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Original scientific article

QUALITY PROPERTIES AND STORAGE STABILITY OF BEEF BURGER AS INFLUENCED BY ADDITION OF ORANGE PEELS (ALBEDO)

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Keywords: *citrus fruits, chemical compositions, healthy diet, dietary fibers, shelf life, low fat, sensory analysis*

Abstract

The objective of this study was to investigate the effect of using the orange albedo (OA) on the quality attributes of low fat beef burger. The analysis included: chemical composition, water-holding capacity, cooking loss% and pH values as well as sensory evaluation of low fat beef burger prepared with the introduction of the OA with a concentration of 5% as a partial fat replacer were also studied. Microbiological analysis of frozen minced meat semi-finished products (burger patties, at minus 18 °C) stored for 126 days was included. According to the obtained results, the OA contains 1.47% of lipids, 1.42% of protein and 24.61% of dietary fiber. The result also showed that the usage of OA has a positive impact on organoleptic indicators of beef burger. Nutritional value, water-holding capacity, cooking loss% and pH of treated burger patties were improved. In addition, the caloric value of treatment samples decreased because of replacing the animal fat with the OA in recipe. During the storage of semi-finished products, Thiobarbituric values (TBA) showed that treatment samples substantially developed using OA instead of animal fat had a lower level of lipid oxidation compared to control samples. The shelf life of treated burger patties was significantly increased compared to control sample by decreasing the microbial growth and rate of fatty acids oxidation. Finally, OA could be accepted as a functional component in meat products.

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Introduction

In today's world, processed foods and fast foods have become primary elements of most people's diets. Rapid urbanization, industrialization, globalization, and a rise in the number of women in the workforce have resulted in a rapid tendency toward fast foods in developing countries like Egypt. Many of these processed foods including meat products lack minimum amounts of dietary fiber. Epidemiological research has demonstrated a relationship between a diet containing an excess of energy-dense foods rich in fat and sugar and the emergence of a range of chronic diseases, including colon cancer, obesity, cardiovascular diseases, and several other disorders [1,2,3]. Various reports have revealed that intake of fiber reduces the risk of such diseases [4].

Recently, the food industries are searching to use or produce new functional food components to improve shelf life of food products and to meet consumer needs that represent in food quality and safety. Several types of dietary supplements were used for therapy different types of diseases. Therefore, the manufacturers tending to use different new types of food additives especially from the plant origin [5,6,7,8,9]. Moreover, biologically active additives derived from a variety of plant species found in Africa, South America, and other hot-climate countries have received inadequate attention. Due to the scarcity of raw meat, the challenge is to substitute and enrich the raw meat with plant-based ingredients. Raw materials from plant sources with high protein content, such as isolated soy protein (90% protein) and wheat gluten (80% protein), are used as examples [10,11,12].

Presence of a large amount of animal fat in meat products accelerates oxidation of lipids conducting to more diminutive shelf life. The lipid oxidation in meat products during the time of processing and storage has a negative impact on such important quality characteristics as taste, color and nutritional value. Various types of plant additives that have antioxidant activity affect the shelf life of processed meat. In current years, the application of natural antioxidants in food has been increased [13,14,15]. Much attention paid to food additives derived from nuts, fruits, vegetables, herbs, and spices planned to be used to fortify food products with dietary fiber, micro and macro elements, to increase shelf life, improve taste and extend the range of meat products [16,17].

Albedo is spongy white tissue rich in cellulose, which is the principal citrus peel component and Figure1 shows a cross section in an orange fruit. Moreover, albedo has better qualities than other sources of dietary fiber due to the presence of associated bioactive compounds (flavonoids and vitamin C) with antioxidant properties, which may exert more health promoting effects in addition to those of the dietary fiber. Citrus by-products main components are pectin 7.50%, hemicelluloses 11.0%, cellulose 36.25% and lignin 22.50% [18].

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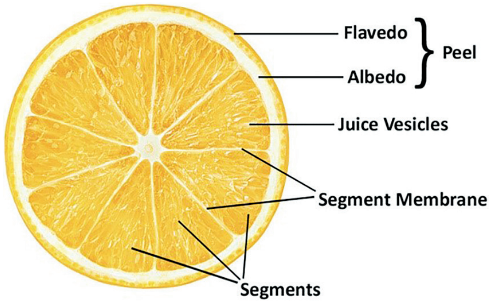

Figure 1. Cross section in an orange fruit

Citrus fiber may be incorporated into a broad range of products such as meat products, fish and dairy product. Dietary fiber is a necessary food component for supporting consumer's health [19]. In meat industry, dietary fiber has a great importance because of its technological properties such as improving textural properties, reducing cooking loss, formulation cost and fat substitution [20]. As for fermented dry sausages, dietary fiber is mostly used for partial fat substitution [21].

Orange fiber usage in sausage product also decreased the bacterial growth and in another hand the growth of lactic acid bacteria was positively affected and decreased the residual nitrite level in sucuk (Turkish sausage) samples [22]. For these reasons, there is an interest in increasing the consumption of low fat meat products and all foods that can supply fiber to daily food intake. Fiber incorporation to food products would help to overcome the current fiber deficit. The source of fiber is important because the differences on the structure and constitution of plant cells can affect fiber properties. Albedo is a white, spongy tissue, which is the principal component of the citrus peel, and could be considered as a potential source of fiber.

Studying the possibility of using of orange albedo as a partial fat replacer and the effect of that on the chemical, physicochemical and sensory characteristics of frozen beef burger was the main objective of this study.

Objects and methods

Chemicals and raw materials

Chemicals and reagents used to conduct methods of analysis obtained from (Sigma-Aldrich Chemical Co., Denmark). Albedo was obtained directly from commercial oranges *(Citrus sinensis)* was obtained from Egypt local market. (OA) was removed by hand using a peeling tool and immediately was frozen at minus 18 °C until being required and before processing of burger the albedo was minced to obtain a pieces with particle size 1–2 mm. Frozen lean beef (6% fat) bought from hypermarket and kidney fat obtained from the local market in Giza, Egypt. Subcutaneous and intramuscular fat, as well as thick and visible connective tissue, were removed from lean beef cuts obtained from boneless rounds.

Preparation of beef burger and final recipe

The control samples were prepared without the (OA). Recipe for "Burger Patties" (control), according to Egyptian standard of frozen beef burger (ES: 1688/2005 ICS: 67.120.10) Egyptian organization for standardization Arab Republic of Egypt (Table 1), and the treatment samples contained 5% of the (OA) used to substitute the same amounts of fat. The selection of the 5% percentage based on previous experiments and this percentage was the best percentage in terms of sensory characteristics. Convenient quantity of each formulation mixed and formed into patties with a weight 100 g and diameter 10 cm. Then wrapped and stored at minus 18 °C until analysis.

Table 1. Beef burger formulation containing orange albedo (OA)

Components %	*Control	Treatment 5% (OA)
Lean meat	65	65
Animal fat	15	10
Orange albedo	—	5
Soy flour	10	10
Onion	3	3
Salt	1.7	1.7
Skimmed milk	1.5	1.5
Bread crust	1.5	1.5
Spices mixture	1.3	1.3
Starch	1	1

*** Control prepared according to (ES: 1688/2005 ICS: 67.120.10) Egyptian Standard of frozen beef burger**

Method of analysis

Chemical composition

Moisture content was by oven method and ash content of the samples determined by the method described in [23]. In addition, Crude protein by Kjeldahl method and crude fat content using the Soxhlet fat extraction method were determined according to [23]. Crude fiber was determined after boiling 5 g defatted sample in refluxing sulphuric acid and sodium hydroxide. Carbohydrate content was measured by difference according to the following equation:

$$\% \text{ Carbohydrate} = 100 - (\% \text{ protein} + \% \text{ fat} + \% \text{ moisture} + \% \text{ fiber} + \% \text{ ash}).$$

Caloric values

Based on a 100 g sample, total calories (Kcal) for uncooked patties were determined using the following values for fat (9 Kcal/g), protein (4.02 Kcal/g), and carbohydrates (3.87 Kcal/g) as defined by [24].

The pH value

The pH value of meat model samples determined by mixing 10 gm of the samples with distilled water (100 ml) for 30 s. values of pH measured at 20 °C with a pH meter (Jenway 3510 pH meter) as stated by [25].

Cooking loss%

The meat samples cooked on a preheated (148 °C) electric grill, the samples were cooked for about six minutes, then converted and heated for another four minutes. To determine the percentage of cooking yield samples weighed before and after cooking as described by [26].

The Thiobarbituric acid value (TBA) determined by the distillation method outlined by [27,28].

Water holding capacity (WHC)

Water holding capacity was determined as described by [29] with some modifications. In summary, each sample

(1 g) mixed with 10 ml of distilled water in centrifuge tube, vortexed for 5 minutes and then centrifuged for 30 min at 5000 rpm. The removal of water layer was done then, the weights (wt.) of centrifuge tubes were measured and the following equation was used to calculate WHC:% WHC = [(wt. of tube after decanting (g) — wt. of dry tube (g)) — wt. of total sample (g)] x100/ wt. of total sample (g).

Microbiological studies

Total plate count, Mold and yeast were conducted according to the protocol described by [30]. Coliform group and Pathogenic (*Salmonella)* determined as recommended by [31,32].

Sensorial analysis

Sensorial analysis of cooked samples carried out as stated by [33]. Pieces from samples cooked as described before, prepared and served warm to evaluation, ten qualified and trained panelists were nominated from the staff of Cairo University, faculty of agriculture, department of food science.

Statistical analysis

The statistical analysis of the results was conducted (one-way ANOVA) by XLSTAT software (Addinsoft, New York, USA). Which Duncan test was used to evaluate the differences between all treatments at significance levels ($p \leq 0.05$).

Results and discussion

Proximate chemical composition of orange albedo

Data presented in Table 2 shows the gross chemical compositions of orange albedo. The results indicated that orange albedo has a high content of fiber and moisture. These results were in agreement with [34].

Table 2. Proximate chemical composition of orange albedo (g/100 g wet basis)

Contents %	Fresh Orange Albedo
Moisture	65.46 ± 0.21
Total fibers	24.61 ± 0.13
Ash	3.21 ± 0.06
Protein	1.42 ± 0.11
Fat	1.47 ± 0.12
Carbohydrate	3.83

Chemical composition of burgers formulas

The quality characteristics of Burger patties presented in Table 3. Based on the analysis of Table 3, it was found that when the (OA) added to the recipe in an amount of 5%, the moisture content increased by 3.05%, WHC by 8.38%, protein by 0.13%, carbohydrates by 0.25%, dietary fiber by 1.26% and pH by 0.19. Along with this, there is a noticed decrease by 4.97% in fat content, 17.97% in caloric value of the product, and weight loss during heat treatment by 5.62%. The decrease in fat content caused by the fact that beef fat in the recipe replaced with the (OA). The reduction of fat in burger by 4.97% and caloric content by 18,23% suggests the development of a low-calorie product. [35,36,37,38,39,40].

Table 3. Chemical, water-holding capacity, cooking loss% and pH values of burger patties

Studied parameters	Control	Treatment 5% (OA)
Moisture, %	59.73 ± 0.14	62.78 ± 0.09
Ash, %	2.21 ± 0.03	2.49 ± 0.04
Protein, %	16.53 ± 0.08	16.66 ± 0.09
Fat, %	18.26 ± 0.07	13.29 ± 0.04
Carbohydrates, %	1.64	1.89
Dietary fiber, %	1.63 ± 0.05	2.89 ± 0.08
Caloric value, k. cal /100g	237.02	193.81
Water holding capacity (WHC) %	67.45 ± 0.03	75.83 ± 0.04
Cooking loss during heat treatment, %	21.04 ± 0.23	15.42 ± 0.23
pH	5.86 ± 0.10	6.05 ± 0.12

TBA values (mg malonaldehyde/kg of beef burger) for control and treatment as affected by using the (OA) as a partial fat replacer presented in Figure 2. Thiobarbituric values (TBA) during the storage of semi-finished products showed that the treatment samples significantly developed using the (OA) instead of animal fat, have a lower level of lipid oxidation, compared to control samples. According to the obtained data, it could be concluded that the partial substitute of animal fat with the (OA) had a positive effect on the quality characteristics and shelf life of products.

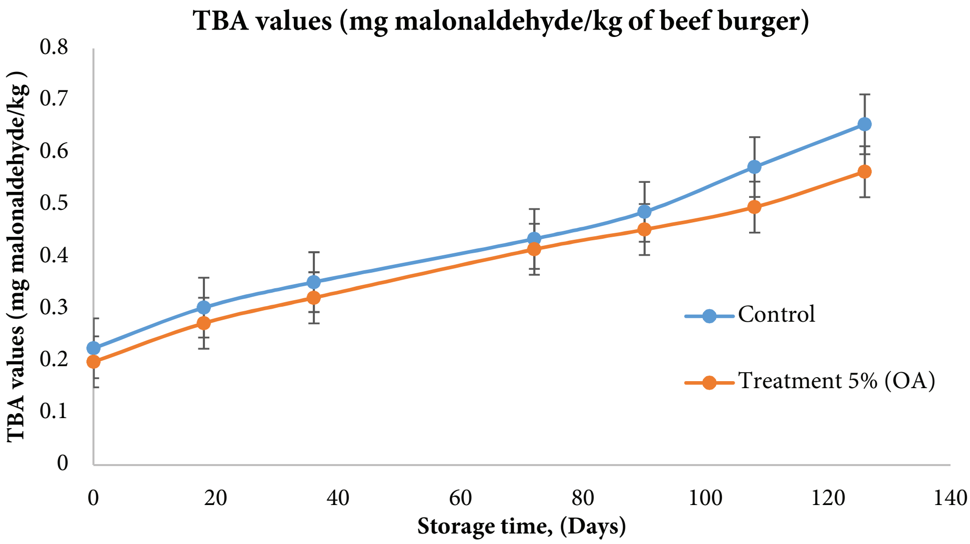

Figure 2. Thiobarbituric values (TBA) during the storage at –18 °C for 126 days (mg malonaldehyde/kg)

Microbiological analysis

Microbiological analysis of samples of burger patties during 126 days of storage at minus18 °C presented in Table 4. Results showed that after 4 months of storage, there is an increase in the total number of microorganisms in both samples. During further storage, there is a slight increase in mesophilic aerobic and facultative anaerobic counts in samples of cutlets for the control Burger. Thus, mesophilic aerobic and facultative anaerobic counts in sample prepared with the (OA) increased to $5{,}0*10^6$ CFU/g, during 108 days of storage.

Table 4. Microbiological analysis of frozen minced meat semi-finished products (Burger patties, at minus 18 °C) for 126 days

Microbiological indicators, day	Control	Treatment 5% (OA)
Total plate count CFU/g, no more than $5*10^6$		
0	$2.2*10^{3a}$	$2.1*10^{3b}$
18	$2.6*10^{4a}$	$2.3*10^{4b}$
36	$4.9*10^{5a}$	$4.5*10^{5b}$
72	$3.7*10^{6a}$	$3.2*10^{6b}$
90	$4.9*10^{6a}$	$4.3*10^{6b}$
108	$5.3*10^{6a}$	$5.0*10^{6b}$
126	$6.1*10^{6a}$	$5.4*10^{6b}$
Mold and yeast CFU/g, no more than 500		
0	61^a	54^b
18	114^a	86^b
36	156^a	144^b
72	198^a	189^b
90	236^a	213^b
108	262^a	245^b
126	286^a	264^b

* Letters a, b, c indicated to the significant differences among various treatments ($p \le 0.05$).

In the control sample, the increase to $4.9*10^6$ cfu/g occurred after only 90 days. Pathogenic organisms, including *Salmonella* bacteria, enteropathogenic Escherichia in the samples of burger and control after storage were not detected. According to the obtained data, it can be concluded that the use of (OA) instead of animal fat increased the shelf life of the frozen product by 18 days, compared to the control sample, which means an increase in the shelf life by 20%. The results of microbiological studies indicated that the control and experimental samples of cutlets were free of pathogens including bacteria of the genus *Salmonella*, enteropathogenic, and acute intestinal infections. Also, *Escherichia coli* and *Staphylococcus* bacteria were not detected during the entire storage period.

Organoleptic analysis

From the point of view of consumers, organoleptic analysis is commonly the ultimate guide to assessment the quality of the products. Therefore, organoleptic analysis conducted in order to assess the color, odor, taste, texture and overall acceptability of cooked samples of control and treatment produced with the (OA). Data presented in Figure 3, reveals that in taste of control samples and treatment there a difference was noticed. The analysis of the obtained data shows that the use of (OA) has a positive effect on all organoleptic indicators. Improvement of organoleptic characteristics such as texture and taste vary in the range of 0.1–0.2 points. The improvement in overall acceptability in relation to the control sample is 0.2 points.

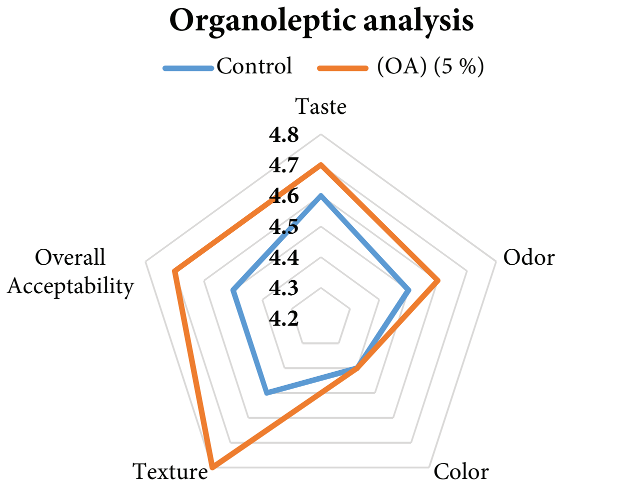

Figure 3. Organoleptic analysis of control and treated beef burger

Conclusion

The use of orange albedo (OA) as a functional additive has a major impact on the quality attributes and storage stability of beef burgers. Furthermore, the use of the OA would increase the fiber content, which is a supplementary nutritional advantage for the customers if an enhancement in dietary fiber is usually recommended. Orange albedo could be beneficial to some of the producers of meat products as a less expensive alternative to conventional meat additives.

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