d}	6.90^{g}	4.93^{k}	8.35^{b}	6.70^{h}	4.88^{l}		
LSD		0.023														
Texture	0	8.50	8.75	6.50	4.25	8.50	7.50	5.50	8.50	5.50	4.50	9.00	6.50	4.25	6.75^{a}	0.01
	28	6.45	6.55	6.10	3.15	6.22	6.95	4.50	8.10	4.40	3.60	8.25	5.85	3.75	5.68^{b}	
Mean 2		7.47^{d}	7.65^{c}	6.30^{g}	3.70^{m}	7.36^{e}	7.23^{f}	5.00^{i}	8.27^{b}	4.95^{j}	4.05^{k}	8.63^{a}	6.18^{h}	4.00^{l}		
LSD		0.026														
Color	0	8.75	9.35	9.55	9.75	9.10	7.25	4.50	8.75	5.50	5.50	8.80	6.25	4.50	7.53^{a}	0.05
	28	8.55	9.30	9.49	9.65	8.70	6.15	4.21	7.20	4.95	5.30	8.42	5.84	4.00	7.06^{b}	
Mean 2		8.65^{e}	9.32^{c}	9.52^{b}	9.70^{a}	8.90^{d}	6.70^{g}	4.36^{k}	7.97^{f}	5.23^{j}	5.40^{i}	8.61^{e}	6.04^{h}	4.42^{k}		
LSD		0.14														
Aroma	0	8.75	8.55	7.50	5.25	8.55	7.50	5.10	9.00	8.95	8.00	9.00	7.75	5.25	7.63^{a}	0.00
	28	6.45	7.15	7.06	4.95	7.50	7.10	4.86	8.25	8.70	7.68	8.25	7.55	5.00	6.96^{b}	
Mean 2		7.60^{f}	7.85^{d}	7.28^{g}	5.10^{i}	8.03^{c}	7.30^{g}	4.98^{j}	8.63^{b}	8.83^{a}	7.84^{d}	8.63^{b}	7.65^{e}	5.13^{h}		
LSD		0.023														
Taste	0	8.50	9.00	6.50	4.25	8.75	6.51	4.25	9.20	9.35	8.70	8.75	7.50	6.50	7.53^{a}	0.02
	28	6.55	7.55	6.15	3.85	7.35	6.19	3.25	8.00	9.18	8.55	8.50	7.23	5.94	6.79^{b}	
Mean 2		7.61^{e}	8.27^{c}	6.33^{g}	4.05^{i}	8.05^{d}	6.35^{g}	3.75^{j}	8.60^{b}	9.26^{a}	8.63^{b}	8.63^{b}	7.37^{f}	6.22^{h}		
LSD		0.040														
Overall acceptability	0	43.25	44.65	36.30	29.00	43.90	36.41	25.60	44.10	36.55	32.20	44.30	35.25	26.00	36.78^{a}	0.06
	28	34.65	38.40	34.65	25.87	37.02	33.51	21.47	38.60	33.78	29.48	41.37	32.62	22.94	32.64^{b}	
Mean 2		39.03^{e}	41.53^{b}	35.48^{f}	27.43^{k}	40.46^{d}	35.01^{h}	23.53^{m}	41.32^{c}	35.17^{g}	30.84^{j}	42.84^{a}	33.94^{i}	24.64^{l}		
LSD		0.15														

Each value in the table is the mean of three replicates.

LSD: Least significant difference

[1]Means (storage) in the same row with different letters are significantly different ($p \leq 0.05$).

[2]Means (treatment) in the same column with different letters are significantly different at ($p \leq 0.05$).

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الإستفادة من المنتجات الثانوية للفواكه والخضروات في تصنيع برجر اللحم البقري

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الملخص العربي

تم إجراء هذا البحث بغرض تقييم الخواص الكيميائية والفيزيائية والحسية وكذلك المركبات النشطة بيولوجيا والنشاط المضاد للأكسدة لبرجر اللحم البقري المصنع عن طريق استبدال اللحم بتركيزات مختلفة (٥، ١٠، ١٥٪) من مساحيق مخلفات الجوافة والطماطم (القشور أو البذور) أثناء التخزين البارد (٤ ± ١ °م لمدة ٢٨ يوم). استبدال مساحيق مخلفات الطماطم والجوافة (القشور أو البذور) عند كل التركيزات أثناء تصنيع برجر اللحم البقري أدى إلى زيادة ($P \leq 0.05$) في محتواها من البروتين والدهون والألياف الخام والمركبات النشطة بيولوجيا مقارنة ببرجر اللحم البقري المرجعي. انخفضت محتويات برجر اللحم البقري من الدهون والبروتين والألياف الخام والقدرة على الاحتفاظ بالماء والمركبات النشطة بيولوجيا ($P \leq 0.05$) مع زيادة فترة التخزين المبرد. كما تم زيادة تدريجية في قيم حمض الثيوباربيتوريك (TBA) والانكماش والفقد أثناء الطهي لبرجر اللحم البقري ($P \leq 0.05$) مع زيادة فترة التخزين بالتبريد. وكانت الزيادة في برجر اللحم البقري المحتوي على مساحيق مخلفات الجوافة والطماطم أقل في المعايير السابقة مقارنة مع برجر لحم البقر المرجعي. كان لبرجر اللحم البقري المحضر بمسحوق قشر الطماطم قيم أعلى ($P \leq 0.05$) من *b و*a مقارنتا بالعينة المرجعية وبعض عينات برجر اللحم البقري الأخرى. يمكن التوصية ببرجر اللحم البقري الذي يحتوي على ٥% من مساحيق الجوافة والطماطم (القشور أو البذور) باعتباره برجر لحم البقر عالي الجودة ذو جودة حسية مقبولة ومصدرًا جيدًا للمركبات النشطة بيولوجيًا من الدرجة الغذائية.