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QUALITY ATTRIBUTES OF LOW – FAT BEEF BURGERS FORMULATED WITH CHICKPEA FLOUR

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ABSTRACT

This study was carried out to prepare low – fat beef burger by partial replacement (2.5, 5, 7.5 and 10%) chickpea flour as fat replacer. Beef burgers were organoleptically evaluated. Also physical properties, gross chemical composition and caloric value were determined. A biological assay on rats was conducted to determine the effect of low fat beef burger diets on feeding and growth parameters and serum lipid profile. Sensory evaluation indicate that no significant differences ($P \leq 0.05$) were found among replacement treatments and control sample. Hardness and juiciness of beef burgers showed nonsignificantly differences ($P \leq 0.05$) among control and replace samples. Non significant differences ($P \leq 0.05$) were also observed among control and all replacement levels considering acceptability. The texture analysis cleared that no significant differences ($P \leq 0.05$) among control and chickpea treatments at. The results of gross chemical composition and caloric value showed a significant decreases ($P \leq 0.05$) in fat content and caloric value by increasing chickpea replacement levels. The biological assay results indicated that the body weight gain and feed intake of rats were significantly ($P \leq 0.05$) affected by chickpea replacement, while, feed efficiency ratio values of rats were not significantly ($P \leq 0.05$) affected by fat replacement. Total cholesterol (TC), triglycerides (TG), and low density lipoprotein cholesterol (LDL-c) of serum were significantly ($P \leq 0.05$) decreased by replacement at ratio of 2.5, 5, 7.5 and 10 by chickpea flour. Calculated atherogenic, index was significantly decreased ($P \leq 0.05$) by fat replacement at all ratios using chickpea flour.

Keywords: Beef burger, chickpea and serum lipid profile.

INTRODUCTION

Meat and meat products show highly satiate characteristics and, in this respect, health risk from high fat intake could be avoided because these types of products could be designed to be less calorifically dense, and while remaining more highly satiating and tasty. In this way, the food industry in general , the meat and related products industry in particular, could contribute to making lives easier and more active (Higgs, 2000).

The consumption of convenience foods in the restaurants such as beef or chicken burgers is increasing now. These products should contain 20-30% of fat to give the desirable succulence and texture (Wilson *et al.*, 1981). The fat of beef burger is characterized by its high content of saturated fatty acids, and cholesterol which are associated with cardiovascular diseases (Oh *et al*., 2005)

The health and nutrition transition in Egypt has been evident for some years; thus, there has been some impetus to collect contemporary data on chronic disease prevalence and trends. Data on hypertension and diabetes have been collected fairly recently on national samples of adults. Cardiovascular disease has risen steadily as a proportionate cause of mortality for both men and women, from 5 to 39.1% for men and from 2.9 to 27.2% of deaths for women (Galal, 2002).

Egypt, and the countries of the Middle East in general, are typical of many middle income developing countries in experiencing a rapid rise in the prevalence of obesity.

Obesity in the Eastern Mediterranean Region has reached alarming levels according to the World Health Organization (Musaiger, 2004).

Chronic diseases associated with excessive fat intake including diabetes, heart diseases and obesity pose a staggering cost, particularly for developing countries and economies in transition (Johns and Eyzaguirre, 2006).

Link of fats to chronic disease is well established. Over consumption of high energy-dense foods may contribute to energy imbalance, and lead to increasing incidence and prevelance of obesity as well as the risk of chronic diseases. Fat replacers are used to provide some or all of the function properities fat while providing fewer calories than the fat being replaced. They are either fat substitutes or mimetics. Fat substitutes are lipid-like substances intended to replace fats on a one to one basis. Fat mimetics are protein or carbohydrate ingredients which function by imitating the physical, textural mouth feel and organoleptic properities of real fats (Shaltout and Youssef, 2007).

Legumes are considered excellent sources of good quality protein; they offer a partial solution of this problem (Khalil, 2006). Since legume seeds are important sources of protein, complex carbohydrates and dietary fiber in the diets, there has been a worldwide interest in searching for potential utilization of unconventional legumes. Researchers have evaluated a myriad texture modifying ingredients, such as plant proteins, gums, starches, and fiber in an effort to improve the sensory properties of low-fat ground beef (Anderson and Berry, 2000).

The aim of this research was to study the affect of a substitution of chickpea flour as a fat replacer to produce a low fat beef burgers with on qualities parameters and consumer acceptance of produced beef burger. A feeding experiments on rats were conducted to measure the biological effects including growth parameters, serum lipids profile and atherogenic index.

MATERIALS AND METHODS

MATERIALS

Local chickpea seeds (*Ciceraríetinum* L.) were purchased from the local market (Gharbiya Governorate, Egypt). Fresh lean beef and kidney fat were obtained from the slaughterhouse in Tanta,Egypt. Sodium tripolyphosphate and ascorbic acid were purchased from El-Gomhoria Co. Trading in Medicines, Chemicals and Medical Appliances, Tanta, Egypt. Other ingredients were obtained from local market in Tanta, Egypt. Male albino rats (Sprague Dawley) weighing 100-110g, were obtained from Agricultral Research Center, Giza, Egypt. Kits used in the determination of total serum cholesterol(TC), highdensity lipoprotein cholesterol (HDL-c) and serum triglycerides (TG) were obtained from Algomhoria Co. for trading in Medicines, chemicals and Medical Appliances.

METHODS

Preparation of chickpea flour:

Chickpea seeds were soaked in distilled water (1:10, w/v) at room temperature (_25 ºC) for 12hr. drained and rinsed three times with 600mL distilled water, then cooked by this method described below:

Boiling: The rinsed soaked seeds were cooked in boil water (100 ºC) in the ratio of 1:10 (w/v) on a hot plate until they became soft where felt between the fingers (90 min).

Drying: The cooked seeds were dried in an electric air draught oven (VEB MLW Medizinische,Gerate,Berlin,Germany) at 50 ºC for 20 h. Chickpea seeds were ground in an electric mill equipped with stainless steel blades (Braun, Model 1021, Germany) to pass through a 60 mesh (British standard screen) nylon sieve (Saleh and Tarek, 2006).

Preparation of beef burgers:

The lean beef and kidney fat sources were separately minced in meat grinder (Moulinex 505, France). Fat content of the lean and fat portions were determined prior to the manufacture of beef burgers. The lean beef (4% fat), kidney fat (90% fat), chickpea flour and water were used to formulate the beef burgers (Table 1).The control beef burger was formulated to contain 65% lean beef, 20% kidney fat 10% water and 5% salts and spices mixtures. Different levels of kidney fat (2.5,5,7.5,10%) were replaced by equal amounts of chickpea flour. Appropriate amounts of each formulation were mixed by hand, subjected to final grinding (0.5 cm plate) and processed into beef burgers (100 g weight, 1.2 cm thick and 10 cm diameter). Beef burgers were placed on plastic foam meat trays, wrapped with polyethylene film and kept frozen at -18°C until use analysis Frozen beef burgers were cooked in a preheated (148ºC) electric oven (VEN MLW Medizinische, Greate, Berlin, Germany) which was standardized for temperature. Beef burgers were cooked 6 minutes, turned over, cooked 6 minutes, turned again and cooked 4 minutes .Cooked beef burger was dried in electric oven at 20 ºC hours cooled, ground and kept in polyethylene bags until further chemical analysis **(**Ali *et al.,* 2011).

Table (1): **Beef burgers formulation containing chickpea**

Fat replacers (chickpea powder)(g)	Lean beef (g)	Kidney fat (g)	Water (g)	Salts and * Spices mixture (g)
control	65	20	10	5
2.5	65	17.5	10	5
5	65	15	10	5
7.5	65	12.5	10	5
10	65	10	10	5

***All treatments were formulated with 2g salt, 1.5g spices mixture, 1g sugar ,0.2g sodium tripolyphosphat, 0.3g ascorbic acid.**

Sensory evaluation:

Sensory evaluation of beef burgers was performed by fifteen staff members of Home Economics Dept. Faculty of Specific Education, Kafr Elsheikh. University. Panelists were instructed to evaluate colour, texture, taste, flovour, odour, hardness, juiciness and overall acceptability. Different attributes were evaluated on 5 point scale, each attribute was discussed and tests were initiated after panelists were familiarized with scales (Ahmed *et al.,* 199٠).

Physical properties

1-Water holding capacity (WHC):

Press technique was used to measure the water holding capacity of raw beef burgers **(Tsai and Ockerman, 1981)**. Raw beef burger (0.5 g) was placed on filter paper (Whatman No. 1, stored over night in saturated KCl) which was placed between two glass sheets and pressed for 20 min by a 1 kg weight. The area of free water was measured using a compensating polar planimeter and the WHC was calculated as follows:

Free water (%) = (Total surface area - meat film area, mm) (6.11) / (Total moisture (mg) in meat sample) × 100

WHC (%) = 100- free water.

2-Cooking loss:

Cooking loss value was determined by calculating the weight differences of three burgers before and after cooking using following equation (Crehan *et al.,* 2000).

$$\text{Cooking loss (\%)} = \frac{\text{Weight before cooking} - \text{Weight after cooking}}{\text{(Weight before cooking)}} \times 100$$

3-Cooking yield

Burgers after cooking were cooled to 21°C for 1 h and blotted before weighing. Samples were weighted before and after cooking. To estimate the amount of fat and moisture retained in the samples, the following calculations were performed according to Aleson *et al.,* (2004).

$$\text{Cooking yield \%} = \frac{\text{[cooked weight (g)]}}{\text{raw weight (g)}} \times 100$$

4-Shrinkage measuring:

Samples areas were measured before and after cooking (A1, A2) respectively, and shrinkage was calculated according to the method of El-Akary (1986) as follows:

$$\text{Shrinkage \%} = \frac{A1 - A2}{A1} \times 100$$

5-Feeder value

Feeder value was determined according to the method described by **Person (1976)** using the following equation:

Feeder value = % water / % organic non fat

Where: %organic nonfat = 100 – (%fat + %ash+ %moisture)

Chemical composition and caloric value

Moisture, ash, protein, fat and fiber contents were determined in dried burgers according to A.O.A.C. (1995). Carbohydrates content were calculated by difference. Caloric value was calculated from the sum of the percentages of crude protein and total carbohydrates multiplied by a factor of 4 (kcal.g-1) plus the crude fat content multiplied by 9 (kcal.g-1), according to Zambrano *etal.,* (2004)

Biological assay

Male albino rats of Sprague Dawely strain (n=4), weighing (100-110g) were kept under hygienic conditions for one week acclimatization period. Rats fed on a basal casein diet according to Reeves *et al.,* (1993), the water was supplied a dlibitum.

Hypercholesterolemic rats

Normal rats fed on a special diet for inducing hypercholesterolemia; the diets were prepared from fine ingredients per 100g according to **Rashwan (1998).** Hypercholesterolemic diets practiced as the following composition:

Rat groups fed a basal diet consisted of protein (12%), sucrose (10%), vitamin mixture (1%), mineral mixture (4%), corn oil (50%), DL-methionine (0.3%), neutral casein 16.28g, cholesterol powder (1.5%) and corn starch up to 100% according to **Campbell (1963).**

After the adaptation period, rats were divided in to 7 experimental groups (4 rats each) and preliminary body weights were initially recorded and the **experiment was conducted as follows:**

Group (1): Rats fed on basal diet negative control.

Group (2): Rats fed on hypercholesterolemia diet positive control.

Group (3): Rats fed on full fat beef burger (control).

Group(4): Rats fed on beef burger prepared with reduction 2.5% of fat by chickpea flour.

Group(5): Rats fed on beef burger prepared with reduction 5% of fat by chickpea flour.

Group(6): Rats fed on beef burger prepared with reduction 7.5%of fat by chickpea flour.

Group(7): Rats fed on beef burger prepared with reduction 10% of fat by chickpea flour.

Each diet was prepared to give equal nutritional value as control casein diet .Rats were weekly weighted through the feeding period which lasted for (42 days) feed intake, body weight gain (BWG) and feed efficiency ratio (FER) were calculated at the end of experiment according to Chapman *et al.,* (1959).

BWG= Final weight –Initial weight

FER= Body weight gain (g/day) / Feed intake (g/day)

At the end of experimental period, the rats were weighed the animals were fasted overnight (12h) anesthetized with diethyl ether and saccrified. Blood samples were collected from the inner canthus of the eye according to the technique of Sanford (1954). The first blood sample (one ml) was collected in a dry clean tube containing heparin as anticoagulant and used for hematological parameters. The second blood sample (5 ml)were drawn and left to clot in a clean dry test tube , then centrifuged at 3000 rpm for 20 minutes to separate serum which kept at -20 ºC for biochemical analysis.

Biological analysis of serum.

Triglycerides (TG), Total cholesterol and High Density lipoprotein cholesterol (HDL-cholesterol) were determined in serum as described by Fossati and Prencipe, (1982), Allian *et al.,* (1974) and Lopez- Virella *et al.,* (1977), respectively Low density lipoprotein cholesterol (LDL-cholesterol) concentrations were calculated as described by Wardlaw and Snook (1990) as following:

LDL-cholesterol= Total cholesterol - HDL–cholesterol-(Triglyceride/5).

Atherogenic index was calculated using the following equation as described by Kawase *etal.,* (2000). Atherogenic index= (Total cholesterol- HDL–cholestrol)/ HDL-cholestrol.

Statistical Analysis:

All the obtained data were statistically analyzed by SPSS computer soft ware according to (Abo- Allam, 2003).

RESULTS AND DISCUSSION

Sensory evaluation of beef burgers formulated by chickpea flour as a fat replacers

Table (2): Sensory evaluation of low fat beef burgers formulated by chickpea powder as a fat replacers.

Treatments	Colour	Texture	Taste	Flavour	Odour	Hardness	Juiciness	Overall acceptability
Beef burger (Control)	2.86 abc ±0.91	3.06 ab ±0.70	2.86 ab ±1.40	3.06 ab ±1.09	3.26 ab ±1.38	3.06 ab ±0.79	3.13 a ±1.30	3.26 a ±1.03
Beef burger With 2.5% Chickpea	2.96 bc ±1.18	2.33 bc ±0.97	2.86 ab ±1.59	2.53 b ±1.40	2.33 bc ±1.34	2.46 ab ±1.18	2.60 ab ±0.98	2.60 ab ±1.29
Beef burger With 5% Chickpea	3.00 abc ±0.92	2.86 ab ±1.12	2.60 ab ±1.50	2.46 b ±1.30	2.33 bc ±1.34	2.40 b ±0.82	2.73 ab ±1.33	2.53 ab ±1.24
Beef burger With 7.5% Chickpea	2.37 abc ±0.70	2.80 ab ±1.08	2.13 b ±1.30	2.46 b ±1.45	2.06 c ±1.09	2.33 b ±1.17	2.33 ab ±0.97	2.26 b ±1.09
Beef burger With 10% Chickpea	2.90 c ±1.35	2.00 c ±1.13	2.06 b ±1.33	2.20 b ±1.26	2.00 c ±1.13	2.20 b ±1.37	2.06 b ±1.38	2.60 ab ±1.40

Values are average ±SD of three replicates.
Values in the same column with the same letter are not significantly different at p≤0.05.

The results of the sensory evaluation shown in Table (2), indicate that control beef burger had the highest value in texture, taste, flavour, odour, hardness, juiciness and overall acceptability. Concerning colour score, it was ranged from 2.37 to 3.00; the highest value was recorded in beef burger with 5% chickpea (3.00). Generally, the colour showed nonsignificant difference ($p \leq 0.05$) among control and all treatments which used chickpea flour as a fat replacer. The results are in agreement with those of Ibrahim *et al.,* (2011).

Physical properties of low fat beef burgers formulated with chickpea flour:

Data in Table (3) show the physical properties of prepared beef burger with chickpea. For the water holding capacity, the high value in all samples in beef burgers with 10% chickpea (8.36%) and the lowest value of beef burgers with 2.5% chickpea powder (5.56%). The increase in water holding capacity may be due to the ability of chickpea powder to absorb and keep more of water. These results are in agreement with those of Ali *et al.,* (2011) who reported that the water holding capacity was increased significantly (p≤0.05) with increasing the levels of potato flakes .

On the other hand, considering cooking loss, the highest value was recorded to control beef burgers (31.9) but the lowest one in beef burgers with 10% chickpea (11.7). Results showed significant (p≤0.05) decrease in all samples treatments compared with control. The lower cooking loss in low fat beef burger may be attributed to higher protein and lower fat contents of low fat beef burger. These results are in agreement with those of Park *et al.,* (2005) and Choi *et al.,* (2010).

Cooking yield values of burgers with chickpea were higher than those of control sample; the highest cooking yield was obtained for burgers with 10% chickpea. It noticed that the yield values are rotated to fat and water retention; such results are confirmed with those of Aleson *et al.,* (2004).

As for shrinkage percentage, data showed significant (p≤0.05) differences between all samples and significant decrease in value of beef burger with chickpea comparing with control, where the highest value was found in control (36.80), and the lowest value was in beef burger with 10% chickpea (8.80). These results agree with those of Ali (1995) and Metwalli, (2005), they found that shrinkage value was decreased with adding soy bean hull fibers.

Table (3): Physical properties of low fat beef burgers formulated by chickpea flour as a fat replacers.

Treatments	Water- holding capacity (%)	Cooking loss (%)	Cooking Yield (%)	Shrinkage (%)	Feeder value (%)
Beef burger (Control)	5.86 d ±1.68	31.90 a ±1.52	68.1 f ± 1.00	36.80 a ±1.00	2.33 a ±0.16
Beef burger with 2.5% Chickpea	5.56 d ±1.70	21.70 c ±1.15	78.3 cd ± 1,29	26.80 b ±1.00	1.38 ab ±0.02
Beef burger with 5% Chickpea	7.65 b ±2.35	14.60 d ±2.64	85.4 b ± 2.22	14.90 g ±1.00	1.58 ab ±0.02
Beef burger with 7.5% Chickpea	6.53 c ±8.72	13,80 d ±1.86	86.2 b ± 1.70	12.90 h ±1.00	1.40 ab ±0.00
Beef burger with 10% Chickpea	8.36 a ±1.68	11.70 e ±1.56	88.3 a ± 2.09	8.80 i ±0.10	1.39 ab ±0.02

Mean values with the same letter are not significantly different (P<0.05)
All values are average of three determinations.

On the other hand, the results in the same Table (3) indicated that the feeder value recorded high values in control beef burger (2.33 %) followed by beef burger with 5% chickpea as (1.58 %). Results showed nonsignificant (p≤0.05) differences between control and all treatments with chickpea. Feeder values for all treatments, however were less than 4.0; this result indicated that certainly all treatments are of good quality according to Pearson (1991), who reported that, good quality meat products have feeder values less than 4.0.

Chemical composition of beef burgers formulated with chickpea

The results of gross chemical composition in a response of different formulation of beef burger with chickpea are presented in Table (4).

Beef burger with chickpea 5% showed the highest moisture content (8%), while beef burger with chickpea 2.5% recorded the lowest moisture content (6%). This may be attributed to the ability to bind the constitute of food and release of water Khalil (2000) reported that cooked beef patties formulated with different levels of hydrated potato flakes had significantly (p≤0.05) higher moisture content than that of control.

Table(4):Chemical composition of beef burgers* formulated by chickpea powder as a fat replacers (on dry weight bases).

Treatments	Moisture %	Ash %	Crude Fat %	Fiber %	Crude protein %	Carbohydrates %	Total caloric Values (K.cal/100gm)
Beef burger (Control)	6.30 bc ±1.00	6.37 cde ±.01	45.65 a ±1.00	4.97 a ±1.00	37.24 b ±0.01	5.77 d ± 1.00	582.89
Beef burger With 2.5% Chickpea	6.00 c ±1.00	6.77 bcd ±0.01	40.21 b ±0.01	6.31 bc ±1.00	37.29 b ±1.00	9.42 c ±0.01	548.73
Beef burger With 5% Chickpea	8.00 a ±1.00	7.33 bc ±1.00	37.05 d ±1.00	6.15 bc ±0.01	37.47 b ±0.01	12.00 b ±0.01	531.33
Beef burger With 7.5% Chickpea	6.90 abc ±0.01	9.19 a ±1.00	34.21 e ±0.58	5.55 bc ±1.00	38.31 ab ±1.00	12.74 b ±1.00	512.09
Beef burger With 10% Chickpea	7.80 ab ±1.00	10.08 a ±1.00	26.78 f ±.01	6.89 ab ±1.00	39.24 a ±0.01	17.01 a ±1.00	466.02

*** All determinations were carried out in dried beef burger at 50 ºc for 20 hrs**
Values are average ±SD of three replicates.

Regarding to ash content, data show an increase in ash content of all treatments comparing with control. These results are in agreement with those of Tornberg *et al.,* (1989).

Values in the same column with the same letter are not significantly different at p≤0.05

The expected decrease in fat contents of beef burgers as a result of chickpea levels increasement was presented in Table (4). The lowest value (26.78%) was observed in beef burger with 10% chickpea. The results showed significant (p≤ 0.05) decrease in fat contents with increasing levels of chickpea and these results are in agreement with those of Mansour (2003). Considering protein, the highest value was found in beef burgers with 10% chickpea (39.24%), and the lowest value in control beef burger (37.24 %). Results showed non significant (p≤0.05) differences between control and all treatments, except beef burger with 10% chickpea. As regards to carbohydrates, the highest levels recorded for beef burger with 10% chickpea (17.01%) and the lowest value recorded in control beef burger (5.77%), and differences were significant. Results showing significant (p≤0.05) increases in carbohydrates are in agreement with those of Tornberg *et al.,* (1989).

From the results in Table (4), it was clear that elevating chickpea level decreased the caloric value of beef burgers. The lowest values were in beef burger with 10% chickpea (466.02 K.cal/100g), this is due to low content of fat. These results are confirmed with those of El-Demery (2010) who reported that energy values of the tested beef burgers were decreased with increasing non fat materials such as orange albedo.

Biological evaluation of low – fat beef burger

The initial weight, final weight, the body weight gain (g), food intake and feed efficiency ratio of rats fed on low fat beef burger diets were estimated to follow up the healthy feed parameters during the experimental period for food daily intake as show in Table (5), it was clearly that it increased in all treated groups compared with control positive group (9.65), the highest food intake in beef burger with 10% chickpea (17.72g) and the lowest food intake in control positive groups (9.65g) comparing with negative control (13.3 g). Results showed significant ($p \leq 0.05$) different between two controls on one side and rat groups fed on all treatments with chickpea on the other side except rat groups fed on beef burger with chickpea 7.5% where no significant ($p \leq 0.05$) difference with two controls. Results indicated that initial weight non significant ($p \leq 0.05$) different between two controls and rat groups fed on all treatments with chickpea except rat groups fed on control beef burger. But significantly ($p \leq 0.05$) different between two controls and rat groups fed on all treatments with chickpea in final weight. The highest final weight was in rat groups fed on beef burger with chickpea 2.5% (149.26) compared with two controls. The results in Table (5), show that the weight gain (g) of rats ranged from 18.8(g) to 48.75 (g) for G1 to G4 and G5, while the body weight gain was decreased for the positive control (G2).

Table (5): Initial weight, final weight, body weight gain, food intake and feed efficiency ratio of rats fed on low - fat beef burgers formulated by chickpea powder as a fat replacers.

Rat groups	Initial weight (g)	Final weight (g)	Body Weight gain (BWG) %	Food intake (FI) gm	Feed efficiency Ratio (FER) %
G (1) Negative control	100.40 d ±0.10	119.20 g ±0.10	18.8 a ± 0.01	13.3 c ±1.00	1.41 a ±1.00
G (2) Positive control	100.55 d ±1.00	85.30 h ±0.10	-15.25 a ±1.00	9.65 c ±1.00	-1.58 a ±1.00
G (3) Beefburger (Control)	102.50 c ±1.00	148.00 d ±1.00	45.5 d ±1.00	16.05 b ±1.00	2.83 a ±1.00
G (4) Beefburger with 2.5 %Chickpea	100.51 d ±0.01	149.26 c ±0.01	48.75 c ±1.00	16.03 b ±1.00	2.86 a ±0.01
G (5) Beefburger with 5%Chickpea	100.44 d ±0.10	149.19 c ±1.00	48.75 c ±1.00	17.02 ab ±1.00	2.86 a ±1.00
G (6) Beefburger with 7.5%Chickpea	100.93 d ±1.00	147.93 d ±1.00	47.00 d ±1.00	16.05 c ±1.00	2.92 a ±0.01
G (7) Beefburger with 10%Chickpea	108.35 d ±1.00	142.60 f ±0.100	34.25 e ±0.01	17.72 a ±1.00	1.93 a ±1.00

Each value is an average four replicates
Negative control fed on basal diet
Positive control fed on basal diet +cholesterol
Mean values with the same letter are not significantly different (P<0.05)

The rat groups fed on beef burger with chickpea (2.5, 5%) had the highest body weight gain (48.75 g). EL-Refai *et al.,* (2011a) reported that neither fat replacer level non fat replacer type had significant effect on final weight, body weight gain (g) and feed efficiency raito of rats.

Results in Table (5) show that the food consumption was unchanged significantly in case of cholesteromic feeding, but the gain of body weight was decreased in positive control groups. Insignificant changes in food consumption were not parallel to the growth of rats as reported by Ennouri *et al .,* (2006).

It is worthy mentioning that the treated cholosteromic groups with chickpea burger resulted in observed increasing of feed efficiency ratio comparing with control positive groups (-1.58), where FER ranged between (-1.58 to 2.92). Beef burgers with 7.5% chickpea had the highest FER comparing with negative control which recorded (1.41) with being no significant different in all samples. Theses results are in agreement with those of Ennouri *et al .,* (2006) .

Serum lipid

Serum lipid profile for rats fed on basal diets, full fat beef burger diets and low fat beef burger diets at the end of experimental period are presented in Table (6). HDL-c and T.G values were not significantly affected (p≤0.05) by fat replacer levels.

Table (6): Serum lipids profile of rats fed on low fat beef burgers diets formulated by chickpea flour.

Rat groups	T.G	Cholesterol (Mg/dl)	HDL (Mg/dl)	LDL (Mg/dl)	Atherogenic index
G (1) Negative control	102.20 a ±3.84	160.50 a ±2.04	75.15 abc ±9.14	64.41 d ± 3.28	1.13 c ± 1.01
G (2) Positive control	122.27 a ±5.43	233.50 c ±3.67	57.35 c ±1.33	151.69 a ±3.21	3.07 a ± 1.10
G (3) Beef burger (control)	109 ab ±2.03	162.72 bc ±1.12	76.32 abc ±2.56	64.6 d ± 2.05	1.13 c ± 1.01
G (4) Beef burger with 2.5 %Chickpea	105.70 ab ±2.00	149.75 d ±3.27	85.40 a ±8.75	47.21 e ±2.18	0.75 e ± 0.10
G (5) Beef burger with 5 %Chickpea	103.55 ab ±3.61	170.25 b ±1.15	78.35 ab ±1.19	71.19 c ± 3.60	1.17 d ± 1.10
G (6) Beef burger with 7.5 %Chickpea	92.82 ab ±1.04	167 b ±1.72	76.07 abc ±1.33	72.37 bc ± 1.01	1.19 d ±1.01
G (7) Beef burger with 10 %Chickpea	84.65 ab ±3.80	138.50 a ±3.09	72.32 abc ±7.14	49.25 e ± 3.40	0.91 de ± 0.10

Values are the average ± SD of four replicates.
Mean values with the same letter are not significantly different (P<0.05).
T.G, Triglycerides; LDL-C, low density lipoprotein cholesterol; HDL-C, high density lipoprotein cholesterol

It was noticed from Table (5) that the highest TG content (122.27 mg/dl) was found to be in rats fed on positive control beef burgers, the lowest TG (84.65 mg/dl) was found to be in beef burger with 10% chickpea. The highest LDL –c was found to be in rat groups fed on positive control (151.69 mg/ dl). The lowest LDL-c was in rat groups fed on beef burgers with 2.5% chickpea (47.21 mg/dl) and with 10% chickpea comparing with negative and positive control.

EL-Refai *et al.*, (2011a), reported that TG, total cholesterol and LDL were significantly by fat replacers level and not affected by the fat replacer type.

On the other hand, it was clear that the highest cholesterol content was found to be in positive control rat groups (233.50 mg/dl), while beef burgers with 10% chickpea had lowest content of cholesterol (138.50 mg / dl). The addition of hydrated potato flakes as a type of carbohydrates- based fat replacers reduced the cholesterol content of beef patties (Ali *et al.,* 2011).

Feeding on hypercholesteromic diets caused pronounced decrease in HDL – C. The highest HDL-c was found to be in beef burger with 2.5% chickpea (85.40 mg / dl), followed by beef burger with 5% chickpea and control (78.35 mg/dl and 76.32 mg / dl) , respectively . The lowest HDL - c was found to be (57.35 mg / dl) in control positive. These results are in agreement with those of EL-Refai *et al .,* (2011b), who reported that beef patties fortified with mushroom had high hypercholestrolemic lowering effect on TC, TG and LDL-c .

The atherogenic index is an indicator for the susceptibility for atherosclerosis (Kawase *et al.,* 2000). Table (5) showed the atherogenic index for rats fed on basel diets, full fat and low fat beef burgers diets. These results indicated that the atherogenic index significantly ($p \leq 0.05$) decreased as a result of fat replacement.

The highest value in atherogenic index was found in positive control group as (3.07) and the lowest level in atherogenic index was found in beef burgers with 2.5% chickpea as (0.75) being nonsignificant differences comparing to that of G7 (0.91). These results are in agreement with those of Yang *et al.,* (2007).

CONCLUSION

Finally, it could be concluded that the risk of full- fat beef burgers as a rich fat foods can be minimized by replacing 2.5-10% of fat by chickpea flour without imparing the organoleptic or physical properties and corresponding consumer acceptance. Also, triglycerides (TG), total cholesterol (TC) and low density lipoprotein cholesterol (LDL-c) of serum were decreased by replacement 2.5 to 10% of chickpea flour as fat replacers.

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خصائص الجودة للبرجر المنخفض الدهن باستخدام دقيق الحمص

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أجريت هذه الدراسه لاعداد بيفبرجر منخفض الدهن باحلال جزئى بدقيق الحمص كبديل للدهن. وقد تم الآتى التقييم الحسى للبيفبرجر, تقييم الخصائص الفيزيائيه, التركيب الكيميائى والطاقه الحراريه . أجريت التجربه البيولوجيه على الفئران لتقدير تأثير منتجات البيفبرجر المنخفضه الدهن على التغذية, قياسات النمو وليبيدات الدم. أظهرت نتائج الخصائص الحسيه عدم وجود فروق معنويه بين الكنترول وباقى المعاملات. لا توجد فروق معنويه بين الكنترول وباقى المعاملات بالنسبه للعصيريه والصلابه. أيضا لم يلاحظ فروق معنويه بين الكنترول وباقى المعاملات بالنسبه للقبول العام. أوضحت النتائج أيضا عدم وجود فروق معنويه بالنسبه للقوام بين الكنترول ومنتجات بيفبرجر المضاف اليها الحمص بنسب (١٠,٧.٥,٥,٢.٥ %). أوضحت نتائج التركيب الكيميائى والطاقه , انخفاض ملحوظ فى الدهن والطاقه بزياده مستويات الحمص بدائل الدهن . نتائج التجربه البيولوجيه أظهرت أن الوزن المكتسب والطعام الممتص لفئران التجارب حدث لها تأثير ملوحظ باستخدام الحمص كبديل للدهن بينما لم يظهر أى تأثير بالنسبه لمعدل كفاءة الطعام باستخدام الحمص كبديل للدهن. حدث انخفاض ملحوظ فى كل من (الكوليسترول الكلى , الجليسريدات والليبيدات منخفضه الكثافه) بنسب الاختلاف(٥.٧.٥,٥,٢,١٠ %) من دقيق الحمص. لوحظ انخفاض فى مؤشر تصلب الشرايين .