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Quality and Acceptability of Value-Added Beef Burger

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Abstract: The sensory quality attributes of coated anduncoated beef burger patties formulated with texture soy granules or vegetables (peas andcarrots) were studied in comparison to that of the control. In corporation of textured soy significantly reduced the color, marbling, appearance, flavor, tenderness, juiciness, taste andoverall acceptability in comparison with either control or vegetable extended burgers. Addition of peas andcarrots to uncoated burger significantly reduced the binding scores in raw samples, as well as flavor andjuiciness in cooked samples, however, no significant differences could be observed in the other sensory attributes in both raw andcooked products. Vegetable extended burger had the highest cooking loss percent (20.14), followed by control samples (17.83), while soy extended product had the lowest value (15.82%). Application of batter andbreading to vegetable extended burger significantly improved the investigated sensory parameters in comparison with the uncoated samples. On the other hand, application of batter andbreading to soy extended burger revealed no improvement in the sensory quality attributes in both raw andcooked samples. Addition of soy granules andvegetables significantly increased the moisture, ash andcarbohydrate andreduced the fat content of raw burger patties. Moreover the incorporation of textured soy significantly increased the protein content.

Key words: Beef burger · Textured soy · Green peas · Carrots · Sensory quality · Chemical analysis · Energy

INTRODUCTION

The retail sale of beef-burger is a big business. High meat prices prompted the meat producers in Egypt to produce various meat brands extended with non-meat ingredients. However, maintaining the nutritional contribution, organoleptic andtextural properties of such products is a matter of challenge, which necessitates more effort to protect the product integrity, taste, flavuor andtextural sensory attributes [1, 2]. Most of the meat products are rich in fats, but deficient in complex carbohydrates [3]. High animal fat content, saturated fatty acids andcholesterol of various meat products are associated with cardiovascular diseases [4], some types of cancer [5] andobesity [6,7]. To achieve healthy meat products, it is recommended to reduce high fat content to appropriate limits Andincrease the levels of other substances with beneficial properties [8, 9].

Vegetable products [10, 11] andsoy bean [12 - 17] are added to raw or cooked meat products to improve its functional properties, minimize the product cost andimproving or at least maintaining nutritional andsensory qualities of end products that consumers expect [18]. Soy protein is one of the most widely used vegetable proteins in meat industry due to its various technological benefits, whereas it plays a significant role in the modification of the functional characteristics of meat products. It can also be used to replace part of the animal fat. With its hydrating capacity, soy protein can considerably decrease the final cost of the meat products. Despite the many advantages of soybean, its use has been limited because of the characteristic beany flavour [19]. Green vegetables occupy an important role in human nutrition as they provide essential minerals andvitamins [20]. Vegetables could also serve as fillers, binders, fat replacers andsources of dietary fiber andnatural antioxidants in a meat system [21]. Moreover, extension of meat products with green vegetables could reduce production costs andimprove the nutritional qualities of the products.

Meat industry is in continuous updating to improve eating quality characteristics, desirability, value Andpalatability attributes which are the major determinants of consumer acceptance andpreference. In this respect, many efforts have been made to

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improve the quality andstability of burgers to meet the consumer demands. However, to date, there are no vegetable-extended burgers on the commercial Egyptian markets. Therefore, the objective of this research was to develop vegetable-based beef burger andto maintain the sensory andchemical characteristics of this burger.

MATERIAL AND METHODS

Experimental Design: Three trial-based experiments were designed to evaluate the quality of coated anduncoated beef burger formulated with textured soy protein andvegetables (peas andcarrots) in comparison with the control one. Three different meat mixes (30 kg each) were produced, the 1st meat mix (control) was prepared with 65% lean beef and20% beef fat, 1.8% sodium chloride, 0.3% polyphosphate, 3% bread crumb, 5% iced water and 0.5% spices. The second mix was prepared with replacement of 20% of the meat mass with hydrated soy Andthe third mix was prepared with replacement of 20% of the meat with the vegetables. After forming of the burger patties, half of each trial was coated with batter andbreading Andthe other half left uncoated.

Preparation of the Materials: Imported deep frozen beef chuck was purchased from a local store during the 1st third of its shelf life (9 month). Local beef fat was purchased from the Cairo abattoir shortly after preparation of beef carcasses, washed andkept frozen. The lean meat materials were ground through a 6 mm plate, while the fat radicals were ground through a 4 mm plate. The soy granules were purchased from a local supplier, then soaked with twice its weight water andkept in the refrigerator for the second day, whereas it was minced using 3 mm plate before use. Small pieces of peeled carrots and green bean were boiled for 15 minutes, cooled andkept frozen.

The dry batter mix used for application of batter andbreading was formulated with 73% wheat flour, 24% maze starch, 2% salt and 0.5% spices. All dry ingredients were mixed at low speed for 1 minute in a stainless steel bowl mixer. Dry ingredients were then re-hydrated with water at a rate of 1:1 for two minutes, cooled to 10°C in a refrigerator Andthen stored in an ice bath till use to maintain the temperature during batter application.

Burger Production: For the production of control samples, the ground beef was first mixed in a paddle-type mixer with sodium chloride, polyphosphates Andspices for short time before iced water is added Andthen fat is mixed for short time before bread crumbs is added, with the temperature of the final meat mix must not exceed -5°C. The meat mix was then formed into discs of 100g, kept frozen at -18°C Andused as control. For the production of beef burger extended with soy or vegetables, the ground beef was mixed with the recommended amount of rehydrated textured soy or vegetables before mixing with other ingredients.

The produced burger patties from each group were divided into two parts, the 1st part was kept uncoated at -18°C. The second part was coated with batter andbreading. Where, the burger discs were pre-dusted with wheat flour, dipped into liquid batter (10°C) for 15 seconds, drained for 5 seconds andcoated with bread crump. The burger discs were weighed again to determine the coated mass (batter uptake). Coated burger was flash fried using sunflower oil at 170°C for 30 seconds. The flash fried burger discs were cooled Andkept frozen at -18°C till examination.

Investigations

Sensory Evaluation Andcooking Loss: Three samples from each of the uncoated beef burger patties were coded with random numbers andevaluated by 15 member from the Department of Food Hygiene andControl, Faculty of Veterinary Medicine, Cairo University with past experiences in examination of meat products. The samples were evaluated for forming, binding, color, marbling, appearance andoverall acceptability using 10-point descriptive scales, where 1 for extremely poor and10 for excellent. The beef burger patties were then cooked in a preheated electrical grill for a total of 5 minutes, 2.5 minutes on each side (70°C core temperature) before being coded andevaluated by the same sensory evaluation team for bite, tenderness, flavor, juiciness, taste, binding, shape andoverall acceptability.

The batter andbreaded beef burger was evaluated by the same sensory evaluation team before cooking for color andadhesion of burger coat, texture, hardness andoverall acceptability Andimmediately after deep-fat frying (70°C core temperature) for evaluation of bite, tenderness, flavor, juiciness, taste, binding, shape Andoverall acceptability. Moreover, breading crumbs that collected after frying were weighted andthe percentage of breading loss was determined as a percentage of the original weight of the coated product [22]. The weight of beef patties was measured at room temperature before andafter cooking to determine cooking loss.

Proximate Composition Andenergy Value: Three samples from each experiment were homogenized thoroughly two times before being sampled for chemical analysis. Moisture, ether-extractable fat, protein andash contents were determined by the standard procedure of AOAC [23]. Carbohydrate contents were calculated by difference. Total energy estimates(kcal) for raw andcooked beef patties were calculated on the basis of a 100 g sample using Atwater values for fat (9 kcal/g), protein (4.02 kcal/g) andcarbohydrate (3.87 kcal/g) [24].

Statistical Analysis: The values given in each treatment category are the mean values for three replicates. All data were analyzed using Statistical Analysis System (SAS) [25]. Comparisons between treatments within each analysis were tested. Significance was determined by the F-test andleast square means procedure. Main effects were considered significance at $P \leq 0.05$.

RESULTS ANDDISCUSSION

Sensory Quality of Uncoated Beef Burger Patties

Raw Samples: Vegetable-extended burger showed significant lower ($p \leq 0.05$) binding scores than the control andsoy extended burger. While no significant difference in other sensory scores of forming, color, marbling, appearance Andoverall acceptability between control andvegetable extended raw burger patties could be established.

Incorporation of texture soy granules in burger formulation significantly reduce ($p \leq 0.05$) sensory scores of color, marbling, appearance andoverall acceptability than either that of control or vegetable extended burger without detrimental effect on forming andbinding characteristics of the product (Table 1).

Cooked Samples: Cooked burger patties extended with soy showed significantly lower ($p \leq 0.05$) scores for all the examined sensory parameters except binding than control andvegetable extended burger. Meanwhile, no significant difference was established among the control andvegetable extended burger patties. The obtained results were in agreement with those reported by Brewer *et al.* andBilek andTurhan [26, 27].

Soybean is a highly nutritious food material. It plays an important role in human nutrition andhealth [28]. It is used extensively in meat products as a binder for improving yields, as a gelling agent to enhance emulsion stability andas a meat replacement to reduce costs [29, 30].

Table 1: Sensory evaluation of raw andcooked beef burger patties

	Control	Soy-extended	Vegetable-extended
Raw product			
Forming	9.33^{a}	9.33^{a}	9.00^{a}
Binding	9.67^{a}	9.67^{a}	9.00^{b}
Colour	9.67^{a}	8.00^{b}	9.67^{a}
Marbling	9.67^{a}	7.00^{b}	9.00^{a}
Appearance	9.67^{a}	7.00^{b}	10.00^{a}
Overall acceptability	9.05^{a}	8.00^{b}	9.22^{a}
Cooked product			
Bite	8.67^{a}	7.33^{b}	8.67^{a}
Tenderness	8.67^{a}	6.17^{b}	8.33^{a}
Flavour	9.33^{a}	6.00^{b}	7.33^{c}
Juiciness	9.17^{a}	7.00^{b}	8.33^{c}
Taste	8.33^{a}	6.00^{b}	7.67^{c}
Binding	8.33^{a}	8.00^{a}	8.33^{a}
Shape	8.67^{a}	7.00^{b}	8.33^{a}
Overall acceptability	8.67^{a}	6.50^{b}	8.33^{a}
Cooking loss%	17.83^{a}	15.82^{b}	20.14^{c}

a-c: Means with different superscript within the same row differ significantly at $P \leq 0.05$.

The lower sensory scores of flavor in both soy-andvegetable extended burger may be due to decrease in fat content and/or the beany flavor detected by the panelists in the soy-extended burger [19, 31]. In this regard, Singh *et al.* [32] reported that addition of texture soy protein significantly reduced acceptability of goat meat patties in a dose dependent manner. Moreover, Brewer et al. [26] and King *et al.* [33] pointed out that the addition of soy extenders decreased beefy flavor andincreased off flavor scores in ground beef patties.

The control samples had significantly high ($p \leq 0.05$) cooking loss percent probably due to the higher loss of fat during cooking [27]. The cooking loss significantly increased with the use of vegetables extended burger probably due to its lower ability to hold the moisture in the meat matrix [34], whereas, soy-formulated burger had the lowest cooking loss percent due to its ability to hold up water and fat during cooking. Serdaroglu *et al.* [10] reported a possible connection between increased cooking yield andhigher fat retention. Keeping fat within the meat batter during processing is necessary to ensure sensory quality andacceptability. These results supported the findings of Turhan et al. [35] in meat burgers containing hazelnut pellicle andTurhan *et al.* [11] in beef patties formulated with wet okra.

Generally, the sensory quality of beef burger was adversely affected with the use of non-meat ingredients.

Table 2. Sensory evaluation of raw andcooked coated burger patties

	Control	Soy-extended	Vegetable-extended
Raw product			
Color of coat	8.33[a]	8.13[a]	8.67[b]
Adhesion	9.00[a]	9.33[b]	8.00[c]
Texture	8.67[a]	7.00[b]	8.33[c]
Hardness	3.33[a]	7.00[b]	3.13[a]
Overall acceptability	8.67[a]	7.13[b]	8.00[a]
Cooked product			
Bite	8.33[a]	7.33[b]	8.67[a]
Tenderness	9.00[a]	6.33[b]	8.67[a]
Flavor	9.16[a]	6.00[b]	9.00[a]
Juiciness	9.67[a]	7.16[b]	9.33[a]
Taste	8.33[a]	6.33[b]	8.00[a]
Shape	8.00[a]	7.67[a]	8.33[a]
Binding	7.33[a]	7.00[a]	7.00[a]
Crispiness	7.00[a]	7.67[b]	7.00[a]
Overall acceptability	8.33[a]	7.00[b]	8.33[a]
Crumb loss%	1.00[a]	0.50[b]	2.50[c]
Cooking loss%	7.70[a]	3.26[b]	7.11[c]
Batter uptake %	28.82[a]	29.74[a]	25.93[b]

[a-c:] Means with different superscript within the same row differ significantly at $P \leq 0.05$.

However, the detrimental effect of vegetable is lower than that of soy granules. A limited number of studies had been conducted on the suitability of vegetables for use in comminuted meat products. Muller andRedden [34] reported a decrease in fat andcooking loss due to addition of culinary beans in ground beef patties. However, Pizzocaro *et al.* [36] claimed that addition of 2% carrot and10% spinach improved the oxidative stability of poultry hamburgers. Improvement in color andof beef patties due to the addition of boiled carrot andsweet potato have also been reported [37]. Moreover, Bilek andTurhan [27] reported that the addition of flaxseed flour significantly affected the appearance, flavor, tenderness, juiciness andoverall acceptability of beef patties. On the other hand, the sensory scores of beef patties decreased as the flaxseed content increased. Turhan *et al.* [35] found that the overall acceptability scores of beef burgers decreased after more than 1-2% hazelnut pellicle addition.

Meat consumers can readily distinguish characteristics of raw andcooked meat andmeat products that they prefer. Colour measurement is a critical objective quality parameter that can be used for quality index measurements of quality of the meat products as well as quality changes as a result of processing, storage Andother factors [38]. Aroma andflavour are probably the most I mportant attributes that influence the sensory properties of comminuted meat products extended with nonmeat protein additives. Brewer *et al.* [26] reported that soy extenders decreased beefy flavour andincreased off-flavour scores.

Sensory Quality of Coated Beef Burger Patties

Raw Samples: The results given in Table 2 indicated that the application of batter andbreading significantly increased ($p \leq 0.05$) the weight of beef burger patties by 28.82, 29.74 and 25.93% for control, soy- andvegetable-extended burger. Moreover, the application of batter andbreading slightly lower the colour score in all the treatment, with vegetable extended burger had the highest score probably due to the color of green bean andcarrots.

The differences in formulation of beef burger patties induced significant differences in all the investigated sensory characteristics. The control andsoy-extended burger had higher adhesion scores, while the vegetable-extended had the lowest value probably due to the bad adhesion between the vegetables andthe coat. Moreover, the soy extended product showed the highest hardness score which generally decrease the overall acceptability.

Cooked Samples: Cooking coated burger patties (deep fat frying / 70°C core temperature) resulted in significant lower ($p \leq 0.05$) cooking loss than the uncoated burger due to the fact that the coat seals the product andprevents the moisture loss. Furthermore, the significantly higher crump loss in vegetable extended burger was correlated with the low adhesion score in comparison to the high adhesion score for soy-extended burger.

Proximate Chemical Analysis of Uncoated Beef Burger Patties

Raw Samples: The data recorded in Table 3 pointed out that the moisture content of the control burger patties was 60.75% which was lower than that of soy- or vegetable extended burges. It was clear that addition of hydrated soy (2:1) andvegetables significantly increased the moisture content of raw beef patties due to its higher water content. Moreover, the fat content of raw control was within the acceptable technological levels (20%). However, addition of peas andcarrots significantly reduced the fat content of raw beef burger patties to 12.6%, attributable to the low fat content of the added vegetables andthe elimination of the added beef fat. The addition of textured soy also reduced the fat significantly to 14.9%. The protein content of the control was significantly lower that of soy-extended burger, probably due to the high protein content of textured soy (40-45%).

Table 3: Proximate chemical composition andtotal energy of coated anduncoated beef burger patties

	Control		Soy formulated		Vegetable formulated	
	Uncoated	Coated	Uncoated	Coated	Uncoated	Coated
Uncooked product						
Moisture	60.75[a]	60.32[a]	61.80[b]	60.50[c]	61.56[b]	60.20[c]
Fat	20.00[a]	20.50[a]	14.90[b]	16.00[c]	12.60[d]	14.50[d]
Protein	14.95[a]	13.50[b]	15.73[c]	15.09[c]	14.50[a]	14.30[a]
Ash	2.50[a]	3.36[b]	3.50[b]	4.00[c]	5.42[d]	4.90[e]
Carbohydrates	1.81[a]	2.32[b]	4.07[c]	4.41[c]	5.92[d]	6.10[e]
Energy(Kcal/100g)	247.10[a]	247.74[a]	212.98[b]	221.73[c]	194.60[d]	211.60[b]
Cooked product						
Moisture	54.91[a]	52.48[b]	55.80[a]	47.60[c]	54.80[a]	54.90[a]
Fat	22.34[a]	24.90[b]	18.40[c]	26.50[d]	17.00[e]	17.75[e]
Protein	18.45[a]	17.32[a]	19.20[b]	19.00[a,b]	18.70[a]	18.50[a]
Ash	3.50[a]	4.00[a]	4.50[a]	4.60[a]	6.50[b]	5.65[b]
Carbohydrates	0.80[a]	1.30[b]	2.10[b]	2.30[c]	3.00[c]	3.20[c]
Energy(Kcal/100g)	278.33[a]	298.76[b]	250.91[c]	323.76[d]	236.97[e]	246.50[c]

[a-e:] Means with different superscript within the same row differ significantly at $P \leq 0.05$.

The protein content in raw beef patties with added vegetables was slightly lower than the control due to the decrease in red meat content. Tömek *et al.* [39]andKaya andGökalp [40] reported similar results regarding the increased protein content of meat products extended with textured soy. Meanwhile, ash andcarbohydrate contents of raw beef patties were significantly increased by the addition of both textured soy andvegetables. Similar findings were reported by Bilek andTurhan [27].

Cooked Samples: Cooking of the studied burger patties proved that there was about 5-7% less moisture, 2.34-4.4% higher fat, 3.5-4% higher protein, 1% higher ash And1-3% lower carbohydrates depending on the formulation used in production of burger patties. Modi *et al.* [41] reported that frying resulted in about 10% less moisture, 1-2% higher protein and0.4-1.2% higher ash content irrespective of binders.

Proximate Chemical Analysis of Coated Burger

Raw Samples: The proximate chemical analysis andenergy value of coated burger (Table 3) proved that the moisture content of control coated beef burger (60.32%) was lower than either soy (61.5%) or vegetable extended (61.56%) burgers. Such finding could be safely correlated to the deep fat frying, which also caused a concomitant increase in fat content of coated burger. The application of batter andbreading resulted in a significant decrease ($p=0.05$) in protein content Andincrease in ash andcarbohydrates contents due to the batter uptake. Moreover, the higher energy value of coated burger was probably due to oil absorption by the coating materials during deep-fat frying.

Cooked Samples: Frying the coated control andvegetable extended burger resulted in decrease in Moisture(6-7.8%) andcarbohydrate (1-2.9%), as well as increase in fat (4.25-4.4%), protein (3.8-4.2%) Andash (0.6-0.75%). Kolar *et al*. [43] correlated the significant increase in fat content of soy-extended burger after deep fat frying with the high fat binding capacity of soy proteins. Deep-fat frying of coated beef burger with subsequent fat absorption significantly increase the energy value, whereas the most pronounced value was that of soy-extended burger, while the vegetable extended burger was slightly affected.

Energy Value (Kcal/100g) of Coated Anduncoated Beef Burger Patties: The significantly higher energy value of the control burger than that of either soy- or vegetable extended beef burger could be attributed to it's formulation with 20% beef fat andto the fact that fats provide more than twice energy than that supplied by proteins or carbohydrates [42]. It is of interest to emphasize that cooking significantly increased the energy value of all types of burger patties. The highest energy value was observed in the control burger, while that of vegetable extended one was the lowest. Bilek andTurhan [27] attributed the high energy value in cooked beef patties to the reduction in moisture content during cooking.

In conclusion, vegetable as carrot andpeas can be partially substituted fat andmeat in production of beef burger patties to change the bad fast food concept andproved healthier food for consumer without detrimental effect on the sensory attributes of the product. Moreover, application of butter andbread improved the sensory quality of the burger patties especially that produced with vegetable.

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