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Effect of Addition Watermelon Rind Powder on Quality Criteria and Microbial Aspects of Beef Burger Patties during Frozen Storage Periods

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ABESTRACT

The Watermelon rind powder (WMRP) as a natural source of fiber, minerals, amino acids and natural antioxidant compounds. This research was performed to evaluate the influence of addition of WMRP at different level (3, 6, 9 and 12%) from total formula of beef burger patties on chemical, physiochemical, microbiological and sensory characteristics of beef burger patties during frozen storage period at – 18 ±2°C up to 90 days. The obtained results showed that the percentage of the WMR about 37.84 % from the total weight of watermelon fruit which can be considered as by-product for processing. However, the WMRP contained crude fiber (15.98%), total ash (12.55%), Na (515.44 mg/100g), Ca (311.22 mg/100g), Mg (298.61mg/100g), P (288.28 mg/100g), and K (130.04 mg/100g), while Fe (12.98mg/100g) and Zn (3.12 mg/100g) as macro and micro elements. Lysine, leucine, valine and isoleucine were the major essential amino acids (4.97, 4.71, 3.75 and 3.14 gm/100gm protein, respectively). Meanwhile, glutamic, arginine, Aspartic, Alanine and Glycine were the major non-essential amino acids (9.94, 8.91, 6.63, 6.11 and 5.76 gm/100gm protein, respectively). Moreover, the incorporation of WMRP into the beef burger patties as texturized soy substitute, caused to improvement of gross chemical composition as that increased both of fiber, total ash, total soluble carbohydrates content and decreased crude fat of beef burger patties, as well as the improvement of physiochemical quality criteria (pH value, WHC, shrinkage, TVN and TBA values) throughout frozen storage in comparison with control sample. In addition, WMRP inhibited the growth and activity of microbial, as well as reduction of lipid oxidation in tested prepared product. Also, beef burger patties containing the WMRP exhibited a good sensory properties and better acceptability, especially those contained 6 and 9 % WMRP, even after stored for 90 days under frozen condition. The present results are useful of used WMRP in fortification of meat products to improve the nutritionally and healthy safe.

Keywords: Watermelon Rind Powder, Beef burger, Storage Conditions, Quality Criteria.

INTRODUCTION

Beef burger patties are considered one of the among popular food items which were played a significant role in the modern nutritious diet, as a core member of ready-to-eat family prepared in restaurants and at home (Özkan *et al.,* 2004). Beef burger patties are excellent sources of protein, minerals and vitamins however, ground beef was significant a high of fat than beef sirloin, additionally beef burger patties were a molded mixture of ground lean and fatty beef prepared with added salt and seasoning.

In order to attend economic or technological methods, soy protein is the among widely used vegetables protein as an additive in meat products, due to its high biological value as well as it's a good functional character which result an increased the water holding capacity and improving the texture and the acceptance of the final products (Passos-Maria and kuaye, 2002).

Antioxidants are widely used as additives in meat processed because they were increased 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 formation in meat products was limited (Li *et al*., 2013). The present of antioxidant in meat products play the importance role in the kinetic aspects of the nitrite reactions. These ant-oxidants may reduce the nitrous acid formed from nitrite ion (Skibsted, 2011). Thus, the production of N-nitrosamines may be limited by the presence of ascorbate because it's additives to the several reactions that NO from nitrite can participate (Hill *et al*., 1988 and Bryan, 2016).

Watermelon is an important crop grown in the warmer regions of the world. Half of a watermelon fruit is edible while the other half, consisting of about more 35% rind and 15% peel goes to waste (USDA, 2004).

Watermelon is one of the most vegetable crops consumed all over the Mediterranean basin. It's much appreciated as an excellent refreshing summer fruits. Besides vitamins (A, B, C and E), minerals (K, Mg, Ca and Fe), amino acids (citrulline converts to arginine), and natural antioxidant compounds such as carotenoids, phenolics, lycopene, ascorbic acid. (Perkins- Veazie *et al.,* 2007).

The citrulline in watermelon rind (WMR) was give it antioxidant effects that protect you from free-radical damage and additionally, citrulline converts to arginine, an amino acid vital to the heart, circulatory system and immune system and also, the WMR might relax blood vessels as cancer and cardiovascular diseases. The rind was usually discarded; they were edible, and sometimes used as a vegetable and were utilized for the products such as preserve, pectin and other products. (Rimando and Perkins-Veazie, 2005).

The aim of the present study was carried out to investigation the effect of addition of watermelon rind powder (WMRP) at different levels (3, 6, 9 and 12%) from total formula of beef burger patties on chemical, physiochemical, microbiological and sensory characteristics of beef burger patties during frozen storage period at – 18 ±2°C up to 90 days.

MATERIALS AND METHODS

Materials:

Watermelon Fruits (*Citrullus lanatus*): was obtained from local market in Cairo, Egypt. Waste materials used were obtained manually as watermelon rinds (WMR).

Beef meat: was obtained from local butcher shop in the day before processing of beef burger treatments.

Texturized soy:

It was obtained from Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.

Spices: Spices mixture containing of (Cumin 55.0 % - Coriander 21.0% - Black pepper 6.0% - Cloves 6.0% - Cubeb 3.0% - Nutmeg 3.0% - Cardamon 3.0% - Red pepper 2.0% and Thyme 1.0%) was obtained from Harraz market, Cairo, Egypt.

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

Technological Methods:

Preparation of watermelon rind powder (WMRP):

The watermelon rind was separated from the washed fresh watermelon fruits and cut into small pieces and spreaded on trays of air dryer and dried at 50±5°C for 12 hr., then the dehydrated pieces were milled in a laboratory disc mill (Braun AG Frankfurt Type: KM 32, Germany) to fine powder according to the method described by El-Badry *et al.,* (2014).

Preparation of beef burger patties:

Ground beef preparation:

Ground beef was prepared by using sanitized utensils and equipments. The meat was ground in meat grinder (Italmans, Motore Asincrono monoface, Italy) through 6 mm grinder plate at ambient temperature about 25°C (Oroszvári *et al*., 2005).

Preparation of texturized soy and watermelon rind powder blends:

Watermelon rind powder (WMRP) was replaced individually by (20, 40, 60 and 80%) of texturized soy, which represented (3, 6, 9 and 12%) from total formula of beef burger patties. The texturized soy - watermelon rind powder blends were individually blended and homogenized, then kept in polyethylene bags at (4 ±1°C) in a refrigerator for the further processing (Table 1).

Beef burger preparation:

The texturized soy with or without WMRP were hydrated by adequate portion of water; another portion of water was used to dissolve salt and other additives. Ground beef hydrated texturized soy with or without WMRP, salt and another ingredients (Table 1) were mixed by mixer (Braun AG, No, 4122, Germany) for 5min. to ensure good distribution. After mixing each batch, about 3 kg, 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 aerobically packaged in a foam plates, wrapped with polyethylene film and kept at -18±2°C until further cooking and analysis every month periodically (Dreeling *et al*., 2000)

Table 1. Amount and percentage of ingredients used in processing of beef burger patties at different replacement levels.

Ingredients (g)	Amount and percentage of ingredients at deferent replacement levels				
	Control g	3% WMRP g	6% WMRP G	9% WMRP g	12% WMRP g
Ground beef meat	60	60	60	60	60
Texturized soy	15	12	9	6	3
Watermelon rind powder	-	3	6	9	12
Fresh eggs	6	6	6	6	6
Fresh onion paste	5.16	5.16	5.16	5.16	5.16
Salt (sodium chloride)	1.5	1.5	1.5	1.5	1.5
Iced water	10.0	10.0	10.0	10.0	10.0
Spices mixture	2.0	2.0	2.0	2.0	2.0
S. tripolyphosphate	0.30	0.30	0.30	0.30	0.30
S. ascorbate	0.03	0.03	0.03	0.03	0.03
S. nitrite	0.015	0.015	0.015	0.015	0.015
Total Ingredients*	100	100	100	100	100

Cooking of beef burger patties:

The beef burger patties were cooked for measuring the diameter shrinkage and organoleptic evaluation for them. 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).

Chemical and Physiochemical analysis:

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:

1-Chemical analysis:

Moisture, crude protein (Nx6.25), ether extract, total ash, and crude fiber contents of WMRP and beef burger patties were determined using the methods described of the A.O.A.C. (2000). % Total soluble carbohydrates were calculated by differences as followed:

= 100 - (% crude protein+% crude fat+% ash + % crude fiber).

Energy values:

Energy values were calculated theoretically according to the method described by Paul and Southgate (1979) as follows:

Energy value = 4 (gm Protein + gm Carbohydrates) + 9 (gm Fat).

Minerals:

Calcium, Magnesium, Iron, Zinc and Manganese contents of WMRP 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 spectro-photometer 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).

Amino acids profile:

The amino acids profile of WMRP was determined as described by Cosmos and Simon-Sarkadi, (2002) using automatic amino acid analyzer (model: AAA 400). Amino acid score (AAS) was calculated accordance to the FAO/WHO (1973) as follows:

$$AAS\% = \frac{\text{mg of Amino acid in 1 g of tested protein}}{\text{mg of Amino acid in 1 g of reference protein}} \times 100$$

Total polyphenols:

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

Total flavonoids:

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

Total glucosinolates content:

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

DPPH % free radical scavenging activity: was estimated according to the method of Hatano *et al.* (1988).

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).

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).

2-Physiochemical analysis:

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

The Water holding capacity (WHC): The Water holding capacity 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.

The diameter shrinkage:

The shrinkage percentage was calculated as described by American meat science association (Oroszvári *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

3-Microbiological analysis:

Microbiological status of prepared beef burger patties samples (immediately after formulation) was assessed including total bacterial count using Plate Count Agar, incubation at 35–37 °C for 24– 48, mold and yeast count using Potato Dextrose Agar, incubation at 20–25 °C for 2–5 days and psychrophilic bacteria count using Plate Count Agar and incubation at 5–7 °C for 5–7 days (Downes and Ito, 2001; Wehr and Frank, 2004; FDA, 2005). while, Coliform bacteria contamination was detected using presumptive test using Mac- Conkey broth and incubation at 35–37 °C for 24–48 h (Murray *et al*., 2007)

4-Sensory evaluation of beef burger patties:

Beef burger patties containing (0, 3, 6, 9 and 12 %) of WMRP as a substitute of SF 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.

5- Statistical analysis:

Obtained data 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

Average weights of watermelon fruit and percentage of red flesh and whole peel watermelon.

The average weight of watermelon fruit at different sizes (Mean ± SE) for ten watermelon fruits was presented in Table (2). The obtained results clear that the percentage of red flesh of watermelon fruits as the edible portion represented about 56.46 % of the watermelon fruit, while the percentage of rind watermelon about 37.84 % from the total weight as non-edible waste, this rest of the fruit can be considered as a processing by-product (USDA, 2004).

Table 2. The mean average weight of watermelon fruits, the red flesh and whole peel watermelon.

Size of watermelon	Total weight of watermelon Fruit (gm)	Weight of red flesh watermelon (gm)	Weight of whole peel watermelon (gm)	
			The inner white pulp of the rind (gm)	The outer green skin of the rind (gm)
Big size	8050	4705.47±101.51^{c}	3020.23±101.53^{c}	324.53±42.20^{c}
Minimum size	3100	1590.04±51.24^{a}	1197.82±59.15^{a}	309.94±38.90^{a}
Means (gm)	5575	3147.75±79.54	2109.02±55.30	316.93±40.32
Percentage (%)	100	56.46	37.84	5.70

Means± standard error for the means within the same column having different superscripts are significantly varied (P ≤ 0.05).

Nutritional values of watermelon rind powder (WMRP):

Proximate Chemical Composition: The Proximate chemical composition (moisture, crude protein, crude fat, total ash, crude fibers and total soluble carbohydrates) and energy values of WMRP as compared with texturized soy were listed in Table (3).

From the given data it could be showed the significant increase (P ≤ 0.05) in ash, crude fibers and total soluble carbohydrates of WMRP (12.55, 15.98and 60.85%, respectively) on dry weight as compared with texturized soy (6.04, 4.76 and 37.23%, respectively).

While, showed a significant decreased ($P \leq 0.05$) in crude protein, crude fat and energy values of WMRP (8.64%, 1.98% and 295.78 Kcal/g, respectively) as compared with texturized soy (47.28%, 4.69% and 380.25 Kcal/g, respectively).

Table 3. Chemical composition of watermelon rind powder and texturized soy on dry weight (M± SE).**

Chemical Composition (%)	Soy flour	WMRP*
Moisture	7.74 ±0.30 [a]	7.88±0.38 [a]
Protein	47.28±0.24 [b]	8.64 ±0.28 [a]
Fat	4.69±0.13 [b]	1.98±0.16 [a]
Ash%	6.04±0.32 [a]	12.55±0.32 [b]
Fiber%	4.76±0.20 [a]	15.98±0.20 [b]
total soluble Carbohydrates %	37.23±0.48 [a]	60.85±0.52 [b]
Energy values Kcal /g	380.25±0.52 [b]	295.78±0.48 [a]

WMRP*: Watermelon rind powder ** Means± standard error; the means within the same row having different superscripts are significantly varied (P ≤ 0.05).

Thereupon, the watermelon rind powder is considered a good source of crude fiber, total soluble carbohydrates and minerals. Therefore, it should be utilized in food fortification (Apsara and Pushpalatha, 2002).

The above mentioned data are in accordance with those obtained by Al-Sayed, and Ahmed, (2013).

Nutritional Protein Quality of WMRP:

The nutritional protein quality of WMRP were evaluated according to its content of essential (indispensable) amino acids, in comparison to the reference protein pattern of FAO/WHO (1973), as presented in Table (4). It could be noticed that, Lysine, Leucine, Valine and Isoleucine were the major essential amino acids of WMRP, it were recorded 4.97, 4.71, 3.75 and 3.14 gm/100gm protein; respectively. Besides, glutamic, arginine, Aspartic, Alanine and Glycine were the major non- essential (dispensable) amino acids which were found (9.94, 8.91, 6.63, 6.11and 5.76, gm/100gm protein respectively. These results were relatively comparable with data recorded by Kim *et al.,* (2009).

Generally, the WMRP protein had adequate contents of lysine, leucine, valine and Isoleucine which were the major indispensable amino acids and glutamic, arginine, aspartic, alanine and glycine were the major dispensable amino acids therefore, the use of WMRP in the beef burger patties manufacture and other foodstuffs may be has added economic value for human nutrition.

Table 4. Amino acids composition of watermelon rind powder compared by the reference protein pattern of FAO/WHO (1973).

Amino acids	Watermelon rind powder gm/100gm sample	gm/100gm protein	FAO/WHO(1973) gm/100g protein	Amino acids score (%)
Essential (indispensable) amino acids (EAA)				
Threonine	0.12	1.13	4.0	28.25
Valine	0.42	3.75	5.0	75.0
Isoleucine	0.35	3.14	4.0	78.5
Leucine	0.53	4.71	7.0	67.28
Phenyl alanine	0.17	1.57	6.0	59.66
Histedine	0.22	2.01		
Lysine	0.56	4.97	5.5	90.36
Total EAA	2.37	21.28		
Non- Essential (dispensable) amino acids (NEAA)				
Aspartic	0.75	6.63		
Serine	0.23	2.09		
Glutamic	1.13	9.94		
Proline	0.12	1.13		
Glycine	0.65	5.76		
Alanine	0.69	6.11		
Tyrosine	0.29	2.61		
Arginine	1.01	8.91		
Total NEAA	4.87	43.09		

Minerals content of watermelon rind powder (WMRP):

The Minerals content (Na, K, Ca, Mg, P, Fe and Zn) of WMRP was determined and listed in Table (5). From the obtained data it could be noticed that, the WMRP contained a high amount of sodium (515.44 mg/100g), calcium (311.22 mg/100g), Magnesium (298.61mg/100g), Phosphorous (288.28 mg/100g), and Potassium (130.04 mg/100g), as macro-elements.

At the same results in Table (5), it could be noticed that the WMRP contained a considerable amount of both Ferrous (12.98mg/100g) and Zinc (3.12 mg/100g) as micro-elements when compared with the reference of minerals pattern (RDA, 1989). The above mentioned results are in accordance with those reported by Perkins Veazie *et al.,* (2007).Generally, the WMRP could be considered as a good source of macro and micro-elements and therefore it could be utilized watermelon rind powder in food fortification.

Table 5. Minerals content of watermelon rind powder on dry weight

Minerals	Minerals content of WMRP* mg/100g	**RDA (mg/ day)
Na	515.44	2000-4000
K	130.04	2000-4000
Ca	311.22	800-1200
Mg	298.61	280-350
P	288.28	800-1200
Fe	12.98	10-12
Zn	3.12	12-15

WMRP* Watermelon rind powder.

RDA: Recommended Dietary Allowances of minerals**

Antioxidant properties of watermelon rind powder (WMRP): The health promoting phytochemicals including total polyphenol, total flavonoid and total glucosinolate contents as antioxidant compounds and the total antioxidant activities (TAA) of WMRP were determined and the obtained results were shown in Table (6).

Table 6. Phytochemical and Antioxidant activity of watermelon rind powder and texturized soy on dry weight. (M±SE)

Items	Watermelon rind powder	Texturized soy
Total polyphenols as gallic acid (ppm)	2308.1±2.55[b]	1575.6±2.38[a]
Total flavonoids as rutin(ppm)	3817.5±2.55[b]	1178.9±2.38[a]
Total glucosinolates as allyl isothiocyanate (ppm)	1831.44±1.89[b]	885.5±2.38[a]
DPPH activity (%)	98.46± 0.52[b]	61.46±0.11[a]

***Means± standard error for means within the same row having different superscript are significantly varied (P ≤ 0.05).**
DPPH: 1,1-diphenyl-2-picrylhydrazyl.
Trolox: 6-hydroxy-2,5,7,8-tetramethyl-2- carboxylic acid.

From the obtained data, it could be noticed that the WMRP have a highest content of total polyphenols (2308.1 ppm), total flavonoids (3817.5 ppm) and total glucosinolates (1831.44 ppm) as a compared with texturized soy (1575.6, 1178.9 and 885.5 ppm, respectively), also the % DPPH free radical scavenging activity was a highest in WMRP (98.46%) when compared with texturized soy (61.46%). These results were relatively comparable with those obtained by Tlili, *et al.,* (2011) and Al-Sayed and Ahmed, (2013). So, the addition of WMRP to beef burger patties causes the increase of shelf-life and improve original quality properties, especially the healthy safe quality, with providing the consumer of food containing the WMRP with the healthy beneficial functions.

Quality characteristics of frozen beef burger (at-18±2°C for 90 days) as affected by different levels effect of watermelon rind powder (WMRP) and frozen storage period.

Gross chemical composition of frozen beef burger patties (at-18±2°C for 90 days):

The chemical composition of beef burger patties (moisture, crude protein, crude fat, total ash, crude fiber and total soluble carbohydrate) at zero time and through frozen storage period for 90 days at (-18 ±2ºC) was presented in Table (7).

Table 7. Chemical composition of beef burger (on dry weight) as affected by Substitution levels of WMRP and frozen storage periods (at -18±2°C for 90 days)

Properties	Substitute levels of the WMRP (M± SE)				
Storage period (days)	**Control**	**3%**	**6%**	**9%**	**12%**
Moisture%					
0	67.82±1.27[a]	67.80 ±1.30[a]	67.75 ±1.31[a]	67.71 ±1.29[a]	67.70 ±1.31[a]
30	67.66 ±1.21[a]	67.69 ±1.28[a]	67.66 ±1.29[a]	67.67 ±1.26[a]	67.63 ±1.30[a]
60	67.70 ±1.24[a]	67.71 ±1.29[a]	67.69 ±1.28[a]	67.68 ±1.28[a]	67.60 ±1.29[a]
90	67.63 ±1.25[a]	67.60 ±1.27[a]	67.61 ±1.29[a]	67.60 ±1.28[a]	67.58 ±1.26[a]
Protein% (on dry weight)					
0	58.19 ±1.21[b]	56.99 ±1.27[b]	55.77 ±1.27[ab]	54.60 ±1.11[a]	53.39 ±1.22[a]
30	58.07 ±1.17[b]	56.10 ±1.22[b]	55.03 ±1.28[ab]	54.08 ±1.17[a]	53.05 ±1.27[a]
60	57.35 ±1.11[b]	55.41 ±1.21[b]	54.42 ±1.29[ab]	53.62 ±1.15[a]	52.66 ±1.25[a]
90	56.32 ±1.16[b]	54.53 ±1.18[b]	53.77 ±1.26[ab]	53.00 ±1.19[a]	52.02 ±1.27[a]
Fat % (on dry weight)					
0	14.03 ±0.88[a]	13.94±0.91[a]	13.86 ±0.97[a]	13.76±0.90[a]	13.67 ±0.96[a]
30	13.63 ±0.87[a]	13.21±0.93[a]	13.90 ±0.94[a]	13.50±0.92[a]	13.00 ±0.93[a]
60	12.77 ±0.83[a]	12.67±0.97[a]	13.03 ±0.92[a]	12.91±0.91[a]	12.83 ±0.92[a]
90	11.95 ±0.80[b]	12.03±0.98[b]	12.36±0.91[ab]	12.61±0.97[ab]	12.70 ±0.97[a]
Ash % (on dry weight)					
0	10.54 ±0.97[a]	10.75 ±0.87[a]	10.94±0.83[ab]	11.17±0.87[ab]	11.34 ±0.87[b]
30	10.50 ±0.98[a]	10.54 ±0.88[a]	10.59 ±0.87[ab]	10.61±0.85[ab]	10.68 ±0.80[b]
60	10.44 ±0.94[a]	10.50 ±0.90[a]	10.55 ±0.88[ab]	10.58±0.87[ab]	10.61 ±0.84[b]
90	10.40 ±0.93[a]	10.43 ±0.89[a]	10.48 ±0.87[ab]	10.50±0.89[ab]	10.53 ±0.89[b]
Fiber % (on dry weight)					
0	0.84 ±0.09[a]	1.16 ±0.07[b]	1.49 ±0.07[c]	1.81 ±0.07[d]	2.13 ±0.07[e]
30	0.79 ±0.10[a]	1.10 ±0.07[b]	1.43 ±0.07[c]	1.79 ±0.08[d]	2.11 ±0.08[e]
60	0.75 ±0.07[a]	1.06 ±0.07[b]	1.37 ±0.07[c]	1.75 ±0.07[d]	2.10 ±0.07[e]
90	0.71 ±0.08[a]	1.01 ±0.09[b]	1.30 ±0.09[c]	1.70 ±0.09[d]	2.10 ±0.07[e]
total soluble Carbohydrates % (on dry weight)					
0	16.4 ±0.10[a]	17.16±0.07[ab]	17.94±0.07[bc]	18.66±0.07[cd]	19.47±0.11[d]
30	14.27 ±0.11[a]	14.66±0.09[ab]	14.80±0.09[bc]	15.60±0.07[cd]	16.25±0.07[d]
60	14.15 ±0.10[a]	14.59±0.07[ab]	14.75±0.11[bc]	15.42±0.11[cd]	16.13±0.11[d]
90	14.03 ±0.09[a]	14.51±0.07[ab]	14.64±0.09[bc]	15.26±0.07[cd]	16.01±0.07[d]

Means± standard error; the means within the same row having different superscripts are significantly varied (P ≤ 0.05).
Total soluble Carbohydrates% calculated by deference as following: 100-(Protein+ Fat+ Ash+ Fiber)

From statistical analysis of these obtained data in Table (7), it could be noticed that non-significant differences in moisture content in all beef burger patties samples control and containing WMRP at zero time or observed throughout frozen storage period.

Also, showed that a non-significant differences in crude protein content between beef burger patties control and containing (3 and 6%) WMRP, while caused a significant decrease with beef burger patties control and containing (9 and 12%) WMRP at zero time or observed throughout frozen storage period

In the same way, from obtained results in Table (7), it could be noticed that non- significant differences in crude fat content in all beef burger patties control and samples containing WMRP at zero time and but caused a significant increased between beef burger patties control and samples containing WMRP (12%) WMRP when the end frozen storage period.

Also, for ash content showed a non- significant difference between sample control and containing (3, 6 and 9%) WMRP, while caused a significant increase with beef burger patties containing (12%) WMRP at zero time or observed throughout frozen storage period

On the other hand, from data in Table (7), it could be appeared that a significant increase in crude fiber content of beef burger patties containing at different levels (3, 6, 9 and 12%) of WMRP as compared with control sample at zero time also, and through frozen storage period for 90 days at (-18 ±2ºC) observed throughout frozen storage period.

In the same way, for total carbohydrates content, showed that a significant increase in total carbohydrates content for sample contained 6, 9 and 12% WMRP as compared with control sample at zero time and through frozen storage period. But showed non-significant differences with beef burger patties samples contained 3% WMRP at zero time and through frozen storage period. The above mentioned data are in accordance with those obtained by Al-Sayed, and Ahmed, (2013) and Akgül and Özcan, (1999).

Generally, the WMRP it was considered a good source of crude fiber and minerals and low fat content. Therefore, it could be the beef burger patties containing WMRP had a good nutritional quality even after frozen storage for 90 days at -18 ±2ºC, and the incorporation of the WMRP into the beef burger patties, as a substitute of SF, could be improved their nutritional quality with regards fat, ash and crude fiber contents

Physiochemical quality criteria of frozen beef burger patties (at-18±2 ^{o}C for 90 days) as affected by addition different levels of WMRP instead of texturized soy and storage periods:

Frozen storage stability for the most important physiochemical 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 addition levels of WMRP were investigated and presented in Table (8). From the obtained results it could be noticed that, the addition of WMRP, instead of texturized soy to beef burger patties recorded no significant decrease (P≤0.05) in pH values when compared with control sample. On the other hand, the pH value was increased continuously in all beef burger patties throughout frozen storage. The increment rate was slight decreased as the addition level of WMRP increase, whereas, the control sample exhibited the highest pH value at any time of frozen storage. The increment of pH values for all tested beef burger 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 data, it could be observed that the WHC of beef burger patties samples were slightly (P≤0.05) increased by increasing the incorporation level of WMRP from 3 % to12 % into the beef burger patties, as the result of increment crude fiber and carbohydrates, by incorporating the WMRP into the product, which characterized with a highly efficiency to bound water. During frozen storage, the WHC values were decreased 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 (Oroszvári *et al*.,2005). Also, the loss of WHC during frozen storage may be due to protein denaturation and loss of protein solubility (Osheba *et al*., 2013)

With regards diameter shrinkage which was considered one of the most important physiochemical 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. As given in Table (8), the percentage of diameter shrinkage in beef burger patties was decreased continuously with increasing the addition level of WMRP. 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 WMRP at different levels of 3 to 12 %. These results are in accordance with those found by Oroszvári *et al*. (2005). On the other hand, the thiobarbituric acid values (TBA) of beef burger patties were affected by WMRP addition and frozen storage period, as given in Table (8). Also, it could be noticed that the incorporation of WMRP into the beef burger patties caused significant decreased (P≤0.05) in TBA values by increasing substitution level (3, 6, 9 and 12% of WMRP) (0.76, 0.59, 0.54 and 0.43 mg/kg, respectively) as compared with control sample (0.91 mg/kg) at zero time. TBA values of different beef burger sample were gradually increased with advancement of frozen storage period. This increase in TBA values during storage could be indicating continuous oxidation of lipid and consequently the production of oxidative by products (Brewer *et al*. 1992 and Osheba *et al*., 2013). Also, TBA values through frozen storage period for 90 days at (-18 ±2ºC) showed a significant decrement (P≤0.05) for beef burger patties samples contained WMRP as compared with control sample. The above mentioned data are in accordance with those obtained by (Zhang *et al*., 2005).

Table 8. Physiochemical properties of beef burgers as affected by Substitution levels of WMRP and frozen storage periods at -18±2°C for 90 days.

Physiochemical properties Storage period (days)	Substitution levels of the WMRP (M± SE)				
	Control	3%	6%	9%	12%
	PH value				
Zero time	6.94±0.27[a]	6.92±0.29[a]	6.88±0.22[a]	6.77±0.27[a]	6.75±0.25[a]
30	7.01±0.33[a]	7.00±0.26[a]	6.96±0.25[a]	6.86±0.26[a]	6.83±0.26[a]
60	7.19±0.29[a]	7.16±0.28[a]	7.11±0.26[a]	7.05±0.28[a]	7.02±0.27[a]
90	7.30±0.28[a]	7.20±0.27[a]	7.21±0.29[a]	7.23±0.29[a]	7.25±0.28[a]
	Water Holding Capacity (WHC) as bound water %				
Zero time	83.15±1.18[a]	83.32±1.15[a]	83.47±1.11[a]	83.63±1.10[a]	83.78±1.13[a]
30	82.73±1.17[a]	83.12±1.16[a]	83.31±1.10[a]	83.57±1.11[a]	83.31±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 %				
Zero time	9.64±0.45[b]	9.45±0.44[ab]	9.23±0.43[ab]	9.13±0.45[a]	9.02±0.46[a]
30	10.53±0.48[c]	10.01±0.49[b]	9.98±0.49[b]	9.53±0.47[ab]	9.23±0.49[a]
60	12.14±0.51[c]	10.60±0.48[b]	10.13±0.47[b]	9.60±0.49[ab]	9.46±0.44[a]
90	13.18±0.59[d]	11.01±0.44[c]	10.31±0.49[b]	9.91±0.48[ab]	9.64±0.48[a]
	Thiobarbituric acid value (TBA) mg malonaldhyde/kg sample				
Zero time	0.91±0.10[e]	0.76±0.12[d]	0.59±0.09[c]	0.54±0.07[b]	0.43±0.08[a]
30	1.17±0.17[e]	0.99±0.16[d]	0.71±0.11[c]	0.63±0.08[b]	0.47±0.09[a]
60	1.54±0.14[e]	1.28±0.15[d]	0.84±0.12[c]	0.76±0.09[b]	0.52±0.08[a]
90	2.05±0.19[e]	1.84±0.18[d]	1.19±0.16[c]	0.95±0.11[b]	0.76±0.10[a]
	Total Volatile Nitrogen value (TVN) mg/ 100g sample				
0	11.79±0.37[b]	11.12±0.31[a]	10.50±0.32[a]	10.30±0.29[a]	10.13±0.28[a]
30	17.12±0.32[c]	14.53±0.34[b]	13.82±0.31[b]	13.44±0.30[ab]	13.12±0.29[a]
60	22.19±0.34[e]	20.69±0.37[d]	19.09±0.35[c]	16.22±0.37[b]	15.00±0.31[a]
90	27.10±0.35[e]	25.83±0.33[d]	23.20±0.37[c]	21.06±0.35[b]	20.01±0.34[a]

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

Concerning, as given in Table (8), it could be showed that the incorporation of the WMRP into the beef burger patties caused significant decreased (P≤0.05) in TVN values, as the addition level increase (3, 6, 9 and 12%) of WMRP it were presented (11.12, 10.50, 10.30 and 10.13 mg/ 100g, respectively) as compared with control sample (11.79 mg/100g) at zero time storage, On the other hand, a gradual increase in TVN 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 beef burger patties containing WMRP at any time of frozen storage.

In general, the addition of WMRP into beef burger patties led to significant decrement for both TBA and TVN values may be due to the antimicrobial and antioxidant properties of WMRP due to its high phytochemical compounds such as polyphenols, flavonoids, glucosinolates content as shown Table (6).

Microbiological aspects of frozen beef burger patties (at-18±2 °C for 90 days) as affected by addition different levels of WMRP instead of texturized soy and frozen storage periods:

In view of safety evaluation of any processed foods to be ready for human consumption, the microbiological quality is mainly undertaken (Lin *et al*., 2000) and also, Its known that meat and their products are considered one of the most perishable foods therefore, it's 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).

In this study, 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, Psychrophilic bacteria and coliform bacteria group were examined periodically at 30 days intervals during frozen storage for 90 days. The obtained results are recorded in Table (9). From statistical, it could be noticed that no significant differences (P≤0.05) in microbial counts (TBC, mold and yeast counts, Psychrophilic bacteria and coliform bacterium) between all beef burger patties samples at zero time of frozen storage. After that, the counts of the former microbial 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 count for beef burger patties samples containing WMRP was increased with increasing the addition levels (3, 6, 9 and 12 % of WMRP) and also much higher than control sample, it's the result of the complementary effect of freezing and the antimicrobial effect of polyphenols, flavonoids and glucosinolates content of WMRP and their breakdown products especially allyl isothiocyanate which are naturally occurred at a high concentration in the WMRP (Keum *et al*., 2004).

It's worth to note that the tested microbial quality criteria of all beef burger were within the permissible counts reported by EOS. (2005), that recommended the total bacterial and coliform bacteria 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 WMRP during frozen storage it could be mainly attributed to the antimicrobial and antioxidant properties of polyphenols, flavonoids, glucosinolates for WMRP, and their breakdown products especially allyl isothiocyanate which are naturally occurred at a high concentration in the WMRP.

Table 9. Microbiological aspects (log cfu/g) of beef burgers as affected by Substitution levels of WMRP and frozen storage period at -18±2°C.

Microbiological aspects Storage period (days)	Substitution levels of WMRP (M± SE)				
	Control	3%	6%	9%	12%
	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[ab]	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; the means within the same row having different superscripts are significantly varied (P ≤ 0.05).

Organoleptic quality criteria of frozen beef burger patties (at-18±2°C) as affected by addition different levels of WMRP instead of texturized soy and frozen storage periods:

The organoleptic properties of meat products were greatly affected by the ingredients used in processing treatments and by storage conditions. They also correlated significantly with physiochemical, chemical 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 WMRP at different levels of (3, 6, 9 and 12%) instead of texturized soy during frozen storage at –18±2˚C up to 90 days compared with the control samples. 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 (P≤0.05) alteration in all sensory quality criteria between beef burger sample containing WMRP up to the level of 9% and control beef burger sample. While, the increment of incorporation level to 12% into the product caused a significant decreased all sensory properties of beef burger patties when compared with the control sample. Beef burger patties containing 9% WMRP had the highest sensory scores for tenderness, juiciness, appearance and overall acceptability, and also there was no significant variation (P≤0.05) 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 control sample and beef burger patties containing WMRP up to the addition level of 9%, after which no significant variation in the most properties was occurred throughout frozen storage, when compared to control sample. While, the beef burger patties containing WMRP up to the level of 12% 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 frozen storage period. The above mentioned data are in accordance with those obtained by Abd-Elghany (2014)

In general, it could be showed that beef burger patties containing the WMRP exhibited a good sensory properties and better acceptability when compared with control sample, especially with incorporation of 9% WMRP, even after stored for 90 days under frozen storage conditions (at -18±2°C for 90 days).

Table 10. Sensory properties of beef burgers as affected by substitution levels of WMRP and frozen storage period (at -18±2°C)

Storage period (days)	Substitution levels of WMRP (M± SE)				
	Control	**3%**	**6%**	**9%**	**12%**
			Color		
Zero time	8.00±0.79[b]	8.00±0.81[b]	8.05±0.80[b]	8.20±0.81[b]	7.35±0.79[b]
30	8.00±0.81[b]	7.90±0.80[b]	7.90±0.79[b]	8.10±0.78[b]	7.30±0.81[a]
60	7.85±0.78[b]	7.85±0.79[b]	7.85±0.73[b]	8.00±0.76[b]	7.25±0.77[a]
90	7.90±0.80[b]	7.80±0.80[b]	7.75±0.71[b]	7.90±0.77[b]	7.20±0.79[a]
			Taste		
Zero time	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		
Zero time	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		
Zero time	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		
Zero time	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		
Zero time	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		
Zero time	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; the means within the same row having different superscripts are significantly varied ($P \leq 0.05$).

CONCLUSION

Influence of substitution of texturized soy by different levels (3, 6, 9 and 12%) of watermelon rind powder from total formula of beef burger patties caused to improvement of gross chemical composition as that increased for crude fiber, total ash, total soluble carbohydrates content and decreased crude fat in beef burger patties, as well as the improvement of physiochemical quality criteria (pH value, WHC, shrinkage, TVN and TBA values) throughout frozen storage, in comparison with control sample. In addition, WMRP inhibited the growth and activity of microbial in tested prepared product. Also, beef burger patties containing the WMRP exhibited a good sensory properties and better acceptability, especially those contained 6 and 9 % of the WMRP, even after stored for 90 days under frozen condition. The present results are useful of used WMRP in fortification of meat products to improve the nutritionally and healthy safe.

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تأثير إضافة مسحوق قشر البطيخ في برجر اللحم البقري على معايير الجودة والحالة الميكروبية خلال فترات التخزين بالتجميد

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يعتبر مسحوق قشرة البطيخ مصدر طبيعي للألياف الغذائية والمعادن والأحماض الأمينية والمركبات المضادة للأكسدة الطبيعية. وقد تم إجراء هذا البحث لتقييم تأثير إضافة مسحوق قشرة البطيخ بمستويات مختلفة (٣ ، ٦ ، ٩ و ١٢٪) من التركيبة الإجمالية لخلطة اقراص برجر اللحم البقري على الخصائص الكيميائية والفيزيائية والميكروبيولوجية والحسية خلال فترة التخزين المجمدة في (- ١٨± ٢ م°) تصل إلى ثلاثة أشهر. أظهرت النتائج التي تم الحصول عليها أن النسبة المئوية لقشرة البطيخ كمخلف حوالي ٣٧.٨٤٪ من الوزن الكلي للثمرة والتى تعتبر مخلفات ثانوية للمصانع. وكذلك وجد أن مسحوق قشرة البطيخ مصدرا للألياف الخام (١٥.٩٨ ٪) والرماد (١٢.٥٥ ٪) ، الصوديوم (٥١٥.٤٤ ملجم / ١٠٠ جم) ، والكالسيوم (٣١١.٢٢ ملجم / ١٠٠ جرام) ، المغنيسيوم (٢٩٨.٦١ مجم / ١٠٠ جم)، الفسفور (٢٨٨.٢٨ ملجم / ١٠٠ جم) ، و البوتاسيوم (١٣٠.٠٤ ملجم / ١٠٠ جم) ، الحديد (١٢.٩٨ملجم / ١٠٠ جرام) و الزنك (٣.١٢ ملجم / ١٠٠ جم). وكانت اعلى الاحماض الامينية الاساسية هى الليسين، الليوسين، الفالين، الايزوليوسين (٤.٩٧ ، ٤.٧١ ، ٣.٧٥ و ٣.١٤ جرام / ١٠٠ جرام بروتين ؛ على التوالي) ، أيضا ، الجلوتاميك ، أرجينين ، الأسبارتيك ، ألانين والجليسين هي أعلى الأحماض الأمينية الغير اساسية (٩.٩٤ ، ٨.٩١ ، ٦.٦٣ ، ٦.١١ و ٥.٧٦ ، جرام / ١٠٠ جرام بروتين على التوالي ، ومحتوى منخفض من الدهون. وعلاوة على ذلك ، فإن اضافة مسحوق قشرة البطيخ في خلطة أقراص برجر اللحم البقري، كبديل لدقيق فول الصويا أدى الى تحسين التركيب الكيميائي لأقراص البرجر حيث زادت ذلك نسبة الألياف الخام والرماد ومحتوى الكربوهيدرات الكلى وأنخفضت نسبة الدهون الخام ، وكذلك تحسين معايير الجودة الكيميائية والفيزيائية (قيمة الرقم الهيدروجيني ، القدرة على ربط الماء ، الانكماش ، قيم القواعد النيتروجينية ورقم حمض الثيوباربتيوريك) خلال التخزين بالتجميد بالمقارنة بالعينة القياسية. بالإضافة إلى ذلك ، تحسين جودة الآمان الصحى بتثبط نمو الميكروبات. كما أظهرت النتائج أن أقراص برجر اللحم البقري التي تحتوي على مسحوق قشرة البطيخ لها خصائص حسّية جيدة وأفضل فى القبول ، خصوصاً تلك التي تحتوي على ٦ و ٩٪ من مسحوق قشرة البطيخ، حتى بعد تخزينها لمدة ٩٠ يوماً تحت التخزين بالتجميد. النتائج الحالية أكدت أن استخدام مسحوق قشرة البطيخ في برجر اللحم البقرى أدى إلى تقوية وتدعيمه منتجات وتحسين السلامة والآمان من الناحية التغذوية والصحية.